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Analytic Network Process (ANP) for Housing Quality Evaluation: A Case Study in Ghana

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A thesis submitted in partial fulfillment of the requirements for the degree in Master of Arts

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By

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Abstract

Quality of housing is crucial to an individual's quality of life as it is known to affect human health and well-being. Several studies have employed different methods to assess housing quality. These methods, however, failed to account for the interdependence among the factors (criteria) used for evaluating the quality of housing. This thesis proposes an Analytic Network Process (ANP)-based framework, integrated into Geographic Information Systems (GIS), to assess housing quality. ANP is a multicriteria analysis method. It provides a tool for identifying the relative importance of all the elements (criteria) influencing a goal of decision/evaluation problem (e.g., the problem of evaluating housing quality). The method allows for incorporating dependence relationships into the multicriteria evaluation procedure. A case study of housing quality evaluation at the district level in Ghana using the framework is presented. A set of quality based indicators related to the physical (structural material, dwelling types, housing services), socio-economic (tenure and household density (overcrowding) and environmental (modes of solid waste and liquid waste disposal) aspects of dwellings was used for the evaluation. The results demonstrate the effectiveness of the proposed approach. The GIS-based ANP approach allows for examining spatial distribution of housing quality. It also identifies the most important factors (indicators) contributing to the variability of housing quality in Ghana.

Key words: Analytic Network Process (ANP), Geographic Information Systems (GIS), Multicriteria Decision Analysis (MCDA), Housing quality, Ghana.

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CHAPTER ONE

INTRODUCTION AND CHAPTER OUTLINE

1.1 Introduction

Housing is one of the basic necessities of life and a key aspect of human existence. Irrespective of the level of society's socio-economic development, it remains a basic human need with its quality, cost and availability being vital to an individual's quality of life (Bogdanović & Mitković, 2005; Jiboye, 2010a). Availability of housing constitutes a critical component of quality of life and a vital indicator for measuring quality of life. Previous studies have established relationship between quality of life and housing (Das, 2008; Oswald et al., 2003; So & Leung, 2004; Zebardast, 2009). These studies demonstrated that housing is an important domain that contributes to the overall quality of life of individuals. Das (2008) reported that, satisfaction from condition of housing is strongly correlated with satisfaction with overall quality of life. Oswald et al. (2003) found that housing related variables explains a substantial portion of the variance in life satisfaction. So and Leung (2004) have shown that there is a strong correlation between sufficient housing, visual acceptability of the houses and quality of life.

Housing may vary in its type, size and design, but whatever form it takes, there is a need to measure its quality to ensure that it gratifies the resident's family and cultural norms (Mohit, Ibrahim & Rashid, 2010). Human beings spend more than 85 per cent of their entire life inside buildings, hence, the characteristics of the buildings are of utmost importance to an individual's quality of life (So & Leung, 2004). Based on the need to assess the quality of the houses and recognizing the importance of housing satisfaction to a person's overall quality of life, numerous studies have employed different methods to assess housing quality. Housing quality assessment have been applied in several studies.

Twitchell (1948) presented the appraisal method used by the Committee on the Hygiene of Housing (USA) to evaluate housing quality in the United States. The method measured housing quality based on a system of numerical scores. This was a unique feature of the method. These numerical scores consisted of penalty points that are assigned to conditions of the dwellings that fail to meet accepted housing standards as stipulated by the committee. Houses that fail to meet these standards comprised of houses with deficiencies, which may adversely affect health, safety or essential livability. Each deficiency in the houses is graded according to the seriousness of that condition as a threat to health or safety or as an impairment of general livability. For comparative purposes, the approach classified houses into quality grades based on the median total penalty scores and shown on a map, which summarizes the appraisal of the houses. This method is intended for use primarily in areas known to contain mediocre or poor housing and not for city-wide applications.

Pollard (1953) adopted a method similar to the appraisal method to assess housing quality. However, this method takes statistical equivalent as a point of departure (% of dwelling units that are dilapidated in a given census tract is equivalent to the probability that any one dwelling unit in that tract is dilapidated). Pollard argued that the appraisal method would largely fail to produce a clear picture of the relative quality of housing. This is because there are an uneven number of dwelling units in each group (a group being those building blocks having the same number of penalty points). Just like the appraisal method, Pollard's method involved allocation of penalty points to the percent of dilapidated buildings for each census tract. These methods were used in developed country, specifically the USA.

Unlike the developed world, developing countries lack an active real estate (housing) market with well-documented housing information, which can be used for effective assessment of housing quality. As such, Rindfuss et al. (2007) proposed a new method based on a standardized subjective rating process. This method involves observation from outside including taking pictures of dwelling units, having an intuitive sense of their relative value and ranking them on a five-point quality scale. They argued that, the standard building-components method (asking questions on building materials used in the dwelling unit) that was being used in developing countries is poor at measuring housing quality as these surveys do not have a standardized set of questions.

Furthermore, Kurian and Thampuran (2011) developed a methodology for assessing housing quality using requirements of a target population based on multivariate statistics. The method identified various indicators (location, design of buildings, materials and construction techniques, aesthetics etc.) that contributed to the housing quality requirements of a homogeneous population in a community and their relative weightings. In order to study the relationships between the various factors and indicators, they used a stepwise multiple regression model.

Although different methods have been proposed and used to assess quality of houses, a common limitation of these methods is that, except Twitchell (1948), none of them accounted for the spatial patterns of housing quality as an important aspect in making well-informed housing decisions as classifying areas according to the quality of houses. Also, they are limited by their selected application areas; that is, their focus on homogenous population and non-city-wide case studies. In addition, these methods used very basic techniques for the evaluation, as a result not able to produce a comprehensive appraisal of housing quality. Because of the simplistic nature of these methods, it is necessary to consider a more comprehensive approach to evaluate housing quality. Moreover, the indicators used for housing quality assessment have multiple and conflicting aspects that need to be addressed as housing quality evaluation. Multicriteria Decision Analysis (MCDA) techniques are suitable for addressing these challenges.

MCDA allows for capturing the diversity of indicators (criteria) for the assessment of housing quality, providing decision makers (and policy makers) a better understanding of the trade-offs between evaluation criteria (Natividade-Jesus, Coutinho-Rodrigues, & Antunes, 2007). MCDA can combine a large number of evaluation criteria to obtain a composite measure of housing quality and allows weighting of individual indicators. The MCDA-based composite housing quality scores could inform subsequent housing decision-making like tenants or buyers choosing suitable dwellings, and architects selecting the best design alternatives during the preconstruction stages.

Studies that used MCDA to assess housing quality include Can (1992) and Meng and Hall (2006). Can (1992) used generalized concordance-discordance analysis to assess residential quality as a discrete multicriteria evaluation problem and generated a general performance score for geographical units based on their socioeconomic attributes. Meng and Hall (2006) employed a relatively simple multi-attribute analysis. The method involved ranking and weighting of housing quality indicators by community people to create an index. The weighted sum of the indicators was used to create the housing quality index.

However, Can (1992) and Meng and Hall (2006) methods fail to account for the relationships between the indicators used for the assessment of housing quality. To address this limitation, Analytic Network Process (ANP) could be used. Thomas Saaty, who is also the author of the well-known Analytic Hierarchy Process (AHP), proposed the ANP technique (Saaty, 1996). The ANP is a MCDA method that incorporates the influences and interactions among the elements of the system (decision problem) and allows for more complex, interdependent, relationships, and feedback among elements in the hierarchy. Furthermore, ANP makes it possible to consider all kinds of dependence and feedback in the decision problem (Sipahi & Timor, 2010).

ANP is gaining popularity and has found application in various fields. In the field of solid waste management, Khan and Faisal (2008) have used ANP for prioritizing and selecting appropriate municipal solid waste disposal methods, Aragone´s-Beltra`n et al. (2010) applied the method to select the optimal location of municipal solid waste plant in Valencia (Spain). Other studies that have used ANP include Banar et al. (2007) for choosing one of the four alternative landfill sites in Eskisehir (Turkey). In the transport sector, Banai (2010) applied ANP in light rail route selection by taking into account the station area landuse interaction and property value. Likewise, Bottero and Lami (2010) used the method to support the decision-making process related to the choice of different transport scenarios in the town of Venaria Reale, Northern Italy. In risk assessment, Nekhay, Arriaza, and Boerboom (2009) used ANP for soil erosion risk evaluation in Spain by identifying agricultural areas with higher soil erosion risk, and Neaupane and Piantanakulchai (2006) employed the method for landslide hazard assessment in Nepal, Spain. Other areas of the ANP method applications include industrial management (Karsak, Sozer, & Alptekin, 2003; Partovi, 2006), construction planning and project selection (Chen et al., 2005; Cheng & Li, 2005), energy policy (Erdogmus et al., 2006; Ulutas, 2005) and forest management (Wolfslehner et al., 2004). Most of these studies (e.g. Banai, 2010; Nekhay et al, 2009) have indicated the effectiveness of the ANP method in their application areas as it allowed for interdependence and interrelationships among the factors and indicators used and further measured dependencies among them. Other studies (e.g. Banai, 2010, Nekhay et al., 2009) have stipulated that ANP can be used as a tool for making predictions under uncertainty (limited data).

Although ANP has found its application in different fields with much success, it remains to be explored in its application to housing quality evaluation. The method has not been applied in this field, especially in the GIS-MCDA domain. This research therefore seeks to apply ANP method to assess housing quality at the district level in Ghana to find out how effective the method would be in evaluating housing quality by taking into account the relationship between the indicators.

1.2 Objectives

There are three main objectives of this thesis:

1. to develop an ANP-based framework for housing quality evaluation,
2. to integrate the framework into GIS, and
3. to apply the framework for housing quality evaluation in Ghana.

Assessment of housing quality is a complex process that involves selecting and evaluating several criteria (indicators) which affects the quality of houses. There are dependencies among these criteria that have to be analyzed as housing quality evaluation. ANP as a multicriteria decision analysis method is particularly suitable for dealing with complex decision problems which are characterized by inter-relationships among the elements. Using ANP for housing quality evaluation can help the decision maker(s) to translate a number of indicators and the relationships between them into manageable units of information. The ANP through its network structure can better capture the complex evaluation problem of housing quality by allowing the dependence relationships among the criteria (indicators) to be assessed, and the relative importance of all the indicators that have an influence on housing quality to be evaluated.

Housing quality is considered as an abstract, theoretical entity with no straightforward operational definition (Goodman, 1978). Ibem (2012) used the term housing quality to denote those highly valued attributes that housing possesses that make it suitable in meeting occupants' needs. According to Meng and Hall (2006) a normative definition of housing quality generally refers to:

> The grade or level of acceptability of dwelling units and their associated and immediate residential environment, including the design and functionality of housing structures, building materials used, the amount of internal and external space pertaining to the dwelling, housing utilities, and basic service provision. (p. 415).

For the purpose of this research, Meng and Hall (2006) definition was adopted. In housing quality assessment, two dominant approaches are used, objective (quantitative) and subjective (qualitative) measures. The quantitative aspect of housing quality evaluates the physical, social and economic components. The subjective evaluation is based on user's assessment of the ‘comfort’ or ‘quality of life’ that are afforded by different dwelling types. Because of the difficulty in measuring housing quality with the subjective approach, the objective measurements have often been used for housing quality index (e.g. Can, 1992; Fiadzo et al., 2001; Meng & Hall, 2006; Muoghalu, 1991). The objective measurement evaluates the physical features, amenities, services, and environment of the dwelling units. However, objective measurements have been criticized for failing to explain the psychosocial aspects of residential satisfaction (Mohit et al., 2010). Nevertheless, this study adopted the objective approach, because the perceptions of residents are not incorporated into the assessment.

1.3 Rationale and Contribution to Literature

The provision of housing has been a burden for some time now creating deficit in access to housing in Ghana. The shortage in the housing availability is estimated at 1.7 million housing units (Ansah, 2013). While trying to meet the general housing needs of the people, access to decent and good quality housing still pose another serious challenge to sustainable growth and development, as it is a stimulant to the national economy. There has been an increasing demand for additional housing stock, the condition and total quality of the existing stock, most of which falls short of the expected quality standards. Greatest of the existing stock lack basic amenity and infrastructure and are deteriorating fast due to lack of maintenance. What is currently known is that, there is difference in housing quality between urban and rural areas. Further, within the urban areas, there exist a difference in housing quality between the rich neighbourhoods and the poor ones. However, the disparities at the district levels have not been examined. In order to address imbalances in housing and housing quality, existing spatial variations in quality have to be identified. The effectiveness of the MCDA method, specifically ANP, in assessing the spatial pattern of housing quality, would be a precursor to any attempt at addressing this nagging issue of housing imbalances at the districts in Ghana. In addition, the findings of this study is of significance to housing policy and housing development in Ghana.

This study intends to contribute to the literature by demonstrating the usefulness of the ANP method for analysing spatial patterns of housing quality. In this regard, the findings of this work would advance research in the area of MCDA. Additionally, this study would be useful to researchers who are interested in probing the usability of ANP in tackling other spatial evaluation problems such as site selection and land use assessment problems.

1.4 Thesis Organization

The rest of the thesis is organized into five chapters. Chapter 2 overviews relevant literature on housing quality evaluation (definition, indicators and measurement approaches) as well as GIS-based ANP applications (various fields, criteria used, etc.). The GIS-ANP based framework for housing quality evaluation is described in Chapter 3. Chapter 4 focuses on application of the GIS-ANP framework to housing quality evaluation in Ghana. Results and discussions are presented in Chapter 5. Finally, Chapter 6 provides a summary of the research and concluding remarks. Discussion of the strengths and limitations of the GIS-ANP approach for housing quality evaluation, implications of the study and suggestions for future work are presented.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter presents a review of literature on Analytic Network Process (ANP) and housing quality assessment. It is structured into two sections. The first section discusses the ANP applications with a focus on those using Geographic Information System (GIS) based ANP. Section two provides an assessment of the definition of the concept of housing quality, measurement approaches of housing quality, followed by the types of indicators used to operationalize the concept. The chapter concludes with a synopsis on how GIS-ANP has been used and how housing quality has been assessed.

2.2 Overview of Analytic Network Process

Analytic Network Process as a multicriteria decision (evaluation) method is a more general form of the Analytic Hierarchy Process (AHP). The AHP is a theory of measurement introduced in 1980 by Thomas Saaty. It is used to derive relative priorities on absolute scales from both discrete and continuous paired comparisons in multilevel hierarchic structures (Saaty, 2006). This method adopts a hierarchical structuring of the decision or evaluation problem. The top element of the hierarchy is the overall goal for a decision with the alternatives listed in the bottom level of the hierarchy.

The AHP assumes independence between the elements of the same level and between different levels (upper levels from lower levels) in the hierarchy. This implies that, AHP does not allow for the option of having top-to-bottom and bottom-to-top interdependent relationships between a group of factors, or for interdependent relationships within a cluster of factors (Taslicali & Ercan, 2006). Consequently, AHP is limited to rather static and unidirectional interactions among the decision problems and alternatives with little feedback. AHP has also been criticised for the problem of rank reversal (Belton & Gear, 1983; Dyer, 1990; Holder, 1990; Khan & Faisal, 2008; Leung & Cao, 2001). This problem is attributed to the assumption of the hierarchic decomposition of the AHP method (Saaty, 1986), which can produce arbitrary results or the rankings of alternatives (Belton & Gear 1983; Dyer, 1990). Saaty (1996) proposed the generalization of AHP called Analytic Network Process (ANP) in order to overcome the limitations of the AHP method.

The ANP method offers a general framework to deal with decisions without making assumptions about the independence of higher level elements from lower level elements and the independence of the elements within a level (Saaty, 1999). Many decision problems cannot be designed hierarchically because they comprise the interaction and dependence of higher-level elements in a hierarchy on lower-level elements (Saaty, 2006) as independence of elements rarely occurs in real life situation. Therefore, ANP is represented by a network, rather than a hierarchy and does not specify levels in a hierarchy. As in most real world situations, the method considers elements to be interdependent of each other. The replacement of the single direction relationships of AHP with dependence and feedback of ANP makes it more powerful than AHP in the decision situations with uncertainty and dynamics. In addition, ANP avoids the problem of rank reversal, making the method more accurate and useful than AHP as a decision or evaluation tool for complex situations (Taslicali & Ercan, 2006). Sabri and Yaakup (2008) carried out a comparative analysis of AHP and ANP in assessing urban sprawl. They concluded that the results obtained from ANP seem more rational than that of AHP.

Although AHP uses a linear hierarchic structure and ANP adopts a network structure, both methods apply pairwise comparisons among elements using a 1-9 numerical scale (Saaty's fundamental scale); where one means equal importance of two factors (e.g., evaluation criteria) and nine indicate an extreme level of importance of one criterion over the other. While the two models rely on pairwise comparison matrix, both models use expert opinions as inputs for decision factor weighting. But the benefit of ANP comprises the option of network model structuring that echoes the interdependence between the things in the real world quite well (Nekhay et al., 2009). ANP can help the decision makers to translate a number of variables and the relationships between them into manageable units of information (Aminu et al., 2013). Further, ANP can model complex decision problems where AHP is not sufficient. Considering the ANP as an extension of the AHP, the fundamental differences between the two MCDA methods can be summarized as:

1. with the AHP, decision problems are structured into a hierarchy (top to down), whiles with the ANP, they are structured as a network.

2. in AHP, elements are considered/ assumed as independent, hence the consideration of the decision criteria as such, whiles the ANP assumes interdependence of the elements and decision criteria.

3. AHP considers alternatives as independent from each other as well as from the decision criteria, whereas the ANP considers them to be dependent on the decision criteria and each other.

A list of the GIS-ANP applications is shown in Table 2.1. Most of the studies were conducted in Europe and Asia with only one study in Africa. Though ANP has been popularized over the past decade, it is quite new to the field of spatial multicriteria decision analysis as an applied model. GIS-ANP enable the method to account for the spatial/geographical aspects of the problems being evaluated.

Table 2.1: GIS-ANP Applications

Study	Decision/ Evaluation Problem	Study Area	Input (Data-Hypothetical / Real)	Software (GIS)	Software (ANP)	Number of Criteria
Neaupane and Piantanakulchai, 2006	Landslide hazard assessment.	Nepal	Real	N/A	MATLAB	6
Nekhay Arriaza and Boerboom, 2007	Soil erosion risk evaluation.	Olive groves of Montoro, Spain	Real	ArcGIS	Super Decisions Software & MATLAB	6
Sabri and Yaakup, 2008	Urban Sprawl	Iskandar, Malaysia	Real	ArcGIS	Super Decisions Software & Excel	16
Nekhay, Arriaza and Boerboom, 2009	Soil erosion risk evaluation.	Spain	Real	N/A	Super Decisions Software	6
Babalola and Busu, 2011	Site suitability analysis for landfill siting in Damaturu town Nigeria.	Nigeria	Real	ArcGIS	Super Decisions Software	9
Ferretti, 2011	Land suitability assessment for siting a municipal solid waste landfill.	Province of Torino, Italy.	Real	ILWIS	Super Decisions Software.	24
Ferretti and Pomarico, 2012	Siting process of a waste incinerator plant.	Province of Torino, Italy	Real	ILWIS	Super Decisions Software	19
Sarvar et al., 2012	Finding an optimum site for building neighbourhood parks.	Bonab Township, Iran.	Real	ArcGIS	Super Decisions Software	11

Isalou et al., 2013	Locating a suitable place for landfilling municipal solid wastes.	Kahak Town, Qom City, Iran.	Real	ArcGIS	Microsoft Office Excel 2007 & MATLAB	11
Agarwal et al., 2013	Delineation of groundwater potential zone.	Unnao District, Uttar Pradesh India.	Real	N/A	N/A	10
Aminu, et al., 2013	Sustainable tourism planning in wetland environment.	Malaysia	Hypothetical	ArcGIS	Super Decisions Software	N/A
Shahmoradi and Isalou, 2013	Selection of a suitable site for establishing wastewater treatment plant	Kahak, Iran.	Real	N/A	Super Decisions Software	12
Ferretti and Pomarico, 2013a	Analysing land suitability for ecological connectivity	Piedmont Region, Italy.	Real	IDRISI	Super Decisions Software	12
Ferretti and Pomarico, 2013b	Land suitability for ecological corridors	Piedmont Region, Italy	Real	IDRISI & ILWIS	Super Decisions Software	12

2.2.1 Decision/Evaluation Problem

GIS-based ANP has found application in different fields across a number of decision or evaluation problems. The major categories of problems are related to waste management (Babalola & Busu, 2011; Ferretti, 2011; Ferretti & Pomarico, 2012; Isalou, Zamani, Shahmoradi, & Alizadeh, 2013; Shahmoradi & Isalou, 2013) and risk assessment (Neaupane & Piantanakulchai, 2006; Nekhay et al., 2007, 2009). In terms of waste management, scholars have used the method to assess different decision problems including site selection problems for landfilling municipal solid wastes (Babalola & Busu 2011; Ferretti, 2011; Ferretti & Pomarico, 2012; Isalou et. al., 2013) and wastewater treatment plant (Shahmoradi & Isalou, 2013). In relation to the problem of risk assessment, Nekhay et al. (2007, 2009) evaluated soil erosion risk. Neaupane and Piantanakulchai (2006) assessed landslide hazard. Few studies have tackled other decision or evaluation problems such as: land sustainable for tourism development (Aminu, et al., 2013), evaluating urban sprawl (Sabri & Yaakup, 2008), delineation of ground water potential zone location (Agarwal, Agarwal, & Garg, 2013), ecological land suitability (Ferretti & Pomarico, 2013a; Ferretti & Pomarico, 2013b), and locating neighbourhood parks (Sarvar, Hesari, Mousavi, & Orooji, 2012).

2.2.2 Input

The input utilized by these studies were real world problems as outlined above, except Aminu et al. (2013) who adopted a hypothetical input (see Table 2.1). Although these studies differed in terms of the specific problems, it was noted that, in terms of data inputs, most of the studies used topographic and thematic maps (Agarwal et al., 2013; Babalola & Busu, 2011; Ferretti, 2011; Ferretti & Pomarico, 2012; Ferretti & Pomarico, 2013b; Neaupane & Piantanakulchai, 2006; Nekhay et al., 2009; Shahmoradi & Isalou, 2013), field surveys and questionnaires (Agarwal et al., 2013; Nekhay et al., 2007, 2009; Sabri & Yaakup, 2008; Sarvar et al., 2012), followed by expert opinion (Ferretti, 2011; Ferretti & Pomarico 2012; Ferretti & Pomarico, 2013a; Ferretti & Pomarico, 2013b; Nekhay et al., 2007, 2009; Sabri & Yaakup, 2008; Sarvar et al., 2012) and satellite and aerial photos (Agarwal et al., 2013; Neaupane & Piantanakulchai, 2006; Nekhay et al., 2007). The diversity of data inputs is a testimony to the usefulness of ANP in dealing with a wide variety of decision and evaluation problems.

2.2.3 Evaluation Criteria

Once decision problems are identified, a set of evaluation criteria is used to operationalize them. Different researchers have used varying criteria with the total number also varying due mainly to the different problems that they assessed. This is in relation to the fact that the set of evaluation criteria is problem-specific.

The number of criteria adopted by the studies varied and ranged from a minimum of three (Ferretti & Pomarico, 2013a; Ferretti & Pomarico, 2013b; Sarvar et al., 2012) to a maximum of twelve (Shahmoradi & Isalou, 2013). With the sub-criteria, ranging from a minimum of eleven (Isalou et al., 2013; Sarvar et al., 2012) to a maximum of twenty-four by Ferretti (2011). Agarwal et al. (2013) in delineating ground water potential zone location used ten criteria. Ferretti and Pomarico (2013a) in their ecological land suitability analysis relied on three criteria and twelve sub-criteria. Sarvar et al. (2012) used three criteria and eleven sub-criteria to aid in finding an optimum site for building neighbourhood parks. Sabri and Yaakup (2008) assessed urban sprawl problem using four criteria and sixteen sub-criteria.

There were also substantial differences in the number of criteria and subcriteria used in studies dealing with similar decision/evaluation problems. For example, different sets of criteria were considered by the studies on the waste management decision/evaluation problem. Whilst Shahmoradi and Isalou (2013) considered twelve criteria, Ferretti and Pomarico (2012) took into consideration four criteria and twenty sub-criteria. Isalou et al. (2013) used four criteria and eleven sub-criteria in their study of site suitability for landfilling municipal solid wastes.

Some of the criteria and sub-criteria adopted by the studies (Babalola & Busu, 2011; Ferretti, 2011; Ferretti & Pomarico, 2012; Isalou et al., 2013; Shahmoradi & Isalou, 2013) were related and can be put under the broad index of hydrology (distance from rivers and water bodies, wells and springs (groundwater), accessibility (distance from roads, and residential areas and distance from city/town), natural-topography (slope, wind direction, and aspect) and general public acceptance index (soil texture, land use, and geology). Apart from these general criteria, Babalola and Busu (2011) in determining sites that are appropriate for landfill siting in Damaturu town, Nigeria used rainfall as one of the criteria whereby the annual average rainfall data of the study area were collected and used. In addition, Ferretti (2011) and Ferretti and Pomarico (2012) used other sub-criteria in combination with the above mentioned criteria. They are: slides, flood areas, ground water depth, elevation, river basin, watershed protection plan, an index of naturalness, water quality index, distance to dangerous industries and population density of the area. Ferretti (2011) added distance to land reclamation areas and distance to waste production centre.

In the area of risk assessment, Nekhay et al. (2007, 2009) considered six factors, and Neaupane and Piantanakulchai (2006) measured five factors in their studies of risk assessment. Four factors (criteria) cut across the studies, they are: rivers and streams proximity/ channel proximity, land use and vegetation cover/ grass vegetation cover factors, slope steepness and slope length. In evaluating soil erosion risk in Spain, Nekhay et al. (2007, 2009) also made use of rainfall runoff factor and soil erodibility. Whiles, underlying geology and groundwater hydrology were used by Neaupane and Piantanakulchai (2006) in their landslide hazard assessment in Nepal.

