GIS Modelling Based Site Analysis for Small and Medium Construction Enterprises in Greater Helsinki Region

Master's Thesis

Submitted in partial fulfillment of the requirement for the degree

International Master of Science in Construction and Real Estate Management

International Master of Science in Construction and Real Estate Management

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And finally, to my family, I can't thank you enough for the sacrifice you made for me. May Allah bless you with a long joyful and happy life.

Semir Tofik Ahmed

Original Conceptual Formulation

"GIS Modelling Based Assessment of Small and Medium Construction Enterprises in Greater Helsinki Region"

Conceptual Framework

This master's thesis research will try to investigate in to factors that affect the performance of small and medium enterprises (SME) with the help of GIS modelling. The performance of SME's is influenced by both internal and external factors. Internal factors are those factors which are largely within the control of the management of the organization. These factors include experience of the management team, functional skills (e.g., planning, organizing, leading and controlling of business operations and human resources) of management, marketing strategy, organizational structure of business, amount and source of initial equity, staff training and development (Pearce and Robinson, 2000). External factors on the other hand are factors which are largely uncontrollable by the enterprise. Level of infrastructure development (including road and railway networks, power supply lines, communication networks), tax and economic policy of government, demographic makeup and customer base, political climate and economy are some of external factors that influence the performance of business enterprises (Mathew & Michael J 2010).

For this research the focus will be on external factors affecting the performance of small and medium enterprises in the greater Helsinki region. A GIS modeling will be used to represent, transform, visualize and analyze geospatial data. In early times geography was more focused on how the earth looks like, but these days with the digitalization of geospatial information with GIS software, business enterprises can make a better decision on how to allocate resources, understand spatial distribution of attributes, understand the difference places make when conducting business (Paul, Michael, David J. M. and Davis W. R. 2005). For this

research attributes which have a high influence on the performance of SMEs in Helsinki region are only considered.

Objectives and Aim

One of the major indicators of a growing economy is the flourishing and booming of small and medium enterprises (SMEs). These Enterprises play an important role in the acceleration of a country's economic development. Almost all big businesses that exist today started originally as a small business or as a breakout from other small businesses (Mukole k, 2010).

SMEs contribute to the economic growth of a country by creating job opportunities for the local community, by innovation and implementation of smart sustainable technologies to generate wealth to the local community. Since small and medium enterprises work in coherent with other local businesses, they directly or indirectly influence large portion of the society's economical activities (Fida, 2008). The success of SMEs can usually be associated with the development of socio-economic growth of local communities. Since SMEs depend on the local labor force, they are very important alleviating poverty and closing the wealth gap between the rich and poor (Cook and Nixson 2000).

The objective of this research is to investigate how geospatial data with the help of GIS modeling, can be used to identify the effect of doing construction business on certain locations. It will analyze how a place a makes a difference for SMEs construction firms. The odds of SMEs failing during their initial period of establishment is staggeringly high (John 2010). If 100,000 start operating a year 95 percent of them will eventually fail and close their doors (Thankappan and Hammer 1980). Considering the important role SMEs play in creating jobs, it is essential to reduce failure rate by working and focusing their effort on location that give them a competitive age. Utilization of GIS modeling to investigate suitability of involving in construction business in certain location, town or village will give them a better advantage over those who don't utilize the knowledge stored in GIS models.

This research's aim is to find out which demographic attributes are a good indicator of success for small and medium-sized construction. Maps showing these different demographic attributes will be generated with the help of a geographic information system (GIS) software.

Research questions

The research's objective is to investigate how certain demographic features of a town or village creates a favorable condition to do business. The application of GIS Modeling will add another dimension to how demographic data are stored, transformed, analyzed and illustrated. With the help of GIS software, the research will try to study what demographic factors are the main contributors for the success or failure of small and medium-sized construction enterprises in the greater Helsinki metropolitan region. The research will try to give an answer to the following research questions.

- What percentage of small and medium-sized construction enterprises stop doing business in the past decade.
- Which demographic features of a certain location are a good indicator for suitability of conducting construction business.
- Prove the hypothesis that the success of SME construction enterprises is dependent on the location where they do business with the help of GIS modeling.
- Indicate potential construction sites for future business if the hypothesis is found out to be true.

Methodology

The research will primarily depend on Finnish statistical institute, Statistics Finland, for primary data about demographic facts and small and medium-sized construction firms. Suomen Yrittajat, which is one of the largest business

organization in Finland will be the other source of data and more information about SMEs in Finland.

The research will also look into construction companies which have utilized geographic information system to do feasibility study on finding suitable locations by analyzing certain demographic characteristics.

ArcGis software will be used to store and analyze demographic data and generate maps.

Scope and Limitation of Research

The Focus of this research is small and medium-sized construction enterprises who run their business in the greater Helsinki metropolitan area. According to the definition of small and medium enterprises, SMEs comprise three different categories of enterprises, namely micro-enterprises, small enterprises and medium-sized enterprises. The official EC definition of SMEs takes account of three different factors; level of employment, level of turnover, and size of the balance sheet (European Commission 2005).

Company Category	Employees	Turnover	Balance sheet total
Micro	<10	< 2 million euro	< 2 million euro
Small	<50	< 10 million euro	< 10 million euro
Medium	<250	< 50 million euro	< 43 million euro

Table: SMEs Classification Threshold (European Commission 2005 p-11)

The research investigation is limited to understanding the effect of certain demographic characteristics of a population on the performance of SME Construction firms. This Characteristics to be investigated include population density, population growth rate, rate of unemployment, education level and household income.

Significance of Research

Small and medium-sized enterprises (SMEs) are the main engine behind developed marketing economies. These enterprises by far represent the majority of all enterprises and hence they are main driving force behind development of entrepreneurship and the economy in general (Stefanoić, Milošević and Miletić 2009). In the 28 European union nations SMEs are responsible for hiring 66.6% of employees and 56.8% of value added. In the case of Finland, SMEs account for 65.5% of employee and 59.8% of value added. The research will try to find how small businesses can get a competitive advantage by utilizing GIS modeling software to analyze geospatial data and use it to their advantage.

Schedule:

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Preliminary investigation											
Literature Review											
Gathering of necessary data											
Analysis of Data (GIS modeling)											
Report Writing											
Defense of Thesis											

Budget:

	Price (euros)
Purchasing books	300
Transportation cost	150
Printing	150

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Signature of the Supervisor

Abstract

GIS Modelling Based Site Analysis for Small and Medium Construction Enterprises in Greater Helsinki Region

GIS is a powerful technology with a significant potential to store, manipulate and analyze data. This research paper proposes the utilization of GIS technology by small and medium-sized construction enterprise for the purpose of carrying out a suitability analysis of potential construction sites. SMEs are the backbone of 21st economy and the source of income for millions of people employed by them. SMEs are susceptible to failure and face several challenges. One of the challenge SMEs which are involved in real estate face is getting the information to explore a new market. The demand for real estate is influenced by macro-factors such as the general economic condition, interest rates, government policy and, demographic factors. Although it is a complex task to evaluate the correlation between these factors and the demand for real estate it is something SMEs and real estate developers need to do. The capability of GIS to be used for site analysis and identification of suitable sites was demonstrated by using ArcMap 10.5, a GIS Software, for the suitability analysis the greater Helsinki region for real estate development. The researcher of the study was able to perform site analysis which incorporated several factors that drives the demand for real estate and generate detailed maps indicating suitable sites in the greater Helsinki region.

Key words: GIS, SMEs, Suitable location, Site Analysis, Real Estate, economic condition, demographic factors.

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List of Abbreviation

AHP	Analytic Hierarchy Process
EC	European Commission
ECSO	European Construction Sector Observatory
ESRI	Environmental System Research Institute
EU	European Union
GDP	Gross Domestic Product
GIS	Geographic Information System
GWR	Geographically Weighted Regression
LED	Local Economic Development
MCDA	Multi Criteria Decision Analysis
MCDM	Multi Criteria Decision Making
OECD	Organization for Economic Cooperation and Development
SAB	Small Business Administration
SAW	Simple Additive Weighing
SME	Small and Medium Enterprises
SIG	Système d'Information Géographique *(French)*

List of Symbols

d	margin of error
n	Sample Size
N	Population Size
σ	Standard deviation
z	z-score or a standard score
A	Alternate location
C	Suitability criteria
w_i	Weight of criteria i
S_n	Total score of alternate n
p_k	Ranking of kth criteria

Chapter 1

Introduction

According to economic experts, millions of people are employed by Small and medium-sized enterprises (SMEs) making it the main steering wheel for economic growth in twenty-first-century economy (Calabrese 2017). In Finland, 98% of all enterprises are classified as SMEs at the end of 2017. They employ 1.21 million personnel, 49% of all employed personnel and € 319 billion in annual turnover (Statistics Finland 2015).

According to Statistics Finland (2015), there are 18125 small and medium-sized building construction enterprises operating in Finland and have an annual turnover of more than € 14.4 billion. These enterprises are involved in several activities in building construction including residential real estate development.

The demand for real estate development is influenced by several factors such as regional demographic and socio-economic factors (Greer 2003). SMEs who are involved in real estate development need to analyze these factor, when deciding where to construct new residential housing. Geographic Information System (GIS) is an innovative tool which can be used to store, analyze and display spatially referenced data. The advancement in computing power and the availability of spatial data has made GIS a powerful decision support tool (Huang 2018).

SMEs face lots of challenges and are more susceptible and at risk to failure especially at the early stage of their establishment (Haas 2007). SMEs working in today's highly competitive economy need to make well informed and data-driven decision to ensure profitability and avert the risk of failure (Gibcus 2010). One of the problem that SMEs, which are involved in real estate development, faces is the lack of information and tools to explore new markets (Ni 2014). This research proposes the utilization of GIS for site analysis, which involves evaluating multiple factors that drive the real estate sector to identify suitable locations, new markets, and new opportunities.

1.1 Background of the Study Area

Helsinki is the world's second northernmost capital city. The establishment of the city dates back to the 15th century. Helsinki was founded by the decree of King Gustave Vase of Sweden at the mouth of river Vantaa in 1550. Over time the city grew southward to its current location. Helsinki has been the serving as the seat of government since it replaced Turku as the capital city of Finland in 1812 (Encyclopedia Britannica 2018).

Helsinki metropolitan region which encompasses the capital city and 13 other municipalities is home to 1.475 million inhabitants, which makes up 30% of the total population of Finland. It is the most densely populated metropolitan area with the highest altitude (Helsinki Region 2017).

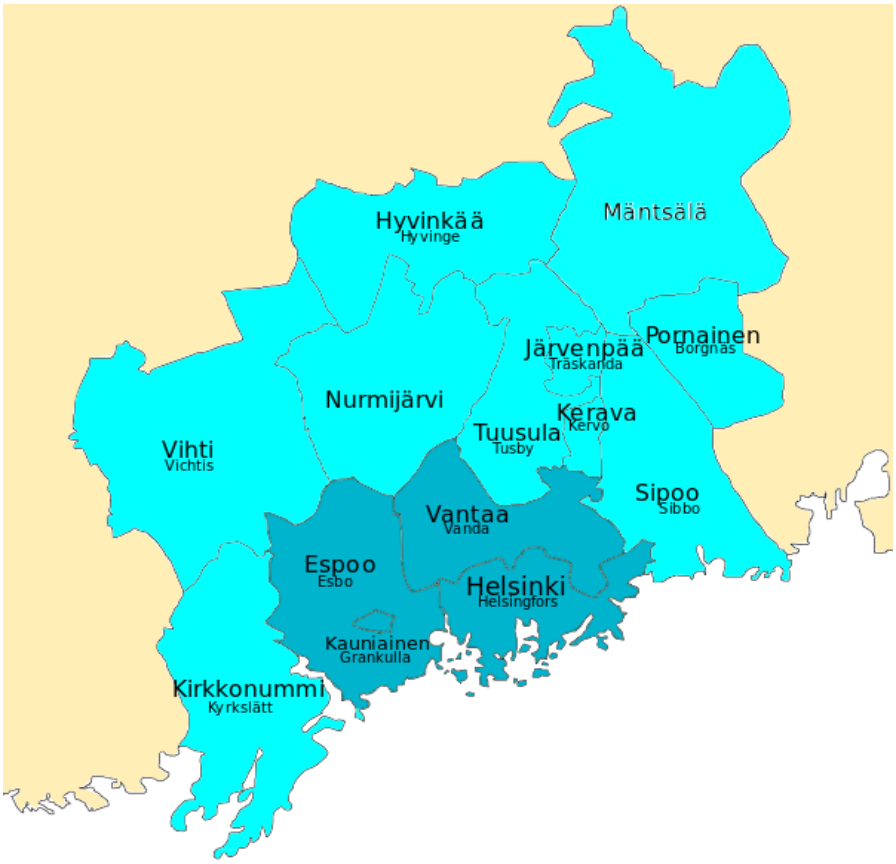

Figure 1.1-1: Helsinki Metropolitan Region[1]

[1] Greater Helsinki region Map. www.helsinkiregion.fi

1.1.2 Small and Medium Construction Enterprises

Latameconomy, Latin America Economic Outlook (2013) Describes SMEs (Small and Medium-Sized Enterprises as a part of a wider heterogeneous universe which constitute extremely diverse economic agents, whose characteristics are dependent on the type of business sector they are involved in, the markets they operate their service in, the service they provide and how connected and tangled they are with other supportive institutes and to the macroeconomic context.

According to the statistics Finland, the number of enterprises operating in Finland stood at 357,000 in 2016. Among the 357,000 enterprises, 350,000 were classified as small and medium-sized enterprises (SMEs). These SMEs constitute 98 percent of the total stock of enterprises. Business enterprises in Finland had a total of 388,000 establishments of which 93 percent were used by SMEs' establishments. The statistics gathered on the activity of enterprise estimate that the gross value of the output of business establishments was 285 billion euro. This output value was higher by nine billion euro in contrast with 2015. SMEs' establishments take the lion's share, 51 per cent of products, or 4.7 billion euro of the total increase in gross value in the entire country. The majority of this growth was from SME's establishments which are involved in construction and service industries. (Statistics Finland 2016)

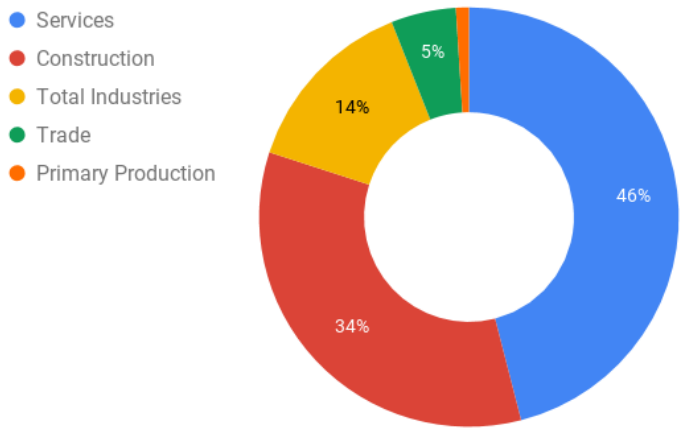

Figure 1.1-2: Distribution of SMEs' Production Growth (%) in 2016 Source[2]

[2] Statistics Finland, Enterprises Number 2017. www.stat.fi

1.1.3 Demography of Helsinki Region

The population of Finland stood at 5,513,130 according to recent statistics from Statistics Finland in the year 2017. It grew by 9833 persons from the previous year, this was the smallest growth since 2000. Majority of this growth is primarily concentrated at the greater Helsinki metropolitan region.

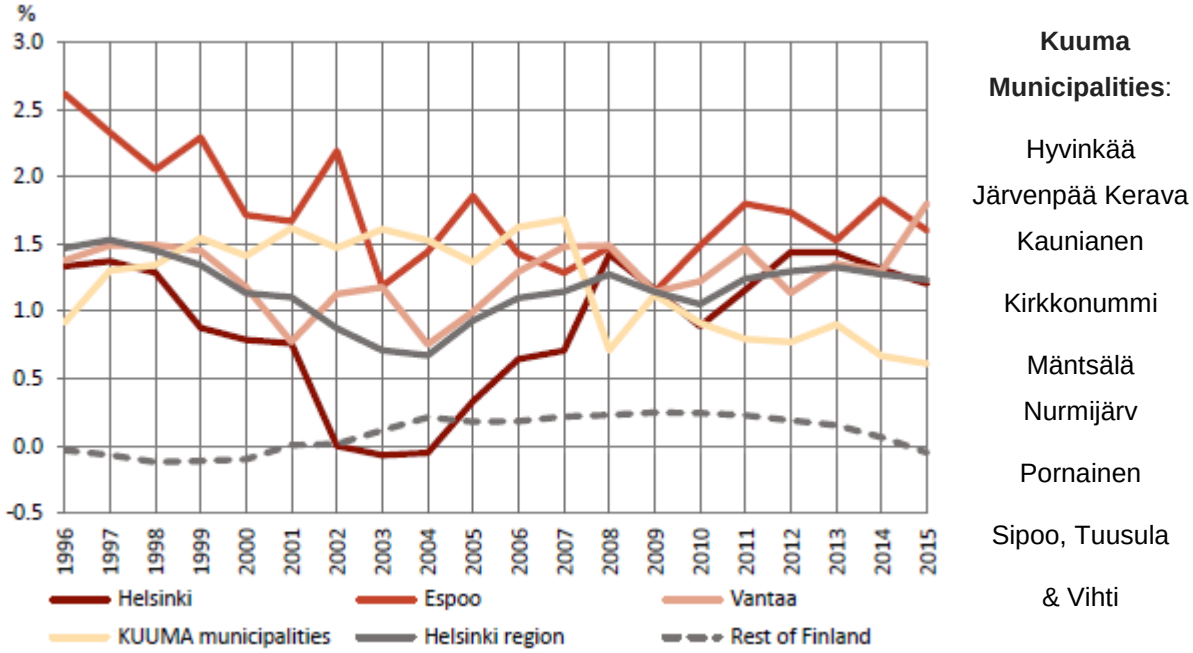

Figure 1.1-3: population growth rate greater Helsinki metropolitan region and Finland[3]

At the end of the year 2017 the population of Helsinki metropolitan region was 1,154,967 and greater Helsinki metropolitan area was 1,475,095. In 1996 the population for greater Helsinki metropolitan stood at 1,134,000. This indicates that the population of the region grew by roughly one quarter over the past twenty years. The region has seen a growth of 13% in the past decade while the population growth for the same period over the whole of Finland was 7%. The population growth outside of the greater Helsinki metropolitan region during the past two decades was only 2%, suggesting the population growth was more concentrated in the Helsinki region. The population growth of Helsinki metropolitan has been between 1.2 and 1.3% on average annually from the year 2010-2017, this slightly faster rate which was observed from the year 2000 to 2010 but slower

[3] Helsinki Region Trend, Current Review of Development in the region, 2017, https://www.helsinginseudunsuunnat.fi/

than the rate in the 1990s. 80 percent of greater Helsinki region residences reside in the Helsinki metropolitan area. Population growth in Helsinki metropolitan area, Helsinki, Vantaa, and Espoo, is faster than the rest of the greater Helsinki municipalities. In the past two decades, the largest population growth was registered in the municipality of Espoo with 40%, followed by Vantaa with 29%, while Helsinki's population grows by around 20%. The population growth in the greater Helsinki region excluding the three Helsinki metropolitan municipality was 27% during the same period. (Statistics Finland 2018)

1.1.4 Migration Trend in Helsinki Region

The population growth of the greater Helsinki region is kept by the growing number of migrates coming from other parts of Finland and from abroad. According to recent statistics from Statistics Finland, the net migration to the greater Helsinki region at the end of 2017 was 4770 persons.

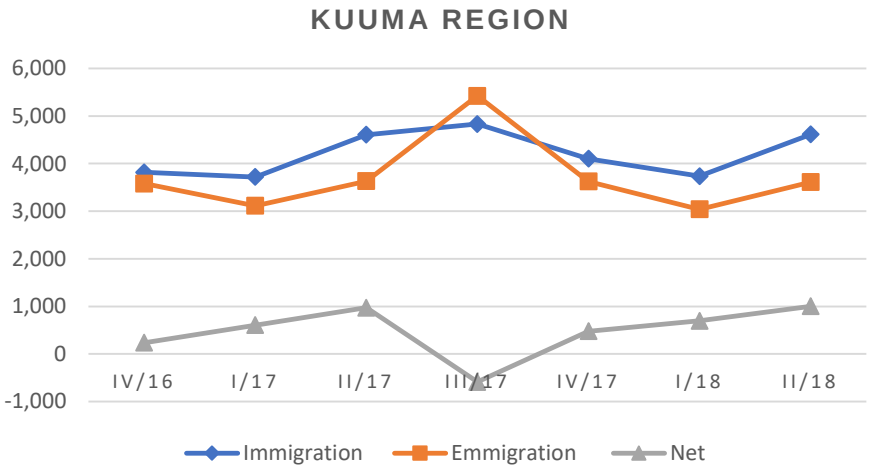

Figure 1.1-4: Net Migration in Kuma region[4]

Domestic net migration from to Helsinki region from other parts of Finland has been slightly increasing from the year 2008 onwards. Net migration was negative for the years between 2000 and 2007 as a result of more people moving to other parts of Finland from Helsinki region than coming in. Greater Helsinki regions population grew by 15,890 persons according to population statistics in 2017. This increment

[4]Helsinki Trend 2017, Statistics Finland

was 20% more than that was recorded in the previous year. Current trends in migration movement of people in and out of Helsinki region municipalities is shown below.

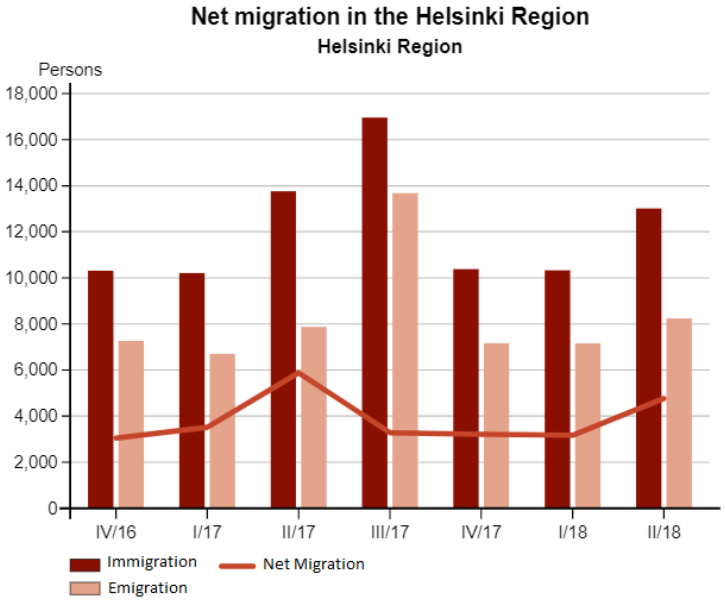

Figure 1.1-5: Migration in Helsinki Region[5]

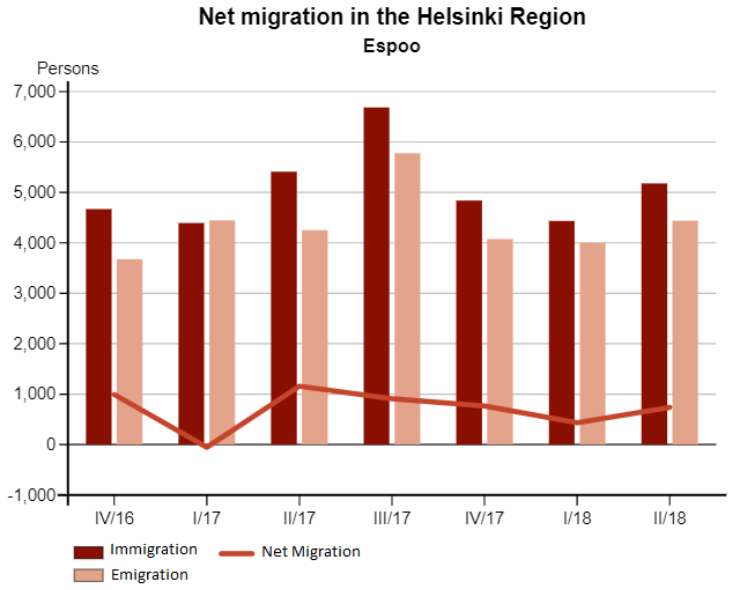

Figure 1.1-6: Migration in the city of Espoo[6]

[5] Helsinki Region Trend Current review of development in the region, 2017, https://www.helsinginseudunsuunnat.fi/

[6] Helsinki Region Trend Current review of development in the region, 2017, https://www.helsinginseudunsuunnat.fi/

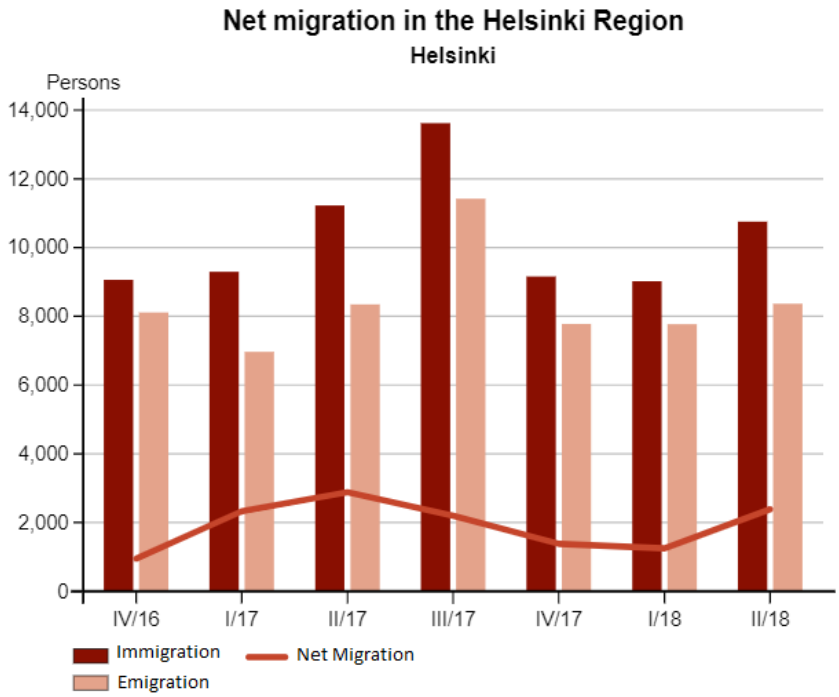

Figure 1.1-7: Migration in the City of Helsinki[7]

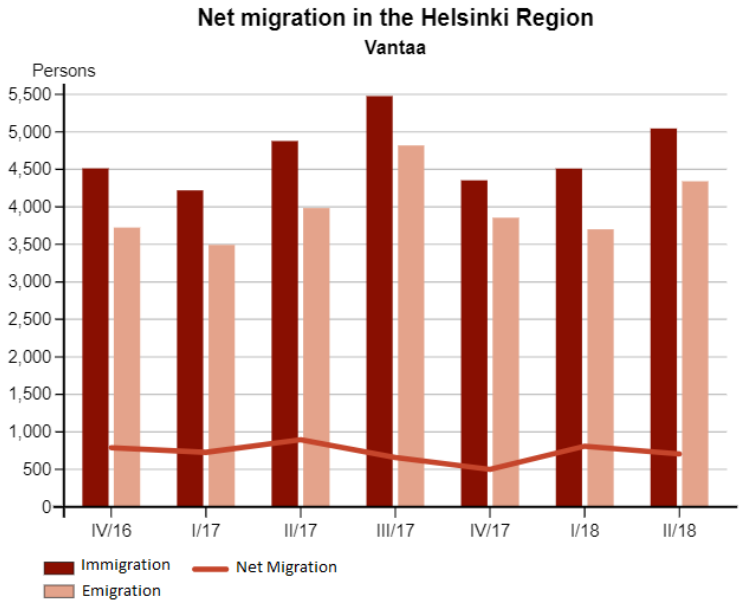

Figure 1.1-8: Migration in the City of Vantaa[8]

[7] Helsinki Region Trend Current review of development in the region, 2017, https://www.helsinginseudunsuunnat.fi/

[8] Helsinki Region Trend Current review of development in the region, 2017, https://www.helsinginseudunsuunnat.fi/

There is strong growth in immigration of people with a foreign background. Foreign nationals move to Helsinki region both from outside Helsinki and from broad. Among the 15,890 persons who moved to the Helsinki region 10,820, around two-thirds, are people from countries outside Finland. Helsinki regions migration gain has grown by 6 percent while elsewhere in Finland the migration gain from foreign nationals has decreased by 23 percent from the highest number recorded in 2016 after the immigration mass influx due to asylum seekers. In 2017, The migration gain from foreign nationals has gained momentum in the municipality of Espoo but it has slowed down in the municipality of Vantaa and in municipalities outside the three metropolitan cities. The number of foreign nationals increased by 4980 in Helsinki, by 2560, 2190 and 1050 persons in the city of Espoo, Vantaa and Kuuma municipalities respectively.

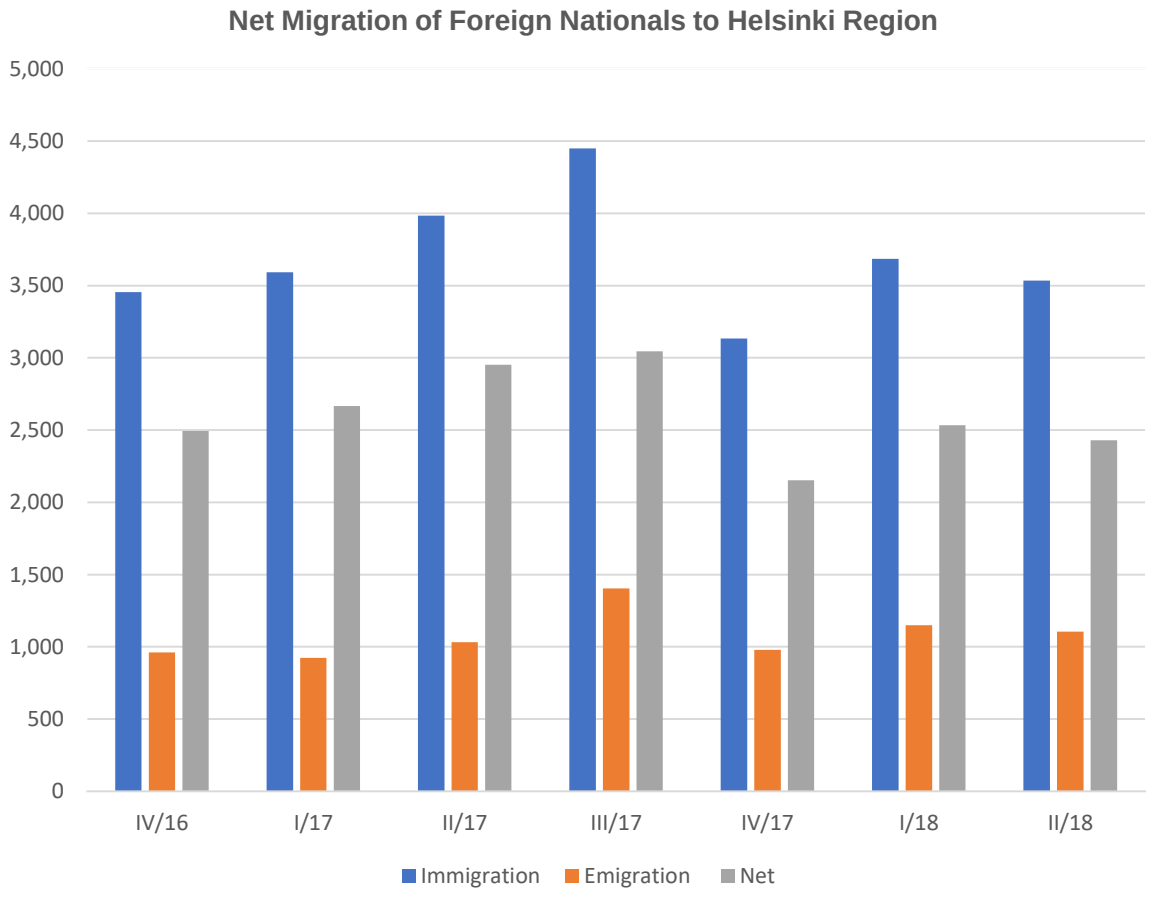

Figure 1.1-9: Net migration of Foreign nationals to Helsinki region[9]

[9] City of Helsinki, urban facts, Statistics Finland

1.1.5 Economy of Helsinki Region

In recent years the economic growth of Finland has gained momentum. currently, it is out of the continued recession that started in 2011 and continued till 2014. In 2016 Fenland's gross domestic product picked up to 189.6 billion Euros, which indicated a 1.4% increase from the previous year, 2015. The growth in GDP is driven upwards by an increase in investment in construction, which in turn lead to solid export performance. The economy is expected to grow in the coming couples of years, propelled by the construction industry. (ECSO 2018)

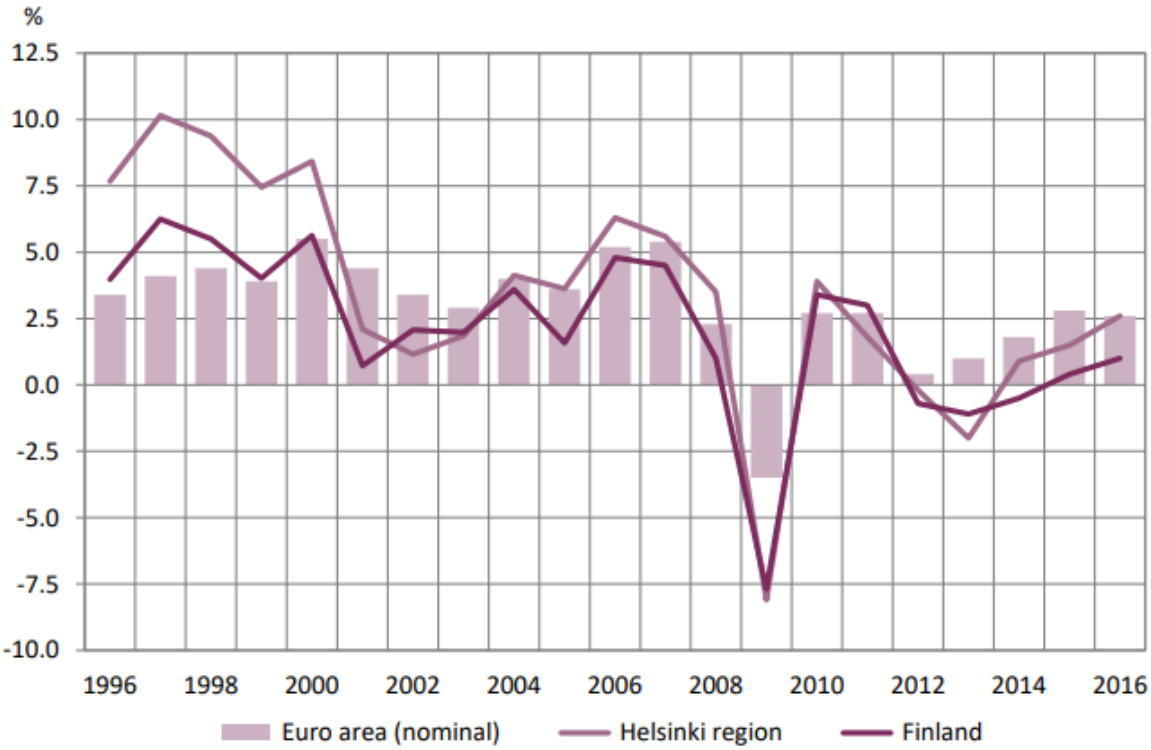

Figure 1.1-10: GDP growth percentage (%) change from the previous year [10]

Helsinki region has the highest population with tertiary level education, 36% of the population having a university level qualification or above. The region is a creative and innovative hub of Finland. Helsinki region is the most dominant economic region in Finland. It is where the headquarter of most Finnish companies is located. Helsinki region enjoys a GDP growth percentage which is slightly above the

[10] Review of Development in the Helsinki region 1996-2016, Statistics Finland

average of the whole of Finland (see figure above). With an urban population of 1.6 million and more than 750,000 jobs, it contributes 34.2% of the total gross domestic product (GDP) of Finland. Before the collapse of the Soviet Union, Helsinki region economy was more dependent on manufacturing and forestry, after the collapse, the economic growth shifted to ICT and knowledge-based economy (Marco B. et al., 2011).

