Masters
Program
in **Geospatial**
Technologies

MAPPING THE QUALITY OF LIFE EXPERIENCE IN ALFAMA

A case study in Lisbon, Portugal

Pearl May delos Santos dela Cruz

Dissertation submitted in partial fulfilment of the requirements
for the Degree of *Master of Science in Geospatial Technologies*

UNIVERSIDADE NOVA
UNIVERSITAT JAUME·I
WESTFÄLISCHE WILHELMS-UNIVERSITÄT MÜNSTER

MAPPING THE QUALITY OF LIFE EXPERIENCE IN ALFAMA

A case study in Lisbon, Portugal

Dissertation supervised by

Professor Pedro da Costa Brito Cabral, PhD

Dissertation co-supervised by

Professor Jorge Mateu, PhD
Kristina Helle

March 2011

ACKNOWLEDGMENTS

I would like to express my gratitude to my supervisor Prof. Pedro Cabral and co-supervisors Prof. Kristina Helle and Prof. Jorge Mahiques, for their supervision and exceptional support. My sincere thanks as well to Prof. Marco Painho, for all the kind suggestions and guidance.

To all the faculty members of ISEGI, New University of Lisbon, especially to Angela Santos, Olivia Fernandes, Sofia Santos, and to all the staff of New Technologies laboratory, thank you for the assistance and moral support. I would also like to genuinely thank all my classmates, for making this Master's a fun adventure, and to Dian Melati, who has helped me during my fieldwork.

My profound thanks towards the European Commission (Erasmus Mundus Program) MS in Geospatial Technologies Consortium, for providing this opportunity and financial resources so people coming from the Third World countries like me can pursue their studies in Europe.

I would also like to thank my family, for giving me the support and guidance every moment of my life. Last, but not the least, thank you to my beloved Oscar Vidal Calbet. This could not have been written without your generous help and patience all throughout the thesis period.

MAPPING THE QUALITY OF LIFE EXPERIENCE IN ALFAMA

A case study in Lisbon, Portugal

ABSTRACT

This research maps the urban quality of life (QoL) in Alfama, Lisbon (Portugal) through objective and subjective measures. A survey of 69 respondents and locations of social services were gathered signifying the subjective and objective QoL respectively in the physical, economic, and social domain. The relationship between the two measures is examined using correlation analysis. It was determined that the association between them is weak and not significant, which could have been caused by the geographic scale and the sample size chosen. These two factors also affected the spatial autocorrelation check implemented to the 15 subjective indicators using the Moran's I test. The results of this spatial autocorrelation check were the basis of the type of spatial prediction method used for each indicator. Out of 15, only 3 indicators were spatially autocorrelated. These 3 indicators were interpolated using Ordinary Kriging (OK). The rest is interpolated using the voronoi polygon. The 15 prediction maps were used to create the overall subjective QoL with the utilization of the Multi-Criteria Decision Analysis (MCDA) method called Weighted Sum. With all indicators grouped together, four maps are produced namely, physical, social, economic, and the overall QoL. Both physical and economic domains showed comparatively a below average QoL while the social domain with an average to above average result. The overall, which is the weighted sum of these three domains, generated a below average to an average assessment.

KEYWORDS

Correlation

Geographical Information Systems

Ordinary Kriging

Quality of Life

Spatial Prediction

Weighted Sum

ACRONYMS

CV – Cross-validation

GIS – Geographic Information System

GLS – Generalized Least Squares

INE – Instituto Nacional de Estatística

ISEGI – Instituto Superior de Estatística e Gestão de Informação

LOO – Leave-one-out method

MCDA – Multi-Criteria Decision Analysis

OK – Ordinary Kriging

OLS – Ordinary Least Squares

QoL – Quality of Life

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1. INTRODUCTION

1.1. Background

"Socrates, we have strong evidence that the city pleased you; for you would never have stayed if you had not been better pleased with it." — Plato

Plato is right when he says that people may tend to stay in a place they are pleased; but this is something applicable only to a particular situation. Different factors play important parts in the decision-making. Especially in this era, factors such as budget, social issues, and emotional connectedness to the place play the utmost reasons. Deciding on staying in a place is not only a matter of choice but also of opportunities. These opportunities make up the indicators of Quality of Life (QoL).

QoL is a multifaceted concept that has been a significant feature in research. Numerous authors focus their attention in establishing its definition and how it can be measured (Campbell et al., 1976; Rogerson, 1999; Seik, 2000; Costanza et al., 2007; Bonnes et al., 2007; Das, 2007; Tesfazghi, 2009). Costanza et al. (2007) noted that it has been an explicit or implicit goal from an individual to the world.

"QoL is a broad term which encompasses notions of a good life, a valued life, a satisfying life, and a happy life."(McCrea, Shyy, & Stimson, 2006)

In fact, QoL in urban areas has been increasingly recognized by planners in assessing the urban environment. This has been one of the major objectives of urban policies; create a better quality of life for the residents. As the level of urbanization has been increasing relentlessly at least in one part of a country, certain to transpire are its positive (i.e. employment creation) and negative aspects (i.e. growing issues of disorder, environmental degradation) that will tend to influence the quality of life of residents. A rising need of QoL evaluation is on the mark.

Based on the worldwide Mercer 2010 Quality of Living Survey, Lisbon, the capital and the wealthiest part of Portugal, ranked the 45th out of 420 cities. Mercer (2010) defines Quality of Living as based on indicators that are 'objective, neutral and unbiased'. QoL on the other hand (the focus of study), may also include subjective indicators based on people's perceptions and opinions.

Even then, with Lisbon covering an area of 84.8 km^2, variability across the city exists, with comparatively bad off and affluent inhabitants. This in turn led to an interest to study the area of Alfama, a part of Lisbon recognized to be occupied by destitutes. A case study is done to evaluate the urban QoL in Alfama, encompassing two civil parishes (*freguesias*) of the city, Freguesias São Miguel and Santo Estevão. With the main purpose to assess the urban QoL in Alfama using objective and subjective QoL measures, specific goals are identified, which are the following: determine the relationship between objective and subjective QoL measures; determine which subjective indicators have the highest priority for each domain (Physical, Social, and Economic); and find out if subjective QoL measures are spatially autocorrelated. Two hypotheses are also formulated prior to the study; that there is no linear relationship between objective and subjective QoL measures, and that subjective QoL measures are not spatially dependent. Specific questions that this research tries to answer are also identified based on the two hypotheses. Is there a significant relationship between objective and subjective QoL measures? Are subjective QoL indicators spatially autocorrelated? What is the current QoL situation in Alfama? What are the fundamental indicators for the residents of Alfama? These questions together with the hypotheses are answered at the end of the study. Using Geostatistics' spatial interpolation method and Multi-Criteria Decision Analysis (MCDA), a QOL map of Alfama is produced. QoL issues and problems are pinned down, and urban amenities and services are assessed according to the results found.

1.2. Theoretical Framework

Based on existing framework of Tesfazghi (2009), the following framework was conceptualized (Fig. 1):

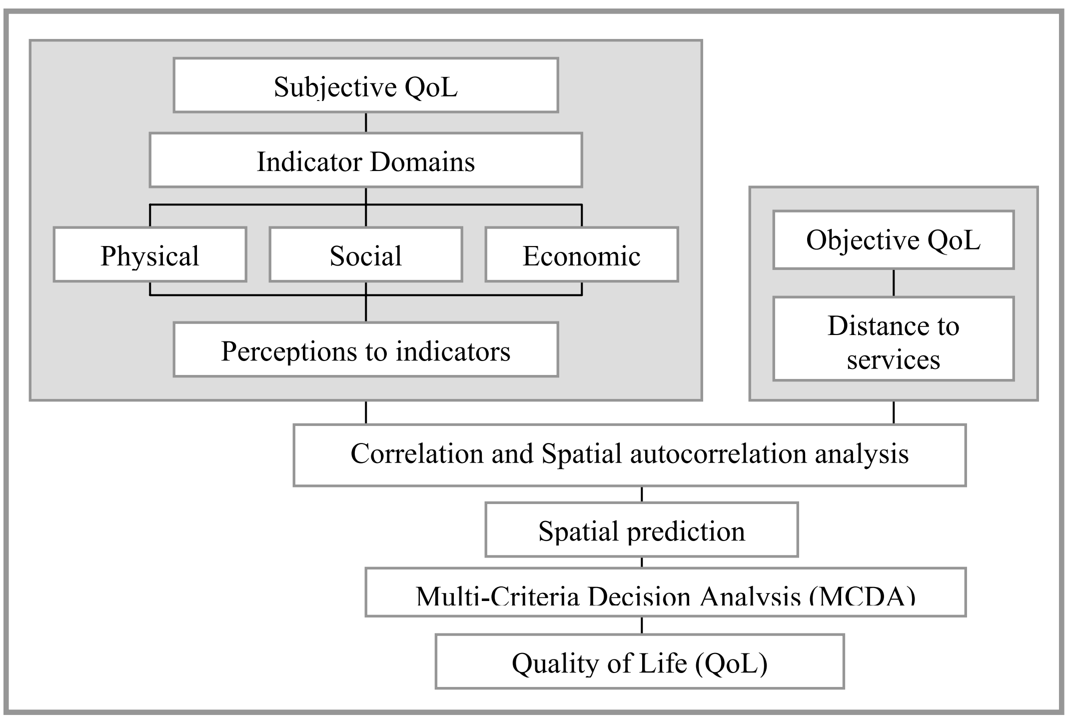


Figure 1. Theoretical framework of QoL (Tesfazghi, 2009)

Since it is argued in various researches that both subjective and objective measures are necessary to understand QoL (Turksever & Atalik, 2000), both are considered for QoL measurement.

Subjective QoL is measured using perceptions of respondents towards specified indicators. These perceptions are assumed to show their QoL assessment based on their experiences. Evaluated indicators are grouped into three main domains, the Physical, Social, and Economic, which constitutes the subjective QoL. The distance to services on the other hand signifies the objective QoL. It ponders upon the accessibility of the social services from the survey respondents' locations.

Subjective and objective QoL indicators are tested for correlation and spatial autocorrelation. The results of these tests served as the basis for the spatial prediction analysis. This is discussed in detail in the Research Methodology Chapter.

Once the prediction maps for each indicator was generated, the Multi-Criteria Decision Analysis (MCDA) method called Weighted Sum is used to create the overall QoL map. This represents the QoL based on the analysis results, and the weightings provided by the respondents.

2. LITERATURE REVIEW

Broad discussions on the definitions and different perspectives on QoL measurements are presented. The review starts with the identification of definitions and conceptual model of QoL followed by various perspectives and indicators it contains. Finally, some existing methodologies of measuring the overall QoL are reviewed.

2.1. Definitions of QoL

Varied definitions of QoL are documented in the literature. One of the most prominent is QoL as an "individual's overall satisfaction with life" (Campbell et al., 1976). Campbell et al. (1976) define QoL experience (they referred to as individual well-being) using people's perceptions, evaluations, and satisfactions, referring that QoL is about how people perceive the environmental attributes and the satisfactions they get from it. The authors aim is to explain QoL experience based on the domains of life (Marans, 2003), which is widely used by authors including Seik (2000). It was argued that subjective measures are significant in defining QoL..

The study of Li & Weng (2007) on the other hand deals with QoL assessment through integration of remote sensing and census data, which evidently defines QoL based only on objective measures since it only considers scientific and/or statistics data.

Costanza et al. (2007) in contrast define QoL in terms of human needs (objective) that need to be satisfied based on well-being (subjective). These authors describe human needs as "basic needs for subsistence, reproduction, security, affection, etc.". Subjective well-being in result is assessed by individuals' or groups' responses to questions about happiness, life satisfaction, utility, or welfare (Costanza et al., 2007). In this case, the authors discuss QoL in terms of objective and subjective measures, which are applied in this study; that QoL is a measure of objective and subjective domains of life.

2.2. Conceptual Models of QoL

Conceptual models are vital in the analysis and understanding all aspects of QoL. Various models are differentiated in terms of scale and indicators used. There are also models that are theoretical (Campbell et al., 1976) or actual (Tesfazghi et al., 2009), and extensive (Shafer et al., 2000) or definite (Tesfazghi, 2009). In scale for an instance, studies are frequently done in country or city level (i.e. Campbell et al., (1976); Li & Weng, 2007; Santos & Martins, 2006). Few studies dealt on neighborhood or individual level (i.e. Dashora, 2009; Tesfazghi, 2009), which are rather intensive and yet a good way to identify the local area variability. But then, Costanza and Maxwell (1994) argue that "in moving between scales, we trade off the loss of detail (heterogeneity) for the gain of predictability". Therefore, 'correct scale' does not exist as they say (Costanza et al, 2007). However, even a neighborhood scale is valid; a question of its aggregation to a city or country level for government planning materializes.

Majority of study differs as well with using subjective or objective indicators and/or both. For an instance, Li & Weng (2007) define a methodology (Fig. 2) to measure QoL using only objective data, which are remote sensing and census.

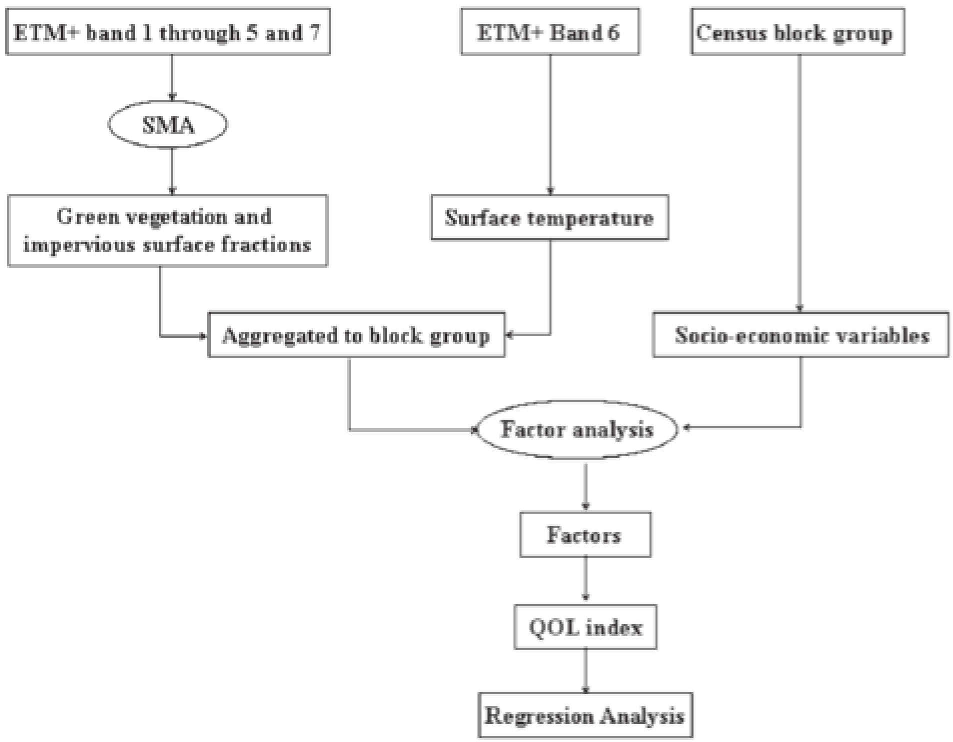


Figure 2. Analytical process framework for QoL index development (Li & Weng, 2007)

Two kinds of variables were derived from these two sources; environmental variables which are greenness and surface temperature using a Landsat image, and 26 socio-economic variables extracted from census. Factor analysis was also conducted to determine the major group of factors of QoL to which an index map is generated by using weighted factor scores for these final main factors. Then regression models were constructed to approximate the QoL.

On the other hand, although Campbell et al. (1976) in some point argued that both objective and subjective measures are necessary for QoL assessment, these authors mainly dealt with subjective measures. Fig. 3 illustrates the associations between residential domain satisfactions and QoL. It suggests the assessment of environmental attributes and stated that QoL depends on individual’s perceptions and experiences. This framework is used particularly to define the subjective QoL part of this study, to which perceptions or assessments of domains of life by residents imply subjective measures.

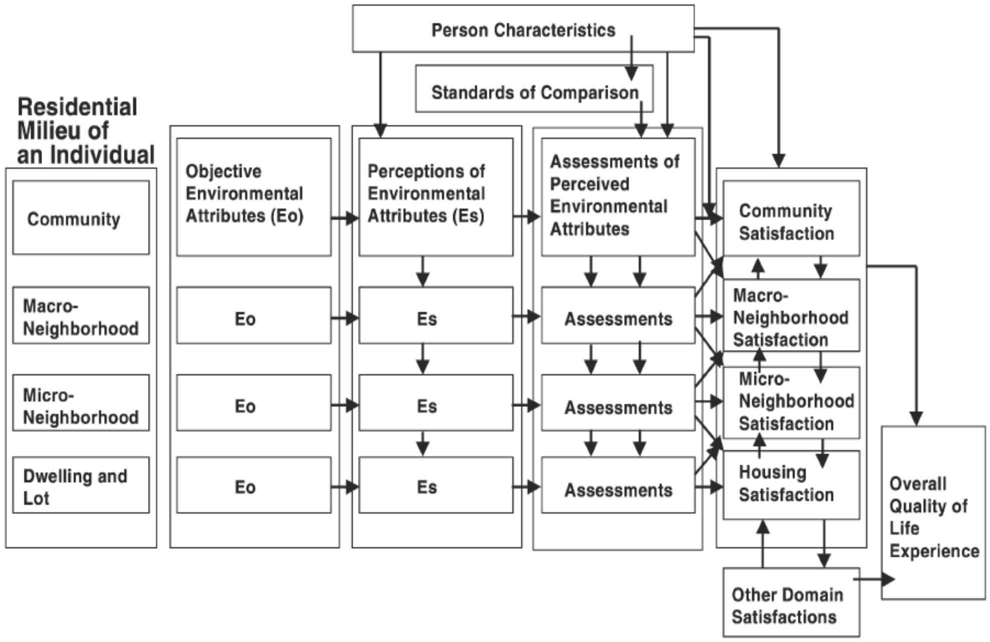


Figure 3. Quality of Life Experience based on life satisfaction (Campbell et al., 1976)

Costanza et al. (2007) however, define QoL with the integration of both objective and subjective measures, see Fig. 4. It was explained that human needs will be met unless opportunities (built, human, social, and natural capital and time), which stands for the objective measures, are provided through implemented policies of the government. With the human needs achieved, the subjective well-being measured in terms of happiness, utility, and welfare, will be greater.

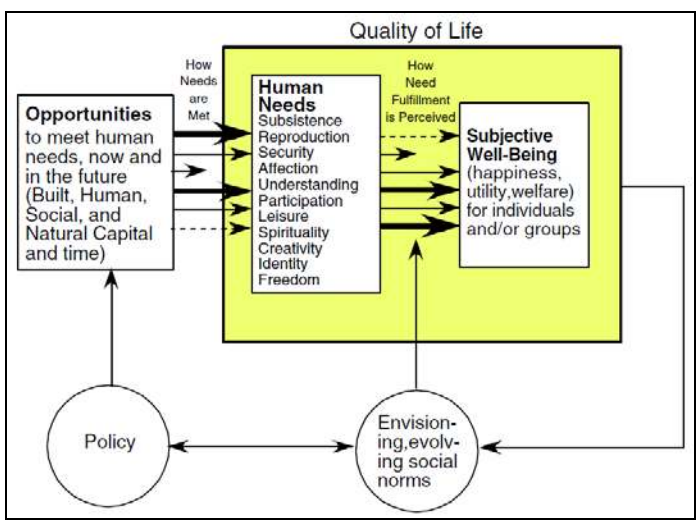


Figure 4. Quality of Life (QoL) signifying the relations between human needs, subjective perception of fulfillment, and opportunities being provided (Costanza et al., 2007).

Costanza et al. (2007) discussed that with this model, the following can be uncovered: (1) potential relationships between the fulfillment and the importance of needs, (2) probable discrepancies between fulfillment and importance grouped by type of capital required to fulfill each need, (3) variation in weights by population characteristics and, (3) variation in overall QoL.

Similarly, Tesfazghi (2009) dealt with urban QoL using these two perspectives, subjective and objective. The author came up with the following conceptual framework (Fig. 5) by combining both.

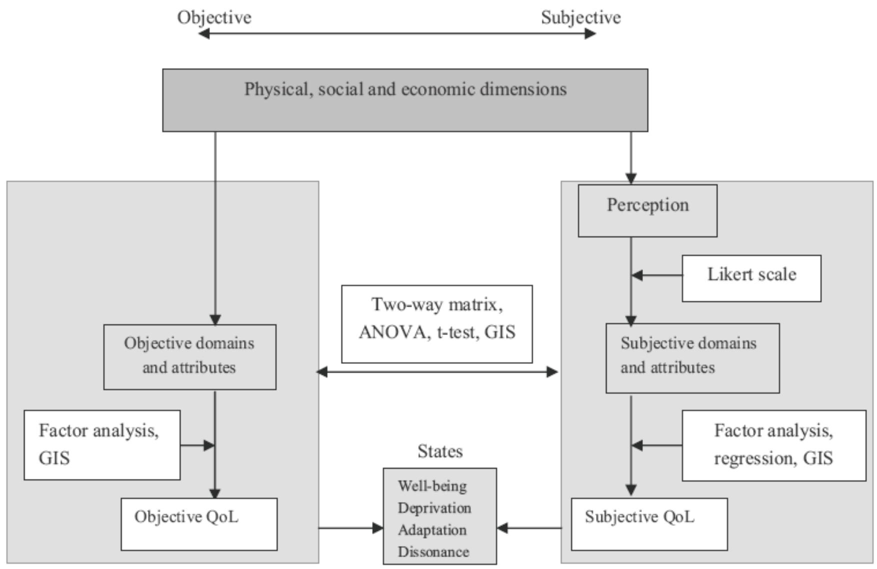


Figure 5. Conceptual framework (Tesfazghi, 2009)

It was suggested that because QoL study is commonly being done at regional and country level, large scale variability of QoL study is needed. Determining the variability at the smallest administrative units such as in neighborhood scale is significant since in general, government plans are executed at this level (Tesfazghi, 2009).

This is in particular (both objective and subjective) were used in the study. The conceptual framework is constructed in the assumption that QoL can be utterly measured using both objective and subjective data. That objective measure is important but so is subjective measure. Perceptions of residents towards their QoL cannot be neglected since they were the ones experiencing it hence; both are integrated in the study. In the subsequent sections, both perspectives are defined and explained.

For an extensive comparision of QoL theoretical models, refer to Vankamp et al.(2003) which demarcate various concepts behind QoL.

2.3. QoL Perspectives

Two perspectives are identified during the development of QoL as a concept. These are the objective and subjective perspectives. The first is described as involving concrete objects such as employment, level of education, family income, and other physical, social and economic aspects (Bowling, 2005). These are 'domains' of life that are 'quantifiable' in nature.