2.2.4 Methodology and Software

In terms of the methodology employed, apart from the GIS and ANP techniques, a few studies included other methods. Example, Agarwal et al. (2013) combined remote sensing, GIS and ANP. Ferretti (2013b) combined Ordered Weighted Average (OWA) with ANP and GIS, while Shahmoradi and Isalou (2013) and Isalou et al. (2013) used GIS, integrated fuzzy logic and ANP models. In applying the ANP method, the existing studies made use of the various steps introduced by Saaty (2006) which include the following: (1) Definition of the network structure; (2) Pairwise comparison of elements in clusters; (3) Forming the super matrix by putting all weights yield from last step; (4) Forming the weighted matrix by multiplying weights of clusters to super matrix; (5) Forming the limit matrix; and (6) Synthesizing the results to get the priorities. In order to determine the weights among the attributes as well as criteria, the studies used pairwise comparison and the matrix manipulation method, which involve computing the unweighted supermatrix, weighted supermatrix, and the limit matrix (Saaty, 1999; 2006).

The software utilized to carry out the ANP computations had variations among studies. The most common software was the Super Decisions software (Babalola & Busu, 2011; Ferretti, 2011; Ferretti & Pomarico, 2012; Ferretti & Pomarico 2013a, 2013b; Nekhay et al., 2007, 2009; Sabri & Yaakup, 2008; Sarvar et al., 2012; Shahmoradi & Isalou, 2013). Super Decisions software aids in the creation of the network structure of the decision/evaluation problem, the interdependence of the clusters and further, implements the ANP for the pairwise comparisons.

Few studies used MATLAB (Isalou et al., 2013; Neaupane & Piantanakulchai, 2006). Others used MATLAB in addition to Super Decisions software (Nekhay et al., 2007, 2009). Nekhay et al. (2007, 2009) argued that, Super Decisions software supports only a simple cluster comparison and in order to reach the weighted supermatrix they relied on MATLAB. Whiles Sarvar et al. (2012) used the MATLAB to process the results of the questionnaire from experts. Aside Super Decisions and MATLAB, Isalou et al. (2013), Sabri and Yaakup (2008) and Sarvar et al. (2012) used Microsoft office excel. For example, Isalou et al. (2013) used Excel for the ANP calculations.

The ANP technique and its computation software do not include cartographic functions, as a result, GIS software was employed by the existing studies. GIS software was used to develop layers of spatial information (thematic maps), displaying and representing the results of the ANP computations, standardization of maps, carrying out overlay analysis of the weighted and criterion maps, site identification and modelling the final maps. Many of the studies used ArcGIS (Babalola & Busu, 2011; Isalou et al., 2013; Nekhay et al., 2007, 2009; Sabri & Yaakup, 2008; Sarvar et al., 2012), few studies used ILIWIS (Ferretti, 2011; Ferretti & Pomarico, 2012; Ferretti & Pomarico, 2013b) and IDRISI (Ferretti & Pomarico, 2013a).

2.2.5 Effectiveness of the ANP Method and Advantages of Integrating GIS with ANP

The effectiveness of the ANP method for tackling the decision/evaluation problems has been reported in some of the reviewed studies. According to Khan and Faisal (2008) ANP helped in arriving at a more holistic conclusion and provided an understanding as to why a waste disposal alternative ought to be preferred. The capability of ANP to account for interdependencies between the factors and the different importance of the factors used in the evaluation was emphasised by several studies (Ferretti, 2011; Ferretti & Pomarico 2013a; Isalou et al., 2013; Neaupane & Piantanakulchai, 2006; Nekhay et al., 2009; Sarvar et al., 2012). Nekhay et al. (2009) stated that ANP allowed them to model the interdependence of the processes responsible for soil erosion and also resolved the complexity of the physical process of soil erosion through the introduction of expertise into the evaluation exercise. Further, Isalou et al. (2013) in their study of site selection for landfilling municipal solid wastes acknowledged that applying the ANP model provided the possibility of assessing effective relationships of each discrete criterion on each other and on its overall goal in the form of network. Ferretti (2011) in her study of land suitability assessment for siting a municipal solid waste landfill also argued that the application of ANP allowed the dependence relationships among the criteria to be assessed, and the relative importance of all the elements that play an influence on the final choice to be evaluated. Therefore, ANP is a useful tool to help in making the decision/evaluation process traceable and reliable.

The reviewed studies further indicated the ability of GIS as a veritable tool for decision support. Babalola and Busu (2011) in their study demonstrated the efficiency of GIS in the site selection process for landfill. The efficacy of integrating ANP and GIS has been alluded to in the reviewed studies as giving a favourable result (e.g. Babalola & Busu, 2011; Sabri &Yaakup, 2008). Neaupane and Piantanakulchai (2006), Sarvar et al. (2012) and Agarwal et al. (2013) acknowledged the efficiency of GIS-ANP in dealing with complex decision/evaluation problems. For example, Neaupane and Piantanakulchai

(2006) in their study generated a hazard map of potentially unstable parts in lesser Himalayas to demonstrate the successful application of the method. Sarvar et al. (2012) specified that combining the final criteria weights using the ANP model with the GIS capability showed proper areas for locating neighbourhood parks at districts of the city. According to Ferretti and Pomarico (2013a) spatial ANP is a powerful tool for solving complex problems with connections and correlations among multiple objectives as recorded in their evaluation of land suitability for ecological connectivity. Thus, the integration of GIS and ANP methods provides a mechanism with which complex issues can be carefully explored and immediate feedback for decision-makers (DM) provided.

Further, other studies confirmed the ability of GIS-based ANP to be able to evaluate the decision problem in the event of limited data; uncertainty (Neaupane & Piantanakulchai, 2006; Nekhay et al., 2007; 2009) as noted with the conventional approach by Banai (2010). In addition, GIS-based ANP allows handling of heterogeneous information and provides a significant contribution in the strategic decision-making phase (Ferretti & Pomarico, 2013b). The integrated approach affords the means by which to execute complex trade-offs on multiple evaluation criteria while taking the DM's preferences and the spatial variability of the criteria into account (Ferretti & Pomarico, 2012). Ferretti (2011) and Ferretti and Pomarico (2012) alluded to the suitability of the GIS-ANP method for assessing real world problems. Through feedback enabled by the network structure of ANP, it better captures the complex effects interplay in human society.

2.3 Housing Quality

2.3.1 Introduction

This section first examines the definition of the concept of housing quality and the measurement approaches used in evaluating housing quality. This is followed by the types of indicators used to operationalize the concept.

2.3.2 Concept of Housing Quality

Housing quality has long been an important benchmark for measuring the condition of the living environment of humans and how it meets their needs. Housing quality was originally considered as one of the six housing norms including: space, tenure, structure type, expenditure, and neighbourhood norms as identified in the housing adjustment and adaptation theory of Morris and Winter (Morris et al., 1976, as cited in Ibem 2012; Yust, Hadjiyanni & Ponce, 1997). Norms as put forward by the housing adjustment and adaptation theory comprised of culturally derived criteria that households use to judge their housing and that of others (Yust et al., 1997).

Housing quality has been interpreted in many ways. According to Lawrence (1995) the concept is a complex one that is neither absolute nor static. As a result, it varies between countries and among specific groups of people in each country at varying time scales. The concept of housing quality has attracted the attention of researchers from many disciplines, which has resulted in a wide range of contributions to the subject. Currently, there is no universally accepted definition as the concept has been defined and interpreted variously across disciplines and researchers.

Aliu and Adebayo (2010) adopted a theoretical definition by considering housing quality as a function of six latent indices, namely neighbourhood prestige, living convenience, location, use value, structural design and mobility control. Lee and Oh (2012) defined the scope of quality of housing as covering all areas including the characteristics of residential service that are formed based on various elements. These elements include an indoor residential environment, an environment of an inner complex, an environment of complex surroundings, a service brand and other factors. Rindfuss et al. (2007) considered the quality of housing from the health and affordability standpoint. They defined quality as including characteristics (those required for public health, including toilet facilities, cooking facilities, and protection from the elements) in addition to the value of housing.

Other scholars have adopted definitions that highlighted the characteristics of the dwelling units; for example, Kurian and Thampuran (2011) argued that a good habitat requires enough space, separate rooms for different purposes and enough privacy, good climatic conditions such as enough sunlight, free passage of air and availability of water nearby, good drainage and sanitary facilities. Likewise, Ibem (2012) used the concept to refer to those highly valued attributes or defining characteristics of housing (such as durability of construction materials, structural soundness, spatial adequacy etc.) that appeal to occupants' needs.

From the foregoing, it can be deduced that the definition of housing quality embraces many factors, which include the physical condition of the building and other facilities and services that make living in a particular area conducive (Aribigbola, 2008). In addition, it can be observed that, housing quality as used by the different authors is a multifaceted abstract term that has cultural, social and economic connotations. It accounts for both quantitative and qualitative aspects of residential units, their immediate surroundings, and the needs of the occupants (Meng & Hall, 2006). Further, the concept can be seen as an expression of an idea, which proposes that a project or development is closer to perfect or further away from perfect (Ibem, 2012). This means that what constitutes an ideal is context specific and varies among individuals and different socioeconomic groups. While for some researchers, the ideal lies within existing standards and codes, for others, the ideal lies within what users interpret as ideal (Amole, 2008).

2.3.3 Measurement of Housing Quality

Housing quality as a multi-dimensional and complex concept is difficult to define and to measure. As a result, researchers have used different ways of measuring it. Lawrence (1995) argued that given the wide range of contributions on the subject, there has been little consensus about the means and measures used to assess housing quality. Lawrence (1995) identified three approaches that focus on:

(i) the point-of-view of the individual, be it that of an architect, a building contractor, a housing administrator, or a resident; by this approach, people are meant to evaluate a specific residential environment using one or more sociological and/or psychological research methods,

(ii) the material/quantifiable characteristics of housing, especially in terms of the external appearance of residential buildings and their functional, technical and construction components, and

(iii) the supply of housing (annual construction output), of the cost of new residential buildings, of the rationale and outcomes of housing construction grants to public authorities and private firms, and of housing subsidies and allowances to households.

A review of the housing quality literature indicates that two primary methodological approaches are used in measuring housing quality: objective (quantitative) and subjective (qualitative) approaches (see Table 2.2). The quantitative aspect of housing quality refers primarily to the structural, material, social and economic constituents of housing products or outcomes that can be measured and that result from the performance of the housing sector. These factors include: price, tenure, economic impacts, environmental impacts and structural norms of housing standards (Meng & Hall, 2006). Others include physical characteristics, facilities and services in dwellings (Mohit, Ibrahim, & Rashid, 2010). On the other hand, the qualitative dimension is much more subjective. It represents the perceived meanings and values of factors such as the ‘comfort’ or ‘quality of life’ that are afforded by different dwelling types, lifestyles, and the preferences and expectations of the inhabitants (Meng & Hall, 2006). As a result, what is considered as perfect lies within the purview of inhabitants. This implies that what is perceived as high quality, by one person or group of persons may be of limited or low quality to other individuals. Therefore, this perception is closely related to the psychosocial aspects of the resident. This approach is therefore considered as ‘bottom-up’ approach, since the assessment is from the point of view of the residents themselves.

Table 2.2: Relevant Studies on Housing Quality

Study (Year)	**City**	**Approach**	**Method and Software Used**	**Data**	**Indicators**	**Mapped Results**
Spain, 1990	USA	Objective	Statistical	Annual Housing Survey data, 1983.	Environmental Social	
Muoghalu, 1991	Benin, Nigeria.	Objective	Similar to Appraisal Method - assignment of penalty scores to houses that fail to meet minimum standards	Fieldwork	Physical Social	
Can, 1992	City of Syracuse (NY)	Objective	Multivariate statistics (Factor analysis) and Multicriteria analysis (Generalized Concordance-Discordance Analysis)	US Census Bureau's TIGER files and the Census of Population and Housing, 1980 Summary Tape File 1	Physical Economic Social	Yes
Beamish, 1994	USA	Objective	Stepwise Regression	Census Data, 1980.	Physical Social	
Cook and Bruin, 1994	USA	Integrated	Stepwise Regression	National American Housing Survey (AHS), 1987.	Environmental Social	
Fiadzo, Houston and Godwin, 2001	Ghana	Objective	Cronbach's Alpha and Factor Analysis.	Core Welfare Indicators Questionnaire (CWIQ) survey of 1997.	Social Physical Economic Environmental	
Meng and Hall, 2006	Lima, Peru.	Objective	Multicriteria Analysis- Simple Multi-attribute Analysis (MCA)	Micro-level census data (households)	Physical Social Economic	Yes (ArcGIS)
Olotuah, 2006	Oba-Ile-Nigeria.	Subjective	Multiple Regression Analysis	Field survey (questionnaire)	Physical Environmental	
Rindfuss, Piotrowski, Thongthai and Prasartkul, 2007	Nang Rong District, North-East Thailand.	Subjective	Standardized subjective rating process (also called, Relative Housing Quality Method)	Interviews	Physical	

Coker, Awokola, Olomolaiye, and Booth, 2008	Ibadan	Objective	American Public Health Association (APHA) Method-Penalty scoring	Field survey: Housing quality Survey Form (HQSF) and Environmental Survey Form (ESF).	Physical	
Aliu and Adebayo, 2010	Lagos State, Nigeria.	Objective	Logistic Multivariate Technique	Structured questionnaires	Physical Environmental	
Aderamo and Ayobolu, 2010	Ilronin, Nigeria.	Objective	Factor Analysis	Primary (structured questionnaire) and Secondary sources.	Environmental Physical Economic	Yes
Jiboye 2010b	Osogbo, Nigeria.	Subjective	Descriptive statistics and Analysis of Variance (ANOVA)	Questionnaire	Physical	
Jiboye, 2011	Southwest Nigeria.	Subjective	Analysis of Variance test (ANOVA) and SPSS	Questionnaire	Physical Environmental	
Kurian and Thampuran, 2011	Kerala	Subjective	Stepwise Multiple Regression Model and SPSS.	Survey (questionnaire)	Physical Environmental	
Amao, 2012	Apete-Ibadan, Nigeria.	Objective	Correlation Analysis	Questionnaire administration and personal observation	Physical Environmental	
Bradley and Putnick, 2012	28 Developing Countries.	Objective	Statistics (ANOVA)	The Multiple Indicator Cluster Survey (MICS), 2005–2007	Physical	
Buckenberger 2012	Manukau City, Auckland Region, New Zealand.	Subjective	Qualitative-Nvivo	In-depth interviews and brainstorming	Physical Environmental	
Ibem 2012	Nigeria	Subjective	Descriptive statistics, Categorical Regression Analysis and SPSS	Cross sectional Survey (structured questionnaires)	Physical Environmental Management	
Lee and Oh, 2012	Korea	Integrated	Housing Quality Index (HQI) Scoring Method and Market Participant Study Method.	Questionnaire, Real estate pricing	Physical Environmental	

Due to the high local and regional disparities in the quantitative and qualitative dimensions of housing quality, it is challenging to define a standardized set of criteria and indicators that apply equally to all areas at all times. Further, it is challenging to capture broad-based meanings and principles of qualitative concepts such as comfort and quality of life if only quantitative indicators are used (Meng & Hall, 2006). Currently, there are calls to integrate both approaches.

With regard to the reviewed studies, the two major approaches (objective and subjective) were dominant with few adopting an integrated approach (Table 2.2). Studies by Aliu and Adebayo (2010), Amao (2012), Beamish (1994), Bradley and Putnick (2012), Can (1992), Coker et al. (2008), Cook and Bruin (1994), Fiadzo et al. (2001), Meng and Hall (2006), Muoghalu (1991) and Spain (1990) adopted objective approach. Aderamo and Ayobulu (2010), Buckenberger (2012), Ibem (2012), Jiboye (2010b; 2011), Kurian and Thampuran (2011), Olotuah (2006) and Rindfuss et al. (2007) provide examples of a subjective approach. Cook and Bruin (1994) and Lee and Oh (2012) applied an integrated approach.

2.3.4 Types of Indicators

Housing quality is usually evaluated from the perspective of economic, social and/or physical conditions (Francescato, Weidemann, Anderson & Chenoweth, 1979; Jiboye, 2010b). Economic criterion seeks to provide the relationship between rent and income; physical criterion focuses on the integrity of the dwelling in terms of design, appearance and appropriateness of fixtures; while social criterion relates to the incidences of diseases and the degree of overcrowding (Jiboye, 2010b).

According to Meng and Hall (2006) four criteria provide the basis for identifying indicators to produce a meaningful housing quality index (HQI). These include objective, scientific/technical, management, and socio-cultural criteria. Each class of criteria has its own concerns that govern the selection of specific indicators from available data resources. The indicators of the objective criteria should represent the local environment and must be comprehensive enough to address problems that include poverty and inequity in the housing sector. With regard to the scientific/technical criteria, the indicators ought to be separable into geographically localized components and must be based on household-level data so that they can be measured both locally and globally as well as spatially in order to identify statistical and spatial distributions of HQI. Regarding the management criteria, indicators should be easily obtained from available data and succeeding calculations and must be easy to understand, and cost-effective so that the analysis of housing quality and housing segregation can be effectively utilized by policy makers within a study area. Lastly, the indicators of social and cultural criteria should contain the preferences and priorities of the community in the housing programs. And that, local participants should be able to appraise indicators selected from the above criteria to make housing enhancement proposals acceptable relative to local norms and expectations.

Kutty (1999) stipulated that commonly used indicators of housing quality include structural adequacy, neighbourhood quality, residents' perception of neighbourhood safety, level of public services provided, access to work and other amenities, room density and housing affordability.

2.3.4.1 Indicators used by Empirical Studies

As suggested above, there is little consensus about the indicators that should be used to examine housing quality within specific cities. This has resulted in considerable variability in the indicators that are adopted. They can broadly be grouped under four headings: physical, environmental, social and economic criteria. Each class of criteria incorporates variables/ indicators that are used to operationalize them.

The physical criterion of housing quality considers the quality of housing in terms of adequacy and availability of basic housing infrastructures, suitability of the building design, integrity of the building elements (physical sustainability) as well as that of fixtures within the dwellings. Indicators such as the adequacy and availability of basic housing infrastructures (internal facilities/amenities or housing services) include variables such as the presence of water, presence of electricity, access to solid and liquid waste treatment, type of toilet, type of kitchen etc.; suitability of the building design have aesthetics, number of storeys; the integrity of the building elements (physical sustainability) looks at physical quality and have variables such as material quality (type of wall materials, type of floors, type of roof, whether walls are painted or not etc.).

The environmental criterion reflects environmental quality of neighbourhoods and takes into account location, environmental sanitation and neighbourhood facilities (basic infrastructures). That is, accessibility/ proximity to facilities (schools, market, banks etc.), mode of refuse collection and frequency, external environment of house, landscape, neighbourhood prestige etc.

Regarding the social criterion, it takes into account the space and household density. Overcrowding (number of persons per room, households per house) is used as an indicator for the social criterion which considers density. The economic criterion which reflects housing affordability is defined in terms of such measures as: tenure, gross rent, housing cost burden (percentage of household income devoted to housing), housing value, etc.

Regardless of the methodological approach (subjective or objective) adopted, the indicators did not differ much as they overlap the different approaches. Except for the accessibility and distance factors that was embraced much by the studies that used the objective approach. For example, with respect to the subjective approach, Jiboye (2010b) in assessing housing quality in Nigeria used indicators such as the adequacy and availability of basic infrastructures like water, electricity and road, access to solid and liquid waste treatment; suitability of the building design; the integrity of the building elements like doors, windows, roofs, floors and walls, as well as that of fixtures within the dwellings. Ibem (2012) used housing unit attributes (number of bedrooms, size of kitchen and storage, size of bedrooms); housing services and infrastructure (sanitary and drainage facilities, power supply, portable water supply, external lighting, garbage disposal facilities); and neighbourhood facilities (public transport service, playground for children, healthcare facilities, educational facilities) to study residents' perception of the quality of public housing in urban areas in Ogun State, Nigeria. Likewise, Olotuah (2006) in assessing housing quality in suburban areas in Oba–Ile, Nigeria used variables consisting of age of buildings, number of bedrooms, household size, type of kitchen, use of kitchen, regularity of electricity supply, type of toilet, use of toilet etc. Rindfuss et al. (2007) in measuring housing quality in Thailand used lagged indicators consisting of the size of the house, the number of storeys, state of repair, roof material, whether walls are painted and whether the walls of concrete block have a finish, etc.

With regards to studies that applied the objective approach, Fiadzo et al. (2001) in assessing housing quality in Ghana, constructed, and used housing quality index comprising structural quality (e.g. type of wall and roofing material), physical amenities (cooking fuel, lighting fuel, source of drinking water and type of sanitation), accessibility of location and quality of life amenities (distance to the nearest source of drinking water, markets, schools, health centres, public transportation). Spain (1990) adopted the number of persons-per-room (overcrowding), housing value, gross rent and tenure as indicators of housing quality against which he appraised the importance of race, residential mobility, household composition, gender and other factors in the United States of America. Similarly, Cook and Bruin (1994) using an integrated approach relied on three housing indicators: crowding, affordability and satisfaction examined the extent to which White, African-American and Hispanic single-parent women experienced housing problems. Further, Lee and Oh (2012) using indicators such as: indoor residential environment, an environment of an inner complex, an environment of complex surroundings, a service brand and other factors, included variables such as the sufficiency of open space, that is, the adjacent park, the quality of the educational environment, distance to bus stop, distance to elementary school, the number of rooms and size, structure of apartment etc. in assessing housing quality in Bundang New Town, Korea.

2.3.5 Determinants of Housing Quality

From the findings of the studies it can be deduced that, the physical aspect of housing tends to affect the quality of dwellings more as most of the studies identified it as a factor or had the residents mentioning variables relating to physical criteria as impacting on their housing quality when the subjective approach was used. Aderamo and Ayobolu (2010) revealed that five structural variables affect housing quality including: basic facilities, energy and ownership, material quality, water quality, and utility factors. Kurian and Thampuran (2011) in their assessment of housing quality using location, infrastructure, design, aesthetics, materials and construction techniques, sustainability and concept (ideas individuals have about their dwellings in terms of design, type of building, materials to be used etc.) as their indicators found that the order of importance regarding housing quality in Kerala, India is as follows: materials and construction techniques, sustainability, aesthetics, concept, infrastructure, design and location. Further, Jiboye (2011) found that the quality of residential neighbourhoods of Bodija and Moremi Estates in Nigeria is determined and affected by factors which deal mainly with the quality of the dwelling, environment and those that are demographic in nature. Factors that deal with the quality of dwelling include: satisfaction with building design and adequacy of storage spaces and room sizes, privacy level, adequate security, ventilation, lighting conditions and suitability of dwelling components such as roof, wall, floor, window etc. Amao (2012) found that a positive and significant relationship exists between housing quality and variables like ventilation, lighting, spaces, aesthetic, security, drainage, sanitation, type of construction materials, landscape, and external environment of the house. This implies that housing quality in the study area tends to increase as the conditions and availability of these variables (ventilation, lighting, spaces, aesthetic, security, landscape, sanitation, type of construction materials and external environment of the house) improves within the area. Using a multiple regression model to assess housing quality in suburban areas of Nigeria, Olotuah (2006) found that there is a significant relationship between housing quality and three predictor variables: age of buildings, use of toilet and frequency of collection of refuse. Buckenberger (2012) indicated that the quietness of the location and the proximity to schools were very important for families. On the other hand, physical (fixed elements) quality attributes were central to their dwelling perceptions.

Other studies established a relationship between income, tenure and education on the one hand and housing quality, on the other hand. Amao (2012) argues that it is the income of the household that determines the quality of the house as most of houses with poor condition belong to the low income category. This is because income influences the type of structure that is built. Further, Ibem (2012) in his study of resident's perception of the quality of public housing in urban areas in Ogun State, Nigeria found that housing delivery strategies, spatial deficiencies in housing units, organizational capacity of housing providers, age, income, education and tenure status of the residents were the key factors influencing residents' perception of housing quality. Spain (1990) using the number of persons-per-room (overcrowding), housing value, gross rent and tenure as indicators of housing quality against which he evaluated the importance of race, residential mobility, household composition, gender and other determinants in the USA found that factors such as marital status, household composition, income and race had significant influence on housing quality.

2.3.6 Methods

Most of the studies employed statistical methods for creating housing quality index (Aderamo & Ayobulu, 2010; Aliu & Adebayo, 2010; Beamish, 1994; Bradley & Putnick, 2012; Cook & Bruin, 1994; Fiadzo, et al, 2001; Ibem 2012; Jiboye, 2010b, 2011; Kurian & Thampuran, 2011; Olotuah, 2006; Spain, 1990). The statistical methods used include: factor analysis (Aderamo & Ayobulu, 2010), multiple regression analysis (Olotuah, 2006), stepwise regression (Beamish 1994; Cook & Bruin, 1994) and stepwise multiple regression model (Kurian & Thampuran, 2011). Ibem (2012) used categorical regression analysis and descriptive statistics, and Jiboye (2010b) used descriptive statistics and ANOVA. Fiadzo, et al. (2001) however, adopted factor analysis and Cronbach's alpha in creating a housing quality index.

Some studies adopted what can be termed as the scoring method (see Coker et al., 2008; Lee & Oh, 2012; Muoghalu, 1991). The method involves assigning penalty scores to buildings that failed to meet minimum standards. Coker et al. (2008) used the method by the American Public Health Association (APHA) which involves a system of penalty scoring rather than positive scoring. That is, the higher the arithmetic score of the condition under evaluation, the more substandard is the situation. Muoghalu (1991) used a method which is similar to the appraisal method employed by the Committee on the Hygiene of Housing in the USA. Meng and Hall (2006) and Can (1990) adopted multicriteria analysis. Can (1990) integrated multicriteria analysis (generalized concordance-discordance analysis) with a statistical method (factor analysis).

2.4 Summary and Conclusion

The review of relevant studies indicates that there is a very limited research about integrating GIS and ANP. As far as the author is aware there is no study that used GIS-ANP for evaluating housing quality. In terms of the evaluation criteria used for assessing the decision/evaluation problems, the review reveals that the ANP method can be used for tackling problems with a number of criteria ranging from 6 to 24. However, many studies argue that with an increase in the number of criteria, the complexities increase in relation to the pairwise comparisons (Bayazit, 2006; Begicevic, Divjak, & Hunjak, 2010; Ferretti & Pomarico, 2013b; Nekhay et al., 2007, 2009; Wolfsleher et al., 2005).

Further examination of the literature reveals that, though ANP is new to the field of GIS, the method can be applied to deal with a wide range of decision/evaluation problems. This affirms that the method has potential to be applied to any decision/evaluation problem, provided that the accurate evaluation criteria are identified and there are some dependencies among them.

