# University of Alberta

Location and Allocation of English-Chinese Kindergartens
in the City of Edmonton

By

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# Abstract

This thesis deals with determining locations for current elementary schools offering the English-Chinese Bilingual kindergarten (ECBK) program for preschool children in Edmonton, and simultaneously optimally allocating them to new school locations. The $p$-median model generates excellent results for kindergarten locations, which to a large extent reduce the average distance from residences to schools. However, the application of the $p$-median model is based upon prior assumptions regarding constraints and target function. Therefore a survey was applied to validate the main assumptions, and to identify the reasons why parents sent their children to kindergartens as well as the factors influencing parents who are selecting ECBKs. The results indicated parents are more concerned about "quality" such as the quality of education and teacher quality rather than travel time when they select a kindergarten. The factor of travel time or transportation mode doesn't appear to significantly influence school selection.

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# Chapter 1. Introduction

The metropolitan area of Edmonton has a population of 937,845 and area of 418.62 km² (*Edmonton CMA Population, Forecast* 2005). The Municipal Census (2005) reports 712,391 people reside within Edmonton's city area. The population of children under five is 29,944 which accounts for approximately 4.2 per cent of the resident population of Edmonton. According to Census Canada 2001, the number of people who declare themselves as Chinese ethnic origin in Edmonton is 41,285, which represents 4.4% of the total population. Combing these numbers, there are an estimated 640 children between 4 and 6 years old of ethnic Chinese origin in Edmonton.

The English-Chinese Bilingual Kindergarten program was introduced at the kindergarten level in Edmonton Public Schools in 1982. The program provides the opportunity for students to learn both the English and Chinese (Mandarin) languages. This thesis is concerned with the current and future geographical distribution of English-Chinese Bilingual Kindergarten sites. Thus, the objectives of this study are:

1) To assess the effectiveness of geographical location distributions of the current 5 English-Chinese Bilingual Kindergartens with regard to the total demand weight of target population (4-6 years old Chinese children) and average travel distance from residences to schools. Specifically, I attempt to find if current 5 English-Chinese Bilingual Kindergartens are at optimal locations which have minimum total distance from residences to kindergartens according to the distribution of target population.

2) To determine the best locations from 159 Edmonton Public elementary school sites for 5 English-Chinese Bilingual Kindergartens for Chinese kindergarten children by using the $p$-median location-allocation model.

3) To validate the assumptions that the $p$-median model is based on by using an Internet survey questionnaire. Specifically, how significant is travel distance in the decision of current parents and parents considering the English-Chinese Bilingual Kindergarten Program? What are the other factors influencing parents selecting an English-Chinese Bilingual Kindergarten school?

# Chapter 2. Literature Review

## 2.1 Heritage Language Education in Canada

### 2.1.1 Ethnic Diversity and Language Diversity

Canada has always enjoyed a multi-language and multi-cultural milieu. In addition to its two official languages – English and French – there are a considerable number of native speakers of German, Spanish, Italian, Arabic, Latin and other truly foreign languages (i.e., those that are not cognate with English or French) including Russian, Japanese, Korean, and Chinese. The increasing population of speakers of heritage languages has created diverse communities and altered Canada's demographical constitution. Simultaneously, it has enriched the linguistic makeup of Canada with a large variety of foreign languages. In 2001, about 1.8 million people living in Canada were immigrants who arrived during the previous 10 years. Of these, 58% speak Asian languages (including Arabic, Chinese, Hindi, Indian, Japanese, Korean, and etc..), 20% European languages, 11% Caribbean, Central and South American languages, and 8% African languages (*Canada's Ethnocultural Portrait: the Changing Mosaic* 2003). Jedwab's (2000) study of the 1991 census revealed that in Canada, the Chinese (28%), Italian (15%) and Portuguese communities (11%) account for more than half of all Canadians who speak neither English nor French.

Canadian immigration policy as always had as its primary objective supplying a labour pool, historically for settlement and agriculture, more recently to support industrialization (Parai 1975). Through an examination of the historical development of

key institutional features of Canada's immigration policy, Green and Green (2004) also found that immigration has been used for a variety of goals, including filling open lands, providing labour, and offsetting the aging population. Canada has been a nation of immigrants since 1479, when the first European, John Cabot, landed in Newfoundland and claimed it for Britain (Kelly and Trebilcock 1998). The largest mass of immigrants landed in the 1850s, arriving mainly from Great Britain, the United States, and Northern Europe. The early immigration policy heavily restricted immigrants from other countries. Therefore, immigrants entering Canada before the 1960s were predominantly European. By the early 1960s, amendments to the Immigration Act eliminated discrimination against race, color, national origin, religion or gender as part of immigration policy and stated that "any suitably qualified person from any part of the world could be considered for immigration to Canada, without regard to his race, colour, national origin, or the country from which he comes" (*Canadian Diversity: Respecting Our Differences*). As a result of these changes, tremendous ethnic diversity occur in Canada—with more than 70 ethnic groups residing in Canada and over 100 languages spoken. Immigrants have contributed to Canada's population and labour force growth, diversified the ethnic and linguistic composition of the country and contributed valuable human resources to the economy. At the time of the 2001 census, immigrants represented the highest proportion of the population in 70 years and immigration accounted for more than two-thirds of the population growth in that year (*Canada's Ethnocultural Portrait: the Changing Mosaic* 2003). According to the 2001 census (*Population by Selected Ethnic Origins* 2005), Canada has 34 ethnic groups with at least one hundred thousand members each.

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Ancestries with more than 1 million people claiming them are English (19.2%), French (15.7%), Scottish (14%), Irish (12.9%), German (9.0%), Italian (4.3%), Chinese (3.5%), Ukrainian (3.6%), and aboriginal (North American Indian) (3.4%).

Every year, Canada's Citizenship and Immigration issues an Annual Report on Immigration, which outlines plans for the next year. For 2006, Canadian Immigration plans to admit between 225,000 and 255,000 newcomers to Canada as permanent residents in 2006 (*Canada's Immigration Plan for 2006*).

## 2.1.2 Multiculturalism Policy

Canada's federal government gradually recognized society's increasing concern about the rights of minority groups to retain their own culture and language. In 1971, Canada passed the Multiculturalism Act, which made Canada the first country in the world to adopt an official Multiculturalism Policy. This Act stated that its purpose was to encourage members of all ethnic groups in Canada to maintain and share their language and cultural heritage with other Canadians (Esses and Gardner 1996). In 1988, the "Act for the Preservation and Enhancement of Multiculturalism in Canada" was passed, which stated that one of the objectives was to "preserve and enhance the use of languages other than English or French" (*Canadian Multiculturalism Act* 1988). This Act affirmed that Canada recognized and valued its rich ethnic and racial diversity.

## 2.1.3 The Development of Bilingual Education

Language is often considered as an important symbol and tool in the formation and spread of culture. Nettle and Romaine (2000) suggested that every language is a monument to the culture it has been vehicle to. Baker (2001) declared that language lies at the heart of human education, culture and identity. When a language dies so does culture, identity and knowledge that has been passed down from generation to generation through and within that language. The increasing demands of heritage language education have been expressed by visible minority groups since the 1960s. From the perspective of various language groups, the term "heritage language" conveys the sense of attachment— people in these communities wish to express the cultural and historical aspects during learning and using these languages (Jedwab 2000). Those parents who speak English or French as a second language expect their children to retain their ethnic cultures by learning and using their heritage languages.

On the other hand, international language education is regarded as an essential component of the Canadian culture. It is also a good reflection of its culture diversity (sometimes it is used as multiculturalism). Diversity has been a fundamental characteristic of Canada. Canada's approach to diversity is based on the belief that the common good is best served when everyone is accepted and respected for whom they are, and that this ultimately makes for a resilient, more harmonious and more creative society. This faith in the value of diversity recognizes that respect for cultural distinctiveness is intrinsic to an individual's sense of self worth and identity, and a society that

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accommodates everyone equally is a society that encourages achievement, participation, attachment to country and a sense of belonging (*Canadian Diversity* 2005).

Provincial government policies have promoted the development of international languages as an integral part of the Canadian education system. During the past few decades, western Canadian provinces (especially Alberta, Saskatchewan, and Manitoba) have released multicultural policies to support international language learning. These provincial policies have an active impact on public schools. Today, in addition to English and French, Alberta provides 16 different language programs in four types—second language programs, bilingual programs, provincially developed programs and locally developed programs. So far, in the Edmonton area, eleven international language programs are being provided in Public School Districts and Roman Catholic Separate School Districts. The languages are Chinese, Arabic, Cree, German, Hebrew, Italian, Japanese, Latin, Polish, Spanish and Ukrainian (*Languages Studies Brochure* 1997).

Originally bilingual language school programs are provided at the request of minority groups who desire to preserve and transmit their own cultures and languages from one generation to another. Increasingly however, other factors such as globalization, diversity of Canadian society, colorful cultural mosaics, and ever-increasing needs for better communication and cooperation on the part of native Canadians with non-English and non-French speaking people play a significant role in promoting the development of international language education programs. More and more students and parents come to realize the importance and the necessity of languages in the future dynamic global workplace, and therefore participate in these programs in school. Consequently, language

education receives more and more attention. In Alberta, children speaking a first language other than English account for a growing share of the student population. About one in three Alberta high school students enroll in a second language course. Enrollments in international language programs have been growing steadily over the last five years (*Trends and Issues in Language Education* 1997).

## 2.1.4 The Effects of Second Language Learning on First Language

Educators studying bilingual children have shown that learning a second language has no negative impact on acquiring the first language. Even the loss of instructional time in the first language in favor of the second language has never been shown to have negative effects on the achievement of the first language. Commins (1981) has proven that increased time in French instruction led to greater proficiency in French, with no loss to English. On the contrary, at a general cognitive level (the development of the brain and of mental functions), bilinguals have an advantage over monolinguals. The skills acquired in one language can be transferred to learn another language. Commins's study (1991) reconfirmed that transfer of skills from first language to second language is possible. Bournot-Trites and Tellowitz (2002) similarly confirmed that cognitive abilities acquired in the learning of one language can be put to use in the acquisition and proficiency of the other language. The first language skills were shown to be enhanced, even if instruction time in the first language was reduced in favour of the second language instruction. Bialystok (2001) suggests that bilinguals have the ability to transfer skills between the first language and the second language, and advantages in such areas as metalinguistic

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ability, divergent thinking, attitude control over attention, and inhibition. Lambert and Tucker (1972) examined the students of grade 1, 2, 3, and 4 in a French immersion programme in Montreal and found the immersion students were equivalent to the English students in literacy skills. They also confirmed that the skills which are developed in one language can be used for acquiring proficiency in the other language. In addition, many of the studies reviewed concluded that the bilingual students have higher academic achievements than monolingual students in some areas. Turnbull and Lapkin (2003) found that the French immersion students outperformed the non-immersion students in the regular program in reading, writing, and mathematics. Dewaele and Pavlenko (2003) revealed that second language users can approximate native speaker values in productivity and lexical diversity in the target language without losing the original values in their first languages. In terms of English and Chinese education, Marsh (2000) carried out a study on grade 7 students who were instructed in Chinese and the students who received instruction in English in Hong Kong and found that the achievement in the first language (Chinese) and second language (English) were both enhanced through instruction in English.

## 2.2 English-Chinese Bilingual Education

The ever-increasing size of the Chinese population requires Chinese language education in school. Edmonton's Chinese (Mandarin) Bilingual program was thus conceived in 1982 so as to meet Chinese children's needs in this context.

*Edmonton Chinese Bilingual Education Association* (www.ecbea.org) has more details about this program. The following highlights the basic structure of the program:

In 1982, an experimental English-Chinese language program was introduced at the kindergarten level in Edmonton Public Schools. The success of this initiative led to the formal establishment of the English-Chinese Bilingual Program in 1983. Each subsequent year led to the establishment of a higher grade (Grades 1 to 6).

The English-Chinese Bilingual Program is provincially approved by Alberta Learning and is offered by the Edmonton Public School Board. Students in this program study the provincially approved curriculum like students in an English-core program, except that instructional time comprises as close to 50% in Chinese as possible. The development of social, physical, intellectual, and language skills are primary objectives in kindergarten.

At the elementary level (Grades 1 to 6), the subjects taught in English are: English Language Arts, Science, and Social Studies. Subjects taught in Chinese are: Chinese Language Arts, Mathematics, Art, Health, and Physical Education. Music may be taught in both languages.

This program is unique in North America, both because it is a complete continuum of studies from kindergarten to high school graduation, and it is accomplished all during regular school hours. (*Edmonton Chinese Bilingual Education Association*)

English-Chinese Bilingual programs are now provided within Edmonton Public Schools and only for students attending this program. Edmonton Public Schools is the second largest school district in Alberta, with more than 80,000 students within 203 schools (*Three-year Education Plan 2005-2008*). District schools typically are organized as kindergarten to grade 6, grades 7 to 9 and 10 to 12. The Edmonton Public Schools have 31 alternative programs focusing on areas like the arts, athletics, and technology, which are offered from elementary to junior high schools to meet the needs of students (*2006-2007 Guide to Alternative Programs*). They also offer 14 special programs for students with special education needs, and transition programs for students having challenges in traditional classrooms.

English-Chinese Bilingual programs are currently offered at four junior high schools, three senior high schools, and the following five elementary schools: Caernavon Elementary School, Dovercourt Elementary School, Kildare Elementary School, Meadowlark Elementary School, and Meyonohk Elementary School. 2830 students have enrolled in English-Chinese Bilingual kindergartens since the program's establishment in 1982. These five kindergartens received their highest number of 192 students enrolled during the 2000-2001 school year. In the 2005-2006 school year, over 1800 students from kindergarten to high school graduation are speaking Mandarin and learning to write Chinese in this program during regular school hours (ECBEA). Historic enrollment data provided by Edmonton Chinese Bilingual Education Association (ECBEA) indicated that among them, 135 children were enrolled in English-Chinese Bilingual kindergartens.

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This program has become the largest and fastest growing bilingual program in the Edmonton Public School district.

The Alberta Government started a new Languages Initiative on April 22, 2004, under which Alberta students in Grades four to nine will study a second language. Beginning in the 2006/2007 school year, the learning of another language in addition to English will become a required component of the grade 4 curriculum. This requirement will be phased in one grade at a time until 2011/2012, when Alberta students in grades 4 to 9 will be required to study another language (*Language Learning Initiatives* 2004). This initiative will be an impetus to promote awareness and respect for second language learning. If people expect their children to grasp a second language, they will have to consider earlier since currently in Alberta, another language in addition to English is compulsory for grade four students. Under this circumstance, the English-Chinese Bilingual Kindergarten program can be expected to gradually attract more and more children.