The objective perspective allows the visualization of some physical, social, and economic aspects of life in aggregate level, which is helpful especially for the governing authorities of policy making. A generalized picture of the current situation of an area is useful in determining which domains are to be prioritized, based on their status or condition. Costanza et al. (2007) stated that objective measures tend to construct a standardized data that are less reliant to social assessment and local adaptation.

Quite the opposite, various issues are raised towards its incompleteness for not considering facets such as features on individual level. Data is standardized in the sense that variability is neglected. reminiscence

The subjective perspective on the other hand is described as including background perception of QoL based on personal and life history, attitudes, goals in life and emotional and physical well-being, as well as melancholy, fretfulness, grief, flexibility and recollection (Bowling, 2005). According to Costanza et al. (2007), it is a subjective measurement which corresponds to the self-reported levels of happiness, pleasure, fulfillment, and the like, coined by Diener et al. (1999) as a 'subjective well-being'.

Costanza et al. (2007) claimed it as a 'self-reported QoL' that centers on life experience that complement social, economic, and health indicators. It was argued that some researchers prefer the subjective since objective perspective has a disadvantage to assess the opportunities that individuals have to improve QoL rather than assessing QoL itself. Haas (1999) on the contrary asserted that QOL is "primarily a subjective sense of well-being".

It was also demonstrated that relative importance of subjective indicators to individuals can be determined, and that is reasonable (Diener et al., 1999). Given that the level of satisfactions that people are getting from experiencing the domains of life vary in general, the level of its contribution or weighting to the overall QoL and importance vary too. A self-reported QoL comes in handy in identifying this variability. For an instance, few studies dealt with multi-criteria and cluster analysis for an instance with the help of surveys collected. Cluster analysis gives an overview of groups of people with parallel precedence. With these two methods, a certain scale can be created to which a policy-making body can use in determining and comparing QoL for development. On the contrary, even if "QoL is subjective and normative, objective reasons might be present too" (Costanza et al, 2007), which is one interesting topic. Likewise, although it can be said that subjective indicators are good measures of QoL, some constraints are up for grabs. A study of (Veenhoven, 2004) discussed the following excerpts:

- *Unstable*. Attitudinal phenomena vary over time and that this variation has little link with reality conditions.
- *Incomparable*. The subjective appraisals cannot be compared between persons. Criteria, mental scales, culture vary between people.
- *Unintelligible*. The criteria used for these subjective appraisals are largely implicit.
- *Essential Objections*. Subjective appraisals can be objectively wrong. This is the 'doctor knows best' argument.
- *Unrelated to Objective Reality*. One of the surprises of social indicators research is that correlations between objective conditions and subjective appraisals tend to be weak.
- *Incorrect*. There are some persistent patterns in subjective appraisals that cannot be easily denounced as irrelevant.
- *Validity Doubts.* When objective matters are measured by self-report, there is always the problem that survey questions may evoke responses to different matters than the investigator had in mind.
- *Reliability Doubts*. Even when self-reports fit the subject matter, there is still the problem of precision.

However, there is a rising need for subjective indicators. It is very crucial especially in social policy. Veenhoven (2004) argued that it is vital in knowing what people want and need. In policy assessment and goal attainment, often objective measures are applied, but most often, it is not enough and sometimes subjective measures are more appropriate to use. Objective indicators go amiss too. Therefore, although there are some resources saying that both may not be necessarily related directly, the combination of both approaches is still the most promising perspective for a more complete evaluation of urban quality of life (Santos & Martins, 2006).

2.3.1. The Relationship between Objective and Subjective QoL

Few studies dealt with finding the relationships of objective and subjective indicators of QoL. There are studies claiming that with these two main perspectives, a better QoL assessment will be created. Schwarz and Struck (1999) argue that individual's objective conditions of life and subjective well being associations are weak in experimental studies. Likewise, a small number of studies (Mccrea et al., 2006; Cummins, 2000; Marans, 2003) have been conducted in determining the relationships of these two. Even then, most of these literatures showed that there are disagreements between both. A very interesting argument was of Cummins (2000) where it was argued that there is a property of homeostasis that when the objective threshold of living is low, it influences and disturbs this balance causing a higher covariation with the subjective measure.

Nevertheless, it was established that both include domains and/or indicators of life which contribute to the general QoL (Campbell et al., 1976). Quality of life indicators have been sorted out by different people of different background. In this study however, QoL indicators are grouped into three domains; the physical, social, and economic domains. Note that a domain is defined in this case as a group of indicators.

It was argued that domains affect the QoL in varying degrees depending on situations such as if it is linked with current experience (Schwarz & Struck, 1999). It was suggested that even the content of domains or needs changes. Therefore, a method that will determine the weighting a certain person is using at a particular place and time is needed (Costanza et al, 2007).

2.4. Methodologies for QoL Measurement

Various methodologies were applied in QoL assessment. For an instance, Detroit Area Study (DAS 2001), which aims to measure one aspect of quality of life – the quality of place or community life, uses both subjective and objective perspectives (Marans, 2003). It makes use of Geographic Information System (GIS) in geocoding the addresses of over 4000 respondents throughout Detroit area. The survey, census, environmental and community data were used to determine the QoL in Detroit.

Another example is of Tesfazghi (2009) where the subjective QoL and its variability are determined in Kirkos sub-city using statistical methods (i.e. descriptive statistics, factor analysis, and multiple regression) and GIS techniques in analyzing and visualizing the information. Analysis of variance (ANOVA) was used to examine the associations between subjective and objective QoL attributes. The scores of both were provided using mean and factor analysis.

In this study however, statistical methods such as correlation and spatial prediction techniques were used to quantify and visualize the QoL of Alfama. Since visualization has always been helpful in assessing problems and deciding the solutions especially for social policy making, a spatial prediction method is one good way to do this. This is based on the argument that residential survey data can be interpolated using spatial prediction methods to estimate neighborhood characteristics (Auchincloss et al., 2007). Auchincloss et al. (2007) did a study to which residential surveys and supplementary data were combined to illustrate the availability of healthy foods in Baltimore, New York, and Forsyth County, North Carolina. It was examined whether survey data interpolation was assisted by spatial correlation and supplementary data. Four interpolation models namely ordinary least squares, residual kriging, spatial error regression, and thin-plate splines were compared. The authors concluded however that spatial interpolation was only valuable if spatial correlation was at least moderate. The right prediction method also varies depending on the objectives, availability of data, and spatial patterns identified (Auchincloss et al., 2007). Various interpolation methods are needed to augment data availability such as in evaluating the health effects of residential environments (Auchincloss et al., 2007).

2.5. Summary

The objective and subjective measures have inadequacies. Some literatures stated that integrating both measurements will improve the validity, accuracy, and completeness of the QoL assessments.

Costanza et al. (2007) stated that “QoL is normative, and no completely “objective” measures can be done because by its very nature, QoL is a normative and subjective concept”. Nevertheless, it was discussed that QoL may well be more objective. A question such as why specific things or doings make individuals subjectively happy is one good example.

A survey respondent of Georgiou (2009) said, “QoL is both subjective and objective. There are things “out there” such as housing, getting food, the weather, all sorts of quite objective things, which of course, affect how I feel, but how I choose to respond is up to me”. This is in fact hold for all since people think differently. It is therefore important in assessing QoL not only to include objective but also the subjective QoL measures since knowing variability is also imperative.

3. STUDY AREA

According to the European Union (EU), an urban area is a place with more than 750,000 inhabitants (Wendell Cox Consultancy, 2010). Lisbon, the capital and largest city of Portugal, is the 12th most populous urban area in the EU (Soares, n d). From its city land area of 84.8 km^2, it extends further than its administrative boundary up to 958 km^2 to which the number of inhabitants reached 2,435,837 (Urban Audit, n.d.).

With Lisbon having the largest/second largest container port in the "Europe's Atlantic coast", it is considered as one of the major economic centers in Europe. Based on the Euromonitor International's Top City Destinations Ranking, it is the sixth most visited city in Southern Europe with its International Airport serving about 13 million passengers per year (Bremner, 2008).

Alfama is a part of Lisbon located in the north of Tejo River, southeast of Castle of São Jorge, and east of Lisbon commercial center, see Fig. 6. It is one of the spaces of Lisbon that has no clearly defined boundaries, identifiable based on living standards, local characteristics, and/or structural morphology. Most references even differ with which civil parishes (freguesias) are included. These ambiguities make it interesting as a study area. With its unique morphology, other distinctive characteristics described below make it appealing to create a QoL assessment. In this case, since it has no clearly defined boundaries, only the two civil parishes São Miguel and Santo Estevão were included in the study, covering most parts of Alfama. The two parishes in this case are assumed to be equivalent to Alfama, and are used simultaneously.

Besides its unique morphology, Alfama is described to have apparently poor housing conditions where nearly 5% of the houses are abandoned such as the picture in Fig. 7. During the great 1755 Lisbon Earthquake, Alfama was not destroyed due to its solid bed rock underground. This is why Alfama is considered as the oldest district of Lisbon. Since Arab domination until present, it is recognized as a home for deprived neighborhood. The graph in Fig. 7 from 2001 statistics shows that 363 buildings in Alfama were already built since 1919.Degradation of houses is insurmountable and further rehabilitation is of great need. At the present, continuous renovation has been on the run for its narrow streets, old houses and buildings. In fact, a rehabilitation planning was started in 1959. The Lisbon City Council initiated the Committee for the Protection and Improvement of Alfama. However, it was only a success after the creation of the Technical Department in the 1980s. Alfama became the priority area for rehabilitation and urban renewal.

The RECRIA – Regime Especial na Recuperaçãoo de Imóveis Arrendados (Special Scheme for the Recovery of Rented Property) was also established in 1988, giving financial aid through the

Instituto de Gestão e Alienação do Património Habitacional do Estado e Câmaras Municipais (Institute for the Management and Sale of Housing belonging to the State and Town and City Councils), for rented houses that need repair and preservation. With the 'Special Protection Plan' created, four main goals were agreed upon: (1) architectural heritage protection (2) social and economic fabric support and expansion by creating proper conditions for habitation and for commercial activities; (3) traditional urban uses protection; and (4) safety conditions definitions (Alves, Sacadura, & Vaz, 1995). The housing quality indicator linked to these rehabilitation programs is examined in the QoL assessment.

With a total area of 254,593.4 m^2 for the two parishes, Alfama caters 3,726 population as of 2009 (Câmara Municipal de Lisboa, n d).According to the 2001 statistical data of Portugal, the female exceeds the male population with a difference of 371. The female is evidently higher than the male population as shown in Fig. 8. With regards to age, the graph is apparently hard to compare since the number of years differs between groups. But assuming that the three age divisions in Fig. 8 represent the young, middle-aged, and old people respectively, it shows that the middle-aged are the highest. The group of old people is also higher than the young people with a difference of 213.

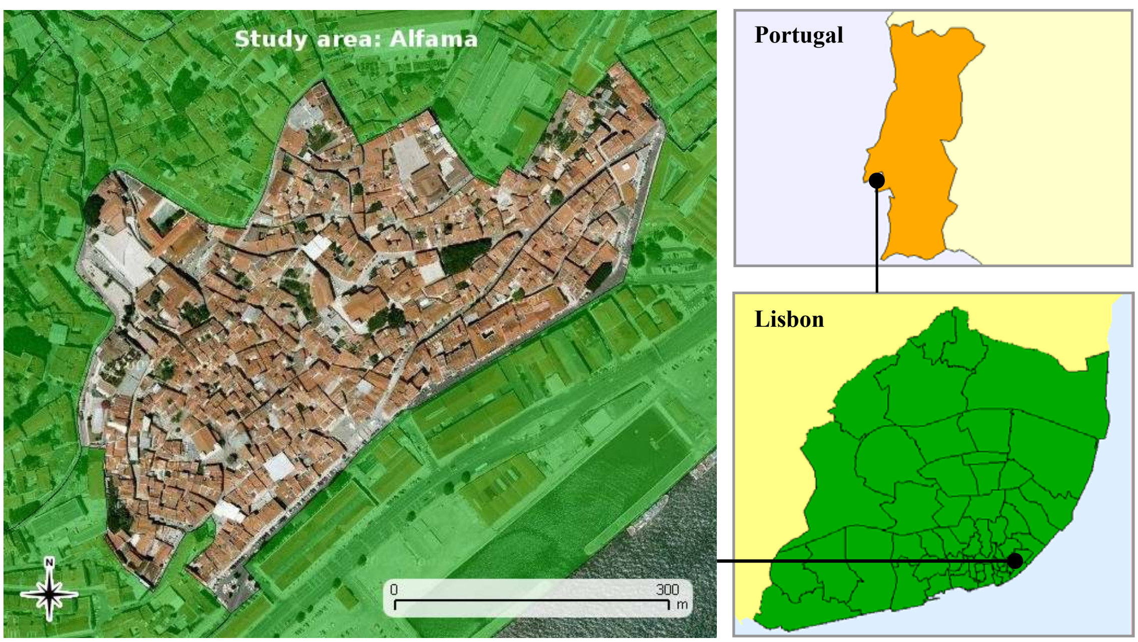


Figure 6. Study area

Fig. 9, which demonstrates the educational attainment of thec residents in 2001 shows that the residents of Alfama are clustering in the left side of the graph, illustrating that 3,188 residents are included in the categories of don't know how to read and write, completed 1º/2 º/3 º cycles of basic education, or secondary education. Only 714 residents are inside the categories from

MEDC (Completed medium course) to COUNI (Studying in the University). This simply shows that the residents of Alfama have poor level of education, which is verified in the study through subjective QoL measures.

Although Alfama as described is comprised of deprived neighborhood, poor housing conditions, and residents with low level of education, it is visited by many tourists and considered as one of the tourist attractions in Lisbon. Several places such as the Miradouro das Portas do Sol and Miradouro de Santa Luzia (viewpoints) in the northwest, and Cathedral Sé de Lisboa in the southwest are found in the area. These attractions together with other social service location points are collected in the fieldwork, see Fig. 11. Notice that in addition to numerous bus and tram stops around Alfama, it is also strategically located close to Santa Apolonia Metro and Train stations found in the northeast, which seem easily accessible for all. On the contrary, Fig. 10 which shows the signal seen before entering the periphery of Alfama, illustrates that the central area is not accessible by vehicles. The effects of this contradicting transport morphology inside and out of Alfama in QoL are analyzed in detail in Chapter 4.

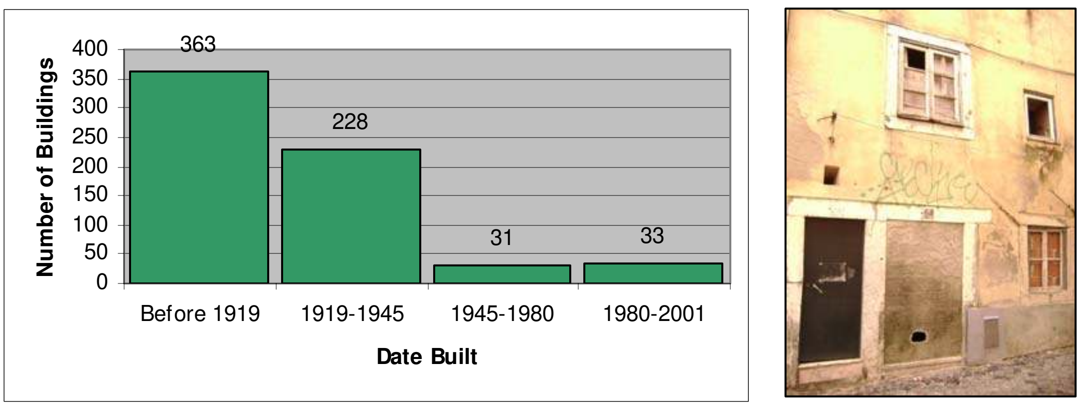


Figure 7. Building ages (INE, 2001) and a picture of an abandoned building

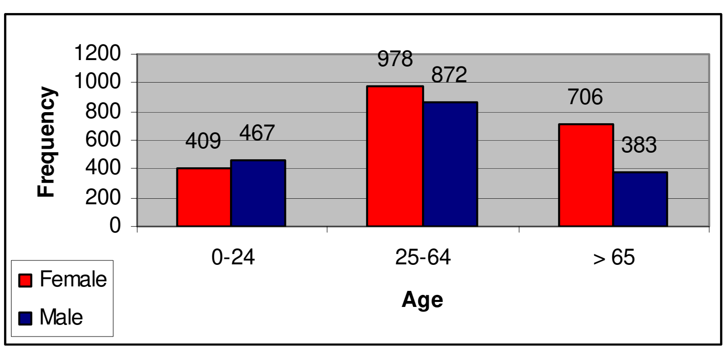
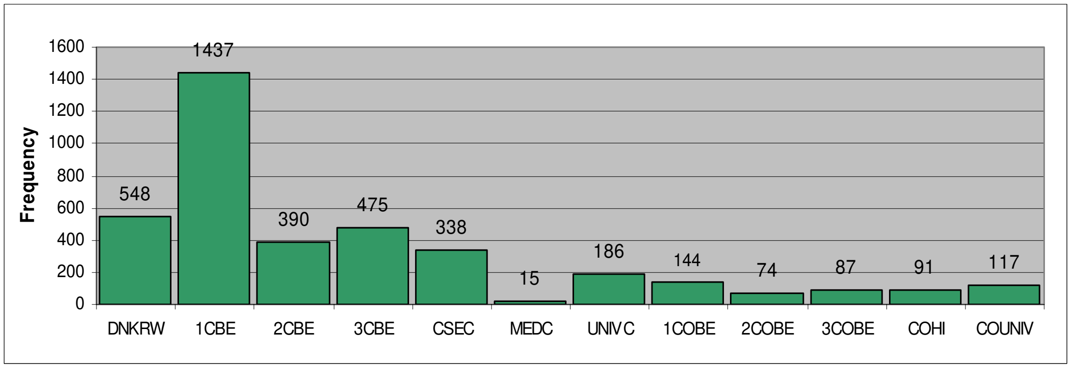


Figure 8. 2001 Population age of Alfama (INE, 2001)

Several museums are also circling around the study area such as Museu Militar in the northeast and Museu do Fado in the center, drawing the attentions of the tourists. Five banks and two hostels are also found in the area.

Another important services present in Alfama are the police station located in the northeast and two small clinics found in the center and in the northeast. Note that the latter is not included in the health care accessibility (indicator) analysis since it only specializes and offers radiography and check-up. Only hospitals that offer long-term patient stays are considered.



DRW – Do not know how to read and write	UNIVC – Completed university course
1CBE – Completed 1º cycle of basic education	1COBE – Studying 1º cycle of basic education
2CBE – Completed 2º cycle of basic education	2COBE – Studying 2º cycle of basic education
3CBE – Completed 3º cycle of basic education	3COBE – Studying 3º cycle of basic education
CSEC – Completed secondary education	COHI – Studying in high school
MEDC – Completed medium course	COUNI – Studying in the University

Figure 9. 2001 Educational attainment in Alfama (INE, 2001)

Figure 10. Alfama road access

As a touristic area, it also caters numerous shops (low and high order shops) and restaurants as shown in Fig. 12. The former consists of shops like souvenir, antiques, shoes and dress shops. The latter on the other hand comprises of various Portuguese restaurants several of them offering Fado music. The statistics of the market and food services collected in the fieldwork are given in Chapter 5.

With its unique urban morphology, touristic environment, and alarming physical, social and economic issues, Alfama is beyond doubt interesting for a QoL assessment. Although a tourist attraction for many, the QoL of the residents in Alfama needs to be evaluated. The effects of these particular characteristics (objective QoL) on the judgments and perceptions of the residents (subjective QoL) towards the QoL in Alfama are investigated.

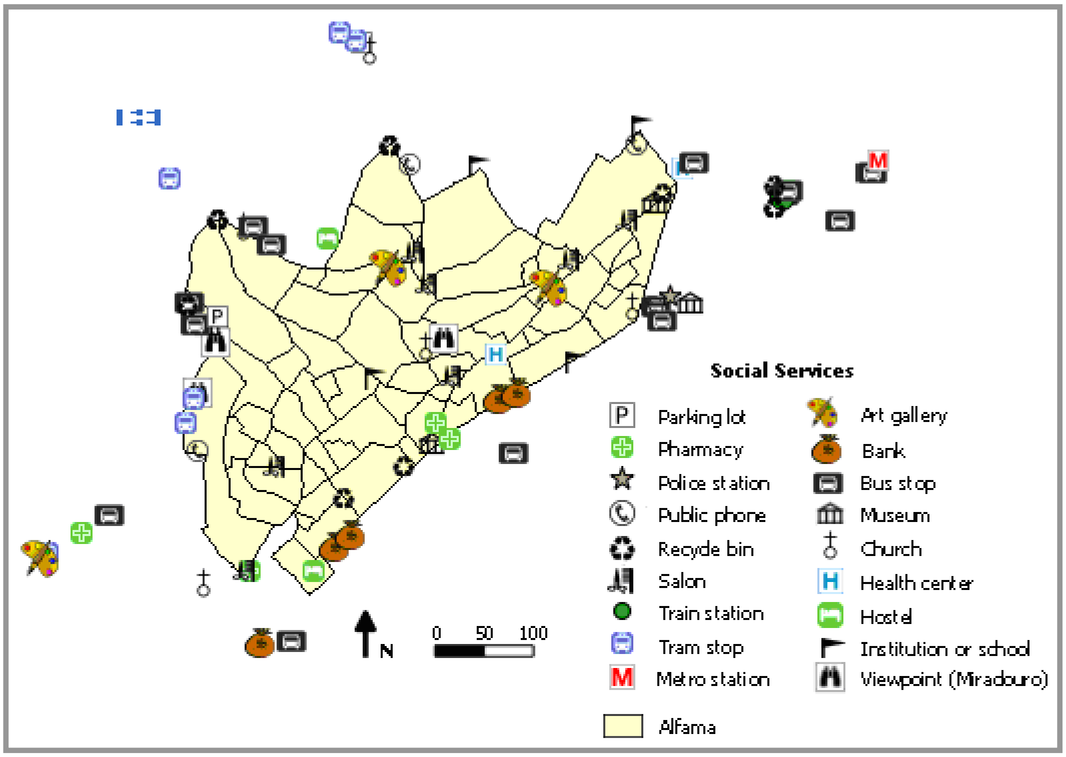


Figure 11. Social services in Alfama

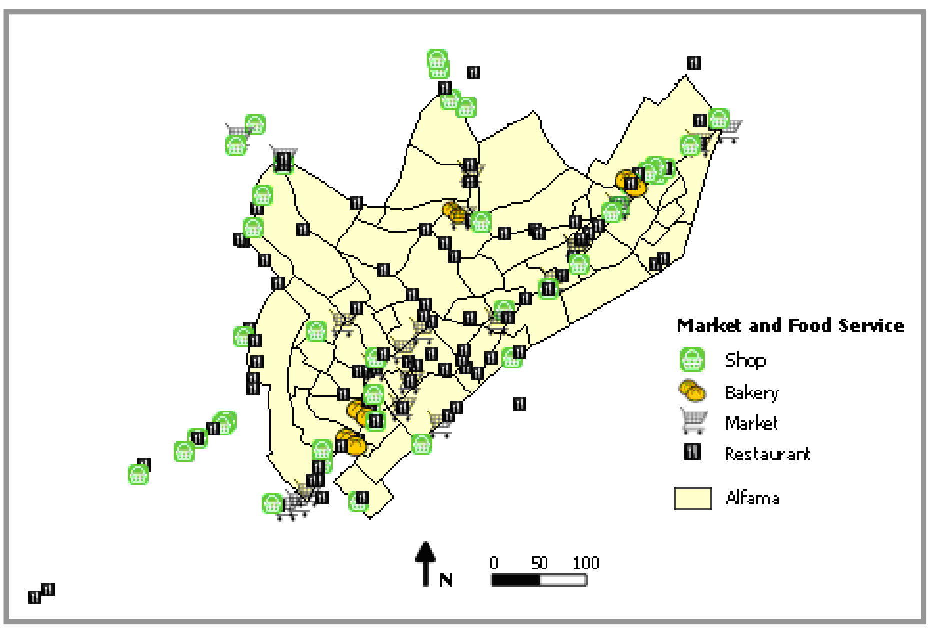


Figure 12. Market and food services in Alfama

4. RESEARCH METHODOLOGY

With the aim to determine the current QoL in Alfama, this chapter discusses the methodology used for the assessment. The chapter is divided into three parts namely input data, spatial prediction, and weighted sum. The first part defines the data collection and the preparation for analysis. The second part, which is the core element of the methodology, discusses the analysis done including the correlation procedure and spatial prediction models used to examine the data to come up with the interpolated maps. The last part on the other hand discusses the method used to create the overall QoL map of Alfama.