From the housing quality review, it was found that a single standardized set of indicators or variables is not available for assessing housing quality. However, there were similarities among the indicators and variables. For example, in the USA, Spain (1990) used two criteria (social and economic) with four variables (crowding, housing value, gross rent and tenure) and Beamish (1994) used two criteria (physical and social) with three variables: age of structures, units that were crowded and units that lacked plumbing.

Housing quality variables used in developed countries did not differ much from those adopted by studies in developing countries. However, due to lack of active housing market in most developing countries, the economic criterion variables (housing value, housing cost burden, gross rent, etc.) were not used much by studies (especially those that adopted objective approach) in developing countries. Studies such as Fiadzo et al. (2001), Meng and Hall (2006) and Aderamo and Ayobolu (2010) only used tenure as part of their variables. It was revealed that most studies in developing countries relied typically on the physical criterion. This can be attributed to the data availability and accessibility of relevant datasets. With regards to the approach, it was found that whether the study was done in developed or developing country did not impact the adopted approach as the approaches overlap across studies.

CHAPTER THREE
THE GIS-ANP METHOD

3.1 Introduction

This chapter presents the GIS-based Analytic Network Process (GIS-ANP) approach for evaluating the quality of housing. A background of GIS based multicriteria decision analysis (GIS-MCDA) is discussed first, followed by a description of the ANP method. The main section of the chapter presents the GIS-ANP framework to be used for the empirical study of housing quality evaluation.

3.2 Multicriteria Decision Analysis

Multicriteria decision analysis (MCDA) is a family of techniques that aid decision makers in properly structuring multi-faceted decisions and evaluating decision alternatives on the basis of multiple, conflicting criteria and selecting the best alternative(s) under the presence of diverse criterion priorities (Greene, Devillers, Luther, & Eddy, 2011; Jankowski, 1995; Voogd, 1983). The fundamental principle of multicriteria decision-making is that decisions should be made by use of multiple criteria (Cheng, Li, & Yu, 2005).

MCDA allows complex qualitative and quantitative information to be appraised and measured in a systematic way while taking account of subjective views of the evaluation criteria and their relative importance. Criterion in the context of MCDA is a generic term that includes both the concept of attributes and objectives (Malczewski, 1999). Consequently, two broad classes of multicriteria decision analysis or decision problems can be distinguished: multiattribute decision analysis (MADA) and multiobjective decision analysis (MODA) (Hwang & Yoon, 1981). Attributes are properties of real-world geographical system. They are used as the measurements of preference related to objectives. While objectives is a statement about the desired state of the system under consideration and are functionally related to, or derived from, a set of attributes (Malczewski, 1999).

Multiattribute decision problems have usually specific single objective or overall goal (e.g., site suitability analysis for housing development) and are connected with a finite set/limited number of predetermined alternatives and discrete preference ratings (Jankowski, 1995; Tzeng & Huang, 2011; Zanakis et al., 1998). The set of alternatives are known and the MADA procedure involves evaluating and ordering the alternative decisions and selecting the best or most preferred alternative. However, multiobjective decision problems have multiple (conflicting) objectives which are to be achieved simultaneously while evaluating a very large or an infinite set of feasible alternatives. The multiobjective analysis is model-oriented, where the alternatives must be designed using the methods of mathematical programming of optimization problems (Jankowski, 1995; Tzeng & Huang, 2011). For the most part, GIS-MCDA belongs to the domain of multiattribute analysis (Malczewski, 2006) within which this research is situated.

3.3 Spatial Multicriteria Analysis

Conventional MCDA techniques have largely been non-spatial. Given the limited capabilities of conventional MCDA to analyse and visualize the geospatial data/information, the combination of the MCDA methods with spatial analysis and visualization techniques could improve the decision support procedures in terms of presenting and communicating the results to the decision makers. Hence, there is opportunity for integration of MCDA methods with GIS (Carver, 1991).

Spatial MCDA is a process that consists of procedures involving the utilization of geographical data and the preferences of the decision maker (DM), and the manipulation of data and preferences according to specified decision rules. Spatial MCDA takes advantage of both the capability of GIS to manage and process spatial information (facts) and the ability of MCDA to aggregate the geographical data with value-based information (decision maker's preferences) into one-dimensional value (Malczewski, 1999). According to Ferretti and Pomarico (2012) the foremost benefit of the GIS-MCDA integration is the fact that decision makers can introduce their own opinions (preferences with respect to evaluation criteria) into the decision making process and receive feedback on their influence in policy evaluations through geovisualization. Integration of GIS and MCDA support a decision-making process through a systematic, transparent and replicable approach enabled by use of thematic maps.

3.4 GIS-based (spatial) Multicriteria Decision Analysis Framework

Decision making is a process; hence, it involves a sequence of activities. Malczewski (1999) outlined the sequence of activities in the GIS-MCDA framework which involves the following components: defining the decision problem, identifying evaluation criteria and constraints, determining decision alternatives, criteria weighting, applying a decision rule, performing sensitivity analysis and making a recommendation (see Figure 3.1).

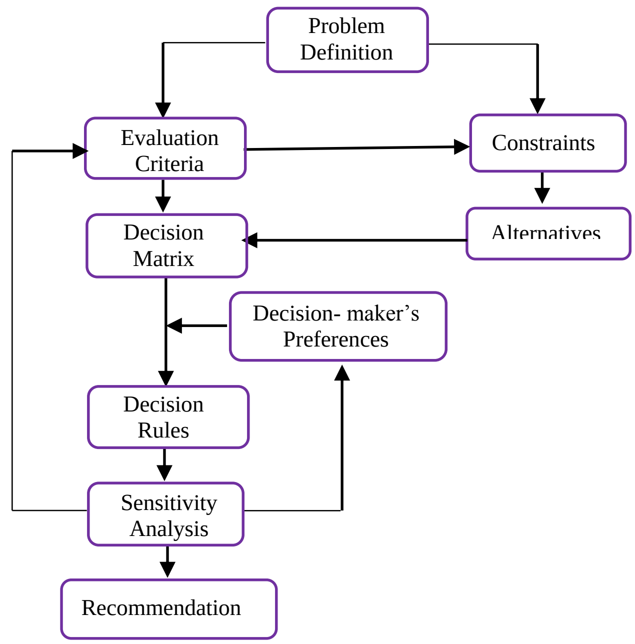


Figure 3.1: Spatial Multicriteria Decision Analysis Framework (*Source:* Malczewski, 1999).

The decision making process starts with recognition and definition of a decision or evaluation problem to be solved. At this phase, GIS provides a support of the decision making process by its capability to store, manage, retrieve and analysis of spatial data. After articulating the decision problem, a set of evaluation criteria (objectives and attributes) is identified on the basis of which the alternatives are evaluated. Attributes are a measure of achieving the objectives, which reflects all concerns relevant to the decision problem. The evaluation criteria are represented in the form of maps, otherwise referred to as criteria/attribute maps, thematic or data layers. The criterion map is a geographical attribute of the alternatives which are used to evaluate their performance. Identification of decision alternatives defined geographically in terms of location, spatial pattern etc. follows. Alternatives are defined in terms of restrictions (constraints) which determine feasible alternatives. They are often generated in GIS based on spatial principles of proximity, connectivity and overlay methods.

Decision maker's preferences regarding the evaluation criteria are then incorporated into the analysis in terms of weights (importance of each criterion relative to other criteria). Decision makers' preferences reflect their values and interests with respect to the evaluation criteria. The evaluation criteria, alternatives and criteria weights are usually organized in the form of an evaluation matrix.

The decision rule phase integrates the preceding steps. A decision rule determines how best to evaluate alternatives or to decide which alternative is preferred to another by allowing the ordering (ranking) of the alternatives. It integrates the data (geographical data layers) and information on a set of alternatives and decision makers' preferences into an overall assessment of each alternative. The robustness of the results (rankings of alternatives) is determined through sensitivity analysis, which involves ascertaining the effects of changes in the inputs (geographical data and decision maker's preferences) on the outputs (ranking of alternatives). If modifications of inputs do not affect the outputs considerably, the ranking is considered robust.

The final stage of the procedure is the recommendation phase. It is based on the ranking of the alternatives and the sensitivity analysis. Recommendation may include the best alternatives or set of alternatives for implementation.

3.5 Analytic Network Process (ANP)

The ANP method is an extension of the Analytic Hierarchy Process (AHP). Unlike AHP, the ANP approach does not make any assumptions about the independence of higher-level elements from lower level elements in a hierarchy or about the independence of the elements within a level in the hierarchy. As a result, ANP utilizes a network structure without the need to specify levels (Saaty, 2004). ANP extends the applications of the AHP to incorporate components, dependence and feedback using the supermatrix approach (Saaty, 1996).

Many decision problems cannot be structured hierarchically as they involve the interaction and dependence of high-level elements on lower-level elements. Not only does the significance of the criteria define the significance of the alternatives in a hierarchy, but also the significance of the alternatives themselves defines the importance of the evaluation criteria. Consequently, in ANP the decision alternatives can rely upon criteria and each other as well as criteria can rely upon alternatives and other criteria (Saaty, 2001). The hierarchical relation between criteria and alternatives are generalized to the network structure. The network structure of ANP makes it possible to model various criteria without concern about the order of priorities. Therefore, ANP can be considered as a system-oriented method. It provides the possibility to take interdependencies between the decision factors into consideration by allowing interaction and feedback within clusters (inner-dependence) and between clusters (outer-dependence). The fundamental concepts behind the ANP approach has been summarized by Saaty (1999) as follows; the ANP method:

1. is built on AHP;
2. by allowing for dependence, the ANP goes beyond the AHP by including independence and hence also the AHP as a special case;
3. is a nonlinear structure that deals with sources, cycles, and sinks. A hierarchy is linear, with a goal in the top level, and the alternatives in the bottom level;

4. deals with dependence within a set of elements (called inner dependence) and among different sets of elements (called outer dependence);

5. makes possible the representation of any decision problem without concern for what comes first and what comes next as in a hierarchy through its looser network structure;

6. prioritize not just elements but also groups or clusters of elements; and

7. utilizes the idea of control hierarchy or a control network to deal with different criteria, eventually leading to the analysis of benefits, opportunities, costs, and risks.

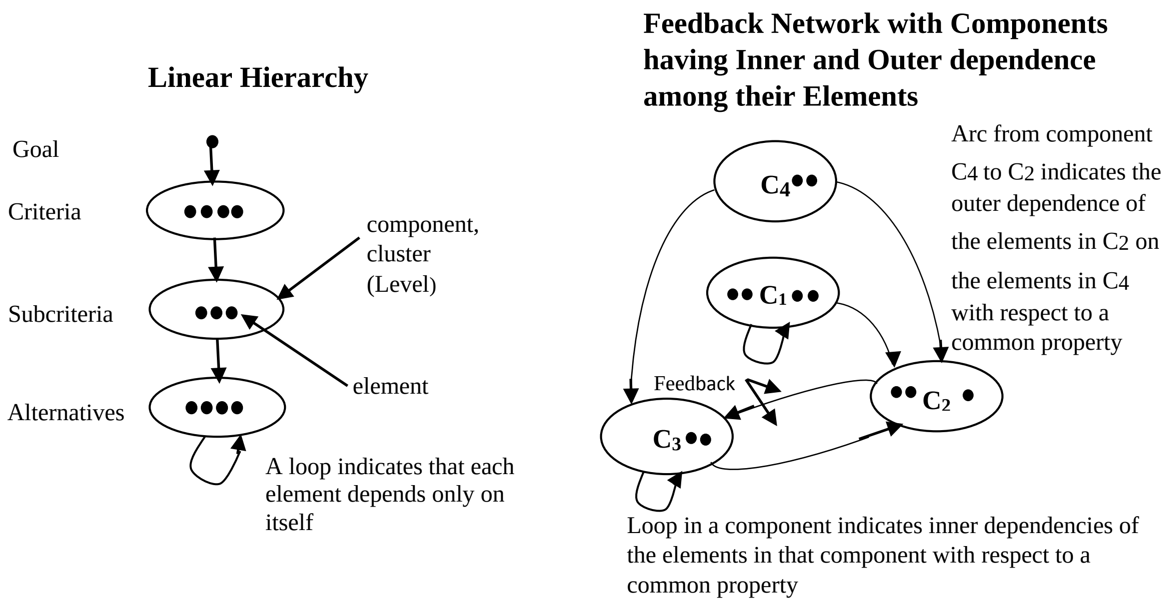


Figure 3.2: Comparison of a Hierarchy with a Network (*Source:* Saaty, 2004).

The structural difference between the AHP (hierarchy) and the ANP (network) is illustrated in Figure 3.2. A hierarchy is a linear top down structure with no feedback from lower to upper levels, with the goal at the top level and the alternatives at the bottom level. Network spreads out in all directions and the clusters of elements are not arranged in a precise order and can be distributed along a number of directions representing interactions between clusters and loops within the same cluster (Saaty, 2004). The elements of the system are represented as nodes. Nodes of the network refer to components of the system, whereas arcs represent interactions between them. If an interaction between the nodes is identified, they are connected with an arrow. The orientation of the arrow shows the direction of the influence between two nodes. Loops denote inner dependencies amongst nodes of the same cluster. Using a bridge evaluation example (Saaty, 2003) the decision problem of selecting the best bridge among two bridges with evaluation criteria safety and aesthetics can be structured as shown in Figure 3.3 using the AHP and ANP methods. The next section outline steps of the ANP.

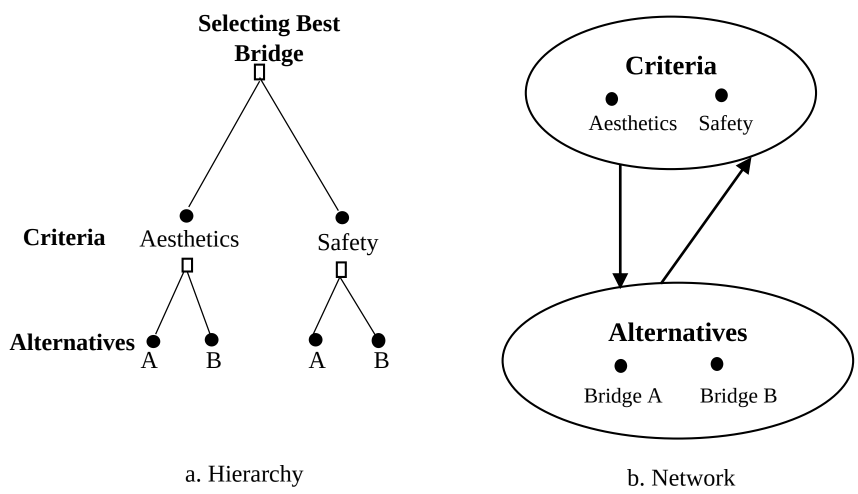


Figure 3.3: The Bridge Model Presented in a Hierarchy (a) and Network (b) of Criteria (“clusters”, denoted by ovals) and Alternatives (“nodes”, dots within clusters) with feedback (*Source:* Banai, 2010).

3.6 The ANP Procedure

Decision making with ANP involves a sequence of steps along the lines outlined in Figure 3.4.

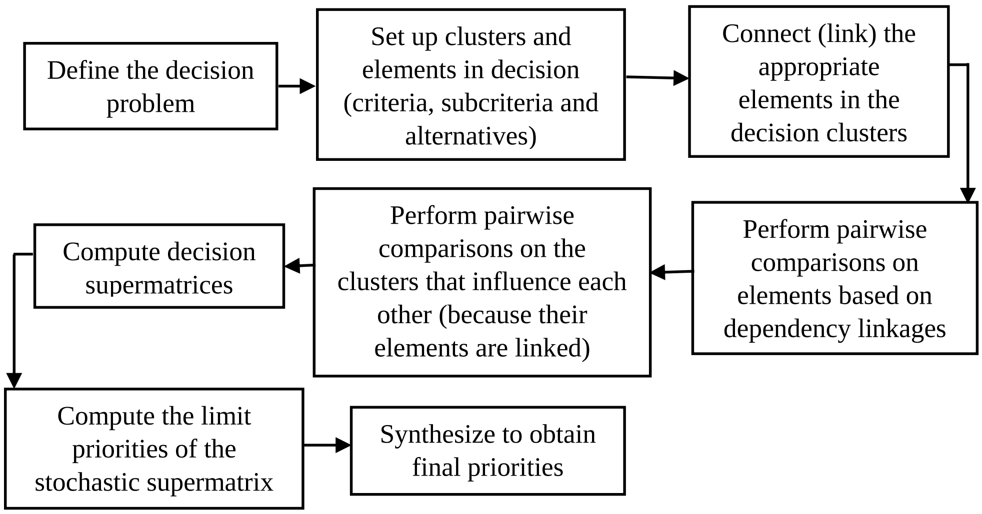


Figure 3.4: Steps followed in the Analytic Network Process
(*Source:* Adapted from Saaty, 2008a).

Step 1: Model construction and problem structuring

This step entails developing the structure of the decision making process. It includes defining the main objective and identifying groups or 'clusters' constituted by various elements ('nodes') that influences the objective (Saaty, 2001). The clusters and elements belonging to the respective clusters have to be determined; that is, the decision makers have to determine a goal cluster, a criterion and sub-criterion cluster, and an alternative cluster with possible influences between them identified. Further, the problem should be stated and decomposed into a rational network system (Lee, 2010). The network construction represents an important and a very creative phase in the problem-solving process.

Step 2: Pairwise comparison and determination of priority vectors

With regard to this step, the relative importance of each criterion with respect to the others is carried out, in order to find the level of contribution of each criterion to the achievement of its related objectives. Comparative or relative judgements are made on pairs of elements. The relative importance values of each element are determined based on a ratio scale of 1–9, that is Saaty's fundamental scale (see Table 3.1). Although this step is same for the ANP and AHP methods, the basic question asked in ANP is considerably different from that in AHP. It is expressed as follows: ''with respect to the control (parent) element, given a component of the network, and given a pair of components, how much more will one member of the pair dominates (influence) the other component?'', whiles in the AHP method the question is about the dominance of one element over another with respect to the parent component" (Nekhay et al., 2009, pg. 3097).

Table 3.1: Scale for Pairwise Comparison

Intensity of importance	*Definition*	*Explanation*
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another.
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another.
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance highest	The evidence favoring one activity over another is of the possible order of affirmation.
Reciprocals of above	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, the *j* has the reciprocal value when compared with *i*.	A reasonable assumption

Source: Saaty (2004).

There are two levels of pairwise comparisons in the ANP method: the cluster level, which is more strategic, and the node/element level, which is more specialized (Ferretti, 2011). Cluster comparisons involve comparing clusters with respect to another cluster. While paired comparisons on the elements within the clusters themselves are performed according to their influence on each element in another cluster they are connected to (outer dependence) or on elements in their own cluster (inner dependence). Aside the two levels, alternative comparisons are carried out whereby all the alternatives are compared with respect to each of the elements within components. Comparison of elements is made according to which element influences a given element more than another element. Element comparisons are made with a control criterion or sub-criterion of the control hierarchy in mind. Pairwise comparisons are represented in a matrix format. If there are *n* components to be compared, the matrix is defined as:

$$P = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \end{array}$$

$$= \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} 1 & p_{12} & \cdots & p_{1n} \\ 1/p_{12} & 1 & \cdots & p_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/p_{1n} & 1/p_{2n} & \cdots & 1 \end{bmatrix} \end{array}$$

When comparing two components, the score of p_{12} in the pairwise comparison matrix represents the relative importance of the component in the C_1 row over the component in the C_2 column, i.e., $p_{12} = w_1/w_2$. The reciprocal value of the expression ($1/p_{12}$) is used when the component C_2 is more important than the component C_1. Instead of assigning two numbers (weights) w_1 and w_2 to the components C_1 and C_2 and forming the ratio w_1/w_2, we allocate a single number from 1 to 9 from the fundamental scale to represent the ratio (w_1/w_2). For example, the score of 1 represents equal importance of the two components (C_1, C_2) and 9 signifies extreme importance of the component C_1 over the component C_2. The absolute number from the scale is an approximation to the w_1/w_2 ratio. The derived scale gives w_1 and w_2. After all pairwise comparison is completed; the priority weight vector *(w)* is computed. That is, each value in the pairwise matrix is divided by the sum of its column and then the criterion (priority) weight is calculated as an average value of the normalized pairwise comparisons. A measure of consistency is then calculated using equations (3.1) and (3.2) respectively to capture uncertainty in judgements:

$$CI= \frac{\lambda_{max}-n}{n-1} \tag{3.1}$$

$$CR = \frac{CI}{RI} \tag{3.2}$$

where CI and CR are Consistency Index and Consistency Ratio, respectively, λ_{max} is the largest priority of the pairwise comparison matrix and *n* is the number of classes. *RI* is the Ratio Index. The value of *RI* for different *n* is given in Table 3.2. A consistency ratio of less than or equal to 0.10 or 10% is acceptable. If CR is greater than 10%, we need to revise the pairwise comparisons.

Table 3.2: Ratio Index for different values of *n*.

Order (n)	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Source: Saaty (2008b).

Step 3: Supermatrix formation

After the weights have been derived from the pairwise comparison matrix, the next step consists of the progressive formation of three supermatrices: the initial or unweighted, the weighted, and the limit supermatrix. All priority vectors from the pairwise comparisons are organized in appropriate columns, which in turn forms the supermatrix, a two-dimensional matrix of elements by elements (Figure 3.5).

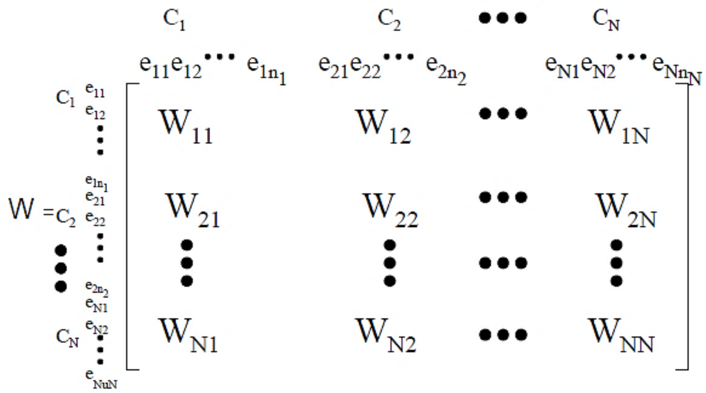


Figure 3.5: General structure of a Supermatrix (*Source:* Saaty, 2008b).

From the supermatirx, the component C_1 includes all the priority vectors derived for nodes that are “parent” nodes in the C_1 cluster. The supermatrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control criterion. Each column of a supermatrix is either a normalized priority with possibly some zero entries or all of its block entries are zero. For example, if there is no linkage between, say component C_1 and C_2, then W_{12} would be zero. However, if there is some relationship, then the entry would be non-zero suggesting an outer dependence. An inner dependence would exist if there is a linkage within the components of a cluster, $\{e_{11}, e_{12},\ldots e_{1n_1}\}$. This supermatrix is not weighted, and called the unweighted supermatrix which may not be stochastic. The unweighted supermatrix is transformed by the matrix of cluster priorities into a column stochastic matrix (columns add to one) called the weighted supermatrix; i.e. multiplying all the elements of the unweighted supermatrix by the corresponding cluster weight (the priorities obtained from the cluster level comparison, with respect to the general goal which were determined in step 2).

The limit supermatrix is computed by raising the weighted supermatrix to powers until it converges to obtain a long-term stable set of weights. The supermatrix is raised to a limiting power, such as in equation (3.3), to obtain a matrix where all the columns are identical and each gives the global priority vector (Bottero and Lami, 2010).

$$\lim_{k \to \infty} W^k \tag{3.3}$$

where, W = weighted supermatrix and k = the number of successive powers through which the weighted supermatrix is raised. The limit matrix provides the relative importance weights for every element in the model.

Step 4: Determining final priorities

The last step determines the final values (weights) of the elements by their prioritization with respect to the structure of the whole system. The final priority weights which account for component (element) interactions can be extracted from the limiting matrix and can be read from any column since they are all the same. In addition, the final priorities of all the elements in the network can be normalized (that is, the values associated with elements are determined by normalizing each block (cluster) of the limit supermatrix).

It is import to indicate that the ANP method has some inherent weaknesses. Due to the complexity of the method, its application is time consuming compared to AHP. Further, the ANP method involves numerical calculations in assessing composite priorities; as a result, the pairwise comparison calculations become complex when the number of criteria increases as very high number of pairwise comparisons need to be conducted (Nekhay et al., 2007, 2009; Percin, 2008; Wolfsleher et al., 2005; Wu, Lin & Peng, 2009). However, there are numerous different ways in which the pairwise comparison input data can be carried out such as graphic, verbal, matrix and questionnaire formats that can be used to input the data, which can make the data collection and analysis easier (Hallikainen, Kivijärvi, & Tuominen, 2009).

3.7 GIS-ANP Framework

The framework for the housing quality assessment problem is shown in Figure 3.6. The framework integrates the ANP methodology with GIS techniques. It can be subdivided into four major steps: (i) the problem definition/ criteria identification, (ii) data input (iii) ANP procedure, and (iv) GIS implementation.