1.1.6 Construction

The migration of local people from the countryside to major cities and the influx of migrants for countries outside the EU has created a stronger demand for housing in recent years. This has led to the growth in construction. In 2016 the investment budget allocated for construction activities has increased by 6.5% in comparison to the previous year. The forecast for the next two years also shows a positive sign that the construction industry will perform well, although at a lower rate than the one registered in 2016. (European Construction Sector Observatory 2018)

Growth in construction was one of the main drivers of the growth of the Finnish economy in 2016, with construction investments increasing by some 6.5% compared to the previous year. Construction was boosted by the active residential construction in particular, as the demand for housing remains strong in all major cities. (The Finnish Property Market 2017)

In European countries construction of building increase the number of existing housing stock by 1% each year (Matthew 2014). Building Stock in Finland grew by 0.72% in 2017 compared to the previous year. In the last 27 years, the number of buildings has increased by 31% or by 361 000. The rate of growth of building Stock has been decreasing since the beginning of the 1980s and it is observable from figure 1.1-11 below. In the Helsinki region there are approximately 750 000 dwellings, of which approximately 60% are occupied by the owners (Laakso & Loikkanen, 1995). The price of housing in Helsinki and Helsinki region has gotten significantly higher since the end of the recession which Finland was in in the early 1990s (Tom Kauko 2010).

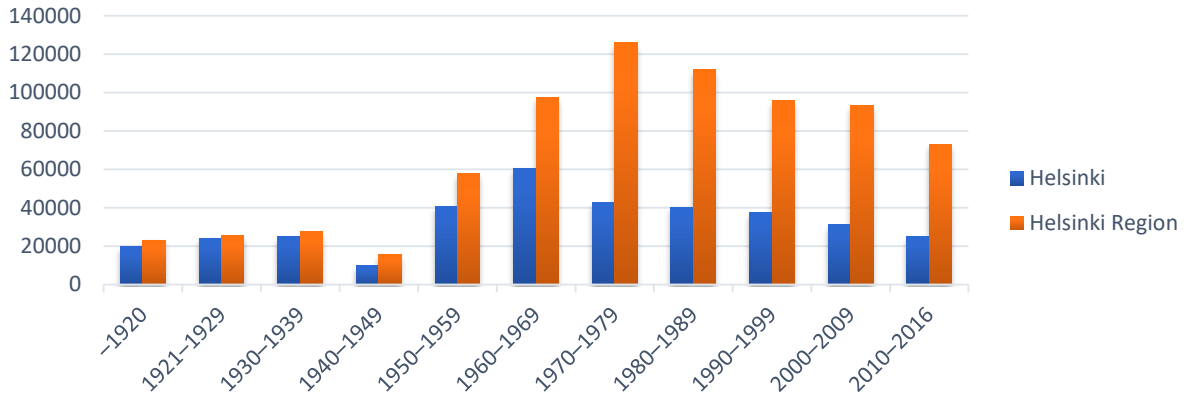

Figure 1.1-11: Helsinki and Helsinki Region Dwelling by Year of Construction source HRI[11]

According to the statistics Act (62/1994) residential building in Finland are classified into three main categories, Detached and semi-detached houses, attached house and blocks of flats. The number of buildings permits issued to construct detached and semi-detached houses in 2017 are 45.8% lower when compared to the number of buildings permits issued in 2010. Similarly, the number of permits issued for attached housing construction in 2017 is 20.8% lower than the numbers of permits issued in 2010. Contrary to detached and attached housing, the number of permits to construct blocks of flats in 2017 is 42.0% higher in comparison to the number of permits in 2010 (www.stat.fi).

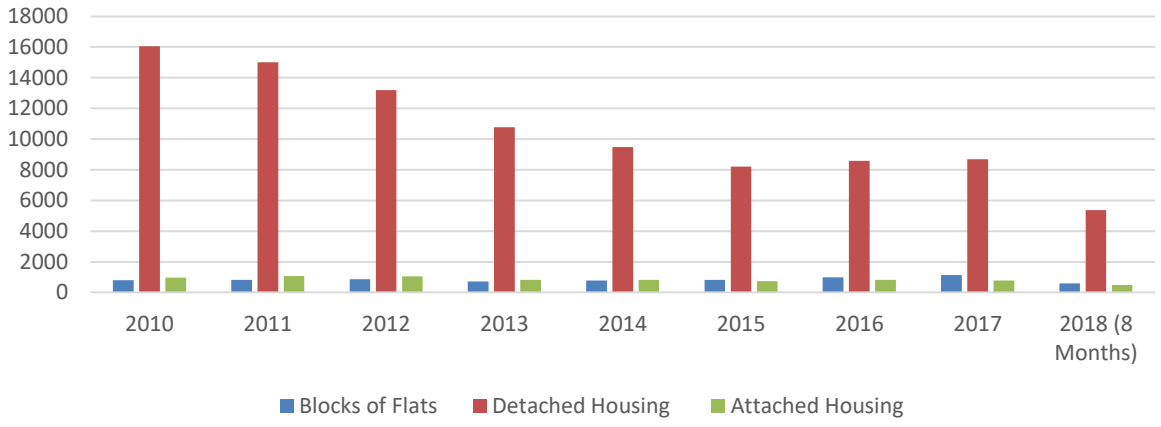

Figure 1.1-12: Number of Building Permits from 2010 – May 2018.[12]

[11] Helsinki Region Info share https://hri.fi
[12] Statistics Finland

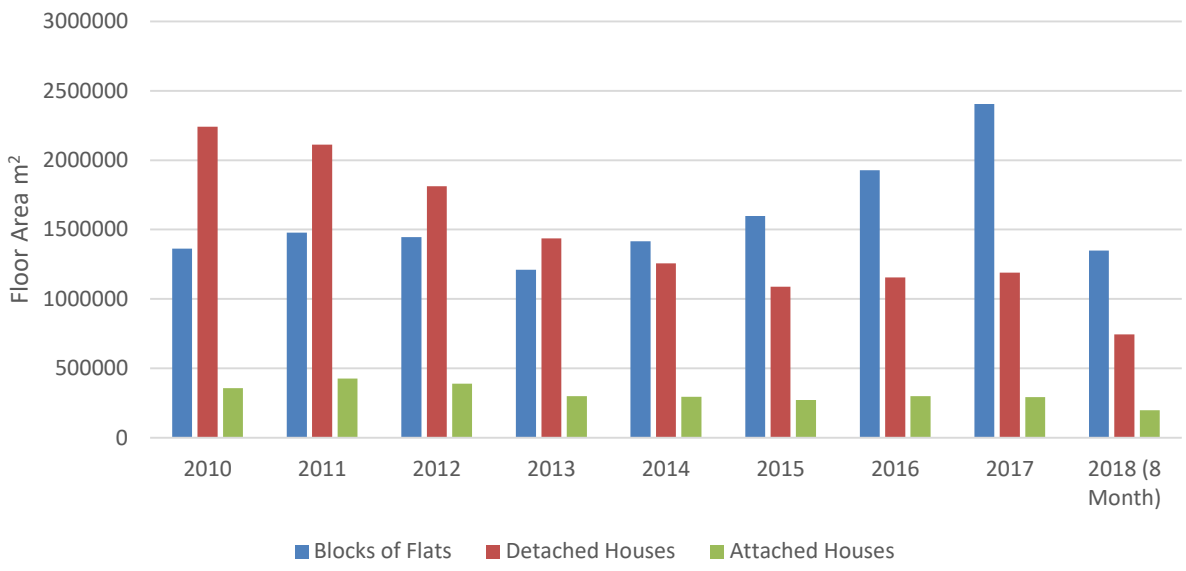

Figure 1.1-13: Floor Area Under Construction from 2010 – August 2018[13]

1.2 Introduction to GIS

Geographic information system, also known as GIS, is a digital software system which is used for organizing geospatial data. The term geographic in GIS is to imply that the location of data is understood or can be determined and expressed in geographic coordinates (x, y, z) or (latitude, longitude, Altitude). GIS models are often represented as pictures or maps with different color gradients, as well as in a table and graphs which yield invaluable knowledge and this is what the term information in GIS represent. The term system refers to the fact that GIS has the capability to digitally process spatial data with a computer. The system allows for gathering, inputting, transforming, combining data and analysis and outputting (Graeme 1994).

[13] Statistics Finland

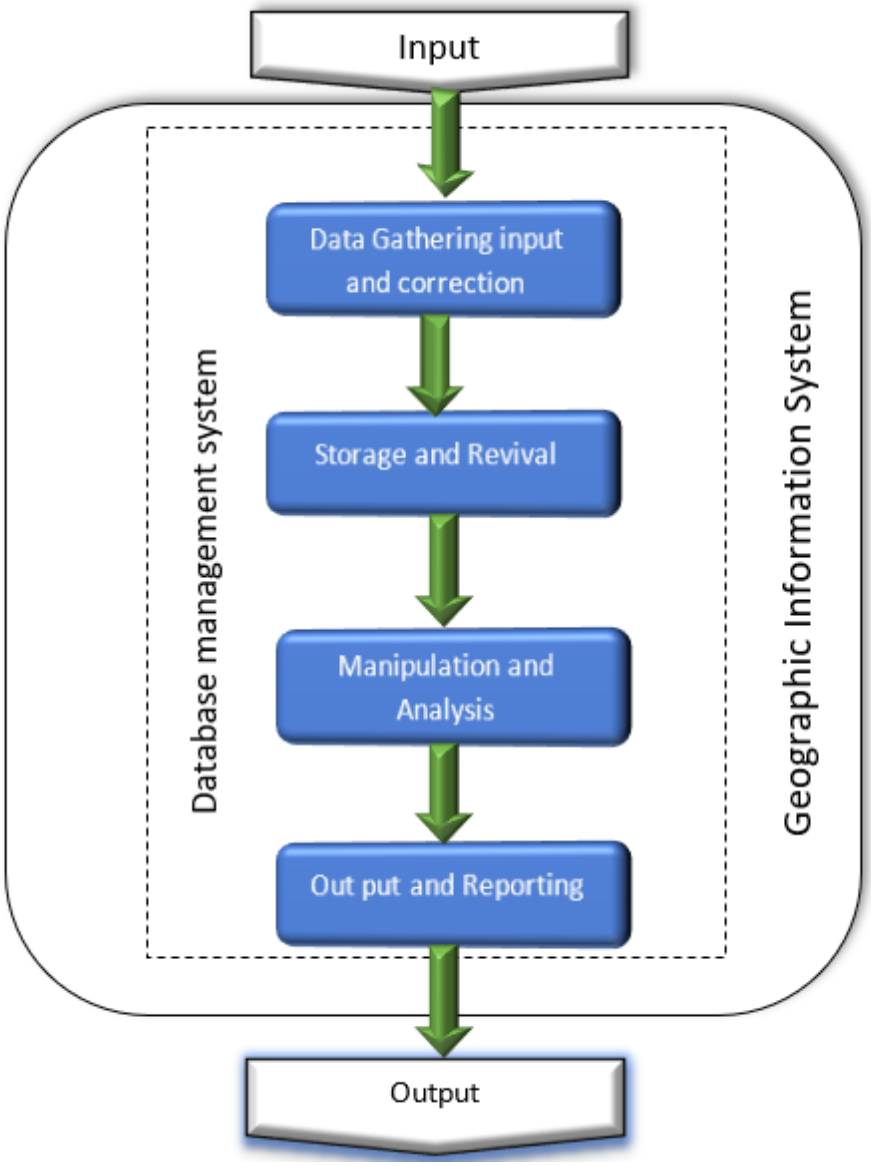

Figure 1.2-1: The Architecture of GIS[14]

The use of GIS-based software is rapidly growing with the acceleration of data gathering and organizing by governmental agencies, Private companies, research institutes, universities and statistics organizations. Even though the cost of developing the database for GIS is significantly high, the favorable cost to benefit ratio is encouraging these organizations to continue utilization of GIS software (Johnson 1992). Geospatial data for GIS can be collected from airplanes, ships, ground-based instruments or boring equipment but an overwhelming amount of

[14] Paul A. L & Graham C, 1995, p. 8.

data for GIS are generated from satellite images. Without the digital processing and display imaging the data would have been left in computer storage and the information stored in them not being utilized.

1.3 Statement of Problem

In earlier times the study of geography was mostly associated with mapping different features of the earth, including landscapes, soil, ocean, and atmosphere. The main objective of geography as a field of sciences is to make a clear understanding of the world by carefully observing, measuring surveying and analysis of data gathered from the world at large. The information generated from these processes is generally presented in either a map or written format (Peter 2004). Geography not only can it be used to describe natural phenomena's but it can also be used to illustrate human behaviors.

Human Geography	Physical Geography
Population	Landscape
Economical Activities	Inland Water bodies
Transportation Facilities	Flora and Fauna
Urban Areas	Climate
Human Settlement	Soil
Political Borders	Ocean
Religion	Environment and Atmosphere

Table 1.3-1: The two main classification of geography[15]

The development of computers and digitalization of everything has sped up the processing, analysis, and storage of geospatial data. This data stored in a computer are made easily accessible whether it is for searching maps, finding the

[15] Michael Pacione, 2009, p.2

location of objects or planning of complex activities. This computer system is known as geographic information system (GIS) (Michael 2009).

Every human activity and natural phenomena that occur on earth can be explained from a spatial perspective. Since every action human being does happen somewhere in space, it can be represented with the help of maps. The maps generated allows people to find places easily, save time spent on journeys by finding convenient routes, help in the decision making of city planning, infrastructure development, improving wildlife sanctuaries, assisting enterprises in finding hot spots to conduct their business and several other applications.

In today's competitive world, where rapid globalization and technological advancements are a significant factor, it is critical for industries to make the right decision on where to conduct their business. Industry firms need to investigate factors ranging from economical and demographical to political and social, before making a decision to do business in a certain location, town, municipality or nation (Yupo 2011).

Growth in computing and networking power has enhanced GIS software capability to manage a large quantity of spatial information related to both natural phenomenon and human activities. This has accelerated the application GIS to several disciplines including land use planning, facility management, land management and urban planning (Johnson 1992).

Despite the fast growth of the GIS database, small and medium-sized enterprises face problems getting information to explore new markets (Sharon vice president of Laurus Construction).

With a higher than average risk of failure, SMEs need a reliable means of getting information for the purpose of making a better decision. The study will present how GIS tools might be used to gather data, analyze and help SMEs construction enterprise for the selection of suitable construction location.

1.4 Research questions

The research's objective is to investigate how certain demographic features of a town or village creates a favorable condition to do business. The application of GIS Modeling will add another dimension to how demographic data are stored, transformed, analyzed and illustrated. With the help of GIS software, the research will try to study what demographic factors are the main contributors to the success or failure of small and medium-sized construction enterprises in the greater Helsinki metropolitan region. The research will try to give an answer to the following research questions.

- Which demographic features of a certain location are a good indicator for suitability of site real estate development?
- Which location factors are a good indicator for suitability of a site for real estate development?
- Is it possible to Indicate potential construction sites for future construction of real estate?
- IS GIS suitable for performing site analysis for real estate development?
- Prove the hypothesis that the success of SME construction enterprises is dependent on the location where they do business with the help of GIS modeling.

1.5 Motivation and Objective of the Research

Figure 1.5-1: Application of mapping[16]

The map shown was prepared by Dr. John Snow indicating the cluster of where most cholera deaths occurred during the 1854 London cholera outbreak. Through visual assessment, Dr. Snow found out that a pump on Broad Street was the reason for the spread of the disease. This map clearly demonstrates how data or information stored on maps can give another dimension to how we observe the world around us.

Laurus Construction Corporation, a general contractor from the state of California, is specialized in the construction and renovation of commercial and residential

[16] Dr. John Snow 1984

buildings. The company utilizes ZoomProspector to select town and location to do business in (Norman M. 2012). ZoomProspector is website which uses GIS tools to gather and analyze demographic, population, income, labor, consumer, education, innovation, occupation, transportation, environmental, entrepreneurship data, and provide helpful information for business and investors on local economic trends (Tom 2009).

The management of Laurus Construction uses GIS data provided by ZoomProspector to analyze the profile of the town where they had success and expand their business to other towns with similar characteristics (Norman M. 2012).

The main objective of the research is to deploy GIS software tools for visualizing and analysing of demographic and economic features of greater Helsinki region. The research will try to investigate how these features can be used by small and medium-sized construction enterprise to select suitable sites to construct residential buildings. Below are the main objectives of the research

- To develop an understand of demographic features of greater Helsinki region and how they are important in making decision for selection of suitable sites
- To develop an understand of economic features of greater Helsinki region and how they are important in making decision for selection suitable sites
- To generate maps visualizing demographic and economic features of greater Helsinki region using ArcMap 10.5 (GIS tool)
- To analyze demographic and economic data, polices and regulations and present suitable construction sites in form of a map
- Make a suggestion how to better utilize GIS tools for better decision making by small and medium-sized construction sites.
- To investigate if there is casual relation between suitability factors and where SMEs construct residential building.

1.6 Research Method

> *"It does not a great brain to do original research. One must be highly motivated, exercise good judgement, have intelligence, imagination, determination and a little luck. One of the most important quality in doing a research is to ask the right question at the right time."*
>
> Julius Axelrod

It is the burning desire of people to grips their environment and to understand the nature of understand the nature of the phenomena it presents. One of the means to develop this understanding is through a research. Scientific research is a systematic process of collecting and analyzing information in manner that adheres with strict protocol and structures. A scientific research performs a methodological study to answer a research question or to prove and disprove hypothesis (Abiy 2009).

Researchers need to formulate their research approach depending on the research questions. There are different methods for different problems (Kothari 2004). The research uses a mix of a posterior method of epistemology and inductive reasoning to construct knowledge. A posterior knowledge, which is also known as empirical knowledge, is based on observations of the world, phenomenon, and events and interacting with them in some manner. In a posterior, it is possible to combine and extend already existing knowledge to come up with a new idea (Hegde 2015).

The research uses inductive reasoning to justify the outcome of the research. Inductive reasoning makes an inference from particular to general based on evidences (Hegde 2015). In inductive argument, provided that the premises are true the conclusion made based these premises cannot be false (Gupta 2015). This research tries to take into account several demographic and economic factors that have some sorts of effects on the suitability of sites for real estate development. After these factors have been investigated and proper literature

review is done, GIS tools are used to combine manipulate and analyze demographic and socio economic data and come out with a generalization.

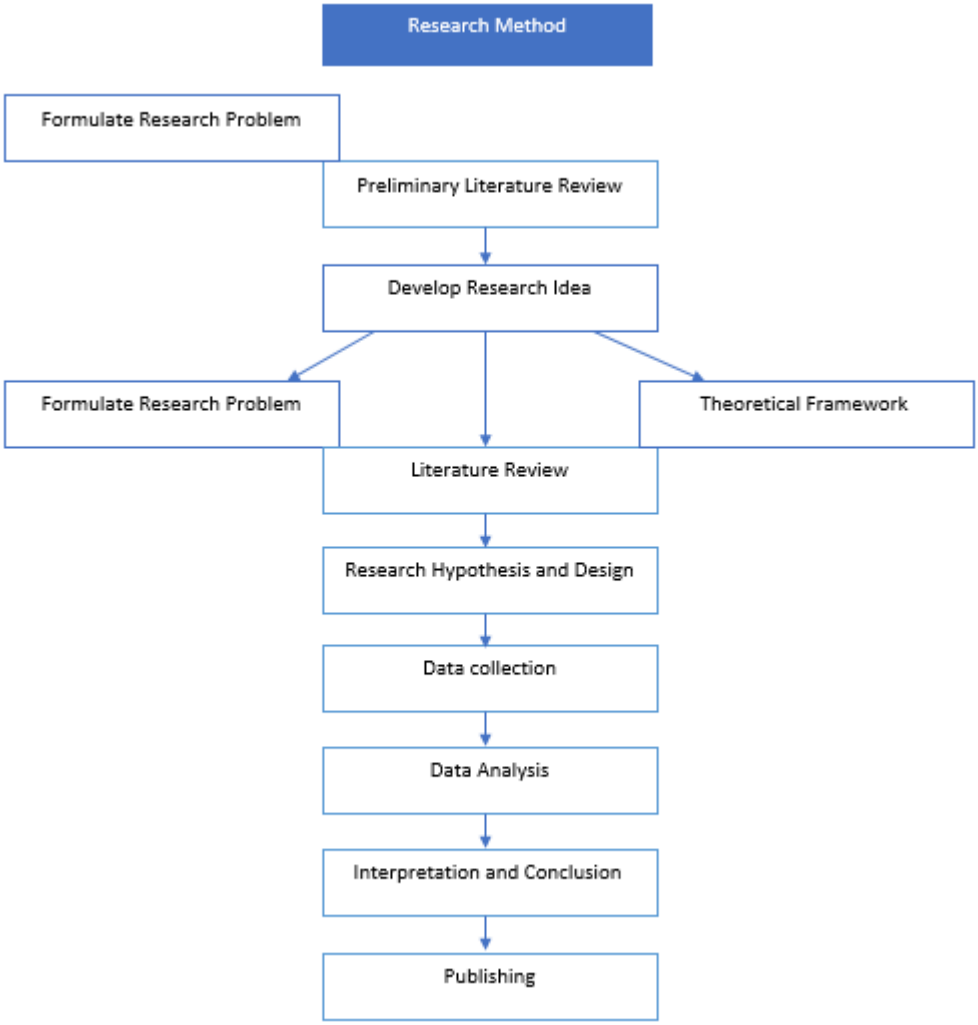

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Figure 1.6-1: Schematic presentation of research process[17]

The main objective of the research is to analyze the suitability of sites for residential real estate development by SME enterprises. In order to carry out the multi-criteria analysis of sites, a survey is done to determine weighing factors for the different variables. The research will primarily depend on secondary data from Finnish statistical institute, Statistics Finland, for demographic facts and small and

[17] Based on Abiy Z 2009. P.4

medium-sized construction firms. Data about SMEs is also collected from Suomen Yrittajat, which is one of the largest business organization in Finland.

The research will also look into how construction companies can utilize geographic information system to identify suitable locations for real estate by gathering, manipulating and analysis of several variables and carrying out multi-criteria analysis as well as generating maps indicating best spots of construction.

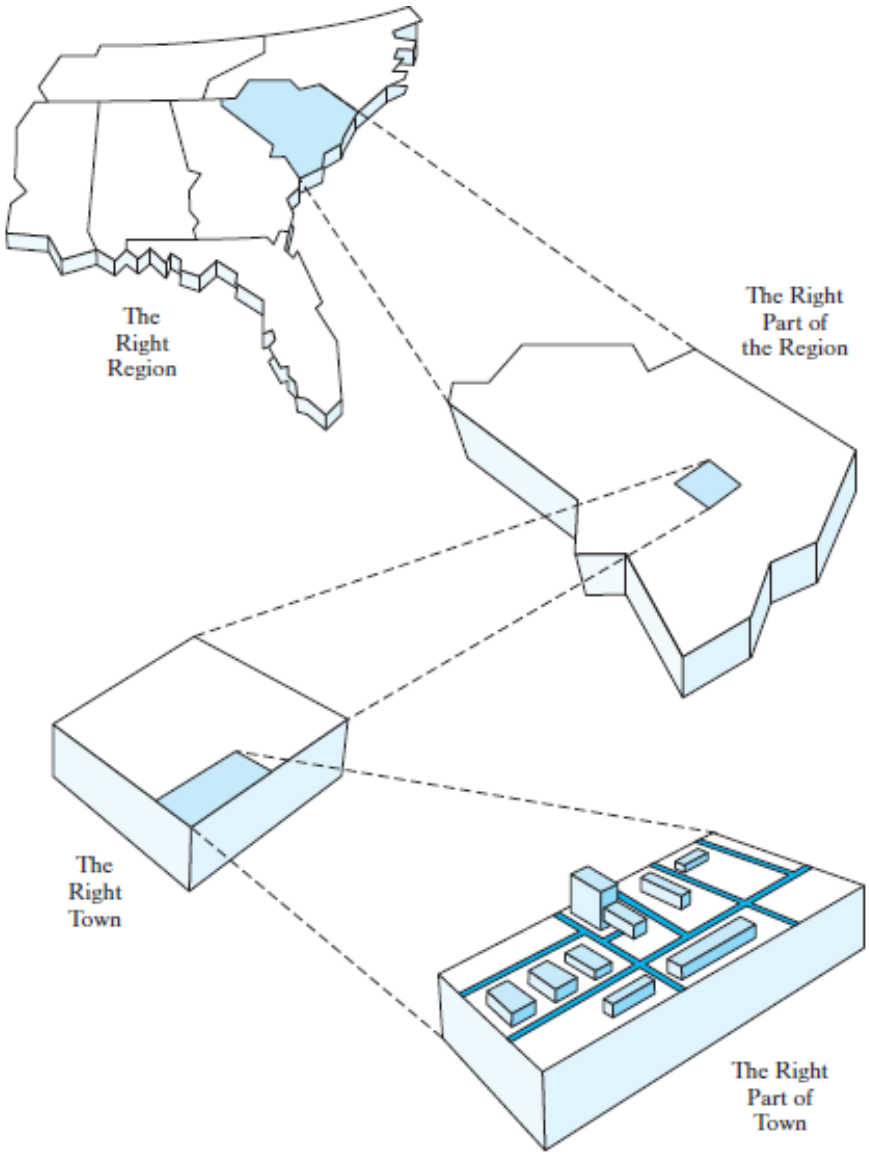


Figure 1.6-2: The Location Decision[18] Significance of Research

[18] Dale M. Lewison andM. Wayne DeLozier, Retailing 1984 p. 341.

The unique thing about this research is that it utilizes Geographic Information System (GIS) software extensively for the purpose of storing, integrating, manipulating, analysis and display of spatially referenced data. GIS date their origin from the 1960s, but utilization becomes widespread in the 1990s (Burrogh 1998).

Despite the presence of a wide range of literature and support system for SMEs, nine out of ten startups fail over the course of two decades (Patel 2015). SMEs enterprises in Finland, account for more than 98% of all enterprises, hence reducing the rate of SMEs is essential for the wellbeing of a country's economy (Tidd and Bessant 2013).

Figure 1.6-3: Cumulative Industry Survival rate for establishments started in 2000[19]

In this research GIS software is used to integrate multiple databases from different sources, analysis of spatial correlation between different variables, utilizing spatially generated descriptive variables, including demographic data, population growth, economic variables, employment level, household income, land use and zoning plans, infrastructure in multi-criteria analysis to determine suitability of site for real estate development by SME construction enterprises.

[19] Bureau of labor statistics, USA 2012

GIS tools can be used to incorporate spatial analysis with determinants of the suitability of sites for real estate development, and help small and medium-sized construction enterprises make a well informed and adequate decision that is more likely to bring success to their business.

The implementation of GIS tool in the analysis of the suitability of a site for real estate makes it is easier to integrate data from several sources and generate maps that can be readily used by SME enterprises. The table below shows typical questions that can be answered with the help of GIS tool, especially with regards to selecting and identifying treats patterns and suitability of locations.

Types of Question	Example Questions
Identification	Is the zone commercial, residential, rural?
Location	Where does suitable features occur?
Trend	How does this features change over time?
Pattern	Is there any association between two different features?

Table 1.6-1: Typical questions that can be answered using GIS[20]

1.7 Scope of Research

This research study is restricted to analysing the suitability of sites for the construction of residential buildings in the greater Helsinki region. The municipalities included in the research are Helsinki, Vantaa and Espoo, and Kuuma municipalities, Hyvinkää, Järvenpää, Kerava, Kaunianen, Kirkkonummi, Mäntsälä, Nurmijärv, Pornainen Sipoo, Tuusula & Vihti.

The GIS-based suitability analysis is done for these 14 municipalities. The multi-criteria suitability analysis will take into consideration demographic features such as population growth, population size, and population density, economic features like employment rate and the number of middle-income household. The analysis also involves analysis of location factors like distance from city centre, distance

[20] : Based on Rhind 1988

from public transport terminal, distance from public parks, distance from major roads and distance from densely populated areas.

Municipality	Area km2	Population	Population Density 2017 (per km2)	Person with Foreign background %
Helsinki	213.57	643,272	3,012.00	15.5
Espoo	312.26	279,044	893.63	16.1
Vantaa	238.37	223,027	935.63	18
Kauniainen	5.88	9,624	1,636.73	6.7
Helsinki Metropolitan region	**770.26**	**1,154,967**	**1,499.45**	**16.05**
Hyvinkää	322.62	46,739	144.87	5.7
Järvenpää	37.55	42,572	1,133.74	5.2
Kerava	30.62	35,554	1,161.14	10.1
Kirkkonummi	366.1	39,170	106.99	7.7
Mäntsälä	580.84	20,803	35.82	3
Nurmijärv	361.84	42,159	116.51	4.2
Pornainen	146.5	5,121	34.96	2.4
Sipoo	339.62	20,310	59.80	4.9
Tuusula	219.51	38,646	176.06	4.4
Vihti	522.06	29,054	55.65	5
Rest of Helsinki Region	**2,927.26**	**320,128**	**109.36**	**5.67**
Greater Helsinki Region	**3,697.52**	**1,475,095**	**398.94**	**13.8**

Table 1.7-1: Demographic Characteristics of greater Helsinki Region-Population, Density-2017[21]

The study focuses on small and medium-sized construction enterprises which are involved in the construction of residential buildings and has an annual turnover of less than EUR 50 million or a balance sheet total less than EUR 43 million or employs less than 250 persons.

1.8 Structure of the Report

The reporting of the research was classified into several chapters. The chaptalization is done in a manner that complies with the most commonly used

[21] Finland statistics 2017, Finland, Greater Helsinki Region

way of report writing for scientific researches. The format of the chaptalization will help in presenting the information effectively. The report has six chapters and their main focus are elaborated as follows:

- **Chapter 1 Introduction:** tried to provide an appropriate introduction to topics which are relevant to the research. In addition to this, the aim and objective, research questions that the research aims to answer, scope and significance of the study were briefly discussed in the first chapter

- **Chapter 2 Literature Review:** is a compilation of researches, books, articles, journals, conference papers, and literature written related to the research topic. The intensive search for appropriate literatures provided the researcher with a better understanding of the most important factors that needed to be considered in the research. The literatures reviewed assisted in figuring out current situations in the utilization of GIS technologies and how they can be employed by Small and medium-sized enterprises for a better decision. The information gathered in this stage of the research also helped in identifying where the research gap lays.

- **Chapter 3 Approach and Methodology:** Gives an elaboration and justification of the research method implemented for carrying out the studies. The chapter includes an explanation of the research framework and how ArcMap 10.5 (ArcGIS software) was utilized for the visualization and analysis of data. The information gathered and the sampling technique employed are also discussed in this chapter.

- **Chapter 4 Results and Analysis:** in this chapter, the result of primary and secondary data analysis are presented and maps are generated with ArcMap 10.5. The correlation between the different factors affecting location decision and the success of Small and medium-sized construction enterprises is investigated in this section.

- **Chapter 5 Conclusion and Recommendation**: The analysis and outcome of the research are elaborated on the final chapter of the report. A brief explanation of how the research questioned are answered is presented in the chapter. Maps showing suitable sites for construction of residential buildings by small and medium-sized construction enterprise are published. These important findings of the research and its limitation are also elaborated. Finally, areas of further research are pointed out and recommendations are stated.

Chapter 2

Literature Review

2.1. Review of Geographic Information System

Shahab Fazal (2008) defines GIS as a system that can capture, store, check, integrate, manipulate, analyze and display data which are spatially referenced to the Earth. This normally involves a spatially referenced computer database and appropriate applications software. What makes GIS unique is the fact that it needs spatial data. Here spatial means it is related to space; the real world location. This is the reason why GIS is based on basic geographic concepts.

Didier (1990) gave a definition to GIS which is more focused on decision making. He defined GIS as a set of data which are referenced to space, organized in a manner which makes retrieving of synthetic data easy. Similarly, Dagorne et al., (1991) specify Geographic information system as a geographic database which is interconnected, digital and graphics. It is a system that compliments statistical databases and can store and manipulates a wide range of physical, human and or socioeconomic data.

Batty and Xie (1994) describe geographic information system (GIS) as a technology which is capable of handling information on both location and its characteristics within a single system. Even though GIS is widely used for visualization of information, its capability of modeling is graduating becoming a prominent and more widely feature of the system (Klosterman 1998 and Nedović-Budić 1998). With the exponential growth in the sheer volume of information and ease of access to spatial data, GIS is becoming an essential tool for urban modeling and processing.

According to Michael Kennedy (2016), GIS has several applications, this includes — Land usage — Helping determine land uses, zoning, environmental impact analysis, locational analysis, and site analysis. In addition, Michael (2016) states

that GIS has a wide range of application in Identifying, delineating, and managing areas of environmental concern, analyzing land-carrying capacity, and assessing environmental impacts.

Throughout its development, GIS technologies are characterized by their diverse application in urban planning, urban architecture, environmental protection, transport and logistics, engineering networks, real estate, and military planning. Even though the complexity of GIS software has hindered the ease at which someone accesses these application, modern GIS software, hardware and databases are becoming more readily available to ordinary users. Maliene et al., (2011) state that the widespread acceptance of GIS technology has established its wider relevance to the analysis of contemporary cities.

Current progress in GIS technology has created favorable conditions for the development of solution-supporting systems at all stages in the planning and design process – although there is still much work to be done if its promised utility is to be realized (Maliene et al., 2011).

2.1.1. Application of GIS in Construction

Dalibor Bartoněk et al (2010) mention that GIS technology is more and more widely used in the technical practice of construction activities. Dalibor and his colleagues state that problem related to spatial position (location) of a construction project can be analyzed in parallel with the feasibility and purposefulness study of projects by applying GIS technology. In addition to this, they mention that GIS can be used to get a more detailed technical solution to traffic structure projects worked out.