4.1. Input data

This section provides the description of how data is collected and prepared for analysis as shown in Fig. 13. It shows that there are two kinds of data collected; the subjective and objective data. The former is provided using resident surveys, which represents the perceptions of the respondents abstracted using Likert scale (Tesfazghi, 2009). The latter on the other hand is supplied using the service location points found in Alfama. It includes locations of health care centers, public transport facilities, recycling bins and many others. This is collected to establish the distances of the respondents' residences from the service locations provided inside and close Alfama representing the objective data. The details of the pre until post fieldwork are further discussed in the following subsections.

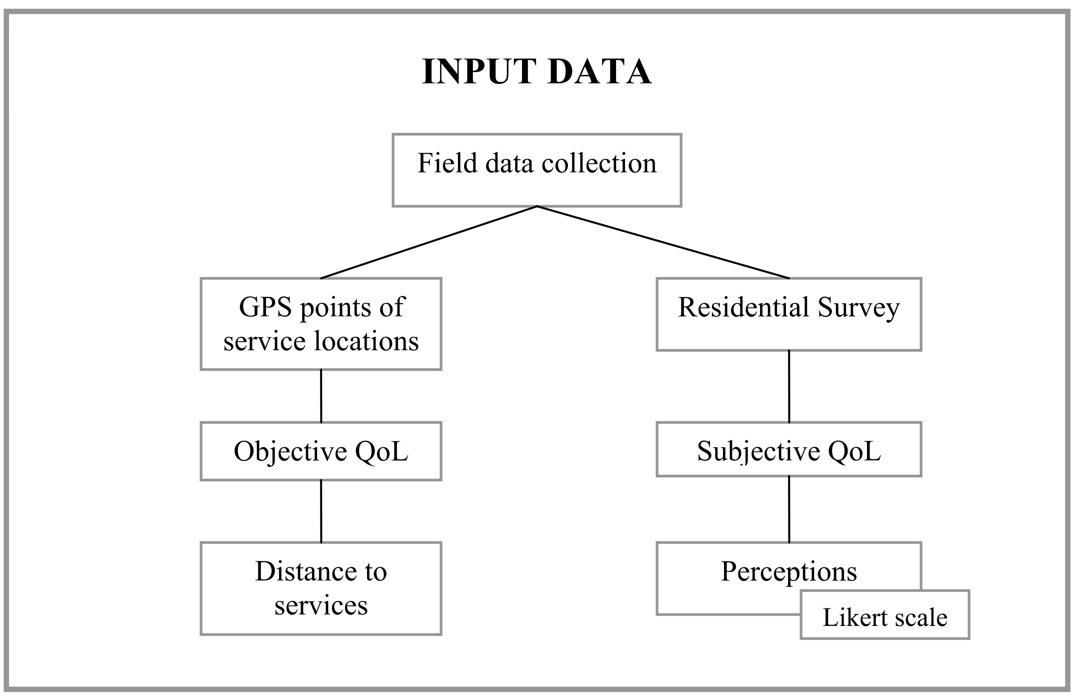


Figure 13. Field data collection and preparation

4.1.1. Pre-Fieldwork

In the fieldwork preparation, a two-page survey questionnaire was set. A base map of the study area was first prepared to put in the survey form, which informed the respondents about the study area extent giving them a quick overview. An extensive research was also done to identify the essential indicators for QoL assessment. Four main domains are finalized namely physical, social, economic, and personal life. Note that even all are considered for correlation analysis; only the first three domains are included in creating the overall QoL since the personal life domain is only used for describing respondents' general QoL perceptions. There were in total 15 indicators considered for analysis from physical, social, and economic domains, see Tables 1, 2, & 3. These indicators and the survey itself are based on the work of (Dashora, 2009)Dashora (2009). See Appendices A & B for the survey questionnaires in Portuguese and English.

Indicator	Definition
Street cleanliness	The hygiene or sanitation in the streets.
Car circulation	The movement or flow of vehicles.
Car parking space	The sufficiency of parking lots.
Green space	The availability of green spaces, with it defined as an urban open space for green spaces like the garden of Miradouro das Portas do Sol.

Table 1. Physical domain

Indicator	Definition
Safety at home	The assurance that no any kind of assault such as robbery will occur at home.
Safety at streets	The assurance that no any kind of assault such as robbery will occur at streets.
Health care center accessibility	The ease of access to health care centers with it only referring to hospitals offering long-term patient stays.
Supermarket accessibility	The ease of access to supermarket (defined in Table 5).
Public transport facilities accessibility	The ease of access to public transport facilities (defined in Table 5).
Recreational center accessibility	The ease of access to recreational/cultural centers (defined in Table 5).
Recycling bin accessibility	The ease of access to recycling bins (defined in Table 5).
Neighborhood interactions	The interactions and/or communications within the neighborhood.

Table 2. Social domain

Indicator	Definition
Level of education	The general educational attainment of the residents
Affordability of housing cost	The housing cost in relation to family income of the residents
Housing quality	The physical condition of houses.

Table 3. Economic domain

Indicator	Definition
Level of happiness	The degree of happiness of living in Alfama
Level of trust	The degree of trust with the neighborhood
Feeling of inclusion	The feeling of belonging in Alfama; the feeling of not being secluded
Overall satisfaction	The overall level of satisfaction of living in Alfama

Table 4. Personal life domain

The questions are constructed in a five-point Likert scale (Tesfazghi, 2009) to measure their QoL perceptions from extremely poor to excellent. The column of scale of priority is added to determine the relative importance of all the indicators in each domain (physical, social and economic) and for each domain itself. This provided the weightings used in mapping the overall QoL in Alfama.

Personal information is asked at the beginning of survey for descriptive purposes, say their number of years of residence in Alfama and if they have consistent interactions with their neighbors. Note that the latter is very crucial to discern as suggested by Sastry et al. (2002). People who interact and who aren't would certainly differ in QoL perceptions.

A question regarding the rating of their current QoL in Alfama is asked at the beginning and at the end of the survey to determine answer consistencies. Responses at the start state their intuitive QoL rating, and at the end their more coherent and well-thought rating of QoL since the latter is answered after knowing the considered indicators in the study. These two questions are based on the work of Seik (2000).Questions about their personal life indicators defined in Table 4 are also provided in the last section of the survey, tailored from Jamieson (2007).

The questionnaire is prepared both in English and Portuguese to accommodate local and foreign people living in Alfama. There were several revisions made to ensure the clarity and simplicity of the questions, pre-tested by my advisers and a group of people. This helped identify parts that are not straightforward.

The HP iPAQ hw6910 device which includes the ArcPad application is used for GPS purposes. The base map is uploaded in ArcPad including the administrative and road data. This is used in determining the locations of the respondents and service locations in Alfama. Additional Portuguese documents were also prepared to further clarify the questions in the survey.

Only a target of 75 respondents is pursued since time is limited. A stratified random sampling was first planned to which the number of respondents is stratified based on the length of the streets. However, due to difficulties finding people to answer the questionnaire in this scheme, sampling the first 75 people willing to answer the questionnaire is done. This is further discussed in 4.1.2.

4.1.2. Fieldwork

A total of 75 residents in Alfama responded to the survey. But due to some missing answers, only 69 are considered. People walking on the streets of Alfama are asked if they live there and have time to answer a survey. Due to the previous plan of using a stratified random sampling, a random knocking on the doors for each street was done at the beginning of fieldwork. But due to the failure of having at least five respondents in one day, a different strategy was used giving at least 7 respondents a day. People walking on the streets especially those going and coming out of work were targeted, done by staying and waiting in the three most visited parts of Alfama. One is close to the tram stop in Miradouro das Portas do Sol. Another in the open space in front of Museu do Fado and the last one close to Museu Militar and Santa Apolónia Metro station, see descriptions of Fig. 11. The survey was entirely done by the author itself except for one day where one interviewer is employed. With the respondents' consents, their residences were also located and stored in GPS. The survey almost took a month to finish, from the last week of October until the third week of November 2010, excluding rainy days.

For the collection of service location points in and close Alfama, every street was visited and points of interests were collected. The data gathering took one week to finish in the last week of November 2010. There were in total 310 service points gathered.

4.1.3. Post-Fieldwork

The data collected during the fieldwork were entered in the computer. The GPS survey points (locations of respondents' residences) are used to input and store the answers for each respondent. These answers are represented in the spatial attribute data by numbers, done using the open-source software QuantumGIS. Accuracy check is done to verify that correct data is entered. The weightings (scale of priority) acquired also in the survey are normalized to make a common scale for each indicator and domain of QoL. All the weightings are given in Chapter 5.

The collected service points were grouped into 11 objective inicators, defined in Table 5. Statistics and maps of these collected service points are shown in Chapter 5.

Indicator	Definition
Recycling bin	A container for recyclable materials.
Parking lot	A vacant lot for parking cars.
Police station	An edifice for police officers.
Recreational center	A place that promotes at least one of the following: culture, arts, sports, social interaction, entertainment, leisure, and fun. This includes for an instance art gallery, museum, cinema, theatre, commercial center, sports center, internet point and swimming pool.
Supermarket	A big market place to buy particularly food items and other necessities.
Urban open space	An open space for green spaces, playground, park or simply just a square in the case of Alfama.
Main street	Includes Rua dos Remedios, Largo do Museu de Artilharia, Rua do Jardim do Tabaco, Largo do Chafariz de Dentro, Rua do Terreiro do Trigo, and Largo do Terreiro do Trigo.
Public transport facilities	Specifically pertains only to transport stops where the public can access the tram, bus, metro and train.
Restaurant	A place where foods are served in return for money.
Institution	Pertaining to an educational institution for preschool, primary, secondary and higher.
High and low order shop	Shops for all expensive and cheap, often and rarely bought goods.

Table 5. Objective indicators

The distance matrix tool is used to determine the nearest distances of each indicator for each survey point. This is the final objective data which is tested for correlation with the subjective data in the subsequent subsection.

4.2. Spatial Prediction

The prepared objective and subjective datasets were used to create the spatial prediction maps. This is done using the decision tree from Hengl (2009), see Fig. 14. Each part is discussed in detail in the succeeding subsections except the methods on the right part of Fig. 14 since no significant correlations are found.

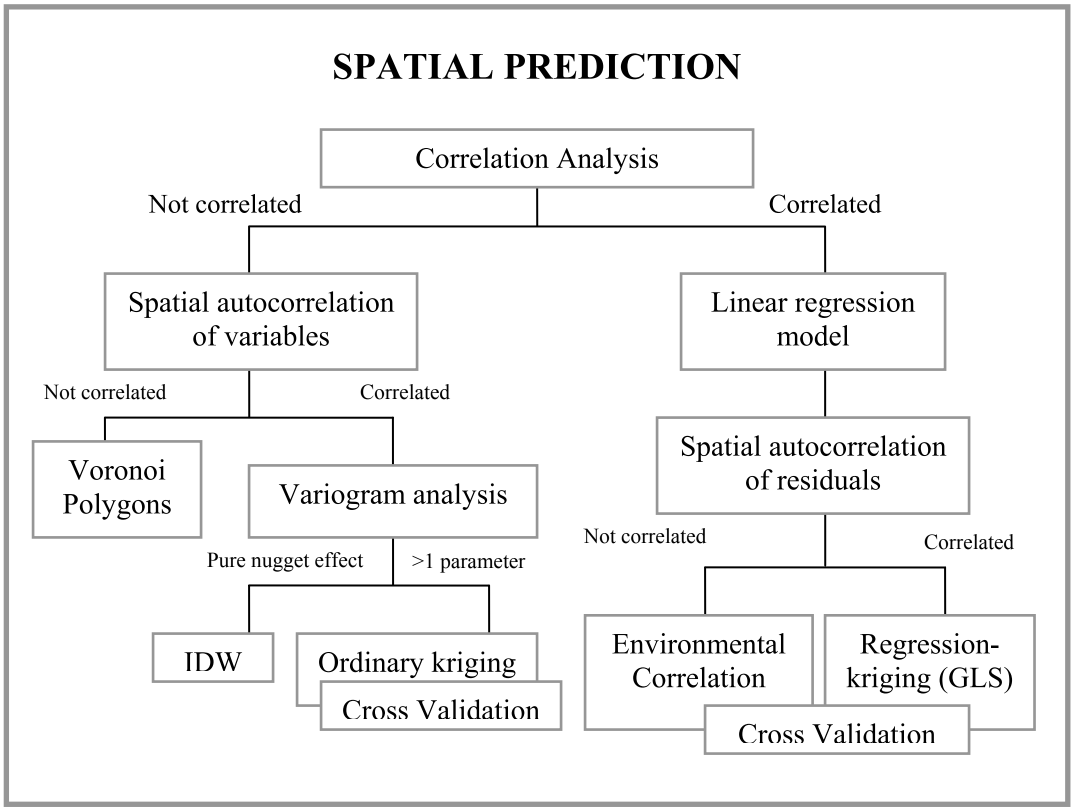


Figure 14. Analysis part of the methodology (Hengl, 2009)

Note that all statistical procedures in Fig. 14 are carried out using R, and all mapping processes in QuantumGIS. All R functions used are indicated in this chapter but for the commands, refer to R Help files. The formulas however which all these commands follow are discussed in the succeeding subsections.

4.2.1. Correlation Analysis

A test of correlation is performed in the pursuit to interpolate QoL, defined as the degree of relationship between two or more variables and represented using the correlation coefficient, i.e., a number that identifies the association between variables.

Because there are numerous variables considered, and the correlation is yet known, the two-tailed test is used. The direction of the correlation is discerned after the analysis.

Two different kinds of correlation coefficients are used in the study. These are the Spearman's rho and the Polyserial correlation. The former is a much known method in identifying correlation or dependence. It ranks first the data and then performs the Pearson correlation of the rank of the data (Reimann et al., 2008). It is good to use when dealing with ordinal data with outliers. If you are simply interested in correlation, Spearman rho is a safe way to go (E. Pebesma, personal communication, January 15, 2010). This is used to do inter-correlation between subjective indicators since all of them are ordinal. The latter on the other hand is best for correlating a continuous variable with an ordinal one. According to Uebersax (2006), polyserial correlation is used when a certain degree of precision is needed. Although the Spearman's rho is a non-parametric statistical method that can also be used to correlate continuous and ordinal variables, it is only used to correlate between ordinal variables. In this case, the continuous variable is the objective data since it deals with distance. The subjective data on the other hand represents the ordinal variable since it is only the perceptions denoted in a five-point Likert scale. Since both are continuous and ordinal, the Polyserial correlation is used. Polyserial gives more precision with the correlation values compared to Spearman's rho, which has a lower power.

Spearman's rho is computed using the R function *cor*. This function follows the formula in Eq. 1, taken from Paler-Calmorin & Calmorin (1997):

$$r_s = 1 - \frac{6\Sigma D^2}{N^3 - N} \qquad (1)$$

where:

r_s = Spearman's rho

D^2 = Sum of the squared differences between ranks

N = Number of cases

The Polyserial correlation on the other hand is done using the R function *polyserial*. Parameters like the maximum likelihood estimator is used in computing the Polyserial correlation coefficient, which is solved using nonlinear equation system derived from Olsson et al. (1982). The function used also generates P-values that tell the bivariate normality of the variables. Since the study is dealing both with continuous and ordinal variables, the latter is treated to be numeric and both are assumed to be bivariate normal.

Significance testing is also performed to determine if correlations are statistically significant; that it occurs not by chance. The following premises are used for the hypothesis testing:

Null hypothesis: There is no linear relationship between objective and subjective indicators.

Alternative hypothesis: There is relationship between objective and subjective indicators.

The P-value is generated to determine the significance. With a significance level (α-level) set to 0.05, a p-value lower than this means the rejection of the null hypothesis. This would mean that there is a significant correlation between objective and subjective indicators based on the data. Otherwise, the null hypothesis is not rejected.

Since no significant correlations were found as discussed previously, the variables were tested for spatial autocorrelation. Otherwise, if there are significant correlations, a multiple linear regression model is fitted using a dependent variable (subjective indicator) and two or more independent variables (objective indicators). The residuals are taken from the difference between the sample and the estimated function value and are tested for spatial autocorrelation. If a significant spatial autocorrelation is obtained, a Regression-Kriging is used for interpolation. Otherwise, an Ordinary Least Squares (OLS) is used. But since no significant correlations were obtained, the study proceeded to Moran's I spatial autocorrelation test, which is discussed in the next subsection.

4.2.2. Moran's I test for uncorrelated variables

"Spatial autocorrelation is concerned with patterns in the values recorded at locations, as opposed to patterns in the locations *per se* (Upton & Fingleton, 1985)."

Since no correlations between variables were found, measures of correlations of variables in space are acquired, called spatial autocorrelation. As what Tobler stated in his First Law of Geography, "everything is related to everything else, but near things are more related than distant things".

This test is needed to proceed to interpolation. Moran's I, which gives a number that measures the correspondence of an outcome variable to spatially related areas, is applied (Pfeiffer et al., 2008).

Moran's I is calculated using the function *moran.test*. This function follows Eq. 2 taken from Bivand et al. (2008):

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2}, \qquad (2)$$

Moran's I is computed as a proportion of the product of the variable and its spatial lag, cross-product of this variable, and with the spatial weights employed for adjustment (Bivand et al., 2008). The formula consists of y_i which is the *i*th observation, $\bar{y}$ which is the mean of the variable of interest, and w_{ij} which *is* the spatial weight of the link between *i* and *j*.

For the variables that are spatially autocorrelated, the Ordinary Kriging (OK) is used for interpolation. Otherwise, the Voronoi polygon is used. Interpolation methods are discussed in the subsequent subsections.

4.2.3. Ordinary kriging

Once proven to have spatial autocorrelation, the Ordinary Kriging (OK) is used to create the spatial prediction map. Since a variogram model is needed for this, a sample variogram is created, using the R function *variogram*. Note that a sample variogram is an estimate of the variogram using the N_h sample data pairs z(si), $z(s_i + h)$ for a number of distances h_j by Eq. 3 (Bivand et al., 2008).

$$\hat{\gamma}(\tilde{h}_j) = \frac{1}{2N_h}\sum_{i=1}^{N_h}(Z(s_i) - Z(s_i + h))^2, \quad \forall h \in \tilde{h}_j \tag{3}$$

Once satisfied with the sample variogram, the variogram is created by fitting a parametric model to it (Bivand et al., 2008). It circles around the values of range, sill, and nugget. The range and the sill are simply the horizontal and the vertical extent of the model respectively, while the nugget is usually defined as the measurement error (Bivand et al., 2008). The variogram is fitted to the sample variogram using the R function *fit.variogram*.

There are two types of result that can be acquired in variogram modeling. One is with a pure nugget effect and another with parameters >1. The former means that there is completely no spatial autocorrelation and that only a mechanical interpolator such as Inverse Distance Weighting (IDW) can be used for interpolation. But since this product is not acquired, this is not used in the study. The latter on the other hand means a variogram with a non-random behavior trend used for Ordinary Kriging (OK) interpolations.

OK assumes an unknown constant trend and a known variogram, assuming the mean and covariance stationarity and a normal distribution of values. It is based on the model (Eq. 4):

$$Z(\mathbf{s}) = \mu + \varepsilon'(\mathbf{s}) \tag{4}$$

where μ is the constant stationary function (global mean) and ε'(s) is the spatially correlated stochastic part of variation (Hengl, 2009). With Eq. 9 as the base model, the prediction is done using Eq. 5:

$$\hat{z}_{\mathrm{OK}}(\mathbf{s}_0) = \sum_{i=1}^{n} w_i(\mathbf{s}_0) \cdot z(\mathbf{s}_i) = \boldsymbol{\lambda}_0^{\mathrm{T}} \cdot \mathbf{z} \tag{5}$$

where w_i is the kriging weights, λ_0 is the vector of w_i, and **z** is the vector of *n* observations at primary locations (Hengl, 2009).

OK is performed by the R function *krige*. Note that the formula used in the command is variable ~ 1, where 1 defines a single constant predictor, leading to a spatially constant mean coefficient (Hengl, 2009).

The resulting OK interpolated image is exported to an ASCII raster file and imported in GRASS environment for weighted sum process preparation. The FWTools Shell is also used to translate the image since coordinate system/projection issues occurred. This made the images compatible and overlay-able with other indicator prediction maps.

4.2.3.1. Cross-validation

Checking the quality of maps is usually done by generating the mean prediction error (ME), and the root mean square prediction error (RMSE). But since it requires gathering additional samples and no time is allotted for this, a cross-validation is then used for the OK results. It works by producing two sets from dividing the data set consisting of the modeling set and validation set. The former is used for variogram modeling and kriging on the locations of the validation set, and the validation measurements are compared to their predictions (Bivand et al., 2008).

There are three types of cross-validation methods namely, k-fold, leave-one-out, and Jackknifing. In this case, the leave-one-out (LOO) is utilized. This is a type of cross-validation which uses each sampling point to determine the accuracy of the prediction. Each sampling point is evaluated against the whole data set (Hengl, 2009). If the cross-validation residuals are small, and the mean is close to zero and no evident structure (Bivand et al., 2008), then it means the prediction performed is relatively accurate.