## 2.2.1 Parents' Attitudes toward Bilingual Language Education

A number of studies reveal parents' attitudes toward bilingual language education for their children. The majority of the linguistic minority parents (the Latino parents) surveyed supported bilingual education (Lee 1999). Shin (2000) studied the attitudes of Korean parents, Hispanic parents and Hmong parents toward bilingual language education in California (Shin and Gribbons 1996, Shin and Lee 1996, Shin and Kim 1998) and found that an average of 88% of all the parents surveyed agreed that bilingualism can

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lead to practical, career-related advantages, results in superior cognitive development, and was necessary to maintain primary language and culture (2000). Berryman (1983) found that immigrant parents strongly support their children's second-language acquisition; they want to be involved in their children's language learning. Amaral's (2001) study confirmed that the longer the parents are in the United States, the more inclined they are to place their children in programs with little or no English support. Also, parents tended to place their children in settings that mirrored the language patterns used in the home. In addition, the higher the parent's level of education, the more likely they were to place their children in bilingual programs where home language support was available.

However, little research has been done regarding attitudes held by Chinese parents toward bilingual education. In addition, previous research on immigrant Chinese parents has been mainly carried out in the United States; few such studies have been conducted in Canada. Li (2001) explored the expectations of Chinese Immigrant parents for their children's education in Canada and demonstrated that the expectations of these Chinese immigrant parents are significantly shaped by the dynamic and complex interplay of indigenous Chinese cultural expectations and the challenges of acculturation. Padilla and Sung (1995) discovered that Chinese, Korean and Japanese parents displayed what might be called integrative motivational orientations in promoting their children's learning of their heritage language. In Lao's survey (2004) in San Francisco, the vast majority of Chinese dominant parents strongly believed that bilingualism would bring their children practical advantages and would help youngsters establish a positive self-

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image. They also believe that a high level of bilingualism can provide better career opportunities. Influenced by Chinese traditional culture and historical background, Chinese parents are reputed to have high expectations for their children, especially in academic performance. The essence of Confucian philosophy which exalts the scholar and emphasizes human malleability, the value of self-improvement, and the unity of the family has been strongly acting on Chinese society for thousands of years (Chen and Lan 1998). Chinese have practiced this value for centuries from one generation to the next.

Chinese grandparents have similarly high expectations for their grandchildren. Their expectation partly can be seen as concerns for all aspects of education, including program selection, curriculum selection, school selection, etc.; the other part of this expectation often takes the form of pressure on their children – asking them to make sacrifices to help to ensure the grandchildren success. Under Xiao—the Chinese value of "filial piety", children perceive their parental expectation through parental involvement, and do their best to meet parental demand. Because of the double expectations from two generations, the education for children is therefore a crucial problem for the whole family.

## 2.2.2 Chinese Parents' Attitudes toward Their Heritage Language

Jedwab (2000) has observed that the Chinese community has a high rate of heritage language retention. Specifically, Chinese Canadians are the most loyal to their mother language, compared to other ethnic groups in Canada. They use English or French in their working places; however, they mainly speak Chinese at home. Both the 1991 and 1996 census data reveal that persons of Chinese ethnic origin are more likely to use their

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language in their home than any other groups (Greek, Italian, Polish, Portuguese and Ukrainian) (Jedwab 2000). According to Census 1996, 82% of Chinese people in the Edmonton Metropolitan Area speak their own language at home. Li (1995) examined second-generation Chinese Americans and confirmed the importance of continued use of the heritage language as the primary language of communication among family members, both adults and children.

Chinese parents are more inclined to expect their children or next generations to carry on language, customs, and traditions than parents of other minority groups. One reason is that Chinese parents respect their traditional culture and are proud of Chinese ethnicity. They believe that Chinese culture provides enduring moral principles necessary for survival in a rapidly changing world (Wong and Ujimoto 1998). Many elderly Chinese are convinced that traditional Chinese virtues, such as being family minded, socially harmonious, self-restrained, and conscientious are far more beneficial to young people than are the undisciplined, self-absorbed, pleasure-seeking tendencies of the average American youth (Yang 1986). Learning Chinese was seen as a vital way to retain cultural roots and to provide cultural ballast. The other reason comes from the concern of the decline in the usage of their mother tongue during the language shift or transfer to English. Chinese immigrants—especially the first and the second generations—have the experience of maintaining their first language while learning English. In the process of fitting into Canadian life, English as a majority language apparently becomes a necessary communication tool in more contexts when contacting a largely English-speaking community, while Chinese is used in fewer and fewer settings (families, relatives and

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friends speaking Chinese). The loss of language strengthened people's awareness of traditional culture loss. The assimilation to mainstream English-speaking society seems to fail to provide this group enough self-fulfillment, especially from the Cognitive Needs layer (Maslow 1970)—need to have a sense of meaning and purpose of one's life. They wish to retrieve their cultural roots by recovering language. They expect their next generations to maintain awareness of their distinctive ethnic origins, as well as understand and promote the core and soul of their traditional culture.

## 2.3 Chinese in Edmonton

Chinese-speaking people in Canada, including people speaking Mandarin, Cantonese and other Sinitic languages constitute a significant proportion of the total population in recent years. Chinese is Canada's third most widely spoken language with more than 850,000 native speakers (*Multiculturalism* 2003). During 1999 to 2003, China had been the largest source of immigrants to Canada. In 1998, close to 20,000 Chinese citizens came to Canada, representing 11.3% of all immigrants; that number had jumped to almost 33,000 in 2002, representing over 15% of the total immigration figures (*Immigration* 2003). Chinese was the largest group, surpassing one million in 2001 and representing 3.5% of the total population and 26% of the visible minority population. Between 1996 and 2001, the number of Chinese Canadians increased by 20% (*Canada's Ethnocultural Portrait: the Changing Mosaic* 2003).

Census Canada 2001 confirms that Chinese is the largest visible minority group in Canada. According to Census Canada 2001, the number of people who declared themselves as Chinese ethnic origin in Edmonton is 41,285, which represents 4.4% of the

total population. In 2001, the Chinese and South Asians were the two largest groups; in 2017, they are projected to remain the largest and to account for almost half of all visible minority persons, with a population by 2017 between 1.6 million and 2.2 million (*Population Projections of Visible Minority Groups, Canada, Provinces and Regions* 2005).

In 2005, Edmonton City Council approved a series of special initiatives, two of which aimed to attract immigrants to Edmonton and to build a welcoming and supportive community for newcomers. Administration had sought to identify actions that can increase immigration levels to Edmonton and considered how best to provide or support programs that attract immigrants (*Building the capital city* 2005). Early in 2005, Mayor Mandel publicly stated this goal of making Edmonton more attractive and welcoming to immigrants for the economic prosperity of the region and the overall vibrancy of the city. In 2004, 56.5% of all immigrants to the province went to Calgary, while only 29.2% came to Edmonton (Derwing et al. 2005). This study also (Derwing et al. 2005) developed 27 recommendations to report to the City of Edmonton, one of which was a comprehensive website specifically designed for potential residents and immigrants, highlighting the appealing features of Edmonton. Educational resources and opportunities have been becoming important attractions for potential immigrants. About 31% of respondents emphasized access to education resources as "best things" about the city. In the future, more immigrants, including Chinese-speaking people, will be attracted to come to Edmonton. The Chinese population will account for a higher and higher percentage of total population. The education needs for their children will receive more

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and more attention; schools will be asked to provide more vigorous language learning opportunities for immigrants and their children.

## 2.4 New School Building Regulation and Open Boundary Policy

### 2.4.1 New School Building Regulation in Alberta

The above literature mainly focuses on the factors of travel time or travel distance when studying existing school location distributions. In Alberta, school location problems may be involved in building new schools, providing spaces to existing schools or replacing obsolete schools. Actually, new constructions are considered only when absolutely necessary. The Education Minister makes decisions on school facilities based on several priorities. The first priority is to choose projects that are vital to the health and safety of students and staff. New construction to address a critical need for new classroom space is in the second priority.

In addition, school boards review the need for new space and are required to substantiate their applications indicating that:

(a) additional space is needed based on space utilization data and enrollment projections for the next five years;

(b) no other space is available in another school in the jurisdiction, or in schools belonging to another jurisdiction in the community, or in the region, to which transportation may be feasible;

(c) other facilities that could be used for instruction are not available in the community or region (*School Capital Funding* 2003).

In Alberta, new school construction is supported by the School Capital Funding Programs as defined in *K-12 Learning System Policy, Regulations and Forms Manual*. The Capital Funding Programs are designed to enable school boards to provide new space to improve the physical quality and the functional adequacy of a school building, and to prolong the life of existing school buildings and sites. The new construction can result in new facilities or additions to existing facilities in order to meet enrollment needs, educational program demands, or to replace obsolete facilities. Each year, the Alberta government approves an annual capital budget for the next three fiscal years. School boards are responsible for planning and evaluating their own district's needs and priorities. After the release of the annual capital budget, school boards submit a ten-year and a three-year capital plan to Alberta Infrastructure in order to be considered for school capital funding. The ten-year plan is general in nature. It is, however, intended to provide clear direction for the identification of the district's long term facilities needs and emerging capital priorities. The three-year plan is updated each year to reflect local changing needs. Projects shall specifically identify the district's priorities for capital investment (*Ten-year Facilities Plan*, 2006-2015).

New school buildings require the approval of the Ministers of Infrastructure and Learning. The Minister announces the School Building Board's decisions on approved capital projects, usually in December of each year. In June, 2005, Edmonton Public Schools submitted its ten-year facilities plan to Alberta Infrastructure and Transportation

for the period 2006-2015. It identifies that the demand for new construction nearer the student population base will intensify as the student population in the suburban areas of the city continues to increase (2005). In its *Three-year Capital Plan* (2005), 16 new schools were proposed as new construction projects, in which there are 11 elementary schools with kindergarten (2005). According to the latest news, the province will provide the Edmonton Public School Board with $17.3 million for their top priority project—the construction of a new high school in the Riverbend-Terwillegar community in southwest Edmonton. The school will be built to accommodate 1,000 high school students. (*News Release: Alberta Students to Benefit from New School* 2005).

## 2.4.2 Alberta's Open Boundary Policy

In Alberta, the school board is responsible for providing an education for each student residing within its jurisdiction. Boards may establish attendance boundaries for each school. Schools are required to enroll students residing within their boundaries, if the school program is determined to be suitable for the student by the Board. Resident students are given priority over non-resident students if there are insufficient resources and facilities to accommodate both (*Our students, Our future* 1998).

The open boundary policy means that Alberta parents do not have to send their children to a school in their attendance area or board jurisdiction. They may enroll their children in any school that has the resources and facilities to accommodate them, but they may have to pay for transportation or arrange their own. Parents may therefore choose to send their children to special programs offered by schools outside their immediate

jurisdiction, for example, bilingual or immersion programs (*Our students, Our future* 1998). In my study, the $p$-median model assumes that parents always prefer the English-Chinese kindergarten closest to their residences.

## 2.5 Location-Allocation Problem and *P*-median Model

### 2.5.1 Location-Allocation Problem

The classic location-allocation theory, first propounded by Weber (1929), determines the best industrial location between raw material sites, markets for manufactured goods, and transportation. The location-allocation problem therefore deals with several spatial factors for finding the optimal industrial location and the minimal transportation costs. Cooper (1963) introduced a type of location problem which determines the optimal number of sources, location, and capacity for each site so as to minimize the shipping costs from destinations to sources. Scott summed up this kind of problem based on three given conditions: 1) a set of $n$ points representing $n$ needs which are located at different sites in the real world; 2) a numerical weight to be attached to each point; 3) a set of $m$ indivisible centroids without predetermined locations as potential locations which hold a certain service. The location-allocation problem, in its most general form, is to identify the number of facility locations among $m$ centroids, and simultaneously determine the allocation of needs for $n$ points so as to achieve optimal objective function (Scott 1970).

A variety of objective functions for location-allocation problems have been studied in the literature. These objectives, generally, fall into two groups: minimization

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and maximization. 1) The minimizing function is usually associated with any forms of cost between facilities and demand points such as travel costs, transportation cost and response time (Rosenfield et al. 1992, O'Kelly 1987, Kuehn and Hamburger 1963). A classical and most widely recognized optimality problem, which seeks the minimal aggregate weighted distance between demand points and their nearest facility, is solved by the $p$-median model. 2) The maximizing function is to seek maximal service effectiveness of facilities (Mirchandani and Reilly 1987, Repede and Bernardo 1994, Fujiwara et al. 1987). The Holmes model was employed by Hodgson for maximization range of air tanker effectiveness (Hodgson and Newstead 1983). The problem of maximizing coverage (population covered) within a desired service distance by locating a fixed number of facilities was examined by Church and ReVelle (1974).

The location-allocation models have been widely applied in private industry for identifying the optimal location for infrastructure like warehouses, factories, airline hub locations, oil wells, forest harvest areas, and in retail locations like retail stores and locations of franchises. On the public application side, locations including emergency medical services systems, fire centers, health centers, day care and school systems have been extensively discussed in a number of studies (Hodgson and Rosing 1996). Emergency service systems such as ambulance and fire stations usually require a quick responding time to save life or property. In this context, location models are formulated to seek minimum average response time.

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## 2.5.2 *P*-median Model

The $p$-median problem is to discover the optimal number of $p$ sites that can offer all the potential demands by shortest weighted distance. It was first defined by Hakimi (1964) on a network of fixed nodes and fixed demands. Each node was considered a demand as well as a potential facility location. It has been the most widely used model dealing with location-allocation problems since its start with the classic heuristic method by Teitz and Bart (1968). This model was formulated to a linear format by ReVelle and Swain in 1970.

In the area of public facilities, specifically school and day care systems, a great deal of the location-allocation problem is solved with the $p$-median model. Hodgson and Doyle (1978) took travel time as an objective function to study optimally accessible locations of day care centers for transit users. In another article on daycare center location-allocation problem, Hodgson (1981) considered a journey-work model as a compromise between the model minimizing home-facility travel times and the one minimizing facility-workplace travel times, which sought day care center locations en route from residences to workplaces. Tewari and Jena (1987) studied location of high schools in India with a $p$-median model to obtain maximal population coverage within 8 km service distance. Møller-Jensen (1997) examined the maximal accessibility at a maximal travel time to attend school for six-year-old children in Copenhagen. Pizzolato and Silva (2004) applied a capacitated $p$-median model in the southeast region of Brazil to determine new school locations added to the existing school facilities.

## 2.6 Geographical Information Systems (GIS) and Their Application in Choosing Sites

### 2.6.1 GIS

Geographical information is essential for effective planning and decision making in modern society. Many of our decisions depend on the extent of the details of information about specific places on the Earth's surface. The implementation of many research projects also requires distinguishing among various geographical places. The primary purpose of Geographical Information Systems (GIS) is to analyze spatial data for research and decision making. Spatial data refer to the data on geographical features and consist of spatial-attribute data—the locational and geometrical attributes of features— and nonspatial-attribute data—attributes other than spatial ones (Okabe 2006). Although there is no single universally agreed upon definition of GIS, there is consensus that it can be understood through the following perspectives.