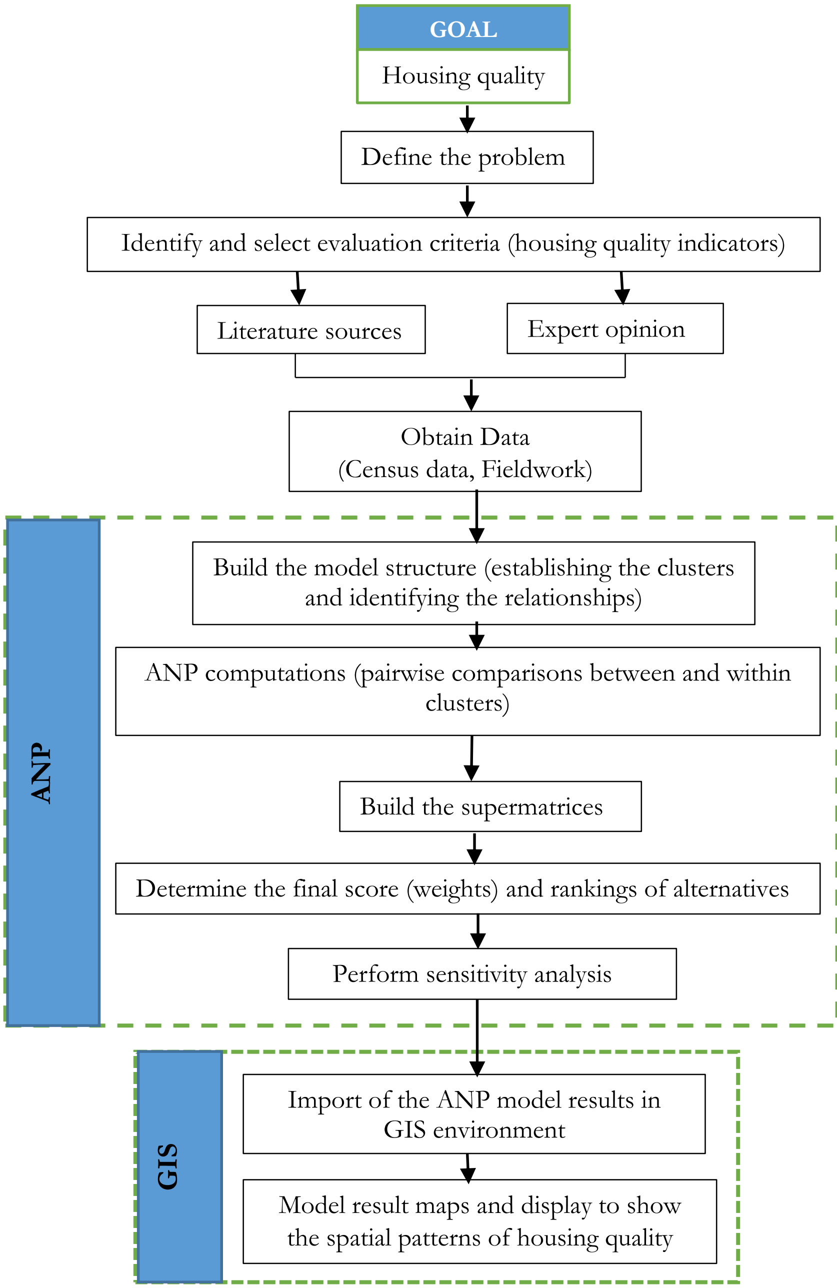


Figure 3.6: Framework for Evaluating Housing Quality.

i. The Problem definition / Criteria identification and selection

The first step in the housing quality assessment is to define the problem by developing a conceptual model for the decision/evaluation problem. This is the central part of the qualitative component of the ANP as this conceptual model drive all succeeding works for solving the decision problem. It is important to have a clear starting point with specific goals and objectives. In general, the problem of housing quality evaluation involves choices among criteria (factors) which affect the quality of the houses that are multiple and often with conflicting nature. Once the goal is defined, the next step is to identify and select the criteria to be used for the assessment. Criteria identification can be done through experts identifying the factors and/or through literature search to find the factors used by previous studies and selecting those that are applicable to a particular case study.

ii. Data input

After the criteria has been selected, the next process is to obtain the relevant data needed for the assessment. Data about houses relating to the selected evaluation criteria should be collected. For example, with the criteria structural quality, data related to the quality of the dwelling units should be collected such as type of wall material, floor, etc.; the datasets can be obtained from census data or through field work. Preparation and classification of the obtained data is carried out for the ANP model (adaptation of the data to the necessity of the ANP model).

iii. ANP procedure

The ANP procedure is adopted for obtaining the criteria weights (see Section 3.6). The ANP computations will be performed using the Super Decisions software and the results transferred into GIS. The ArcGIS software will be used. After, a sensitivity analysis can be carried out to test the robustness of the pairwise comparisons.

iv. GIS implementation

Upon completion of the ANP analysis, the ANP model is synthesized for the final weights. The weights are imported into Microsoft Excel spreadsheets. Data cleanup and editing are then performed on the spreadsheets including verifying that the text for each geographic reference in the data tables matched the text in the ArcGIS shapefile that it would be joined with. Other cleanup procedures include removing the limit matrix column that contains the general weights of the criteria used for the assessment and those of the alternatives (districts). Once the data tables for the ANP model are cleaned, the table containing the normalized values (weights) is joined in ArcMap to the shapefile of alternatives (district administrative boundaries of Ghana) based on a common identifier using the Join and Relate tool. After incorporating the data into GIS, modelling of the data (weights) is carried out to develop the housing quality spatial maps. This allows for examining the spatial patterns of housing quality.

3.8 Summary

MCDA is a well-known approach for supporting decision-making process. The method can be integrated into GIS for performing spatial multicriteria decision analysis or GIS-based MCDA. The main concern of this chapter was the ANP method utilized for evaluating housing quality. The chapter elaborates on the procedures involved in using the method and discusses the GIS-ANP framework to be used for the housing quality assessment in this study.

CHAPTER FOUR

GIS-ANP: APPROACH TO EVALUATE HOUSING QUALITY

4.1 Introduction

This chapter focuses on an application of the GIS-ANP method for evaluating housing quality at the districts in Ghana. The GIS-ANP framework discussed in the previous chapter will be employed. The first sections provide a brief description of the study area and details of the data utilized in this research as well as the selected variables, followed by a demonstration of the GIS-ANP framework to evaluate the quality of housing.

4.2 Study Area Profile

This section provides a profile of the study area. It is divided into two parts. The first part gives a brief description of Ghana, starting with the location and size characteristics. It then proceeds to describe the administrative structure of the country. The second part of the section follows with a description of the housing profile of the country.

4.2.1 Location and Size and Administrative Characteristics

Ghana is located on the west coast of Africa. It shares its northern boundary with Burkina Faso, eastern with the Republic of Togo, western with La Cote d'Ivoire and to the south by the Gulf of Guinea. Ghana lies between latitude 4° and 12° north of the equator. It also lies astride longitude 0° and 10 minutes east. Ghana has a total land area of 230,020 km^2, with a population of 24,658,823 based on the 2010 population and housing census (Ghana Statistical Service [GSS], 2012).

Ghana is constituted of ten administrative regions, which are subdivided into districts. As of 2010, 170 administrative districts existed in Ghana, made-up of 164 districts/municipal and 6 metropolitan areas. However, post censual assessment recommended that 45 new districts be created bringing the total number of districts currently to 216, subdivided into 6 metropolitan, 49 municipalities, and 161 district assemblies. The districts are considered the third-level administrative subdivision of the decentralized administrative system of the country. The three-tier system in use is the national, the regional and the district (which is the spatial unit of analysis in this study). Figure 4.1 is a map of the study area showing the regional and district maps of Ghana based on the 170 administrative districts.

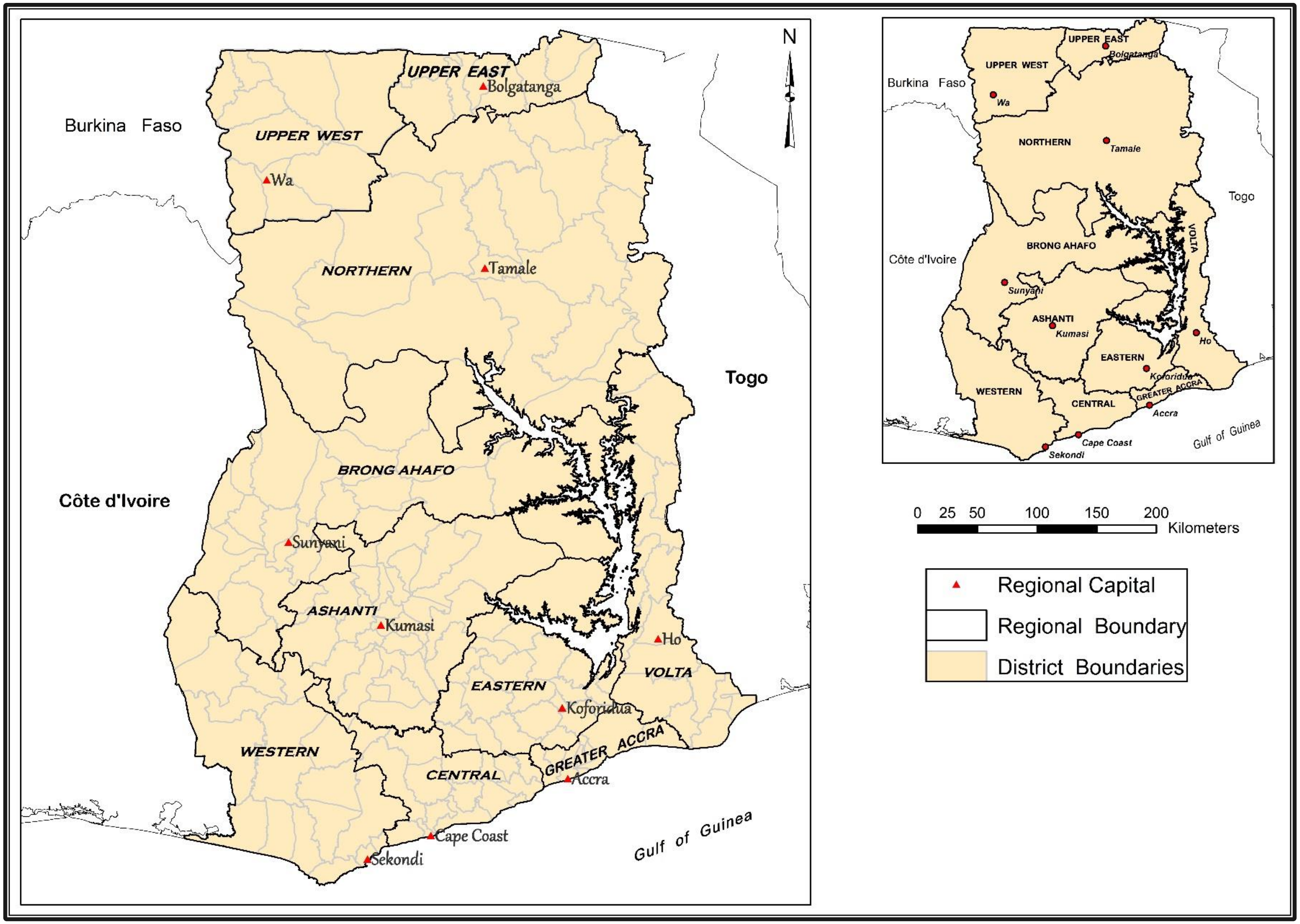


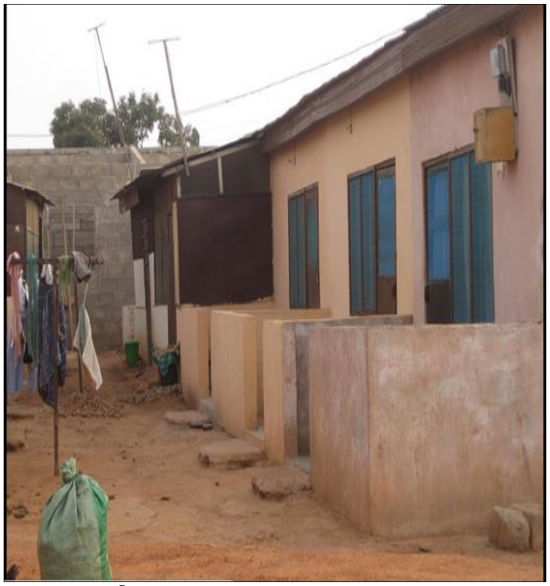
Figure 4.1: Regional and District map of Ghana.

4.2.2 Housing Profile of Ghana

Housing conditions in Ghana are affected by several factors, which include the location of the building, the local culture, the construction materials, and the amenities and funding services. The 2000 and 2010 Population and Housing Censuses of Ghana classify dwelling units into the following categories: Separate house, Semi-detached house, Flat/Apartment, Compound house (rooms), Huts/Buildings (same compound), Huts/Buildings (different compounds), Tent, Improvised home (kiosk, container), Living quarters attached to office/shop, Uncompleted building and other.

In Ghana, four key housing types predominate: single family homes, flats/apartments, single room occupancy in compound housing, and huts (buildings made up of earthen materials) shown in Plate 4.1. Compound housing dominates, which is followed by huts, single family and multi-family (flats/apartments) housing (Fiadzo et al., 2001). According to Fiadzo et al. the traditional compound house comprises of a large rectangular structure facing a courtyard with generally, 10 to 15 rooms around three sides of a courtyard.

The 2010 population and housing census indicate that, the total stock of houses in the country is 3,392,745 with a percentage of 57.7% in rural areas and the urban share of 42.3%. In terms of regional distribution, Ashanti has the highest proportion of houses (16.9%), followed by the Greater Accra (14.0%) and Eastern (12.7%) regions. The Upper West region has the lowest number of houses that is a total housing stock of 2.4% (GSS, 2012).



Compound House

Source: https://www.flickr.com/photos/jennab/419123497/in/photostream/

Huts

Source: http://www.superstock.com/stock-photos-images/1890-18761

Single Family Homes

Source: http://www.ghanafind.com/detail_page.php?recordID=149214

Flats /Apartments

Source: http://gh.geoview.info/heavy_rains_at_mp_flats_sakuono_estates,40566967p

Plate 4.1: The Four Dominant Types of Housing in Ghana.

The 2010 population and housing census specifies that 51.5% of households reside in rooms in compound houses, 28.7% in separate houses and makeshift dwelling units (tents, kiosks, containers and attachment to shops or offices) constitute 2.0% (GSS, 2012). According to the Ghana Statistical Service (2008) living in semi-detached houses, flats or apartments is not common among Ghanaian households. However, flats or apartments are more common in the urban areas than the rural.

4.3 Data and Data Sources

This study utilized secondary data; that is, the 2010 Population and Housing Census of Ghana. The data were acquired from the Ghana Statistical Service. The data collected comprises of information on dwelling types, the quality of structural materials used in constructing the housing units (walls, floors, and roof), ownership type (holding/tenure arrangement) and internal unit facilities (housing services) including type of lighting, source of water supply and toilet facilities etc. Data were also collected on the method of disposal of solid and liquid waste as well as household composition per dwelling. In Ghana, housing data are produced at the level of enumeration areas, which are later aggregated to the district level. Currently, there are 216 districts in Ghana, but this study made use of data based on the 170 administrative districts (164 districts/municipal and 6 metropolitan areas) that were in operation during the 2010 population and housing census.

Datasets used for the evaluation of housing quality consist of structural quality of building materials, types of physical amenities in the house, types of dwelling units, household characteristics and tenancy arrangements. These datasets were operationalized in the form of indicators and variables that was used in measuring housing quality.

The map coverages used for this analysis was provided by the Remote Sensing and Geographic Information System Lab at the Department of Geography and Resource Development, University of Ghana.

4.4 An Illustrative Example: The ANP Housing Quality Evaluation

The next sections illustrate the procedure for using the GIS-ANP framework introduced in the previous chapter to assess housing quality. The main goal of the process is to rank districts within a region according to their housing quality scores and also identify the relative importance of the housing quality factors to housing quality for the districts.

4.4.1 Structuring of the Decision Problem

In the context of housing quality assessment, the goal of the decision/evaluation problem is to rank geographical units according to selected indicators. The spatial units constitute a finite set of alternatives with the indicators constituting a finite set of criteria. The overall objective of the analysis is to assess housing quality at the district level in Ghana. The next step in structuring the decision problem is to define the indicators to be included. The problem of evaluating the quality of residential areas at the district level in Ghana present us with a situation in which one has to combine a number of evaluation criteria (indicators) to obtain a measure of housing quality. The assessment of housing quality at the district level in Ghana was carried out based on variables considered as relevant indicators of housing quality. Set of criteria was identified through a survey of literature that provided information on various factors (indicators) that contribute to housing quality. By reviewing the literature, it was found that various researchers had used a certain set of criteria for assessing housing quality (see Section 2.3.4.1). These studies provided the base for selecting the set of criteria used in this case study.

A comprehensive set of evaluation criteria that reflect all the concerns relevant to the evaluation problem was identified according to indicators that contribute to housing quality and their respective variables used to operationalize them. Housing quality was measured with a variety of indicators (criteria) clustered into four main groups: physical, economic, social and environmental attributes of housing. Figure 4.2 shows the framework of the evaluation problem structured by a hierarchical network or heirnet model (see Khan & Faisal, 2007), where the goal according to which the problem has been structured and the evaluation criteria that assess the achievement of the objective are presented. There are four components in the model, namely: goal, evaluation criteria, sub-criteria, and alternatives (districts in the Greater Accra region have been listed here for demonstration). There are hierarchic dependences from goal to evaluation criteria and from criteria to decision alternatives. The relevance of these hierarchic dependencies is to show how the goal is decomposed into a set of criteria and how alternatives (districts) are evaluated from this set of criteria. Evaluation criteria and alternatives have a feedback control link so that a strong connected structure could be attained to ensure that the evaluation components are linked to the goal. There is an inner dependence within the physical group indicated by the loop, while there is outer dependence between the physical and economic criteria groups shown by the dashed arrow.

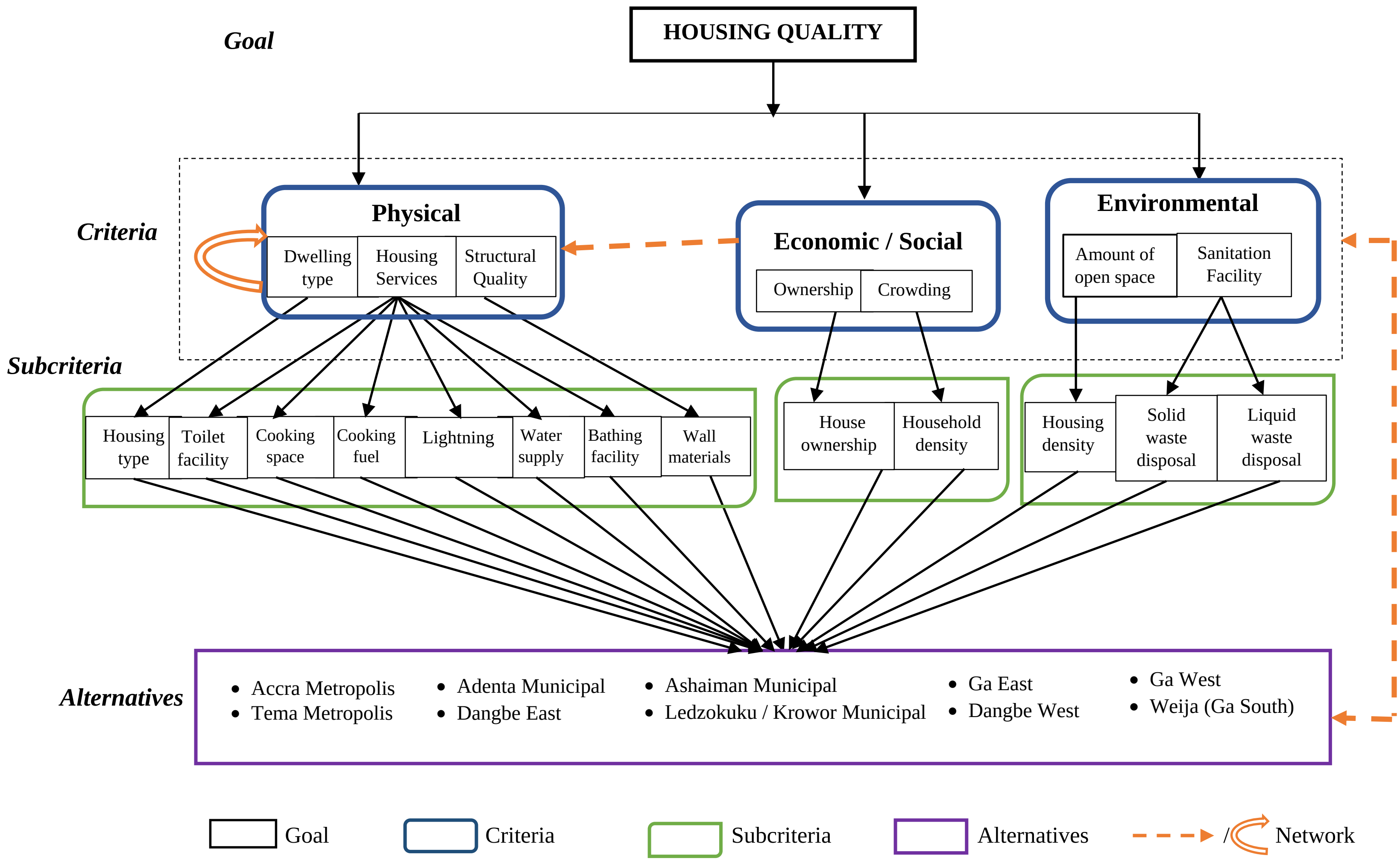


Figure 4.2: Structure of Housing Quality Evaluation Problem in Ghana.

Seven categories of criteria shown in Figure 4.2 relevant to the physical, economic, social and environmental attributes of housing were used to operationalize the clusters used in the ANP model. These sets of criteria can be assembled numerically at the individual household level and represented on a map in aggregate form for district levels. Following is a description of the clusters and their respective elements (nodes).

4.4.1.1 1st Cluster: Physical Criterion

This cluster represents the physical attributes that contributes to housing quality. It includes the following indicators: dwelling type, housing services and structural quality. Dwelling type comprised of the different models of housing in Ghana; housing services is made up of the housing facilities or internal amenities that are available in the residence (measured by variables such as type of toilet facility, type of bathing facility etc.); structural quality involves the materials used for the dwelling, including outer/wall material, floor material and roof material (only wall material was used in this study due to data constraint and it was coded as outer material).

4.4.1.2 2nd Cluster: Socio-economic Criterion

The economic criterion embraces tenancy arrangements (ownership), which involves whether a dwelling is rented or owner occupied. One variable (rent free) was dropped because people who fall into this category were neither owners nor renters. In Ghana, this set of occupants usually have a family member who might be a household member or not, owning the residence in which they live or they stay in a family residence**.** The social criterion encompasses variables related to overcrowding. Average household size per dwelling was used in this study to measure overcrowding.

4.4.1.3 3rd Cluster: Environmental Criterion

The physical environment is recognized as an essential part of housing. The quality of life in a housing environment is both influenced by the quality of the dwelling place and the quality of the immediate environment; i.e. the residential complex as a whole (entire residential neighbourhood) (Bogdanović and Mitković, 2005). This criterion takes into account physical characteristics of the environment. Environmental factors include environmental sanitation and crowding of the land. Environmental sanitation was measured using modes for solid and liquid waste disposal, whereas crowding of the land by buildings; i.e. the amount of open space in neighbourhood was measured using housing density. Table 4.1 summarizes the selected clusters and their respective elements/nodes. Once the clusters and respective elements were selected, the ANP model was constructed.

Table 4.1: List of Housing Quality Criteria together with Elements

CLUSTER	ELEMENTS
PHYSICAL	*Structural Quality* • Wall material *Housing Facilities / Services* • Source of water supply • Source of lighting • Type of cooking fuel • Type of cooking space • Type of toilet facility • Type of bathroom *Structural Design* • Type of housing
SOCIO-ECONOMIC	*Ownership* • Owner occupied • Renting *Overcrowding* • Number of households per house
ENVIRONMENTAL	*Amount of Open Space* • Housing density *Environmental Sanitation* • Mode of drainage disposal • Mode of refuse disposal

4.4.2 ANP Model Construction

To develop an ANP model, one needs to identify the problem, define criteria and sub-criteria and specify the relations between them and their interactions. A network model has a criteria cluster and an alternative cluster, but no goal. The network model was structured with a single control criterion: housing quality. The objective is to try and determine housing quality for the districts in Ghana by considering what housing characteristics and attributes affect and contributes to housing quality and introduce them as clusters, nodes and influence links in a network. The decision alternatives are the districts.

In the present application, the model has been developed according to the simple network structure. A simple network contains clusters, nodes/elements and connections or links which are all contained in a single window. In a case of a more complex problem, Saaty (2005) recommends the use of four sub-networks: Benefits, Opportunities, Costs, and Risks (BOCR) (i.e. structuring the decision problem according to the complex network structure). The “complex” network makes it possible to abridge the problem structuring by classifying issues in the traditional categories of positive and negative aspects. The favourable characteristics are called benefits, while the unfavourable ones are called costs; the uncertain aspects of a decision are the positive opportunities that the decision might generate and the negative risks that it can necessitate. Each of these four aspects employs a separate network structure for the decision situation (Saaty & Vargas, 2006). Consideration of these sub-networks permits keeping in mind all scopes of the decision problem. The “simple” network is a free-modelling approach, which is not supported by any guide or pre-determined structure (complex network structure). The network structure of the housing quality decision problem and the interdependences between the clusters have been simulated using Super Decisions 2.2.6. Software[1], which creates a list of the pairwise comparisons needed to run the assessment. The selected criteria for the decision problem refer to physical, economic, social and environmental indicators of housing quality and were clustered into three main groups (clusters) as outlined above. Figure 4.3 displays the model with the clusters and their respective elements.

According to the ANP methodology, once the network has been identified, it is necessary to represent the influences (or interrelationships) among the elements (nodes). This task was approached in the following way. First, all the elements in the clusters were supposed to have an influence on the alternatives (see Figure 4.4). Second, further relationships were identified concerning the potential influences among the elements of each cluster (outer dependence); i.e. between the physical and economic/social cluster represented by the arrow from the physical cluster to the economic/social cluster in Figure 4.3. Third, a feedback structure was introduced whereby alternatives were linked to criteria in order to compare them for preference to find out what set of criteria contributes more to housing quality of a district (see Figure 4.5).

[1] www.superdecisions.com.