Cross-validation is done using the R function *krige.cv,* to which z-score of validation is obtained. The z-score is calculated using Eq. 6 (Bivand et a., 2008):

$$z_i = \frac{Z(s_i) - \hat{Z}_{[i]}(s_i)}{\sigma_{[i]}(s_i)} \tag{6}$$

where:

$\hat{Z}_{[i]}(s_i)$ = cross validation prediction for s_i

$\sigma_{[i]}(s_i)$ = kriging standard error.

Bivand et al. (2008) noted that compared to the standard residuals, the z-score takes the kriging variance into account: that is, a standardized residual. Then if the variogram model is correct it will show a z-score with mean and variance values close to 0 and 1 respectively.

4.2.4. Voronoi polygons

The Voronoi polygon is used for variables found to have no correlation and spatial autocorrelation. Although Hengl (2009) stated that determining the global mean for the study area is statistically acceptable, a voronoi polygon can also be applied, as suggested by Costa (verbal communication, December 14, 2010) since it doesn't take into account neighborhood values unlike methods such as kriging.

A voronoi polygon is created using the voronoi diagram. This diagram is explained by Okabe et al., 1992) as locations associated in space with the closest of the point set according to the Euclidean distance, resulting to a plane's voronoi digram into the areas related with components of the point set (Okabe et al., 1992). The areas comprising the voronoi diagram then is the voronoi polygon.

In mathematical terms, say p_i is the nearest point from p or vice versa, thus the relation between them can be defined by Eq. 7 (Okabe et al., 1992):

$$V(p_i) = \{x|\ \|x - x_i\| \leq \|x - x_j\| \text{ for } j \neq I, j \in I_n\} \quad (7)$$

where:

n = finite number of points in the Euclidean plane, assumed to be $2 \leq n < \infty$

p = n points to which the Euclidean distance from p to p_i is given by

$d(p, p_i) = \|x - x_i\| = \sqrt{[(x_1 - xi_1)^2 + (x_i - x_{i2})^2]}$

x = Cartesian coordinates or (location vectors)

The resulting area for Eq. 8 is the voronoi polygon associated with p_i. The Voronoi diagram then created by p is given by (Okabe et al., 1992):

$$\mathcal{V} = \{V(p_i), \ldots, V(p_n)\} \quad (8)$$

A total of 12 raster files are created for all indicators except the 3 indicators where kriging method is used.

4.3. Weighted Sum

Using the spatial prediction maps for all QoL indicators as inputs, four maps are produced. The three maps correspond to the three main domains considered, which are the Physical, Economic, and Social indicators. The other is the Overall Quality of Life map. Below in Fig. 15 is the generalized framework.

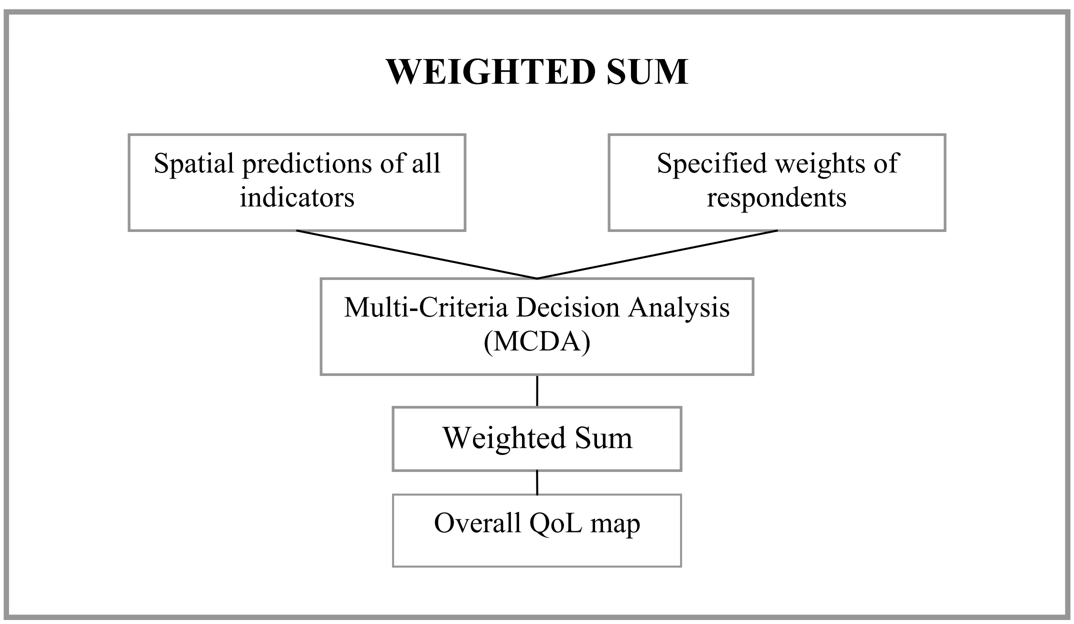


Figure 15. Multi-criteria decision analysis

The Multi-Criteria Decision Analysis (MCDA) method called Weighted Sum is used for the four maps. Weighted sum is a way to transform the variables relative to its importance, by using 'weights' that are scaled, see Eq. 9 taken from Kim & de Weck (2005):

$$J_{\text{weighted sum}} = w_1 J_1 + w_2 J_2 + \cdots + w_m J_m \tag{9}$$

where:

w_i (i = 1, …, m) = weighting factor for the *i*th objective function

J = variables

The weights are acquired from the survey in which a column is allocated for the scale of priority of respondents. It corresponds to the relative importance of the indicators within a domain, and also for each domain within the overall QoL. These weights are then normalized to get a sum of 1 for each domain and for the overall indicators.

5. RESULTS

This chapter is divided into three parts: the results from the survey, interpolation, and the weighted sum. First are results from the survey, which show the statistics and characteristics of respondents, as well as the service point locations. Next is the result from interpolation, which shows the maps for each indicator, and the last is the results from the weighted sum, which shows the maps for each domain and for overall QoL.

5.1. Survey statistics

5.1.1. Respondents' characteristics

A total of 75 sample surveys are collected in the fieldwork. But due to missing answers, only 69 are considered. Below in Fig. 16 is the map of Alfama with the distribution and location of respondent survey points.

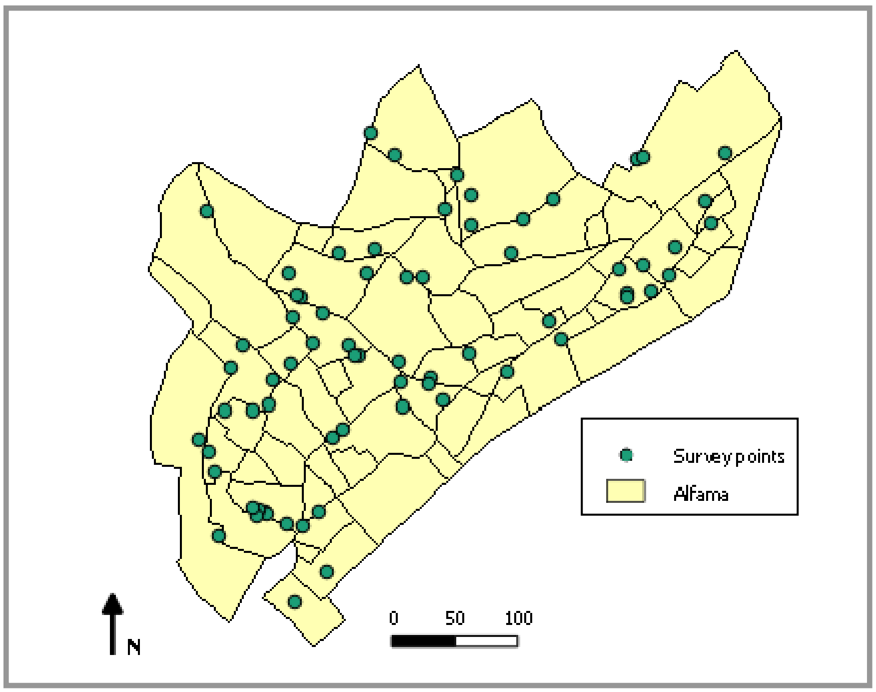


Figure 16. Respondent survey points in Alfama

The survey points are roughly well-distributed except in the border, commercial and touristic areas like the "Miradouro" in the northwestern part and the industrial places in the southeastern boundary. Below in Fig. 17 is the frequency of respondents by age and gender.

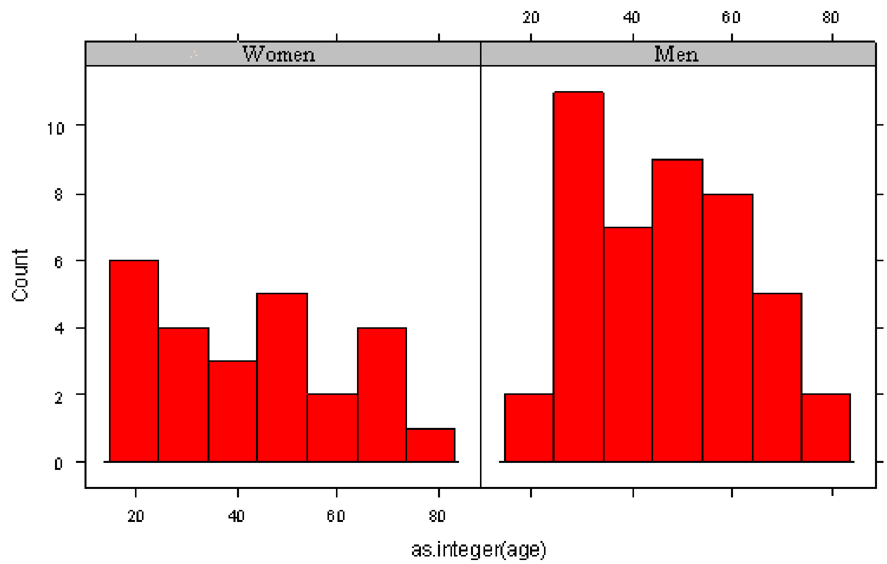


Figure 17. Age vs. gender

There are 25 females and 44 males. The highest percentage of females comes from the age of 15 to 25 and the lowest from the age of late 60's. The males on the other hand have highest percentages on the age of 26 to 35, and 46 to 55.

Table 6 shows the respondents' characteristics with its frequencies. The Profession column shows the line of work of respondents categorized according to the class provided by the Instituto Nacional Estatistica (INE) of Portugal. Notice that most of respondents are under the categories 'Clerks and related workers' and 'Retired'. It is observed that the population of Alfama is comparatively old, which is confirmed based on the 2001 statistics as described in Chapter 3.

The survey required that respondents should have lived in Alfama at least for one year. Table 6 shows that most respondents have lived from the range of 1-10, 21-30, and 60-75 years. This illustrates that they spent mostly half of their lives in the area.

Table 6 also shows that more than half of the respondents only finished elementary and secondary level of education. Considering the fact that most of the respondents ranged from 20-55 of age, the educational attainment acquired in Alfama is very low.

Table 6 also shows the household size, number of residents with family cars, and people with neighborhood interactions. Notice how good the interactions are with 55 out of 69 respondents saying they have good neighborhood interactions.

Description	Frequency
Profession	
Armed Forces	1
Senior government officials, corporate and general managers	3
Professionals and scientists	6
Technicians and associate professionals	2
Clerks and related workers	23
Service workers and shop and market sales workers	4
Skilled agricultural and fishery workers	0
Craft and related trades workers	4
Plant and machine operators and assemblers	1
Elementary occupations	1
Retired	16
Student	3
Unemployed	5
Educational Attainment	
Did not study	2
Elementary	19
Secondary	29
Bachelor	8
Licensure	8
Master	3
Doctoral	0
Number of Years Living	
1-10 years	25
11-20 years	8
21-30 years	10
31-40 years	5
41-50 years	7
51-60 years	4
60-75 years	11
Household Size	
1 - 2 persons	39
3 - 4 persons	27
5 - 7 persons	3
Family Car Owner	
Yes	39
No	30
People with Neighborhood Interactions	
Yes	55
No	14

Table 6. Respondents' characteristics

5.1.2. Service location points

Fig. 18 shows the locations of 310 service points collected within and close Alfama. With only the services within Alfama, it already has 15 markets, 85 restaurants, 4 bus and tram stops, 24 high and low-order shops, 3 museums, and other services. Table 7 shows a list of services found within Alfama.

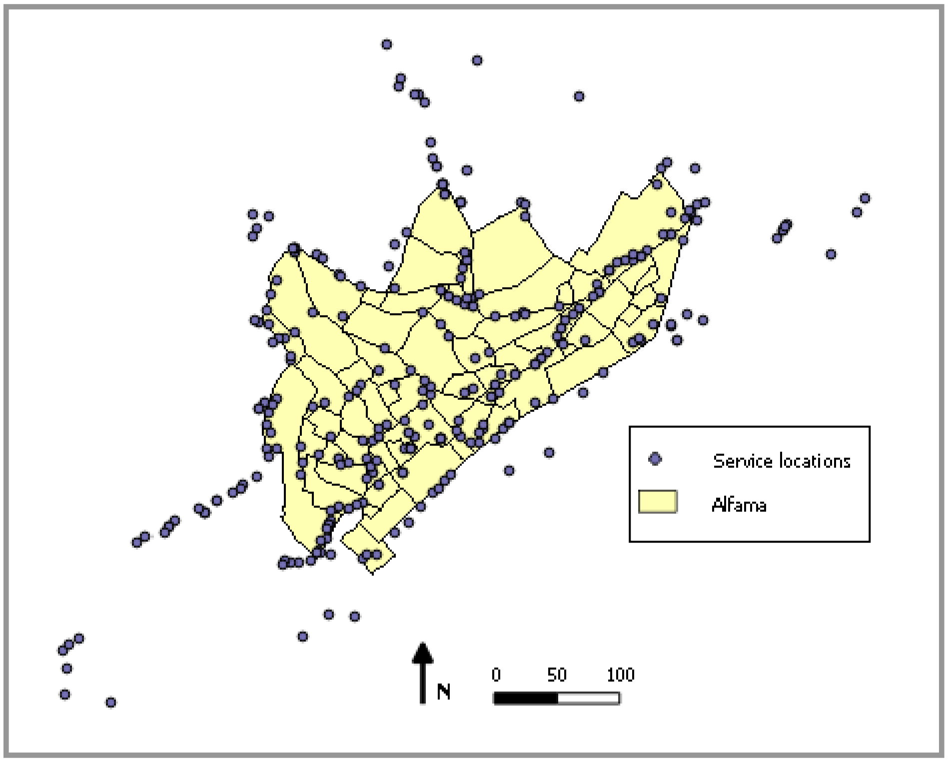


Figure 18. Service locations in Alfama

Table 7 illustrates how touristic Alfama is, full of restaurants with its very own 'Fado' performances, museums to visit, must-go viewpoints (miradouros), and old churches to see. Although an advantage, it hides the fact that the people inside Alfama is said to be suffering from poverty with 58.6% of the residents having no economic activities, based on 2001 statistics.

Services	Frequency	Services	Frequency
Urban open space	9	Phone booths	2
Pharmacy	1	Shower place	1
Bakeries	4	Hostel	1
Markets	15	Drinking fountains	4
Restaurants	85	Salon	7
Bus stops	2	Recycling bins	2
Tram stops	2	Museums	3
High and low order shops	24	Laundry shop	1
Internet café	1	Art Galleries	2
Government offices	3	Churches	2
Police station	1	Recreational centers	2
Bank	1	Sports centers	2

Table 7. Services within Alfama

5.2. Interpolation results

5.2.1. Correlation

The Tables 8, 9 and 10 below show the results for Polyserial correlation. Note that most of the correlations interesting to find here are negative correlations. For an instance, we want that the closer (smaller distance) the health care centers, the higher the accessibility perceptions of the residents there. But with a 95% confidence level, no correlations were considered for interpolation since the p-value exceeded the 0.05 significance level. Although an exception is the correlation between the variables transport stops with the parking lot, which has a 0.010 p-value. But in this case, it is assumed random since a positive correlation between them does not makes sense. Remember that choosing the correlations is somehow subjective and is valid on the part of the researcher because random correlations can happen.

The test of Bivariate Normality and Spearman's rho correlation results are in the Appendices Tables 18-23. For the Bivariate Normality test, it illustrates that only 20% of the correlation results are bivariate normal. 80% of it exceeds the p-value 0.05, which can be caused of ordinal data assumed to be numeric. Nevertheless, all are considered bivariate normal for the polyserial correlation test.

For the Spearman's rho results, which are used to correlate among subjective variables, Table 18 shows comparatively strong correlation coefficients. The highlighted rows are variables correlated at least by 0.40 up. Notice that in particular, the personal life domain gives more than 0.70 correlation coefficients.

Objective	**Subjective**					
Distance from a nearest service	Level of education		Affordability of housing cost		Housing quality	
	Rho	P-value	Rho	P-value	Rho	P-value
Recycling bins	<0.00	0.129	0.23	0.120	-0.06	0.130
Parking lots	0.04	0.130	0.02	0.128	-0.03	0.130
Police stations	-0.13	0.128	0.14	0.125	-0.04	0.130
Recreational centers	-0.07	0.129	0.03	0.127	0.05	0.130
Markets	0.06	0.130	-0.03	0.127	0.22	0.122
Urban open spaces	-0.10	0.127	-0.14	0.124	-0.07	0.129
Main streets	0.08	0.128	0.08	0.127	0.12	0.128
Public transport facilities	0.23	0.122	0.04	0.127	0.22	0.123
Restaurants	-0.12	0.128	-0.17	0.123	-0.06	0.129
Institutions	-0.12	0.127	-0.03	0.128	-0.01	0.130
High and low order shops	-0.01	0.131	-0.05	0.127	0.21	0.122

Table 8. Polyserial correlation of economic indicators

Objective	**Subjective**							
Distance from a nearest service	Street cleanliness		Car circulation		Parking space		Green Space	
	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value
Recycling bins	0.06	0.128	0.09	0.126	0.04	0.128	-0.05	0.130
Parking lots	-0.04	0.128	0.08	0.129	<-0.0	0.130	<0.0	0.131
Police stations	0.10	0.126	0.02	0.131	0.01	0.129	0.06	0.128
Recreational centers	0.05	0.127	0.26	0.119	0.07	0.127	0.05	0.127
Markets	0.18	0.123	0.16	0.125	-0.13	0.125	<0.0	0.129
Urban open spaces	0.10	0.126	-0.02	0.128	0.02	0.127	0.09	0.128
Main streets	-0.02	0.128	0.23	0.119	-0.02	0.128	-0.10	0.130
Public transport facilities	-0.03	0.127	-0.16	0.124	-0.10	0.126	-0.10	0.128
Restaurants	0.13	0.125	0.20	0.12	-0.26	0.118	0.09	0.128
Institutions	-0.01	0.128	-0.16	0.124	0.04	0.128	0.33	0.112
High and low order shops	0.07	0.127	-0.07	0.126	-0.12	0.124	-0.02	0.129

Table 9. Polyserial correlation of physical indicators

Objective	**Subjective**															
Distance from a nearest service	Safety				Accessibility										Neighbor-hood interactions	
	Home		Streets		Health care center		Supermarket		Transport stops		Recreational center		Recycling bin			
	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value
Recycling bins	-0.02	0.130	0.13	0.127	-0.10	0.127	0.10	0.126	0.47	0.096	0.17	0.123	0.22	0.120	0.08	0.127
Parking lots	0.15	0.127	0.25	0.12	0.08	0.127	0.15	0.124	0.45	0.010	0.22	0.119	0.10	0.125	0.07	0.127
Police stations	0.09	0.129	-0.18	0.124	-0.12	0.126	-0.06	0.127	-0.18	0.125	-0.05	0.127	-0.01	0.127	0.05	0.127
Recreational centers	0.19	0.124	0.12	0.127	0.10	0.128	0.02	0.129	0.22	0.121	0.27	0.117	0.25	0.117	-0.04	0.128
Markets	-0.16	0.127	-0.14	0.126	0.03	0.129	0.30	0.115	<0.00	0.129	0.22	0.121	0.02	0.127	0.09	0.127
Urban open spaces	-0.07	0.129	-0.05	0.129	-0.10	0.127	-0.01	0.128	-0.30	0.115	-0.07	0.126	0.06	0.126	0.03	0.130
Main streets	0.11	0.128	-0.04	0.129	-0.13	0.126	-0.09	0.127	-0.13	0.127	-0.13	0.124	0.07	0.126	-0.11	0.126
Public transport facilities	0.29	0.117	0.19	0.122	0.02	0.129	0.07	0.127	0.13	0.127	0.04	0.129	0.30	0.114	-0.10	0.126
Restaurants	-0.16	0.127	-0.17	0.125	<0.00	0.128	0.20	0.123	0.03	0.129	0.25	0.117	0.03	0.127	0.07	0.127
Institutions	0.18	0.126	0.11	0.127	0.07	0.128	0.10	0.126	-0.05	0.128	0.24	0.120	-0.10	0.126	0.07	0.128
High and low order shops	-0.25	0.121	-0.21	0.123	-0.09	0.127	0.05	0.128	-0.21	0.122	-0.15	0.125	0.05	0.126	-0.05	0.128

Table 10. Polyserial correlation of social indicators

5.2.2. Moran’s I results

Table 11 shows the Moran’s I results for the 15 indicators. The highlighted rows illustrate the variables that met the 0.05 significance level set for spatial autocorrelation. These indicators are the variables safety at home with 0.00565, public transport facilities with 0.004544, and recycling accessibilities with 0.002270 p-values. Remember that these three spatially autocorrelated variables are interpolated using Ordinary Kriging. The rest is interpolated using the Voronoi polygon.