From the perspective of information that GIS deals with, David Rhind defined it as "a computer system for collecting, checking, integrating and analyzing information related to the surface of the earth" (Rhind 1988). GIS is known for its capabilities in creating, analyzing, manipulating, storing and representing spatial data (Hanson 1995). GIS is a useful tool to integrate and evaluate from several sources based on geographical locations. Source data include information derived from photogrammetry, cartography, remote sensing, field data collection, and experimentation results. GIS deals not only with geographical information, but it can also enable the integration of text, images, maps,

and even sound recordings, in a single electronic space (Knowles 2002). Different information can be stored simultaneously into different layers. These layers can be integrated by multiple map overlays in order to assemble the components of the complex real world pattern (De Blij et al. 2004).

From the perspective of systems, as its name implies, a GIS is a computer-based system with functional parts—four subsystems: 1) a data input subsystem, 2) a data storage and retrieval subsystem, 3) a data manipulation and analysis subsystem and 4) a reporting subsystem (DeMers 2005). Like many other computer systems, a GIS is mainly composed of hardware, software, data and people. The related hardware includes devices capturing geographical data, devices converting the information to digital form, and devices processing data and other physical components on which the system runs. Moreover, the Internet is a new type of GIS platform, serving as "Web-based GIS" (meaning that the primary software and data will reside on the Internet, to be rented by the user for performing project work) (Davis 2001). The up-to-date information regarding GIS products and related services is published annually in the International GIS Sourcebook (e.g. *GIS World Source* 1996). Shamsi (2002) also discussed GIS software products and their prices in more detail.

## 2.6.2 The Application of GIS in Choosing Sites

GIS analysis has been used in methods of optimization and design (Goodchild 2002). One example can be found in finding optimum water pipe routes to link two proposed reservoir sites to future demand areas in the Langkawi Island, Malaysia (Baban

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et al. 2004). Location-allocation is one of the most useful applications of GIS in the public and private sectors (Berry 1995). Miller and Shaw (2001) introduced some examples of GIS and location-allocation models integration. GIS technology, in combination with appropriate data and spatial analysis, serves to narrow the list of prospective suitable locations (Thrall 2002). GIS data were used to choose sites for restaurants by Tawarmalani and Sahinidis (2002). Yeh and Chow (1996) integrated GIS and a location-allocation model that generated a set of solution spaces to help decision makers to narrow down their searches and decisions for open space sites in Hong Kong. Because there are many examples of the use of location-allocation models in the academic literature and in real-world applications, location/allocation models have been implemented as add-on modules in several commercial GIS packages (Fotheringham 2000). Cromley and McLafferty (2002) discussed GIS analysis—integrating data layers spatially and considering both location and site characteristics in identifying candidate facility locations for locating health services sites.

For this study of the location-allocation problem for English-Chinese kindergartens in Edmonton, GIS provides a high quality map of the locations of the current kindergartens, with an accurate coordinate system. This allows me to calculate the actual straight line distances between any known kindergarten location and the residence of target preschool children. The intelligent GIS options link attributes of features to locations (target population to residence areas) with different layers showing how information interrelates. GIS is a good tool for output maps presenting how service is allocated—in this case, the allocation of preschool children to their nearest kindergartens.

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## 2.7 Quantitative Research Method and Survey

### 2.7.1 Quantitative Research Method

A quantitative method deals with numeric data and anything that is measurable. These two methods take different data to do research. Neuman and Kreuger (2003) described the nature of data from quantitative approaches as "hard data". Hard data is in the form of numbers. Quantitative research emphasizes precisely measuring variables, testing hypotheses set up before and studying the relationships between hypotheses. They also found quantitative social work researchers often use a technocratic perspective, apply "reconstructed logic", and follow a linear research path. Quantitative research tests theories. The deductive method is used in quantitative research (Taylor and Trumbull 2005). In quantitative researches, interaction with subjects, modifying instruments, and having subjects to participate in data analysis are not typically practiced (Spradley 1980).

### 2.7.2 Survey

A survey provides a quantitative or numeric description of some fraction of the population—the sample—through the data collection process of asking questions of people (Fowler 1988). As Grove remarked, "surveys produce information that is inherently statistical in nature. Surveys are quantitative beasts" (1996). The term "survey" includes cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection with the intent of generalizing from a sample to a population (Babbie 1990). A survey involves designing questions, learning to quantify or count responses, and statistically analyzing data.

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Questionnaires are a main survey method of data collection used in quantitative research. Franklin and Osborne (1971) defined a questionnaire as "an instrument consisting of a series of questions and/or attitude—opinion statements designed to elicit responses which can be converted into measures of the variable under investigation". A questionnaire collects information from people, and analyzes the data in order to find the causes of phenomena. Questions are usually formed in a systematic structure to serve the research topic. Questions should concentrate on the problem and phenomenon studied. Only relevant questions should be asked. Questionnaires can be designed for self-administrated surveys, face-to-face interviews, telephone surveys, computer-assisted forms on the Internet, or to be sent by e-mail. These choices raise additional considerations in deciding to use survey methods (Nardi 2006). Researchers can obtain information on human activity, behaviour, ideas, opinions, attitudes, and feelings by directly asking people questions. Dillman (1978) describes four types of question contents: behavior, belief, attitudes, and attributes. Attribute questions are produced to obtain demographic information about the respondents such as age, gender, occupation, income and etc., whereas the other three are directly relevant to the research problem. Behavior questions ask what people do; belief questions ascertain what the respondent thinks is true; and attitude questions are designed to establish what they think is desirable (de Vaus 1996).

# Chapter 3. Methodology

This chapter consists of two parts that describe the methodology utilized in this study. The model section details the $p$-median model, assumptions, data and sources, and solution techniques. The survey section discusses survey technique, question design, the data source, target population, sample, and analysis method.

## 3.1    Locating Kindergarten Locations

I applied a linear $p$-median model developed by ReVelle and Swain (1970) in order to discover the optimal locations for the current five English-Chinese kindergartens in the city of Edmonton. My goal was to minimize the travel distance from English-Chinese kindergarten locations to preschool children's residences based on target population which was defined as Chinese children between 4 and 6 years old in Edmonton. I assessed the current five English-Chinese kindergarten locations by comparing the total weight distances generated by the current set of locations and the optimal five sites solution. The study aimed to identify a set of candidate sites measured by weighted values corresponding to Chinese population, and then determine the most suitable sites based on specific criteria. I integrated the $p$-median model with desktop Arcinfo GIS. The 5 optimal kindergarten location sites produced by the model were represented as points linked to the Edmonton EA map by using Arcinfo.

### 3.1.1 *P*-median Model Description

The goal of the $p$-median approach is to discover the optimal number of $p$ sites that can offer all the potential demands by shortest weighted distance. This study

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attempted to approximate the target function Z–the minimization of the travel distances (measured by Euclidean distance on the map) between preschool children's residences and nearest schools. The nearest schools were defined in terms of Euclidean distance. Euclidean distance is a commonly used measure of the distance between two points on a plane (Fotheringham et al. 2000). The $P$-median model as proposed by ReVelle and Swain (1970) can be formulated as follows.

Minimize:
$$Z = \sum_{i=1}^{m} \sum_{j=1}^{n} W_i D_{ij} X_{ij}$$

Subject to:

$$\sum_{j=1}^{n} X_{ij} = 1 \quad i=1, 2, \ldots, m \qquad (1)$$

$$Y_j - X_{ij} >= 0. \quad i=1, 2, \ldots, m, j=1,2,\ldots, n \qquad (2)$$

$$\sum_{j=1}^{n} Y_j = p \quad j=1, 2, \ldots, n \qquad (3)$$

$$X_{ij} >= 0, \quad i=1, 2,\ldots, m, j=1, 2,\ldots, n \qquad (4)$$

$$Y_j >= 0, \quad j=1, 2,\ldots, n \qquad (5)$$

Where:

    i: demand point;

    j: potential point;

    m: the integer number of demand points;

    n: the integer number of potential points;

    p: the integer number of facility;

$W_i$: demand weight at i;

$D_{ij}$ : distance between demand i and site j;

$X_{ij}$:     $\begin{cases} =1, \text{ if the whole demand at i is allocated to j} \\ =0, \text{ if not allocated to j;} \end{cases}$

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$Y_j$:     $\begin{cases} =1 \text{ if potential site } j \text{ is a facility} \\ =0, \text{ otherwise;} \end{cases}$

## 3.1.2 Data and Sources

The geographical data I used were the city of Edmonton dataset obtained by integrating Edmonton feature data into the Canadian shapefile[1] at Census enumeration area (EA) level. EA is defined as a "small area composed of one or more neighbouring blocks, used by Statistics Canada for distributing questionnaires to households and dwellings (*Enumeration Area*)". The Edmonton feature data were referred to as dissemination area (DA) which included a unique identifier, area, population counts, and the longitude and latitude attached to each DA (*Dissemination Area*). The DA is a new standard geographic area. It replaces the EA as a basic unit for dissemination. A shapefile stores non-topological geometry and attribute information for the spatial features in a data set (Kumar et al. 2006). The feature data were available through GeoSuite 2001 which provides a DA reference map listing that facilitates the identification of appropriate DA reference maps (GeoSuite 2001). There were 1067 EAs and corresponding population counts, longitude and latitude in the Edmonton EA shapefile.

## 3.1.2.1 Target Population and Demand Points

In Alberta, the minimum age for kindergarten is four years and six months old as of September 1 (Kindergarten Guide). The research problem was the current five

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[1] The Canadian shapefile was provided by Professor M. John Hodgson. Professor Hodgson is a Professor Emeritus in the Department of Earth and Atmospheric Sciences at the University of Alberta.

English-Chinese kindergarten locations and the future attendance was not considered. The target population group was therefore defined as Chinese children between 4 and 6 years old who will receive services, in this case specifically the opportunity to attend English-Chinese kindergartens. However, there was no way of obtaining the exact target subpopulation of each EA, since the Census data do not contain subpopulation information on Chinese children (4 to 6 years). Two kinds of categories in Census data were referred: categories of children population by gender and age—0-4 years female, 0-4 years male, 5-9 years female, 5-9 years male, 10-14 years female, 10-14 years male and etc., categories of population by mother tongue—English, French, Chinese, Italian, German, Polish and etc..

I relied on Census 2001 for data preparation because it had the least aggregate population data available at the EA level, which was the basic smallest unit area in the Census. The Census data were downloaded through the website of the University of Alberta library. Calculating the target population of children aged 4-6 years was based upon two assumptions: the spatial distribution of children in each age range was the same; the population of Chinese children had the same proportion as that of the Chinese population per capita. I first calculated the percentage of Chinese population at EA level, then obtained the population of children between 0 and 9 years old at EA level by adding 4 group populations together (0-4 years female, 0-4 years male, 5-9 years female, and 5-9 years male). The target population of 4-6 years Chinese children was calculated by multiplying the children population (0-9), the percentage of Chinese population and a

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factor of 2/9 which ensured that age range of 4-6 could be drawn out from the age range of 0-9. The estimated target population was 640.

The demand area was each EA having the target population. After cleaning all the null and zero EAs, the centroid of each remaining EA was created to represent the demand point. For an EA to have a positive demand for this target population, an EA must have at least one Chinese child between 4 and 6 years. The population of Chinese children 4-6 years of age in each EA target population was attached as the weight to the demand point. Figure 3.1 shows the distribution and density of the target Chinese children (4 to 6 years) in the Edmonton EAs. The highest density value of the target population was between 0.47% and 1.18% per capita. Graduated-colored symbols were used to represent target population zones with various densities in the Edmonton area. The figure also demonstrated that the target population were concentrated in northern, south-western, and at several south-eastern areas. The largest numbers of zones with zero target population were found at north-eastern, north-western and eastern areas. 230 EAs had a target population less than 4, while 4 EAs had a target population greater than 10. 250 centroids were identified as the demand points, which represented EAs having a target population greater than one.
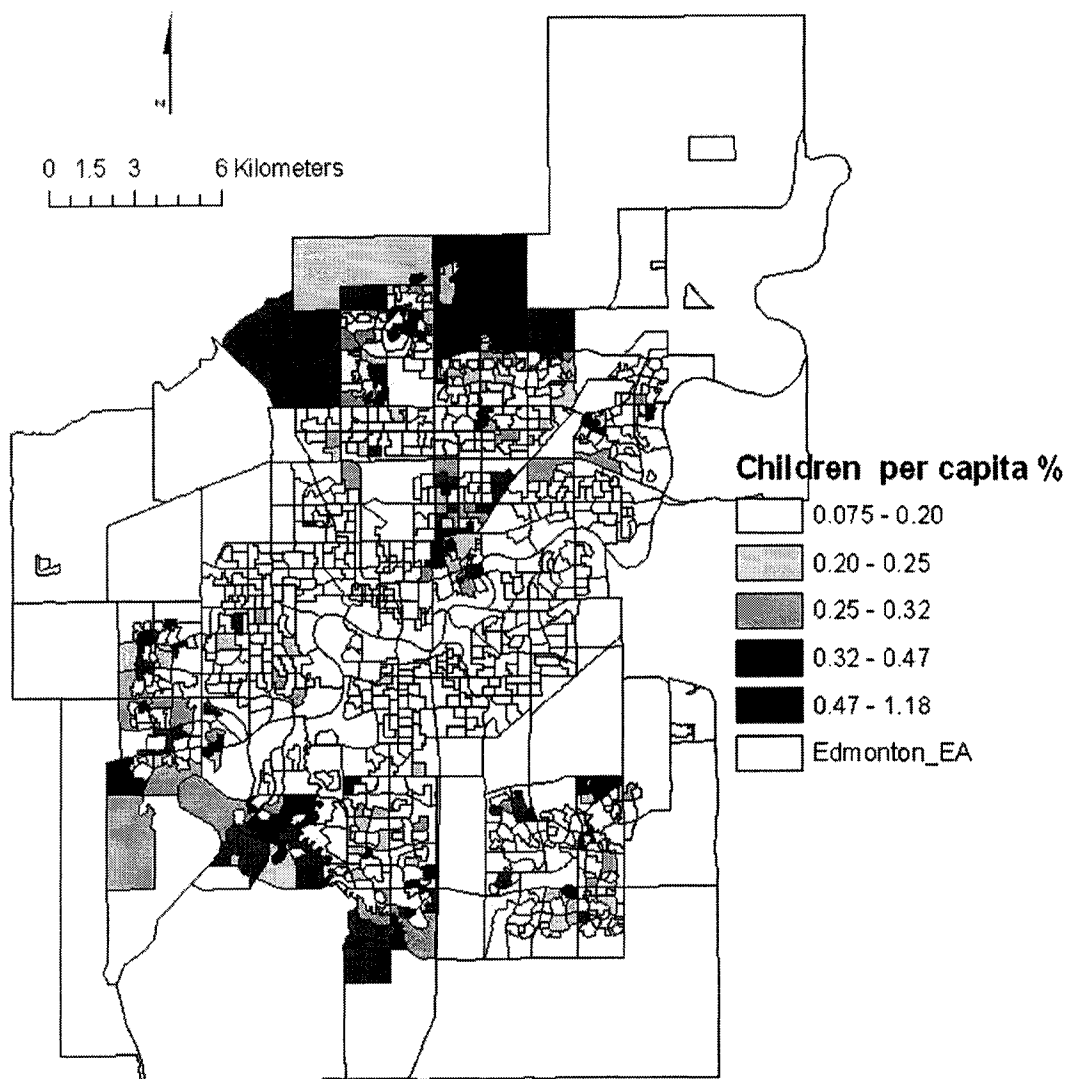
Figure 3.1 Chinese children (4-6 years) population per capita in Edmonton EA.