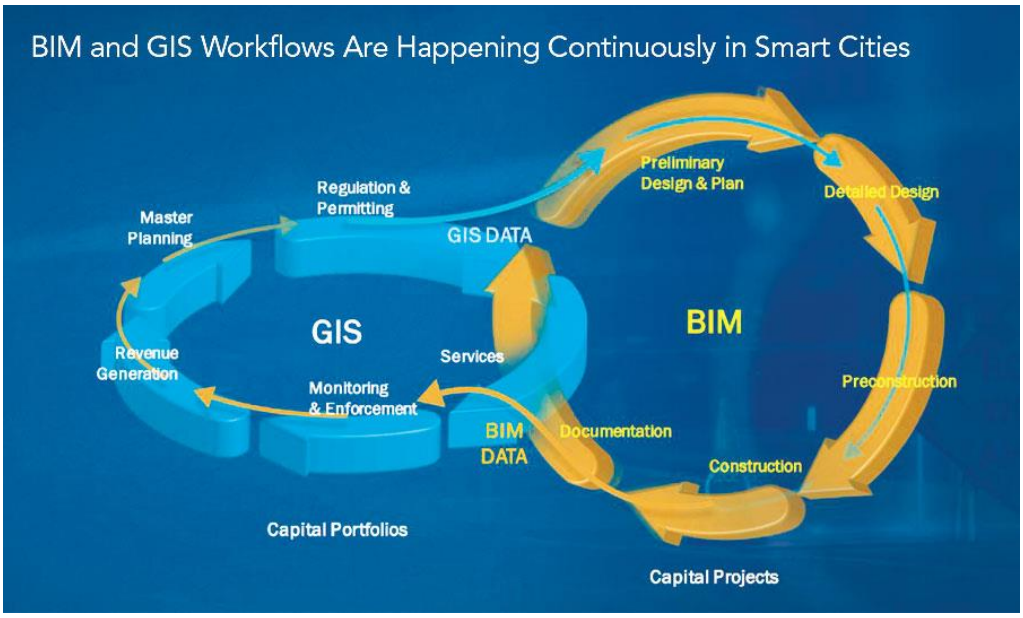


Figure 2.1-1: BIM and GIS[22].

2.1.2 Application of GIS in Urban Planning

The world's population is growing by 1.2% on average annually: by approximate 82 million people a year. This expansion has a radical effect on the nature of urbanization in Africa, South America, Asia and other regions with a rapid growth in urban population. (WorldBank, 2007).

GIS implements relatively new spatial technologies to capture, analyze and visualize geographic phenomena (Masser and Ottens, 1999). Nevertheless, in the late 1990s, the boundless use of GIS by professional designers and its effective integration into design practices was debatable (Stillwell et al., 1999). Harris (1999) suggested that designers might remain suspicious about the power of computer-based models, and Klosterman (1998) forecasted that it could take 25 years for designers to program computer programs. Yet, since 2000, there is a reason to believe that the introduction of GIS to support planning activities is increasingly important. Godschalk and Lacey (2001)

[22] Paul, S. (2018) BIM vs GIS or BIM and GIS – Why are we still in doubt?

Figure 2.1-2: Tokyo's Transit Based Development Concept. [23]

Every circle in the picture represents a 1000m radius from train stops. Each spot has shops, public spaces, parks and recreation facilities within walking distance. (Coumans 2018).

2.1.3 GIS as a Research Method

In many disciplines ranging from natural and social sciences, has a long history of using map for analyzing the value of spatial relations, patterns, and associates (Gregory 2007). However, it is only recently that GIS computer analysis environments are being used to process this spatial information in a meaningful way. (Decker 2001)

You gain a spatial advantage when you use GIS to locate, analyze and evaluate information and consequently make better decisions. By integrating GIS tool in a research method, a researcher can achieve better, complete and effective research (Songnian 2011). With GIS researcher can incorporate several types of

[23] Coumans 2018

data and present it in a more informative way by generating maps. GIS is perfect for multiple types of researches, Spatial analysis can be done at a micro level, based on postal code, to a macro level, based on municipalities or even countries. It is possible to use GIS in almost all studies since everything can be referred to certain specific spatial location; it is only a matter of identifying where the special component lays.

GIS offers a different means of analyzing functions, several ways of representing the same phenomenon in a different level of sophistication and examining relationships in space when it is used as a research tool. These are some of the advantages of GIS research method compared to traditional research method, which does not incorporate this additional information. (Goodchild 1999)

Goodchild (1999) and his co, list out the following circumstance when to choose GIS as a research analysis tool.

- whenever the data is referenced spatially
- when a spatial relationship between objects is important to the analysis
- when the volume of data is substantial to be handled by spreadsheets like Excel since options such as spreadsheets tend to only work for small databases
- if the integration of data from a variety of sources require extensive manipulation, re-sampling, and change of format
- When the research analysis involves several areas of interest
- When the visual aspect of the analysis is important and if the researcher aims to present the results to different audiences
- when the results of the analysis are likely to be used as input by other projects, or when the data are being extensively shared.

STAGES IN ANALYSIS	
TRADITIONAL APPROACH	**GIS AND SPATIAL ANALYSIS APPROACH**
Identify Issues, Problems	Identify Issues, Problems
Collect relevant data	Collect relevant and potentially relevant data
Exploratory data analysis histograms, charts, graphs	Exploratory data analysis 1. histograms, charts, maps, computer graphics displays, overlays, interaction with data base 2. Preparation for tests data manipulation data reduction map scale selection
Build model	Build model
Run model tests on parameters	Run model(s) simulations tests on parameters sensitivity analysis
Report results	Report result

Table 2.1-1 Comparison between Traditional and GIS Analysis Approach

As GIS continues to become more accessible to non-expert users, there is a wide range of new and creative opportunities in research. As with any new tool, GIS can be used incorrectly and provide misleading results. Any researcher familiar with standard statistical analysis software can relate to this concept. Use of the tool is not simply a matter of collecting a dataset and pushing buttons in the software. Good research necessitates collection of appropriate data in an appropriate fashion and then conducting an intelligent, well-thought-out analysis that makes sense for the hypothesis or question being addressed

2.1.4 Spatial Analysis

Spatial analysis examines internal relationships and relationships between holdings and defines common geographical areas and their characteristics in relation to other data collected. It is common for spatial thinking to be communicated directly through our experience and knowledge of the local environment or place. If you go to different places in town, use an informal situational analysis. When location data is carefully and methodically evaluated to determine the models, a formal spatial analysis is used. GIS facilitates the analysis of space. Although GIS is a relatively new tool, the concept of social analysis based on geography is quite old. Past researchers in a variety of disciplines including anthropology, forestry, health care, history, biology, political science, urban planning, geography, economics, and sociology have included analysis in their research projects.

Urban Systems Analysis is long-term modeling and simulation of scientific use. As Harris (1985) claims, digital computer has stimulated and stimulated city stimulation since the early 1950s. In addition, the computer's impact was direct and indirect due to digital computing, enabling the use of statistical and other research methods (e.g., mathematical programming). Therefore, the history of the city analysis is closely linked to the development of a computer and the statistical and mathematical methods. The introduction of geographical information systems (GIS) reflects the long tradition of urban analysis in technological changes. Over the past 15 years, GIS has been extensively studying the role and potential of supporting the analysis and design of different cities (e.g. Levine and Landis 1989, Harris and Batty 1993).

The use of GIS for city analysis is numerous. GIS, a database management tool, provides data mapping capabilities for displaying geographic information and data collection functions for assignment (Levine and Landis, 1989). These front-end and back-end capabilities enable analysts and designers to better manage, view and communicate information (Miller, 1999). The performance of these functions is also enhanced by interactive data modeling techniques (e.g., cartographic analysis,

data routines) that can improve urban traffic analysis and land use. Analysis (for example, Landis and Zhang, 1998a, b). In some cases, the use of GIS in the urban analysis may even allow the researcher to rid himself of "zone tyranny" (Spiekermann and Wegener, 2000). In spite of its considerable advantages, the GIS in itself does not relieve the analyst of the need to handle the nuances, complexity and subtle relationships customary in urban research.

With respect to the complexity of spatial data modeling, the recently published version of Fotheringham (2000) asks whether the implementation of a GIS is a step forward or a step backward in state modeling. In answering this question, he points out that GIS-based modeling is now a step backward - although commercial GIS software now includes spatial models, it is generally obsolete for cartographic techniques. far from the frontiers of research. In urban planning analyzes, the introduction of GIS has implied that the discipline includes a space for modeling. However, there are no statistical models for conventional urban analyzes (Landis and Zhang, 2000) and ignore important issues such as the fact that conventional statistics do not close the data properly (Griffith, 1988), insufficient independence and rigidity of geographic data (e.g., spatial data connection), different effects on geographic data processes (e.g., heterogeneity), and effects of form and effects. Representation in Spatial Analysis A series of these problems (e.g., Ansel and Griffith, 1988) is surprising because urban analysts are slowly adapting to the technical evolution of spatial statistics rather than introducing them. SIG, but it's starting to change.

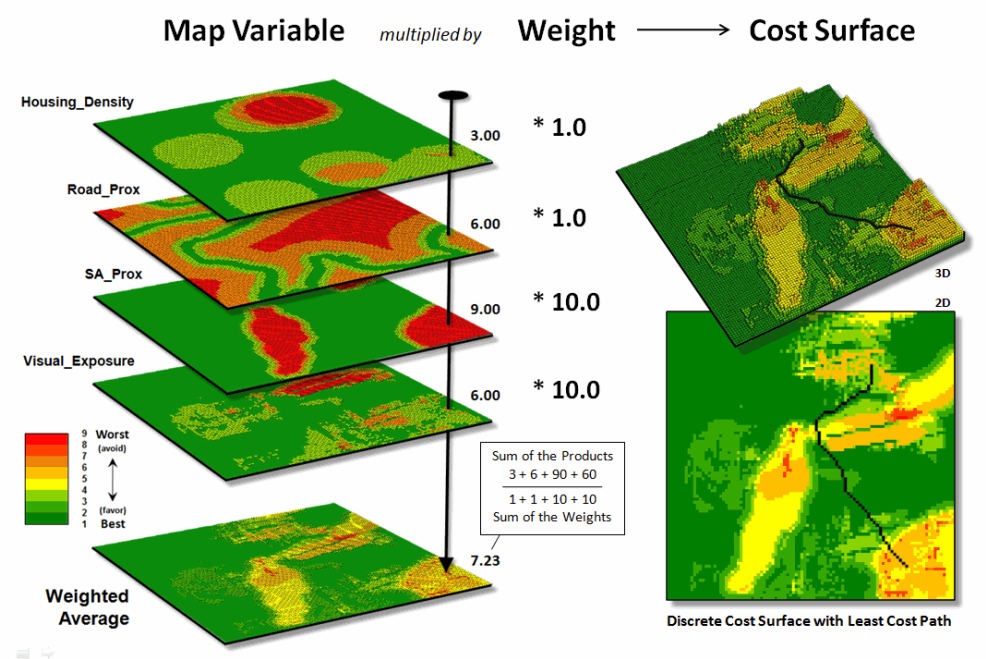


Figure 2.1-3: Weighted overlay analysis using GIS.[24]

2.1.5 GIS for Site Selection

The process of determining a location with suitable features, that meets certain demands or requirements is called site selection. Site selection is a crucial decision that all business ranging from small business to mega factories need to make. The process of choosing a suitable site involves an array of critical factors derived from economic, social, environmental and demographic disciplines. Geographic information system along with multi-criteria analysis methods are being implemented to analysis this socio-economic and demographic information. (Shouman 2002)

Choosing a site is an optimization process for various purposes, including real estate project development, plant renewal and habitat, farmland protection, and public space. Once the page is selected, its purpose can be designed - or programmed - more accurately. Programming takes place in different spaces, from building to individual buildings. The program is usually quantified and the quality of the room is expected to meet the project's expected needs. By knowing more

[24] Joseph K. Berry (2007). Map analysis. Understanding Spatial Patterns and Relationships.

about the site and the needs and preferences of future users, the program can be improved. (LaGro 2013)

According to Lagor (2013) Identifying a site at the programming stage can provide information about the site and the environment that can facilitate or prevent the use of the site. The first visit to the site will help you determine which site properties should be mapped and analyzed during the design process. Customers may have unrealistic expectations of site development and potential restrictions on site must be created as soon as possible. Site's feasibility depends on various additional information, such as:

- current aerial satellite image
- Land usage and zoning maps
- Rail and highway maps
- Geological maps showing soil characteristics
- Natural hazard vulnerability maps
- Administrative and Taxation maps

The purpose of site suitability analysis is to determine whether a site fits the required criteria and constraints. This analysis significantly reduces the time and effort required to search records, process data and conduct field surveys manually. The selection of a plot of land for urban development is becoming increasingly a difficult task, especially in a growing real estate market with strict environmental standards and safety regulations. The results of the site suitability analysis will provide detailed maps indicating the most appropriate locations for the construction of a certain facility while at the same time filtering out unsuitable or undesirable sites. when determining the best location for development, certain aspects are more important than others. The process of suitable site selection for a certain purpose must be based on a set of criteria in accordance with local standards. A scoring system which involves weighting factors can be used to

assess the overall suitability of a specific site with regards to different aspects of suitability. (Kumar 2011)

Spatial decision problems generally include a multitude of possible alternatives and a number of contradictory and incompatible criteria. Alternatives are often evaluated by multiple people (policy makers, executives, stakeholders, stakeholders). People are generally characterized by clear preferences as to the relative importance of the criteria by which the alternatives are assessed. Therefore, many GIS decisions lead to a GIS-MCDA-based multi-critic decision-making process. These two research areas, GIS and MCDA, can mutually support each other. (Murayama 2011)

On the other hand, GIS technology and methods play an important role in the analysis of decision problems. Indeed, GIS is often recognized as a "decision support system" that integrates the integration of regionally referenced data into a problem-solving environment (Cowen 1988, Cowen, D., 1988). 1555. [Google Scholar] On the other hand, the MCDA offers a variety of technologies and procedures for structuring decision-making and designing, evaluating and prioritizing alternative solutions. In the synergetic functions of GIS and MCDA, we see the benefits of promoting theoretical and applied GIS-MCDA research.

Gumusay (2016), in his assessment of suitable site for marina construction, came to the understanding that latest improvement in Geographic Information System made it more efficient to carry out a fast, cheap and reliable analysis of sites compared to the traditional methods. Now, it is possible to analyze geographic, land usage and zoning, economic, demographic and accessibility data sets to identify suitable sites. The aim of Gumusay's (2016) study was to determine areas appropriate for the construction of marinas using topographic and demographic data in the current shoreline using the multi-criteria decision-making method of the analytical hierarchy process (AHP). Erosion, landslide, tsunami, land usage and zoning, environmentally hazardous areas, utility lines, data on sea traffic, neighborhood population, age patterns, and household income data were included in his study. AHP method gave each data set a weight and a scoring system for

the selection of marinas was developed. The subsequent map from the analysis shows the suitability of areas for marina construction by classifying them into four groups, good, fair, poor and not suitable. By utilizing the MCDM APH method with GIS tools, which integrates multiple data sets with different weights and types, he was able to create a decision support system that allowed authorities to perform an accurate analysis which is cost effective and time-saving.

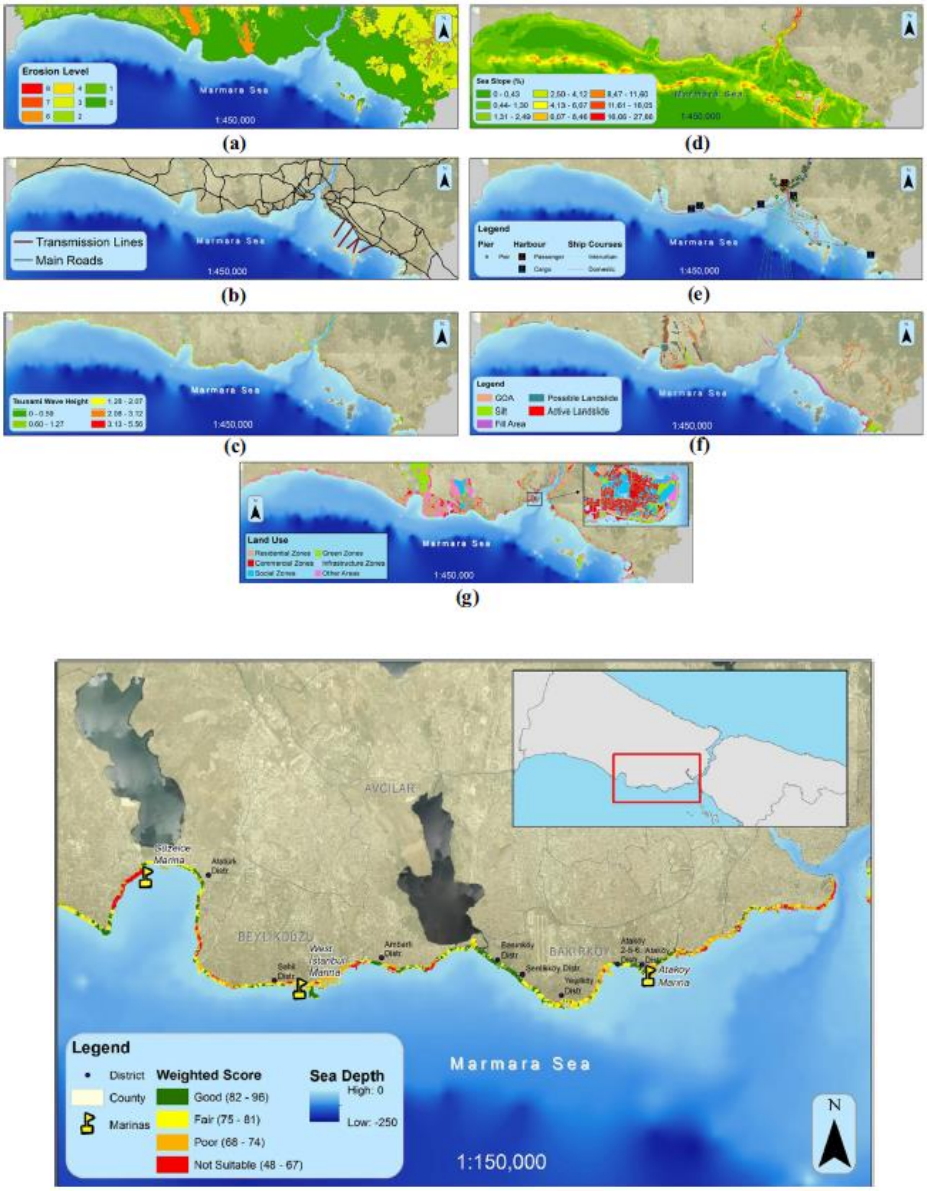


Figure 2.1-4: suitable site for construction of marina along the coastline of Istanbul[25]

[25] Gumusay'a 2016

2.1.6 GIS for Economic Development Analysis

It quite a recent thing, to implement Geographic information system (GIS) tools for the investigation of economic development. Local economic development agencies (LEDs) who are using GIS programs have achieved a very positive result. Global economic realities and increased information age expectations have motivated LED agencies to provide a wide range of spatial economic data on the Internet (Murphy 2009).

Economic development is something which is achieved through the coalition and team effort of several key players including professionals, business leaders, and the communities. The application of GIS technologies encourages and facilitate collaboration and teamwork between these diverse group of experts. Even rudimentary use of GIS is playing an immense role in successful development Projects.

Figure 2.1-5: Map showing level of poverty in London 1898-99.[26].

GIS was not the choice of economic analysts until the late 1990s Even though, it was first developed in the 1960s. The development of GPS and advancement in remote sensing technology coupled with improvement of sophisticated analysis

[26] Charles Booth, British Library

techniques resulted in the availability of huge volume data. These factors have made GIS an important tool for economic development analysis.

Pogodzinski (2013) listed the following features of GIS, which made it a key instrument for economic development analysis

1. Capability to take into accounts the spatial aspects of economic development.
2. Provides new perspective of viewing problems, that promotes collaboration and allows for well-informed decisions based on a range of data.
3. More comprehensive approach.
4. Ability to well organize a big volume of data.
5. Larger area and more information can be analyzed in comparison to traditional methods.
6. consolidates vector and raster information (Mapping) and information an ascending from differing sources, for example, GPS
7. requires just a couple of GIS tools to attempt the rigorous task of economic analysis

2.2 Review of Key Factors Driving Real Estate Business

Real estate business is a highly profitable and lucrative business sector for investors. It represents the biggest proportion of the wealth of most people (Nguyen 2017). According to the most recent statistical releases from statistics Finland (2017), 3,827,000 persons, which is around 70% of the total population, lives in 1,669,900 housing units which they own themselves.

The growth and development of population and interest for real estate at the regional level are firmly connected to the situation in the labor market. The immigration of people from one region to another due to job opportunities are also an important factor that influences demand for real estate. They likewise significantly affect households' real and anticipated earnings, which sequentially influences both the demand and price of real estate (Brueggeman 2008).

The factors affecting the real estate sector are broad and complex (Gu 2018). The decision to invest in certain real estate in certain location should come after thoroughly investigating the overall economic suitability, tendencies, and viability of the surrounding region. It is highly improbable that a real estate business will succeed if the region its operating doesn’t have sound economic growth, population growth, and job growth. (Griswold 2012).

The truth about real estate sectors is that it is affected by factors which cannot be controlled. These factors govern the demand, pricing as well as the potential return of investment. Understand and evaluating these factors has a big significance in the success of the investment (Eman 2018). The following section of the literature review is a brief compilation of publications written on factors that drive the real estate sector. This includes

- Demographic Factors
- Economic Factors
- Location Factors

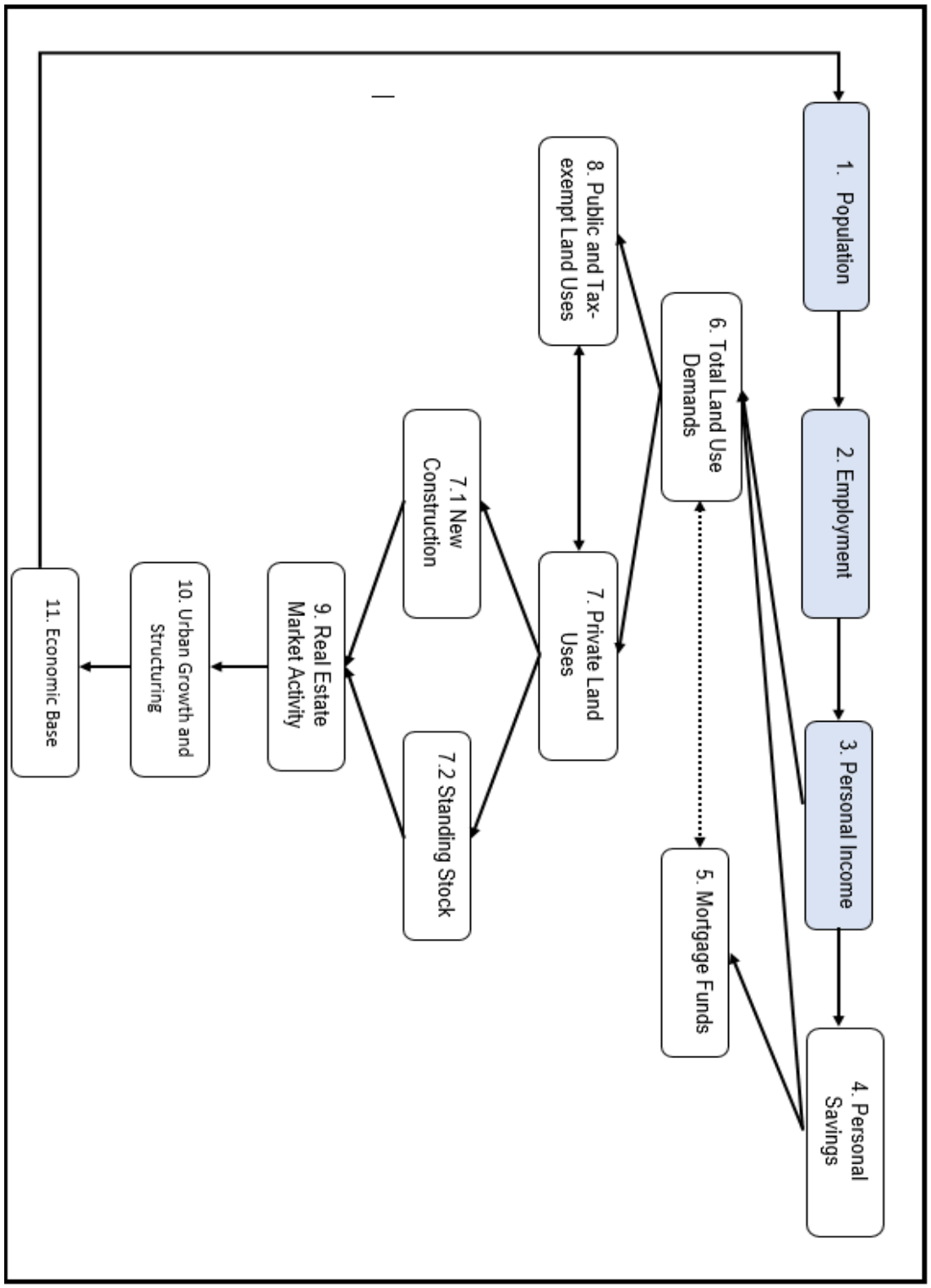


Figure: Flow in real estate construction sale and financing markets[27]

[27] Fred E. Case 1966. Real Estate Brokerage

2.2.1 Demographic Factors

Demography is the study of the population which focuses on the scientific portrayal of human Population, especially their structure concerning age and sex, and factors that alter it, which includes, births, migration, and death (Rogers 2015). These demographic statistics are a regularly neglected however critical factor that influences how housing is valued and what kinds of properties are sought after. Major changes in the demographic structure of a country can significantly influence patterns of real estate development for quite many years.

It is a no brainer to say that housings are constructed to be utilized by households. As a result of this their demand at regional and country level is closely tied with the demographic features of households, such as its size and structure (Laakso 2000). Kuismanen et al. (1999) by applying the model used by Mankiw et al. (1989) to analyze the relation between population size and structure, and demand for housing, They were able to show that these demographic features are the main reason for change in pricing and demand forr housing over a period of time. Manganelli (2015) similarly states that demographic changes and inclination changes have a long-lasting influence on real estate demand. Demographic features (rate of birth, death rate, and migration) influence, for the most part, the number of housing required to lodge the populace, while sociological features of society govern the quality, technological and functional aspect of housing required.

According to Kuismanen et al. (1999) results from their estimation, Housing demand of Helsinki region residence per capita rapidly increases for the age group of 20 -29 years. Statistics from statistics Finland (2016) also backs the claim made by Kuismanen et al. (1999), the average age of first time home buyer is on average 28.5 years. So from the standpoint of real estate demand, the size of the age group 20-29 years old play significant role in real estate markets, because this age group is generally considered as the period of time when young man and woman move out of the family and when mobility is higher.

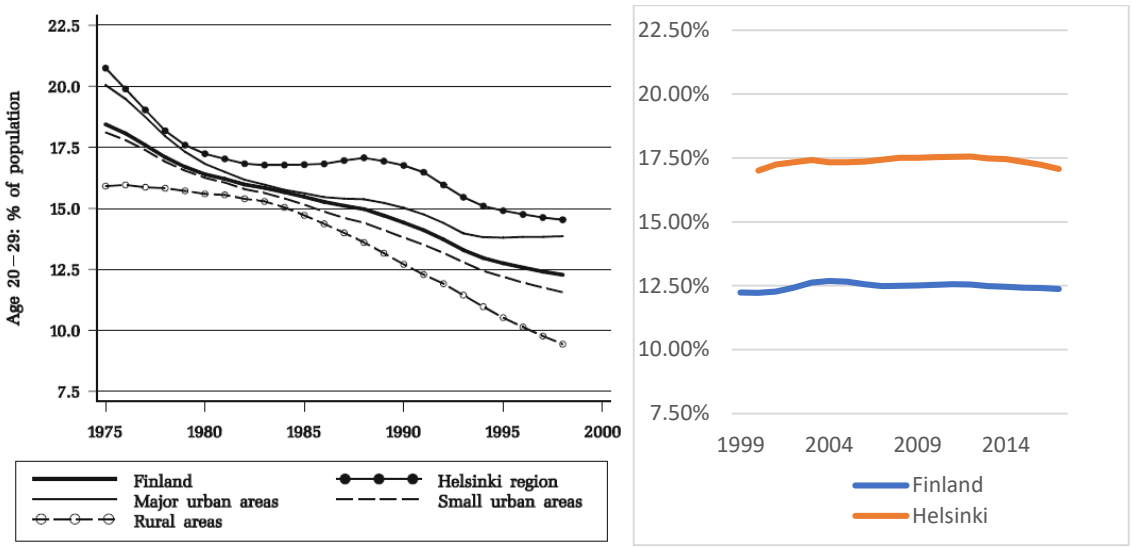


Figure portion of (%), 20 – 29 age group. Laakso 2000 and continuation statistics Finalnd.

Increments or diminishes in populace are the aftereffect of three events: births, death, and individuals moving into or out of the region. In many regions, births rates surpass mortality rate, and in this way most regions experience moderate development. So the genuine effect on real estate demand originates from a dynamic and portable society Griswold (2012). There has been a been significant movement in population from rural areas to southern urban areas in Finland, driving the demand for housing. (Lilja 1990).

According to Finnish Immigration Service, Migri, Immigration is the arrival of people into country form another for temporary or permanent residence. The majority of countries have placed their own rules and laws that regulates the number of people coming and how they are qualified. According to population data act 507/1993 states that a person has to be registered and counted along with the permanent population, if the person is intending to stay in Finland for more than a year or has been living in Finland over a quarter of a year without interruption. As a result of their societal position and lower earning, immigrants settle in regions with modest housing, and, thusly, the convergence of foreigners often diminishes the return value of the real estate (Shatilo 2014).

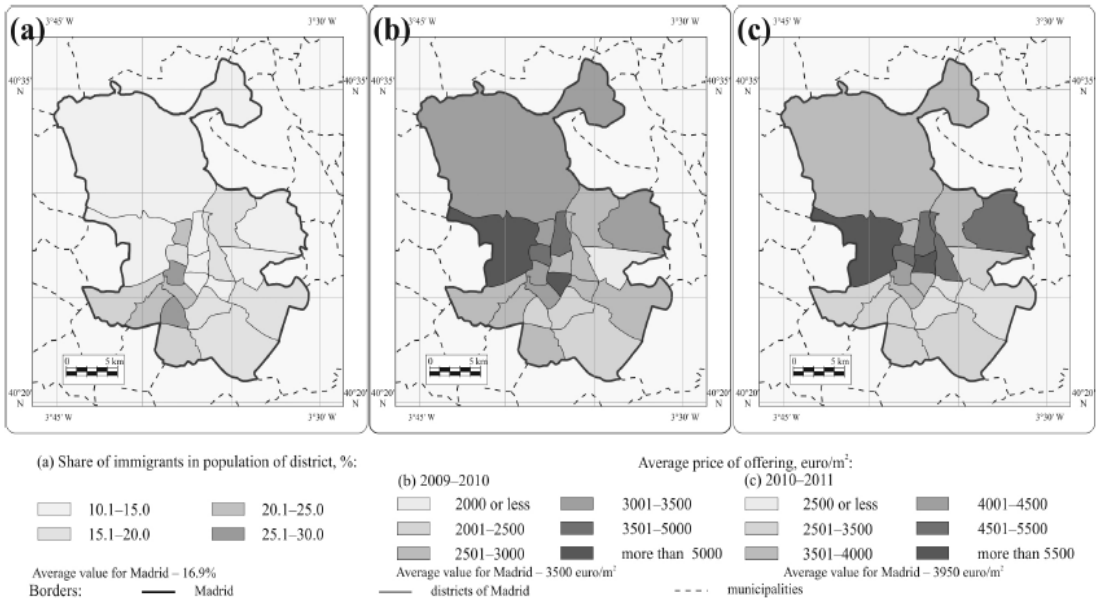


Figure Correlation between settlement pattern of immigrants in 2009–2010 (a) and housing prices in Madrid by districts in 2009–2010 (b) and 2010–2011 (c). **Source:** D. P. Shatilo 2014 p53

After the years of the baby boom and bust the portion of population between the age of 20 and 29 has been decreasing monotonically due the low fertility rate. But the most prevalent trend in Finland is that, the rate at which the number of housing increase has been faster than the population growth rate. This has resulted in the reduction of the household size per housing and this trend can be seen in the figure below. (Laakso 2000)

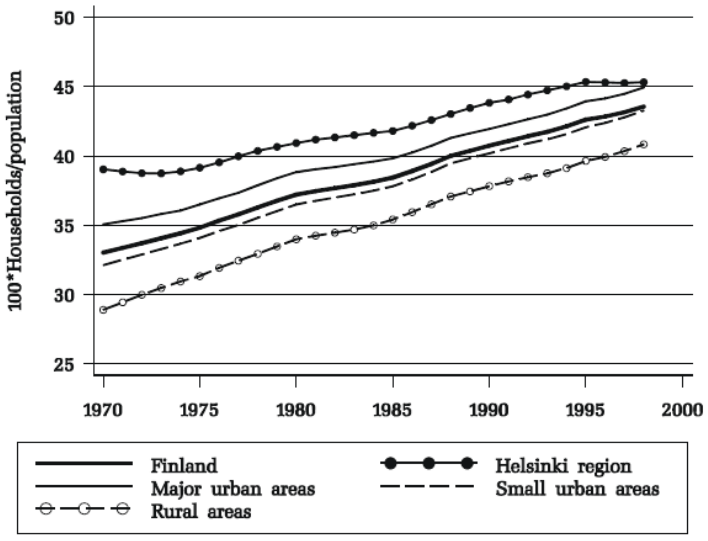


Figure: Household per occupant Laakso 2000

2.2.2 Economic Factors

The general economy's condition significantly affects the real estate market, as the capacity of consumers to cover costs of housing depends to a great extent on key economic factors, such as, GDP, interest rate, employment rate and growth of earnings (Matthews 2016).

Accommodations are a must and are a noteworthy part of a family spending consumptions. Englund (2002) said that a families residing in western countries (West Europe and North America spend well over a quarter of their total income on accommodations. In the case of Finland, housing represent 66% of the total accumulation of wealth of a household (Statistics Finland 1998).

Housing demand depends on personal income. With higher economic growth in the economy and rising wages, people are able to expend much more on housing, increasing demand and driving up cost. Demand for real estate can be considered as elastic, getting higher when unemployment rate goes down and lowering down when unemployment rate is on the rise. (Pettinger 2017)

According to Griswold (2012) reduction of unemployment rate and creation of job is an important element that drives the demand for a real estate. Real estate economist estimate that for every 300 jobs created in a city 200 new households are required. Griswold (2012) state that the following factors has an effect on the demand on housing and need to be assessed when choosing location for real estate development.

- Level of income
- Increment in wage and salary
- Diversity of job industry
- Type of industry
- Decline in unemployment rate
- Consumer confidence

According to Laakso (2000) the floor area of households per capita in Finland has been steadily increasing despite the employment condition at times not being very promising. The growth rate of floor area per capita in Helsinki region is lower than those observed in rural areas. This phenomenon is happening partly as a result of the migration influx to the capital region.