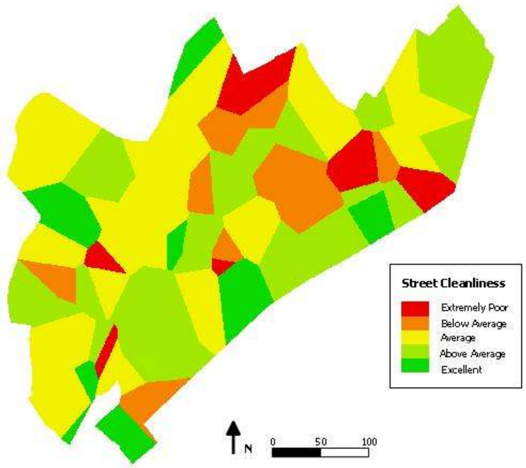
Subjective Indicator	Moran's Index	P-value
Street cleanliness	-0.075618	0.453490
Car Circulation	0.084046	0.226065
Parking Space	0.040147	0.500866
Green Space	0.029617	0.584764
Safety at Home	0.209053	0.005651
Safety at Streets	0.107389	0.134920
Health Care center Accessibility	-0.082397	0.405184
Supermarket Accessibility	-0.056243	0.608571
Public Transport Facilities Accessibility	0.215310	0.004544
Recreational Center Accessibility	0.027370	0.606232
Recycling Bin Accessibility	0.234164	0.002270
Neighborhood Interaction	-0.084477	0.388314
Level of Education	0.020318	0.664140
Affordability of Housing Cost	-0.011197	0.965526
Housing Quality	0.102984	0.147231

Table 11. Moran’s I spatial autocorrelation

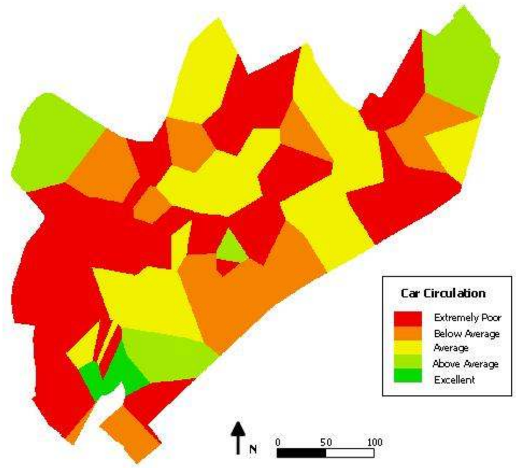
5.2.3. Voronoi Polygon

Using the voronoi diagram method, the voronoi polygons for all indicator not spatially autocorrelated are generated, see Fig. 19. Notice that the variables car circulation, car parking space and green space are particularly disturbing. As expected, most respondents indicated that they lack these three the most hence, the responses are frequently extremely poor, which is due to the labyrinth-like narrow streets of Alfama that hamper car circulation nor space for parking. With it being an urban neighborhood, it also hinders the presence of green space.

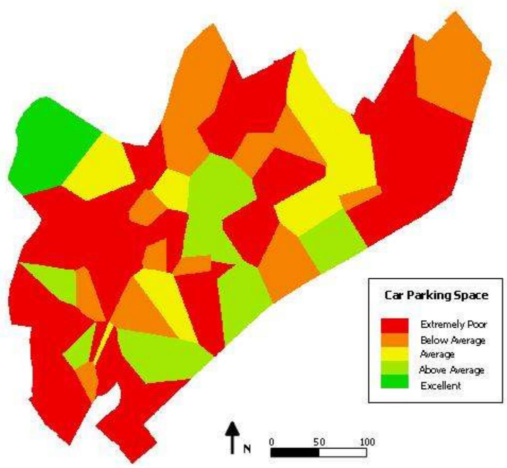
1. Street Cleanliness



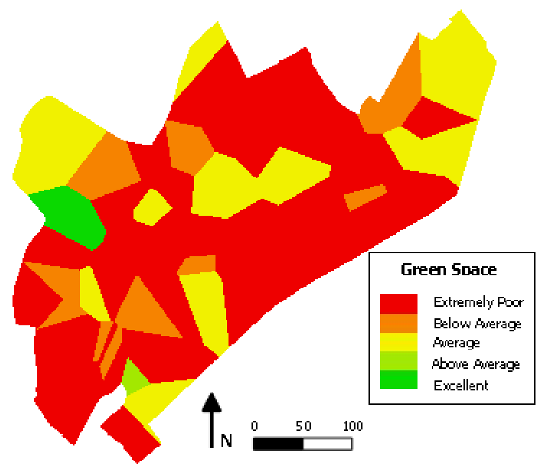
2. Car Circulation



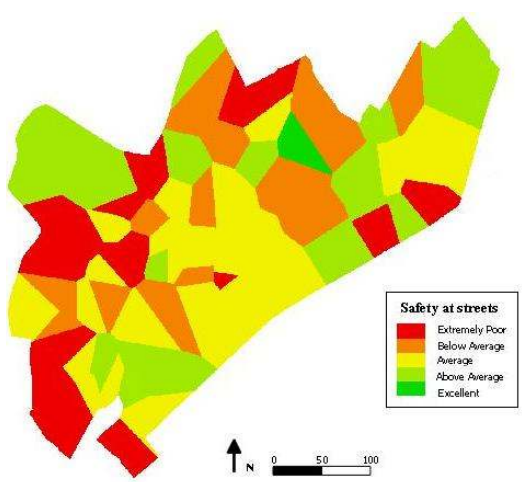
3. Car Parking Space



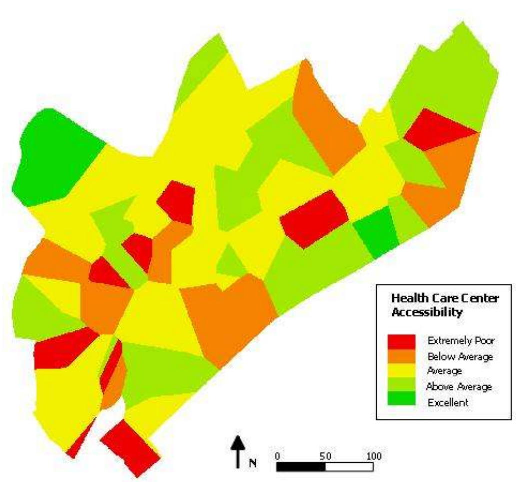
4. Green Space



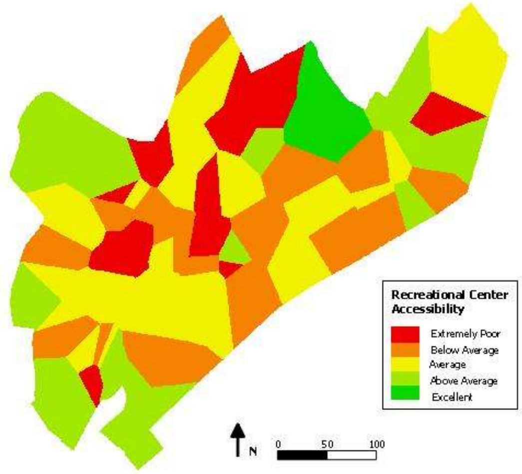
5. Safety at Streets



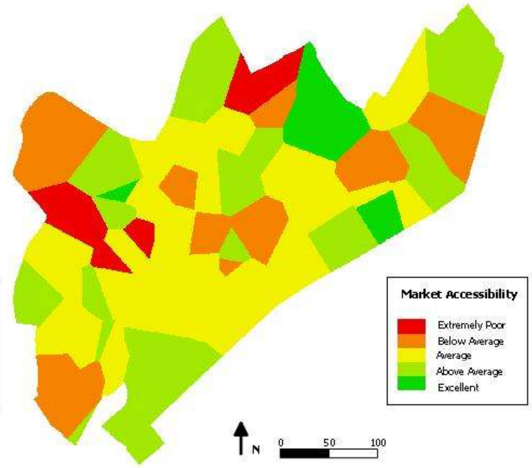
6. Health Care Center Accessibility



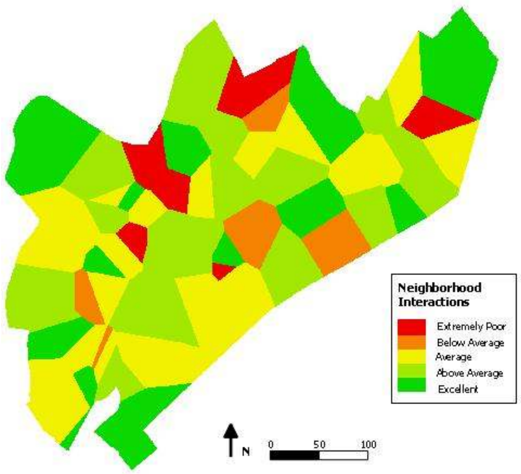
7. Recreational Center Accessibility



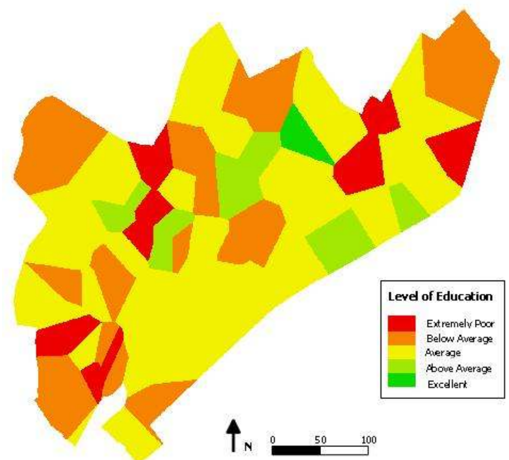
8. Supermarket Accessibility



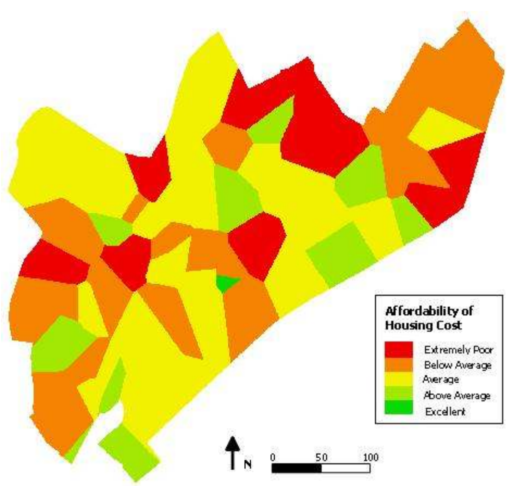
9. Neighborhood Interactions



10. Level of Education



11. Affordability of Housing Cost



12. Housing Quality

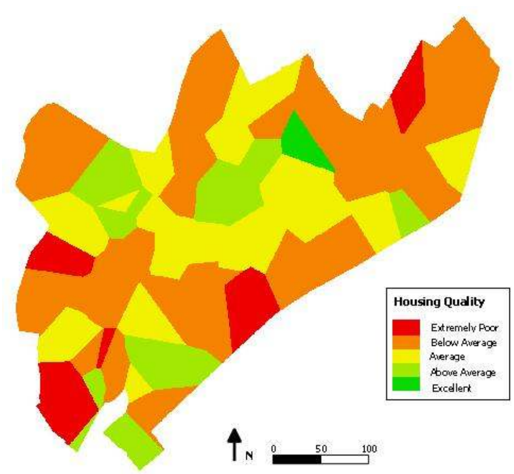


Figure 19. Voronoi polygons

Perceptions on safety at streets are extremely poor on the southwestern boundary of Alfama, while the health care center accessibility has some random reds at the center. Perceptions on recreational center accessibility are also unexpectedly poor on the northern and central Alfama, which is surprising since Alfama is close to museums, and other recreational/cultural center. Assessment on supermarket accessibility on the other hand seems good since only few people answered extremely poor. The respondents commented that markets are everywhere, though the supermarket like 'Pingo Doce' is quite far. Perceptions on neighborhood interactions are really good with few reds but more greens. Surprising as well, is the level of education to which the map gives an impression of an average level of education, which contradicts with the 2001 statistics data. Lastly, Fig. 19.11 and 19.12, which are the perceptions on affordability of housing cost and the housing quality illustrate below average assessments.

5.2.4. Ordinary Kriging (OK)

The variogram models are generated for the three variables significantly spatially autocorrelated as shown in Fig. 20. The Spherical model is fitted for the recycling bin accessibility, see Fig. 20.1. It uses a partial sill of 0.258, and a range of 38. Notice how the first two points fits well with the model. The second graph on the other hand shows that an Exponential model fits better with the variable safety at home. It uses a partial sill of 0.099, and a range of 12. Lastly, the third graph uses an Exponential model with a partial sill of 0.0437, and a range of 26. All three use 0 nuggets, illustrating that the vertical jump from the origin 0 to the value of the three variograms do not exist in this representation.

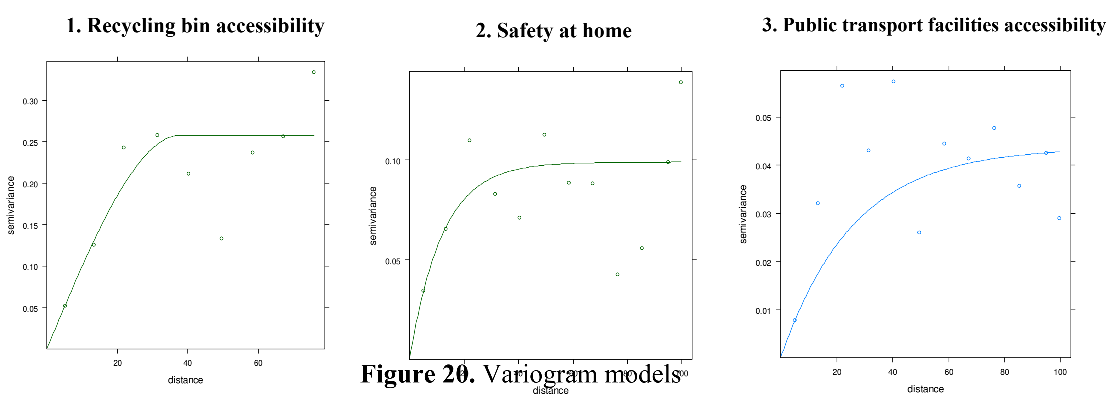


Figure 20. Variogram models

With these three variogram models created, the OK is interpolated. Fig. 21 shows the prediction for safety at home. Notice the above average perceptions of home safety in the northeastern part of Alfama.

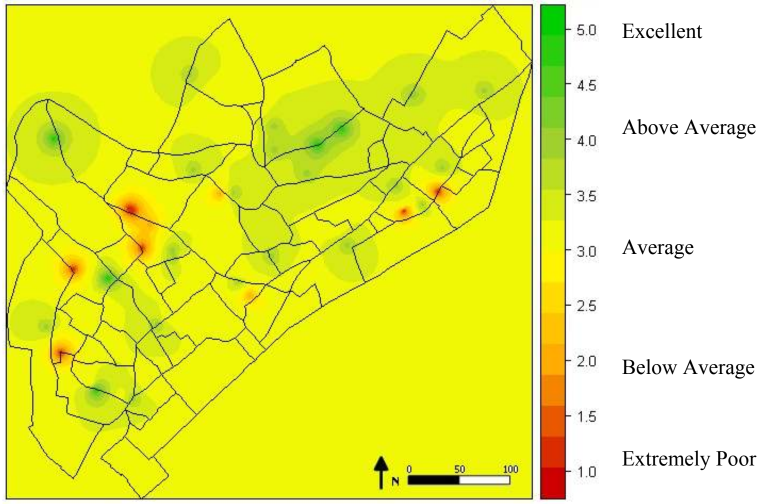


Figure 21. Safety at home

Fig. 22 on the other hand seems illustrating above average responses arbitrarily on the southern area. It also shows that the northwestern area has moderate accessibility while the rest exemplifies an excellent accessibility and some random extremely poor parts.

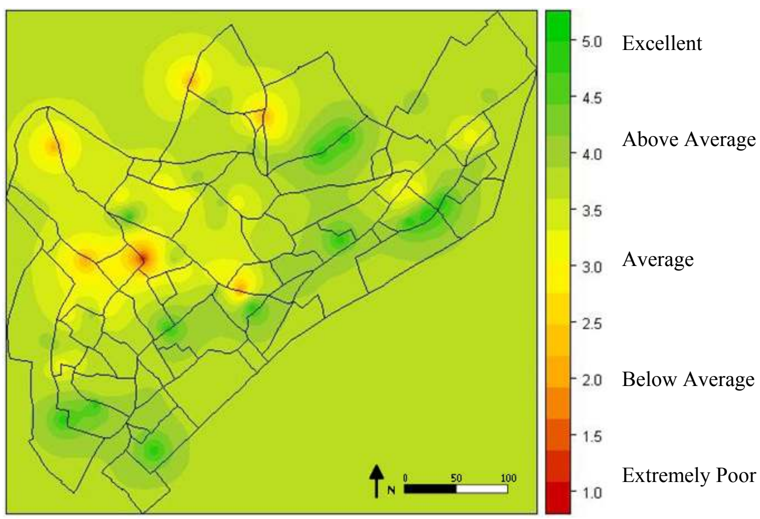


Figure 22. Public transport facilities accessibility

In Fig. 23, it shows that the perceptions on recycling bin accessibility seem fluctuating. With a higher sill used, it illustrates how respondents' opinions are canceling out since the scale excellent' and extremely oor are almost always nearby one another.

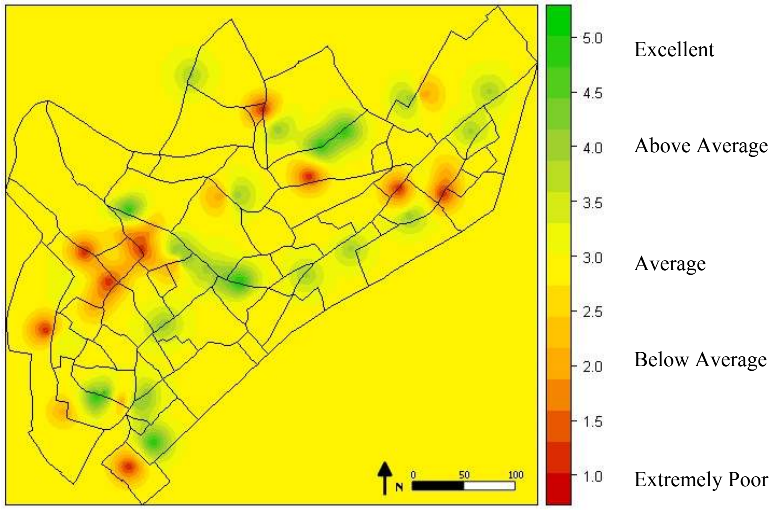


Figure 23. Recycling bin accessibility

5.2.4.1. Cross-validation for OK

The quality of prediction for OK is checked through Cross-validation (CV). Fig. 24 shows the CV residuals for the variable safety at home. The green dots indicate under-prediction and the red dots indicate over-prediction. In this case, the highest under-prediction and overprediction are -2.424 and 1.903 respectively. This is in fact high, which means that the variogram still may be enhanced. But with mean residual of 0.01018 and mean z-score of 0.01915 close to zero as shown in Table 12, the variogram is acceptable.

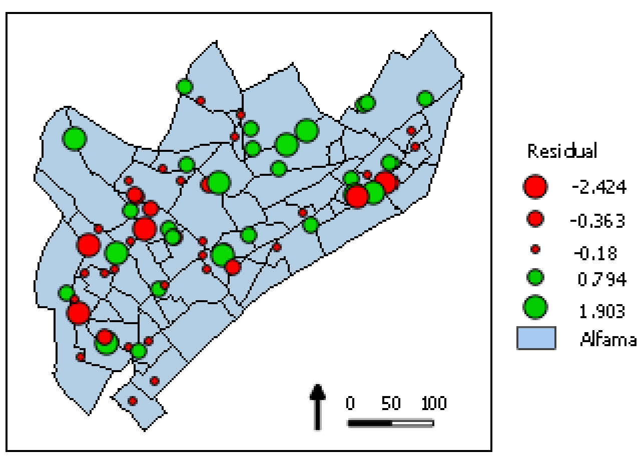


Figure 24. CV residuals for safety at home

	Prediction	Prediction Variance	Observed Values	Residuals	Z-score
Min.	1.705	0.02796	1.000	-2.42358	-10.056
1st Qu.	3.156	0.08072	3.000	-0.36333	-1.2097
Median	3.236	0.08940	3.000	-0.17995	-0.5957
Mean	3.222	0.08013	3.232	0.01018	0.01915
3rd Qu.	3.363	0.09124	4.000	0.79378	2.60450
Max.	4.088	0.09329	5.000	1.90268	6.38808

Table 12. Summary report of CV for safety at home

Fig. 25 shows the CV residuals for public transport facilities accessibility. Compared to Fig.24, the mean residual and z-score mean shown in Table 13 are closer to 0. With the mean and variance close to 0 and 1, the variogram is satisfactory.

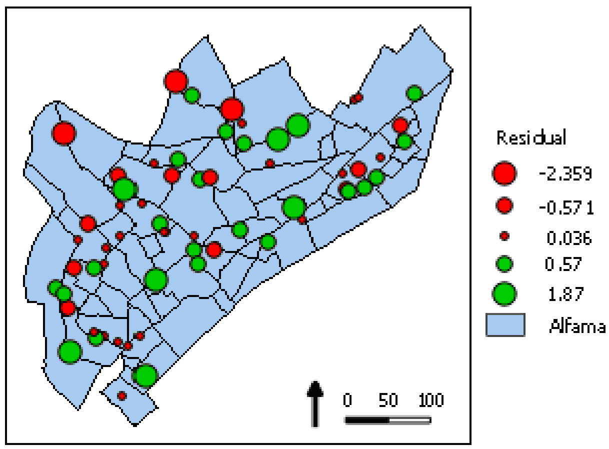


Figure 25. CV residuals for transport facilities accessibility

	Prediction	Prediction Variance	Observed Values	Residuals	Z-score
Min.	2.440	0.009422	1.000	-2.359038	-11.301
1st Qu.	3.411	0.035374	3.000	-0.571409	-2.916
Median	3.761	0.043237	4.000	0.035570	0.189
Mean	3.681	0.038150	3.681	0.0003426	0.009
3rd Qu.	3.934	0.045650	4.000	0.5704147	2.670
Max.	4.682	0.051803	5.000	1.8702533	8.942

Table 13. Summary report of CV residuals for transport facilities accessibility

The last CV residual calculation is for the recycling bin accessibility shown in Fig. 26. Although the under- and over-prediction are high with more than the value of 2, the mean and variance in Table 14 are reasonable.

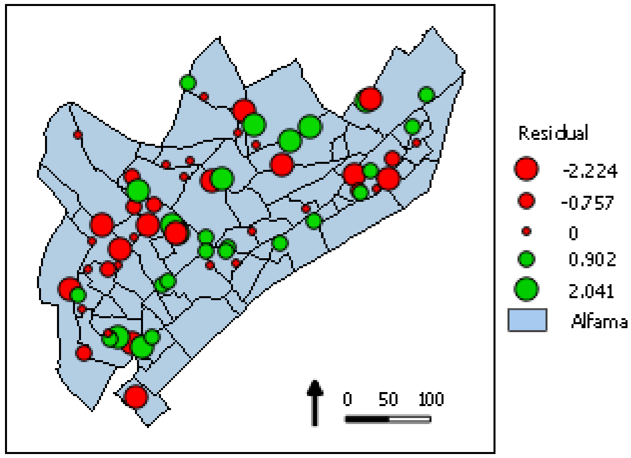


Figure 26. CV residuals for recycling bin accessibility

	Prediction	Prediction Variance	Observed Values	Residuals	Z-score
Min.	2.356	0.02796	1.000	-2.18341	-9.1994
1st Qu.	2.940	0.08072	2.000	-0.73885	-2.8856
Median	3.036	0.08940	3.000	-0.01342	-0.0449
Mean	3.160	0.08013	3.116	-0.04447	-0.0822
3rd Qu.	3.332	0.09124	4.000	0.98175	3.21578
Max.	4.705	0.09329	5.000	2.06028	8.07613

Table 14. Summary report of CV residuals for recycling bin accessibility

5.3. Weighted sum results

After creating the interpolations using the Voronoi Polygon and Ordinary Kriging, all are summed up using the method Weighted Sum. It uses 'weights' which gives the relative importance for each indicator. Below in Table 15 are the weights for all variables. Remember that these weights are acquired from the survey and normalized afterwards. Under Physical domain, the street cleanliness was given the highest weight, safety at home for the social domain, and affordability of housing cost and housing quality for the economic domain.