This map shows the distribution areas of the target Chinese children (4 to 6 years) in Edmonton.

## 3.1.2.2 School Locations and Potential Sites

The address list of 159 Public Schools was downloaded from the *Edmonton Public Schools* (*Kindergarten Guide*). Addresses and names of all the elementary schools within the Edmonton Public district, including the ones providing English-Chinese kindergarten programs, were collected through the address list. Three fields were created to store school ID, name and address respectively in an Excel spreadsheet. After standardizing and properly formatting data, the addresses and names of all the elementary schools were saved in a Comma Separated Values (*.csv) format that allows automatic uploading to Arcinfo for later geocoding. Geocoding is the process of assigning an absolute X/Y location to a geographic feature, referenced by a relative location, such as address (Hutchinson 2004). The most common form of geocoding is the matching of addresses to a street network (Hutchinson 2004), although a variety of other strategies are possible (Laender et al. 2005). In order to obtain spatial data of schools—a point form shapefile—geocoding was performed to match school address to an Edmonton street shapefile[2] and create point features. After the first geocoding, I got 97% matched addresses, among which only three were in status "T," which means tied with another address for the highest score. I then manually rematched these three to the right addresses. The spatial database was produced as one of the results of geocoding, which stored data such as X/Y location, address, and name for each public school site.

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[2] The Edmonton Street shapefile was provided by Vladimir Yasenovskiy, who is a graduate student in the Department of Earth and Atmospheric Sciences at the University of Alberta.

Each public elementary school was represented as a point based on geographical location. Since the English-Chinese bilingual program at the kindergarten level is at present offered only within Edmonton public schools, I then identified all 159 elementary school sites as a set of potential sites which were put into the $p$-median model so that the most suitable sites would be located from them. 250 demand points and 159 potential sites are shown in the following Figure 3.2.
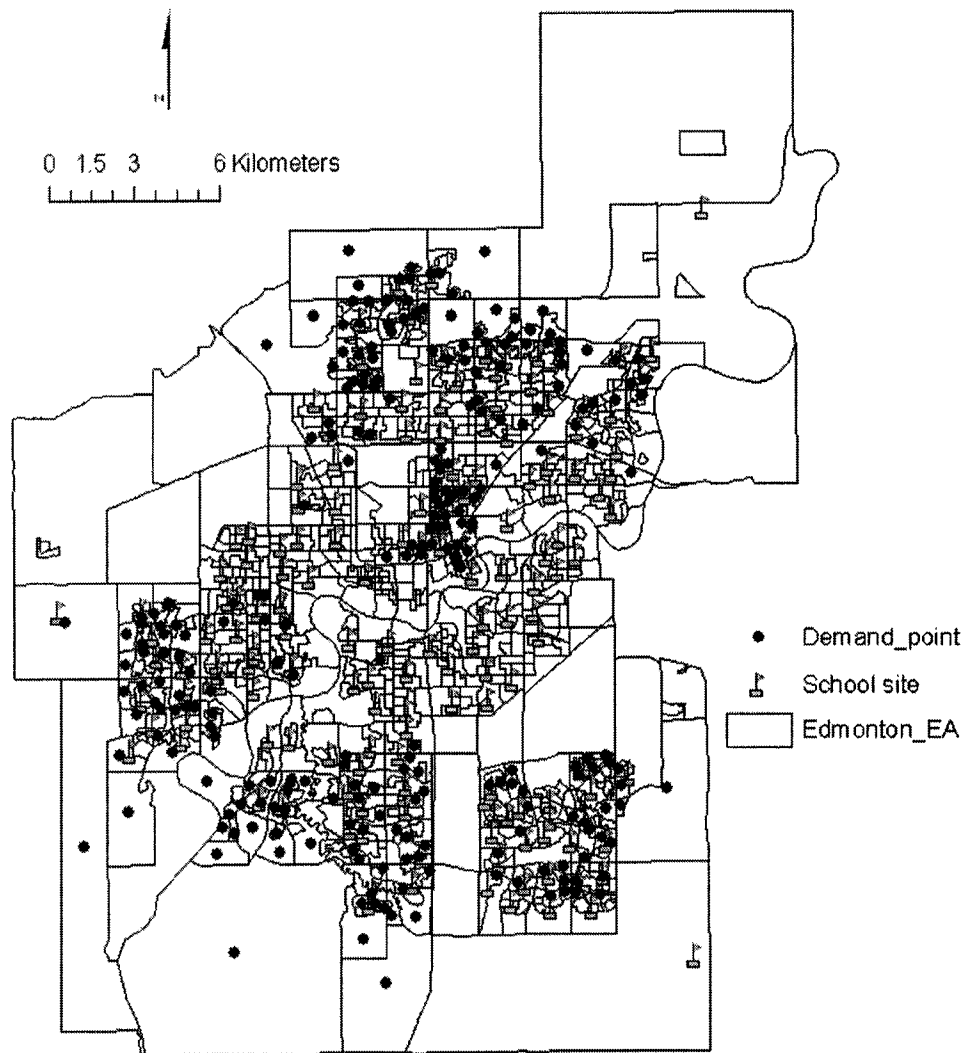
Figure 3.2 Demand points (250 EAs having target population more than one) and potential sites (159 Edmonton Public elementary schools)

### 3.1.3 Solution Techniques

A number of techniques have been developed to solve space location-allocation problems. Virtually all of the optimal techniques require at some point the application of a branch and bound algorithm and offer exact solutions. Because of this, some problems

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may take an inordinate amount of computation time to solve (Church and Sorensen 1996). The first heuristic algorithms presented by Teitz and Bart (1968) represent the most popular and practical approach to this problem due to their simplicity and easy implementation. This study is the selection of 5 optimal locations for the current five English-Chinese kindergartens from 159 Edmonton Public elementary schools, which comes out $C_{159}^5$ possible solutions. Because of the size encountered, I employed the Teitz and Bart (1968) heuristic in this case which has proven to provide excellent results, although it does not guarantee global optimal solutions. See Chapter 4 for a discussion of the results.

## 3.2 The Survey

This survey studied the attendance in the English-Chinese Bilingual Kindergarten program in the Edmonton area to identify the reasons why parents sent their children to these kindergartens; it examined relationships between a decision in favor of selecting a certain kindergarten site and factors putatively related to school selection and parents' opinions on the importance of these factors. In this study, I used an online questionnaire to obtain the relevant data.

### 3.2.1 Online Survey

An internet survey posted on a Web site is more convenient for data entry than its paper counterpart, and results can be automatically analyzed (Fink 2006). Web-page-based surveys offer significant advantages in terms of reach, speed and economy (Mann and Stewart 2000). Online survey also has its disadvantages: systems can go down or be

unreliable, respondents must be able to use a browser, and browser must support survey graphics (Fink 2006). Garson (2002) discussed a variety of web software packages for survey research. I used *SurveyMonkey* at http://www.surveymonkey.com/ to host and build questionnaires posted on web sites. It also provided data collection and basic response analysis functions. For further discussion, see 3.2.7 Analysis Methods below.

## 3.2.2 Target Population

The target population for this survey consisted of persons from two groups: current parents and prospective parents. Current parents were those whose children attended the English-Chinese Bilingual Kindergarten program within five public schools in the metropolitan Edmonton area (Caernavon Elementary School, Dovercourt Elementary School, Kildare Elementary School, Meadowlark Elementary School, and Meyonohk Elementary School) during the 2005-2006 academic year. Prospective parents were those who did not have children attending this program during 2005-2006 but were considering sending their children to English-Chinese Bilingual Kindergartens in the future. According to a report from the *Edmonton Chinese Bilingual Education Association*, 135 children were registered in this program during the 2005-2006 academic year. The parents whose children had attended this program in previous years (before 2005-2006) were not considered as a target population because this study was to locate English-Chinese Kindergartens for the current preschool children. Parents of 135 English-Chinese Kindergarten children were thus included as one source of the target population. Choosing current parents and prospective parents as the target population was

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because this project was to study the current locations of English-Chinese Kindergartens, which accommodates the educational needs for the current kindergarten-aged children.

### 3.2.3 Question Design

Survey questions were designed to discover parents' attitudes and opinions toward sending their children to English-Chinese Bilingual Kindergartens in the metropolitan Edmonton area, as well as travel times under their actual condition and desirable condition, respectively.

This questionnaire (see Appendix A for the questionnaire for current parents and Appendix B for the questionnaire for prospective parents) consisted of two sections—the introduction and questions. The first section gave a brief introduction to the purpose of this study, the person conducting it, and the use of the results. The question section consisted of four questions, which the parents would be able to complete in approximately 5 minutes. The first question was an open-ended checklist question. The possible responses were listed by items for respondents to select. The last item under the name "Others. Please specify" asked respondents to formulate their own opinion. A rating scale question was used for the second question, and respondents were encouraged to rate the importance of a variety of given factors that may have influenced parents' decisions on the selection of English-Chinese Kindergartens. A ranking question was also used in the third question which asked parents to make a comparison and select the top three important factors. The last question was in an open-ended form intended to obtain the travel time (counted by minutes) in regard to the mode of transportation which

respondents adopted to send their children to kindergartens. The order of questions followed a sequence from general to specific. The first question was asked to gain some general idea of why attending an English-Chinese Kindergarten was thought to be important. The second and third questions provided a variety of given factors which might impact on parents' decision on the selection of English-Chinese Kindergartens and encouraged parents' to evaluate the importance of those factors. The last question was intended to investigate certain factors—travel time and transportation mode.

Two sets of questionnaires were designed to suit two different survey groups respectively—the current parents and the prospective parents. Questions in these two were organized in the same form and the same order. The alternatives under each question were also of the same order and content. The wording for questions in these two sets was slightly adjusted in accordance with two survey groups. The first question for the current parents set asked why parents sent their child to English-Chinese Kindergarten, while the same question in the prospective parents set was phrased: "if you are considering sending your child to English-Chinese Kindergarten, what reasons are informing your decision?" Same question alternatives were provided under these questions.

### 3.2.4 Ethics

The Arts, Science and Law Research Ethics Board (ASL REB) at the University of Alberta states that all research involving human participants conducted by researchers in the Faculties of Arts, Science, and Law (whether faculty, staff, or student) must be

approved by the ASL REB, or by statutory or appointed members of the REB to whom authority for some decision-making may have been delegated (ASL REB). Before conducting this survey, an ethics application (see Appendix D for Ethics) Application was submitted and approved (see Appendix E for Certificate of REB Approval) by the ASL REB.

## 3.2.5 Sample and Recruitment

Non-probability sampling was used in this survey to draw units from the target population because it was an inexpensive, fast, and convenient way to get the sample. The survey population was carefully selected to represent the target population (current parents of 135 kindergarten children and prospective parents). Because of the unpredictable number of prospective parents, I only planned a convenience sample of 30 for the prospective parents group to study. Another reason of taking 30 samples was for the economic consideration since there was no financial support to this project.

The survey participants were recruited through a web advertisement (see Appendix C for Survey Invitation Letter) placed on the Message Board of *Edmonton China* (www.edmononchina.com), the biggest Chinese web portal in Edmonton, which has more than 7000 registered members since its establishment on May 9th, 2004. By adding a survey invitation message on this open public forum and putting URLs of online questionnaires on it, registered members and visitors were informed and encouraged to participate in this survey. The advertisement directed participants to the questionnaire websites where they were asked to fill in the online questionnaire.

## 3.2.6 Pilot Test

Before formal launch, a pilot test is usually conducted to refine a questionnaire. The results of the pilot survey are not meant to obtain a comprehensive view of target population's responses but to provide indicative and directional data for the following survey. Two-stage pre-testing was conducted for this survey. First, Dr. Stan Ruecker and Dr. Lisa M. Given provided very helpful comments on the question design. Second, 5 parents from each target group participated in a pilot to help check the validity of the URL and the accuracy of the content and format for the questionnaire, as well as estimate the survey completion time. By carrying out this pilot, the efficiency of instructions, organization, and completion time estimates were improved, and a few wording choices were changed.

## 3.2.7 Analysis Methods

Data from each response were tracked and recorded by SurveyMonkey. I transferred the responses from SurveyMonkey to spreadsheet files for later analysis and used Microsoft Excel as the main data entry system and analysis tool. All the four questions were designed to answer the following questions: (1) why parents send their children to English-Chinese Bilingual kindergartens; (2) how parents evaluate the influencing factors when they consider a certain English-Chinese Bilingual Kindergarten, especially the role of travel distance measured by travel time on decision making. Responses were categorized into two areas based on the study aims. I represented the results as simple percentages and counts to illustrate frequencies of responses.

The Statistical Package for Social Science (SPSS) was used for data analysis. A nonparametric one-sample chi-square test was performed to compare cross-participant difference of opinion on the importance of "Travel time less than 20 minutes" as an influencing factor. Standard t-tests were also run on each participant group to determine if "20 minutes" is the average travel time spent on the trip. See Chapter 4 for a discussion of the results.

# Chapter 4. Results and Analysis

This chapter summarizes the $p$-median model solutions and survey questionnaire responses. A comparison of the locations of five current English-Chinese kindergartens and the five ideal locations produced by the $p$-median model is made in order to illustrate how the target function—the minimization of the travel distance (measured by Euclidean distance) is improved. The survey results are broken down into three categories: the reasons for the attendance at an English-Chinese kindergarten program, the factors influencing the selection of a certain kindergarten site, and the extent of influence of the transportation mode and the time spent on the trip.