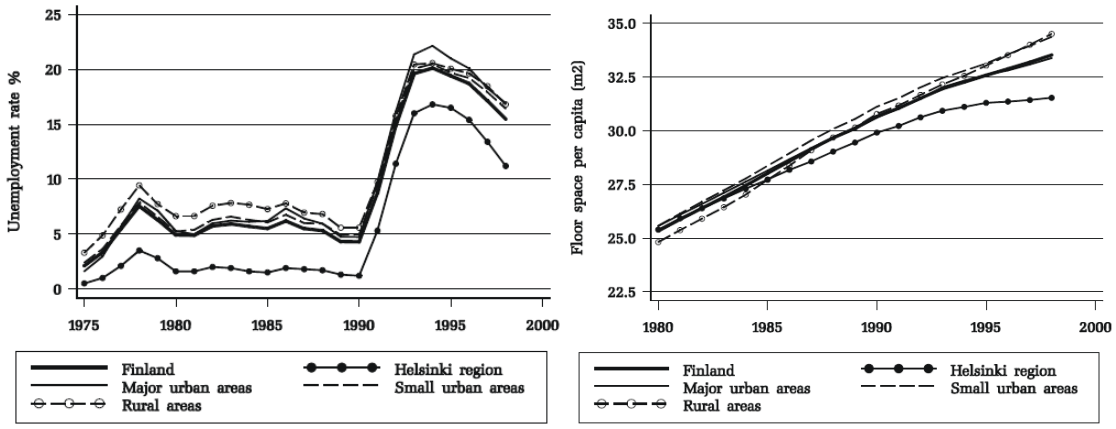


Figure unemployment rate (left) and floor area per capita (right)[28]

2.2.3 Location Factors

The demand for housing market is highly connected to its physical location. Location is so important that even in time recession and economic downward spiral, price of housing in major cities might still continue to rise (Great Britain Parliament 1983). Demand is high for areas which are desirable due to their proximity to commercial centers, good educational institutes, good public transport links and facilities (Pettinger 2017).

The most crucial location factor that drive the demand of real estate is accessibility (Muth 1969). In recent years' people are more focused of choosing location with good localized services which are accessible in a walking distance and as such reducing the usage of vehicles (Marzluff et al. 2008 and Handy 1993).

Desirability of neighborhood for real estate development is influenced by location factors such as state of the surrounding properties, proximity to public parks and

[28] Laakso (2000)

recreational facilities, impression of the neighborhood, cleanliness, rate of crime, availability of major employers or industries. (Moore 2009)

Residential	Commercial	Industrial
Access to work place	Access to Highways and arterial roads	Access to Highways
Access to commercial centers	Access to Consumers	Access to Airport
Scio-economic factors	Access to Labor	Access to Labor
Public Spaces	Access to auxiliary business	Access to auxiliary business
Public Services	Public Services	Pubic Services
Tax	Tax	Tax
Land use and zoning	Land use and zoning	Land use and zoning
Public transport links		

Table Location factor influencing different types of real estate. Marzluff et al. 2008 503

2.3 Research Gap

The comprehensive literature reviews done in this chapter elaborate the capability of Geographic Information System (GIS) tools to be utilized in construction sectors, urban planning, spatial analysis, location decision and economic analysis. Any factor which can be spatially referenced can be effectively analyzed by GIS (Berry 1996). GIS has a huge potential for visualization and analysis of big volume of spatial data (Chen 2014).

The production rate and demand of housing is a dependent on demographic, economical and location factors. Shifts in demographic size and structure and economic patterns affect the distribution of populace which in turn shifts the

demand in housing (Laakso 2000). All this variable factors indicated above can be analyzed spatially, which justify the utilization of GIS technology for analysis.

In today's competitive world, it is important for business to continuously improve and innovate so that they are not left behind. Companies are so competitive and efficient, that a small problem a company faces could cause a major hurdle to the goals the company wants to achieve. The smallest structural change in the organization could have a significant impact on the profitability of the business. (Hood 2013). One of the powerful tool that business can exploit is GIS technology (Pick 2005). Real estate developer and small construction enterprises which adopt the GIS for analysis and location decision making, will improve their productivity (Peterson 1998).

The review of publications highlights the tremendous potential of GIS technologies for analysis of suitability and location decision. The literature reviews also indicate that GIS technology is being used more and more by experts and business sectors in different field for wide range of purposes. One of the business sectors that could benefit from the potential of GIS technology are small and medium enterprises that are involved in real estate development, but from the review it was observed that there was lack of publication discussing its usage by SME construction enterprises. Making well informed and data based decision is crucial for the longevity small and medium enterprises. This research will to try to bridge the gap by demonstrating how GIS based suitability analysis of sites can easily be done for location decision in greater Helsinki region.

Chapter 3

Research Methodology and Approaches

3.1 Overview

According to Small Business Association (SBA), only 25% of small and medium sized companies make it to 15 years (SBA 2012). Among the many reason that contribute to the failure of SME are lack of information about market to make an optimized decision and wrong choice of location (David 2007). External factors such as political, economic, demographic, social, technological and environmental are something that SMEs can hardly control. SMEs need to make an active decision on where to conduct their business by evaluating this factors (Luca et al, 2015). This research study aims to establish the impact of land use and zooning plans, demographic and socio economic on the suitability of sites for real estate development by utilization of GIS tool, so that small and medium sized construction enterprises choose adequate location that will most likely bring success to the firm.

Research is a scientific and systematic way collecting information and analysing of data to seek answers to question or problem. For research to be scientific is must be done in steps and the steps must be repeatable or iterative (Mamun et al, 2014). Research method and methodology are extremely important in scientific research process. They describe the manner research problems are formulated, how information is gathers and analysed and generalization is made. Scientific research methodology is fundamental for the credibility of outcome of research (Pathak 2008).

This chapter the research report discusses the methodology used to conduct the research and reach generalizations. The procedure how the research is done, and what and why certain tools are chosen is elaborated. For this research positivism philosophy epistemology is adopted as an approach. The philosophy of positivism

argues that only observable and measurable phenomenon will generate credible data to make generalization from (Saunders et al, 2009). The data analysed in this research will be used to make an inductive generalization. The current research study embraces the epistemology that states knowledge can be gained through empirical evidence (Butchvarov 1970).

3.2 Research Paradigm

When conducting any scientific research, it is recommended that the researcher clearly state the basis for knowing what she/he know. A research should do the study within the bound of a paradigm once it is chosen (Kuhn 1971). Harré et al, (1987) defined paradigm as a combination of a metaphysical theory describing the nature of objects in specific field of study and a method which is designed to gain knowledge about those objects. It is recommended that before choosing methodology of research and appropriate paradigm, the researcher must develop an adequate understanding the research area (Saunders et al, 2009).

A positivistic paradigm is based on the school of thought that focuses on experience. It pursues to explain and predict what happened, on the basis of observations made through senses. Through the observations a researcher can develop an understanding of regularities and casual relationships between elements it is composed of. In a positivist research, it is possible for the researcher to be objective and conduct the study as an external observer. Hence, positivistic ensure that all knowledge acquired through observation can be verified and authenticated, making it scientific (Kuda 2012).

This current research's main objective is to investigate into factors that determine suitability of sites for real estate development and generating a map indicating where this suitable sites are with the help of GIS tool. Finally, a mapping showing the activity of SME construction firms is compared with the mapping showing suitable sites, to determine if there is a correlation. Since the research studies each of factors which determine suitability of sites before making a rational

generalization and uses measurable data and observations, the appropriate paradigm should be positivism philosophy.

In positivistic research it is assumed that the research neither affects nor get affected by the observations. The researcher need to develop a strategy to collect data formulate hypothesis based on existing theories (Remenyi et al, 1998 & Saunders 2009). For the current research, the researcher hypothesizes that suitable sites for real estate development can be identified by combining and manipulating demographic and socio-economic factors of certain locations using GIS tools.

3.3 Research Design

Research design is a plan or blueprint of the research clarifying how the research questions are answered. The plan should provide a sequence of activities that will assist the readers to grasp the link between the research questions, the approach that is adopted to address the questions, the assumptions made for the approach, how data was gathered, manipulated and analyzed, outcomes and conclusion of the research (Kuada 2012).

Researcher need to develop the research design, methods for collecting the necessary data and procedures used in the analysis, keeping in mind the objective of the research and availability of resources including time and money. Preparation of the research design must be done with great deal of attention to avoid mistakes that will undermine the credibility and validity of the research done (Kothari 2004).

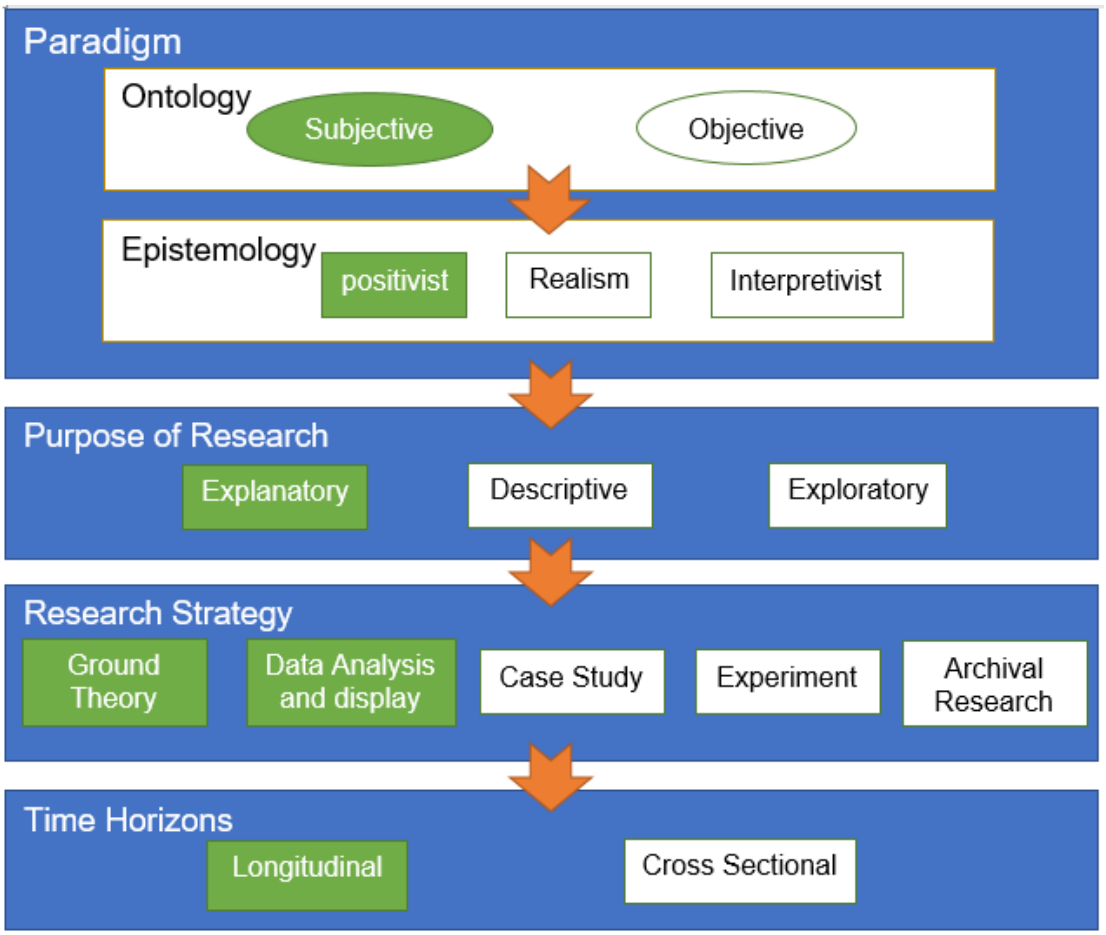


Figure 3.3-1: Research Design[29] (parts with green background are the once used for this research)

3.3.1 Purpose of Research

A research can be classified as exploratory, explanatory, descriptive or predictive depending on the purpose of the research (von Damon et, al. 2011). Descriptive research aim at describing phenomenon by conducting surveys, interviews or observations. While descriptive research focuses on what is happening rather than why it is happening, explanatory goes a step further by explaining why it is happening in addition to describing the phenomenon (von Duane et, al. 2011).

The purpose of this research for most part of it is to describe and explain why and how certain demographic and socio-economic features affect the suitability of certain locations. The objective of explanatory researches is to understand the

[29] Based on Saunders 2009

casual relationship between different variables (Robson 2002 & Saunders 2009). The thesis aims to understand what is happening in Helsinki region with regards to its demographical and socio-economic features and investigate the relation between these features and the suitability of sites for real estate Development. This in turn will be used to access SME enterprises in relation to where they are doing residential building construction projects.

3.3.2 Research Strategy

One of the most important and significant step in research is, the formulation of the research questions and problems (Campbell et, al. 1982). Campbell et, al, point out that the form of the question provides as important clue for the selection of the appropriate research strategy. The research question or problem that the study will try to answer are stated as follows

- Is it possible to utilize GIS tools to analyze information about certain locations in a manner that is beneficiary to SMEs Construction firms?
- Which demographic and socio economic features are critical when analyzing suitability of sites for real estate development?
- Test the hypothesis that there is a correlation between success of SME construction enterprises and where they conducted their business

Based on the research questions and problems formulated for this research, application of grounded theory as the research strategy was deemed necessary. Grounded theory is best way to extend knowledge based on what is already known. The inductive reasoning and logic behind this research strategy is what makes it attractive for this research. Grounded theory combines with inductive to help researcher predict and explain phenomenon (Goulding 2002 & Saunders 2009).

By carrying out intensive literature review, the researcher this current study was able to find out which factors are good indicator of suitability of sites for real estate development by SME construction firm. The research implements inductive logic to combine these different factor come up with a rational generalization. Aristoteles

describe inductive logic as an argument which is based on a posteriori knowledge, state that if the particular premises are true, then a generalization and conclusions made on these premises cannot be false (Gupta 2015).

To make an inductive generalization and conclusion, data display and analysis was done on the different factors affecting suitability of site for real estate development. In data display and analysis induction procedure, the researcher groups and displaying in manners which enable relationships between several variable can be examined. (Miles 1994)

For generating map to display the different data, GIS tool, ArcGIS 10.5 was used. The utilization of this tool enabled the gathering of relevant data together for examination. Geographic approach, using GIS software, has created a new way of visualizing and solving problems (Coburn 2000).

3.3.3 Time Horizon

The time horizon of a research is to define the perspective at which the research is done (Laura 2016). A research can be a snap shot, focusing on phenomenon happening on a particular point in time or a longitudinal one, making observations over a certain of period of time (Daniel 2004 & Daymon et al., 2002). In longitudinal research the study is conducted repeatedly on the same target groups (samples remain the same). The most crucial aspect of longitudinal researches is that is possible to track changes and development over a period of time (Saunders 2009).

Even though the current research focuses on the change and development of demographic and socio-economic variable over time, the research conducted is a cross-sectional study. It is not possible to conduct longitudinal research for this study due to the shortage of time. The disadvantage of longitudinal research is that it requires longer time and costs higher compared to cross-sectional research (Malhotra 2006). The data used for this research are collected from the statistical organization of Finland and open data provider, making it possible to conduct the research with minimum time and money. Similarly, the survey to determine weight

factors for the different factors was done with an online survey in a cross-sectional manner.

3.4 Research framework

The first step of any scientific research is formulation of problems and proposal development. The main aim, the research methodology and significance of the study is identified on this step (Mamun 2014). A researcher proposal is an important aspect of a research and should be carefully considered by the researcher (Denicolo 2012).

These research proposes the utilization of GIS tools to assess Small and Medium-sized construction with regards to the choice of suitable locations for real estate development. At the beginning of a research one of the difficult thing is to avoid research questions which are vague and diffused (Judith 2005). The research questions and objectives of these research was refined by conducting a preliminary literature review. To decide on the research topic, the researcher tried to take in to account the following criteria.

- Relevance and Significance
- Avoidance of duplication
- Timeliness
- Feasibility of the study to be conducted with the limited time and financial resources.
- Applicability of the outcome the research
- Personal interest and motivation to the researcher
- Ethical acceptability

After choosing proper topic of research, the researcher of this current study formulated a conceptual framework or synopsis for conducting the study. Synopsis is the set of broad ideas, a description of the holistic nature of the topic (Reichel

1987). The researcher introduced the aims and objectives, state the hypothesis, phenomenon, preliminary research design, study area and study target of the research in the conceptual formulation. Formulation of an adequate conceptual framework in the early stage of research helps the researcher understand current situation and become more aware of phenomenon to be analyzed carefully (Ribeiro 2015).

Part of the conceptual formulation and background study of the research area this study was to set objective and aim the study. The set of objectives helps the researcher focus the researcher's investigation. It also helps in answering the research questions or moving a step closer toward the end goal (Azlan 2013).

The researcher of this study tried to develop the objectives:

- As Simple as possible (not to complex and unsolvable)
- Specific (focused and not vague)
- Stated in advance so that the research is focused on answering the problems.
- To avoid collection of unnecessary data, and
- Organize the research in well-defined phases

Once the aim and objective of the research topic are defined, the next step in the research was to further develop the understanding and obtain sound knowledge through extensive literature review. Literature review is a demonstration of what theoretical knowledge the researcher possesses or developed while conducting the study (Randall 2005).

The main idea of literature review in not just about compilation previously done researches related to the topic, it is also about discovering critical deficiencies of currently implemented methods and methodology related to the topic of study. It allows the researcher to identify who are the prominent researchers and what they have written, what are the prevalent ideas and critical questions being asked.

Literature review also helps researchers to steer away from unintentional duplication of previously written researches. (Shazia 2014)

The critical literature review done in this current study enabled the researcher to:

- To justify the significance of the study
- Reveal studies which are significant for the study
- Go in detail with the current research problem
- To see how past studies contributed to
- To discover frontier of the field related to the study
- Make sure there is no replication of similar topic

After the critical literature review and proper formulation of research questions, the researcher chooses a research design which aims at answering and providing solutions to the problems. This involves choosing the research paradigm and research strategy as well as the time horizon and analytical logic that was used for conclusion.

Researches can be either qualitative or quantitative (Ernst 2015). Since this current research involves study of statistical data to investigate and analyze suitability of sites, the research is classified as a quantitative one. The research implements systematic and methodological analysis of demographic and socio-economic factors to determine their causal relationship with suitability of sites for real estate development. The research employs GIS and mathematical modeling to provide fundamental connections empirical observations.

For the current research, which involves utilization of GIS modeling to identify suitable locations for SMEs, a positivistic paradigm is the appropriate choice. As a procedure the researcher chooses inductive approach to the analysis of data.

Data analysis and display induction procedure allowed the researcher to examine relationships between different categories of variables and make an inductive generalization by mapping of the data with the utilization of ArcMap 10.5.

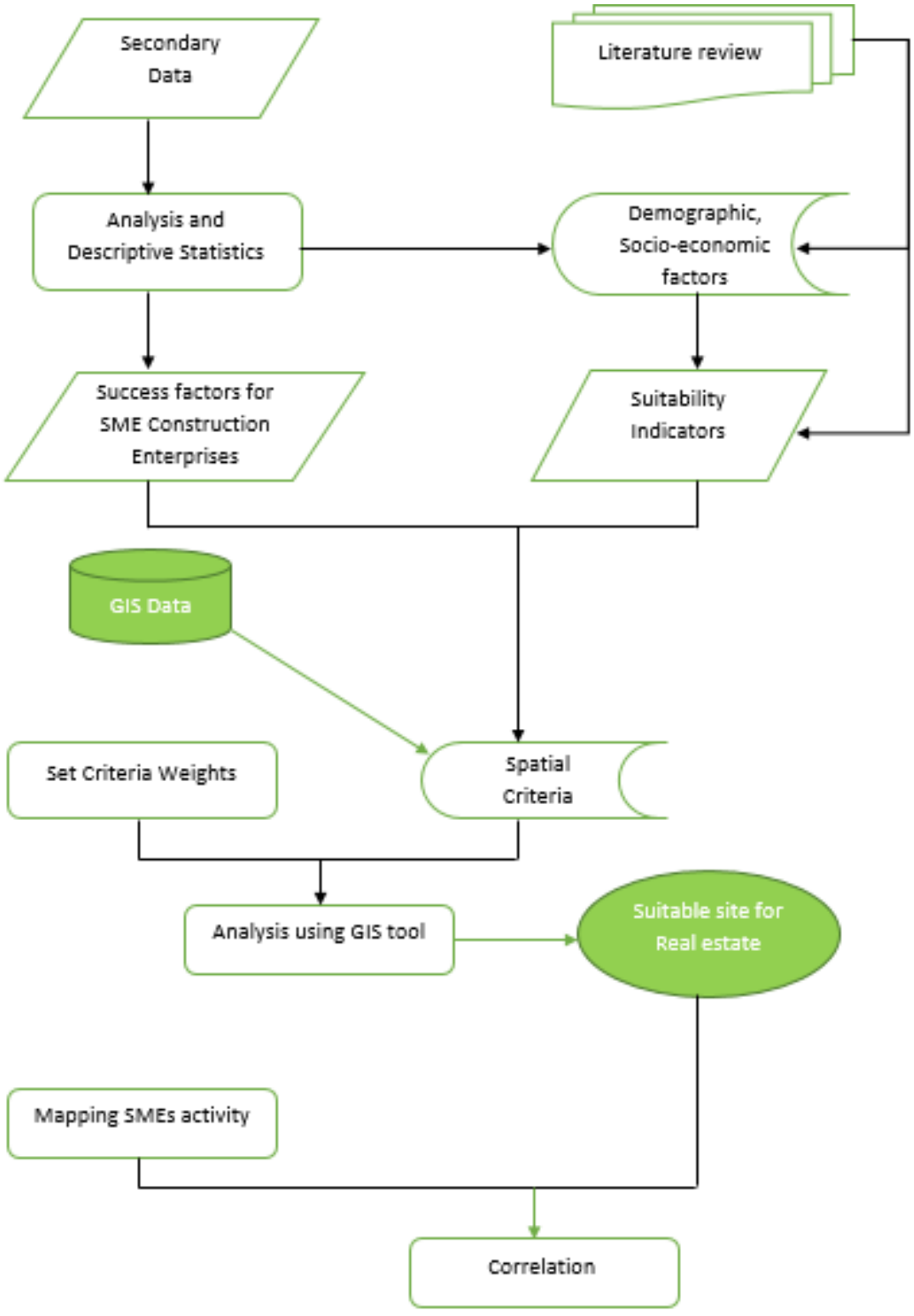


Figure 3.4-1: Research Framework[30]

[30] Own work

3.5 Collection of Data

Before the process of data collection, a researcher has to formulate the research problems and the research design. Once this is done, then the researcher has to make a decision on which data and in which method it has to be collected (Kaser 2012). It is a recommended practice to take into consideration the data requirement for a specific study, since availability of data is one of the main issues for researchers going beyond literature review. Researcher need to consider several reasons that restrict availability of including time, cost and etc. (Fellows and Liu 2015).

A research can be classified as a primary or secondary research depending on data used in the study. Those researches which involves collection of data that does not already exist are classified as primary research whereas those involving the gathering and synthesizing of already existing data rather than generating primary data are classified as secondary Research (Jugenheimer 2014). For the purpose of this research, the researcher used both primary and secondary data.

3.5.1 Primary Data

The analysis of this current research is done mostly on secondary data collected from different sources. It is not always necessary to spend valuable time and energy to collect primary data to conduct research. But, when there is a noticeable gap in research and lack of already existing data related to the research problem, the researcher should address the problem by collecting her or his own data.

For the current research, it was necessary to determine weight factors of different factors that determine suitability of sites. This factors may differ from one industry to another and from one municipality to the other. As a result, it was necessary to determine which suitability factors are given higher priority and which are given less attention by residence of Helsinki region and SME firms when selecting a site for constructing residential buildings in greater Helsinki region.

The primary data which was required for the purpose of this research, was collected through online surveying. The survey questions were sent out to residence of Helsinki region, SME enterprises, urban and city planners based in Helsinki region.

3.5.2 Secondary Data

The identification of sources of data for a study is an important step in the approach and methodology development stage, since it will minimize the time required to actually gather the necessary data for the analysis stage of the research. Secondary data specially with regards to saving time and money play a crucial role in facilitating the data collection process for a researcher. (Kurtz 2009)

Secondary data can be both raw data and publications from different sources (Saunders 2009). The majority data used for the purpose of this research will be collected from the local statistical agency, TilaStockskus (Statistcs Finland), Maan Mittaus Laitos (National Land Survey of Finland), official website of municipalities and Suomalainen avoimen datan portaali (Finnish open data portal).

Data	Source	Comment
Administrative Boundaries	www.diva-gis.org	Base map of Helsinki Region
Boundaries By Postal Code	Maan Mittaus Laitos (National Land Survey of Finland)	Base map of Helsinki Region
Demographic data; Population, Population Density, Population Growth	TilaStockskus (Statistcs Finland)	Statistics From 2017
Economic Data; Income per house hold, Unemployment rate	TilaStockskus (Statistcs Finland)	Statistics from 2017
Land use zoning Map	Municipalities official website	Latest master plan
Transport infrastructure: road network, bus routes and bus stops	Helsinki Regional Transport Authority (HSL)	

Table 3.5-1: Secondary Data Collected[31]

[31] Own work

Using demographic data or statistics from population will help researcher achieve a higher quality (Vogt 2011). The researcher of this study chose to use secondary data from statistical agencies, because they provide high quality level raw data. Open statistical data, which are provided by TilaStockskus, are made freely available for researchers and decision makers for analysis. Statistics are accessible on the whole country on various topics grouped by municipalities, postal codes or map network.

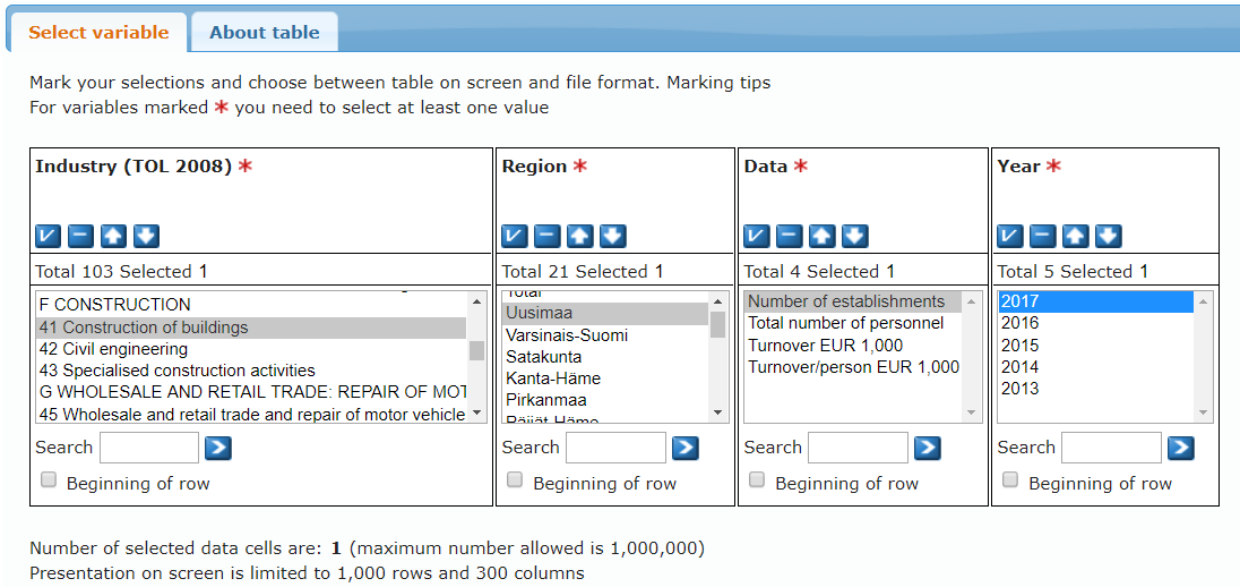


Figure 3.5-1: How to extract data from statistics Finland (TilaStockskus).[32]

Figure above demonstrate how to extract data about number of enterprises working in different regions

The literature review was also an important part of this research, several publications were investigated to develop background knowledge about, characteristics of Small and Medium Enterprises (SME), the utilization of GIS for data organization and analysis, and identification of different factors that influence suitability of site for real estate development. This publication, which are secondary source of data, were gathered from different online platforms, ProQuest EBook Central, Springer Link, Scirp, IEEE*Xplore* and google Scholar.

[32] http://pxnet2.stat.fi

Researchers must take a great caution when utilizing secondary data for conducting a research. The researcher must make sure that the secondary data is suitable and adequate in the context of the research problem which the researcher wants to solve. The researcher need to understand the meaning and limitation of published statistics before making further analysis based on them (Bowley 1937 & Kothari 2004). The researcher of this study assessed the following characteristics of secondary data before using them for analysis:

- Reliability – assured by using data from trusted sources
- Suitability – manipulated in such a way that it fits the need of the study
- Adequacy – accurate statistics relevant to the study area.

3.5.3 Data Quality Goal and Validity

Utilization of high quality data is an important prerequisite in the advancement of knowledge through scientific research (Pearce 2006). When a researcher collect data, he or she must guaranty the reliability of the data, i.e. it should be free from error; consistency, making sure it gives same result even after manipulation; valid and relevant for the research.

For the current research the data quality goals are summarised in the table below.

Parameter	Goal	Indicators
Time-related coverage	Data used are date and not too old	Only recently available data are used
Geographical Coverage	Data is Spatially referenced. Data are limited to study area	Finland background Data
Precision	Variance of data is checked	undefined
Consistency	Apply uniform methodology	Undefined

Table 3.5-2: Data quality goals of the research[33]

[33] Based on Wenzhong Shi 2002

3.6 Sampling

When a researcher is interested in drawing rational conclusion about a certain population group on the basis of observation made on parts of this population, he or she need to collect a sample. The sampling should be designed with the goal of inferring a certain feature of the target population (Spiegel 2010). Sampling techniques are a variety of methods that allow you to reduce the volume of data you need to collect, when properly done, not only does it allow the researcher to save time and effort but also money (Pathak 2008).

The Researcher of the current study chose to conduct survey rather than using published literatures to determine weighing factors for different suitability criteria, because a survey will give a more reliable result, which is more representative of the desire of residence of Helsinki region.

3.6.2 Sampling Design

Vigilant sample design creates a means for obtaining estimates which are unbiased about the population mean or total. Sample design is the process of selecting sampling frame and sampling technique. (Henry 1990)

The sampling design of the survey is as follows.

- **Universes** – Residence of Helsinki region
- **Source List or sample frame** – residence of Helsinki region who is active user of the internet. This is because Google form was used to conduct the survey.
- **Sampling unit** – A person residing in Helsinki region and participating in the survey
- **Sampling Method** – Probabilistic random sampling

3.6.3 Sample Size

The sample size is the quantity of items included in a sample. Careful and planned sample size selection is important to the validity of any conclusion made based on the sampling. Sample size should be optimum, not too big nor too small, so as to meet reliability requirements (Kothari 2004).

The sample size for simple random sampling, can be determined by setting the desirable level of confidence, margin of error and the number of the total population.

- Deviation (margin of error) d:

$$d = z\sqrt{\left(\frac{N-n}{N}\right)\frac{\sigma^2}{n}}$$

- Solving for n, will give the necessary sample size to determine the mean of a population

$$n = \frac{1}{d^2/_{z^2\sigma^2} + 1/_N} \quad \text{..... (Thompson 2012)}$$

	Confidence level = 95%			Confidence level = 99%		
	Margin of error			Margin of error		
Population size	5%	2,5%	1%	5%	2,5%	1%
100	80	94	99	87	96	99
500	217	377	475	285	421	485
1.000	278	606	906	399	727	943
10.000	370	1.332	4.899	622	2.098	6.239
100.000	383	1.513	8.762	659	2.585	14.227
500.000	384	1.532	9.423	663	2.640	16.055
1.000.000	384	1.534	9.512	663	2.647	16.317

Table 3.6-1Sample size for different population size, confidence interval and margin of error[34]

[34] www.surveyanyplace.com

The size of a sample in a survey is governed by the money spent to collect the data and sufficiency to meet desires confidence level (Dunn 2016). Since the survey for this study was conducted using free online platform, cost was not used as a basis for determining the sample size. The researcher's aim was to collect response from 384 participants to reach 95% confidence level, but due to time constraints and lack of respondents, the sample size was limited to 50.

3.6.4 Sampling Technique

For the survey of this research a probabilistic simple random sampling method was implemented. Probability sampling is the most common survey-based research strategies; which a researcher can use to answer the research questions or achieve the objectives Saunders (2009).

3.7 Pilot Study

Prior to sending out the survey questions to SME construction company respondents, a pilot study was carried out to refine questions and improve the validity. Pilot study which is the replica of the main survey, is conducted to bring light to the weakness of the questions. Saunders (2009) state that pilot study is important step to determine a more efficient and appropriate plan.

The pilot study was carried out by sending the survey questions to selected personnel, engineer and architects for commenting and constructive criticism. With the response obtained from the participants of the pilot study, the researcher was able to:

- Evaluate clarity of instructions
- Clarify question and avoid ambiguities
- Identify if any major factor was omitted and
- If there was any comment

3.8 Study Area

The focus of this study is Helsinki region the most populated region in Finland, covering 3697.52 km^2 (Helsinki Region 2018). There are 14 municipalities in this region including the municipality of Helsinki, Espoo and Vantaa. According to the national statistics agency, TilaStockskus, the population of Helsinki region in 2017 was 1,475,095. This is approximately 26.7% of the total population of Finland.

The region extend from 59°55' – 60°50' N latitudes and 24°10' – 25°30' E longitudes. It is about 1.1% of the total surface area of the country (figure below). The region is cultural, tourist and economic hub of the country. The GDP of the region is approximately 34.3% of the total GDP of Finland. The region is also home to quarter (24.66%) of the total enterprise establishments (TilaStockskus 2015). Considering the economic significance and number of SME enterprises operating in the region, the researcher assumed it's a right decision to choose Helsinki region as the focus of the study.

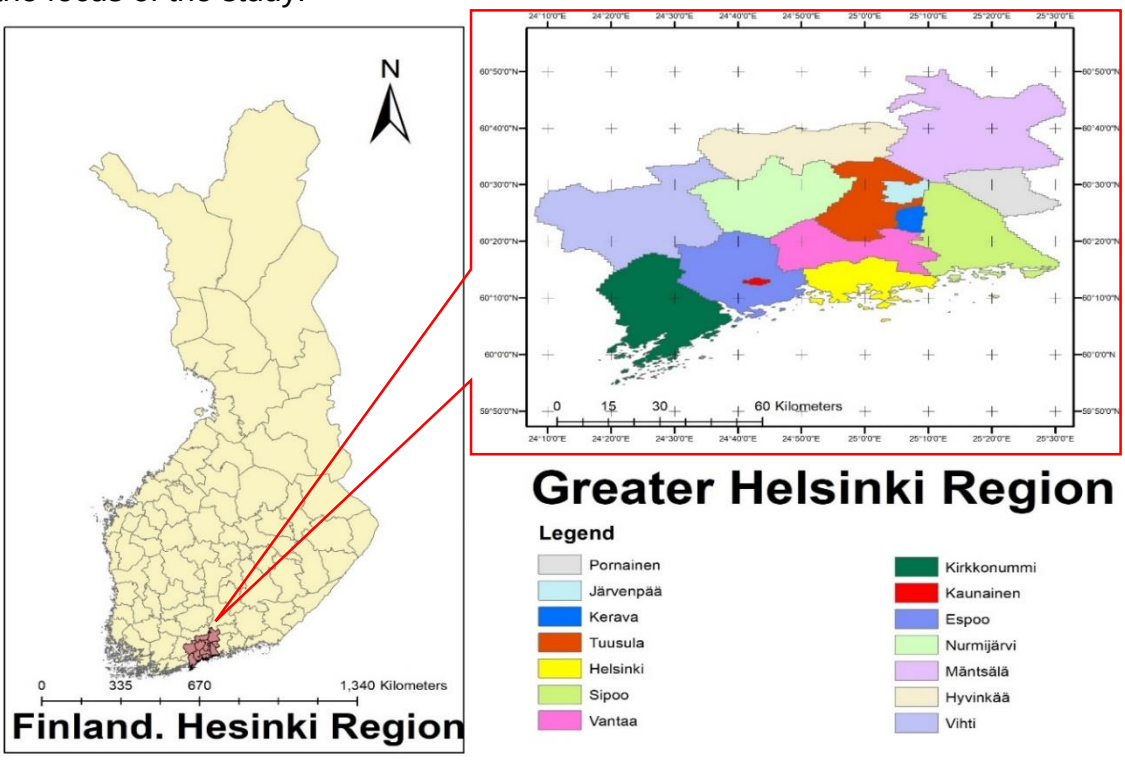


Figure 3.8-1: Greater Helsinki region[35] (generated using ArcMap 10.5)

[35] Generated using ArcMap 10.5

3.9 Research Methodology

The research method used was discussed in chapter 1 section 1.6. To answer the research questions, a 6 step procedure was designed. These 6 step formulate the research methodology of the research and they are briefly elaborated as follows:

Step 1: Identification of criteria for suitability of sites

This step involves identifying factors which indicate suitability and profitability of sites to conduct real estate development (or construction of residential building) project. These criteria are identified after intensive literature review was done in chapter 2.