Domain	Weight
Physical	
Street cleanliness	0.31
Car circulation	0.19
Car parking space	0.22
Green space	0.28
Social	
Safety at home	0.182
Safety at streets	0.180
Health care accessibility	0.136
Supermarket accessibility	0.117
Public transport facilities accessibility	0.123
Recreational center accessibility	0.099
Recycling bin accessibility	0.087
Neighborhood interaction	0.076
Economic	
Level of education	0.246
Affordability of housing cost	0.377
Housing Quality	0.377

Table 15. Spatial weights used for each indicator

Using these weights, the physical, social, economic, and overall quality of life maps are generated. Fig. 27 shows the Physical QoL, which clearly illustrates how appalling the perceptions of respondents on indicators consisting this domain. Approximately 40% of the area is of extremely poor level.

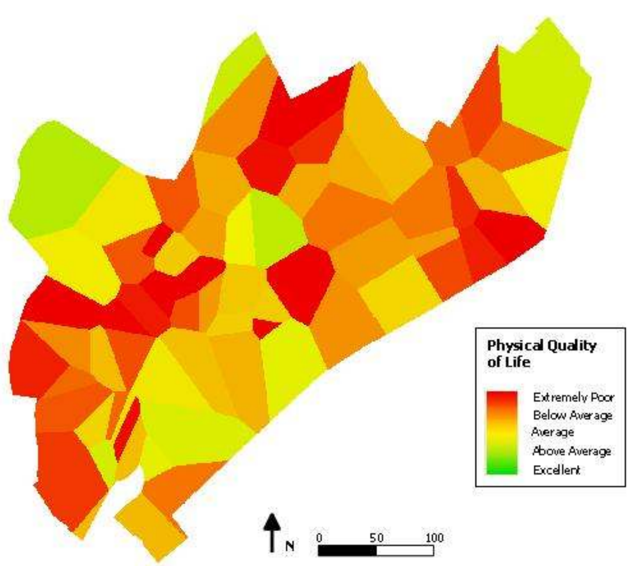


Figure 27. Physical quality of life

The Economic QoL in Fig. 28 in contrast shows a moderately better assessment than the Physical QoL. Though some extremely poor parts, the rest is below to above average.

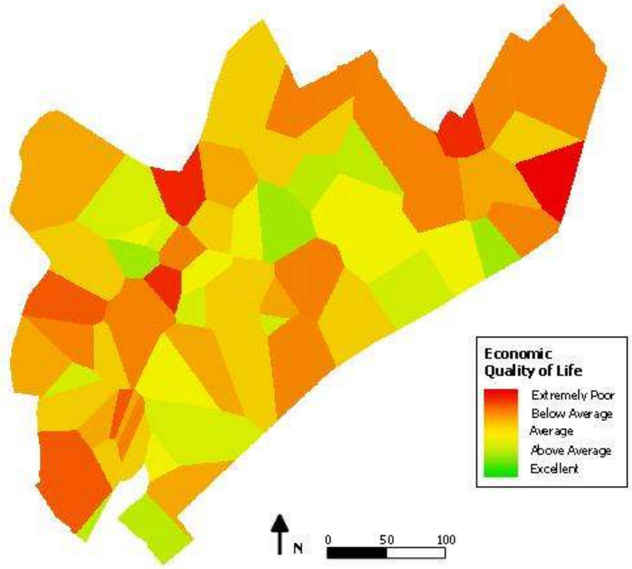


Figure 28. Economic quality of life

Similarly, the Social QoL in Fig. 29 shows a better assessment in comparison to other two domains. It exemplifies an average to above average Social QoL except to some areas in the north, northeast and northwest of Alfama.

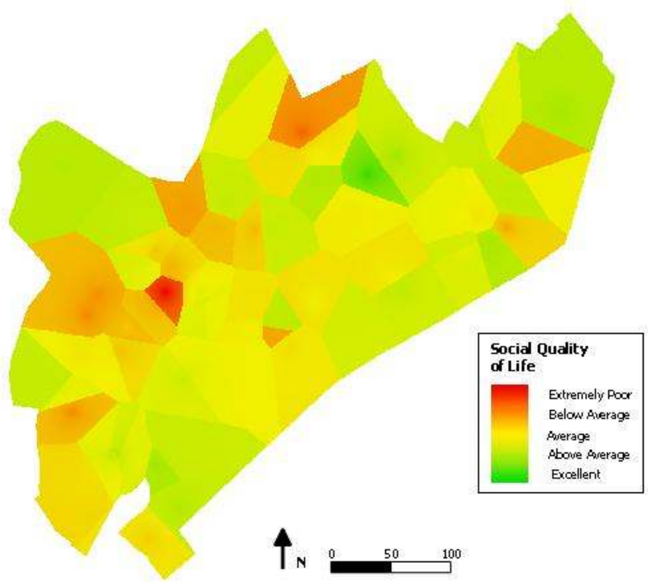


Figure 29. Social quality of life

Using the weights provided in Table 16 and the three previous maps for all domains, the overall QoL in Fig. 30 is produced. Notice that the Social and Economic domains have similar weights with the physical domain having the lowest weighting.

Domain	Weights
Physical	0.246
Social	0.377
Economic	0.377

Table 16. Spatial weights used for each domain

Fig. 30 roughly demonstrates a below average to average overall QoL. It exemplifies poor assessments mostly for the southwestern part of the study area.

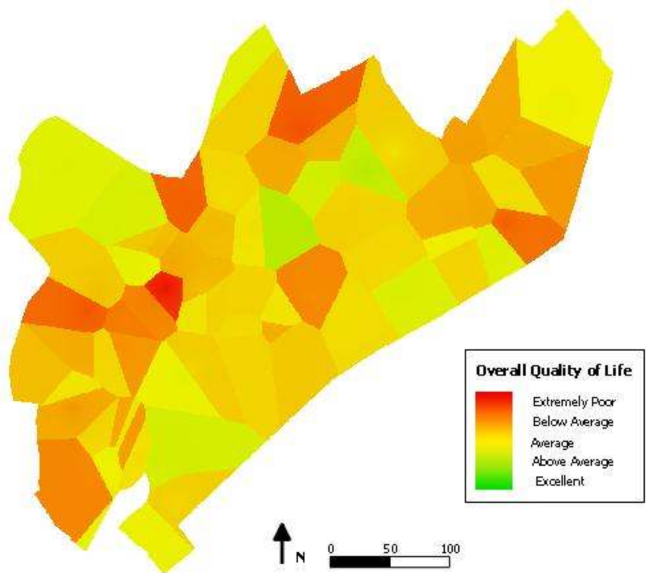


Figure 30. Overall quality of life

6. CONCLUSION

Quality of life, defined in this case using perceptions of the people living in the study area, is in fact very intricate. Beginning from a medical term, it evolves to a deeper ground with a concrete definition yet to arrive. Hitherto, it encompasses other fields of domains and its measurement is also yet to be disputed. Arguments stirred up particularly on how it can be measured on its fuller extent as possible. Some came up with different scales and indices measuring QoL by health, personal development, work, relationships, wealth and others. Some organized all these thoughts and came up with a group of objective and subjective indicators of quality of life. Even then, still its definition and measurement is yet to progress.

In this case, the study defined QoL as simply the objective and subjective measures collectively. Both the objective and subjective indicators are scrutinized to construct a quality of life map based on residents' perceptions and the service locations within and close Alfama. Detailed discussions of findings are presented on the subsequent subsections.

6.1. Discussion

6.1.1. Correlation between objective and subjective QoL

The correlation of objective and subjective indicators has been very weak in existing studies. Similarly in this study, the Polyserial correlation results apparently showed that the objective and subjective data have weak correlations and no significant correlations. But this does not mean that the correlations are equal to zero. It is just that based on the data, the study cannot tell whether they are different from zero. Remember the dictum "Absence of evidence is not evidence of absence (Altman & Bland, 1995)."

Assuming that a Type II error (when the null hypothesis is accepted when in fact it should have been rejected) occurred in statistical hypothesis testing, few problems may have caused this. First is the sample size. Due to time limitation, only 69 respondents are collected. If the sample size for Alfama is computed, with a confidence level of 95%, a confidence interval of 5.1, and a total population of 3726, the mean sample size would have been 337, which is not even half of the samples gathered. In addition, even more than 337 samples are needed for spatial prediction. Achieving the sample size is imperative because this assures the reflectance of the whole population. This means that for a given confidence level, the larger the sample size would mean smaller confidence interval and the smaller the confidence interval, the more reliable an estimate would be. In statistical hypothesis testing, the power to reject the null hypothesis depends on several factors and one of these is the sample size. With a larger sample, the statistical power increases hence, the power to reject the null hypothesis, which is in this case, is the objective and subjective indicators not having relationships.

The second problem may have caused by the significance criterion. The study uses a 0.05% significance level hence; a p-value less than 0.05 should be achieved to accept the alternative hypothesis. Although not recommended, a larger significance level can be chosen, increasing the probability of rejecting the null hypothesis. However, doing this also increases the probability of having a Type I error, rejecting the null hypothesis when it is actually true.

The last and most relevant point is the issue of scale. Aside from the fact that people have different mental scales, and dissimilar criteria on needs and wants through time, there is a problem of geographic scale. Quality of life as defined by Costanza et al. (2007) is a multi-scale, multi-dimensional concept that contains interacting objective and subjective elements. Measuring QoL for different scale-level is of no predicament. It is a matter of constructing the objectives in relation to identifying the composites and structures. It was suggested that in identifying patterns say at the individual scale, the focus should be on larger spatial regions or longer temporal scales to find statistical ensembles for which observations become more regular (Costanza et al., 2007). Note that moving between scales trade off the loss of heterogeneity for the gain of predictability (Costanza et al., 2007). This means that the average within big area is more precise than prediction at many locations. Therefore, choosing the right scale according to objectives is significant in achieving the goals of QoL measurement. In this case, the scale played a role with the correlation. With Alfama's total area of 122,005.69 square meters, adding the fact that only 69 respondents across the area are collected, it returned heterogeneous answers resulting to non-significant correlations. In this case, it proves that favoring a neighborhood scale (large-scale) traded off the predictability of QoL measurement.

There is also an issue regarding the subjective QoL measures. It has been argued in past researches that it is often unreliable and invalid measure of QoL mainly due to the following points: (1) People think differently in terms of criteria and scale of measurement and thus, it is not comparable, and (2) People's answers change abruptly due to instances like mood swings and thus, it is not reliable. These points may have affected the results of the survey, but this doesn't mean that subjective QoL measure is unreliable and invalid. This is proven in the experimental studies of Cummins (2000) to which the population levels of life satisfaction were consistent. Subjective measures can be reliable and valid as long as enough spatial region and sample size are taken. In the Appendix Fig. A1, maps were made to visualize the locations of objective data together with the subjective data (the results of spatial predictions). Although they weren't significantly correlated based on the data, it somehow visually makes some associations especially for the following Appendices in Fig. A1: 5. Street cleanliness assessment with recycling bins; 7. Recycling bin accessibility assessment with recycling bin locations; and 8. Housing safety assessment with police station location. Fig. A1.5 illustrates that the recycling bin locations are actually located in areas where the average, above average, and excellent recycling bin accessibilities are. The same goes with the rest, the places close to service points are showing average' to excellent service accessibilities except for public transport facilities accessibility. These visual results in contrast are affected by the 'noise' that seems to affect the predictability since the values do not spatially fit where it is located.

Assuming that the results are true; that the null hypothesis suggesting that no significant correlation between objective and subjective QoL measures should be accepted, this follows other existing studies illustrating that there is weak correlations between the two types of QoL measures. Cummins (2000) in fact gave an example where Lawrence, Massachusetts is rated as the least desirable USA town to live in. The residents were interviewed regarding this issue and they entirely disagree with the result. They gave a positive outlook towards their neighborhood focusing on social interconnections. It was then suggested that the subjective perspective is using a dissimilar criteria than the objective. In this case, both are incomparable.

6.1.2. Inter-correlation within subjective QoL

For the subjective data correlated with each other, results in Appendix Table 18 showed that most of them are moderately correlated with 9.4% above 0.40 correlation coefficients. Since no significance testing is done, we can't say if these are statistically significant. However, illustrating moderate correlations prove that indicators within subjective perspective have higher correlations compared to correlation between objective and subjective QoL. This is true for other studies as well, telling how weak the correlations between the two perspectives in contrast with the inter-correlations within the subjective perspective. For an instance, in the Appendix Table 17, it shows how the Personal life domain indicators are strongly correlated with other indicators within the domain and other subjective indicators. For an instance, if people have higher feeling of trust with the neighborhood, they also tend to have higher feeling of inclusion.

6.1.3. Spatial autocorrelation of subjective indicators

The results of spatial autocorrelation had the same predicament as the correlation results, mainly due to the selection of geographic scale and the lack of samples. Since Alfama has relatively a small spatial region, and only 69 respondents are taken out of 3726 population, the predictability tends to suffer leading to non-significant spatial autocorrelation. Even with the clustering of similar values, if the region is small, the 'noise' is likely to appear, which affects and decreases the statistical power to reject the false null hypothesis.

6.1.4. Voronoi polygon interpolation

Voronoi polygon is effective in highlighting outliers, and homogeneity or heterogeneity. But since it only considers the Delaunay criterion, it doesn't takes into account the neighboring values in creating the polygons. It also visualizes abrupt change in the values giving a discontinuous surface, which is not realistic.

A total of 12 maps are created using this method. Since I have done the survey and the fieldwork myself, there were some answers to why some extreme values or noise occurred. Alfama is a very unique neighborhood in Lisbon since it preserves its Moorish medieval alleys. It is a touristic area with its exceptional views from atop. Like any part of Lisbon which consists of hills, going in and out of Alfama takes you energy as it has its highs and lows. Since the study is considering only the distance (accessibility) of the services from the respondents as the objective data, elevation and the urban morphology of Alfama may have taken roles. For an instance, all physical indicators except the street cleanliness have the study area mostly red (extremely poor). Fig. 19.2, Fig. 19.3 and Fig. 19.4 from previous chapter showing the car circulation, car parking space, and green space variables respectively prove the fact that in Alfama, cars can barely pass, parking spaces are hardly seen, and green spaces scarcely exist, since the structure of Alfama is not made for these. This confirms the relationship of subjective with the objective data with regard to physical indicators. Subjective QoL are strongly intertwined with the objective QoL especially when the latter is decreasing or poor. This follows what Cummins (2000) proposed in his paper, that the subjective QoL is influenced by the homeostatic control; when a low objective threshold of living is experienced, it puts forth a negative influence to compromise homeostasis and drives the subjective to show increase covariation.

It was also detected during the fieldwork that some questions were not lucid enough for the respondents as it was for the pre-test. It is a question of definition, of what a certain indicator is concerned about. For an instance, the green space variable as given in Table 1, is defined as a type of urban open space which caters green spaces. This includes the small gardens of Miradouro de Santa Luzia as well as Jardim das Canas. However, due to lack of ability to communicate in Portuguese, this variable and others may have not been understood as defined in the study. Although giving explanations could have helped, it may have also caused confusions. This argument however is not testable and hence, no examination is done. Another example is the supermarket accessibility in Appendix Fig. A1.3, which is displayed with market locations. The supermarket as given in Table 2 is defined as a big market place that sells food, which in Portuguese case, only includes ‘Pingo Doce’. On the other hand, the market locations provided in the map includes ‘Talho’ (meat shop), vegetable/fruit/fish store, and minimarket. This is done to determine if it influenced respondents’ answers assuming they misunderstood the question. As shown in the map, there are over 15 food markets found within the study area, which are largely situated in the street of Remédios (Rua dos Remédios) in the south and southeastern sections. Based on the correlation analysis, it was not significantly correlated. Although visually, notice that the places with more markets have relatively better accessibility perception than those in the north and northeastern sections of the study area, which have some answers of extremely poor.

The voronoi polygon result for recreational center accessibility with the recreational center locations in Appendix Fig. A1.4 on the other hand shows many ‘noises’ and red areas in the map. These noises that affected the correlation may have been a problem of definition, although the idea of people with different scales of measurement may have played its role as well. The respondents’ recognition of a recreational center may have been different in this research. For an instance, an art gallery, museum or an internet point found in the study area may not be considered by some as recreational centers. This is verified by the result of a correlation between the two in Table 10, garnering a 0.27 coefficient, which gives an opposite direction (the closer the people to the recreational center, the worse their perception with recreational center accessibility). It seems that the map doesn’t even have a pattern.

For the result of the indicator neighborhood interaction interpolation in Fig. 19.9, it appeared to have the best assessment in the study area. It provided some extremely oor and below average answers but more with average to excellent answers. This suggests that Alfama has good neighborhood interactions, which makes sense since the houses are very close to each other and thus interactions are more possible, compared to a neighborhood with houses far from one other.

The health care center accessibility on the other hand was expected to have less variability since the health care centers are not available or relatively far from Alfama (one clinic is found within but not considered in the analysis since the study only considers hospitals) and thus, each of the residents would have roughly the same level of access. But apparently, Fig. 19.6 shows otherwise, suggesting that respondents have different perceptions with it, maybe caused of a notion that people have different scales of measurement; or since going to hospital is not an everyday necessity for most, unawareness can also be an explanation.

6.1.5. Ordinary kriging interpolation

With the CV procedure done, it showed that the mean residual and variance are roughly close to 0 and 1 yet elevated numbers for under- and over-prediction. But this does not mean that the variogram model is wrong. It can also be due to reasons such as anisotropy or nonstationarity. The variogram model might also be improved by experimenting on the number of cutoff and/or lag distance (experimental variogram), psill and/or range (semivariogram). Note that variogram modeling is a subjective task and a trial and error. Finding the best variogram even require a multidisciplinary team to decide which best illustrates the relationships.

Fig. A1.7 showing the recycling bin accessibility prediction illustrates that the red areas are mostly located in the center of Alfama. Note that according to the website of Câmara Municipal

(municipal government) of Lisbon, the two civil parishes (São Miguel and Santo Estevão) covered in this study are part of the door-to-door collection of recyclables. They provide a schedule for the delivery of bags and the collection of different kinds of recyclables. This is confirmed by most respondents except for a small percentage who said that no collections are being done in their area. This information however is not verified; although according to the map from Câmara Municipal given in Appendix Fig. A2, it clearly shows that the study area is covered by the said collection. Nevertheless, having this process may have caused others' unawareness about recycling bin accessibility since it is of no use and hence putting an extremely poor answer.

The OK result of public transport stops accessibility with transport stop locations in Appendix Fig. A1.9 shows a relatively good assessment. With few answers of extremely poor, the rest is from average to excellent. It seems that with respondents' answers and some comments, transport accessibility is of no problem since they are relatively close to the center of Lisbon, just a walk downhill. This can be a reason why most of excellent answers are in the southeastern section, where the main street going to Lisbon center is situated.

With the prediction result for safety at home in Fig. 21, it shows less variability. Most of the red areas are on the western part of the study area except to the two 'noises' in the eastern part where the police station is located.

6.1.6. Weighted sum

With poor assessments on indicators street cleanliness, car circulation, car parking space, and green space, it made the Physical QoL the worst domain. This suggests that the physical aspect of Alfama is mostly extremely poor in the perception (subjective) of the respondents, which agrees with the objective data statistics, that Alfama is comparatively poor on these indicators in contrast to other areas in Lisbon.

Similarly, the Economic QoL in Fig. 28 shows poor assessment especially on the northeastern and southwestern parts of Alfama. Nevertheless, it illustrates relatively better assessment than the Physical QoL, which is based on the level of education, affordability of housing cost, and housing quality. Out of the three indicators in Economic domain, both level of education (0.343) and affordability of housing cost (0.343) have the highest and similar weightings. The housing quality was the least priority with 0.314 weighting. All three indicators appear to have red areas which agree with statistics and description of Alfama; that education level (with 14% of residents do not know how to read and write) and the number of employed people (with 58.6% of the residents do not have economic activity) are extremely poor. The map seems verify this fact with it mostly belonging to the scale of below average Economic QoL.

For the Social QoL in Fig. 29 which shows a better assessment over the two domains, extremely poor assessments are situated in the southwestern part of the study area. With eight indicators comprising this domain, safety at home and streets garnered the highest weightings as illustrated in Table 15, which made it affect the Social QoL the most, followed by the health care center accessibility and public transport facilities accessibility. Since the safety at streets has the worst assessment over all other social indicators but high weighting, it added negative influence in the Social QoL map. Similarly, the safety at home has high weighting but better assessment and hence, it somehow nullifies the poor assessment of safety at streets. This resulted to assessments of Social QoL circling with average and above average prediction.

Notice that the three domains have similarity with respect to the areas that have poor assessments. These are the north, northeastern, and southwestern parts of Alfama, which resulted to an Overall QoL illustrated in Fig. 30 with poor assessment on the said areas. Remember that both Social and Economic have the same and highest weightings over the Physical domain and hence, they both have greater influence over the Overall QoL map.

6.2. Summary

Due to lack of data, only distance from services as the objective data is tested for correlation with the subjective data. No significant correlations were found and hence, only an overall subjective QoL is done. But this does not mean however that they are entirely independent of each other. This poor correlation is mainly caused by the geographic scale and sample size. The geographic scale chosen controls the gain of predictability. Since the study area is small, it gave a more heterogeneous output, resulting to non-significant correlations.

Likewise, since a small spatial region is chosen, to increase the statistical power to reject the null hypothesis, at least enough sample size should be provided. But due to lack of samples, heterogeneity and thus, ‘noise’ occurred, which most probably affected the analysis.

The effects of these two factors are best illustrated on all prediction maps shown together with the objective data in Appendix Fig. A1. Although it was shown that some values in these maps visually agree with the locations of services, these two factors greatly influenced the heterogeneity of the maps, reducing the predictability and hence, the correlations and spatial autocorrelation. In conclusion, QoL measurement can still be done in a neighborhood-scale like Alfama given that there is enough sample size taken across the area, which will give higher predictability.