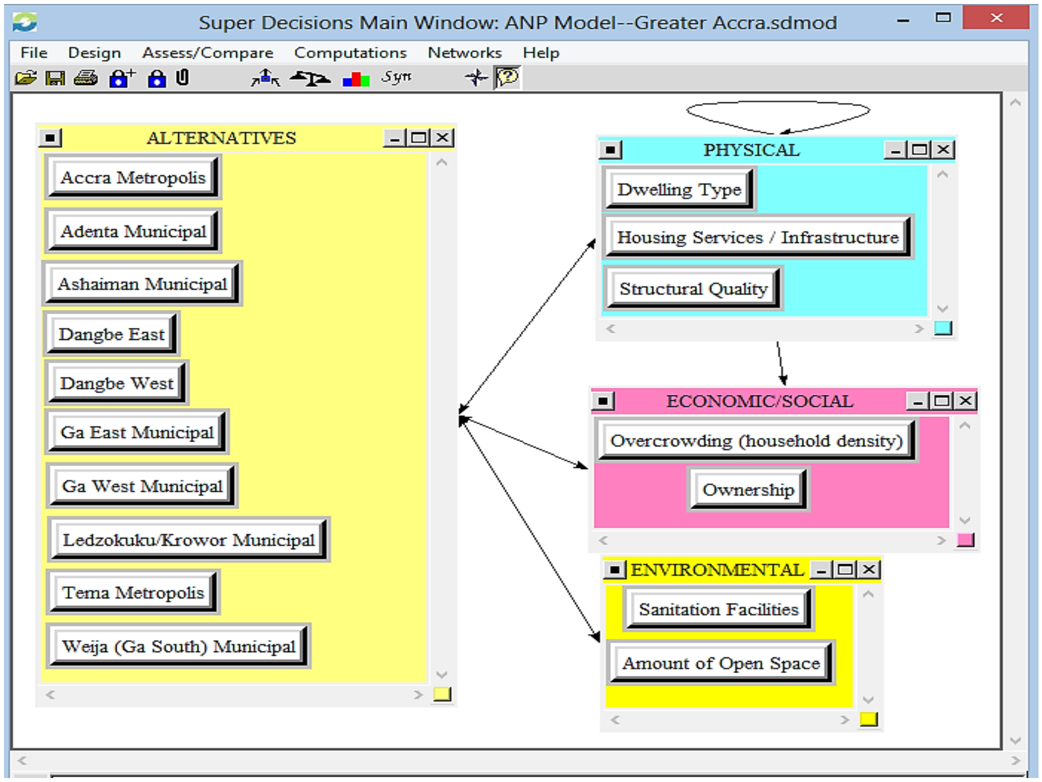


Figure 4.3: The ANP Model for Evaluating Housing Quality at the District Level in Ghana.

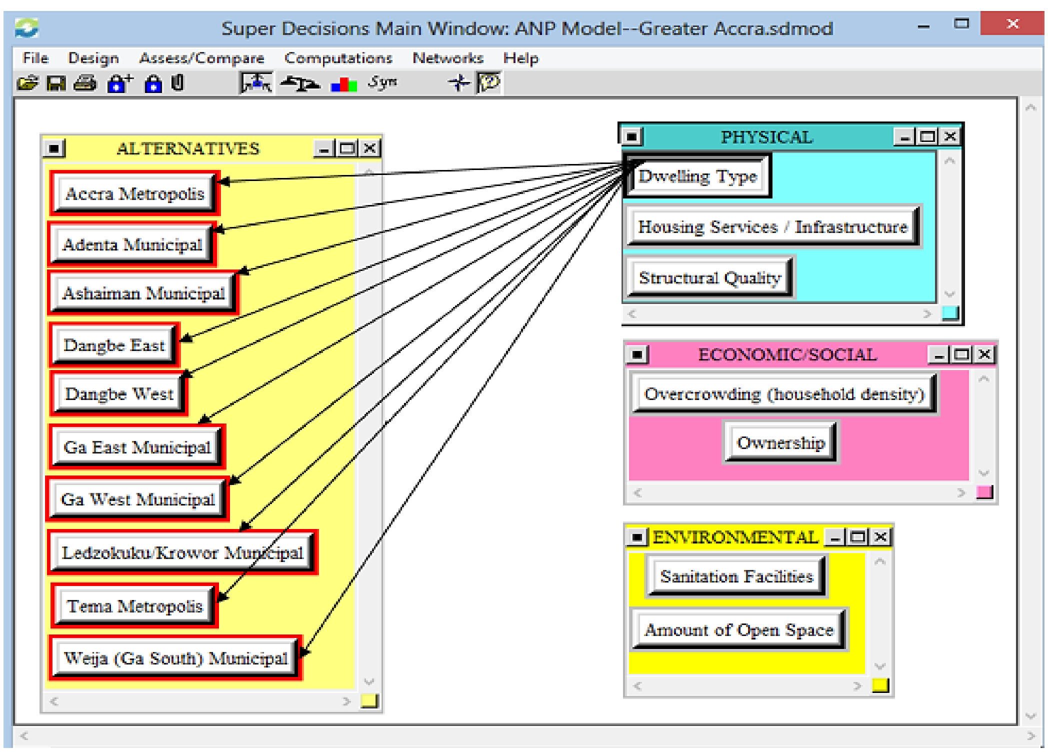


Figure 4.4: Element Dwelling Type connected to Alternatives.

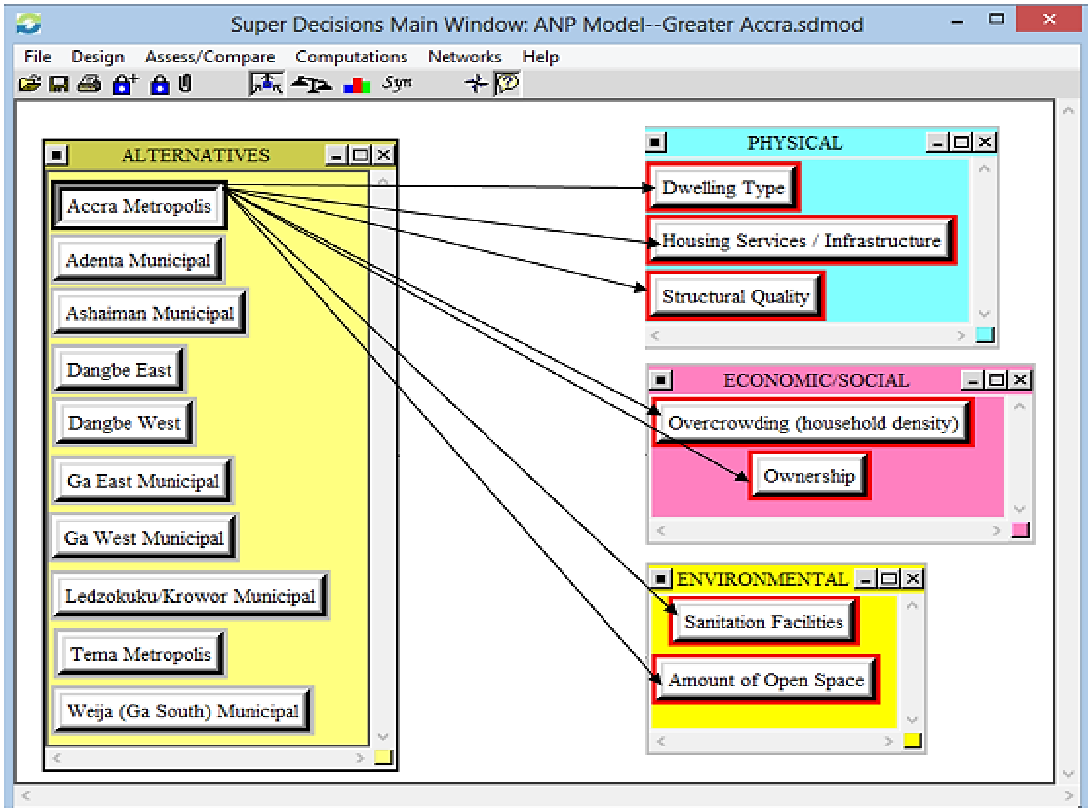


Figure 4.5: Feedback structure with respect to the Accra Metropolis.

A single direction arrow in the model (Figure 4.3) shows the dominance of one factor over another. A double direction arrow shows the mutual influence between the factors (feedback). Loops indicate inner dependences. In this study, only one inner dependence was identified. That is with regards to the physical cluster. After determining the clusters and their elements with the relationships between them, pairwise comparisons were performed on elements within clusters and between clusters to prioritize alternatives.

4.4.3 Conducting the Pairwise Comparisons between Elements

This section consists of conducting all existing pairwise comparisons which are obtained through evaluations using the fundamental scale (Table 3.1). After articulating interdependencies, pairwise comparisons is implemented with respect to all those factors that have an impact on other factors within their own cluster or other clusters of the network. In this case, the factors in a cluster are compared according to their influence on a factor in another cluster to which they are connected (or factors in their own cluster). Due to the nature of the data and variables used for this study, before carrying out the pairwise comparisons for the network model, first an AHP rating model was employed to rate the indicators as to how much they are contributing to housing quality at the various district levels. The indicators outlined above were decomposed into set of subcriteria, consisting of a set of thirteen variables which were used to measure them (see Figure 4.6). The response choices under the variables were categorised based on various classifications and ranked (see Table 4.2) in relation to their contribution to housing quality. Categories that could better distinguish between different levels of housing quality were assigned higher ranks.

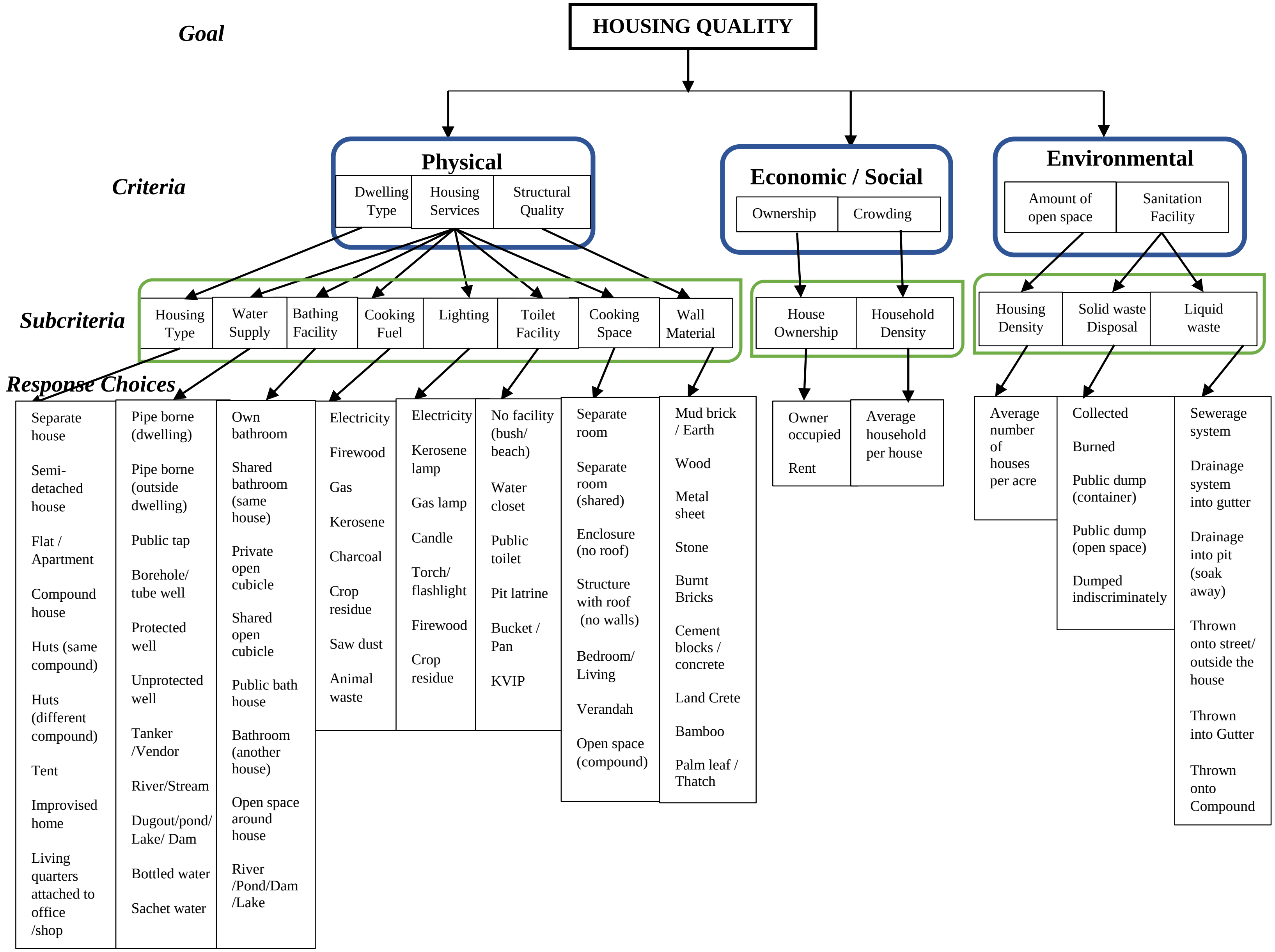


Figure 4.6: Housing Quality Evaluation Problem: The Response Choices for the Variables (Subcriteria)

Table 4.2: Indicator Classification and Ranking

Indicator	***Categories and Ranks***	***Reasons for Clustering and Rankings***
Type of External Material	1. *Fairly- /Non -sustainable:* (Wood, Mud brick/Earth, Metal sheet/Slate/Asbestos, Palm leaf/Thatch (grass) /Raffia, Bamboo). 2. *Most- sustainable:* (Land Crete, Stone, Burnt bricks, Cement blocks/ Concrete).	Ranked based on items relative durability. The ranking was adapted from Meng and Hall, (2006).
Types of Dwellings	1. *Poor /Least quality* (Tent, Improvised home (kiosk/container, Living quarters attached to office/shop, Huts/Buildings (same compound), Huts/Buildings (different compound). 2. *Moderate quality* (Compound house (rooms). 3. *High quality* (Separate house, Semi-detached house, Flat/Apartment).	Ranked based on quality of building material, privacy and noise levels. The least category comprised of makeshift and other improvised dwellings. Huts were added to this category based on the quality of the building materials used.
Source of Lighting	1. *More/Fairly/Least-efficient:* (Kerosene lamp, Flashlight/ Torch, Candle, Crop residue, Firewood) 2. *Most-efficient:* (Electricity, Gas lamp).	The nature of the source of lighting is one of the indicators of quality of life. As society advances, the source of lighting shifts from use of low quality sources such as fuel wood to more efficient ones such as electricity (GSS, 2013). Electricity was considered by Arias and Devos (1996) as the best source of lighting, hence assigned the highest value. Other lighting sources, such as crop residues and firewood, were not as reliable and a permanent source of power. Therefore, assigned the lowest values. Kerosene lamp was added to this category based on its pollutant levels. Ranked based on durability and pollutant level as well as efficiency and quality.

Source of Water Supply (Drinking)	1. *Unimproved:* (River/Stream/Dugout/Pond/ Lake/Dam/Canal, Unprotected well, Tanker supply/Vendor provided, bottled and sachet water). 2. *Improved:* (Protected well, Bore-hole/Pump/Tube well, Rain water, Public tap/Standpipe, Protected spring). 3. *Improved (Piped into dwelling):* (Pipe-borne outside dwelling, Pipe-borne inside dwelling).	The availability of and access to improved drinking water is an important aspect of the health of household members. According to Bradley and Putnick (2012) a hallmark of housing quality in poor and developing countries is clean drinking water. The main source of drinking water was ranked based on hygienic conditions of the water source using the Sanitation Ladder recommended by WHO and UNICEF (2008). Bottled and sachet water was considered unimproved sources, because most of them are not regulated and water from other unimproved sources is sometimes bottled and sold in developing countries (Bradley & Putnick, 2012) with Ghana being no exception.
Type of Toilet Facility	1. *Unimproved:* (Bucket/Pan, Pit latrine, Public toilet, No facilities - bush/beach/field). 2. *Improved:* (*KVIP, Water Closet.)	An effective and hygienic method of human waste disposal available in a dwelling unit is a critical indicator of the sanitary situation of the unit and is an indirect measure of the socioeconomic status of a household (GSS, 2013). As a result, this category was ranked based on hygienic standards, using the classification by the Joint Monitory Programme (JMP) of WHO and UNICEF (2008). * The Kumasi Ventilated Improved Pit latrine is a local alternative of the internationally-used VIP toilet. When used in public toilets it tends to be termed KVIP, while in private use it is just VIP (Jenkins & Scott, 2007). Only the private form are included under KVIP as people using public toilets are classified under public toilet.
Type of Bathing Facility	1. *Moderate /Low privacy and quality:* (Public bath house, Bathroom in another house, River/Pond/ Lake/Dam, Open space around the house, Shared open cubicle, Private open cubicle) 2. *High privacy and quality:* (Shared separate bathroom in the same house). 3. *Highest privacy and quality:* (Own bathroom for exclusive use).	Were ranked based on privacy and quality. Shared open cubicle and private open cubicle were added to the least category because they are improvised. Sharing of bathrooms presents greater problems because of the risks involved as the intensity and number of users (households) increase. In addition, shared bathroom cleaning responsibilities sometimes generates conflicts and squabbles among housewives. As a result, the ranking of the shared separate bathroom as second.

Type of Cooking Fuel	1. *Low quality:* (Crop residue/Saw dust, Firewood, Animal waste). 2. *Medium quality:* (Charcoal, Kerosene). 3. *High quality:* (Gas, Electricity).	The type of fuel used by household also relates to the type and quality of building occupied by households. Electricity was considered by Arias and Devos (1996) as the best source of cooking fuel. Gas and Electricity were ranked higher because they are considered as the modern fuel types (IARC, 2010). Though kerosene is also considered among the modern fuels, was ranked as medium quality due to the high pollution levels associated with it compared to Gas and Electricity. Rank 1 can be considered as traditional, rank 2 intermediate and rank 3 modern. Having open fires in the house increases proneness to respiratory illness. Exposure to wood smoke can have adverse health consequences. Example, prenatal exposure can lead to low birth weight (Siddiqui et al., 2008) therefore this category was ranked low. Ordered in terms of quality (Fiadzo, 2001) and pollution levels.
Type of Cooking Space	1. *Fairly/Least private and comfortable:* (Bedroom/Hall/Living room, Verandah, Enclosure without roof, Open space in compound, Structure with roof but without walls). 2. *Moderately private and moderately comfortable:* (Separate room shared with other household(s). 3. *Most private and most comfortable:* (Separate room for exclusive use of household).	Households with no kitchens at all sometimes cook along the corridor, or in their rooms. According to Muoghalu (1991) this increases the discomfort level of their houses through the production of smoke and increase in house temperature. Hence the addition of bedroom/hall/living room and verandah to the least ranked category. Also, sharing of kitchen invades on family privacy as families would like to prepare their meals privately (Muoghalu, 1991) therefore ranked second. Ranked based on privacy and discomfort levels.

Over-crowding	*Average Households per house* 1. = >2 2. = 1- 2	Ranking adapted from Meng and Hall (2006). Overcrowding is a standard displaying a socially intolerable level of crowding measured by room or household occupancy factor indicator (Muoghalu, 1991). According to Meng and Hall (2006) households per occupied dwelling unit articulates a certain aspect of living space as a basic requirement of shelter to maintain health and privacy. In Ghana, multiple families sharing one dwelling unit is a common phenomenon. Hence, occupancy ratio was considered in assessing housing quality. Dwellings with average household size 1-2 is considered not crowded with greater than 2 as overcrowded.
Tenancy	*1.* Renting *2.* Owner occupied	Ranked based on tenancy arrangement. Owning indicates higher quality than renting does (Aliu & Adebayo, 2010; Spain, 1990). According to Aliu & Adebayo (2010) lack of economic strength or poverty in most developing countries has undermined the quality of housing available to people, the majority of whom are poor. To them, environmental and dwelling attributes are swayed by socioeconomic indices which also define the individual level of wellbeing. They argued that no matter what predilection a renter may express for neighbourhood and dwelling quality, the eventual determinant of housing quality of individuals is their socioeconomic status as a renter or owner occupiers. Ibem (2012) found that tenure status affects dwelling quality. Secured tenure is therefore considered as a vital indicator of good housing quality. Therefore, the rank of 2 for owner occupied and 1 for renting.

Mode of Refuse Disposal	1. *Fairly /Least acceptable:* (Burned by household, Dumped indiscriminately, Buried by household, Public dump (open space). 2. *Most acceptable:* (Collected, Public dump (container).	Ranked based on safe disposal and acceptable modes. Acceptable waste management helps to prevent the spread of some types of infections and improves the quality of the environment. Though public dump (container), with periodic collection have the disposed waste uncollected for a period of times, sometimes up to weeks, was ranked highest together with door to door collection based on the modes of refuse disposal available in Ghana. It is one of the accepted modes since they normally constitute a central dumping site where the waste is dumped into a bin rather than discriminatory and in open spaces.
Type of Drainage System/ Facility	1. *Fairly/ Least improved:* (Thrown onto the compound, Thrown onto the street/outside, Through a drainage system into a gutter, Thrown into a gutter). 2. *Most improved:* (Through the sewerage system, Through drainage into a pit (soak away).	Ranked based on hygienic standards. Part of the quality of residence is the drainage provision which defines the level of water stagnation and invariably the preponderance of breeding grounds for mosquitoes and consequent exposure to the risk of malaria (Aliu & Adebayo, 2010). Throwing of liquid waste onto the compound and gutters pose a threat to residents as this enhances the breeding of vermins, mosquitoes and flies which pose serious threat to life as most of the gutters in Ghana are not covered and sometimes clogged leading to water stagnation. Consequently, the assignment of the least rank to these category.

Housing Density	1. = ≥ 22 2. = 11-21 3. = ≤ 11	This indicator was considered in assessing housing quality because, the quality of housing and neighbourhood environment reduces as the degree of density or level of crowdedness increases (Coker et al., 2008). In Ghana, average plot sizes differ across regions and even within regions and districts. With the state and vested land, the average residential plot size is 30 x 30m (900 square metres). In customary areas, different plot sizes are presently being demarcated, including 30 x 24m (720 square metres), 30 x 27m (810 square metres), 30 x 23m (690 square metres) and 37 x 30m (1110 square metres). Therefore the state and vested plot size (30 x 30m (900 square metres) was adopted for this study, which gives a net density of 11 plots per hectare (UN-HABITAT, 2011). 69.88% and 21.20% of the total land area in Ghana as at 2011 is agricultural and forested land respectively (World Bank, 2014). Therefore, in calculating the housing density in this study, 10% of the total land area of the districts was adopted as residential lands. Housing density was computed using the formula total number of houses in the district divided by total land area i.e. 10% of the total land for the districts. Using the net density of 11 plots per hectare as a benchmark, the classification used to measure housing density was done. With housing density less than or equal to 11 considered as low density, 11-21 as medium density and greater than 22 as high density.

Using the rating method of AHP (Figure 4.7) categories or standards are established for the criteria (indicators), and then they are rated one at a time by selecting the appropriate category under each criterion using the rating spreadsheet (Figure 4.8). The categories are prioritized by pairwise comparing. For example, the standards/categories for the criterion of outer/external material are: most–sustainable and fairly-/non-sustainable. Judgments are entered for such questions as: How much is the most–sustainable category more important than the fairly/non-sustainable category for the outer/external material criterion? The priorities for the various categories were obtained by transforming the ranks of the categories to priority weights.

A rank order of the categories was created for each criterion. That is, every criterion under consideration was ranked in order of preference (their contribution to housing quality). Inverse ranking was used whereby the least contributing category was ranked 1 and the highest 3. Rank sum method was used to transform the ranks into priorities. With this method, each rank is converted to a weight (the higher the weight, the more important the criterion). In this study the higher the weights, the more that category contributes to housing quality. A category with a rank of 3, 2, and 1 was weighted 9, 6 and 3, respectively. In cases of only two categories, the highest rank was weighted 9 and the lowest (rank 1) was weighted 4.5. Using the direct entry mode for the pairwise comparison in the Super Decisions software, these weights (9, 6, 4.5, and 3) were entered for the various categories under each criteria which automatically created the pairwise comparisons and their resultant normalized weights. This is demonstrated for the outer/external material criterion in Figure 4.9.