## 4.1    $P$-median Model Solution and Analysis

### 4.1.1 The Model Solutions

The $p$-median model produced 5 optimal sites for English-Chinese kindergartens from the candidate 159 public elementary schools to serve the target Chinese preschool children between 4 and 6 years old. The locations of the five current English-Chinese kindergartens—Caernarvon, Dovercourt, Meadowlark, Kildare, and Meyonohk—in the Edmonton public school district are shown in Figure 4.1 as well as the respective school area. The five optimal sites are Hillview, Steinhauer, Lymburn, Parkdale, Lorelei (shown in Figure 4.2).
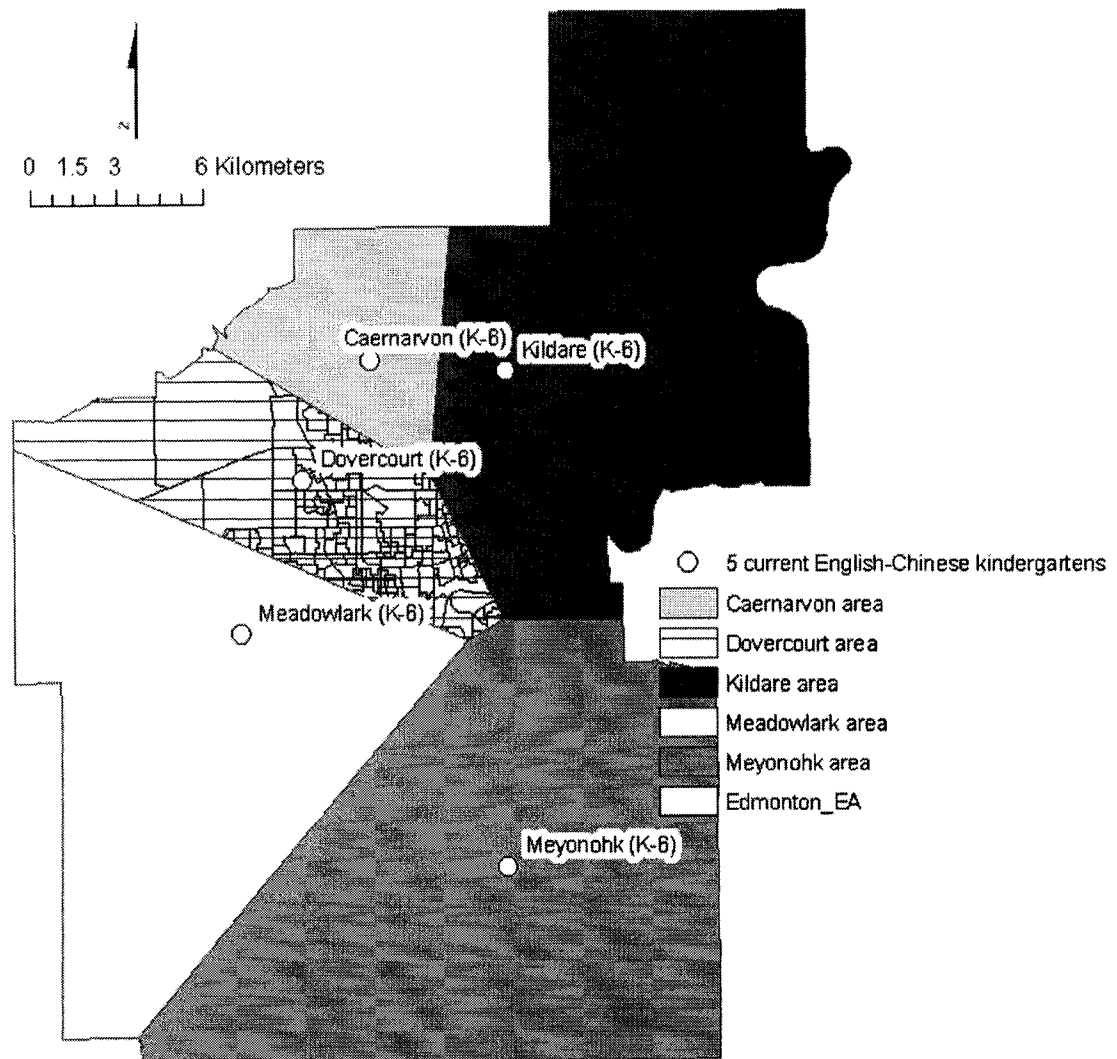
Figure 4.1 Five current English-Chinese kindergartens and their school areas, Edmonton

This map shows the entire city of Edmonton.
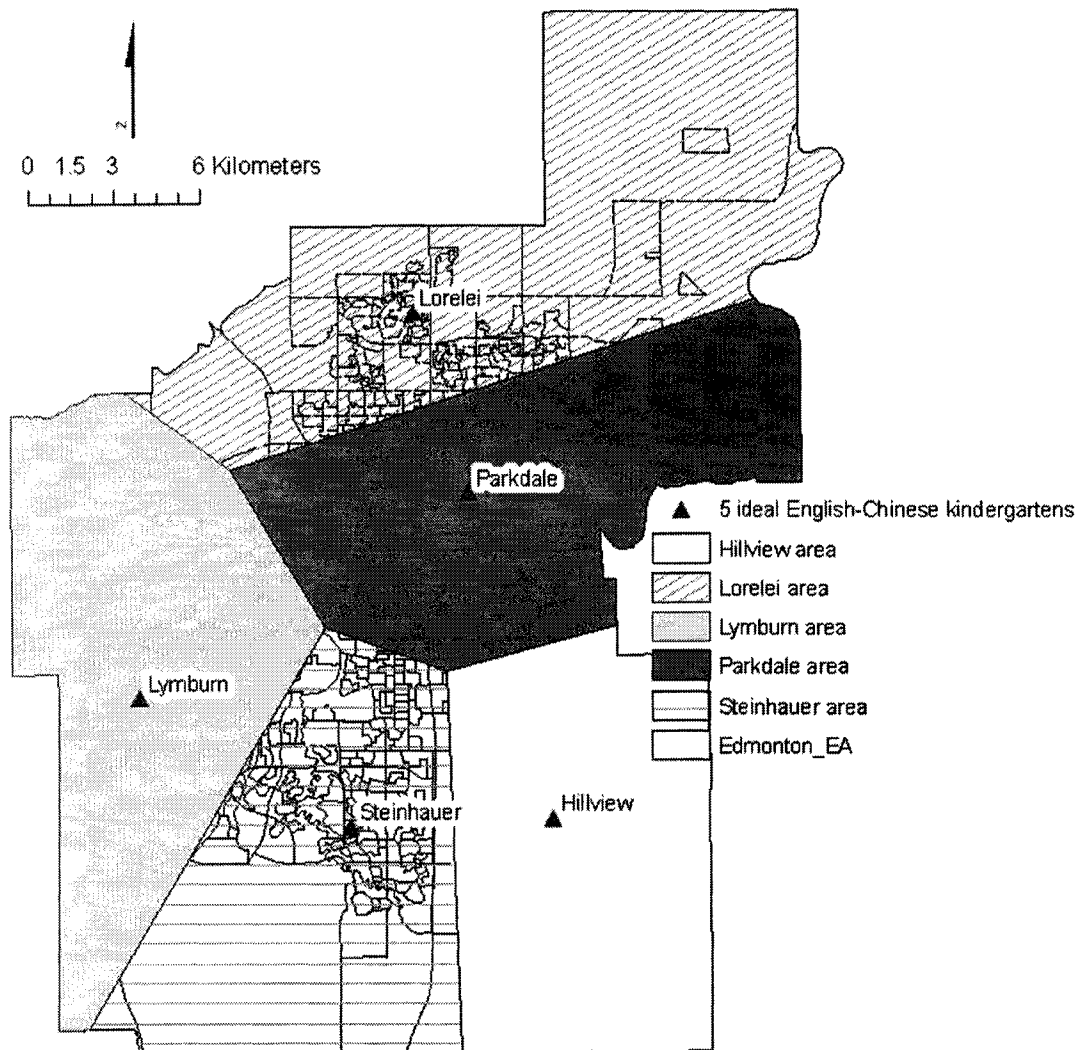
Figure 4.2 Five ideal English-Chinese kindergarten sites and their school areas, Edmonton. This map shows the entire city of Edmonton.

The school areas are represented by wards with various filling patterns. Thiessen Polygons were created by Arcinfo for each kindergarten to show the school area. Each polygon represents only one kindergarten's region having the unique property that any child's residence inside that polygon is closer to the polygon's source point – which is in this case the kindergarten – than to any other kindergarten locations. The current

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kindergarten locations are not very evenly distributed. Three kindergartens—Caernarvon, Dovercourt, and Kildare are located quite near each other. Table 4.1 lists size and percentage of each current school area. Two kindergartens (Meadowlark and Kildare) have the biggest school area with 212 $Km^2$ and 205 $Km^2$ respectively compared to the smallest school area (Caernarvon) of 42 $Km^2$. The optimal locations are much more regularly distributed as compared to the actual locations. Each school has its service area above 100 $Km^2$ (see Table 4.2). In Edmonton, the equally distributed areas are related to the decrease of weight distance. The Lorelei (biggest) size is 52 $Km^2$ bigger than the Hillview (smallest) one. The maximum school area drops from 212 $Km^2$ (Meyonohk) in the actual five Kindergartens to 175 $Km^2$ (Lorelei) in the ideal ones, about a 17% decrease. The percentage of maximum school area also drops, from 30.33% to 25.01%.

| Current five Kindergarten | Size (Km2) | % |
|---|---|---|
| Caernarvon | 42 | 6.07 |
| Dovercourt | 72 | 10.42 |
| Meadowlark | 166 | 23.81 |
| Kildare | 205 | 29.37 |
| Meyonohk | 212 | 30.33 |

Table 4.1 School area sizes of current five English-Chinese kindergartens

Note: The % size difference is quite strong.

| Optimal five Kindergarten | Size (Km2) | % |
|---|---|---|
| Hillview | 123 | 17.59 |
| Steinhauer | 124 | 17.73 |
| Lymburn | 137 | 19.71 |
| Parkdale | 139 | 19.95 |
| Lorelei | 175 | 25.01 |

Table 4.2 School area sizes of five optimal English-Chinese kindergartens

Note: The % size turns out to be roughly equal.

## 4.1.2 Distance, WeightDistance in Optimal and Actual Kindergarten Locations

One of the important factors considered in evaluating the solution produced by the *p*-median model is the distance – specifically, the Euclidean distance between each demand point to its nearest service site. I therefore made a comparison of the solutions of actual and optimal locations here to see how distance and weightdistance are reduced in ideal solution by the model (see Table 4.3). Weightdistance is calculated for each demand point as the product of weight (population count) and distance in Km. All the maximum distance, minimum distance, and maximum weightdistance are shorter in the optimal set of five kindergartens, as I expected: the optimal five kindergarten locations would decrease the straight line distance between kindergartens and the target children's residences, accordingly the travel distance is diminished. Maximum distance is reduced 23.91% from the current solution to the optimal solution. Table 4.3 indicates that for the five kindergartens solution, the current locations are poorly distributed with a high total weighted distance of 2481.63 KmPop. The optimal solution received weightdistance of 1783.33 KmPop with a drop of 28.14%.

|  | Max Distance (Km) | Min WeightDistance (KmPop.) | Max WeightDistance (KmPop.) | Sum WeightDistance (KmPop.) |
|---|---|---|---|---|
| Current 5 | 9.97 | 0.364 | 58.37 | 2481.63 |
| Optimal 5 | 7.59 | 0.106 | 50.95 | 1783.33 |
| Decrease% | 23.91 | 70.74 | 12.71 | 28.14 |

Table 4.3 Allocation of demand points to five ideal English-Chinese kindergarten sites in Edmonton

## 4.1.3 Allocation of Target Population

I studied the allocation of the target population located at demand points in order to examine the quality of the ideal solution produced by $p$-median. 250 EAs with a target population of 640 are allocated respectively to five current and ideal English-Chinese kindergarten sites. I present Figure 4.3 and Figure 4.4 to show the distribution of demand points to kindergartens with spider lines for the actual 5 kindergartens and the ideal 5 kindergartens. Spider lines are created by Arcview to draw a line between each demand location and its nearest service. In this case, I only consider the straight line Euclidean distance when allocating the nearest kindergarten for Chinese kindergarten children. The optimal spider lines (see Figure 4.4) are far more symmetrical than those for the actual locations (see Figure 4.3). Specifically, one location is moved from the north area to the south; this change, in turn, balances the heavy demands in the southern area.
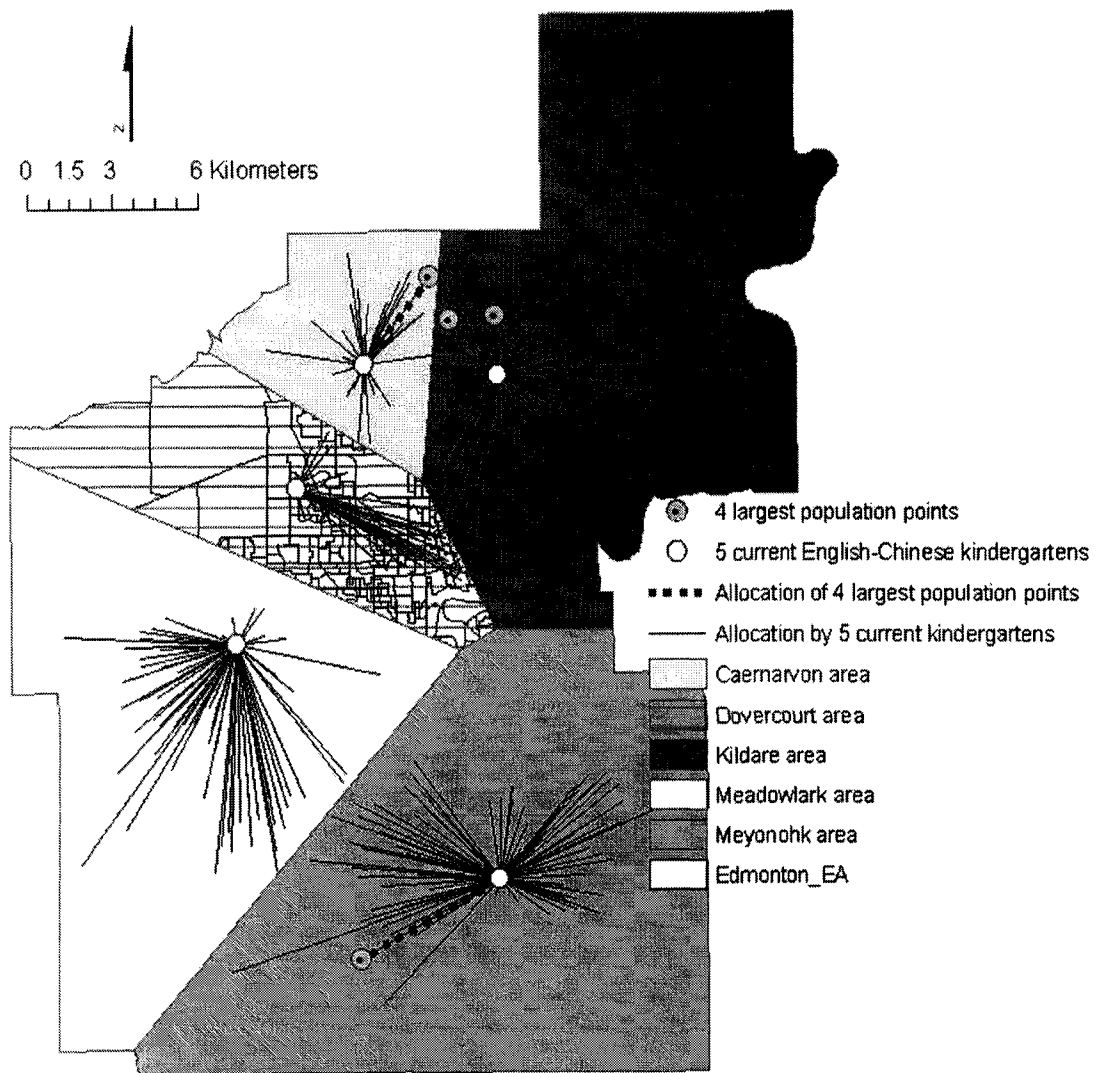
Figure 4.3 Allocation of demand points to five current English-Chinese kindergarten sites,