For the inter-correlations within subjective QoL, it showed moderate correlations, relatively higher than the results between objective and subjective correlations. This verifies the conjecture for most existing studies that inter-correlations within subjective or objective QoL measures have higher correlations than the correlation between the two.

Surprisingly, respondents gave the variable street cleanliness the highest weighting over the other three indicators, followed by the green space. They said that car circulation and car parking space are less important for them since they have accepted the fact that Alfama's urban morphology does not allow it unless a total restructuring is done.

The safety at home (0.182) and streets (0.180) expectedly were given priorities by respondents, followed by hospital (0.136) and transport facilities (0.123) accessibilities. The neighborhood interaction indicator has the best assessment among others, but given the least importance. The safety at streets indicator seems to have the reddest areas (extremely poor) since there were talks about safety issues regarding robbery cases. Alfama is often described as not a good place for a woman to roam around alone. Even I was warned by many respondents especially the employee in Junta de Freguesia (parish council) in Santo Estevão.

The three considered domains shaped the overall QoL map of Alfama. But since the Social (0.377) and Economic (0.377) domains have the highest and similar weightings, both have higher influence over the Physical domain (0.246). The overall QoL map in Fig. 30 shows an average assessment with some extremely poor and below average areas in the northeastern and southwestern portion of the study area. Note that QoL changes over time and hence, this measured overall QoL is only a depiction at a particular time. The weighting, which influences this, is based on the priorities of respondents.

Besides the fact that these weightings vary from one person to another, based on the results, I argue that the common sense comes first before a person takes into account the current objective conditions of the indicators being assessed, in giving the scale of priorities or weightings. The negative influence of low objective QoL threshold experienced that drives the subjective QoL to illustrate increase covariation (Cummins, 2000) is only the second thing that comes into mind of a person in assessing QoL based on the data. This is verified during the fieldwork and when the weights and interpolation results are compared. For an instance, within the Physical domain, the street cleanliness was given the highest priority, even having relatively better assessment over the other three indicators. This is followed by the green space, which has the worst assessment. Within the Social domain, aside from the fact that safety at streets has the worst assessment under this domain, it was given the second highest priority after safety at home, which is reasonably common sense since these two involves the compromise of life. The social and economic domains are given priorities as well over physical even if the latter has the worst assessment, suggesting equal influence from common sense and low objective QoL threshold effect. This could be due to common understanding that social and economic domains are important for a good QoL. This supposition however has no scientific basis since no additional questions were posed in the survey after the question of weightings. Other factors might have played roles in their decision-making (e.g. more indicators are considered in the survey for social domain compared to physical, which could have caused them to favor the former).

Some other conclusions are identified for other variables on the survey. The table in Appendix Table 24 illustrates the ratings of quality of life based only on two questions that were given at the beginning and at the end of the survey questionnaire. The first row serves as the more intuitive answer, and the second for the more coherent and rational rating of QoL. The table suggests that respondents tend to have a better rating assessment for the coherent and rational rating of QoL with its above average and excellent scales having higher frequencies than the intuitive ones. This means that right after answering the questions for all indicators; their coherent rating of QoL is higher. When a test of correlation is done, it gives a 0.60 correlation coefficient suggesting that they are highly correlated.

6.3. Limitations

Certain limitations occurred during the research. Firsts are the geographic scale and sample size. Since there is limited time, it was decided to have a small spatial region, which requires lesser samples. But since only 69 respondents are taken, the results appeared to suffer from the prediction. There is also a problem of objective/secondary data deficiency. Some of the results cannot be supported particularly when reasoning out why certain respondents poorly assessed a particular indicator (i.e. robbery cases or any police reports that would support the result for safety at home and safety at streets). Only distance from services (as the objective QoL measure) is used for correlating with the subjective QoL measures since no other secondary data were collected except the 2001 statistics.

6.4. Future Work

Some 'noises' were found during the exploratory analysis. But due to expected heterogeneity of results, it was included in the study. Not integrating these 'noises' however might improve the correlation and spatial autocorrelation results. A multiple correlation might also improve the relationships between objective and subjective QoL, but of no guarantee.

The experimental (1) and semivariogram (2) models might also be improved by playing with cutoff and lag width (1), psill and range (2). Just remember that increasing/decreasing these parameters would also create consequences (e.g. decreasing the lag width increase the detailed estimates, but increasing as well the noise). Taking into account and testing stationarity and anisotropy can also be done. The latter in particular, which most probably affected the under- and over-prediction of the variables in CV, must be considered.

All these factors may have influenced the weak correlation and spatial autocorrelation, and poor prediction. QoL study is in fact complex and still has more features to be examined and learned. Continuous research is undeniably of need.

For supplementary research, cluster analysis is also an interesting topic to be added in this study. It was one of the objectives at the beginning of research but due to limited time, it was not done. This is helpful in identifying patterns in the data for an instance, a cluster of people who responded similar answers by age and/or profession.

6.5. Recommendation

Since the main issues in this research are the scale and sample size, it is suggested to work on a bigger geographic region and enough samples. If the aim is to extract information in an individual scale, a larger region would give higher predictability of the results, assuming that there is enough sample population. It is also suggested to involve the local government in the research since they will provide information on which indicators are must-puts in the survey.

BIBILIOGRAPHIC REFERENCES

ALTMAN, D., & BLAND, J. M. (1995). Statistics notes: Absence of evidence is not evidence of absence. *BMJ*, *311*, 485. Retrieved from http://www.bmj.com/content/311/7003/485.full.

ALVES, F., SACADURA, F., & VAZ, L. (1995). Alfama; from degradation to rehabilitation. *Cities*, *12*(2), 107-109. doi: 10.1016/0264-2751(95)00028-K.

AUCHINCLOSS, A. H., DIEZ ROUX, A. V., BROWN, D. G., RAGHUNATHAN, T. E., & ERDMANN, C. a. (2007). Filling the gaps: spatial interpolation of residential survey data in the estimation of neighborhood characteristics. *Epidemiology (Cambridge, Mass.)*, *18*(4), 469-78. doi: 10.1097/EDE.0b013e3180646320.

BIVAND, R. S., PEBESMA, E. J., & GÓMEZ-RUBIO, V. (2008). *Applied spatial data analysis with R*. *Development* (illustrate.). Springer.

BONNES, M., UZZELL, D., CARRUS, G., & KELAY, T. (2007). Inhabitants and experts' assessments of environmentalquality for urban sustainability. *Journal of Social Issues*, *63*(1), 59-78. doi: 10.1111/j.1540-4560.2007.00496.x.

BOWLING, A. (2005). *Measuring health: A review of quality of life measurement scales*. *American Journal of Physics* (3rd ed., Vol. 45, p. 159). Berkshire, UK: Open University Press, McGraw-Hill Education. doi: 10.1119/1.11005.

BREMNER, C. (2008). Euromonitor international’s top city destinations ranking. Retrieved September 29, 2010, from http://www.euromonitor.com/_Euromonitor_Internationals_Top_City_Destinations_Ranking.

CAMPBELL, A., CONVERSE, P. E., & RODGERS, W. L. (1976). *The Quality of American Life: Perceptions, Evaluations and Satisfaction*. New York: Russell Sage Foundation.

COSTANZA, R., FISHER, B., ALI, S., BEER, C., BOND, L., BOUMANS, R., et al. (2007). Quality of life: An approach integrating opportunities, human needs, and subjective well-being. *Ecological Economics*, *61*(2-3), 267-276. doi: 10.1016/j.ecolecon.2006.02.023.

CUMMINS, R. A. (2000). Objective and subjective quality of life : An interactive model. *Social Indicators Research*, *52*(1), 55-72.

Câmara Municipal de Lisboa. (n.d.). Juntas de Freguesia. Retrieved November 5, 2010, from http://www.cm-lisboa.pt/?idc=640&pos=45#.

DAS, D. (2007). Urban quality of life: A case study of Guwahati. *Social Indicators Research*, *88*(2), 297-310. doi: 10.1007/s11205-007-9191-6.

DASHORA, L. K. (2009). *Visualization of urban quality of life at neighbourhood level in Enschede*. Master dissertation, The Netherland: International Institute for Geo-Information Science and Earth Observation.

DIENER, E., EUNKOOK, S., LUCAS, R., & SMITH, H. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, *125*(2), 276-302. Retrieved from http://dipeco.economia.unimib.it/persone/stanca/ec/diener_suh_lucas_smith.pdf.

GEORGIOU, J. (2009). Quality of life indicators: The objective-subjective interrelationship that exists within one ' s " place of residence " in Old Age, *5*(9).

HAAS, B. (1999). A multidisciplinary concept: Analysis of quality of life. *Western Journal of Nursing Research*, *21*(6), 728-742. doi: 10.1525/aa.1968.70.3.02a00180.

HENGL, T. (2009). *A Practical Guide to Geostatistical Mapping*. *Office* (2nd ed.). Office for Official Publications of the European Communities.

KIM, I. Y., & DE WECK, L. (2005). Adaptive weighted sum method for multiobjective optimization: a new method for Pareto front generation. *Structural and Multidisciplinary Optimization*, *31*(2), 105-116. doi: 0.1007/s00158-005-0557-6.

LI, G., & WENG, Q. (2007). Measuring the quality of life in city of Indianapolis by integration of remote sensing and census data. *International Journal of Remote Sensing*, *28*(2), 249-267. doi: 10.1080/01431160600735624.

MARANS, R. (2003). Understanding environmental quality through quality of life studies: the 2001 DAS and its use of subjective and objective indicators. *Landscape and Urban Planning*, *65*(1-2), 73-83. doi: 10.1016/S0169-2046(02)00239-6.

MCCREA, R., SHYY, T.-K., & STIMSON, R. (2006). What is the strength of the link between objective and subjective indicators of urban quality of life? *Applied Research in Quality of Life*, *1*(1), 79-96. doi: 10.1007/s11482-006-9002-2.

Mercer. (2010). Defining Quality of Living. Retrieved September 29, 2010, from http://www.mercer.com/referencecontent.htm?idContent=1380465.

OKABE, A., BOOTS, B., & SUGIHARA, K. (1992). *Spatial Tesselations: Concepts and Applications of Voronoi Diagrams* (pp. 65-115). John Wiley & Sons Ltd.

OLSSON, U., DRASGOW, F., & DORANS, N. (1982). The polyserial correlation coefficient. *Psychometrika*, *47*(3). Retrieved from http://www.springerlink.com/content/g0634410m77h5x19/fulltext.pdf.

PALER-CALMORIN, L., & CALMORIN, M. (1997). *Statistics in Education and the Sciences: With Application to Research* (p. 311). Quezon City: Rex Bookstore Inc.

PFEIFFER, D., STEVENSON, M., ROBINSON, T., STEVENS, K., & ROGERS, D. (2008). *Spatial analysis in epidemiology*. (D. Pfeiffer & T. Robinson, Eds.) (p. 142). Oxford University Press.

REIMANN, C., FILZMOSER, P., GARRETT, R., & DUTTER, R. (2008). *Statistical Data Analysis Explained*. John Wiley & Sons Ltd.

ROGERSON, R. J. (1999). Quality of life and city competitiveness. *Urban Studies*, *36*(5), 969-985. doi: 10.1080/0042098993303.

SANTOS, L. D., & MARTINS, I. (2006). Monitoring urban quality of life: The porto experience. *Social Indicators Research*, 411-425. doi: 10.1007/s11205-006-0002-2.

SASTRY, N., PEBLEY, A., & ZONTA, M. (2002). Neighborhood definitions and the spatial dimension of daily life in Los Angeles. *Labor and Population Program Working Paper*, *3*(35). doi: 10.1016/S0021-8693(02)00518-5.

SCHWARZ, N., & STRUCK, F. (1999). *Reports of subjective well-being : Judgmental processes and their methodological implications*. *Most* (pp. 61-84). Retrieved from http://www.fz-juelich.de/inb/inb-mut/innsbruck/sommer06/pdf/unterlagen/reports.pdf.

SHAFER, C. S., KOO LEE, B., & TURNER, S. (2000). A tale of three greenway trails: user perceptions related to quality of life. *Landscape Urban Planning*, *49*, 163-178.

SOARES, N. (n.d.). Uma populacao que se urbanize: Uma avaliacao recente. Retrieved October 25, 2010, from http://web.archive.org/web/20070620202240/http://.

TESFAZGHI, E. S. (2009). *Urban quality of life and its spatial distribution in Addis Ababa : Kirkos sub-city urban quality of life and its spatial distribution In Addis Ababa : Kirkos sub-city*. Master dissertation, International Institute for Geo-information Science and Earth Geo-Information Science.

TESFAZGHI, E. S., MARTINEZ, J. A., & VERPLANKE, J. J. (2010). Variability of quality of life at small scales: Addis Ababa, Kirkos sub-city. *Social indicators research*, *98*(1), 73-88. doi: 10.1007/s11205-009-9518-6.

TUAN SEIK, F. (2000). Subjective assessment of urban quality of life in Singapore (1997–1998). *Habitat International*, *24*(1), 31-49. doi: 10.1016/S0197-3975(99)00026-0.

TURKSEVER, A. N. E., & ATALIK, G. (2000). Possibilities and limitations for the measurement of the quality of life in urban areas. *Social Indicators Research*, 163-187.

UEBERSAX, J. (2006). How to analyse correlation between continuous data and classification data. Retrieved January 15, 2011, from http://www.mathkb.com/Uwe/Forum.aspx/stats/1607/how-to-analyse-correlation-between-continuous-data-and-classification.

UPTON, G., & FINGLETON, B. (1985). *Spatial data analysis by example: Point pattern and quantitative data* (p. 373). John Wiley & Sons Ltd.

Urban Audit. (n.d.). Lisboa city profile. Retrieved September 28, 2010, from http://www.urbanaudit.org/CityProfiles.aspx.

VANKAMP, I., LEIDELMEIJER, K., MARSMAN, G., & DEHOLLANDER, A. (2003). Urban environmental quality and human well-being towards a conceptual framework and demarcation of concepts; a literature study. *Landscape and Urban Planning*, *65*(1-2), 5-18. doi: 10.1016/S0169-2046(02)00232-3.

VEENHOVEN, R. (2004). Why social policy needs subjective indicators. *Social Indicators Research*, 33-45.

Wendell Cox Consultancy. (2010). *Demographia world urban areas & population projections*. Retrieved from http://www.demographia.com/db-worldua2015.pdf.

APPENDICES

Objective	Subjective							
Distance from a nearest service	Level of happiness		Level of trust		Feeling of inclusion		Overall level of satisfaction	
	Rho	P-value	Rho	P-value	Rho	P-value	Rho	P-value
Recycling bins	0.02	0.131	0.15	0.125	0.03	0.127	0.06	0.131
Parking lots	0.05	0.130	0.16	0.125	0.13	0.125	0.13	0.128
Police stations	<-0.00	0.130	-0.11	0.126	-0.16	0.124	-0.06	0.129
Recreational centers	0.09	0.128	0.04	0.128	0.08	0.126	0.14	0.126
Markets	0.10	0.128	-0.17	0.123	0.04	0.127	-0.05	0.129
Open spaces	-0.06	0.129	-0.03	0.129	0.08	0.126	0.04	0.129
Main streets	-0.11	0.128	0.01	0.129	-0.19	0.122	-0.02	0.130
Public transport facilities	-0.06	0.130	0.04	0.128	-0.03	0.127	0.11	0.128
Restaurants	0.22	0.122	-0.10	0.127	0.07	0.126	0.04	0.129
Institutions	0.14	0.129	-0.01	0.129	0.09	0.126	0.09	0.130
High and low order shops	-0.01	0.129	-0.20	0.121	-0.02	0.128	-0.09	0.127

Table A1. Polyserial correlation of personal indicators

	SC	CC	PS	GS	SH	SS	HA	MA	TA	CA	RA	NI	LE	AH	HQ	LH	LT	FI	OS
SC	1	0.14	0.03	0.02	0.02	0.23	0.29	0.30	0.24	0.15	0.24	0.09	0.24	0.11	0.21	0.29	0.27	0.12	0.47
CC	0.14	1	0.59	0.12	0.20	0.34	0.12	0.16	<0.0	0.15	0.28	0.14	-.08	0.28	0.13	0.03	0.20	0.04	0.15
PS	0.03	0.59	1	0.20	0.13	0.35	0.06	0.06	-.04	0.09	0.20	0.08	0.03	0.22	0.05	-.04	0.06	0.01	0.11
GS	0.02	0.12	0.20	1	0.21	0.23	0.10	0.05	-.08	0.23	<0.0	0.13	-.23	0.13	-.03	0.19	0.08	0.15	0.23
SH	0.02	0.2	0.13	0.21	1	0.61	0.27	0.01	0.40	0.28	0.21	0.15	0.05	0.10	-.05	0.35	0.33	0.42	0.41
SS	0.23	0.34	0.35	0.23	0.61	1	0.26	0.18	0.06	0.35	0.29	0.09	0.06	0.23	0.03	0.15	0.32	0.34	0.42
HA	0.29	0.12	0.06	0.10	0.27	0.18	1	0.36	0.05	0.11	0.25	0.07	0.23	0.16	0.17	0.24	0.26	0.12	0.27
MA	0.30	0.16	0.06	0.05	0.01	0.26	0.36	1	0.41	0.34	0.27	0.29	0.40	0.12	0.17	0.18	0.17	0.09	0.16
TA	0.24	<0.0	-0.04	-0.08	0.04	0.06	0.05	0.41	1	0.30	0.25	0.25	0.21	-.03	0.03	0.15	0.17	-.05	0.15
CA	0.15	0.15	0.09	0.23	0.28	0.35	0.35	0.34	0.30	1	0.05	0.33	0.13	-.01	-.03	0.10	0.11	0.28	0.24
RA	0.24	0.28	0.20	<0.0	0.21	0.29	0.29	0.27	0.25	0.05	1	0.12	0.09	0.11	0.07	0.19	0.11	0.24	0.27
NI	0.09	0.14	0.08	0.13	0.15	0.09	0.09	0.29	0.25	0.33	0.12	1	0.09	0.16	0.24	0.40	0.47	0.34	0.36
LE	0.24	-0.08	0.03	-0.23	0.05	0.06	0.06	0.40	0.21	0.13	0.09	0.09	1	0.15	0.26	0.12	0.11	0.19	0.14
AH	0.11	0.28	0.22	0.134	0.10	0.24	0.24	0.12	-.03	-.01	0.11	0.16	0.15	1	0.22	0.17	0.20	0.15	0.10
HQ	0.21	0.13	0.05	-0.03	-.05	0.03	0.03	0.17	-.03	-.03	0.07	0.24	0.26	0.22	1	0.13	0.10	0.05	0.16
LH	0.29	0.03	-0.04	0.19	0.35	0.15	0.15	0.18	0.15	0.10	0.19	0.40	0.12	0.17	0.13	1	0.56	0.63	0.70
LT	0.27	0.20	0.06	0.08	0.33	0.32	0.32	0.17	0.17	0.11	0.11	0.47	0.11	0.20	0.10	0.56	1	0.49	0.50
FI	0.12	0.04	<0.00	0.15	0.42	0.34	0.34	0.09	-.05	0.28	0.24	0.34	0.19	0.15	0.05	0.63	0.49	1	0.60
OS	0.47	0.15	0.11	0.23	0.41	0.42	0.42	0.16	0.15	0.24	0.27	0.36	0.14	0.10	0.16	0.70	0.50	0.60	1

SC - Street Cleanliness
CC - Car Circulation
PS - Parking Space
GS - Green Space
SH - Safety at House
SS - Safety at Streets
HA - Health Care Center Accessibility
MA - Supermarket Accessibility
TA - Public Transport Stops Accessibility
CA - Cultural/Recreational Center Accessibility
RA - Recycling Bin Accessibility
NI - Neighborhood Interactions
LE - Level of Education
AH - Affordability of Housing Cost
HQ - Housing Quality
LH - Level of Happiness
LT - Level of Trust
FI - Feeling of Inclusion
OS - Overall Satisfaction

Table A2. Spearman's rho of subjective indicators

Objective	Subjective								
	Street Cleanliness			Car Circulation			Parking Space		
	Chi-square	df	p-value	Chi-square	df	p-value	Chi-square	df	p-value
Recycling bins	70.25	44	0.007187	67.95	53	0.08109	64.71	53	0.13
Parking lots	42.51	44	0.5356	63.02	53	0.1631	59.53	53	0.2503
Police stations	58.79	44	0.06717	72.43	53	0.0393	75.8	53	0.02161
Recreational centers	47.39	44	0.3359	39.88	53	0.9085	47.2	53	0.6985
Markets	61.23	44	0.04368	51.36	53	0.5381	49.87	53	0.5967
Open spaces	58.08	44	0.07566	72.61	53	0.03808	65.47	53	0.1169
Main streets	73.37	44	0.003585	74.21	53	0.02882	74.38	53	0.02796
Public transport facilities	41.32	44	0.587	59.36	53	0.255	58.02	53	0.2954
Restaurants	44.39	44	0.4551	50.34	53	0.5785	53.64	53	0.4495
Institutions	41.53	44	0.5782	61.92	53	0.1878	56.38	53	0.3498
High and low order shops	64.84	44	0.02209	61.47	53	0.1987	52.43	53	0.4961

Table A3. Test of Bivariate Normality of Indicators (1)

Objective	Subjective								
	Green Space			Safety at House			Safety at Streets		
	Chi-square	df	p-value	Chi-square	df	p-value	Chi-square	df	p-value
Recycling bins	67.03	53	0.09321	53.52	44	0.154	49.42	44	0.2657
Parking lots	47.08	53	0.7029	50.66	44	0.2273	42.32	44	0.5439
Police stations	61.53	53	0.1972	57.65	44	0.08131	49.54	44	0.2616
Recreational centers	47.95	53	0.6707	45.65	44	0.4035	33.68	44	0.8702
Markets	37.48	53	0.9474	52.47	44	0.1786	42.86	44	0.5203
Open spaces	78.68	53	0.01257	57.87	44	0.07837	55.16	44	0.1206
Main streets	81.35	53	0.007389	68.64	44	0.01015	67.5	44	0.01289
Public transport facilities	48.61	53	0.6458	41.19	44	0.5926	37.49	44	0.7453
Restaurants	41.31	53	0.8781	62.61	44	0.03388	42.11	44	0.553
Institutions	47.59	53	0.684	44.88	44	0.435	36.26	44	0.7901
High and low order shops	48.85	53	0.6364	47.87	44	0.3187	27.59	44	0.9748

Table A4. Test of bivariate normality of indicators (2)