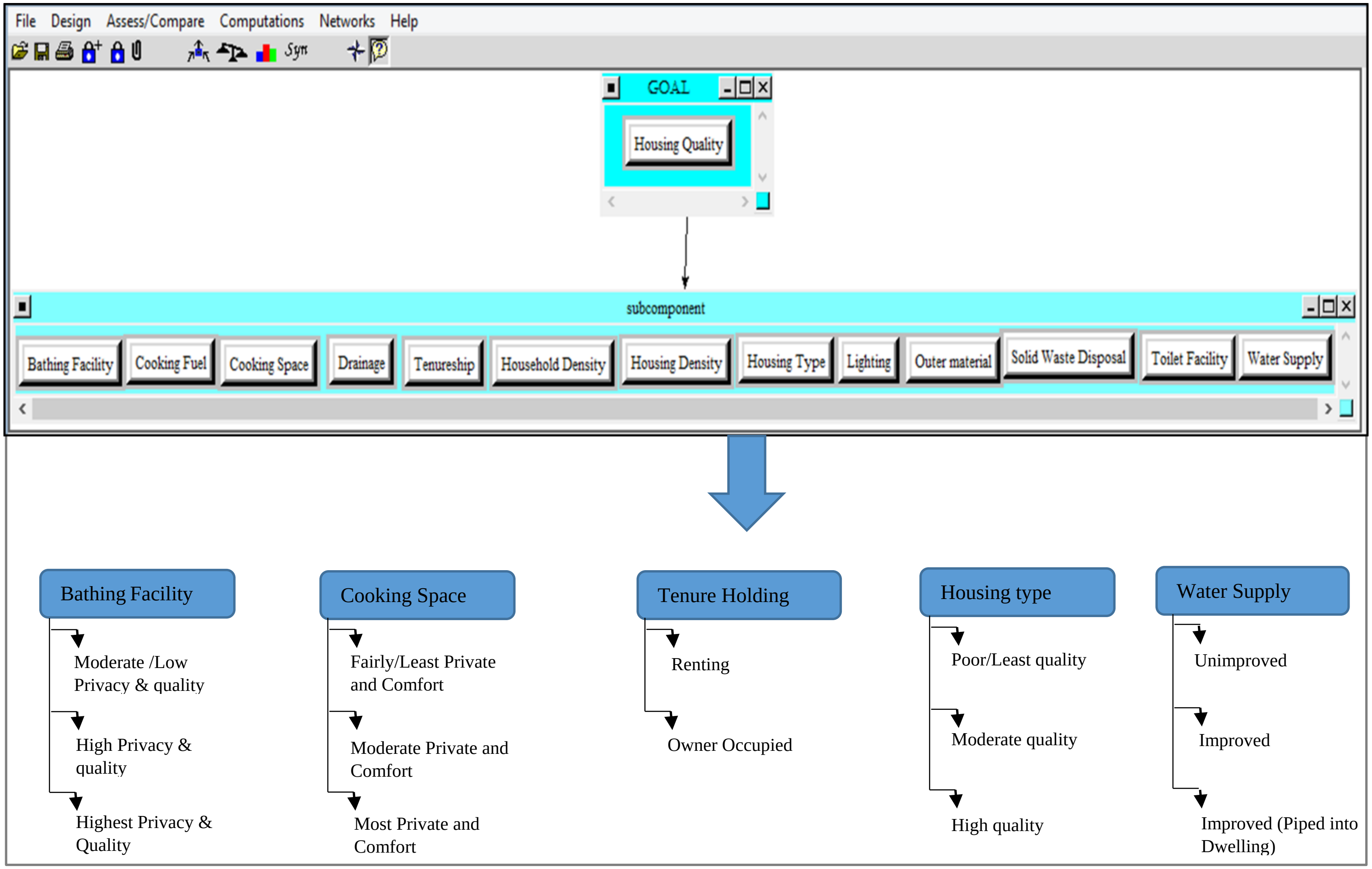
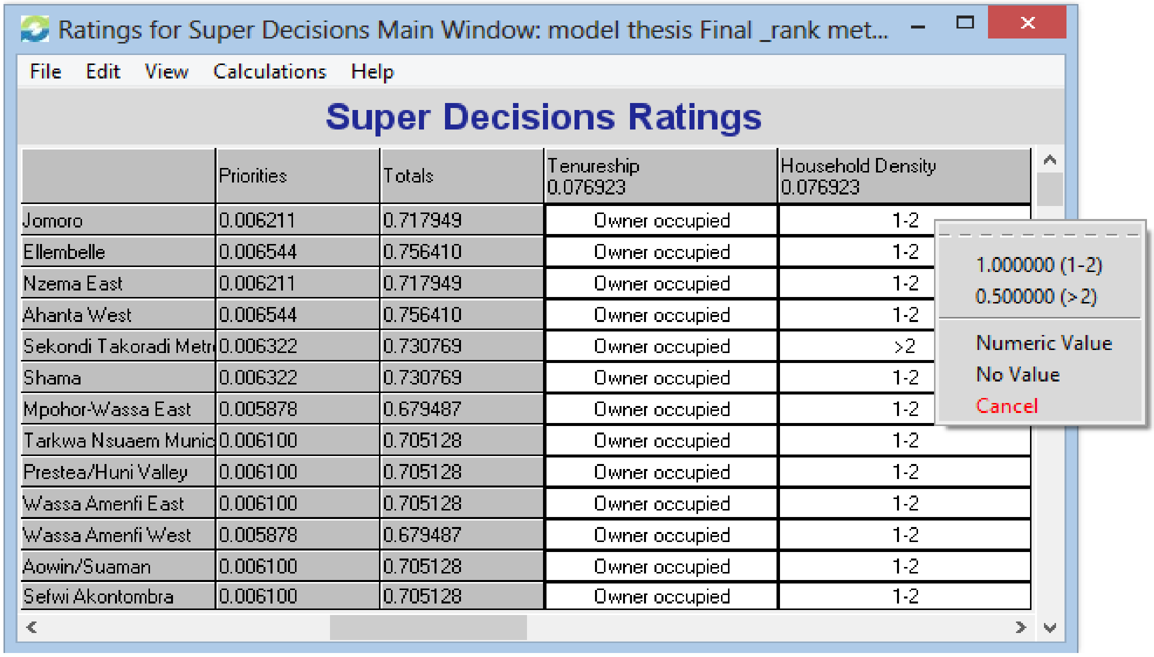


Figure 4.7: Cross section of the Rating model for Housing Quality.

* *For the rest of the categories for the other variables, please refer to Table 4.2.*



	Priorities	Totals	Tenureship 0.076923	Household Density 0.076923
Jomoro	0.006211	0.717949	Owner occupied	1-2
Ellembelle	0.006544	0.756410	Owner occupied	1-2
Nzema East	0.006211	0.717949	Owner occupied	1-2
Ahanta West	0.006544	0.756410	Owner occupied	1-2
Sekondi Takoradi Metr	0.006322	0.730769	Owner occupied	>2
Shama	0.006322	0.730769	Owner occupied	1-2
Mpohor-Wassa East	0.005878	0.679487	Owner occupied	1-2
Tarkwa Nsuaem Munic	0.006100	0.705128	Owner occupied	1-2
Prestea/Huni Valley	0.006100	0.705128	Owner occupied	1-2
Wassa Amenfi East	0.006100	0.705128	Owner occupied	1-2
Wassa Amenfi West	0.005878	0.679487	Owner occupied	1-2
Aowin/Suaman	0.006100	0.705128	Owner occupied	1-2
Sefwi Akontombra	0.006100	0.705128	Owner occupied	1-2

Figure 4.8: Spreadsheet for Rating Model.

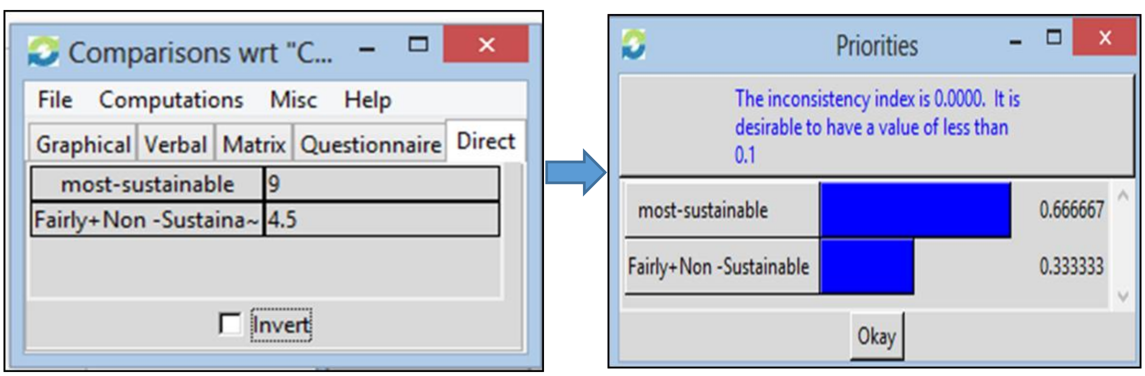


Figure 4.9: Deriving Priorities for the Outer Material Criterion Categories.

Figure 4.9 illustrates the process of deriving the intensities under the outer/external material criterion. Here, the rank weight of 9 for most-sustainable materials and that of fairly-/non-sustainable (4.5) were entered into the Super Decisions software which translated into derived weights of 0.666 and 0.333 with the resultant ideal weights of 1.0 and 0.5 after the pairwise comparisons were automatically created based on the entered values for the categories. The process was repeated to compare the intensities for each of the other indicators.

After the pairwise comparison to derive the intensities for the various categories based on the classifications done in Table 4.2, the response choices for each variable from the census data were aggregated for the categories. In rating the indicators, the category with the highest number of response choices was selected as the dominant one for the indicator under rank for each district. For example, for Jomoro district, under the indicator type of cooking fuel, the total number of response choices for high quality (electricity and gas) is 3,488, medium quality (charcoal, kerosene) 8,063 and low quality (crop residue, sawdust, firewood) 20,795. As a result of these categorized response choices, the indicator type of cooking fuel will have the category for low quality being entered for it, since it has the highest response choices and reflect the dominant type of cooking fuel used by households.

The rating method was employed for this process because, the districts are not compared against each other. As a result, there is no dependence between them. In addition, since expert weighting was not used in this study, it afforded the researcher the opportunity to predict how much each indicator is contributing to housing quality at the various districts which enabled comparison in the ANP model.

The weights (results) from the rating method for the various criteria were used as inputs for the ANP pairwise comparisons. The weights of the criteria for the rating model was converted to percentages and ranked on a scale converted to that of the fundamental scale.

4.4.3.1 ANP Pairwise Comparisons

To reflect interdependencies in the network, pairwise comparisons among all the factors are conducted. A pairwise comparison is a numerical representation of the relationship between two elements that discerns which element is more important with respect to a higher criterion. According to the ANP methodology, the comparison and evaluation phase is based on the pairwise comparison of the elements under consideration which involves comparison between clusters which is more general and the comparison between nodes which is more detailed. The generic question of the pairwise comparisons has the following form: given an element in any component, how much more does a given element of a pair influence that element with respect to a control subcriterion (criterion)? The same kind of question is asked about the comparison of clusters. Cluster comparison is done to establish their importance with respect to each cluster they are linked from. In this study, the clusters are weighted the same. The linked nodes in a given cluster are pairwise compared for their influence on the node they are linked from (the parent node) to determine the priority of their influence on the parent node. All the comparison questions are asked from the perspective of what is contributing more to housing quality. Each comparison has a respective question; for example, “with respect to physical factors of housing quality, which indicator is contributing more to the quality of housing: dwelling type or housing services, and to what degree?” The same question is made for all elements that have an impact on other elements, whether they belong to the same cluster (inner dependence) or to another cluster (outer dependence). The point in doing the comparisons is to obtain their relative weights; i.e. each element/cluster has a certain importance in the network/model, which is represented by weights. During the pairwise comparison process of all the factors, the consistency of the responses must be checked by calculating the Consistency Ratio

(CR). A consistency less than 0.1 is acceptable (see Section 3.6). In this study the consistency ratio was calculated automatically by the Super Decisions software.

In order to assign intensity of importance to each set of indicators, the individual indicators were weighted in relation to each other; i.e. pairwise comparison was carried out for all connections in the model. Results from the rating method formed the basis of the weights assigned to each indicator in the pairwise comparison of the ANP model. This weighting procedure of using the results from the rating method afforded the researcher the opportunity to identify how much each factor or element was contributing to the overall goal of housing quality for each district and hence their subsequent weights assigned. Since some of the indicators had more than one variable used to measure them, the average weights of the variables under those indicators were taken. An average was taken of the six (6) variables (bathing facility, cooking fuel, cooking space, lighting, toilet facility, water supply) used to measure housing services for the physical criterion and the variables (liquid waste disposal and solid waste disposal) for sanitation under the environmental criterion. The final weights of the rating model (see Appendix I) were used as input for the ANP model. The Greater Accra region will be used for demonstrating the pairwise comparison.

The final weights for housing services for the Accra Metropolis is calculated by taking the average of the six variables outlined above, which gives a value of 0.6389 (see the housing services column in Table 4.3). The average of liquid and solid waste disposal is calculated in a similar way, resulting in a value of 0.7500 (see the sanitation column in Table 4.3). The same procedure was carried out for all the other districts.

Table 4.3: Priorities for variables (Housing services and Environmental sanitation) for Greater Accra Region from the Rating Model.

DISTRICT/ VARIABLES	*Bathing Facility*	*Cooking Fuel*	*Cooking Space*	*Lighting*	*Toilet Facility*	*Water Supply*	***Housing Services***	*Liquid Waste Disposal*	*Solid Waste Disposal*	***Sanitation***
Accra Metropolis	0.3333	0.6667	0.3333	1.0000	0.5000	1.0000	0.6389	0.5000	1.0000	0.7500
Adenta Municipal	0.3333	1.0000	0.3333	1.0000	0.5000	0.3333	0.5833	0.5000	1.0000	0.7500
Ashaiman Municipal	0.3333	0.6667	0.3333	1.0000	0.5000	1.0000	0.6389	0.5000	1.0000	0.7500
Dangbe East	0.3333	0.6667	0.3333	1.0000	0.5000	0.6667	0.5833	0.5000	0.5000	0.5000
Dangbe West	0.3333	0.6667	0.3333	1.0000	0.5000	1.0000	0.6389	0.5000	0.5000	0.5000
Ga East Municipal	1.0000	1.0000	0.3333	1.0000	1.0000	0.3333	0.7778	0.5000	1.0000	0.7500
Ga West Municipal	0.3333	1.0000	0.3333	1.0000	1.0000	0.3333	0.6667	0.5000	1.0000	0.7500
Ledzokuku/ Krowor	0.3333	1.0000	0.3333	1.0000	0.5000	1.0000	0.6944	0.5000	1.0000	0.7500
Tema Metropolis	1.0000	1.0000	0.3333	1.0000	1.0000	1.0000	0.8889	0.5000	1.0000	0.7500
Weija (Ga South)	0.3333	0.6667	0.3333	1.0000	0.5000	1.0000	0.6389	0.5000	0.5000	0.5000

The weights from the rating method were converted into a 100 point scale. In each pairwise comparison, any two variables of the same magnitude were assigned a value of 1 from the fundamental scale. The value of 1 was considered the baseline and values higher and below this threshold were assigned based on the magnitude of each indicator. For instance, under the physical criterion, if housing services and dwelling type each had a magnitude of 50, then the weight assigned was 1. If the housing services and dwelling type had magnitudes of 50 and 60 or 50 and 70, then dwelling type was assigned values of 2 and 3, respectively.

This implies that the dwelling type is 2 (weak or slightly) and 3 (moderately) contributing to the quality of housing than the housing services. Alternatively, if the housing services and dwelling type had magnitudes of 50 and 40 or 50 and 30, then housing services was assigned values of 3 and 4, respectively. This implies that the housing services is 3 (moderately) and 4 (moderate plus) contributing to quality than dwelling type. In both instances, it is the magnitude and not the direction that was considered. Based on the weights in Table 4.4, the pairwise comparison was carried out using the questionnaire mode in the Super Decisions software (Figure 4.10). From Table 4.4, the values of 66.67 for housing type, 63.89 for housing services and 100 for outer materials for the Accra Metropolis denote weights of 0.6667, 0.6389, and 1.0000 from the rating model.

Table 4.4: Weights for each Indicator from the Rating Model for Greater Accra Region

District	**Physical Criteria**			**Economic/Social Criteria**		**Environmental Criteria**	
	Housing Type	Housing Services	Outer Material	Household Density	Tenure Holding	Housing Density	Sanitation
Accra Metropolis	66.67	63.89	100	50	50	33.33	75
Adenta Municipal	100	58.33	100	100	100	66.67	75
Ashaiman Municipal	66.67	63.89	100	50	50	33.33	75
Dangbe East	66.67	58.33	100	100	100	100	50
Dangbe West	66.67	63.89	100	100	100	100	50
Ga East Municipal	100	77.78	100	100	50	33.33	75
Ga West Municipal	66.67	66.67	100	100	50	66.67	75
Ledzokuku/ Krowor	66.67	69.45	100	50	50	33.33	75
Tema Metropolis	100	88.89	100	100	100	66.67	75
Weija (Ga South)	100	63.89	100	100	100	66.67	50

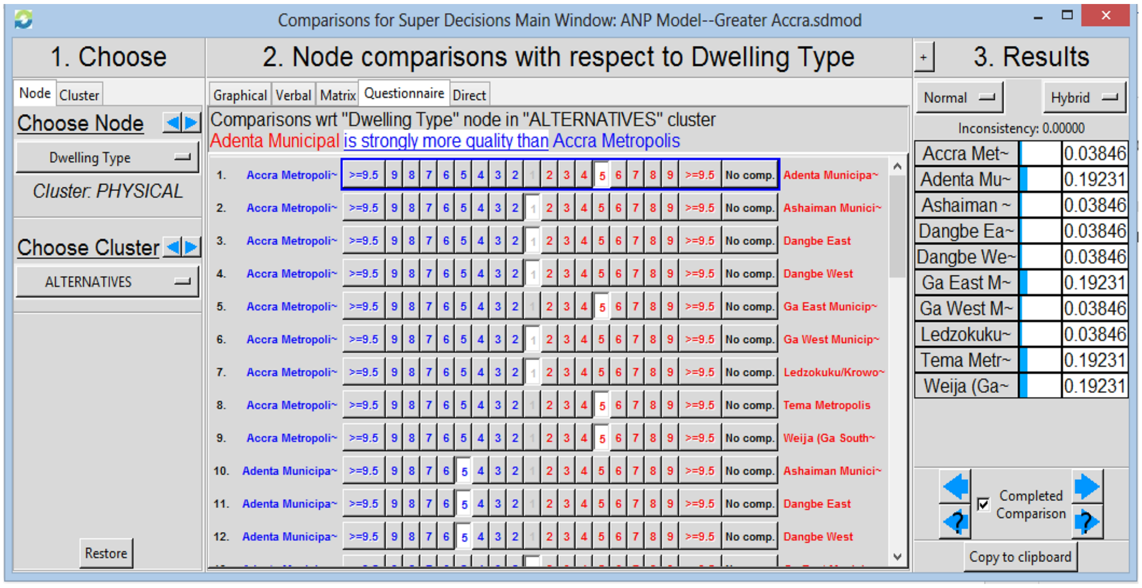


Figure 4.10: The Questionnaire Mode for Comparing Alternatives with Respect to Dwelling Type Node in the Physical Cluster.

Since all the factors (nodes) within the clusters affect the alternatives, the alternatives were compared with respect to each cluster criteria. For example, the physical cluster is connected to the alternative cluster, therefore the districts (alternatives) were compared to the elements in the physical cluster. Since the dwelling type, housing services and outer material are connected to elements in the alternative cluster, there would be a set of numerical judgements for each indicator and the derived weights from these judgements, represented in the reciprocal matrix shown in Tables 4.5 and 4.6 for dwelling type and housing services respectively. A similar procedure was carried out for outer material and the elements in the other clusters; i.e. economic/social (overcrowding and tenure holding) and environmental (housing density and sanitation).

Table 4.5: Pairwise Judgments of Dwelling Type for Alternatives

	Accra	Adenta	Ashaiman	Dangbe East	Dangbe West	Ga East	Ga West	Ledzokuku / Krowor	Tema	Weija	Priorities
Accra Metropolis	1	1/5	1	1	1	1/5	1	1	1/5	1/5	0.03846
Adenta Municipal	5	1	5	5	5	1	5	5	1	1	0.19231
Ashaiman Municipal	1	1/5	1	1	1	1/5	1	1	1/5	1/5	0.03846
Dangbe East	1	1/5	1	1	1	1/5	1	1	1/5	1/5	0.03846
Dangbe West	1	1/5	1	1	1	1/5	1	1	1/5	1/5	0.03846
Ga East Municipal	5	1	5	5	5	1	5	5	1	1	0.19231
Ga West Municipal	1	1/5	1	5	1	1/5	1	1	1/5	1/5	0.03846
Ledzokuku/ Krowor	1	1/5	1	1	1	1/5	1	1	1/5	1/5	0.03846
Tema Metropolis	5	1	5	5	5	1	5	5	1	1	0.19231
Weija (Ga South)	5	1	5	5	5	1	5	5	1	1	0.19231

Inconsistency: 0.0000

Table 4.6: Pairwise Judgments of Housing Services for Alternatives

	Accra	Adenta	Ashaiman	Dangbe East	Dangbe West	Ga East	Ga West	Ledzokuku / Krowor	Tema	Weija	Priorities
Accra Metropolis	1	2	1	2	1	1/3	1/3	1/3	1/4	1	0.0593
Adenta Municipal	1/2	1	1/2	1	1/2	1/3	1/2	1/3	1/4	1/2	0.0406
Ashaiman Municipal	1	2	1	3	1	1/3	1/2	1/2	1/4	1	0.0669
Dangbe East	1/2	1	1/3	1	1/2	1/3	1/2	1/3	1/4	1/2	0.0396
Dangbe West	1	2	1	2	1	1/3	1/2	1/2	1/4	1	0.0631
Ga East Municipal	3	3	3	3	3	1	3	1/2	1/2	3	0.1587
Ga West Municipal	3	2	2	2	2	1/3	1	1/2	1/4	1	0.0914
Ledzokuku/ Krowor	3	3	2	3	2	2	2	1	1/3	2	0.1491
Tema Metropolis	4	4	4	4	4	2	4	3	1	4	0.2637
Weija (Ga South)	1	2	1	2	1	1/3	1	1/2	1/4	1	0.0675

Inconsistency: 0.02983

The judgments in the first row of the reciprocal matrix for the dwelling type indicate that in considering the contribution of the element to the housing quality of the districts, dwelling types in Accra Metropolis contributes a fifth of that of Adenta, Ga East, Tema and Weija (Ga South), but contributing the same as that of Ashaiman, Dangbe East, Dangbe West and Ga West and Ledzokuku-Krowor Municipal. The derived priorities in the last column are computed by dividing each value by the sum of its column and then taking the average of the normalized row sum. Each priority vector's entries sum to one and are placed in their appropriate location in the supermatrix.

After comparing the alternatives with respect to each cluster criteria, the reverse was done whereby, criteria was compared with respect to the alternatives. This is as a result of the feedback links in the model. With regard to this pairwise comparison in the physical cluster, the dwelling type, housing services and outer/external materials were compared with respect to each district. For example, when comparing dwelling type, housing services and outer/external materials with respect to Accra Metropolis, the question is: which factor is contributing more to housing quality, dwelling types, housing services or outer/external materials, and to what degree? From the reciprocal matrix in Figure 4.11, outer material (structural quality) is contributing more to housing quality in the district with a priority of 0.70886, followed by dwelling type and housing services. This procedure was carried out for the other clusters (economic/social and environmental) (Figures 4.12 and 4.13) as well as the other districts.

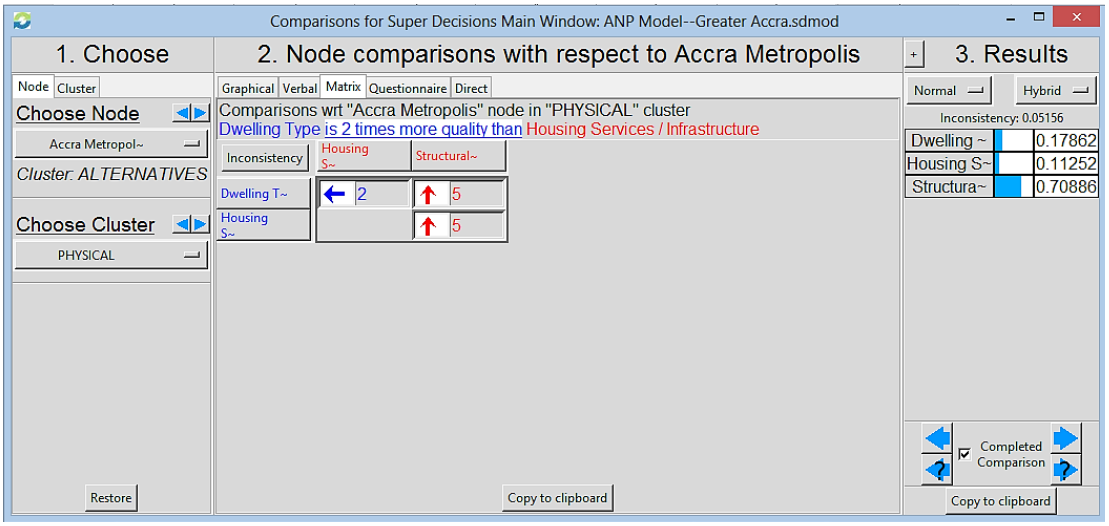


Figure 4.11: Comparison of Nodes in the Physical Cluster with respect to Accra Metropolis.

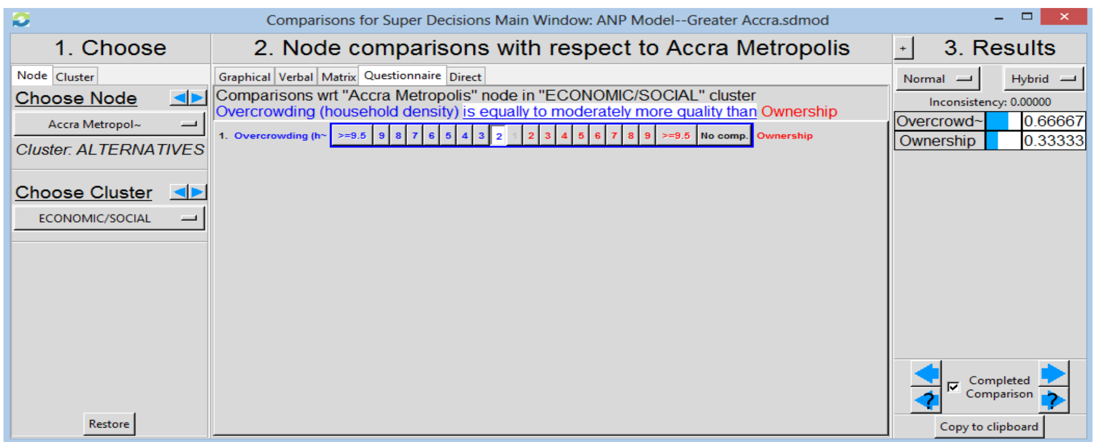


Figure 4.12: Comparison of Nodes in the Economic/Social Cluster with respect to Accra Metropolis.

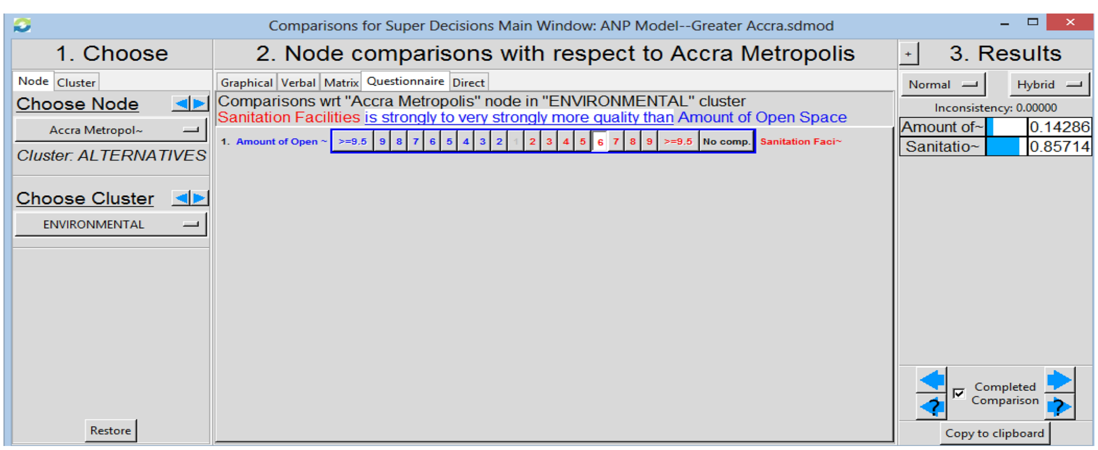


Figure 4.13: Comparison of Nodes in the Environmental Cluster with respect to Accra Metropolis.