The literature review is comprised of relevant materials from range of media including Books, textbooks, article from journals, Historical accounts, reports from statistical agencies, information from Municipalities, previously done researches and dissertations. These materials were gathered from the following online digital libraries

- SpringerLink (https://link.springer.com/)
- Metropolia's Digital Library (https://metropolia.finna.fi/)
- Scientific Research Publication (https://www.scirp.org/)
- ProQuest EBook central (https://ebookcentral.proquest.com)
- Academia (www.academia.edu)
- ScienceDirect (https://www.sciencedirect.com/)
- Doria (http://www.doria.fi/)

The appraisal of literature was done based on the content publication. The following questions were used as a criterion for the selection:

- Has the author addressed topics important to the research?
- Is the publication for the Scientific and academic community?
- Is the observation made the author based on facts?
- Does the researcher implement logical research design?
- Does the publication validate or add new perspective to the research?

- Are the arguments of the author rational and easy to understand and follow?

Step 2 selection of suitable analysis model.

This include identifying the dataset necessary for the analysis part. Develop methods to calculate weight factors for different criteria and method to aggregate different criteria.

The preferred method of analysis for this research is Multi-criteria decision making (MDCM). The selection process of suitable site for a real estate development should come after the evaluation of the several alternatives. This selection is multidimensional and usually involves conflicting criteria (Voogd 1983). MCDM involves three steps according to Hwang (1981).

- Identifying suitability criteria
- Weighing factor
- Aggregation method

If a real estate developer has n alternatives,

$$A = \{a_1, a_2, \ , \ , a_n\}$$

And i set of evaluation criteria

$$C = \{c_1, c_2, \ , \ , c_i\}$$

They can be arranged in array matrix as shown below

	Alternate Sites				
Criteria		a_1	a_2	……..	a_n
	c_1	$c_{11}w_1$	$c_{12}w_1$		$c_{1n}w_1$
	c_2	$c_{21}w_2$	$c_{22}w_2$		$c_{2n}w_2$
	.				
	c_i	$c_{i1}w_i$	$c_{i2}w_i$		$c_{in}w_i$

Table 3.9-1 Evaluation array[36]

[36] Based on Voogd (1983). P 3

For this research the aggregation method implemented is the Simple Additive Weighing (SAW). This technique is the most widely applied method for decision making in MCDM.

According to SAW the final score, which is the basis of evaluation, is calculated by summing the multiple of score of the alternative and it respective weight. This can be mathematically can be expressed as:

$$S_n = \sum_{i=1}^{i} c_{in}\, w_i$$

Where

S_n is the total score of alternate n

c_{in} is score that alternate n gets for criteria i

w_i is weight of criteria i

Step 3 Determination of weight of different criteria

For these step a survey is done to determine the ranking of different criteria. The ranking of the criteria is based on the mean value calculated from the response of the survey. Determine weighing factor is a crucial step, because the value of the weight indicate which criteria are important and which are not important.

One of the simplest technique to determine weighing factor is by ranking criteria. Weighing factors based on ranking is easy to implement when the researcher faces constrain in time and lacks resource. This weighing factors are determined based on the notion that there is an interlinkage between the rank of the criteria and its scale of weighing (Roszkowska 2013). For this research rank sum weight method by Stillwell et al. (1981) was used to convert ranks into weighting values. In this method weight is the ratio of rank of the criteria and sum of all ranks. The equation of this procedure is shown below

$$W_k = \frac{n - p_k + 1}{\sum_{j=1}^{n}(n - p_j + 1)} = 2\frac{n - p_k + 1}{n(n+1)}$$

Where:

W_k is weighing factor of kth criteria

p_k is ranking of kth criteria

n number of criteria under consideration

Step 4 suitability Analysis

- **Restriction based suitability modeling**

No.	Restriction Criteria	Description	Buffer (m)	Data Format
1	Coastline	not suitable due to tides		Polyline
2	Protected areas	Natura 2000		Polygon
3	Rivers	Not suitable due to risk of flooding		Polyline
4	Lakes	not suitable due to moist and seepage		polygon
5	Public green spaces	the public at large give high value for public spaces		polygon
6	Railway tracks	not suitable due to noise issue and vibration		Polyline
7	Highways	Major highways. Unsuitable due to noise pollution		polyline
8	Streets and roads	not suitable to demolish already existing road		polyline
9	Existing building	not suitable to demolish already existing building		polygon

Table 3.9-2 Restriction Criteria and Buffer distance[37]

[37] Own work

This restriction based suitability analysis is carried out to identify locations in greater Helsinki region, where the sites are not suitable for the reasons mentioned in table 3.9-2. The table also indicates places where it is not allowed to construct any building, like national parks and river banks. Areas which are included in this restriction model are eliminated from the weighted overlay suitability analysis.

- **Weighted overlay suitability analysis**

No.	Suitability Criteria	Description	Data Format
1	Proximity to city center	Distance to city center and commercial centers	Polygon
2	Proximity to highway	Distance to major Highways	Polyline
3	Proximity to Public transport	Distance from Railway, metro and bus stations	Point
4	Proximity to public park	Distance from parks, forests lakes	Polygon
5	Population density of Neighborhood	Population density of Area	Polygon
6	Population size of town	Population of area (20 -29 age group)	Polygon
7	Population growth of town	Percentage of growth (20 -29 age group)	Polygon
8	Number of middle income household	Number of household by postal code	polygon
9	Employment rate of town	Percentage of employment in a city	Polygon
10	Land price	Price of empty plot of land per meter sq.	polygon

Table 3.9-3 Suitability Criteria[38]

[38] Own work

Suitability criteria listed in table 3.9-3 were identified after the literature review on factors driving the demand of real estate production. The production rate housing is influenced by regional demographic, economic and social factors. The most influential demographic and economic factors for real estate demand in Helsinki region was studies by Laakso (2000) and his recommendations are used in the suitability analysis of this research as well.

The weighted overlay suitability analysis is done using a GIS software, Esri ArcMap 10.5. All the suitability factors are multiplied with their respective weighing factors and then added up together. Then the results are classified into five suitability categories as shown below.

Step 5 Mapping SMEs activity

This step involves using GIS software to map the cluster of building construction companies in greater Helsinki region. Data was extracted from Statistics Finland (TilaStockskus) about the opening and closure of building as well as the existing Stock of building construction enterprises.

Step 6 Correlation between suitable places identified and activity of SMEs

Once the cluster of building construction enterprises is mapped out, the correlation between suitability of a location and the number of construction enterprise operating in the region is investigated. In other terms, it will give answers to questions like, “does the number of building construction enterprises increase in locations where it is more suitable for real estate development?”, “is there any dependency between this two variable?” and if there is any dependency, “how strong their dependency?”

3.10 Research Ethics

When a research involves human participants it raises a complex ethical dilemma (Nancy 2018). Oxford dictionary defines ethics as the science of morals in human or moral principles or rules of conduct. In the meantime, it defines moral as accepted rules or norms and standard about goodness. Based on this definitions research can be explained as the moral principle that must be followed while conducting a research (Bhole 2015).

This current research was conducted in a manner that assures honesty, respect to intellectual property, confidentiality and social responsibilities.

- Data which was used in the research was gathered from Finland Statistics official web site. The data doesn't involve sensitive information and the researches avoided acquiring such data.
- The research is design and outcome of the research does not harm or embarrass any one.
- The anonymity of individuals and companies which were involved in the survey are kept secret.

Chapter 4

Analysis and Results

4.1 Restriction Based Suiability analysis

The restriction based suitability analysis is carried out to identify places where it is not suitable for residential real estate development. This restriction based analysis is done based on the possibility of using a certain location for any kind of construction work.

72% of the land surface of Finland is covered with forest (Desmas 1977). Even the metropolitan region of Helsinki has its significant portion of its land surface covered with forest. The restriction model suitability analysis subtracts area which are protected and of national interest. These areas include Natura 2000 sites, national parks, green spaces, Lakes, rivers and shorelines.

Figure 4.1-1 Central park Helsinki (left) and Nuuksio national park in Espoo, Kirkkonummi and Vihti (Right)[39].

The restriction analysis also subtracted man made structure which includes already built up areas, Highways and railways. Each of the restriction models are shown in figures 4.1-2 to figure 4.1-10 below.

[39] Semir T.

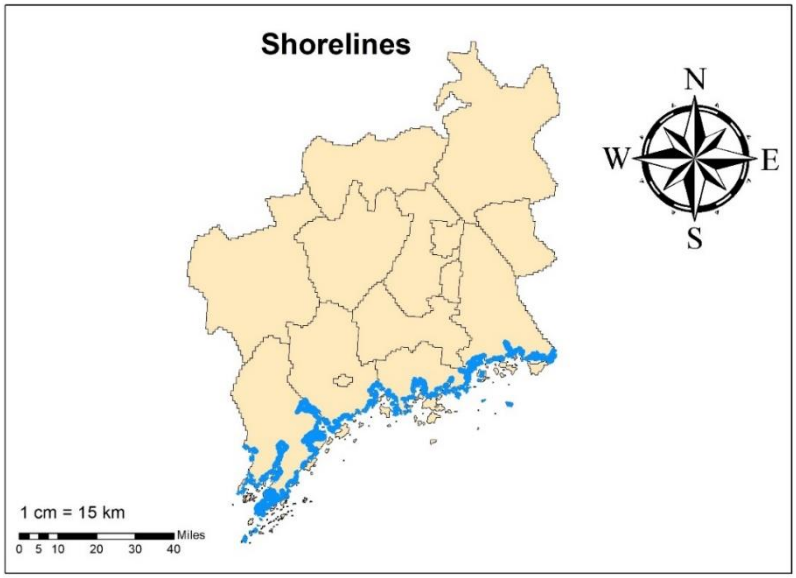


Figure 4.1-2 Shore Lines [40]

Due to high cost and safety areas which are too close to the shoreline are unsuitable for construction of a residential building. For shoreline restriction, 30m buffer is added.

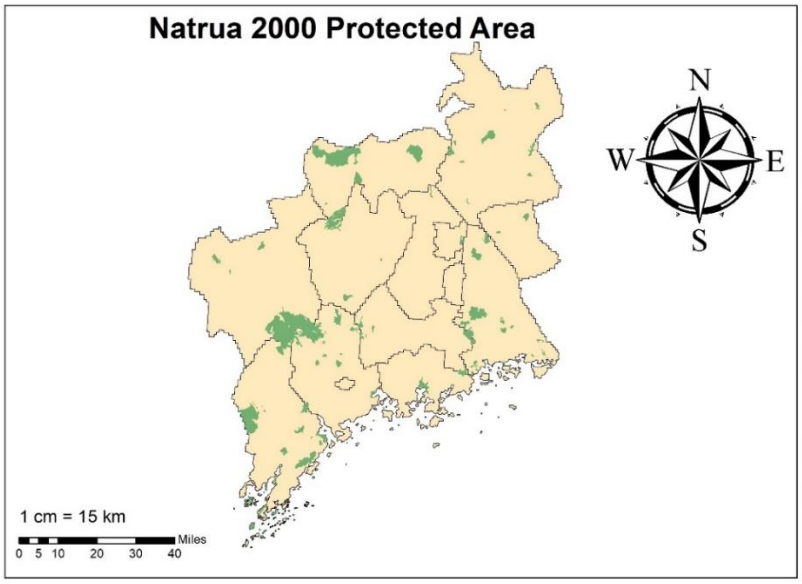


Figure 4.1-3 Protected Areas[41]

These areas which are protected under the European Union directive, to protect and conserve natural habitat. In Finland, these areas represent 50,000 square kilometers or 15% of the total surface area. For protected areas, a 30m buffer

[40] Own work (GIS data www.syke.fi)
[41] Own work (GIS data www.syke.fi)

distance is added to ensure that real estate development doesn't influence the habitat.

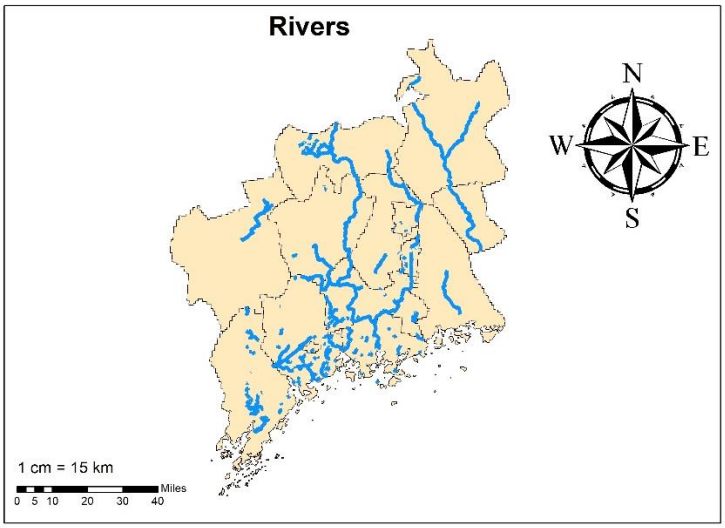


Figure 4.1-4 Rivers in Helsinki Region [42]

Rivers are an important component of natural habitat. They support terrestrial and aquatic animals. As a result of this and due to the high risk of flooding, a 50m buffer is added on each side of the river bank.

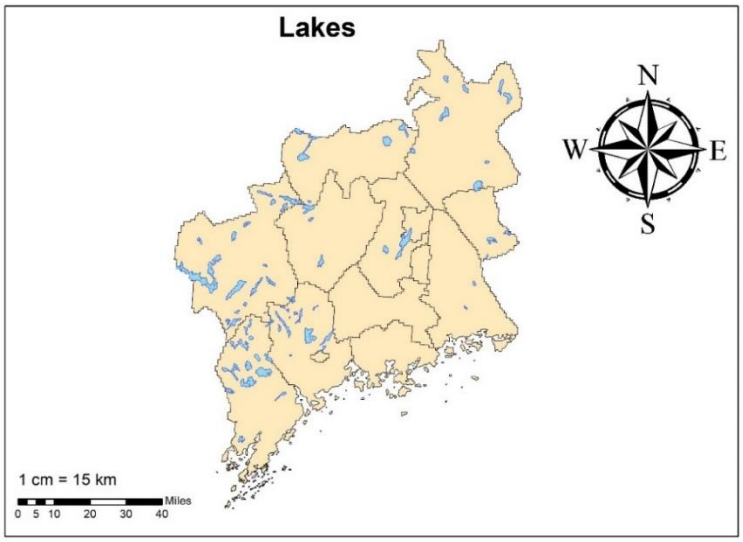


Figure 4.1-5 Lakes in Helsinki Region[43]

Similar to rivers, lakes are also added to the restriction. A buffer distance of 20m is added around the perimeter of the lakes.

[42] Own work (GIS data www.syke.fi)
[43] Own work (GIS data www.syke.fi)

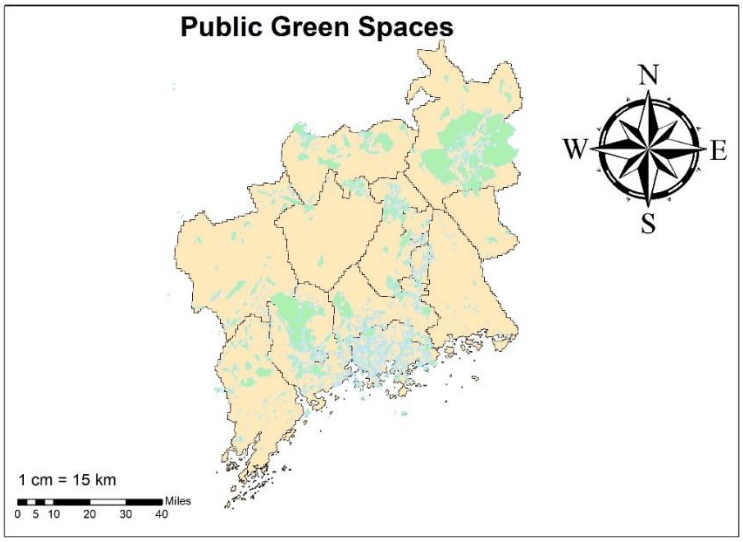


Figure 4.1-6 Public Green Spaces (This layer include national parks) [44]

These areas include urban parks and forests which are not listed as a protected area. For these areas, the buffer distance was set at 20m.

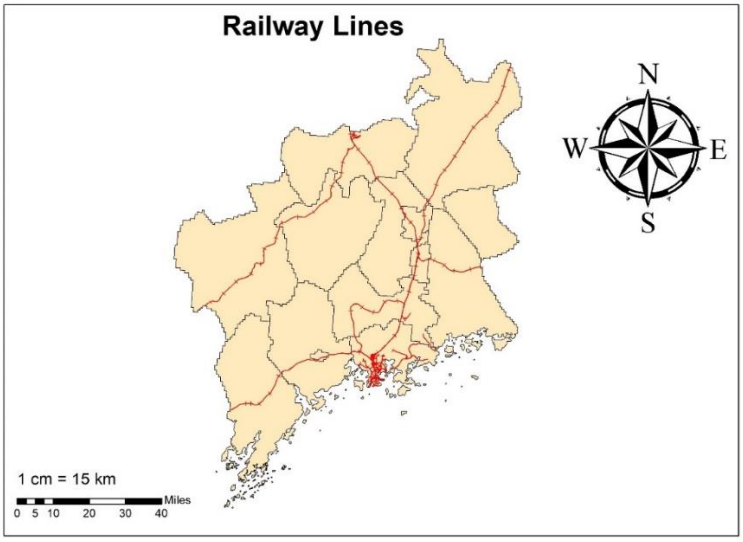


Figure 4.1-7 Helsinki Region Railway and Subway Lines[45]

Locations which are too close to railway lines are considered as not suitable due to the noise and vibration disturbance they cause. For these reasons a 30m buffer distance is added from railway tracks.

[44] Own work (raw data from mapcruzin.com)
[45] Own work (raw data from mapcruzin.com)

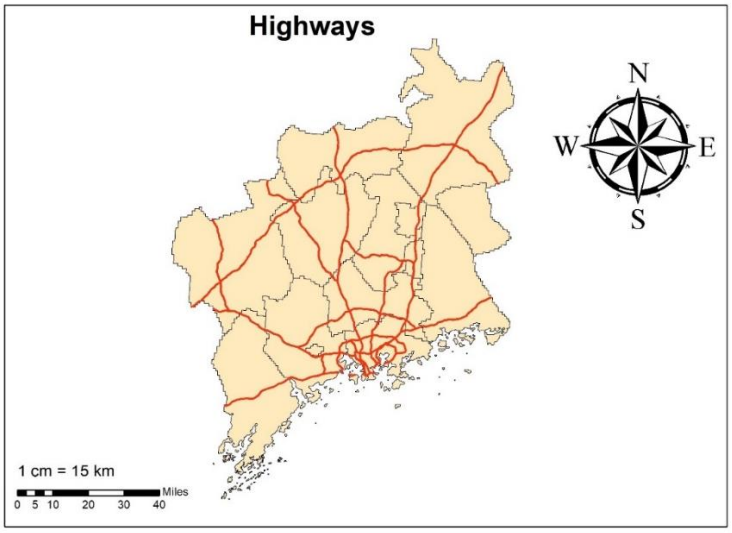


Figure 4.1-8 Helsinki Region Highways [46]

The figure above shows major roads in Helsinki region. Areas near these major roads are added to the restriction because of the noise and air pollution they cause.

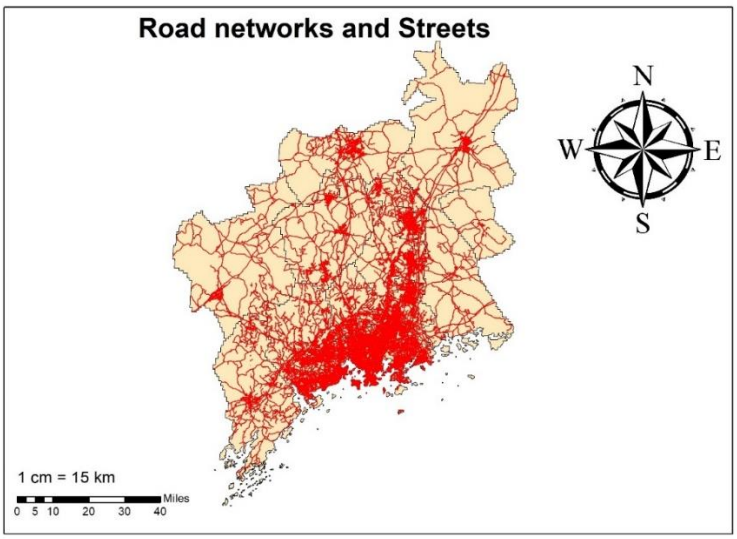


Figure 4.1-9 Helsinki Region Road Network[47]

Already constructed infrastructure cost millions of euros, so for these reasons it was necessary to add road networks and existing building, shown in the figure below, to the restriction model.

[46] Own work (data from Esri ArcGIS)
[47] Own work (raw data from mapcruzin.com)

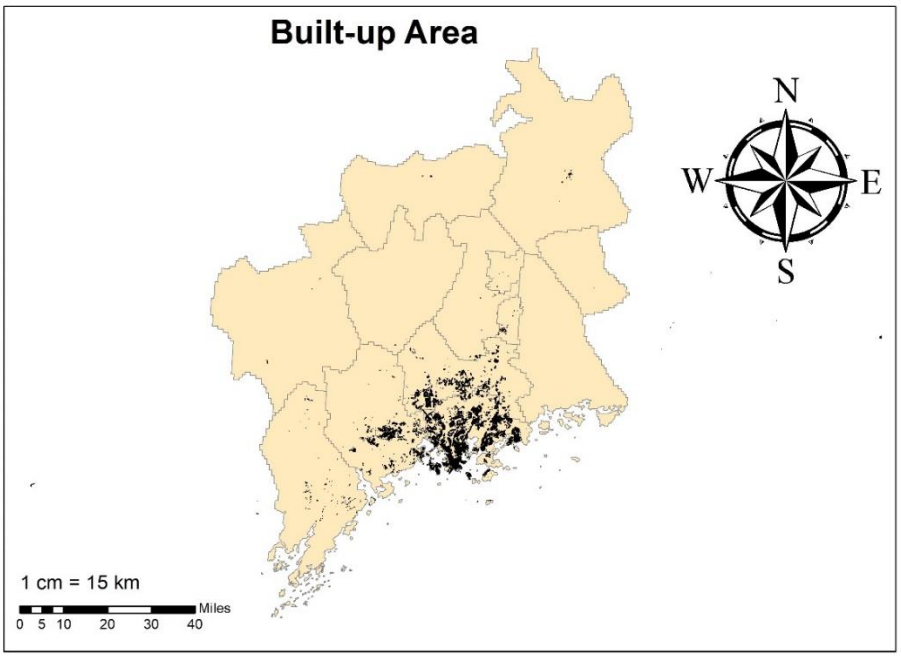


Figure 4.1-10 Helsinki Region Built-up Area[48]

These restriction criteria shown in figures above are then combined together, giving the restriction based suitability analysis for greater Helsinki region. This step is done by using the model builder application of ArcMap 10.5. The geo-processing tools used and the sequence of modeling are illustrated in figure 4.1-12 below.

[48] Own work (raw data from mapcruzin.com)

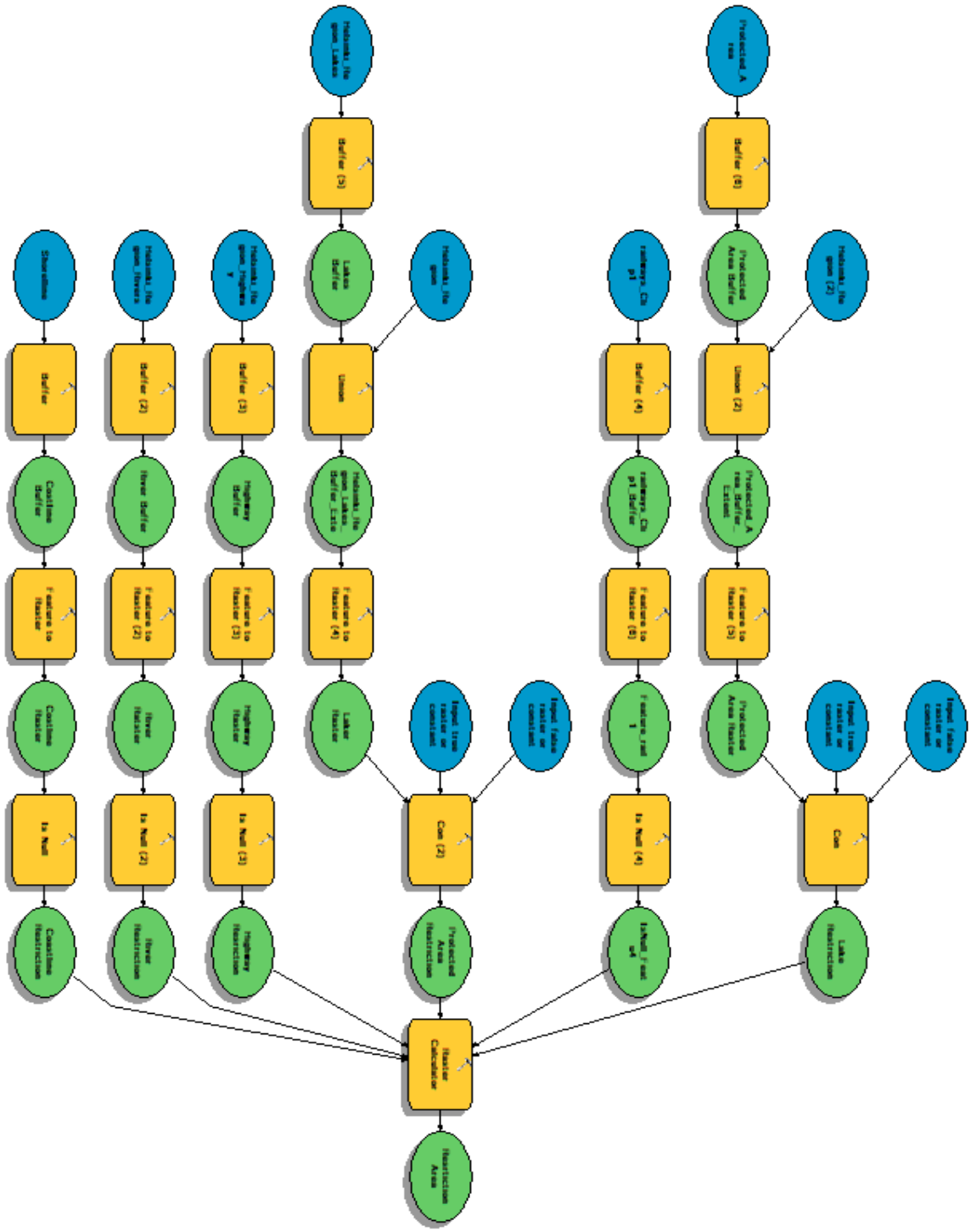


Figure 4.1-11 Restriction Model ArcMap 10.5[49]

[49] Own work

The figure above illustrate which operations are used in the modeling of the restriction based suitability analysis. The blue circles in the figure represent input data and the green circle represent output data after the required operations are done. For the restriction analysis the following operation was used.

- **Buffer:** each layer of data is given with a buffer which is matching to the nature of the area.
- **Feature to raster:** converts input data into a grids which can be assigned values
- **Is null:** gives a value of zero for the input layer
- **Union:** joins two layers' geometry
- **Raster Calculator:** to specify operators, input and values

The result of the restriction based suitability analysis is shown below.

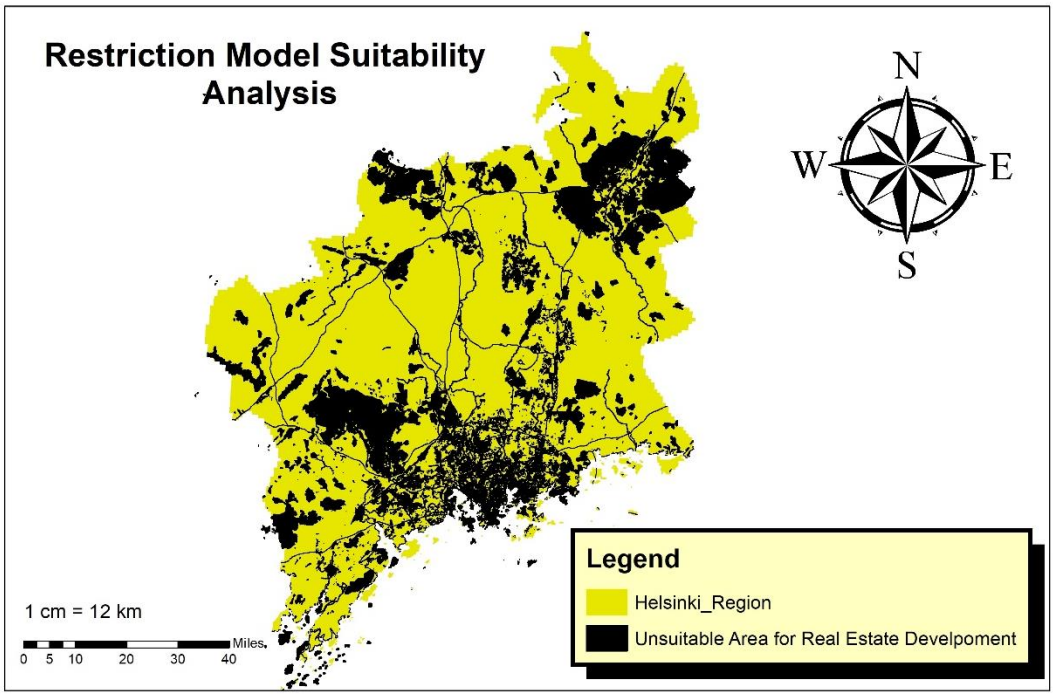


Figure 4.1-12 Result of Restriction Based Suitability Analysis [50]

[50] Own work

The black colored spots in these figures represent locations where it is not suitable for real estate development, since these areas are protected area, green space, lake or river or already built-up area.

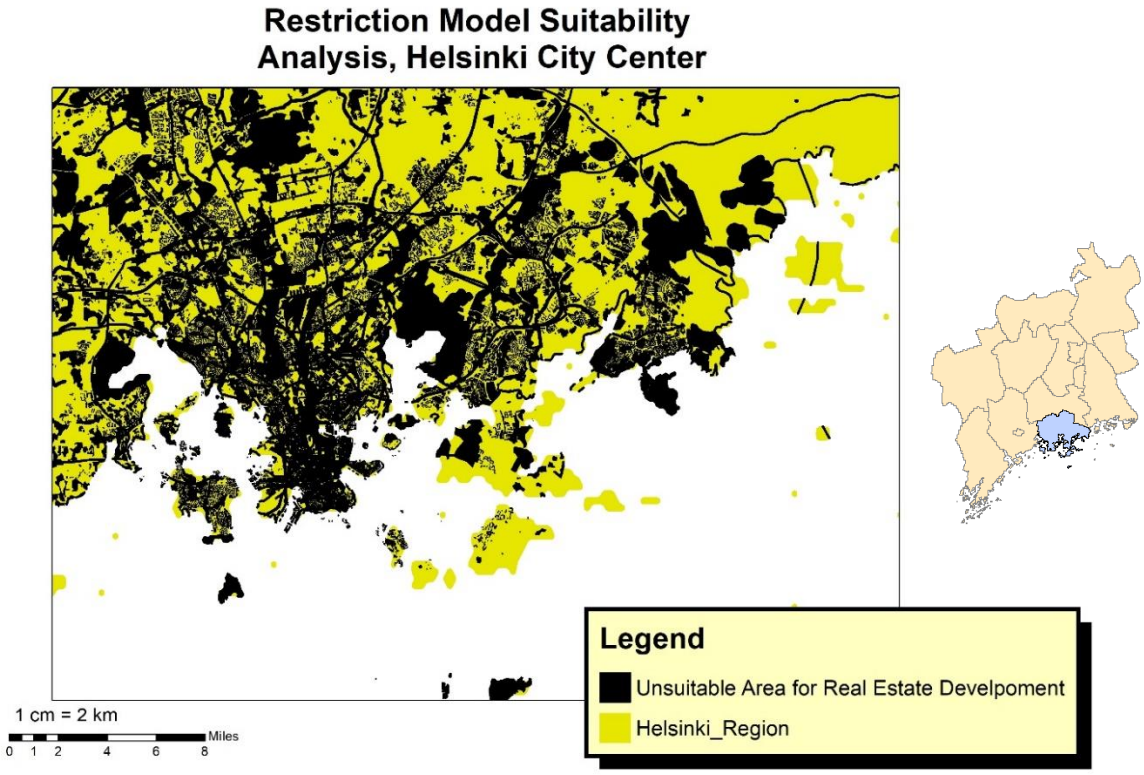


Figure 4.1-13 Helsinki city[51]

The figure above shows that most of Helsinki city center is already densely built-up (this can be notice by the darkness of the area on the map) and there is small free space which is suitable for residential building. The neighborhoods of Vuosaari and areas closer to the boarder of Vantaa, there are pockets of plot lands which can be used for real estate development.

In Espoo and Kirkkonummi region there is abundance of areas which are suitable for construction of residential buildings (see figure below). Most of the unsuitable or restricted areas, which are marked black, are national parks and lakes. The densely built-up areas are on south east Espoo, in the urban district of Tapiola and Kauniainen region.