Edmonton. This map shows the entire city of Edmonton.
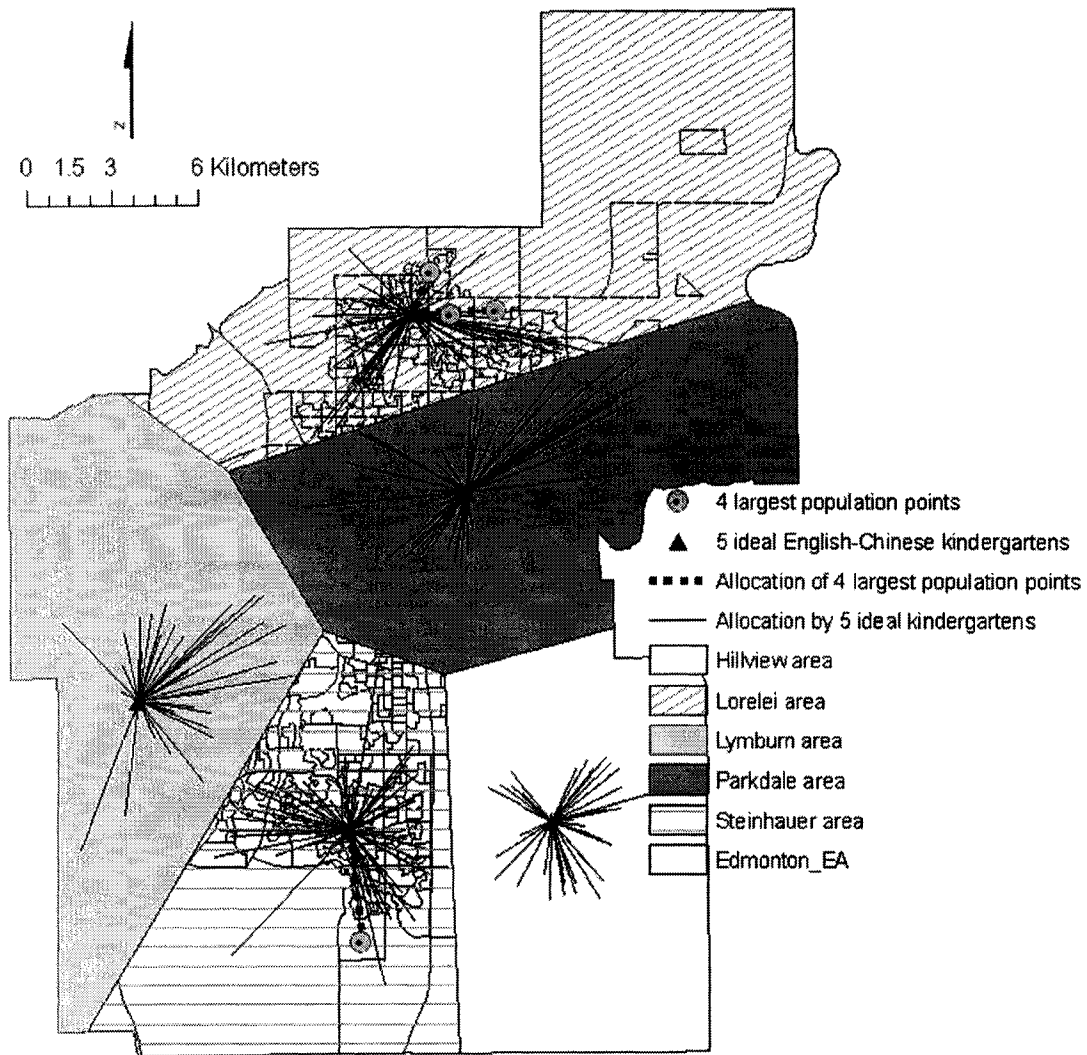
Figure 4.4 Allocation of demand points to five ideal English-Chinese kindergarten sites, Edmonton. This map shows the entire city of Edmonton.

The above two figures also illustrate how the four biggest demand points (the largest population points) are served (as seen in dash line). The distances from the four largest demand points to their closest kindergarten are greatly reduced in the ideal solution compared to the current kindergarten locations, indicating users would be better served. I make a comparison of how well the largest four demand points are satisfied by the actual 5 kindergartens and the optimal 5 ones (Figure 4.5). The figure below indicates

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the optimal solution apparently reduces weightdistance for the three largest demand points. The reduction of weightdistances for all the demand points is between 30.9% and 58.43% except one demand point receives an increase of 20.87% in the optimal set of kindergartens.

| | 19.3 | 11.2 | 10.4 | 10.0 |
|---|---|---|---|---|
| ▣ Allocation of current 5 Ks | 48324.39 | 22821.18 | 58370.60 | 37669.54 |
| ☐ Allocation of expected Ks | 27584.92 | 34223.59 | 40334.55 | 15658.78 |
| Decrease % | 42.92 | -20.87 | 30.90 | 58.43 |
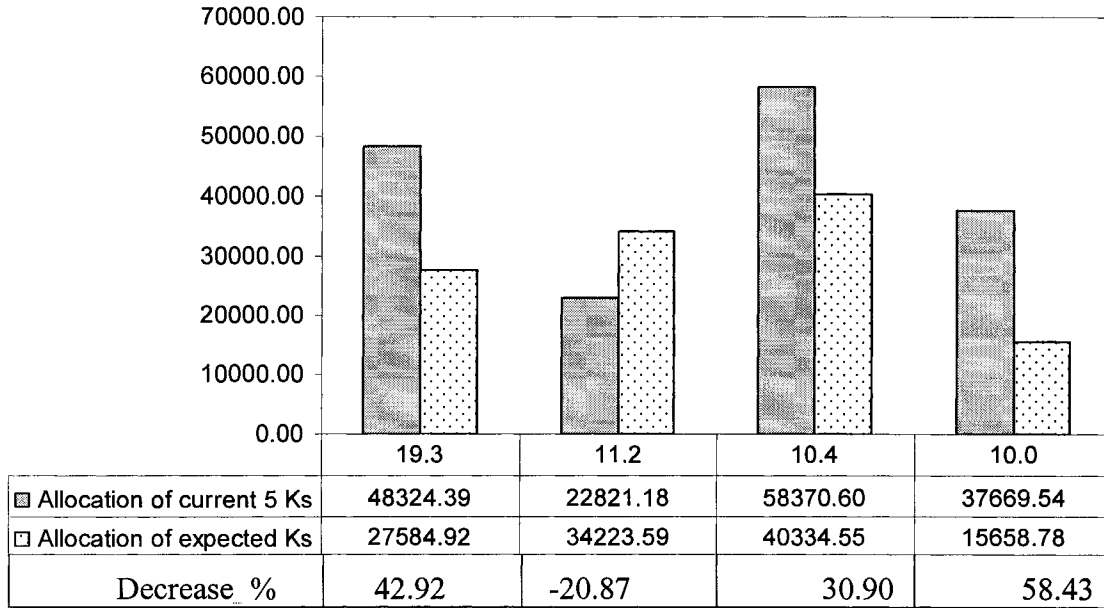
Figure 4.5 Comparison of weight distances in the current and optimal kindergarten sites for 4 largest demand points. The x-coordinate shows the population of the four largest demand areas. The y-coordinate shows the weight distance value for the current solution and the ideal solution.

## 4.2   The Survey Results and Analysis

This survey was available for 50 days on the World Wide Web and it collected 72 responses during this period, including 32 completed responses from current parents, 38 completed responses from prospective parents, and 2 incomplete responses from current parents—one with one missing item in the 2nd question, the other with one missing item in the 3rd question. Because the proportion of missing responses was very low in this

case—2 of 72, I adopted listwise deletion (Allison 2002) to excluded two respondents from the analysis data set. The data obtained from the 70 survey participants were analyzed first to identify the reasons for selecting an English-Chinese kindergarten program from both the perspectives of current parents and prospective parents, and then were used to discover the factors influencing the selection of a certain English-Chinese kindergarten school. A comparison was also made to find the three most important factors when considering a certain English-Chinese kindergarten as well as to validate the importance of the travel distance or travel time in affecting the selection of a specific kindergarten.

When asked reasons for sending their children to English-Chinese kindergartens, respondents provided the highest ratings for the factors relating to competitive advantage. When asked to rate the importance of factors affecting the selection of a particular English-Chinese kindergarten, respondents provided the highest ratings for "Quality of education" and "Quality of teacher". The results suggested that the majority of parents surveyed preferred the car as their chosen mode of transportation to drop-off and pick-up children. When asked about travel time, less than 20 minutes was acceptable to most of the respondents. The implication of the survey finding is that a model merely based on travel time might not be the best kind of model to be using for this kind of problem, and that factors such as quality of education, teacher quality, teaching methods should be also considered as important determinants. Future research might look at adding other kinds of parameters to the model to simulate more realistic and sophisticated situations.

## 4.2.1 Why Attend English-Chinese Bilingual Kindergarten?

The first question is used to examine the reasons for sending children to English-Chinese kindergarten. Of the total responses from all participants, over 50% agree that two factors contributed to choosing an English-Chinese kindergarten program—(1) A. Family members, or friends, or relatives can speak Chinese and (2) D. You want your child to be more competitive for effective communication with Chinese-speaking people (See Table 4.4). 24 respondents from current parents, which accounted for 75% of total respondents, support the competitive advantage of Chinese language for effective communication with Chinese-speaking people and select this as the reason for sending their children to English-Chinese kindergarten. This reason is also chosen by 26 prospective parent participants. Data from the current parents group and prospective parents group reveal a high support (75% and 68%, respectively) on "more competitive for effective communication". Therefore, the high response rate on item D shows that the consideration of the competitive advantage of Chinese language is ranked as the first reason of attending English-Chinese kindergarten. The parents believe that the mastery of the Chinese language could enable their children to have the key to communicate with Chinese-speaking people with the resulting increased potential for economic links and social interaction with them. My survey results on one hand reveal the recognition of the economic values of the language for children's futures; on the other hand, parents sending their children to English-Chinese kindergartens have very high expectation of their children's future career and self development. The survey confirms the results of Lao's (2004) study that the major reasons parents enrolled their children in Chinese-English bilingual school were the practical advantages of being bilingual (e.g., better

career opportunities), positive effects on self-image, and development of skills enabling

effective communication within the Chinese-speaking community. Much lower rates of

choosing the other four reasons (item B, C, E and F) are also found within both two

participant groups.

| Numbers and % of parents choosing these reasons | | | | |
|---|---|---|---|---|
| Reasons* | Current Parents | | Prospective Parents | |
| | Frequency | Percent | Frequency | Percent |
| A. Family members, or friends, or relatives can speak Chinese, so you want your child to go to English-Chinese Kindergarten | 17 | 53.0 | 23 | 60.5 |
| B. Family members, or friends, or relatives like Chinese culture and custom, so you want your child to learn Chinese. | 12 | 37.5 | 9 | 23.7 |
| C. Child likes language learning and wants to study Chinese. | 8 | 25.0 | 6 | 15.8 |
| D. You want your child to be more competitive for effective communication with Chinese-speaking people. So you want your child to go to English-Chinese Kindergarten | 24 | 75.0 | 26 | 68.4 |
| E. Parents have relatives or friends who sent their children to English-Chinese Kindergarten. So you want your children to attend it too. | 3 | 9.3 | 2 | 5.3 |
| F (others):. 1.Chinese is the mother tongue. | 1 | 3.1 | 1 | 2.6 |
| Total: | 32 | 100 | 38 | 100 |

Table 4.4 Numbers and % of parents choosing reasons (* Respondents could pick more

than one choices.)

## 4.2.2 How Do Parents Evaluate the Influencing Factors?

Respondents were asked to rate the importance of the factors affecting the selection of kindergarten on five scales, with the end-points designated as *Very important* and *Not important*. There are 14 items corresponding to each factor to represent three different domains: education quality (teacher quality, education quality, school reputation, and history enrolments), cost (travel time, accessibility), and external influencing factors (friends' decisions, school administration, school facility and surrounding environment). As can be seen in Table 4.5 and Table 4.6, over half of the respondents rate the following five items either as *Somewhat important* or *Very important* : (1) h. teacher quality (personality, attitude to teaching, the way to treat students); (2) i. teaching methods; (3) j. quality of education; (4) k. school reputation; (5) m. class size (less than 20). Both two groups of respondents indicate a consensus on the above four items (h, i, j, k) and rate them as *Very important* factors. Both participant groups give the factor of "Quality of education" a very high rate of 85% and 92% respectively under *"Very important"*, which are the highest two response rates among all the influencing factors, as shown in Table 4.5 and 4.6. For the current parents group, 70% of participants (which is the second highest rate found in this group) agree that "Teaching methods" is *"Very important"*, as seen in Table 4.5. While for the prospective parents group, the second highest rate is given to "Teacher quality"—79% respond to it as *"Very important"*, as seen in Table 4.6.

Another likeness can be found in both the current parents group and the prospective parents group in the opinion on "Class size"—it received 55% and 58 % responses (see Table 4.5 and 4.6) from the current parents group and the prospective parents group respectively, that is, 18 and 22 respondents chose "class size less than 20"

as a *"Somewhat important"* factor. 55% of the current parent respondents denote that the factor of "convenient accessibility (near residence)" is *"Somewhat important"*.