Objective	Subjective								
	Health Care Center Accessibility			Supermarket Accessibility			Public Transport Facilities Accessibility		
	Chi-square	df	p-value	Chi-square	df	p-value	Chi-square	df	p-value
Recycling bins	46.68	44	0.3628	64.12	44	0.02541	62.38	44	0.03538
Parking lots	29.59	44	0.9527	46.53	44	0.3688	46.23	44	0.3803
Police stations	49.84	44	0.2522	57.19	44	0.08757	52.56	44	0.1764
Recreational centers	41.61	44	0.5744	46.02	44	0.3885	52.95	44	0.1671
Markets	54.36	44	0.1362	53.12	44	0.1629	38.87	44	0.6906
Open spaces	49.57	44	0.2608	51.07	44	0.2156	44.79	44	0.4386
Main streets	62.12	44	0.03715	67.88	44	0.01191	68.99	44	0.00942
Public transport facilities	39.74	44	0.6546	53.77	44	0.1485	50.38	44	0.2357
Restaurants	62.54	44	0.03434	52.48	44	0.1784	51.72	44	0.1978
Institutions	51.05	44	0.2163	47.83	44	0.32	48.59	44	0.2934
High and low order shops	44.92	44	0.433	54.74	44	0.1286	62.03	44	0.03773

Table A5. Test of bivariate normality of indicators (3)

Objective	Subjective								
	Recreational Center Accessibility			Recycling Bin Accessibility			Neighborhood Interactions		
	Chi-square	df	p-value	Chi-square	df	p-value	Chi-square	df	p-value
Recycling bins	56.56	44	0.09703	61.73	44	0.03988	55.97	53	0.3639
Parking lots	49.29	44	0.27	65.12	44	0.02087	49.66	53	0.6052
Police stations	73.17	44	0.003748	51.21	44	0.2117	58.64	53	0.2763
Recreational centers	50.01	44	0.2469	63.03	44	0.03131	45.51	53	0.7578
Markets	40.07,	44	0.6407	64.72	44	0.02261	56.53	53	0.3445
Open spaces	38.74	44	0.696	41.51	44	0.579	50.98	53	0.5531
Main streets	65	44	0.02136	80.11	44	0.0007	74.35	53	0.02811
Public transport facilities	57.23	44	0.08706	64.45	44	0.02382	60.19	53	0.2317
Restaurants	48.93	44	0.2818	55.61	44	0.1127	65.05	53	0.1239
Institutions	51.3	44	0.2092	57.42	44	0.08442	48.51	53	0.6494
High and low order shops	47.8	44	0.3211	59.31	44	0.0614	54.78	53	0.4068

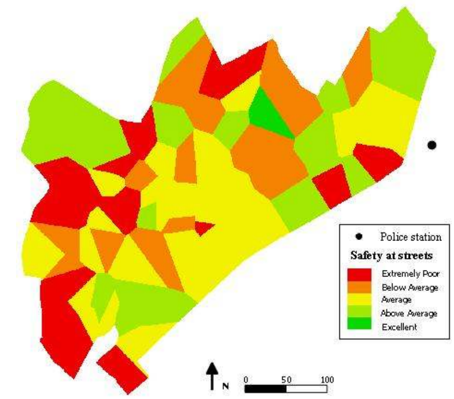
Table A6. Test of bivariate normality of indicators (4)

Objective	Subjective								
	Level of Education			Affordability of Housing Cos			Housing Quality		
	Chi-square	df	p-value	Chi-square	df	p-value	Chi-square	df	p-value
Recycling bins	64.12	53	0.1409	58.23	53	0.2889	52.04	53	0.1894
Parking lots	52.13	53	0.508	40.49	53	0.8963	45.1	53	0.4258
Police stations	69.07	53	0.06816	75.16	53	0.0243	49.87	53	0.2514
Recreational centers	53.67	53	0.4485	47.28	53	0.6955	33.53	53	0.8744
Markets	59.27	53	0.2576	63.84	53	0.1463	49.95	53	0.249
Open spaces	57.35	53	0.3171	48.57	53	0.6472	45.76	53	0.3991
Main streets	74.34	53	0.02816	62.53	53	0.1737	69.15	53	0.0091
Public transport facilities	48.18	53	0.6618	59.86	53	0.2407	36.89	53	0.7677
Restaurants	55.31	53	0.3876	38.72	53	0.9291	49.86	53	0.2517
Institutions	63.6	53	0.1512	57.32	53	0.318	41.85,	53	0.564
High and low order shops	59.8	53	0.2424	53.04	53	0.4728	40.79	53	0.61

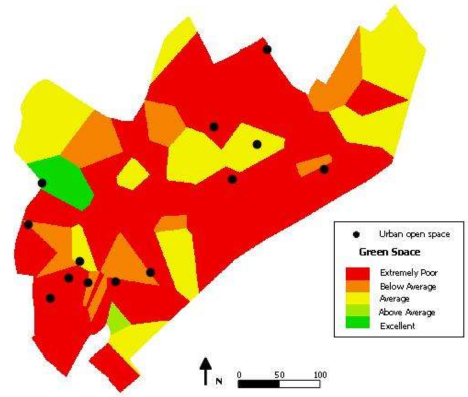
Table A7. Test of bivariate normality of indicators (5)

Figure A1. Visualizing objective with the subjective data

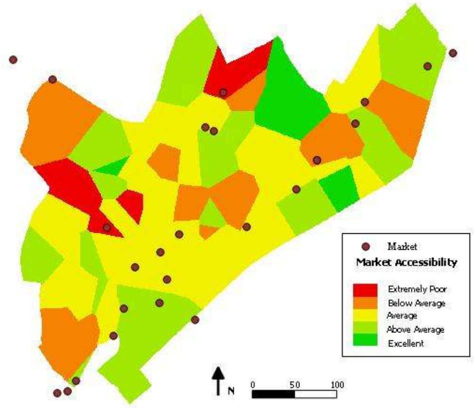
1. Safety at streets assessment with police station location



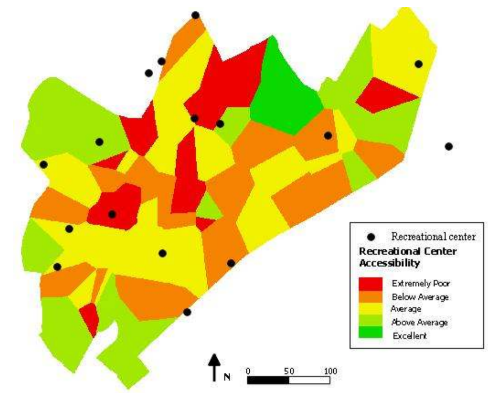
2. Green space assessment with urban open space locations



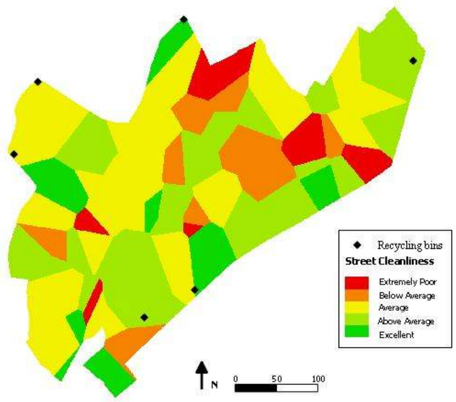
3. Supermarket accessibility assessment with market locations



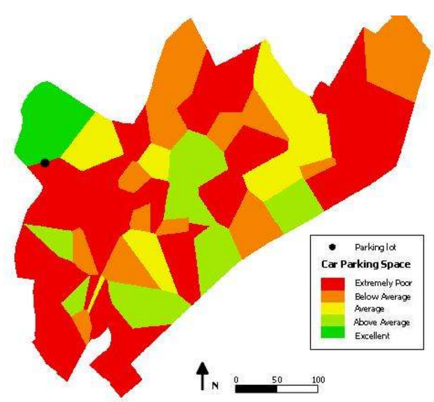
4. Recreational center accessibility with recreational center locations



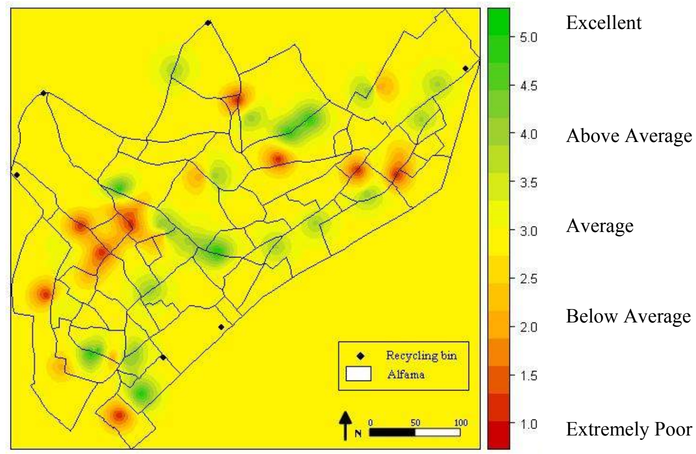
5. Street cleanliness assessment with recycling bin locations



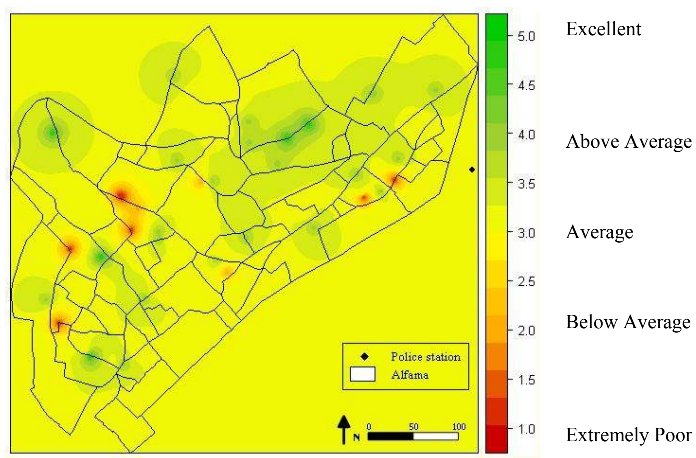
6. Car parking space with parking lot locations



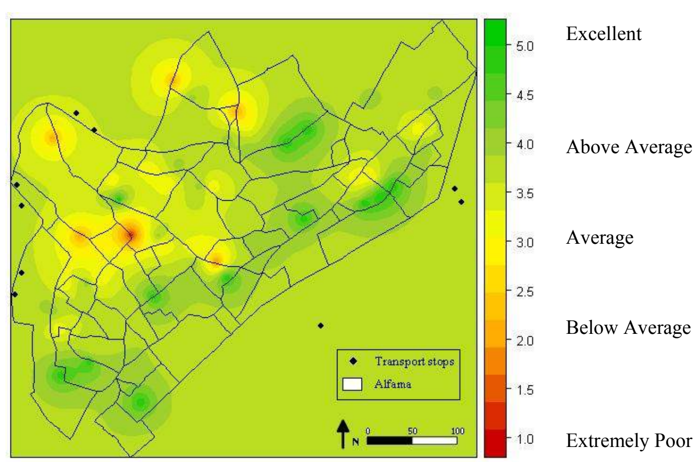
7. Recycling bin accessibility assessment with recycling bin locations



8. Housing safety assessment with police station location



9. Transport stops accessibility assessment with transport stops location



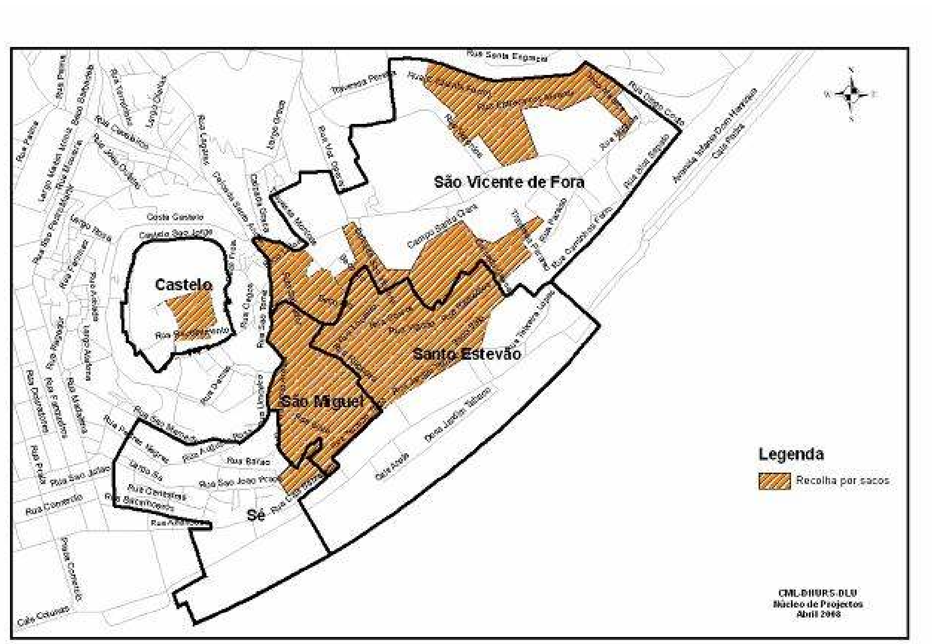


Figure A2. Door-to-door collection of recyclables in Alfama (Departamento de Higiene Urbana e Residuos Solidos)

	Frequency				
	Extremely Poor	Below Average	Average	Above Average	Excellent
Intuitive rating of QoL	3	14	35	14	3
Coherent rating of QoL	4	5	27	26	7

Table A8. Rating of quality of life

Appendix A. Survey questionnaire in Portuguese

Data:

2010 Avaliação da qualidade de vida em Alfama

(Este documento é confidencial e tem como única finalidade este estudo)

Area de Alfama abrangida

Bom dia! O meu nome é Pearl dela Cruz e estudo na Universidade Nova de Lisboa. Actualmente, encontro-me a escrever a minha tese de mestrado sobre avaliação da qualidade de vida em Alfama. Os principais objectivos são os seguintes: saber a actual situação em Alfama; e determinar o nível de satisfação dos residentes sobre a sua qualidade de vida para o ano 2010. Este inquérito será a base do meu estudo por isso espero que me possa dar pelo menos 10minutos do seu tempo para responder as questões abaixo. Agradeço a sua colaboração.

I. Dados pessoais

Género	☐ Feminino ☐ Masculino	**Idade**	
Profissão	☐ Membro das forças armadas ☐ Gerente da administração pública ou empresa privada. ☐ Intelectual ou cientísta. ☐ Técnico de nível intermédio. ☐ Serviços ou vendedor. ☐ Administrativo e similares.	☐ Agricultura ou pesca. ☐ Operário, artífice o trabalhador similar. ☐ Instalador de máquinas ou montagem. ☐ Trabalhador não qualificado. ☐ Outro_______________	
Morada	Rua	Numero	
Tipo de Trabalho	☐ Independente ☐ Por conta de outros		
Habilitações Literárias	☐ 1° ciclo do ensino básico ☐ Licenciatura	☐ 2/3°ciclo do ensino básico ☐ Mestrado	☐ Bacharelato ☐ Doutoramento
Existe alguém na família que possui um carro?	☐ Sim ☐ Não		
Tem casa própria ou alugada	☐ Alugada ☐ Própria		
Número de pessoas que habitam na sua casa			
Número de anos que vive em Alfama			
Tem interacção com os seus vizinhos?	☐ Sim ☐ Não	**Quantas vezes por semana**	
Tem outra casa fora de Alfama onde costuma viver?	☐ Sim ☐ Não		
Se respondeu Sim, acha que a qualidade de vida lá é melhor do que em Alfama?	☐ Sim ☐ Não		

Escala para os estados dos indicadores:

Muito mau **Abaixo da média** **Médio** **Acima da média** **Excelente**

Considerando todos os aspectos de vida, como avalia a sua qualidade de vida actualmente em Alfama?					

II. Indicadores Físicos

Avaliação dos seguintes indicadores:						**Não se aplica**	**Ω Escala de Prioridades (1-4)**
1. **LIMPEZA DAS RUAS** a volta da sua casa							
2. **CIRCULAÇÃO DE CARROS** a volta da sua casa							
3. **ESTACIONAMENTO** a volta da sua casa							
4. **ESPAÇOS VERDES** a volta da sua casa							

Ω A partir das questões acima (1-4), dê as suas prioridades, sendo 1 o maior e 4 o mais baixo.

III. Indicadores Sociais

Avaliação dos seguintes indicadores:						**Não se aplica**	**Ω Escala de Prioridades (1-8)**
1. **SEGURANÇA DENTRO DE CASA**							
2. **SEGURANÇA NAS RUAS** a volta da sua casa							
3. **ACESSIBILIDADE A CUIDADOS DE HOSPITAIS** a partir da sua casa							
4. **ACESSIBILIDADE A SUPERMERCADOS** a partir da sua casa							
5. **ACESSIBILIDADE A TRANSPORTES PÚBLICOS** a partir da sua casa							
6. **ACESSIBILIDADE A CENTROS RECRIATIVOS/CULTURAIS(CINEMA, TEATRO, MUSEU)** a partir da sua casa.							
7. **ACESSIBILIDADE A ECOPONTOS (RECICLAGEM)** a partir da sua casa							
8. **INTERACTIVIDADE COM OS VIZINHOS** a volta da sua casa							

Ω A partir das questões acima (1-8), dê as suas prioridades, sendo 1 o maior e 8 o mais baixo.

IV. Indicadores Económicos

Avaliação dos seguintes indicadores:						**Não se aplica**	Ω **Escala de Prioridades (1-3)**
1. **GRAU DE EDUCAÇÃO** das pessoas que vivem a volta da sua casa							
2. **CAPACIDADE DE SUPORTAR AS DESPESAS DA CASA**							
3. **QUALIDADE DAS HABITAÇÕES** a volta da sua casa							

Ω A partir das questões acima (1-3), dê as suas prioridades, sendo 1 o maior e 3 o mais baixo.

Referindo-se ao grupo de três indicadores das questões acima (fisico(II), social(III), económico(IV)), forneça as suas prioridades, sendo 1 o mais alto e 3 o mais baixo.

II. Indicadores Física	**III. Indicadores Social**	**IV. Indicadores Económica**

V. Vida Pessoal

Avaliação dos seguintes indicadores:						**Não se aplica**
1. **NÍVEL DE FELICIDADE** depois de viver mais de um ano em Alfama						
2. **NÍVEL DE CONFIANÇA** na vizinhança depois de viver mais de um ano em Alfama.						
3. **SENTIMENTO DE INCLUSÃO** no bairro depois de mais de um ano de viver em Alfama						
4. **NÍVEL DE SATISFAÇÃO** depois de um ano a viver em Alfama						

Considerando todos os aspectos de vida, como avalia a sua qualidade de vida actualmente em Alfama?					

Obrigada pela colaboração!!!

Appendix B. Survey questionnaire in English

Date:

2010 QUALITY OF LIFE ASSESSMENT IN ALFAMA

(This document is confidential and for research purpose only)

Alfama Study Area Coverage

Good day! I'm Pearl dela Cruz studying in Universidade Nova de Lisboa. Currently, I am doing my Master Thesis about Assessing the Quality of Life in Alfama. The main objectives are the following: to know the current situation in Alfama; and to determine the level of satisfaction of the residents with their quality of life for the year 2010. The survey will be the basis of my study and so I hope you can give me at least your five minutes to answer the questions below. I hope for your cooperation.

I. Personal Information:

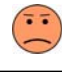
Sex	☐ Female ☐ Male	**Age**	
Address	Street	Number	
Profession	☐ Armed forces. ☐ Senior government officials, corporate and general managers. ☐ Professionals and scientists. ☐ Technicians and associate professionals. ☐ Clerks and related workers. ☐ Service workers and shop and market sales workers.	☐ Skilled agricultural and fishery workers. ☐ Craft and related trades workers. ☐ Plant and machine operators and assemblers. ☐ Elementary occupations. ☐ Others________________	
Type of Work	☐ Independente ☐ Por conta de outros		
Educational Attainment	☐ Elementary ☐ Secondary ☐ Bachelor ☐ Licenciatura ☐ Master ☐ Doctoral		
Is there anyone in the family who owns a car?	☐ Yes ☐ No		
Do you have rented/own house	☐ Rented ☐ Own		
Number of people residing			
Number of years living in Alfama			
Are you having interactions with your neighbors?	☐ Yes ☐ No	**How many times a week?**	
Do you have other house outside Alfama where you partially live?	☐ Yes ☐ No		
If Yes, do you think your quality of life there is better than in Alfama?	☐ Yes ☐ No		

Scale Definition:

Extremely Poor | **Below Average** | **Average** | **Above Average** | **Excellent**

	Extremely Poor	Below Average	Average	Above Average	Excellent
Considering all aspects of life, how do you rate your quality of life currently in Alfama?					

II. Physical Indicators

Assessment of the following indicators:						Not Appli-cable	Ω Scale of Priority (1-4)
1. **STREET CLEANLINESS** around your residence							
2. **CAR CIRCULATION** around your residence							
3. **CAR PARKING SPACE** around your residence							
4. **GREEN SPACE** around your residence							

Ω From the above questions (1 – 4), please give your priorities, 1 being the highest and 4 being the lowest.

III. Indicadores Sociais

Assessment of the following indicators:						Not Appli-cable	*Scale of Priority (1-8)
1. **SAFETY AT HOME** around your residence							
2. **SAFETY AT STREETS** around your residence							
3. **ACCESSIBILITY OF HOSPITAL** from your residence							
4. **ACCESSIBILITY OF FOOD STORE/SUPERMARKET** from your residence							
5. **ACCESSIBILITY OF PUBLIC TRANSPORTATION FACILITIES** from your residence							
6. **ACCESSIBILITY OF RECREATIONAL/CULTURAL CENTER (CINEMA, THEATRE, MUSEUM)** from your residence							
7. **ACCESSIBILITY OF RECYCLING FACILITIES** from your residence							
8. **NEIGHBORHOOD INTERACTIONS** around your residence							

Ω From the above questions (1 – 8), please give your priorities, 1 being the highest and 8 being the lowest.

IV. Economic Indicators

Assessment of the following indicators:						**Not Appli-cable**	***Scale of Priority (1-3)**
1. **LEVEL OF EDUCATION** of the people living around your residence							
2. **AFFORDABILITY OF HOUSING COST** around your residence							
3. **HOUSING QUALITY** around your residence							

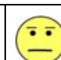
Ω From the above questions (1 – 3), please give your priorities, 1 being the highest and 3 being the lowest.

Referindo-se ao grupo de três indicadores das questões acima (fisico(II), social(III), económico(IV)), forneça as suas prioridades, sendo 1 o mais alto e 3 o mais baixo.

II. Physical	**III. Social**	**IV. Economic**

V. Personal Life

Assessment of the following indicators:						**Not Appli-cable**
1. **LEVEL OF HAPPINESS** over a year of living in Alfama						
2. **LEVEL OF TRUST** in your neighborhood over a year of living in Alfama						
3. **FEELING OF INCLUSION** in your neighborhood over a year of living in Alfama						
4. **OVERALL LEVEL OF SATISFACTION** over a year of living in Alfama						

Considering all aspects of life, how do you rate your quality of life currently in Alfama?					

THANK YOU VERY MUCH!!!