[51] Own work

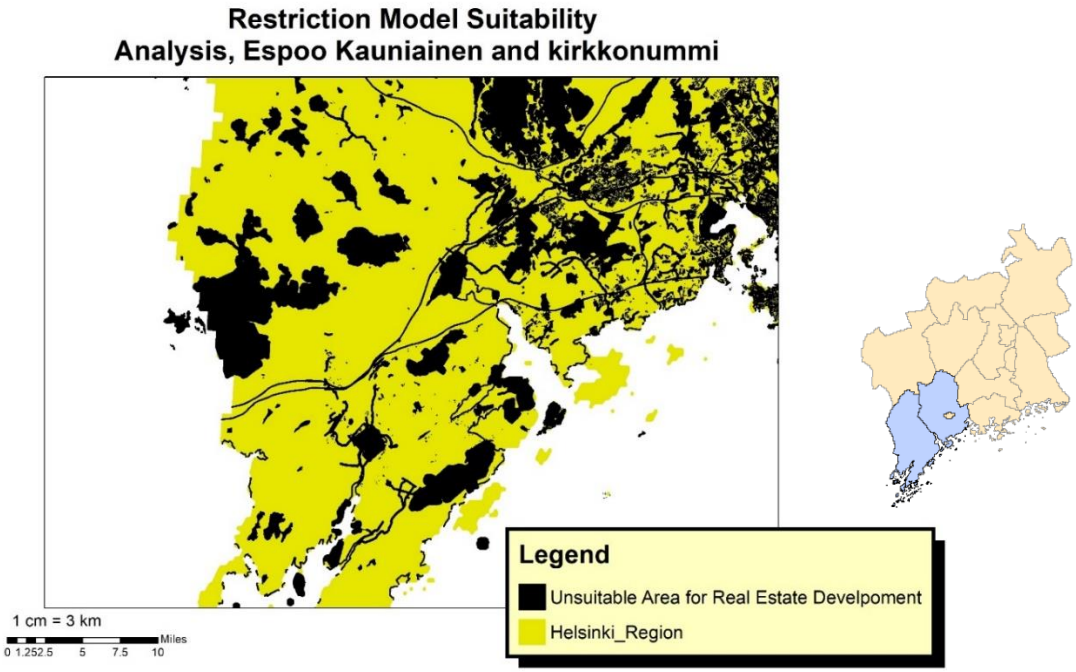


Figure 4.1-14 Municipality of Espoo, Kauniainen and Kirkkonummi.[52]

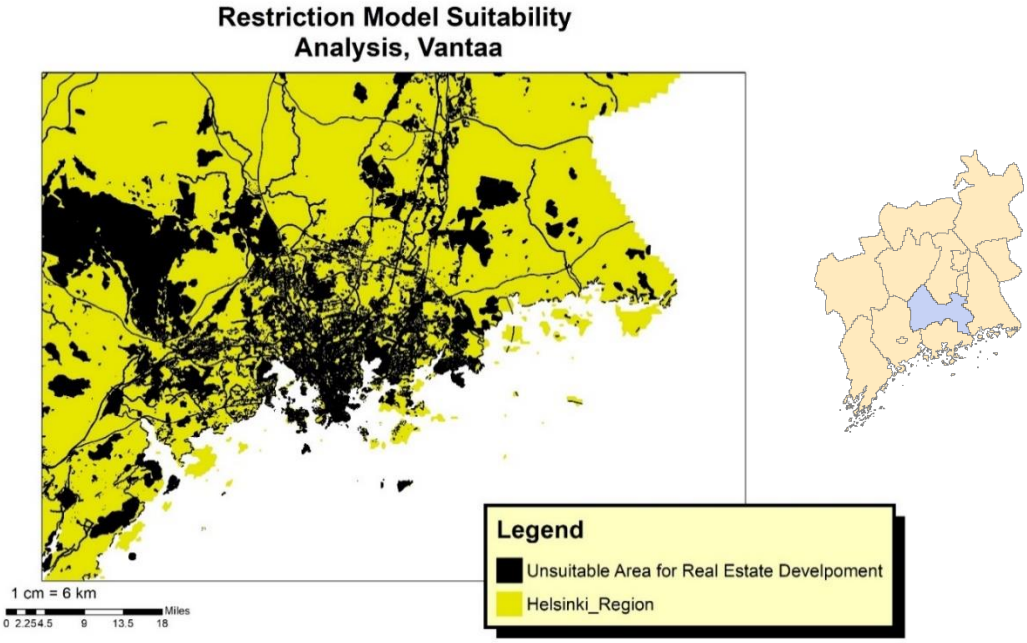


Figure 4.1-15 Municipality of Vantaa[53]

[52] Own work
[53] Own work

Residence of Vantaa municipality, similar to city of Espoo, are sparsely settled. Most of the restricted unsuitable areas are those areas which are closer to the boarder of Helsinki city. Vantaa has abundance of area which is possible to be used for real estate development, especially in the north and east Vantaa region.

4.2 Analysis of Survey for Determination of Weighing Factor

The weighing factor for different suitability factors was determined through online survey sent to young people living in Helsinki region. The reason for the survey was to achieve a more reliable outcome which is more representative of the opinion the population with regards to suitability of site for residential building. The Respondents of the online survey based on where they dwell is shown in the chart below.

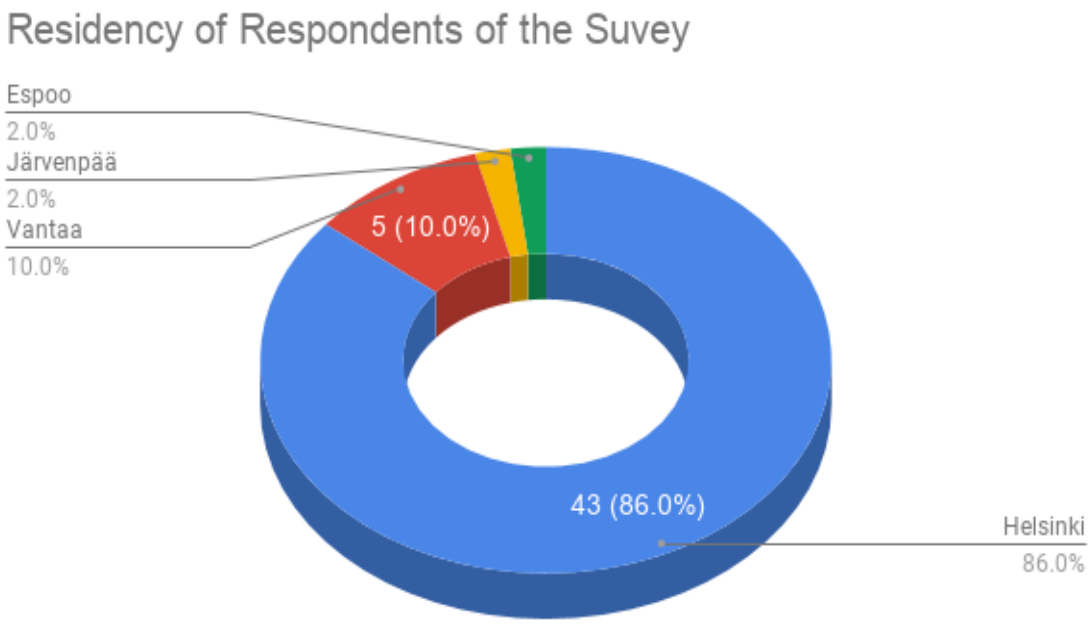


Figure 4.2-1: Residency of respondents of the survey.[54]

Among the 50 Respondents of the survey, 43 (86%) were living in the city of Helsinki, while 10% of the respondents were from Vantaa. According to statistic

[54] Own work

Finland 80% of population of Helsinki region live in the metropolitan area of Helsinki, Espoo and Vantaa.

According to Moore (2009) one of the factor that influence the choose of a location for a real estate development is the desirability and first impression of the neighborhood. The desirability of a location is influenced by several factors including availability of working, access to transport transits, utility shops and public services. According to the response got from the survey, 60% prefer Helsinki city are a place of choice of real estate development. 16% and 12% of respondents chose Vantaa and Espoo respectively. The rest 12% of respondents chose cities outside the metropolitan area. The figure below illustrates the preference of respondents.

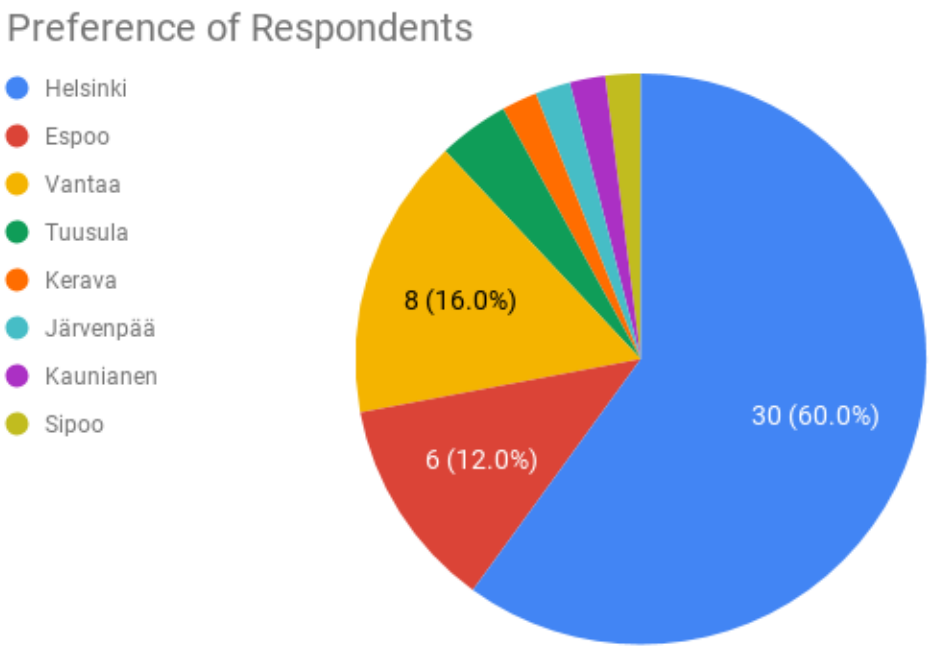


Figure 4.2-2 Respondent's Preference [55]

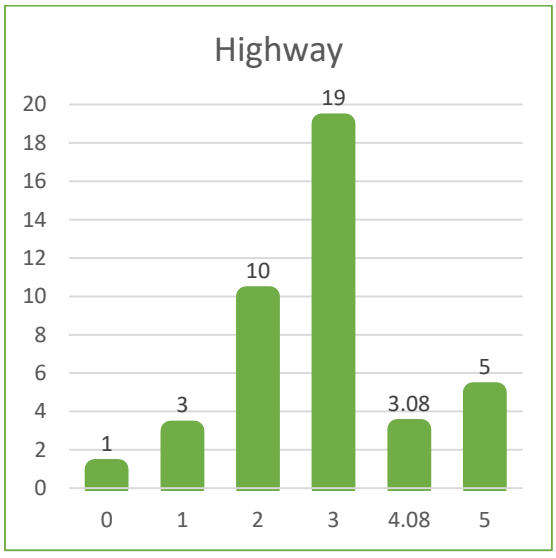
Based on the outcome of the research Helsinki was assigned the highest desirability weighing factor. The city of Vantaa and Espoo are ranked second and

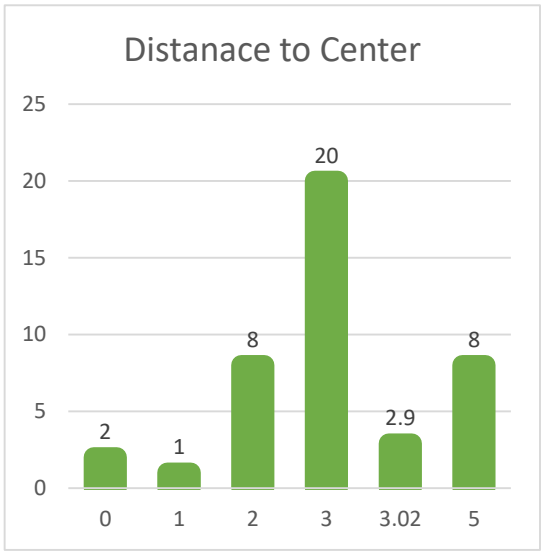
[55] Own work

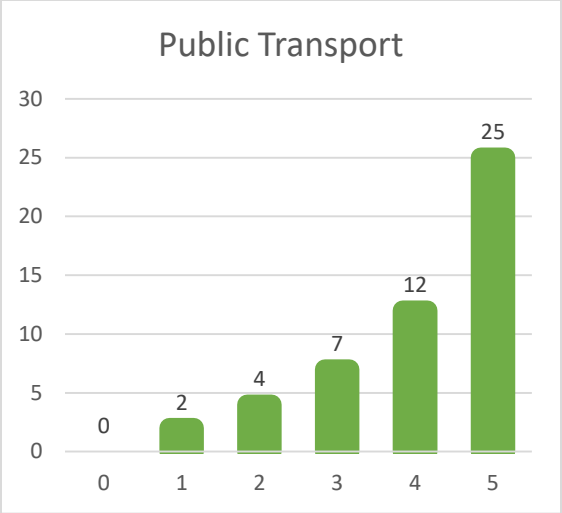
third respectively. The rest of municipalities outside the metropolitan area got a lower desirability weighing factor.

The respondents of the survey gave a ranking to 10 suitability factors, which are important when analyzing the suitability of a site for a real estate development. This factors include.

- Proximity to city center
- Proximity to Highway
- Proximity to public transport transits
- Proximity to public space and greenery
- Population density of Neighborhood
- Population growth of the town
- Population size of the town
- Number of middle income Households
- Employment and unemployment rate and
- Land price






Public Transport
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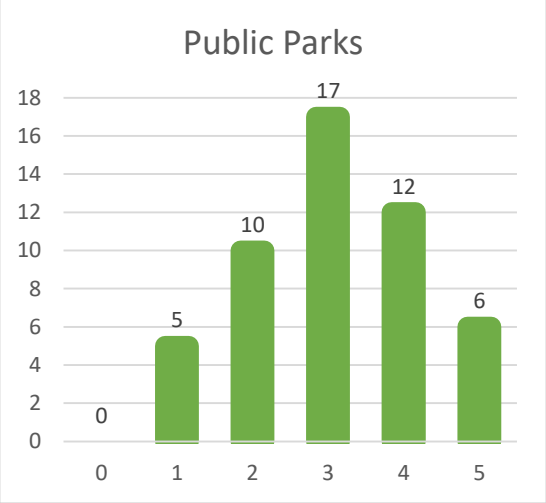
Public Parks
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16
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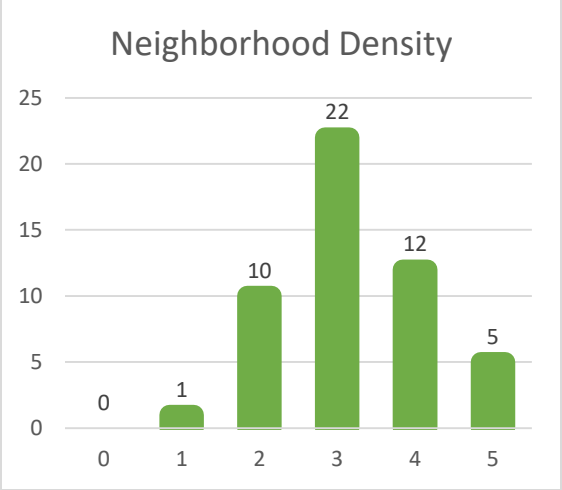
4
5


Neighborhood Density
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20
15
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22
12
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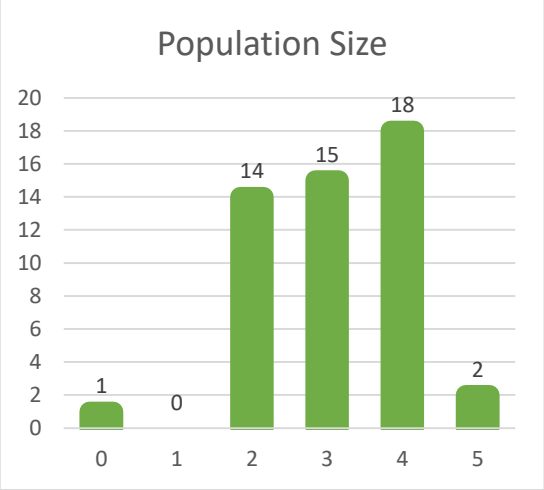
Population Size
20
18
16
14
12
10
8
6
4
2
0
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14
15
18
2
0
1
2
3
4
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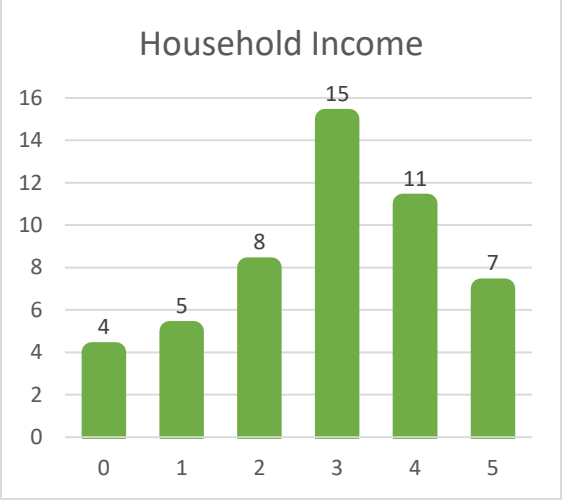
Household Income
16
14
12
10
8
6
4
2
0
4
5
8
15
11
7
0
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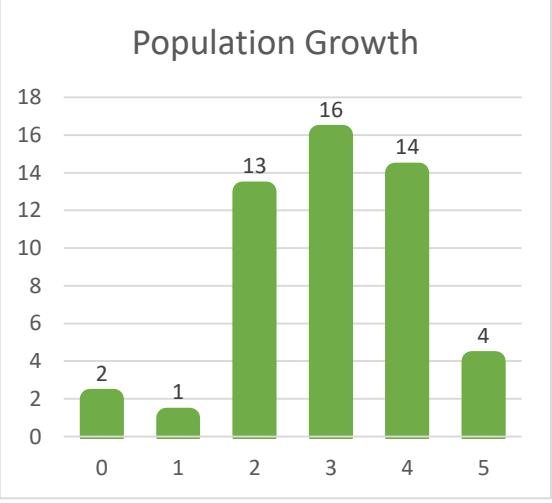
Population Growth
18
16
14
12
10
8
6
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2
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2
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13
16
14
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0
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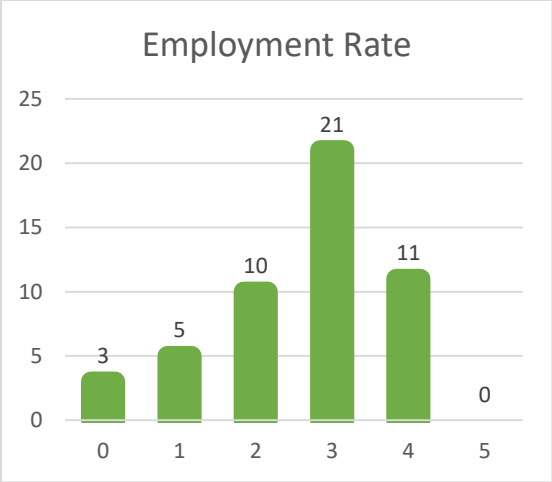

Figure 4.2-3 Charts representing the response of the survey[56]

The result of the survey is summarized in the table shown below

Criteria	Mean	Variance	Standard Deviation
Proximity to city center	3.22	1.4404	1.20017
Proximity to highway	3.06	1.2820	1.132272
Proximity to Public transport	4.08	1.3404	1.15776
Proximity to public park	3.08	1.3404	1.15776
Population density of neighborhood	3.2	0.8980	0.947607
Population size of town	3.1	0.9898	0.994885
Population growth of town	3.02	1.3261	1.151574
Number of middle income household	2.9	2.0918	1.446318
Employment rate of town	2.64	1.2555	1.120496
Land price	3.84	1.1984	1.0947

Table 4.2-1Summary of Outcome of Survey [57]

[56] Own work
[57] Own work

The result of survey indicates that proximity to public transport transit is considered to be the most important criteria for choosing a site for residential real estate development. The second important criteria according to respondents of the survey is land price of empty plot of land. The higher the price of land the less suitable it becomes for real estate development. Employment rate in specific town was give the lowest ranking among suitability factors, number of household with middle income in a neighborhood was ranked second to last, while proximity to Highway was only third to last.

$$W_k = \frac{n - p_k + 1}{\sum_{j=1}^{n}(n - p_j + 1)}$$

Where:

W_k is weighing factor of kth criteria

p_k is ranking of kth criteria

n number of criteria under consideration

No.	Criteria	Ranking	Criteria Weigh
1	Proximity to city center	3	14.55%
2	Proximity to highway	7	7.27%
3	Proximity to Public transport	1	18.18%
4	Proximity to public park	6	9.09%
5	Population density of Neighborhood	4	12.73%
6	Population size of town	5	10.91%
7	Population growth of town	8	5.45%
8	Number of middle income household	9	3.64%
9	Employment rate of town	10	1.82%
10	Land price	2	16.36%
		Sum	100%

Table 4.2-2 Weighing factors for different criteria[58]

[58] Own work

4.3 Weighted Overlay Suitability Analysis

These step of the analysis involves weighted multi-criteria analysis of suitability criteria. Weighted overlay is one of the best methods to perform suitability analysis of a location (Kemp 2007). In this method the different layers (criteria) are reclassified into a common suitability scale; in the case of this research, the data are reclassified into 5 levels using quantile data classification method.

Quantile classification method classifies data in a manner that makes sure that each class contain an equal number of features. In other words, every class will have the same number of data. After the reclassification, each layer is multiplied with weight to determined weighted suitability value, which in turn is summed up with other layers to give total weighted overlay suitability value.

No.	Suitability Criteria	Evaluation Criteria	Range of possible score	Criteria Weigh
1	Proximity to city center	Smaller distance → Higher score	From 1 to 5	14.55%
2	Proximity to highway	Smaller distance → Higher score	From 1 to 5	7.27%
3	Proximity to Public transport	Smaller distance → Higher score	From 1 to 5	18.18%
4	Proximity to public park	Smaller distance → Higher score	From 1 to 5	9.09%
5	Population density of Neighborhood	Higher number → Higher score	From 1 to 5	12.73%
6	Population size of town	Higher number → Higher score	From 1 to 5	10.91%
7	Population growth of town	Higher percentage → Higher score	From 1 to 4	5.45%
8	Number of middle income household	Higher number → Higher score	From 1 to 5	3.64%
9	Employment rate of town	Higher percentage → Higher score	From 1 to 5	1.82%
10	Land price	Smaller price → Higher score	From 1 to 4	16.36%

Table 4.3-1 Suitability Criteria and evaluation parameter[59]

[59] Own work

The different layers of suitability analysis are shown in the figures below. The tabular representation of the weighted overlay analysis is presented in a Table 1D in appendix D.

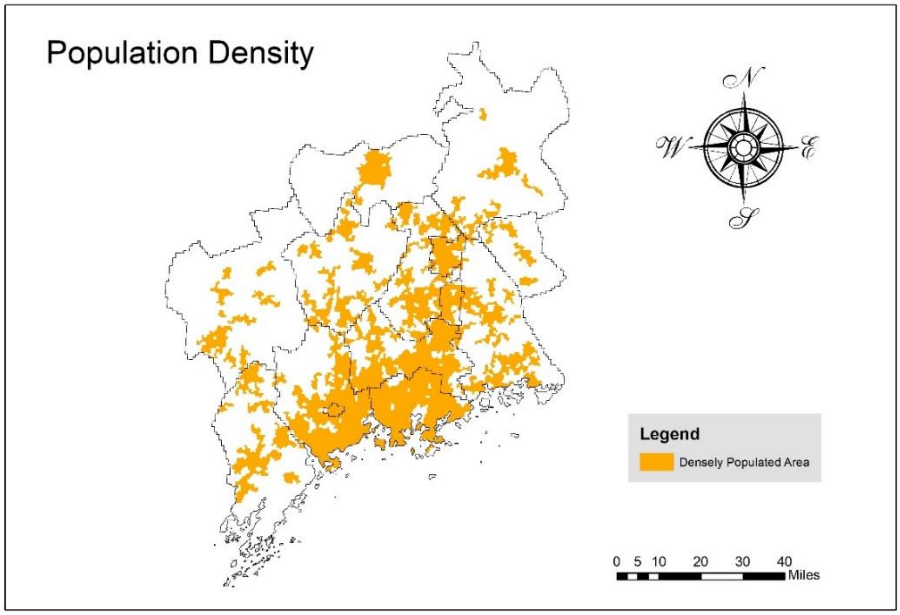

Figure 4.3-1 Desely Populated area in Helsinki Region[60]

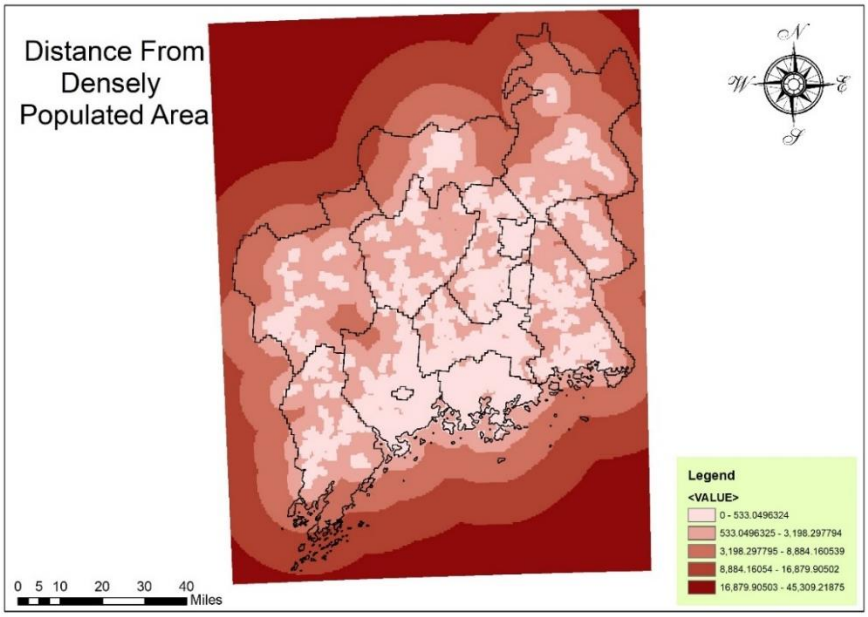

Figure 4.3-2 Distance from Densley Populated Area[61]

[60] Own work (GIS data www.syke.fi)
[61] Own work (GIS data www.syke.fi)

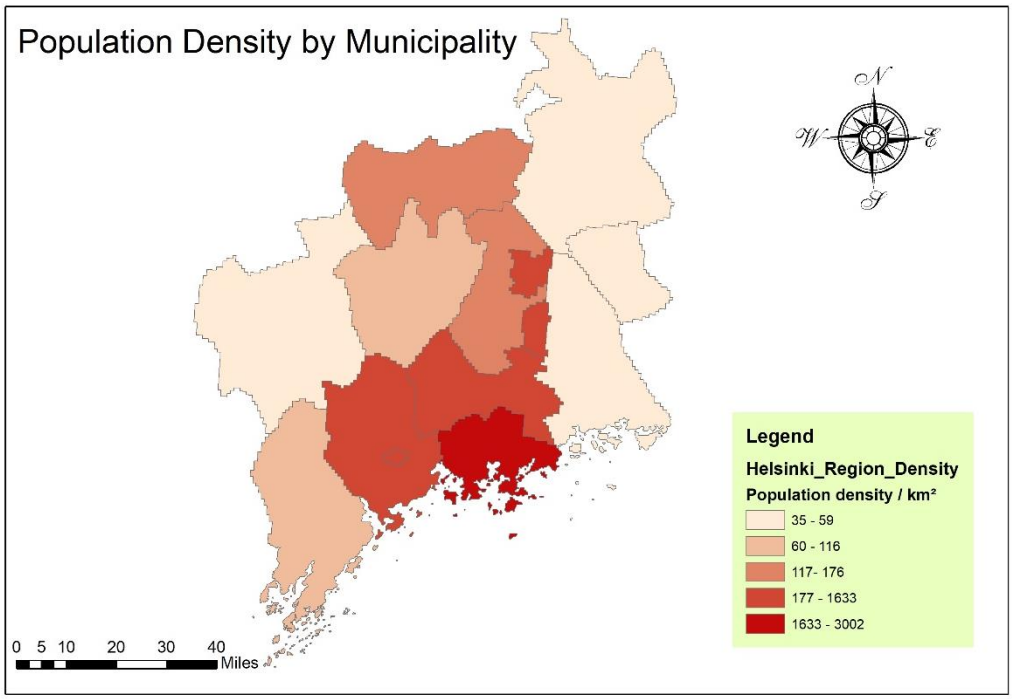

Figure 4.3-3: Populatation Density by Municipality[62]

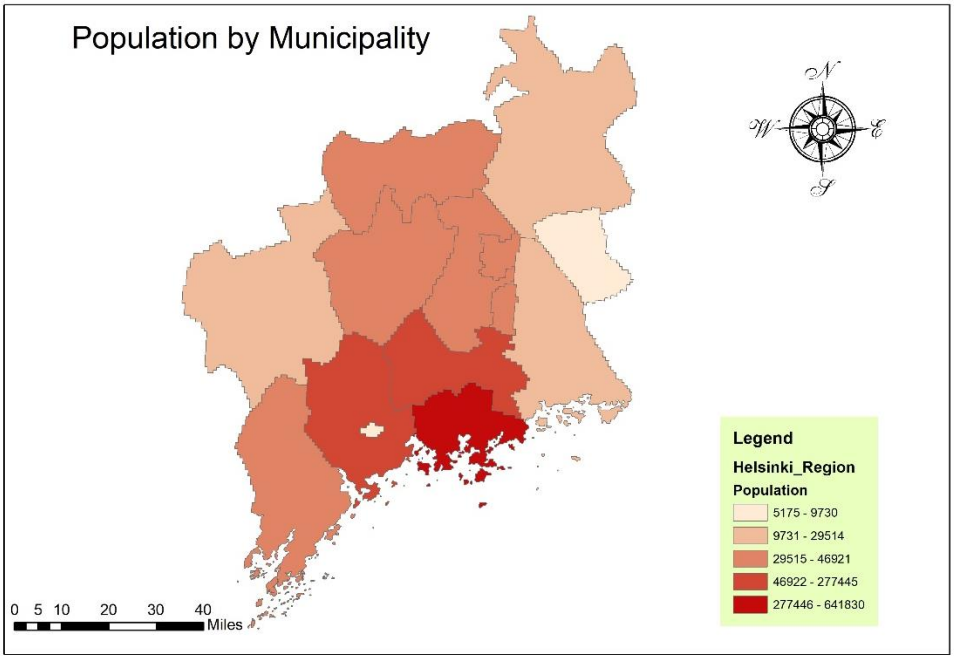

Figure 4.3-4 Population Municipallity[63]

[62] Own work (raw data Finland statistics)
[63] Own work (raw data Finland statistics)

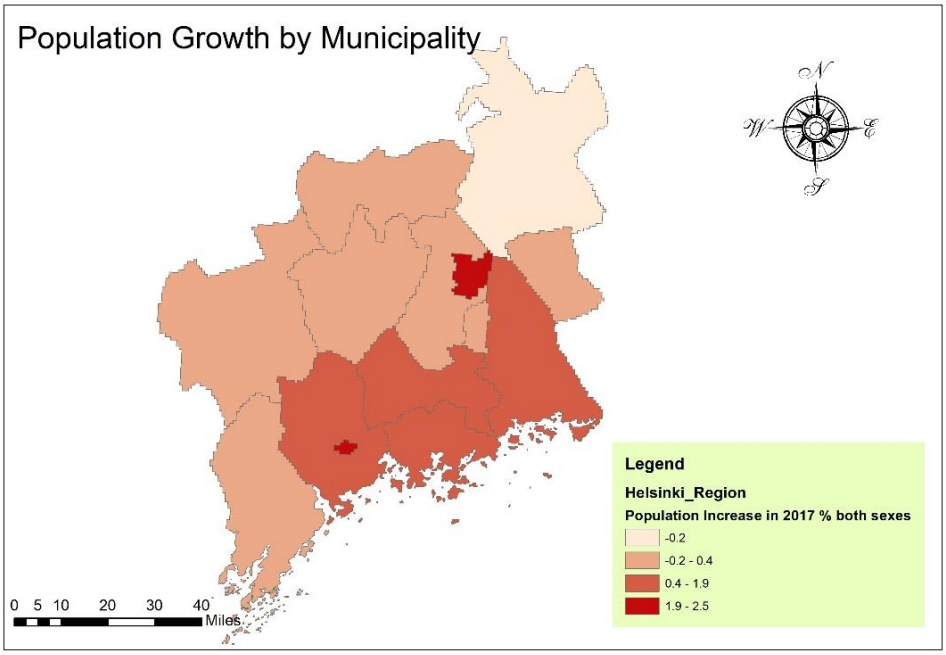

Figure 4.3-5 Population Growth Percentage by Region[64]

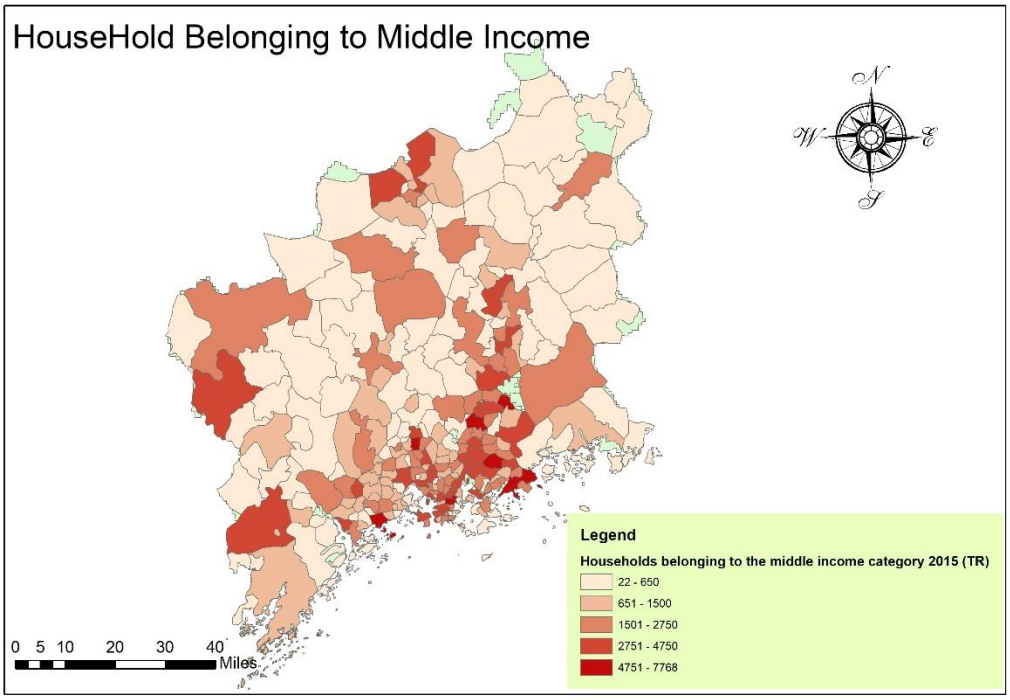

Figure 4.3-6 Number of Middle Income Household[65]

[64] Own work (raw data Finland statistics)
[65] Own work (raw data Finland statistics)