In respect to the factor of "travel time less than 20 minutes", there is no indication that all current parents participants equally viewed "Travel time less than 20 minutes" as very important, somewhat important, less important, not important, or in between . However, this factor was considered *"somewhat important"* by the largest number of survey respondents (14 out of 33 respondents). The finding leads to the same conclusion as seen in current parents group—the largest number of respondents (15 out of 38 respondents) rated "travel time less than 20 minutes" as a *"somewhat important"* factor.

| Numbers and % of current parents evaluating the factors | | | | | |
|---|---|---|---|---|---|
| | Not important | Less important | In between | Somewhat important | Very important |
| a. Travel time less than 20 mins | 3% (1) | 9% (3) | 21% (7) | 42% (14) | 24% (8) |
| b. Good surrounding environment of school (quiet, safe, clean, healthy) | 0% (0) | 12% (4) | 25% (8) | 22% (7) | 41% (13) |
| c. Convenient accessibility (near residence) | 3% (1) | 6% (2) | 18% (6) | 55% (18) | 18% (6) |
| d. Convenient accessibility (near main road) | 12% (4) | 30% (10) | 36% (12) | 15% (5) | 6% (2) |
| e. Convenient accessibility (on the way to work) | 0% (0) | 9% (3) | 33% (11) | 48% (16) | 9% (3) |
| f. School facility (excellent building, classroom and etc.) | 0% (0) | 21% (7) | 33% (11) | 27% (9) | 18% (6) |
| g. School standardized administration (teaching, general service and etc.) | 0% (0) | 9% (3) | 15% (5) | 33% (11) | 42% (14) |
| h. Teacher quality (personality, attitude to teaching, the way to treat students) | 0% (0) | 0% (0) | 12% (4) | 19% (6) | 69% (22) |
| i. Teaching methods | 3% (1) | 0% (0) | 3% (1) | 24% (8) | 70% (23) |
| j. Quality of education | 3% (1) | 0% (0) | 3% (1) | 9% (3) | 85% (28) |
| k. School reputation | 3% (0) | 0% (1) | 9% (2) | 34% (10) | 53% (16) |
| l. History enrollment | 0% (0) | 3% (1) | 22% (7) | 47% (15) | 28% (9) |
| m. Class size (less than 20) | 0% (0) | 9% (3) | 24% (8) | 55% (18) | 12% (4) |
| n. Friends' children attend this kindergarten (so you want your children attend the same one) | 12% (4) | 39% (13) | 30% (10) | 12% (4) | 6% (2) |
| Total responses: | 33 | | | | |
| Missing: | 1 | | | | |

Table 4.5 Importance of factors by the current parent participants

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| Numbers and % of prospective parents evaluating the factors | | | | | |
|---|---|---|---|---|---|
| | Not important | Less important | In between | Somewhat important | Very important |
| a. Travel time less than 20 mins | 3% (1) | 13% (5) | 34%(13) | 39% (15) | 11% (4) |
| b. Good surrounding environment of school (quiet, safe, clean, healthy) | 0% (0) | 5% (2) | 29%(11) | 34% (13) | 32% (12) |
| c. Convenient accessibility (near residence) | 3% (1) | 16% (6) | 32%(12) | 45% (17) | 5% (2) |
| d. Convenient accessibility (near main road) | 8% (3) | 47% (18) | 29%(11) | 16% (6) | 0% (0) |
| e. Convenient accessibility (on the way to work) | 3% (1) | 21% (8) | 29%(11) | 47% (18) | 0% (0) |
| f. School facility (excellent building, classroom and etc.) | 0% (0) | 24% (9) | 32%(12) | 37% (14) | 8% (3) |
| g. School standardized administration (teaching, general service and etc.) | 0% (0) | 11% (4) | 5% (2) | 47% (18) | 37% (14) |
| h. Teacher quality (personality, attitude to teaching, the way to treat students) | 0% (0) | 0% (0) | 0% (0) | 21% (8) | 79% (30) |
| i. Teaching methods | 0% (0) | 0% (0) | 0% (0) | 34% (13) | 66% (25) |
| j. Quality of education | 0% (0) | 0% (0) | 0% (0) | 8% (3) | 92% (35) |
| k. School reputation | 0% (0) | 0% (0) | 0% (0) | 32% (12) | 68% (26) |
| l. History enrollment | 0% (0) | 0% (0) | 21% (8) | 55% (21) | 24% (9) |
| m. Class size (less than 20) | 0% (0) | 11% (4) | 13% (5) | 58% (22) | 18% (7) |
| n. Friends' children attend this kindergarten (so you want your children attend the same one) | 26% (10) | 29% (11) | 24% (9) | 18% (7) | 3% (1) |
| Total responses: | 38 | | | | |

Table 4.6 Importance of factors by the prospective parent participants

## 4.2.3 Top Three Most Important Factors

After the evaluation of each influencing factor, respondents were asked to indicate three factors they felt were the most important factors when considering having their children attend an English-Chinese kindergarten program. The survey results of the current parents indicate "Quality of education" is the most important factor as selected by 13 out of 32 respondents which comprise nearly 41 percent of the survey participants. "Teacher quality" remains the second; 5 out of 32 respondents rank it as "the most important factor", followed by "Teaching methods" (3 %), "Travel time less than 20 minutes" (3 %), and "Good surrounding environment of school" (3 %). It is similar for the prospective parents group that 61 percent of 38 respondents agree that "Quality of education" is the most important factor. Five current parent respondents select "Teacher quality" as the first important factor after the factor of "Quality of education", while this factor is selected by 12 of 38 prospective parent respondents.

For the second important factor, the item of "School reputation" receives the highest support—9 of 32 current parent responses. The survey results indicate most of the prospective parent respondents—a total of almost 95 percent select the following four factors as the second important factor: "Teacher quality", "Quality of education", "School reputation" and "Teaching methods". In addition, response rates for these four factors are very close.

For the third important factor, four items--"Teacher quality", "Quality of education", "School reputation" and "Teaching methods" are more likely selected by current parents participants, among which "Teaching methods" and "Quality of education" are chosen by the same number of participant. The highest response rate of 7

participants can be found on two factors – "School reputation" and "Travel time less than 20 minutes" in the prospective parent group. The subsequent factors of "Teaching methods" and "Teacher quality" also have high responses rates.

Of all the influencing factors, those indicating "quality" such as "Quality of education", "Teacher quality", and "School reputation" are more likely chosen as the top three most important factors by both two groups of participants. "Quality of education", and "Teacher quality" are selected as the first important factors by 18 out of 32 current parent respondents; for the prospective parents group, 92 percent of 38 respondents select these two factors as well. Only one exception is found in the prospective parent respondents—"Travel time less than 20 mins" and "School reputation" have the same highest responses of 7 as the third important factor.

## 4.2.4 Transportation Mode and Travel Time

The answers given by respondents to the question related to transportation mode adopted by the current parent and travel time spent on trip reveal that current parents mainly rely on two modes of transportation—bus and car: 53 percent of current parents report they send children to school by car, nearly 41 percent take public transit, only 2 of 32 current parents (see Table 4.7) indicate they walk children to school on foot which takes less than 8 minutes. For the prospective parent group, the question asks the expected mode of transportation and the time they would like to spend on the trip. From Table 4.7. I notice that out of 38 responses obtained from the prospective parents group, a total of 34 respondents prefer bus or car and it is usually expected to take 15 minutes to get to school (Mode=15). It is interesting to note that 2 out of 38 respondents do not mind what transportation mode or how much travel time they spend. By comparison, the car

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remains the highest response rate in both participant groups. The survey results indicate that "bus" and "car" are the most commonly adopted transportation modes by both current parents and prospective parents. In terms of the time spent on the trip, less than 20 minutes is acceptable by most of the respondents. I found the difference between the observed mean (14.88 minutes) (Table 4.8) and the hypothetical mean (20 minutes) (labeled *Test Value* in Table 4.9) is -5.125 according to a One-Sample T test. The observed significance level is 0.000. I therefore conclude that it is quite unlikely that current parents spend more than 20 minutes from residences to kindergartens on average. A similar conclusion is also found for prospective parents that greater than 20 minutes from residences to kindergartens on average is unlikely, with a mean of 14 (Table 4.10) and a significance of 0.000 (Table 4.11).

| Mode of Transportation | Number of Responses | | Travel Time (minutes) | |
|:---:|:---:|:---:|:---:|:---:|
| | | | Mode | |
| | Current Parents | Prospective Parents | Current Parents | Prospective Parents |
| Bus | 13 | 7 | 15 | 15 |
| School Bus | N/A | 1 | N/A | 10 |
| Car | 17 | 27 | 10 | 15 |
| Foot | 2 | 1 | 8 | 5 |
| Don't mind | N/A | 2 | N/A | don't mind |
| Total | 32 | 38 | | |

Table 4.7 Transportation mode and travel time

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error Mean |
| Time spent on trips for the current parents (mins) | 32 | 14.88 | 5.95 | 1.052 |

Table 4.8 One-sample statistics for "travel time by current parents"

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 20 | | | | | |
| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Time spent on trips for the current parents (mins) | -4.872 | 31 | .000 | -5.125 | -7.27 | -2.98 |

Table 4.9 One-sample test for "travel time by current parents"

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error Mean |
| Time spent on trips for prospective parents (mins) | 38 | 13.84 | 5.659 | 0.918 |

Table 4.10 One-sample statistics for "travel time by prospective parents"

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 20 | | | | | |
| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Time spent on trips for prospective parents (mins) | -6.707 | 37 | .000 | -6.158 | -8.02 | -4.3 |

Table 4.11 One-sample test for "travel time by prospective parents"

# Chapter 5. Conclusion

## 5.1 *P*-median Model

Five kindergarten sites were located so as to minimize the weight distance between the kindergarten facilities and the target preschool children's residences. A set solution of five potential sites produced by the *p*-median model distributes more evenly, which helps to balance the needs of the most intense target population in northern, southwestern, and southern areas, and also reduces the travel distance between children's residences and their nearest English-Chinese kindergartens. The *p*-median applied in this study solved the unlimited the number of facilities location problem to serve an existing population. Another type of problem solved by Holmes (1972) is to locate a limited number of day care facilities to maximize service to an existing population in Columbus, Ohio.

## 5.2 The Survey

The survey result indicates the competitive advantage of Chinese language receives significant attention and is selected by the majority of respondents when parents consider an English-Chinese bilingual kindergarten program.

The largest number of participant parents rate "quality of education", "teaching methods" and "teacher quality" as very important factors. When asked which of several factors would be the most important factor for selecting an English-Chinese kindergarten, *quality of education* and *teacher quality* are ranked in the top two answers by both groups of participants—the current parent group and the prospective parent group. A far greater number of participants rate either *teacher quality, school reputation, quality of education,*

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*teaching methods* as the second important factor. "Quality of education" and "teaching methods" receive the highest responses as the third important factor from current parent participants, while "travel time less than 20 minutes" and "school reputation" are more likely chosen by prospective parent participants. Although lots of influencing factors were given, parents are usually more concerned about quality, including the quality of both the teaching and the teachers when selecting a certain English-Chinese kindergarten school. Travel time and the adoption of different modes of travel are not considered as a critical factor when parents select a certain English-Chinese kindergarten. However, less than 20 minutes was acceptable to most respondents.

## 5.3    Limitations of the Study

### 5.3.1 *P*-median Model Assumptions

### 5.3.1.1 Distance as the Only Factor

The basic modeling is rooted in the assumption that parents consider only the distance from residence to kindergarten. The most critical and unrealistic assumption is that each kindergarten has the same attractions to the prospective preschool children except the distance between schools and residences. Children always prefer the kindergarten closest to their residences.  In the real world, there are many factors influencing the selection of a kindergarten location. Important factors such as education quality, teacher quality, environment, and accessibility are ignored when modeling the kindergarten location-allocation problem. The survey results reveal that "quality" is the most important factor in deciding which kindergarten school to attend.

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The *p*-median model also presumes Euclidean plane distance as the distance between residences to schools. However, in practice, we must follow certain routes which are normally not the straight line. Furthermore, the distance is highly determined by the selections of various routes to destination. The shortest walking distance, shortest distance by bus, and distance by car might not be the same. Therefore, the actual travel time would be more accurate than the Euclidean distance when considering how far it is from residence to school. Since the data of travel time between residences and schools at the EA level in Edmonton are not available, the straight line length between the centroid of each demand EA and Edmonton public elementary school is calculated as the shortest distance. Hodgson and Storrier's (1995) study indicated that different distance measures—Euclidean distance, Manhattan distance, and travel time, produced exactly the same solutions in most of the equal facility numbers. However, there is still no guarantee that this solution will make no difference in terms of school locations and demand allocation by using travel time and Euclidean distance.

## 5.3.1.2 Target Population

The target population is defined as the children between 4 and 6 years old likely to attend English-Chinese bilingual program. However there is no way to obtain the exact target population at EA level, so instead I calculate an approximate population of Chinese children between 4 and 6 years old based on Census 2001. I also assume all Chinese children attend this program. The calculation is also based on the assumption that the population of Chinese children has the same proportion as that of the Chinese population per capita. Census 2001 takes counts of the total population on a base of 5 for any block having a population of less than 15 as one of the measures to protect the privacy of

Canadians and the confidentiality of the data. This may result in a systematic inaccuracy in the estimated target population.

## 5.3.2 Limitations of the Survey

Using the Internet to conduct a survey has significant advantages: participants are recruited with relative ease, and data are collected quickly and easily to form a large data set. There are disadvantages associated with conducting an Internet survey as well. The sample of respondents from the Web site may not be representative of the general population. The same kind of problem exists in my study. Since the survey invitation was posted on *Edmonton China*, an online community bulletin board, most of the participants are registered members and visitors of this virtual community. The survey does not reflect the population as a whole. In addition, as Chinese language predominates in most of the communication in this online community, many other qualified English-speaking participants who might also be interested in this survey did not have opportunities to respond. Further, the use of the computer and Internet restricts the potential participants who do not have computers and Internet access.

## 5.4   Future Research

My future work will mainly concentrate on two issues regarding the data sources and methods adopted in estimating school locations.

Any location-allocation decision making is highly dependent on the quality and accuracy of the data obtained. The location solution presented in this thesis can be improved by using a more recent and accurate target population of Chinese preschool children. Travel time as the weight measuring the distances between potential schools and

target children's residences may also be more accurate than Euclidean distance. The solution suggested by the $p$-median location-allocation model might be more convincing if it used travel time. Since the heuristic algorithm would not guarantee an optimal solution, I plan to use a linear optimization programming—the AMPL modeling language (Fourer et al., 1993) to enumerate all the possibilities to find the global optimal set of English-Chinese Bilingual Kindergarten locations, as well as the allocations of target population.

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# Appendices

## Appendix A: Survey on the Attendance at English-Chinese Kindergarten in the City of Edmonton—for Current Parents

### Survey on the Attendance at English-Chinese

### Kindergartens in the City of Edmonton

For the **current parents** whose children are enrolled in English-Chinese Kindergarten program in Edmonton.