As the physical cluster is inner dependent (connected to itself), it is one of the three clusters being pairwise compared with respect to the physical cluster. Since nodes in the physical cluster are connected to other nodes in that cluster, it influences itself. As a result, nodes in this cluster are being compared with respect to other nodes in the same cluster. Though dwelling type influences housing quality for a district, it also influences housing services and outer material with respect to their contribution. Therefore, the question was asked about which influences the quality contribution of housing services more: itself, dwelling type or outer/external material? And which influences the quality contribution of outer material more: itself, dwelling type or housing services? With regards to which influences the quality of housing services more, a judgment of 9 was assigned to dwelling type over outer/external material and 7 to dwelling type over housing services (Figure 4.14). The value of 9 assigned from the fundamental scale means that the evidence favouring one activity over another is of the highest possible order. In this case dwelling type influencing housing services compared to the outer material. The judgement of 7 means that an activity is favoured strongly over another; its dominance is demonstrated in practice.

This judgment was assigned on the basis that the type of dwelling sometimes influences whether a facility in a house would be shared or not. For example, compound houses are comprised of more than one family; therefore, the likelihood of sharing facilities (toilet, bathroom, and kitchen) among more than one household or family is high. Sharing of facilities among more than a household or family contributes to poor quality of dwellings as issues of privacy arises. According to Muoghalu (1991), sharing presents greater problems with respect to bathrooms, kitchen and toilet because of the risks involved as the intensity and number of users increase. According to Muoghalu, sharing of kitchen space not only engenders conflicts and quarrels among housewives, but also infringes on family privacy as people (families) want to prepare their meals privately. Concerning the question, which influences the quality contribution of structural quality (outer material) more; itself, dwelling type or housing services? Dwelling type was assigned a judgement of 9 over housing services and 7 over structural quality. That is the dwelling type influences outer material, hence influencing its contribution to housing quality. For example, if a dwelling type is a hut or improvised structure, then there is the likelihood that the outer material will be of low quality (mud, scraps, wood etc.). Therefore, contributing to the low quality of houses.

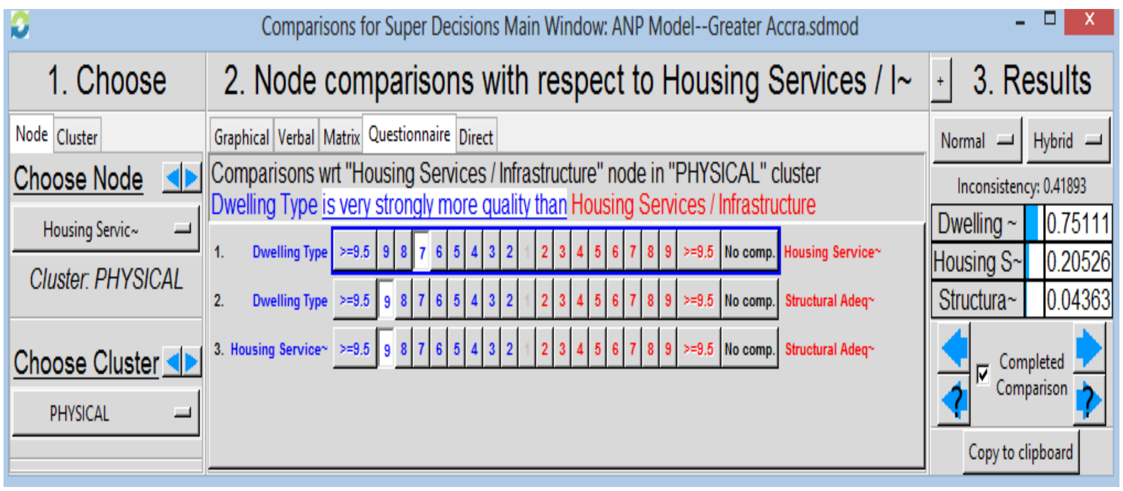


Figure 4.14: Inner Dependent Comparison for the Physical Cluster: Which Influences Housing Services more, Itself, Dwelling Type or Outer/ External material?

Further, outer dependence exists between the physical and the economic/social clusters. That is, an element in the physical cluster is being connected to elements in the economic/social cluster. In this case, housing services is linked to overcrowding (household density) and tenure holding (ownership) in the economic/social cluster.

Therefore, crowding and ownership is pairwise compared with respect to housing services for their influence in contribution to housing quality.

Overcrowding measured by average household per house influences housing services contribution to housing quality. The higher the average of number of households per house, the higher the sharing rate of facilities such as bathroom, kitchen and toilet. Sharing of facilities influences housing quality. When facilities such as bathroom and toilet sharing increases, it imposes a health risk to residents. High sharing of toilet creates unsanitary and unkempt conditions. According to Boadi and Kuitunen (2005) these conditions provide conducive environments for vectors and pathogenic organisms connected with diarrhoea infection, and also increases the possibility of transmitting pathogens from one infected household to others. They found in their study in the Accra Metropolitan area in Ghana that, households who share a toilet facility with more than five other households are more likely to have a high incidence of childhood diarrhoea.

In addition, ownership of a residence has an influence on the maintenance, quality and longevity of facilities and services in the house. When a dwelling is owner-occupied, the owner usually invests in the housing services for long term purposes. Since they are for long term purposes, they are mostly of the highest standards that ends up contributing to the quality of the residence compared to the rental ones, whereby due to the temporal nature of the residents, they do not invest in the maintenance of facilities in the house if the landlord or landlady does not provide. For example, in compound houses with limited bathing services, residents might resort to improvised bathrooms such as cubicle (open/shared) which is of poorer quality instead of investing in a bathroom of higher quality. Consequently, the status of residents in the dwelling affects the housing services they provide.

A comparison question was asked as to whether crowding (average household per house) or ownership, which influences the quality contribution of housing services more. A judgment of 7 was assigned to crowding (Figure 4.15); that is, the contribution of crowding to the quality of housing services is more than the contribution of ownership to the quality of housing services. This judgment was assigned on the premise that although the status of residents affects their maintenance of facilities and services in the house and by extension, the housing services they provide, this is not usually the case as some owner-occupied dwellings still lack some essential housing services. The economic status of some owners occasionally affects their capacity to provide high quality services in the house. However, with regard to household crowding, even if high quality housing services are available, the burden imposed on the service by multiple users in the households will hasten the deterioration of the service thereby affecting the overall quality status of the dwellings. After completing the paired comparisons among the clusters and their elements, the supermatrices are formed.

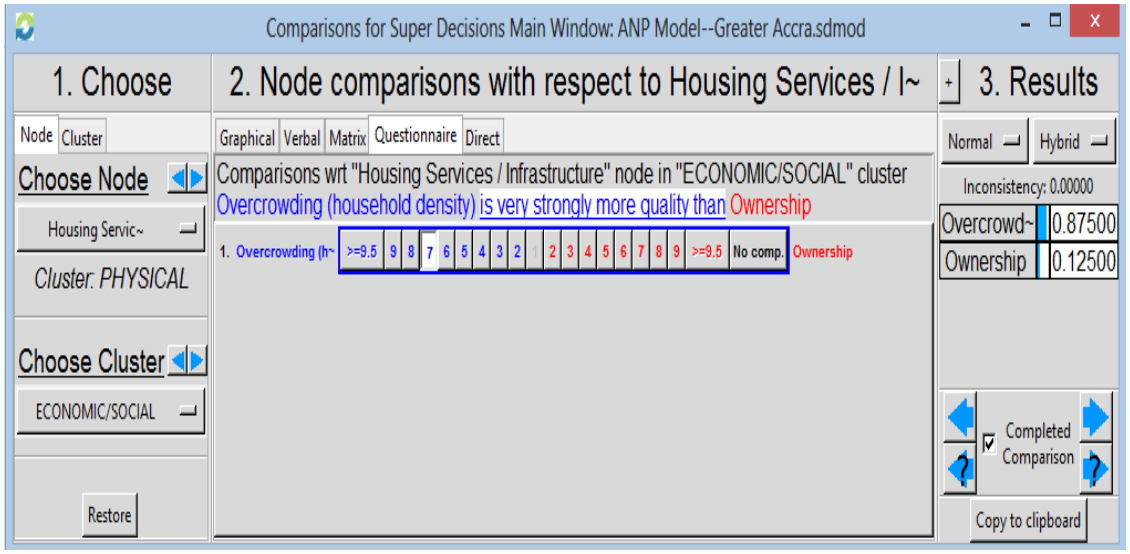


Figure 4.15: Outer Dependence Comparison of the Physical and Economic/Social Clusters: Which Influences Housing Services more: crowding or ownership.

4.4.4 Constructing the Supermatrices of ANP

After obtaining the pairwise comparison matrix, supermatrix of the ANP model was constructed to represent the relative priority of elements. This step consists of the progressive formation of three supermatrices: the initial or unweighted, the weighted, and the limit supermatrix. A supermatrix is a two-dimensional matrix of elements by elements. The supermatrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control criterion.

The original supermatrix of column priorities is obtained from pairwise comparison matrices of elements; i.e. the priorities derived from the different pairwise comparisons. Once all the pairwise comparison matrices (weights obtained from the reciprocal matrixes) have been filled in, the totality of the related priority vectors at the node level forms the unweighted supermatrix. The unweighted supermatrix contains all the network clusters and nodes and represents its interrelationships, which is based on the flow of effect from one element to another, or from a cluster to itself as in the loop. The column for a node contains the priorities of all the nodes that have been pairwise compared with respect to it and influence it with respect to the control criterion “housing quality”. If an element or a component has no input, a zero is entered in the corresponding priority vector. In each block of the supermatrix, a column is either a normalized priority with possibly some zero entries, or all of its elements are equal to zero. The supermatrix of unweighted priorities for the network is shown in two parts in Tables 4.7a and 4.7b.

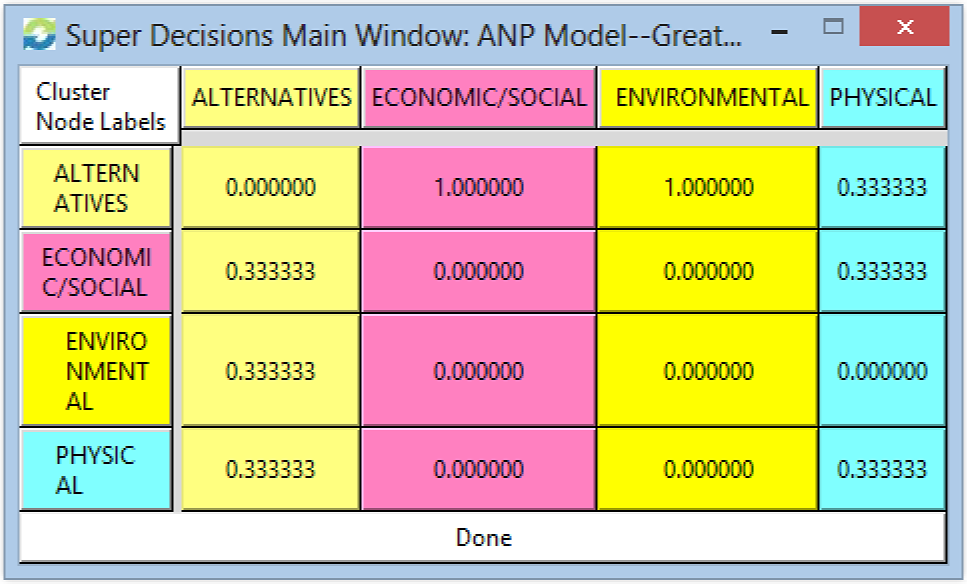
In the supermatrix of Table 4.7a and 4.7b, the sum of each column corresponds to the number of comparison sets. If Accra Metropolis only had three comparison sets, then the corresponding column would sum to 3 because each priority vector sums to 1. By incorporating the results of each reciprocal matrix into one matrix (unweighted supermatrix) results in the sum of each line (column) being more than one. Therefore, each column in Table 4.7a and 4.7b is normalized so that the entries sum to 1 to ensure the matrix is column stochastic. This is done by using the resulting matrix of numbers (weights) from the pairwise comparison of the clusters to weight the corresponding blocks of the original unweighted supermatrix. For example, the values in the (economic/social, alternatives) cell of the cluster matrix (Figure 4.16) is used to weight the unweighted supermatrix by multiplying the value in each cell in the (economic/social, alternatives) component of the unweighted supermatrix. Every component is weighted with its corresponding cluster matrix weight in this way.

Table 4.7a: Supermatrix of Unweighted Priorities for Greater Accra Region

		ALTERNATIVES									
		Accra Metropolis	Adenta Municipal	Ashaiman Municipal	Dangbe East	Dangbe West	Ga East Municipal	Ga West Municipal	Ledzokuku /Krowor Municipal	Tema Metropolis	Weija (Ga South) Municipal
ALTERNATIVES	Accra Metropolis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Adenta Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ashaiman Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Dangbe East	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Dangbe West	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ga East Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ga West Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ledzokuku/Krowor Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Tema Metropolis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Weija (Ga South) Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ECONOMIC/SOCIAL	Overcrowding (household density)	0.6667	0.5000	0.5000	0.5000	0.5000	0.8750	0.8750	0.5000	0.5000	0.5000
	Ownership	0.3333	0.5000	0.5000	0.5000	0.5000	0.1250	0.1250	0.5000	0.5000	0.5000
ENVIRONMENTAL	Amount of Open Space	0.1429	0.3333	0.1667	0.8750	0.8750	0.1667	0.3333	0.1667	0.3333	0.7500
	Sanitation Facilities	0.8571	0.6667	0.8333	0.1250	0.1250	0.8333	0.6667	0.8333	0.6667	0.2500
PHYSICAL	Dwelling Type	0.1786	0.4615	0.1786	0.1721	0.1786	0.4444	0.1429	0.1125	0.4286	0.4545
	Housing Services / Infrastructure	0.1125	0.0769	0.1125	0.1020	0.1125	0.1111	0.1429	0.1786	0.1429	0.0909
	Structural Quality	0.7089	0.4615	0.7089	0.7258	0.7089	0.4444	0.7143	0.7089	0.4286	0.4545

Table 4.7b: Supermatrix of Unweighted Priorities for Greater Accra Region (continuation)

		ECONOMIC/SOCIAL		ENVIRONMENTAL		PHYSICAL		
		Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Accra Metropolis	0.0192	0.0250	0.0218	0.1290	0.0385	0.0593	0.1000
	Adenta Municipal	0.1346	0.1750	0.0855	0.1290	0.1923	0.0407	0.1000
	Ashaiman Municipal	0.0192	0.0250	0.0218	0.1290	0.0385	0.0669	0.1000
	Dangbe East	0.1346	0.1750	0.2855	0.0323	0.0385	0.0396	0.1000
	Dangbe West	0.1346	0.1750	0.2855	0.0323	0.0385	0.0631	0.1000
	Ga East Municipal	0.1346	0.0250	0.0218	0.1290	0.1923	0.1587	0.1000
	Ga West Municipal	0.1346	0.0250	0.0855	0.1290	0.0385	0.0914	0.1000
	Ledzokuku/ Krowor Municipal	0.0192	0.0250	0.0218	0.1290	0.0385	0.1491	0.1000
	Tema Metropolis	0.1346	0.1750	0.0855	0.1290	0.1923	0.2637	0.1000
	Weija (Ga South) Municipal	0.1346	0.1750	0.0855	0.0323	0.1923	0.0675	0.1000
ECONOMIC /SOCIAL	Overcrowding (household density)	0.0000	0.0000	0.0000	0.0000	0.0000	0.8750	0.0000
	Ownership	0.0000	0.0000	0.0000	0.0000	0.0000	0.1250	0.0000
ENVIRONMENTAL	Amount of Open Space	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Sanitation Facilities	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PHYSICAL	Dwelling Type	0.0000	0.0000	0.0000	0.0000	0.0000	0.7511	0.7511
	Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.2053	0.0436
	Structural Quality	0.0000	0.0000	0.0000	0.0000	0.0000	0.0436	0.2053



Cluster Node Labels	ALTERNATIVES	ECONOMIC/SOCIAL	ENVIRONMENTAL	PHYSICAL
ALTERNATIVES	0.000000	1.000000	1.000000	0.333333
ECONOMIC/SOCIAL	0.333333	0.000000	0.000000	0.333333
ENVIRONMENTAL	0.333333	0.000000	0.000000	0.000000
PHYSICAL	0.333333	0.000000	0.000000	0.333333

Figure 4.16: Cluster Matrix for Greater Accra Region.

The numbers in the cells of the unweighted matrix in the (economic/social, alternatives) component that contains nodes for the districts Accra Metropolis, Adenta Municipal, Ashaiman Municipal etc. are multiplied by the number in the cluster matrix, 0.3333 for (economic/social, alternatives) component. The matrix obtained by means of this operation is known as the weighted supermatrix shown in Tables 4.8a and 4.8b. This new matrix is column stochastic (that is, sum to 1). Taking the Accra Metropolis for demonstration, the weight of 0.2222 in the weighted supermatrix was obtained by multiplying its cluster matrix weight of 0.3333 by its corresponding unweighted matrix weight of 0.6667.

Table 4.8a: Weighted Supermatrix for Greater Accra Region

		ALTERNATIVES									
		Accra Metropolis	Adenta Municipal	Ashaiman Municipal	Dangbe East	Dangbe West	Ga East Municipal	Ga West Municipal	Ledzokuku /Krowor Municipal	Tema Metropolis	Weija (Ga South) Municipal
ALTERNATIVES	Accra Metropolis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Adenta Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ashaiman Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Dangbe East	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Dangbe West	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ga East Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ga West Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Ledzokuku/Krowor Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Tema Metropolis	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Weija (Ga South) Municipal	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ECONOMIC/SOCIAL	Overcrowding (household density)	0.2222	0.1667	0.1667	0.1667	0.1667	0.2917	0.2917	0.1667	0.1667	0.1667
	Ownership	0.1111	0.1667	0.1667	0.1667	0.1667	0.0417	0.0417	0.1667	0.1667	0.1667
ENVIRONMENTAL	Amount of Open Space	0.0476	0.1111	0.0556	0.2917	0.2917	0.0556	0.1111	0.0556	0.1111	0.2500
	Sanitation Facilities	0.2857	0.2222	0.2778	0.0417	0.0417	0.2778	0.2222	0.2778	0.2222	0.0833
PHYSICAL	Dwelling Type	0.0595	0.1538	0.0595	0.0574	0.0595	0.1481	0.0476	0.0375	0.1429	0.1515
	Housing Services / Infrastructure	0.0375	0.0256	0.0375	0.0340	0.0375	0.0370	0.0476	0.0595	0.0476	0.0303
	Structural Quality	0.2363	0.1538	0.2363	0.2419	0.2363	0.1481	0.2381	0.2363	0.1429	0.1515

Table 4.8b: Weighted Supermatrix for Greater Accra Region (continuation)

		ECONOMIC/SOCIAL		ENVIRONMENTAL		PHYSICAL		
		Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Accra Metropolis	0.0192	0.0250	0.0218	0.1290	0.0385	0.0198	0.0500
	Adenta Municipal	0.1346	0.1750	0.0855	0.1290	0.1923	0.0136	0.0500
	Ashaiman Municipal	0.0192	0.0250	0.0218	0.1290	0.0385	0.0223	0.0500
	Dangbe East	0.1346	0.1750	0.2855	0.0323	0.0385	0.0132	0.0500
	Dangbe West	0.1346	0.1750	0.2855	0.0323	0.0385	0.0210	0.0500
	Ga East Municipal	0.1346	0.0250	0.0218	0.1290	0.1923	0.0529	0.0500
	Ga West Municipal	0.1346	0.0250	0.0855	0.1290	0.0385	0.0305	0.0500
	Ledzokuku/Krowor Municipal	0.0192	0.0250	0.0218	0.1290	0.0385	0.0497	0.0500
	Tema Metropolis	0.1346	0.1750	0.0855	0.1290	0.1923	0.0879	0.0500
	Weija (Ga South) Municipal	0.1346	0.1750	0.0855	0.0323	0.1923	0.0225	0.0500
ECONOMIC/SOCIAL	Overcrowding (household density)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2917	0.0000
	Ownership	0.0000	0.0000	0.0000	0.0000	0.0000	0.0417	0.0000
ENVIRONMENTAL	Amount of Open Space	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Sanitation Facilities	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PHYSICAL	Dwelling Type	0.0000	0.0000	0.0000	0.0000	0.0000	0.2504	0.3756
	Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0684	0.0218
	Structural Quality	0.0000	0.0000	0.0000	0.0000	0.0000	0.0145	0.1026

The weighted supermatrix is then raised to powers using equation (3.3) until it converges to yield the limit supermatrix shown in Tables 4.9a and 4.9b. The limit supermatrix represents all possible interactions in the system. The relative values for the districts are obtained from any column of the limit supermatrix that in this case are all the same. Afterwards, the respective columns are normalized to obtain the final priorities (see Table 4.9). Normalizing the limit matrix numbers yields their respective housing quality shown in Figure 4.17. The unweighted supermatrix, weighted supermatrix and limit matrix are calculated by the Super Decisions software.

Table 4.9a: Limit Supermatrix for Greater Accra Region

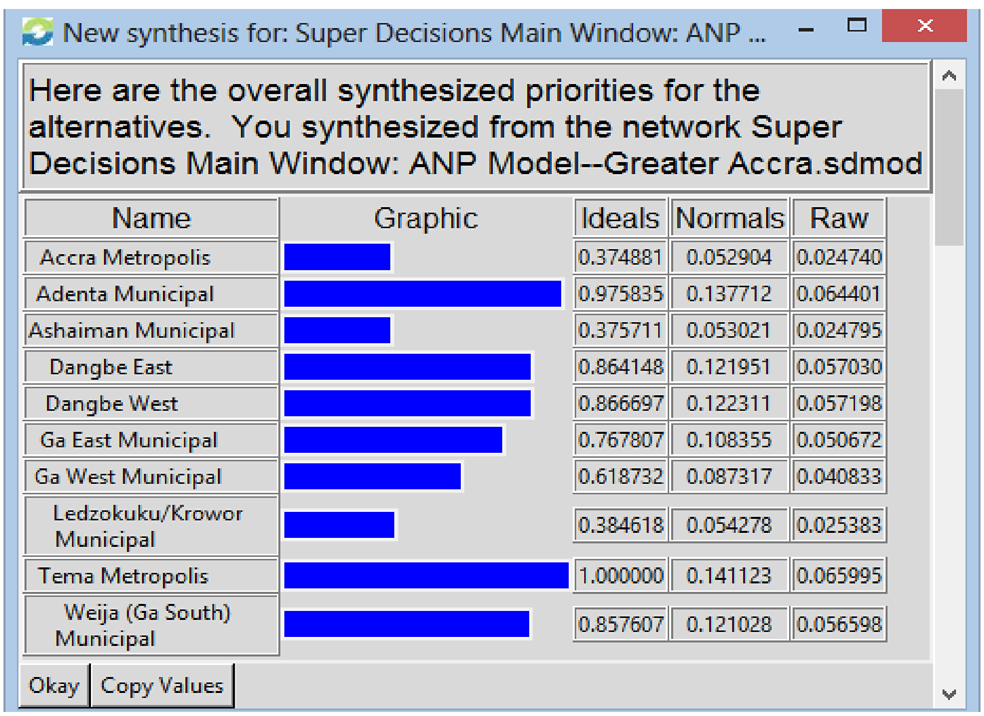
		ALTERNATIVES									
		Accra Metropolis	Adenta Municipal	Ashaiman Municipal	Dangbe East	Dangbe West	Ga East Municipal	Ga West Municipal	Ledzokuku /Krowor Municipal	Tema Metropolis	Weija (Ga South) Municipal
ALTERNATIVES	Accra Metropolis	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247
	Adenta Municipal	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644
	Ashaiman Municipal	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248
	Dangbe East	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570
	Dangbe West	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572
	Ga East Municipal	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507
	Ga West Municipal	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
	Ledzokuku/Krowor Municipal	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254
	Tema Metropolis	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660
	Weija (Ga South) Municipal	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566
ECONOMIC/SOCIAL	Overcrowding (household density)	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970
	Ownership	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660
ENVIRONMENTAL	Amount of Open Space	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733
	Sanitation Facilities	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826
PHYSICAL	Dwelling Type	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912
	Housing Services	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215
	Structural Quality	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008

Table 4.9b: Limit Supermatrix for Greater Accra Region (continuation)

		ECONOMIC/SOCIAL		ENVIRONMENTAL		PHYSICAL		
		Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Accra Metropolis	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247	0.0247
	Adenta Municipal	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644	0.0644
	Ashaiman Municipal	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248
	Dangbe East	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570	0.0570
	Dangbe West	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572	0.0572
	Ga East Municipal	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507
	Ga West Municipal	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
	Ledzokuku/Krowor Municipal	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254	0.0254
	Tema Metropolis	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660
	Weija (Ga South) Municipal	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566
ECONOMIC/SOCIAL	Overcrowding (household density)	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970	0.0970
	Ownership	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660	0.0660
ENVIRONMENTAL	Amount of Open Space	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733
	Sanitation Facilities	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826
PHYSICAL	Dwelling Type	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912
	Housing Services	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215	0.0215
	Structural Quality	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008	0.1008

Table 4.10: Limiting Priorities and Normalized by Cluster Priorities

		Normalized By Cluster Priorities	Limiting Priorities
ALTERNATIVES	Accra Metropolis	0.0529	0.0247
	Adenta Municipal	0.1377	0.0644
	Ashaiman Municipal	0.0530	0.0248
	Dangbe East	0.1220	0.0570
	Dangbe West	0.1223	0.0572
	Ga East Municipal	0.1084	0.0507
	Ga West Municipal	0.0873	0.0408
	Ledzokuku/Krowor Municipal	0.0543	0.0254
	Tema Metropolis	0.1411	0.0660
	Weija (Ga South) Municipal	0.1210	0.0566
ECOCNOMIC/SOCIAL	Overcrowding (household density)	0.5950	0.0970
	Ownership	0.4050	0.0660
ENVIRONMENTAL	Amount of Open Space	0.4701	0.0733
	Sanitation Facilities	0.5300	0.0826
PHYSICAL	Dwelling Type	0.4272	0.0912
	Housing Services	0.1005	0.0215
	Structural Quality	0.4723	0.1008



Name	Ideals	Normals	Raw
Accra Metropolis	0.374881	0.052904	0.024740
Adenta Municipal	0.975835	0.137712	0.064401
Ashaiman Municipal	0.375711	0.053021	0.024795
Dangbe East	0.864148	0.121951	0.057030
Dangbe West	0.866697	0.122311	0.057198
Ga East Municipal	0.767807	0.108355	0.050672
Ga West Municipal	0.618732	0.087317	0.040833
Ledzokuku/Krowor Municipal	0.384618	0.054278	0.025383
Tema Metropolis	1.000000	0.141123	0.065995
Weija (Ga South) Municipal	0.857607	0.121028	0.056598

Figure 4.17: Final Results for Housing Quality for Districts in Greater Accra Region.