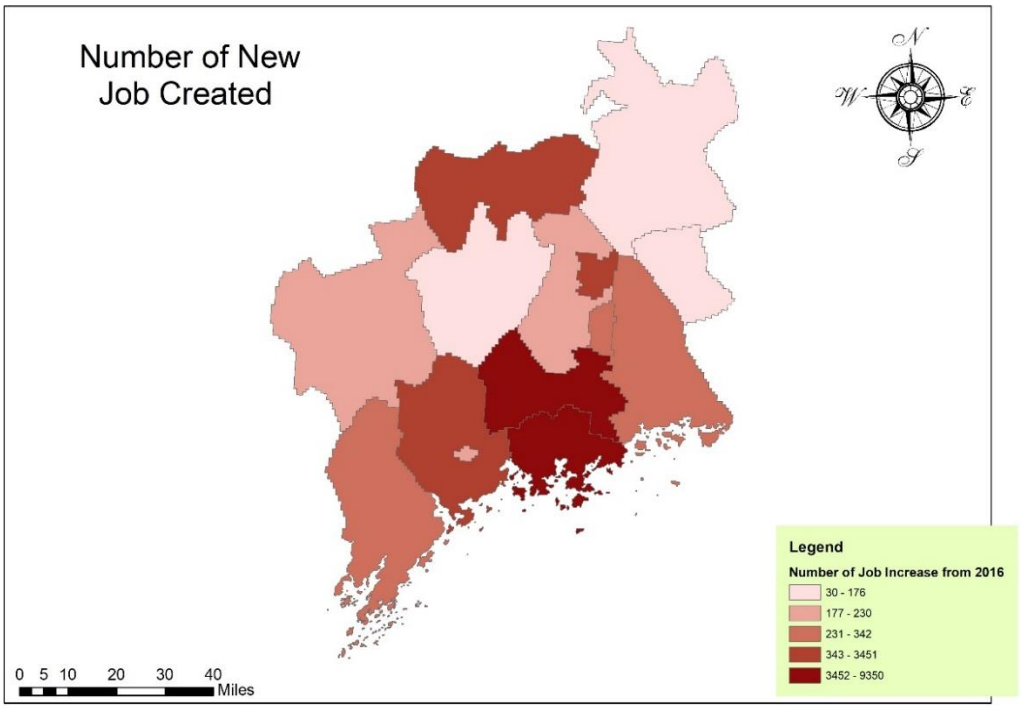

Figure 4.3-7 Number of new Job created in 2017[66]

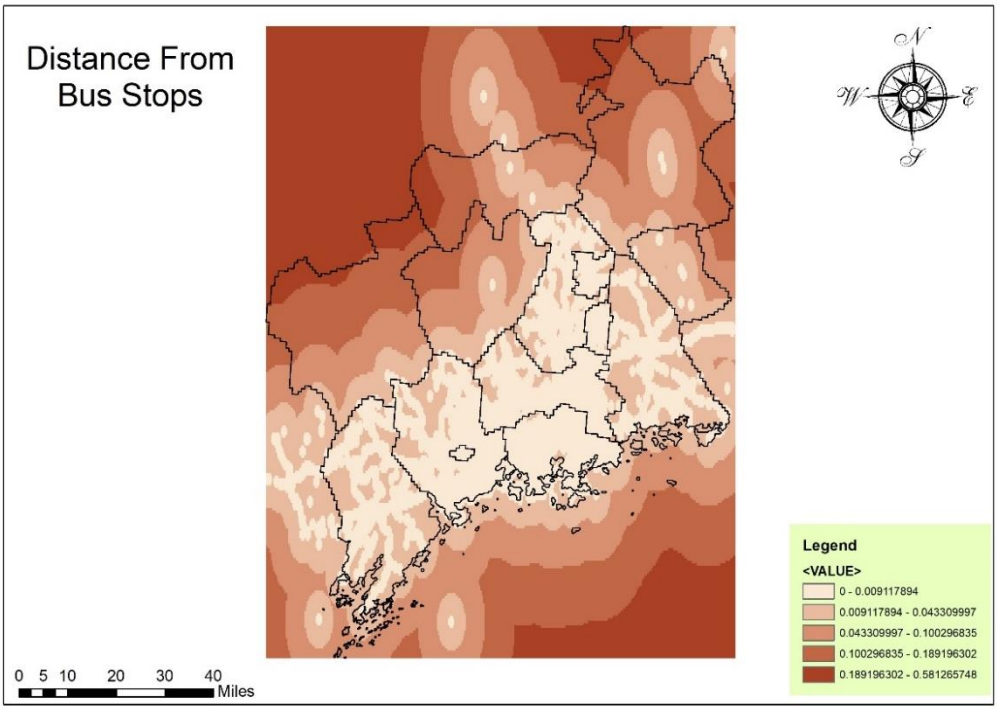

Figure 4.3-8 Distance from Bus stops[67]

[66] Own work (raw data Finland statistics)
[67] Own work. NB. here distance is measured in degrees. 1 degree is equal to 111 km

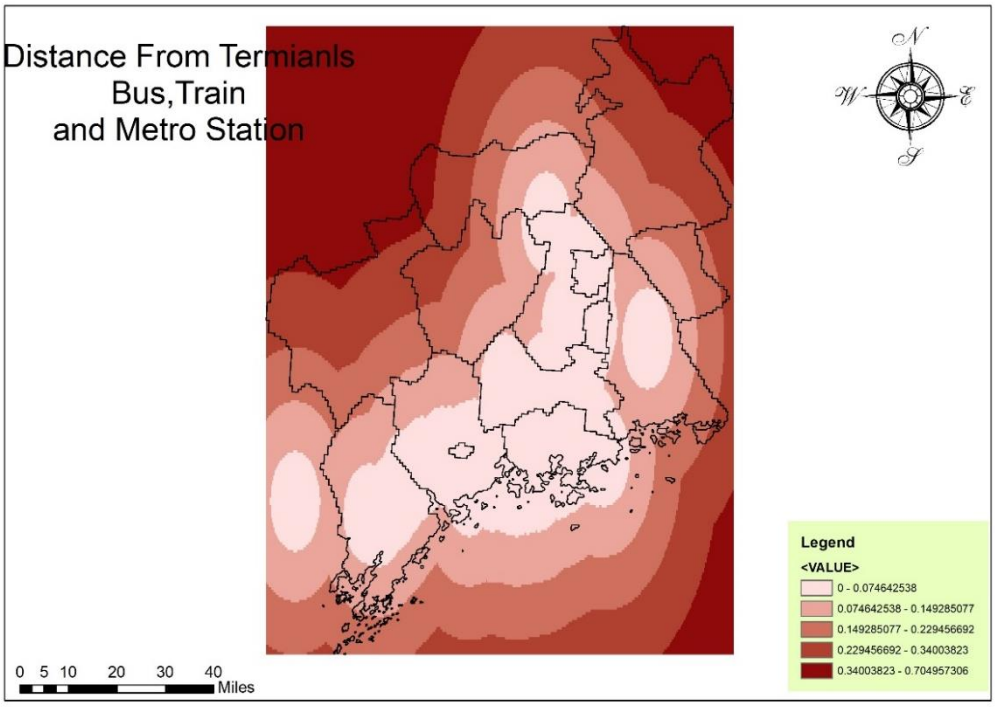

Figure 4.3-9 Distance from Public Transport Terminals[68]

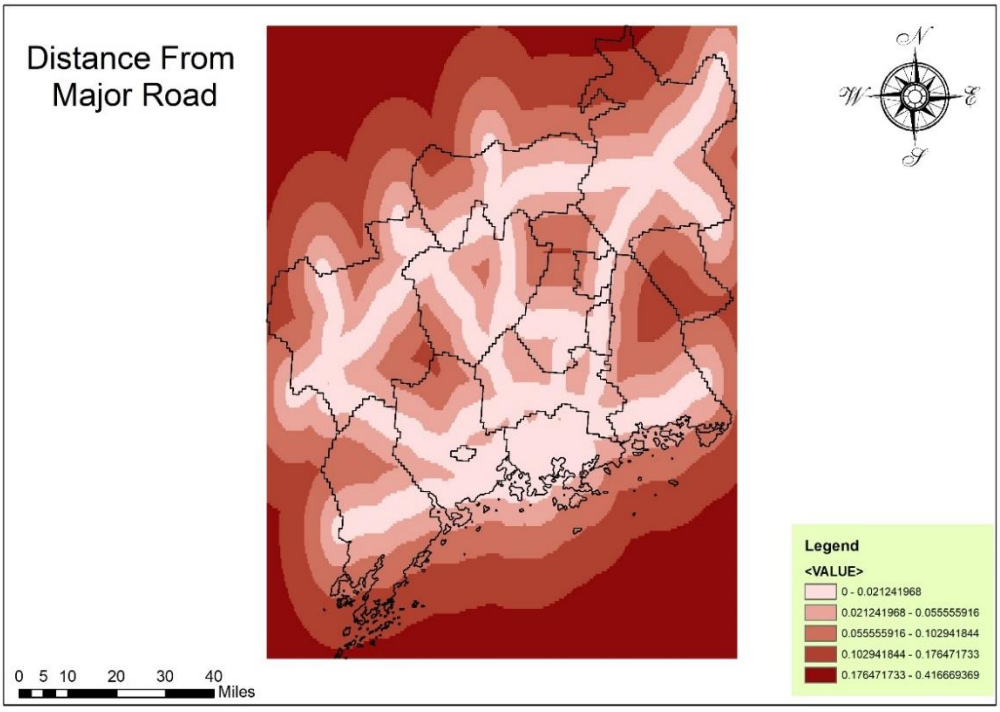

Figure 4.3-10 Distance from Major Road[69]

[68] Own work (GIS data www.hsl.fi) NB. here distance is measured in degrees. 1 degree is equal to 111 km
[69] Own work NB. here distance is measured in degrees. 1 degree is equal to 111 km

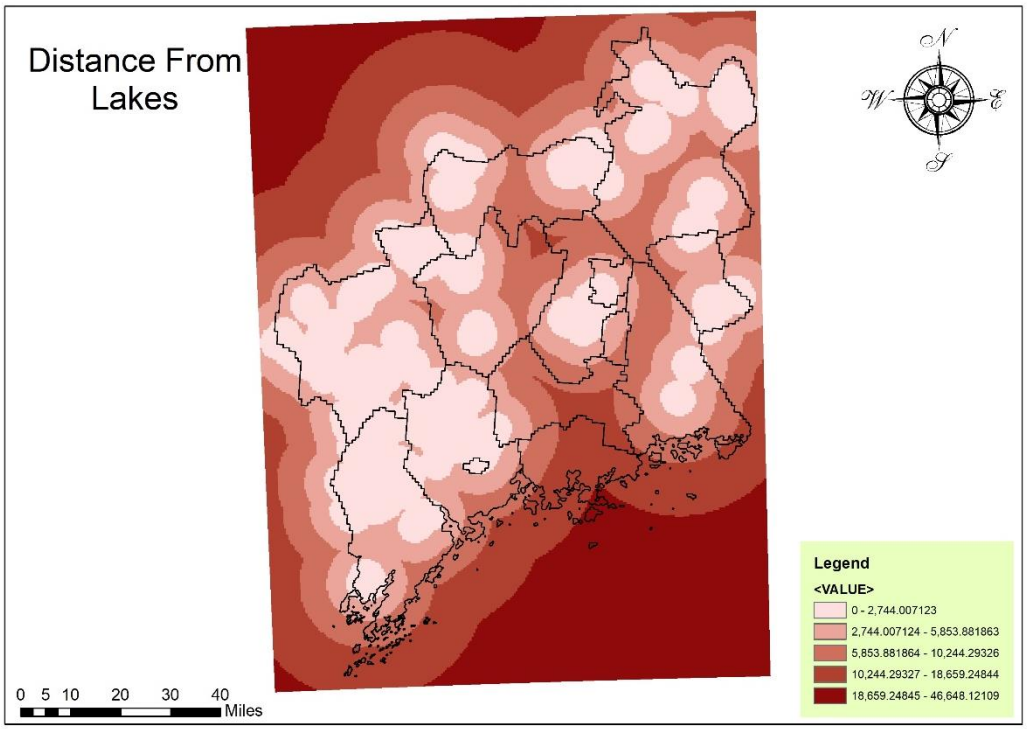

Figure 4.3-11 Distance from Lakes[70]

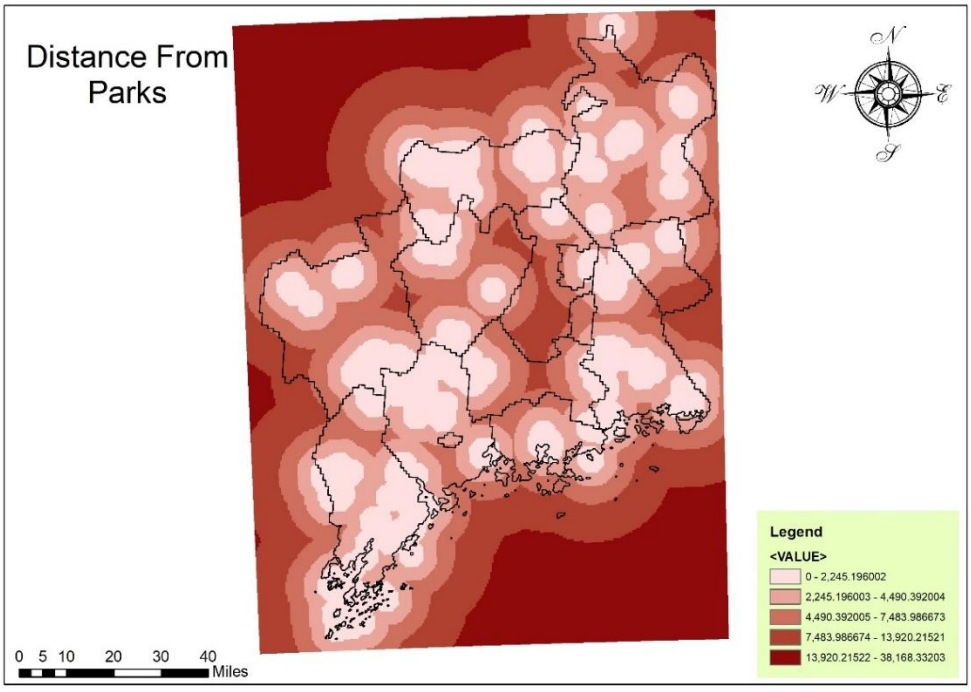

Figure 4.3-12 Distance from Parks[71]

[70] Own work (GIS data www.syke.fi)
[71] Own work (GIS data www.syke.fi)

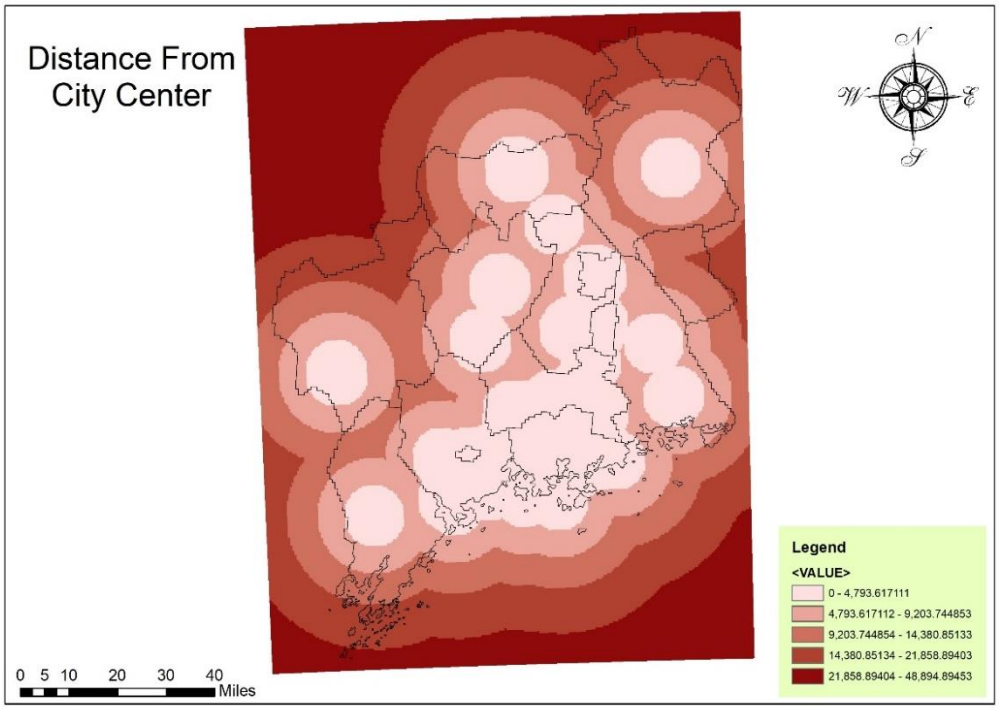

Figure 4.3-13 Distance Form City Centres[72]

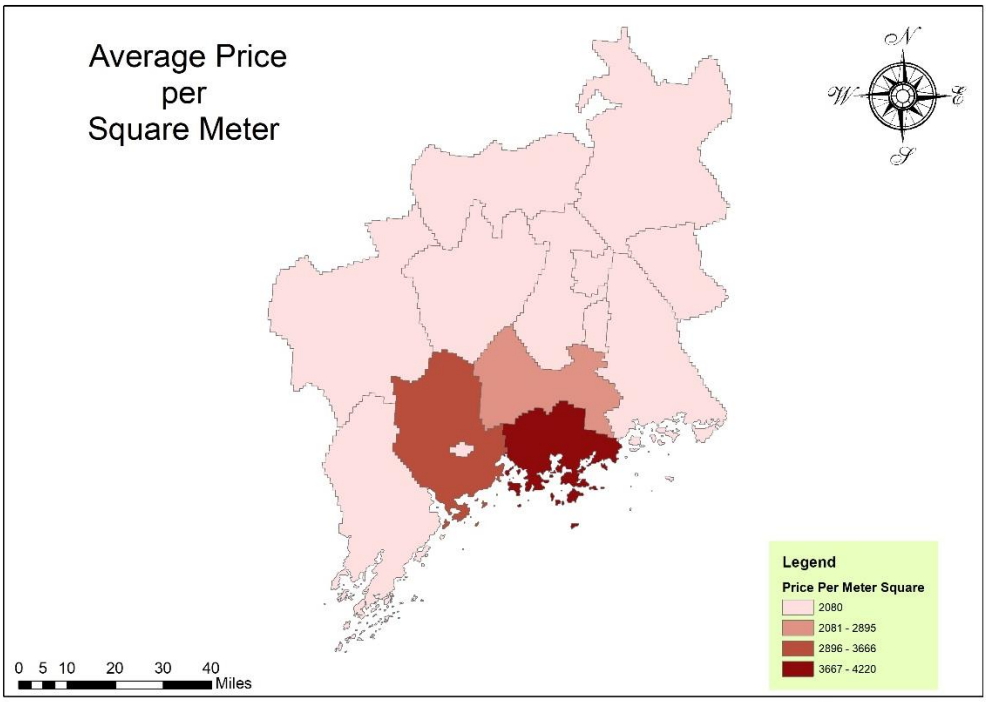

Figure 4.3-14 Average Price for Purchasing House[73]

[72] Own work (GIS data www.syke.fi)
[73] Own work (data source Statistics Finland)

Figure 4.3-15 Weighted Overlay Suitability Model on ArcMap10.5[74]

[74] Own work

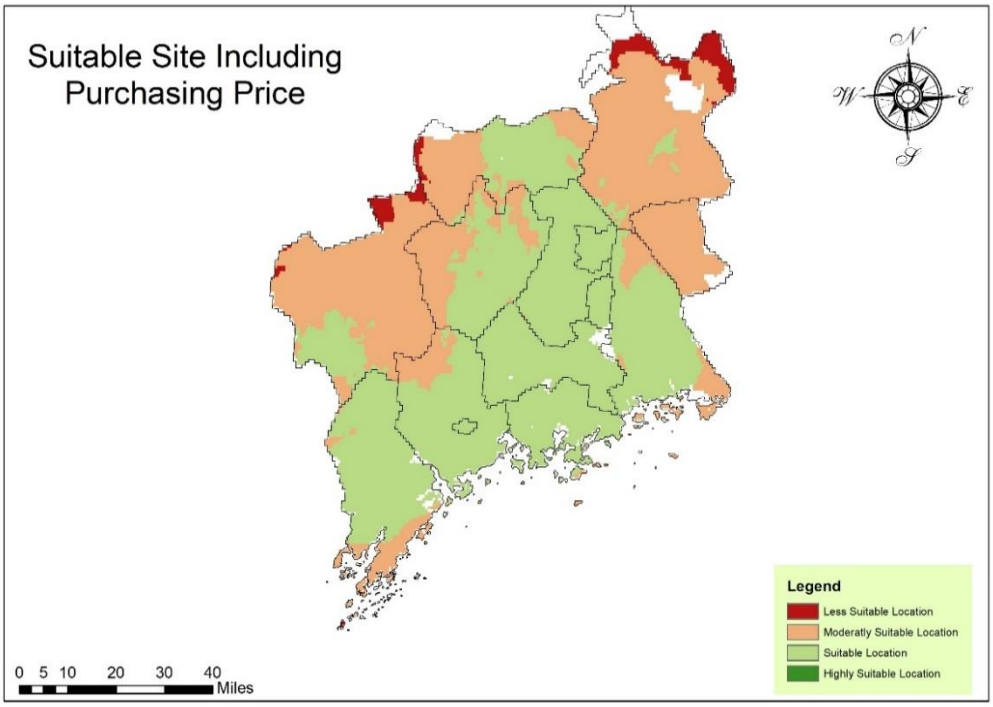

Figure 4.3-16 Suitable Locations Without Restrictions[75]

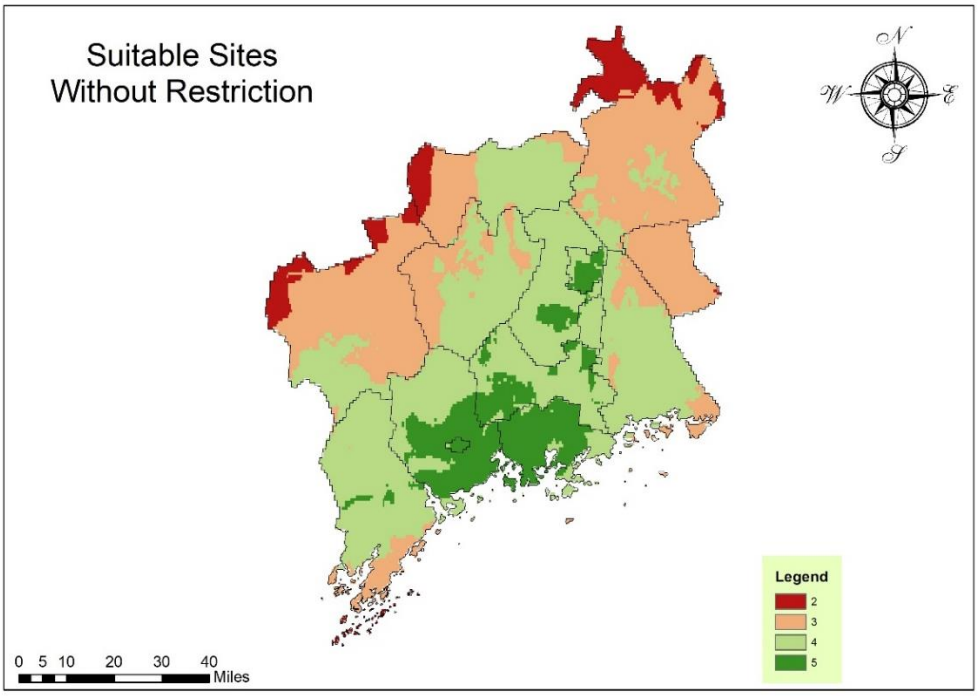

Figure 4.3-17 Suitable Locations Not Including Average Price of Purchasing Real Estate[76]

[75] Own work
[76] Own work

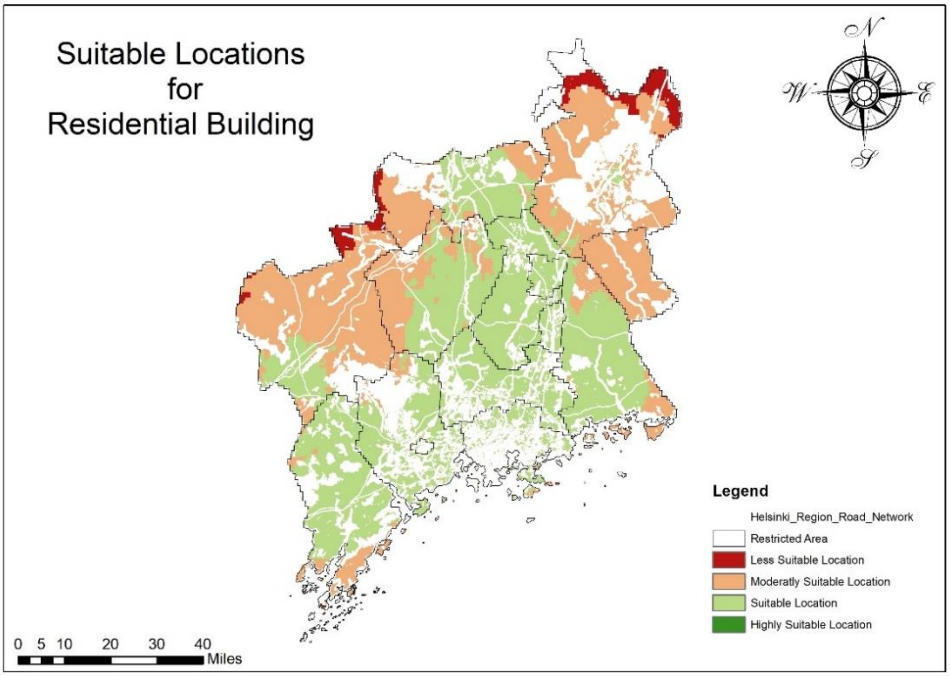

Figure 4.3-18 Suitable Locations for Residential Real Estate Development in Helsinki Region[77]

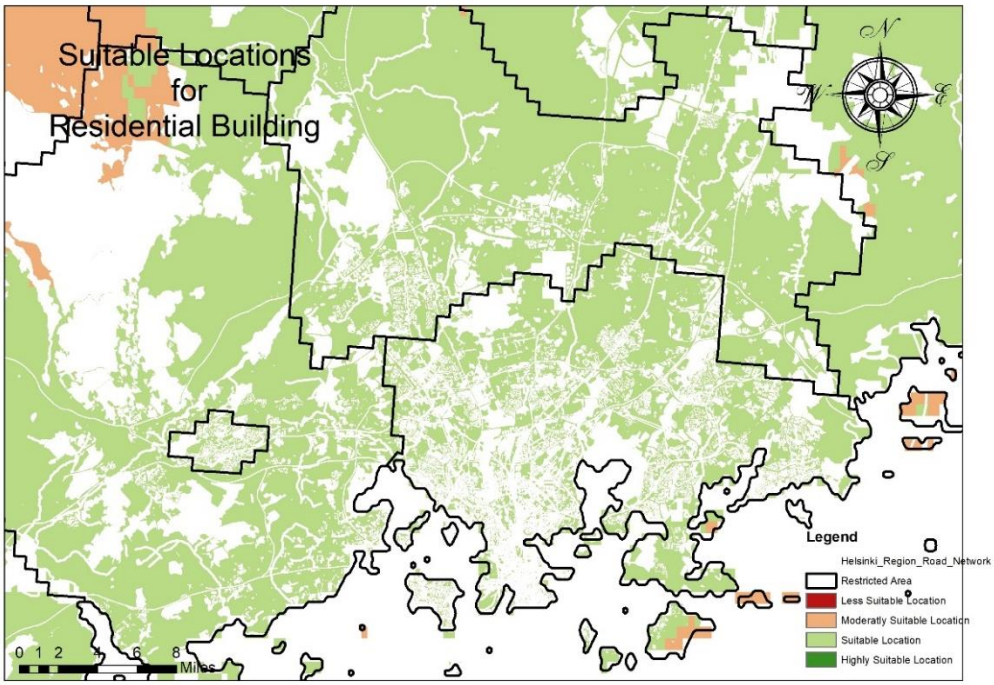

Figure 4.3-19 Helsinki, Espoo, Vantaa and Kauniainen Municipality Suitable Locations for Residential Real Estate Development[78]

[77] Own work
[78] Own work

4.4 Correlation Analysis

At this stage of analysis, the correlation between different suitability factor and the change in the Stock of building construction companies is investigated. The correlation is carried out by using the geographically weighted regression tool of ArcMap 10.5. Performs Geographically Weighted Regression (GWR), a local form of linear regression used to model spatially varying relationships.

The level of correlation between two variables can be estimated by using the Pearson correlation coefficient. The value of this coefficient ranges from -1 to 1, where -1 indicate a perfect negative linear correlation 1 indicate a perfect positive linear correlation, and 0 indicate perfect independence. when positive coefficient is obtained, it indicates that an increase in one variable will result in an increase of the other. To the contrary, when a negative coefficient is obtained, it indicates when one of the variable increases the other variable decreases (Katz 2006). It should be noted that the Pearson correlation coefficient does not indicate a causal relationship between variables (Urdan 2001).

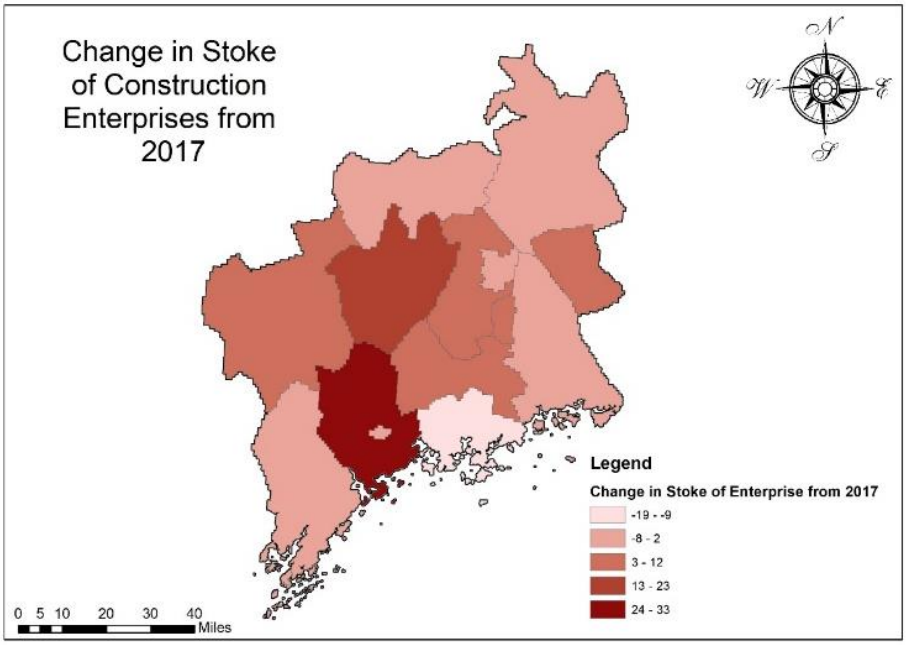

Figure 4.4-1 Change in the Stock of building construction enterprises in Helsinki region[79]

[79] Own work (Raw data from Statistic Finland)

For this study, the researcher conducted an investigation into the strength of correlation between of change in the Stock of building construction enterprises and demographic and economic features of the area such as population size, population growth, population density and number of jobs created.

Pearson coefficient of correlation (R square) between change in the Stock building construction enterprises and demographic, and economic features is calculated for each municipality in Helsinki region. The result of this correlation analysis is shown in Table 4.4-1 below.

	Population Size	**Population Growth**	**Population Density**	**Number of Job Created**
Municipality	local R square	local R square	local R square	local R square
Espoo	0.054614	0.141455	0.238556	0.038482
Helsinki	0.017902	0.001754	0.154988	0.038124
Hyvinkää	0.037505	0.152895	0.33332	0.03833
Järvenpää	0.020567	0.01	0.084473	0.03815
Kauniainen	0.039168	0.089845	0.207385	0.038348
Kerava	0.020638	0.000006	0.183566	0.038157
Kirkkonummi	0.042081	0.103749	0.236555	0.038373
Mäntsälä	0.009443	0.0149	0.106922	0.038014
Nurmijärvi	0.046696	0.107239	0.172794	0.038425
Pornainen	0.019526	0.006238	0.136657	0.038138
Sipoo	0.056954	0.121937	0.216273	0.038507
Tuusula	0.033515	0.070458	0.218736	0.038292
Vantaa	0.033039	0.096892	0.319743	0.038287
Vihti	0.005418	0.066092	0.062327	0.037926

Table 4.4-1 Local coefficient of correlation between demographic feature and change in Stock of Enterprises[80]

The table above indicates the number of change in the existing Stock of building construction enterprises is almost perfectly independent from demographic features such as population size of the municipality, growth in population size, and

[80] Own work

economic feature like the number of new jobs created in the municipality. The coefficient of correlation between change in the number of the Stock of enterprises and population size of municipalities has a range from 0.009443 to 0.0569, indicating the weak relation between them. Similarly, the coefficient of correlation between change in the number of Stock and population growth has a range from 0 in the municipality of Kerava to 0.1414 in the municipality of Espoo.

The correlation strength between the number of jobs created and the change in the Stock of building construction enterprises also happens to be weak. The coefficient of correlation for these two variables is nearly 0.038 in all municipalities. The table above indicates that the change in the Stock of building enterprises has a weak positive correlation with the density of the municipality, the coefficient for these to variables ranges from 0.062 in Vihti to 0.319 in Vantaa.

The correlation coefficient was also calculated to identify the strength of correlation between the change in the Stock of building construction enterprises and the demographic and economic feature for the entire Helsinki region. The summary of the calculation is shown in Table 4.4-2 below.

Population Size	Population Growth	Population Density	Number of Job created	
0.06552	0.002808	0.265542	0.038534	**R Square**
-0.058461	-0.0808	0.035264	-0.04205	**Adjusted R square**

Table 4.4-2 Correlation coefficient between demographic and economic features, and change in the Stock of building enterprise in Helsinki region[81]

The summary of the correlation investigation indicates that there little to no relationship between the increase or decrease of the number of building construction enterprises and the demographic features such as population size. Population growth, and population density.

The second correlation investigation was to quantify the relationship between the number of building construction enterprise in a municipality, and the demographic

[81] Own work

and economic features such as population size, population growth, population density and number of job created. The result of this investigation is shown below.

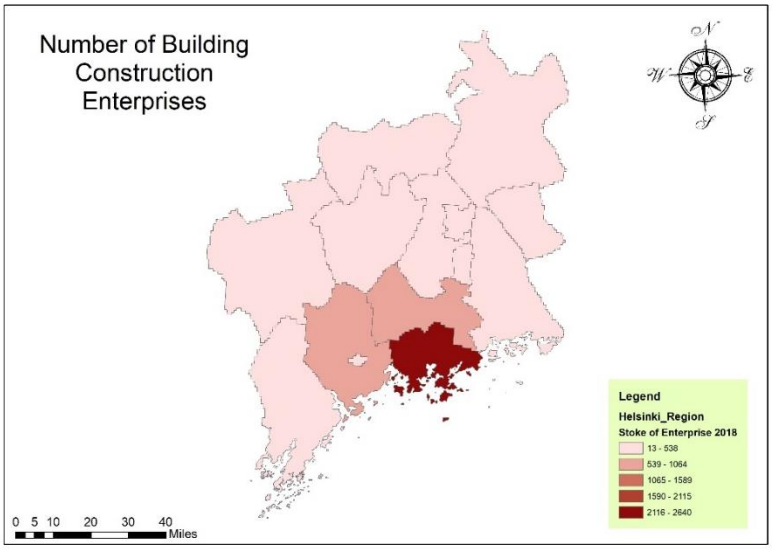

Figure 4.4-2 Number of building construction enterprises[82]

	Population Size	Population Growth	Population Density	Number of Job created
Municipality	local R square	local R square	local R square	local R square
Espoo	0.991078	0.701583	0.664921	0.973076
Helsinki	0.973651	0.95041	0.517792	0.999905
Hyvinkää	0.987347	0.998948	0.647999	0.999869
Järvenpää	0.974567	0.984496	0.472931	0.997327
Kauniainen	0.989524	0.877791	0.632595	0.075966
Kerava	0.975475	0.854414	0.53378	0.999412
Kirkkonummi	0.990074	0.989792	0.649731	0.406781
Mäntsälä	0.970881	0.954004	0.497526	0.994115
Nurmijärvi	0.990113	0.604528	0.621934	0.2327
Pornainen	0.972847	0.819969	0.497506	0.097728
Sipoo	0.991589	0.650409	0.654015	0.609618
Tuusula	0.987876	0.980949	0.619467	0.173009
Vantaa	0.986453	0.999043	0.629006	0.996472
Vihti	0.965945	0.948161	0.454706	0.998009

Table 4.4-3 Local coefficient of correlation between the number of enterprises in a municipality and demographic features [83]

[82] Own work (Raw data from Statistic Finland)
[83] Own work

The table above indicates that the number of existing building construction enterprises is in an almost perfect positive relation with demographic features such as population size of the municipality, growth in population size, and economic feature like the number of new jobs created in the municipality.