This survey is intended to discover why people send their children to English-Chinese Bilingual Kindergartens in Edmonton and what are influencing factors when they consider one English-Chinese Bilingual Kindergarten. The results of this survey will be only used to provide useful information for my thesis. Your participation in this research is strictly voluntary. If you have any questions or concerns about this research project, please contact:

Jing Zhou, Humanities Computing
jing.zhou@ualberta.ca   (780) 432-4179

1. Why do you send your child to English-Chinese Kindergarten? *Check one or more.*

A. Family members, or friends, or relatives can speak Chinese, so you want your child to go to English-Chinese Kindergarten._____.

B. Family members, or friends, or relatives like Chinese culture and custom, so you want your child to learn Chinese._____.

C. Child likes language learning and wants to study Chinese._____.

D. You want your child to be more competitive for effective communication with Chinese-speaking people. So you want your child to go to English-Chinese Kindergarten._____.

E. Parents have relatives or friends who sent their children to English-Chinese Kindergarten. So you want your children to attend it too._____.

F. Other reasons.
Please specify_____.

2. What do you think of the following considerations when you selected one English-Chinese Kindergarten? *Indicate a number from one to five.*

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Very important | Somewhat important | In between | Less important | Not important |

_____a. Travel time less than 20 mins

_____b. Good surrounding environment of school (quiet, safe, clean, healthy)

_____c. Convenient accessibility (near residence)

_____d. Convenient accessibility (near main road)

_____e. Convenient accessibility (on the way to work)

_____f. School facility (excellent building, classroom and etc.)

_____g. School standardized administration (teaching, general service and etc.)

_____h. Teacher quality (personality, attitude to teaching, the way to treat students)

_____i. Teaching methods

_____j. Quality of education

_____k. School reputation

_____l. History enrollment

_____m. Class size (less than 20)

_____n. Friends' children attend this kindergarten (so you want your children attend the same one)

3. Among the above factors, what are the **Top Three** important factors in selecting a certain English-Chinese kindergarten? *Please identify each one (by letter) in order of importance.*

The first important _____.
The second important _____.
The third important _____.

4. If you currently take your child to English-Chinese kindergarten, what mode of transportation do you take? And how much travel time do you spend from your residence to school? *(Possible answer might be: bus 15 mins, car 10 mins etc.)*

## *Thank you for your time and assistance with this survey.*

# Appendix B: Survey on the Attendance at English-Chinese Kindergarten in the City of Edmonton—for Prospective Parents

## Survey on the Attendance at English-Chinese

## Kindergartens in the City of Edmonton

For the **prospective parents** who might send their children to English-Chinese Kindergartens.

This survey is intended to discover why people send their children to English-Chinese Bilingual Kindergartens in Edmonton and what are influencing factors when they consider one English-Chinese Bilingual Kindergarten. The results of this survey will be only used to provide useful information for my thesis. Your participation in this research is strictly voluntary. If you have any questions or concerns about this research project, please contact:

Jing Zhou, Humanities Computing
jing.zhou@ualberta.ca     (780) 432-4179

1. If you are considering sending your child to English-Chinese Kindergarten, what reasons are informing your decision? *Check one or more.*

A. Family members, or friends, or relatives can speak Chinese, so you want your child to go to English-Chinese Kindergarten._____.

B. Family members, or friends, or relatives like Chinese culture and custom, so you want your child to learn Chinese._____.

C. Child likes language learning and wants to study Chinese._____.

D. You want your child to be more competitive for effective communication with Chinese-speaking people. So you want your child to go to English-Chinese Kindergarten._____.

E. Parents have relatives or friends who sent their children to English-Chinese Kindergarten. So you want your children to attend it too._____.

F. Other reasons.
   Please specify_____.

2. What do you think about the following considerations when you are considering selecting one English-Chinese Kindergarten? *Indicate a number from one to five.*

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Very important | Somewhat important | In between | Less important | Not important |

_____ a. Travel time less than 20 mins

_____ b. Good surrounding environment of school (quiet, safe, clean, healthy)

_____ c. Convenient accessibility (near residence)

_____ d. Convenient accessibility (near main road)

_____ e. Convenient accessibility (on the way to work)

_____ f. School facility (excellent building, classroom and etc.)

_____ g. School standardized administration (teaching, general service and etc.)

_____ h. Teacher quality (personality, attitude to teaching, the way to treat students)

_____ i. Teaching methods

_____ j. Quality of education

_____ k. School reputation

_____ l. History enrollment

_____ m. Class size (less than 20)

_____ n. Friends' children attend this kindergarten (so you want your children attend the same one)

3. Among the above factors, what will the **Top Three** important factors be when you consider selecting a certain English-Chinese kindergarten? *Please identify each one (by letter) in order of importance.*

A. The first important _____.
B. The second important _____.
C. The third important _____.

4. If you believe that you may take your child to English-Chinese kindergarten in future, which mode of transportation do you prefer to take? And how long would you like to travel? (*Possible answer might be: bus 15 mins, car 10 mins etc.*)

### *Thank you for your time and assistance with this survey.*

# Appendix C: Survey Invitation Letter

If you

      1) have children enrolled in the English-Chinese Bilingual Kindergartens Program (ECBKs) during the 2005-2006 school years
or
      2) are considering sending your children to this program in future

then I would like to invite you to participate in an online survey. Please click on the link below. Thank you for your time.

1) For the current parents participants whose children are enrolled in the English-Chinese Bilingual Kindergartens Program (ECBKs) during the 2005-2006 school years, please find the survey at
http://www.surveymonkey.com/s.asp?u=245292073432

2) For the prospective parents participants who are considering sending their children to the English-Chinese Bilingual Kindergartens, please find it at
http://www.surveymonkey.com/s.asp?u=157222073428

STUDY PURPOSE-The purpose of this survey is to discover why people send their children to English-Chinese Bilingual Kindergartens in Edmonton and what the influencing factors are when you consider English-Chinese Bilingual Kindergarten. The results of this survey will be only used to support research for my thesis project, which seeks an optimal solution to the location/allocation model for English-Chinese Bilingual Kindergartens in Edmonton.

STUDY PROCEDURE-The study involves an online survey that consists of four questions and will take approximately 5-8 minutes. We would like you to complete the whole survey, but you may skip any questions that you don't feel comfortable answering.

CONFIDENTIALITY-Participant responses will be kept in an anonymous manner. This means that there is no way for your identity to be linked to your responses. The responses of all participants will be stored numerically and only the investigators on the study will have access to that data. Only summarized data will be presented at meetings or in any publications.

RISKS- This study has been reviewed and approved by Arts, Science &Law Research Ethics Board at University of Alberta and has been determined to be of minimal risk to participants.

VOLUNTARY PARTICIPATION-Your participation in this study is completely voluntary and your answers will be kept anonymous. Your are free not to participate

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or to withdraw at any time, for whatever reason.

If you have any questions or concerns about this research project, please contact:

Jing Zhou, Humanities Computing
jing.zhou@ualberta.ca      (780) 432-4179


Sincerely,
Jing Zhou M.A candidate

**Appendix D: Ethics Application—Application to Conduct Research Involving Human Participants**

*UNIVERSITY OF ALBERTA*
*FACULTY OF ARTS, SCIENCE & LAW RESEARCH ETHICS BOARD*

## *APPLICATION TO CONDUCT RESEARCH*
## *INVOLVING HUMAN PARTICIPANTS*

**Principal Investigator(s):**     **Name(s):** _____Jing Zhou/ Arts_____

                                                    **Department/Faculty:** __Humanities Computing__

                                                    **Campus Address:** _____

                                                    **Campus Phone number:** _____

                                                    **E-mail address:** _____jz13@ualberta.ca_____

**(If student)**                              **Name / Department**
                                                    **of Faculty Supervisor / Sponsor** __Stan Ruecker, EFS/HuCo__

                                                    **Supervisor's E-mail address:** __sruecker@ualberta.ca__

                                                    **Supervisor's Campus Phone number:** ____(780) 492-7816__


**Project Title:** _____Survey on the Attendance at English-Chinese Kindergartens in the City of Edmonton_____

**Funding Source(s):** _____N/A_____


Summary of Project / Research Design. **Please attach a more detailed proposal
(i.e., 1-2 pages), including a description of the population from which research participants
will be drawn (e.g., university students, nursing home residents) and a discussion of how
research participants will be solicited. Also attach copies of research instruments (e.g.,
questionnaires, interview guides).**

Please see the survey proposal in Appendix I, questionnaire for current parents in

Appendix II, and questionnaire for prospective parents in Appendix III

_____

_____

_____

Assessment of Risk to Human Participants: [ *attach additional page(s) if necessary* ]

Minimal risk:

* Participants access the online questionnaires without any user ID or password.

* No question asking demographic information (e.g. age, income).

* The completed questionnaires will only be seen by Jing Zhou and her supervisor

Dr. Stan Ruecker.


Description of Procedures to be Undertaken to Reduce Risk to Human Subjects. Please attach copies of consent forms and other similar documents.

* Anonymous questionnaire

* Use only numbers to identify questionnaires


I have read the UNIVERSITY OF ALBERTA STANDARDS FOR THE PROTECTION OF HUMAN RESEARCH PARTICIPANTS [GFC Policy Manual, Section 66] and agree to abide by these standards in conducting my research.

_____ Signature of Principal Investigator(s)

_____ Date

(If Student)

_____ Signature of Faculty Supervisor/sponsor

_____ Date

---

**Submit completed form and attached documents to:**

**Dr. Lynn Penrod, Chair**
**Arts, Science, Law Research Ethics Board**
**Dept of Modern Languages and Cultural Studies**
**200 Arts Building**
mailto:lpenrod@ualberta.ca
**Phone: 492-1199**       January 2006

**Proposal:**
**Survey on the Attendance at English-Chinese**
**Kindergartens in the City of Edmonton**

Jing Zhou
Humanities Computing
University of Alberta
Edmonton, Canada

April 4, 2006

## Introduction

The purpose of this survey is to discover why people send their children to English-Chinese Bilingual Kindergartens in Edmonton and what the influencing factors are when they consider English-Chinese Bilingual Kindergarten. The results of this survey will be only used to support research for my thesis project, which seeks an optimal solution to the location/allocation model for English-Chinese Bilingual Kindergartens in Edmonton.

## Target Population and Survey Population

The target population will be the current parents whose children are enrolled in the English-Chinese Bilingual Kindergartens Program (ECBKs) during the 2005-2006 school years and the prospective parents who are considering sending their children to the English-Chinese Bilingual Kindergartens. According to a report from the *Edmonton Chinese Bilingual Education Association* (ECBEA), in Edmonton 135 children attended this program in 2005-6 years. This survey will deal with a convenience sample of 60 parents or more (30 or more current parents and 30 or more prospective parents).

## Online Questionnaire and Paper Version

In order to get a solid response rate, both an online questionnaire and paper version will be adopted. The online questionnaire will be designed for participants who have access to Internet or would like to answer questions through Internet. In addition, paper copy will be provided to people if they prefer it. Online questions will be created with SurveyMonkey and saved on its server. Respondents can contribute their answers by accessing the URL of the published questions and completing them.

## Recruiting Participants

Participants will be recruited in the following three ways:

1) Collaboration with *Edmonton Chinese Bilingual Education Association* (ECBEA). Peter Wong, President of ECBEA, has approved of this cooperation. Paper labels with the URL of the online questionnaire will be handed out to the ECBEA members who are parents with children enrolled in the English-Chinese Bilingual/Chinese Language Arts/International Baccalaureate continuum in the Edmonton Public School system. The paper version will be provided to people if they would like to do a paper one.

2) Collaboration with *Edmonton China* (www.edmononchina.com), the biggest Chinese

web portal in Edmonton, which has more than 7000 registered members since its establishment on May 9th, 2004. By adding a new topic to this open, public forum and putting the URL of the online questionnaire on it, registered members and visitors can be informed and encouraged to participate in this survey.

3) Collaboration with Edmonton Public Schools. If the survey doesn't yield enough responses through the first and second methods, I will apply to conduct a cooperative questionnaire with Edmonton Public Schools. After Edmonton Public Schools Board approval for the research proposal, five elementary public schools currently providing this kindergarten program will be selected and paper labels with the URL of the online questionnaire will be handed out to the children in English-Chinese Bilingual Kindergarten program in 2006-7 to take home for their parents to access.

## Privacy and Anonymity

The identity of participants will remain anonymous at all times to insure that there is minimal risk of harm to any participant. Data from each participant will be anonymous since participants can access the online questionnaires without any userID or password and won't cause any exposure of true identity. Plus, there is no question asking demographic information (e.g. age, income). The completed questionnaires will only be seen by Jing Zhou and her supervisor Dr. Stan Ruecker.

No identifying information about research subjects will appear in any publicly available material.

When the project is complete, the data will be destroyed. The participation in this research is strictly voluntary; any participant may choose not to submit the questionnaire without suffering any consequences.

# Appendix E: Certificate of REB Approval



**UNIVERSITY OF ALBERTA**

*Arts, Science & Law Research Ethics Board (ASL REB)*
**Certificate of REB Approval for _Fully-Detailed Research Proposal_**

---

**Applicant:** Jing Zhou

**Supervisor** (if applicable): Dr Stan Ruecker

**Department / Faculty:** Department of English & Film Studies/HUCO, Faculty of Arts

**Project Title:** Survey on the Attendance at English-Chinese Kindergarten in the City of Edmonton

**Grant / Contract Agency** (and number):

**ASL REB Application number:** ASL-REB # 1174 (LKP)

**Approval Expiry Date:** April 17, 2007

---

### CERTIFICATION of ASL REB APPROVAL

I have reviewed your application for research ethics review and conclude that your proposed research meets the University of Alberta standards for research involving human participants (GFC Policy Section 66). On behalf of the *Arts, Science & Law Research Ethics Board* (ASL REB), I am providing expedited research ethics approval for your proposed project.

Expedited research ethics approval allows you to begin your research with human participants, but is conditional on the full ASL REB approving my decision at its next meeting (*24 April 2006*). If the full ASL REB reaches a different decision, requests additional information, or imposes additional research ethics requirements on your study, I will contact you immediately.

If the full ASL REB reverses my decision, and if your research is grant- or contract-funded, the Research Services Office (RSO) will also be informed immediately. The RSO will then withhold further funding for that portion of your research involving human participants until it has been informed by the ASL REB that research ethics approval for your project has been granted.

This research ethics approval is valid for one year. To request a renewal after (*April 17, 2007*), please contact me and explain the circumstances, making reference to the research ethics review number assigned to this project (see above). Also, if there are significant changes to the project that need to be reviewed, or if any adverse effects to human participants are encountered in your research, please contact me immediately.

**ASL REB member** (name & signature): Dr Lynn Penrod, Chair, ASL REB

**Date:** 17 April 2006

*May 1, 2003*

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