The coefficient of correlation between the number of building construction enterprises and population size of municipalities has a range from 0.97 to 0.99, indicating the strong positive correlation between them. Similarly, the coefficient of correlation between the number of enterprises and population growth has a range from 0.701 in the municipality of Espoo to 0.99 in the municipality of Vantaa.

The correlation between the number of jobs created and the number of building construction enterprises also indicate a perfect positive and linear relation. The coefficient of correlation for these two variables varies from 0.173 in the municipality of Tuusula to 0.999 in the municipality of Helsinki. On the other hand, the correlation coefficient indicates that there is only a moderate relation between the number building construction enterprises and the density of the municipality, according to the GWR analysis correlation coefficient for the variables varies from 0.454 in Vihti to 0.664 in Espoo.

The correlation coefficient was also calculated to identify the strength of the correlation between the number of building construction enterprises and the demographic and economic feature for the entire Helsinki region. The summary of the calculation is provided in Table 4.4-4 below.

Population Size	Population Growth	Population Density	Number of Job created	
0.98074	0.9984	0.6263	0.9995	**R Square**
0.9793	0.996	0.5092	0.9868	**Adjusted R square**

Table 4.4-4 Correlation coefficient between demographic and economic features, and the number of building enterprise in Helsinki region[84]

The correlation investigation indicates that there is a perfect and positive linear relationship between the number of building construction enterprises in a

84

municipality and the demographic features such as population size and Population growth. The investigation also indicates a positive linear correlation between the number of enterprises and the number of jobs created. On the other hand, a moderate positive correlation is observed between the number of enterprises and the density of population.

4.5 Discussion

Helsinki region is the fastest growing region in Finland. It is one of the very few regions in Finland where the population is expected to increase. This phenomenon brings job opportunity for many including SME construction enterprises in the region. The hosuing production in the Helsinki region will make up 40% of the total housing production by 2040. This indicates there will be a demand for housing in the near future.

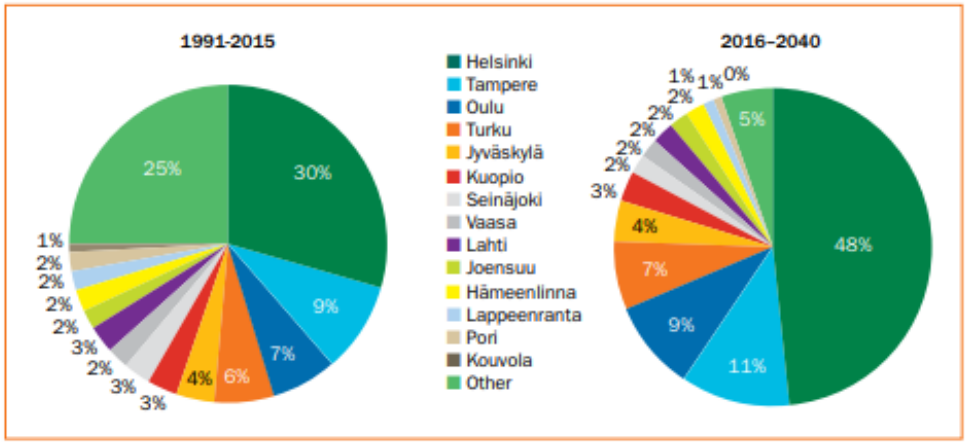

Figure 4.5-1 Distribution of Housing Production[85]

The current research investigated the potential use of GIS for site suitability analysis. The researcher conducted a literature review to identify which demographic and economic feature to incorporate in the site analysis. Once the literature review was done the researcher conducted a survey to determine the weight of these features. And finally, GIS software was utilized to carry out the analysis and generate maps.

[85] KtI, The Finnish Property Market p18

The result of the study is discussed here as follows

Question 1. Which demographic features of a certain location are a good indicator for suitability of conducting construction business?

The demand for housing is influenced by demographic features such as population size, population structure, population growth population, and immigration. According to the literature review, the population size of the age group between 20 – 29 has a higher influence on the demand for housing. Literature also indicates that Immigration has a dynamic impact on the demand, while the effect of population growth is felt after some delay.

According to the online survey conducted by the researcher, the residence of the Helsinki region preferred to live in cities where the population is densely settled. Population density got a weight of 12.73%.

Question 2. Which location factors are a good indicator for suitability of a site for real estate development?

Location is one of the main factors that influence the demand for real estate development. Literature review indicates that desirability of the location has a major influence on the demand. The demand for real estate in major cities like Helsinki might increase despite economic downfalls.

According to the online survey participants gave higher ranking to locations with better public transport links over proximity to highways, proximity to city centre, and proximity to public parks. Proximity to public transport transit received a weigh of 18.18%.

Question 3. Is it possible to Indicate potential construction sites for future construction of real estate?

Literature review shows that it is possible to predict the demand for real estate and identify potentially suitable sites by analysing key factor that influences it. Economic conditions, interest rate, government policy and demography of the

region should be analysed to identify a suitable area. Even though the investigation of the correlation between these macro-factors and the demand for real estate is complex, it is a necessary thing for real estate developers to do.

Question 4. Is GIS suitable for performing site analysis for real estate development?

GIS was first introduced in the 1960s and the ever since then it is being utilized by ever growing people from different sectors. The literature review indicates that GIS is a powerful tool that can be used for gathering, manipulating, analysing and visualizing spatial data. This capability can be used by the construction sector and real estate developers to conduct a suitability analysis of construction sites.

The researcher of this study demonstrated the capability of GIS tool by conducting a suitability analysis of sites in the greater Helsinki region for real estate development. Utilization of GIS software made it possible to incorporate several suitability factors at the same time and investigate their influence.

Hypothesis 1 Prove the hypothesis that the success of SME construction enterprises is dependent on the location where they do business with the help of GIS modeling.

The researcher conducted a correlation analysis to investigate the strength of the relationship between the change in the number of construction enterprises and the demographic features of a location. The result of these investigation shows that there was no statistically significant correlation between the change of the number of enterprise year on year and demographic features of the location.

On the other hand, correlation analysis indicated that there is a statistically significant relationship between the number of enterprises in a municipality and the population size, population growth and the number of new jobs created in the municipality. When these features increase the number of enterprise in the municipality tend to increase. But, this correlation is inappropriate to prove or disprove the hypothesis.

Chapter 5

Conclusion and Recommendation

5.1 Conclusion

The objective of this research was to assess the utilization of Geographic Information System (GIS) technology for conducting a suitability analysis, involving multiple factors that influence the demand for real estate production. The suitability analysis was done with the aim of identifying a suitable location for constructing a residential building by Small and Medium-sized construction enterprises operating in greater Helsinki region.

Real estate demand is influenced by several factors such as the economic condition of the country, government policy, interest rates, and demography. It is a complex task to investigate the correlation between these macro-level factors and the demand for housing at a local level. However, it is necessary for real estate developers to investigate how these factors affect the long term demand for real estate instead of only evaluating the physical condition of the land.

One of the challenge SMEs, which are involved in the development of residential real estate face is lack of information and resource to investigate new markets. This research proposed the use of Geographic Information System (GIS) software for the investigation of suitable sites in the greater Helsinki region. The main goal of the analysis was to examine the possibility of incorporating several suitability criteria and restriction factors.

For this research, the researcher used ArcMap 10.5, a GIS software by ESRI, for the analysis of suitability criteria and generating maps. Weighted overlay suitability analysis was performed after weighing factors for the different suitability factors were determined through an online survey.

The research proved that GIS technologies can be utilized by SME construction enterprises, which are involved in real estate development to examine not only site

conditions such as land and building properties but also analyze the desirability a location, demand and supply for real estate, level of rent and potential future incomes from the property.

GIS is a powerful tool which has an immense potential to be utilized by different sectors including SMEs. The technology and data for GIS analysis are increasingly becoming more accessible and easy to use. The researcher managed to conduct a suitability analysis for the entire area greater Helsinki region with little resources. The researcher strongly believes that SME enterprises can benefit from the utilization of GIS technologies and recommends them to use it to their advantage.

5.2 Limitation of the Study

The aim of the research was to determine how SME construction enterprise can utilize GIS technology for better site analysis and identification of new opportunities and new markets for them to enter. The research involved formulating a sound research design to solve the research problem proposed in the first chapter. Even though every possible effort was made to ensure there was little to no shortcomings, it was not possible to avoid all of them due to several factors and constraints.

- For a population size of more than 500,000 the sample size should be at least 384 In order to achieve a 95% level confidence with a 5% margin of error. But, due to the shortage of time and lack of respondents willing to participates in the survey, only 50 responses where collected. As a result of this, the margin of error increased to 14%.

- When designing the survey, the sample population should have been constituted of people who are interested in buy a residential building in order to get a more reliable outcome on which suitability criteria are considered as more important and which are less important.

- Despite the capability of ArcMap 10.5 to do time-lapse analysis, the study was limited to a short span of time. The researcher believes that if

longitudinal research was conducted, a better outcome could have been achieved from the analysis.

- Most of the data collected for the purpose of the analysis are data classified by municipalities. as a result of this the analysis of the data does not show significant differences from one location to another in the same city, while in reality, one part of town can be more suitable for real estate development of a residential building than others. This can be improved by using data organized by postal code area.

- The number of criteria of site suitability investigation was limited to 10 factors which the researcher identified through the literature review conducted. It is possible to include more factors to get a more reliable out analysis, but in this case the number of criteria was limited to 10 due to lack of resources and time.

- For correlation investigation between suitability factor and SMEs activity, correlation coefficient was calculated to determine the strength of correlation between number of building construction enterprises and demographic features. The researcher believes that a better correlation investigation could have been done if the number of building permit issues by municipalities was obtained.

5.3 Recommendation

The research followed a well-defined research design and a sound methodological procedure. But, the researcher believes that a more efficient suitability analysis result can be obtained by combining more factors and better weighing factors. Laurus Construction Corporation, a small construction enterprise based in Costa Mesa, California, which inspired this research uses over 137 different factors for GIS analysis to identify suitable areas and new markets.

For the analysis, the current research depended on open data providers such as Statistics Finland, Aviondata, Finnish Environmental Institute, and several other

GIS data providers. The researcher tried to limit the source of data to few data providers, but it was not enough to conduct the analysis, and data coming from different sources from different times have an undesirable effect on the quality of the analysis.

- Since only 10 suitability criteria were used for the analysis, more factors can be added to future researches to get a better perspective of how other factors play a role in the suitability of a site for real estate development.
- A better and high volume of data about the activity of SME enterprises can lead to a better understanding of how suitability factors influence their performance.
- By using data classified based on postal code or local area, it is possible to conduct suitability analysis of any location within a municipality.
- Statistics Finland provides well organized and high-quality data. In their archive it possible to obtain data collected from years back and this makes it possible to conduct a longitudinal study with the help of GIS software. Longitudinal study helps to understand how patterns are changing in a region. This way the researcher can make a rational prediction about the future and can recommend where SME should conduct their business.
- The research is carried out only for Helsinki region, so any conclusion made based on this research cannot be applied for other regions. But, the methodological procedure can be repeated to investigate other regions.

Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Date

Signature of the student

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Appendix

Appendix A

Survey questions for determining weighing factor suitability factors

Weighing Factor Survey

Please give a rating for the following factors when choosing suitable site for a residential building construction.

*Required

1. **what municipality do you reside in?** *

Mark only one oval.

- ◯ Helsinki
- ◯ Vantaa
- ◯ Espoo
- ◯ Kaunianen
- ◯ Hyvinkää
- ◯ Järvenpää
- ◯ Kerava
- ◯ Kirkkonummi
- ◯ Mäntsälä
- ◯ Nurmijärv
- ◯ Pornainen
- ◯ Sipoo
- ◯ Tuusula
- ◯ Vihti

2. **which municipality do you prefer for construction of a residential building?** *

Mark only one oval.

- ◯ Helsinki
- ◯ Vantaa
- ◯ Espoo
- ◯ Kaunianen
- ◯ Hyvinkää
- ◯ Järvenpää
- ◯ Kerava
- ◯ Kirkkonummi
- ◯ Mäntsälä
- ◯ Nurmijärv
- ◯ Pornainen
- ◯ Sipoo
- ◯ Tuusula
- ◯ Vihti

3. **How important is the distance to city center when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important at all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

4. **How important is proximity to a motorway when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important at all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

5. **How important is proximity to a bus stop when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important at all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

6. **How important is accessibility of public parks when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important at all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

7. **How important is the population density of the neighbourhood when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

8. **How important is the population size of a neighbour when choosing a site for constructing a residential building?** *

Mark only one oval.

- ◯ 0 not important at all
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 very critical

9. **How important is the population growth rate when choosing a neibourhood for constructing a residential building?** *

Mark only one oval.

- 0 not important at all
- 1
- 2
- 3
- 4
- 5 very critical

10. **How important is household income a neibourhood when choosing a neibourhood for constructing a residential building?** *

Mark only one oval.

- 0 not important at all
- 1
- 2
- 3
- 4
- 5 very critical

11. **How important is employment rate a neibourhood when choosing a neibourhood for constructing a residential building?** *

Mark only one oval.

- 0 not important at all
- 1
- 2
- 3
- 4
- 5 very critical

12. **How important is land price when choosing a neibourhood for constructing a residential building?** *

Mark only one oval.

- 0 not important at all
- 1
- 2
- 3
- 4
- 5 very critical

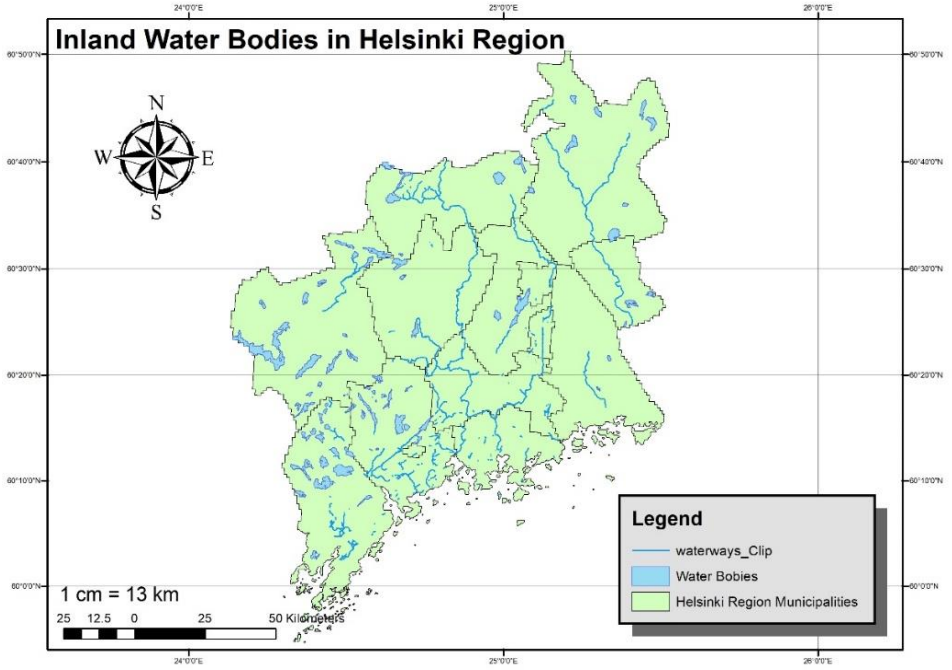
13. **Do you think there is an important demographic or socio-economic factor missing, that should be included when analyzing suitability of site for constructing residential building? please state if the is any**

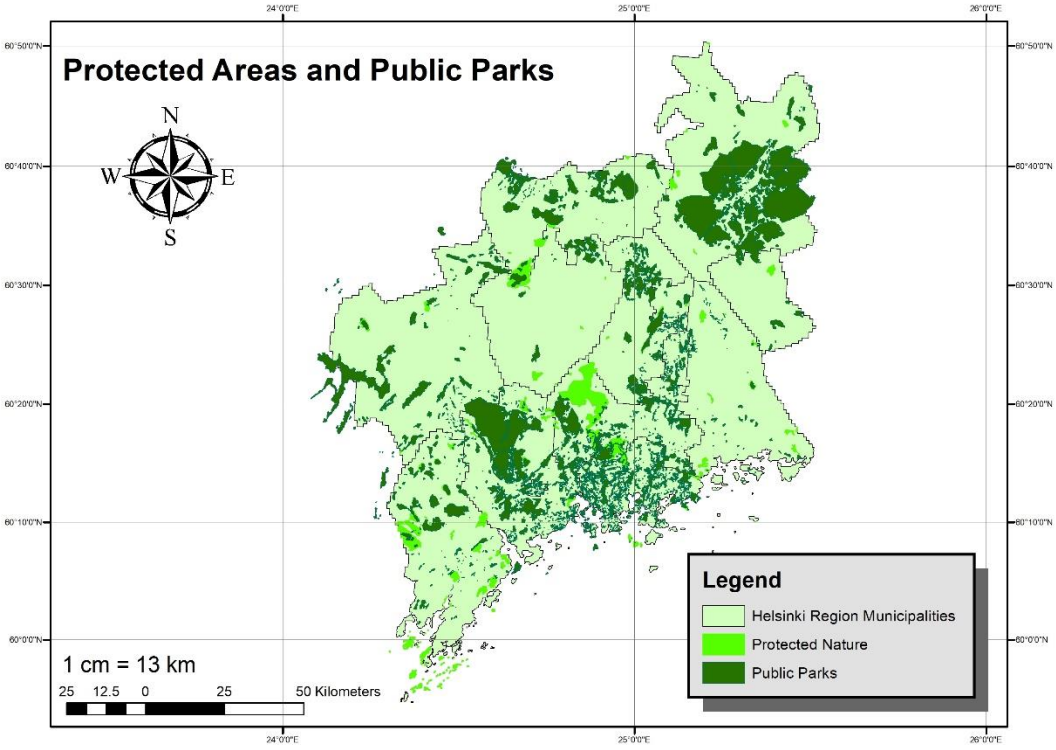
14. **Rate the structure of the questions**
Mark only one oval.

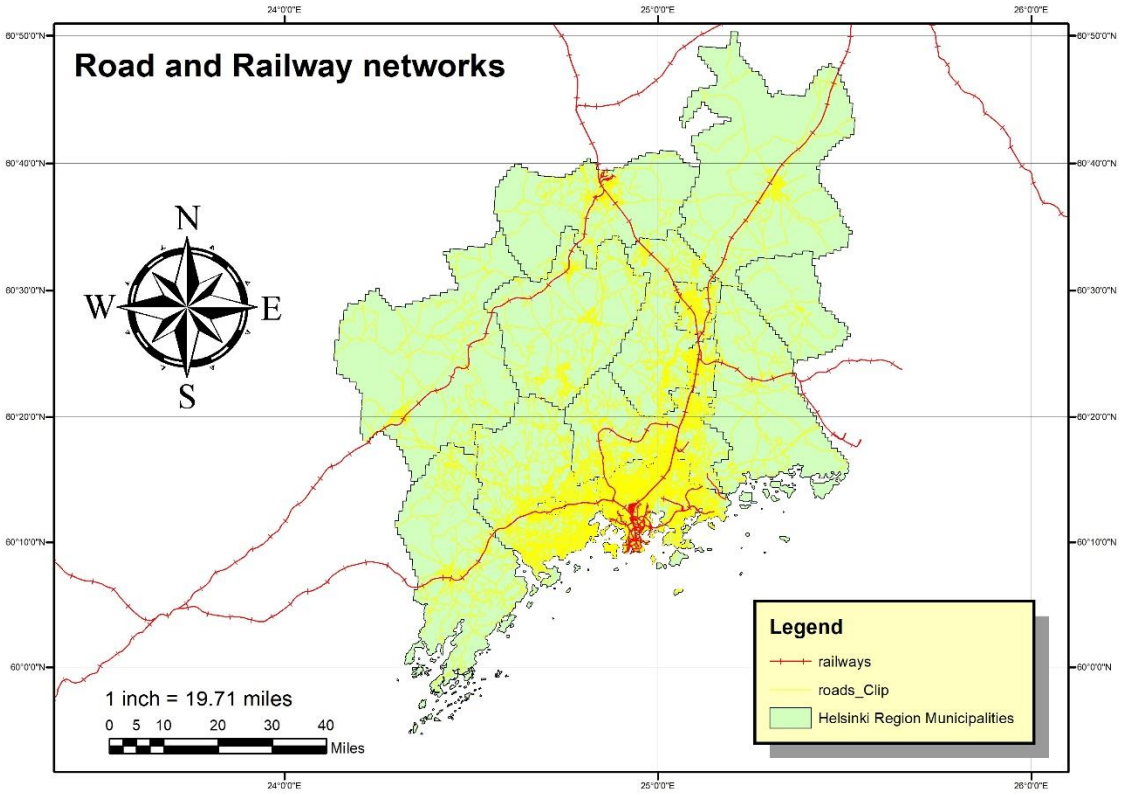
1	2	3	4	5
◯	◯	◯	◯	◯

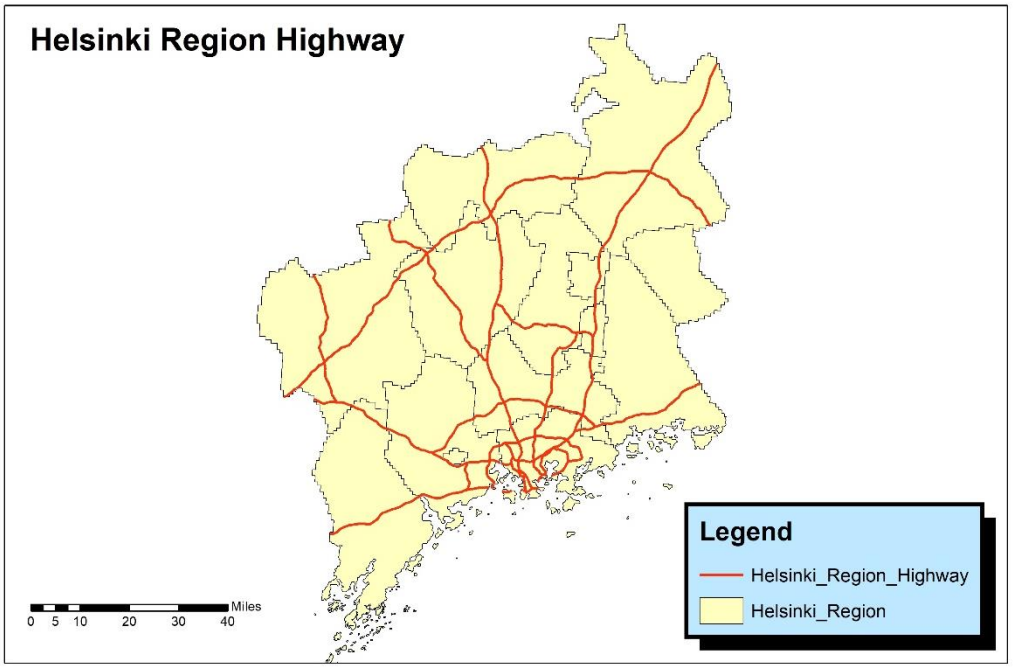
Appendix B

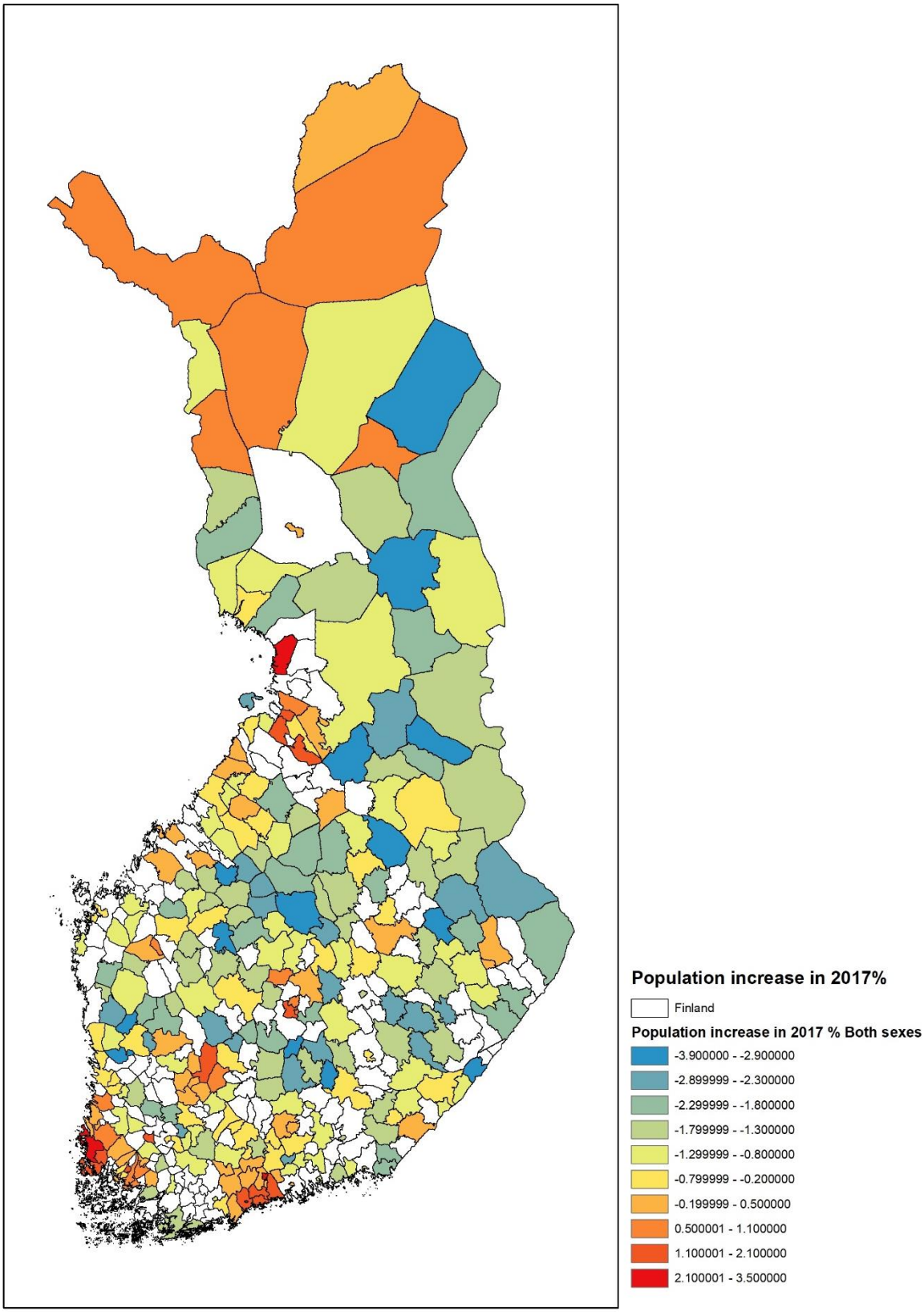
Maps

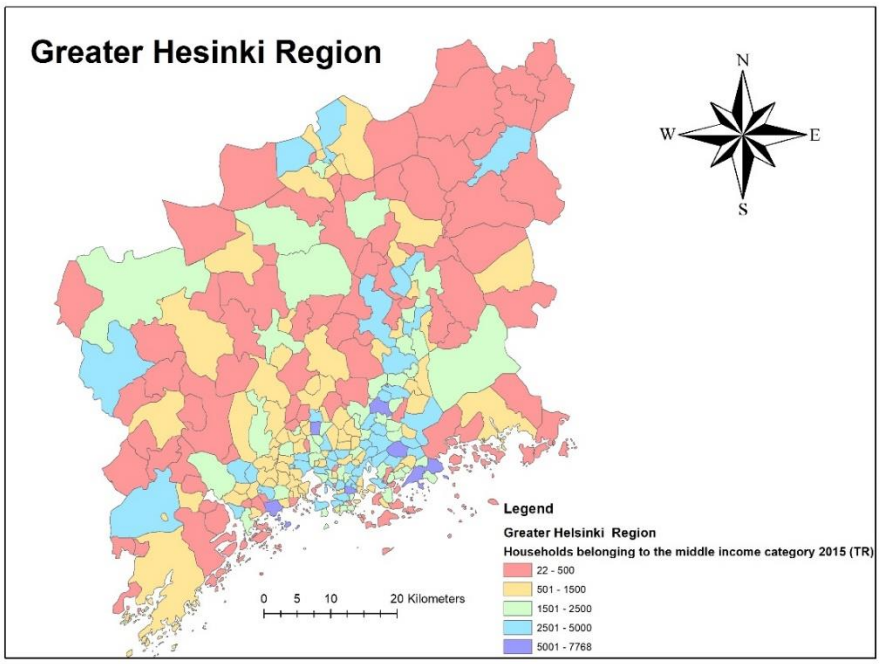


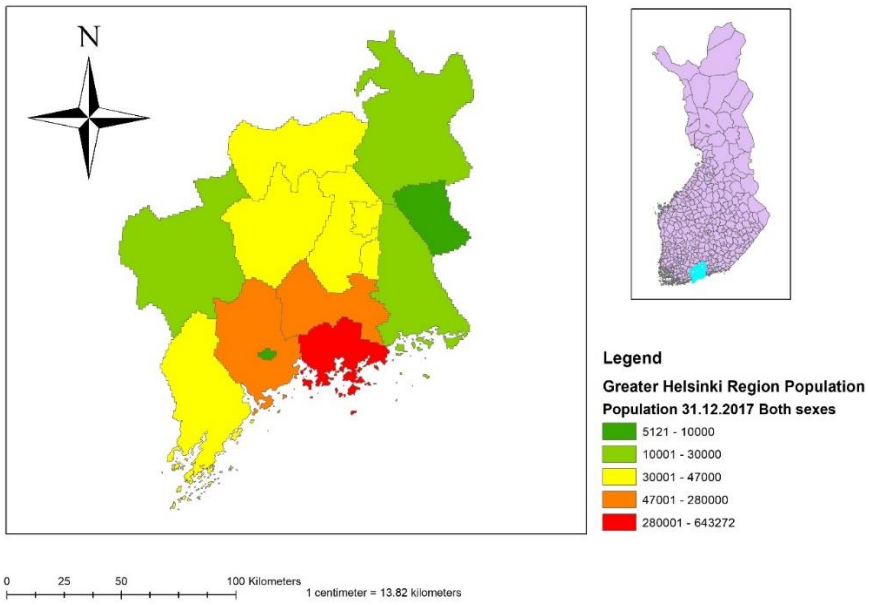



Road and Railway networks
24°0'0"E
25°0'0"E
26°0'0"E
60°50'0"N
60°40'0"N
60°30'0"N
60°20'0"N
60°10'0"N
60°0'0"N
N
W
E
S
1 inch = 19.71 miles
0 5 10 20 30 40
Miles
Legend
railways
roads_Clip
Helsinki Region Municipalities


Helsinki Region Highway
0 5 10 20 30 40
Miles
Legend
Helsinki_Region_Highway
Helsinki_Region


Population increase in 2017%
Finland
Population increase in 2017 % Both sexes
-3.900000 - -2.900000
-2.899999 - -2.300000
-2.299999 - -1.800000
-1.799999 - -1.300000
-1.299999 - -0.800000
-0.799999 - -0.200000
-0.199999 - 0.500000
0.500001 - 1.100000
1.100001 - 2.100000
2.100001 - 3.500000


Greater Hesinki Region
N
W
E
S
0 5 10 20 Kilometers
Legend
Greater Helsinki Region
Households belonging to the middle income category 2015 (TR)
22 - 500
501 - 1500
1501 - 2500
2501 - 5000
5001 - 7768


N
Legend
Greater Helsinki Region Population
Population 31.12.2017 Both sexes
5121 - 10000
10001 - 30000
30001 - 47000
47001 - 280000
280001 - 643272
0 25 50 100 Kilometers
1 centimeter = 13.82 kilometers

Appendix C

Table: Number of small and medium sized building construction enterprises opening, closing and Stock.

Municipality	Enterprise openings 2017	Enterprise Closures 2017	Stock of Enterprise 2017	Enterprise opening 2018	Enterprise Closure 2018	Stock of Enterprise 2018
049 Espoo	104	12	806	70	21	839
091 Helsinki	241	62	2659	194	92	2640
106 Hyvinkää	12	5	194	3	3	186
186 Järvenpää	21	4	207	9	8	203
235 Kauniainen	0	0	17	0	1	13
245 Kerava	8	1	124	11	5	129
257 Kirkkonummi	17	2	189	6	5	187
505 Mäntsälä	12	5	175	9	7	175
543 Nurmijärvi	26	2	256	14	6	270
611 Pornainen	6	1	53	2	1	55
753 Sipoo	9	2	146	1	3	144
858 Tuusula	23	4	232	19	8	238
092 Vantaa	108	31	976	106	43	986
927 Vihti	23	4	189	13	6	193

Appendix D

Table: Suitability layers, range and score and weight used in weighted overlay suitability analysis.

Suitability criteria layer	Quantile Range	Score	Weight
Proximity to city center	0 - 4793	5	14.55%
	4793 - 9203	4	
	9203 - 14380	3	
	14380 - 21858	2	
	21858 - 48894	1	
Proximity to highway	0 - 0.021242	5	7.27%
	0.021242 - 0.055556	4	
	0.055556 - 0.102942	3	
	0.102942 - 0.176472	2	
	0.176472 - 0.416669	1	
Proximity to Public transport	0 - 0.074643	5	18.18%
	0.074643 - 0.149285	4	
	0.149285 - 0.229457	3	
	0.229457 - 0.340038	2	
	0.340038 - 0.704957	1	
Proximity to public park	0 - 2744	5	9.09%
	2744 - 5853	4	
	5853 - 10244	3	
	10244- 18659	2	
	18659 - 46648	1	
Population density of Neighborhood	34.9 - 55.6	1	12.73%
	55.6 - 116.5	2	
	116.5 - 893.5	3	
	893.5 - 1160.7	4	
	1160 - 3002	5	

Suitability criteria layer	Quantile Range	Score	Weight
Population size of town	5175 - 9730	1	10.91%
	9731 - 29514	2	
	29515 - 46921	3	
	46922 - 277445	4	
	277446 - 641830	5	
Population growth of town	-0.2	1	5.45%
	-0.2 to 0.4	2	
	0.4 to 1.9	3	
	1.9 to 0.4	4	
Number of middle income household	22 - 650	1	3.64%
	651 - 1500	2	
	1501 - 2750	3	
	2751 - 4750	4	
	4751 - 7768	5	
Number of new job	0 - 112	1	1.82%
	112 - 256	2	
	256 - 716	3	
	3565 - 716	4	
	9350 - 3565	5	
Land price	4222	1	16.36%
	3666	2	
	2895	3	
	2080	4	