4.5 GIS Integration

After the final weights have been synthesized to obtain the priorities of the districts in terms of their rankings of housing quality, the weights were imported into GIS (see Section 3.7). A housing quality map was then generated displaying the spatial pattern of housing quality at the district level. In order to observe the spatial pattern in the housing quality map, normalized scores were classified into four classes with equal intervals. Figure 4.18 represents the housing quality map generated by ArcGIS 10.2.

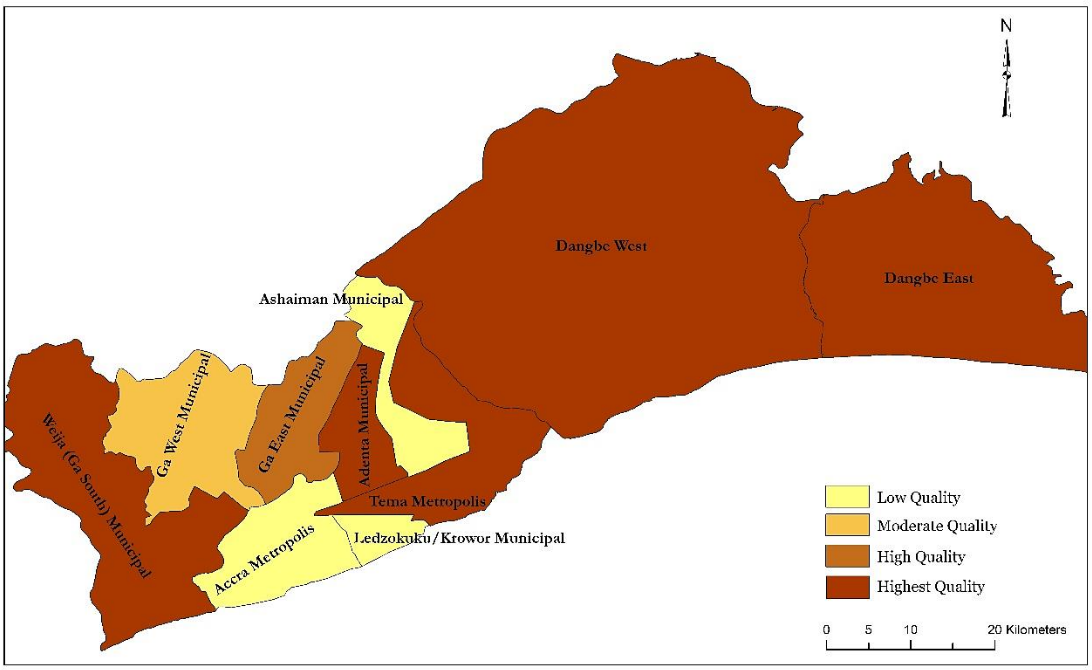


Figure 4.18: Spatial Variation of Housing Quality for the Greater Accra Region.

This procedure demonstrated here for the Greater Accra region was carried out for all the districts in the rest of the nine regions to identify their respective ranks as to housing quality and what are the spatial patterns. The weights (final results) from the ANP model is used as input for mapping the spatial pattern of housing quality for the districts. The next chapter discusses the analysis and results of the ANP models for the regions, including that of the Greater Accra region.

4.6 Summary

This chapter provided a case study of the ANP method to evaluate housing quality at the district level in Ghana using the Greater Accra region for demonstration. It described the study area, the decision framework, the ANP model and the steps that are carried out when using the ANP method to obtain the final priorities for each district.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter discusses the results of the empirical analysis of housing quality at the district level for the ten regions of Ghana. The results of the ANP models are presented and examined. The chapter encompasses the key findings of the study regarding the factors/ indicators contributing to housing quality and the spatial patterns of housing quality for the districts at the regions. The chapter concludes with a summary.

5.2 The Results

The analysis of housing quality was performed at the district level for the rest of the 9 regions of Ghana using the procedure exemplified in Chapter 4 for the Greater Accra region (see Appendix III for the unweighted matrix for the regions). The results of this study are presented graphically in two forms: tabular and geographic (map) formats. See Appendix II for the results of the ANP models presented in tabular form. These results are later classified into classes for the maps. The next section focuses on the discussion of the results with respect to the final priorities of the elements in the ANP model.

5.3 Discussion of the Results

5.3.1 Global Analysis

The ANP method has been applied to evaluate and rank districts according to their housing quality. Model 1 shows the final weights of the districts and the housing quality factors (see Appendix II). From the results of the ANP model, the lower and higher values (weights) indicate lower and higher residential quality/ranking of the districts. Higher scores on an indicator implies that the factor is contributing more to the quality of housing.

Based on the rankings of the districts within the regions, it was found that, the districts with the highest housing quality are: Sekyere Central for the Ashanti region, Dormaa East for the Brong Ahafo region, Tema Metropolis for the Greater Accra region and Komenda-Edina-Eguafo-Abirem for the Central region. With regards to the Eastern region, we have Kwahu South, with the Western region having Ahanta West. The Upper East and Upper West regions have Builsa and Wa East respectively. Whiles the Volta region have Keta Municipal, and Sawla-Tuna-Kalba for the Northern region.

When analysed globally, it was found that the order of increasing importance of the factors contributing to housing quality for the districts in model 1 from the limiting priorities is as follows. Greater Accra region: structural quality, overcrowding, dwelling type, sanitation, amount of open space, ownership and housing services. Northern region: the amount of open space, dwelling type, overcrowding, ownership, structural quality, housing services and sanitation. In the Central region, the order of increasing importance was amount of open space, overcrowding, ownership, structural quality, housing services and sanitation. The order of importance for Volta region is: amount of open space, dwelling type, overcrowding, ownership, structural quality, sanitation and housing services. For the

Eastern region, the importance of housing quality indicators in increasing order of magnitude was as follows: the amount of open space, dwelling type, overcrowding, structural quality, ownership, housing services and sanitation. This order is identical to the order of housing quality indicators for the Ashanti region. The order is the same for the Western region except that ownership and structural quality switch places. In the case of the Brong Ahafo region the order of increasing importance of the factors was amount of open space, dwelling type, overcrowding, ownership, structural quality, housing services and sanitation. Regarding the Upper East and Upper West regions, importance of housing quality indicators in increasing order of magnitude was as follows: amount of open space, dwelling type, overcrowding, ownership, housing services, structural quality and sanitation contributing the least.

The factors that most contributes to the quality of housing in the study area are amount of open space, dwelling type and overcrowding. The amount of open space and dwelling type received the highest scores for nine out of the 10 regions. Overcrowding also received a high score in all ten regions by consistently being among the top three housing quality indicators. At the national level, the average number of households per house according to the 2010 Population and Housing Census was 1.6; thus accounting for the high contribution of this indicator.

The results of the empirical analysis revealed that housing services, sanitation and structural quality are the three least contributing factors to the quality of housing in Ghana, although housing ownership was recorded among the last three housing quality indicators in three regions: the Greater Accra, Eastern and Ashanti regions. This suggests that housing quality in the study area tends to increase as the conditions and availability of the variables used to measure these indicators (housing services, environmental sanitation and structural quality) improve within the study area. For housing services, all the ten regions recorded least scores on this indicator. With the exception of the Greater Accra region, environmental sanitation was ranked seventh in the Eastern, Central, Northern, Brong Ahafo, Ashanti, Western, Upper East and Upper West regions and sixth in the Volta region. With reference to structural quality, with the exception of the Eastern, Ashanti and Greater Accra regions, the rest of the regions received least scores on this indicator, ranking sixth in the Upper East and West regions and fifth in the rest (Brong Ahafo, Western, Central, Volta and Northern regions).

A least score received on an indicator means that the districts in these regions performed poorly on the variables used to measure the indicator. In relation to sanitation, the majority of households adopted the modes of solid waste disposal that are termed as least or fairly acceptable in this study such as burning by household, dumping indiscriminately, burying of the refuse by household and usage of public dump (open space). While they use liquid waste disposal modes termed least or fairly improved such as throwing onto the compound, throwing onto the street/outside, through a drainage system into a gutter etc. For example, in the Ashanti region, with the exception of Kumasi Metropolis and the Obuasi Municipality, all the districts performed poorly on the indicator of environmental sanitation. The 2010 Population and Housing Census analytical report for the Ashanti region indicates that 41.9% of households dispose their solid waste (refuse) by dumping in open public places, 35.4% by putting it in containers in public places and 9.1% percent have it collected. The situation is similar in the other regions which had the least score on this indicator. In the Brong Ahafo region, all the districts performed poorly except the

Sunyani Municipality. Within this region, public dumps are the most common outlet of solid waste disposal in the region. 53.3% used the mode of public dumps in open spaces, with 23.9% and 11.9% using public dumps in containers and indiscriminate dumping respectively. Only 2.9% of households have their waste collected (GSS, 2013). Concerning liquid waste, three methods are used in disposing liquid waste in the region: dumping waste within the compound, the street or outside in the gutter. The compound and the gutter accounts for 90% of the disposal means used by households. As can be seen from these statistics, the population that adopts the fairly or least acceptable modes of refuse disposal exceed those that adopts the acceptable form (public dump in containers and collection) as well as those that adopted improved modes of liquid waste disposal. As a result, the poor contribution of the environmental quality indicator to housing quality in these regions is because of the poor local environmental conditions. In Ghana, waste management difficulties extend from the state to the local municipalities (Thompson, 2011). The quality of the neighbourhood environment influencing housing quality have also been established in studies such as (Amao, 2012; Jiboye, 2011). Jiboye found that, the quality of residential neighbourhoods of Bodija and Moremi estates in Nigeria is determined and affected by factors which deals with the quality of the environment such as clean drainages and safe disposal of garbage.

Although poor environmental sanitation is contributing to poor housing quality, it was observed that the district within which the regional capital[2] is located performed well on

[2] Regional capitals with their respective districts. Ashanti Region: Kumasi (Kumasi Metropolis); Brong Ahafo Region: Sunyani (Sunyani Municipal); Greater Accra Region: Accra (Accra Metropolis); Central Region: Cape Coast (Cape Coast Metropolis); Eastern Region: Koforidua (New Juaben Municipal); Upper East Region: Bolgatanga (Bolgatanga Municipal District); Volta Region: Ho (Ho Municipal); Western Region: Sekondi-Takoradi (Sekondi-Takoradi Metropolis); Northern Region: Tamale (Tamale Metropolis); and Upper West Region: Wa (Wa Municipal).

this indicator. Out of the ten regions, seven (Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Northern and Western regions) had the district with the regional capital receiving the highest scores of the environmental sanitation indicator especially on the variable mode of solid waste disposal. This suggests that sanitation seems to have a priority in the urban centres.

With respect to structural quality, measured by the variable ‘type of outer wall material’, the least contribution of the indicator to the quality of housing in Ghana reflects the current situation on the ground. The main construction materials for outer walls are cement, concrete and mud/mud bricks or earth. At the national level, the 2010 Population and Housing Census found that although there has been a reduction in the proportion of dwelling units with mud/mud brick or earth constituting the outer wall, the figure is still high. A substantial number of dwelling units (34.2%) are made up of these materials, with the share of dwelling units with outer walls of cement or concrete being 57.5 % (GSS, 2012). Lower scores obtained on this indicator can be attributed to the fact that the majority of the housing stock in the country is found within rural areas (57.7%). Many of these dwellings are built from less durable materials. The national census report states that 60.5% of dwelling units in rural areas were made with mud/earth, which means that most of the share of dwellings with cement and concrete as outer wall materials are found in the urban areas with the less housing stock. As a result, the least contribution of this indicator, since the proportion of houses in rural areas is higher than the urban ones with durable wall materials.

It was also found that both the Upper East and Upper West regions had the indicator ranking lower than the other regions which also recorded lower weights on this indicator as stated above. The least ranking of this indicator in these two regions reflects the predominant building material that is used in these regions. The foremost building material used in these regions includes mud, mud brick/earth and thatch. For the Upper East region, mud brick or earth constitutes (80.7%) and cement blocks/concrete (16.0%) of the outer wall material. While the Upper West region have 75% of all materials used for outer walls being mud, mud brick/earth and cement blocks/concrete, having a share of about 21.1% (GSS, 2013).

As stated above, environmental sanitation, housing services and structural quality are the three least contributing factors to housing quality in Ghana. However, in the Ashanti and Eastern regions, structural quality was replaced by ownership, with ownership and the amount of open space, replacing environmental sanitation and structural quality in the Greater Accra region. With housing ownership, though the Ashanti, Eastern and Greater Accra regions all have this indicator as one of their least contributing ones, the indicator ranked lower (6^{th}) in the Greater Accra region compared to the other two where it ranked 5^{th}. The least score of the ownership indicator in the Greater Accra region can be attributed to the fact that nearly half the households in the region rent their dwellings (47%), with 32.7% owning the dwelling they live in (GSS, 2013). Further, the lowest score on amount of open space (housing density) in the region can be attributed to the housing stock of the region. Out of the total housing stock of the country, the Greater Accra region accounts for 14% of the total (the second largest share), though the region has the smallest land area in the country. This share of the region is higher than the 13.4% share of the three northern regions (Northern, Upper East, and Upper West) which include the region with the largest land area of the country i.e. the Northern region. Further, the region has the highest percentage of makeshift dwellings (6.1%) (GSS, 2012). This is reflected in the subsequent highest housing density of districts in the region; to that end, the poor contribution in the amount of open space to housing quality. With the exception of Dangbe East and Dangbe West districts, all the districts in the region received lower weights on this indicator with four districts (Accra Metropolis, Ashaiman Municipal, Ga East Municipal and Ledzokuku-Krowor Municipal) having a housing density greater than the 22 used in this study.

In Ghana, issues related to the variables used to assess the indicator of housing infrastructures and services is of a national nature. For example, source of drinking water for households used as a variable under this indicator is a national problem. An access to improved water sources, especially piped water, is still a national issue, with no major difference between the urban areas and the rural. As stated by the Economist Information Unit (EIU) (1993, cited in UN-HABITAT, 2011) only eight of the country's 170 district capitals have comprehensive piped water networks. An efficient and hygienic method of human waste disposal in a dwelling is of an utmost importance to the health of households. Available toilet facilities in the study area are either of poor quality or inadequate. Currently, the proportion of households that used efficient facilities is about the lower share. It is reported that one in five dwelling units had no toilet facilities and household members either used open fields, the beach or other open areas. 34.6% of households use public toilet facilities, with only 15.4% using a flush toilet and 10.5% using KVIP (GSS, 2012) incorporated under the improved type in this study. Issues of lack of frequent water provisioning in the country make it either difficult or expensive for those households with even the flush toilets to use them; especially in the cities as it demands too much water. As a consequence, most houses end up not providing this kind of improved facility. Therefore, most households resort to the use of public toilets. With variables such as cooking space, cooking fuel, types of bathroom etc., the majority of households were using low or poor quality facilities in dwellings related to them. Further, compound housing is the predominant housing type in the country. This multi-occupancy unit facilitates high rate of sharing due to the large number of households. The WHO and UNICEF (2008) reports that more than five households in Ghana share sanitation facilities irrespective of whether urban or rural. This results in the inadequate facilities in the dwelling not being in good conditions as they are burdened due to overcrowding. These issues can be attributed to the low contribution of this indicator to housing quality in the country as many houses lack basic facilities like toilets, bathrooms and kitchen etc.

In view of evidence in literature linking the availability of basic amenities in housing with housing quality (Aderamo & Ayobolu, 2010; Fiadzo et al., 2001), one can infer from this result that inadequate provision of housing facilities (e.g. toilet facilities, bathroom, cooking spaces, safe drinking water) have influence on housing quality in Ghana. This appears to be consistent with findings of prior studies (Aderamo & Ayobolu, 2010; Ibem, 2012). The quality of internal housing facilities and lack of access to them have been established by these studies as accounting for poor housing quality.

From the global analysis, it was also found that the districts in which the regional capitals were located performed poorly in terms of their aggregate housing quality weights, especially those located in the southern sector of the country, with the exclusion of the Volta region. Accra Metropolis, Kumasi Metropolis, New Juaben Municipal, Sunyani Municipal, Cape Coast Metropolis and Sekondi-Takoradi Municipal all had the lowest scores in their various regions. Ho Municipal was ranked second in the Volta region. The lower ranks of these districts can be attributed to issues of urbanization and lack of economic opportunities. As a consequence of urbanization and lack of economic opportunities in rural areas, many people move to the cities, especially from the northern sector of the country. Therefore, the population growth in these cities has surpassed their capacity and ability to provide basic shelter leading to inadequate housing stock. Most of the regions within which these districts are located showed positive net-migration, according to the 2010 Population and Housing Census. Further, most of these cities are known to be dealing with issues of overcrowding and infrastructure problems. These issues impact the availability and affordability of housing, forcing many to live in substandard dwellings with poor housing quality in these cities. As a result, it was found that these cities performed poorly on many of the indicators used in assessing housing quality, due to high population and dwelling unit densities and poor housing conditions. For example, regarding the indicators of overcrowding (measured by household density), housing ownership (measured by tenure) and amount of open space (measured by housing density), these districts performed poorly on these indicators. Only Sunyani Municipal performed well on the housing density indicator and Sekondi-Takoradi Metropolis on ownership. These reflect the fact that housing in urban Ghana in general is reasonably well built, but it is highly rented and overcrowded.

With the other regions, Tamale ranked fourth in the Northern region, Bolgatanga municipal and Wa Municipal ranked sixth and fourth for the Upper East and Upper West regions, respectively. It was observed that these districts together with Ho Municipal of the Volta region, performed well on the indicators of household density, housing density and ownership. The higher scores on the indicator of house ownership is attributed to the high rate of ownership in these regions. For example, the Upper East, Upper West and Northern regions have over 80 percent of all dwellings being owner-occupied (GSS, 2012). This high ownership rate can be attributed to the construction material used. The predominant outer material for these regions is mud/mud brick or earth, which are easy to acquire and relatively inexpensive. This enables households to construct their own dwellings from the cheapest and most easily obtained materials.

From the results of the top contributing factors in the global analysis, based on the higher contribution of the overcrowding (average household per house) factor, it can be suggested that dwellings in the country are generally not overcrowded with relation to the number of households within a dwelling. This could be explained by the fact that, at even the national level, the average figure is not high (1.6). In addition, based on the calculations and classifications used to measure housing density, it can be argued that, in general, the neighbourhood environment of dwellings in Ghana is not crowded, with the exception of the Greater Accra region, which happens to be the only region with the highest densities and the urban areas in Ashanti, Central, Eastern, and Western regions. Further, it can be stated that, in general, the dwelling types in the country are of the moderate quality as the majority of the districts have the major dwelling type being compound houses. From the analysis, it was found that the most distinguishing factor is housing services; measured by facilities and infrastructures available in dwellings. At the district levels, it was found that most of the districts had similar scores on the other factors, but it varied when it came to housing services.

5.3.2 Analysis by Cluster

With respect to the clusters, as can be seen from the original model (normalized with respect to the cluster section) (see Appendix II), for the Ashanti, Brong Ahafo, Central, Eastern, Northern, Upper East, Volta and Western regions, environmental sanitation was contributing less to housing quality, compared to housing density used as the measure for the amount of open space of the environmental cluster. The gap between the weights of these two indicators are much of a difference, showing how poor environmental sanitation is contributing to the quality of dwellings in Ghana. This difference is consistent for all the above mentioned regions. However, it was observed that the weights obtained in the case of the Ashanti, Western, Eastern and Central regions are a little higher than those obtained by the Upper East, Upper West, Volta, Northern and the Brong Ahafo regions, showing that environmental sanitation in the latter set of regions is of the poorest nature. However, for the Greater Accra region, the situation changes, with environmental sanitation contributing more compared to the amount of open space. The highest weight on the environmental sanitation indicator is as a result of the high collection rate of rubbish in this region; especially, the routine house-to-house collection. At the national level, the region has the highest rate with 48.5% of dwelling units having their solid waste collected from their homes (GSS, 2012). Sanitation is known to be quite poor in Ghana's cities. The UN-Habitat (2011) report on Ghana's housing profile states that only 16% of households in Ghanaian cities have their garbage (solid waste) collected; however, it is 41% in the Greater Accra Metropolitan Area (GAMA) which is within this region.

For the physical cluster, Ashanti, Brong Ahafo, Central, Eastern, Northern, Volta and Western regions all had dwelling type contributing more, followed by structural quality and housing services. Although dwelling type and structural quality are contributing more to the quality of houses than housing services for these regions, it was found that the difference between the weights for Eastern region were approximately equal to 0.47 for dwelling type and 0.42 for structural quality. Indicating that most of the dwellings in the region have high quality and durable materials such as cement and concrete as their outer wall material. For the Volta, Western, Northern and Brong Ahafo regions, the opposite were found whereby the gap between these two indicators was large. For the Volta region, the gap was approximately equal to 0.66 for dwelling type and 0.25 for structural quality, 0.62 and 0.20 for the Northern, 0.66 and 0.25 for Western, with Brong Ahafo having 0.52 and 0.35. These weights reflect the fact that most of the outer materials for dwellings in these regions are of the less quality and durable nature, such as mud/mud brick or earth. For the Upper East and Upper West regions, structural quality and housing service swaps with structural quality contributing less, followed by housing services, and dwelling type contributing more. Similar to the environmental cluster, the contribution of the indicators for the Greater Accra region changes, with structural quality contributing more, followed by dwelling type and housing services. The higher weights of structural quality show that the region has most of its dwellings being built from the high durability and quality material of cement or concrete. The national analytical report of the 2010 Population and Housing Census of Ghana show that about eight in ten dwellings in the region (82.2%) had outer walls built of cement. Consequently, the high contribution of this indicator to the quality of dwellings in the region.

For the economic/social cluster, overcrowding is contributing more than ownership for all the regions. However, it was observed that the weight difference is not that much, which indicates that both factors are contributing much to the quality of houses in the study area.

From the cluster analysis, it was found that dwelling type had the biggest impact on housing quality as the main factor contributing more to the quality of housing in the study area for the physical cluster. Regarding the economic/social cluster, both household density and ownership are contributing much to housing quality in the study area. Although the weights for the household density indicator was slightly higher than that of ownership among all the regions. While amount of open space in the neighbourhood of the environmental cluster is the factor contributing more to the environmental quality of housing in the study area.

5.4 Sensitivity Analysis

In this research, the sensitivity analysis considers the effect of changes in the cluster weights upon the overall housing quality index. In the initial model (model 1) (see Appendix II), a neutral focused perspective was adopted whereby all criteria had equal weights. In order to identify the effects of the various housing quality factors, a ‘‘what-if’’ analysis was carried out. This type of analysis is concerned with a ‘‘what-if’’ kind of question to see how the ultimate answer varies when the inputs, whether judgments or priorities, are revised. The aim of the analysis is to see how these changes affect the final orderings of alternatives. Scenario analysis was carried out and three different housing quality maps are generated by changing the weight assigned to the three clusters in which the evaluation problem was divided: economic/social, environmental and physical factors.

The following three sets of weights (Table 5.1) were considered to simulate the presence of different perspectives on the evaluation process.

- Scenario I (economic/social focused perspective): the 'economic/social' cluster dominates the others. This case shows the situation where economic/social factors weigh 50 % and environmental factors weigh 30% and physical factors, the remaining 20 % in achieving the objective;

- Scenario II (physical focused perspective): the 'physical' cluster dominates the others. With this simulation, the physical factors weigh 50%; and

- Scenario III (environmental focused perspective): the 'environmental' cluster dominates the others by weighing 50%, physical 30% and economic/social 20%.

Table 5.1: Combination of Weights for the Sensitivity Analysis

	Cluster Weights		
Scenarios	Physical	Economic/ Social	Environmental
I	0.20	0.50	0.30
II	0.50	0.30	0.20
III	0.30	0.20	0.50

Table 5.1 summarizes the combination of weights associated with each scenario. Models 2 to 4 (see Appendix II) show the results of the ''what-if'' analysis. The scenario analysis reveals some interesting findings. When the weights of the physical cluster were increased (model 3), dwelling type received the highest weight in all the regions at the global level except the Greater Accra region. In Ghana, the largest dwelling type is the compound housing, which is a multi-occupancy structure. Even though not of the highest quality like single-family houses and apartments due to high sharing rates and lack of privacy issues,

it is still of a moderate quality compared to the other forms of makeshift facilities and huts. The higher dominance of this dwelling structure can be attributed to the higher weight of this indicator when housing is assessed from the physical perspective. It was also found that five out of the ten regions performed well on the indicator of structural quality. Eastern, Ashanti, Brong Ahafo and Central regions all had structural quality receiving the second highest weight with the Greater Accra region having the indicator ranking first. Whereas, Western, Northern, Volta, Upper East, and Upper West regions all performed poorly on the indicator of structural quality. The same regions had this indicator ranking among the least three in all the other models. This shows how structural quality is poorly contributing to housing quality in these regions.

Further, assessing housing quality from the economic/social focused perspective (model 2), the overcrowding factor which ranked third in most of the regions in model 1, ranked first in seven of the regions (Eastern, Ashanti, Brong Ahafo, Greater Accra, Northern, Upper East, and Upper West). This gives the indication that, at the national level the dwellings in Ghana are generally not crowded based on the average household size per house. In addition, it can also be argued that, economic/social aspects of housing is contributing much to the quality of dwellings in the study area as both the indicators used to operationalize this cluster ranked among the highest three indicators in nine regions when housing is assessed from the economic/social perspective, with overcrowding also ranking among the top three in all the regions from the physical perspective.

With model 4 (the environmental perspective), as in the neutral perspective (model 1), amount of open space received the highest weight in nine of the regions. Environmental sanitation was still ranked among the least three with a rank of 6^{th} in eight of the regions and 7th in the Upper West region not including the Greater Accra and Western regions. The least ranks of this indicator even when the environmental cluster is prioritized shows how serious the issue of environmental sanitation is in the country.

Regarding the cluster level, when the weights of the various clusters were increased, no changes were recorded in the rankings of the indicators in the physical and environmental clusters for the regions in all the three models. The rankings were the same as reported for model 1. However, there were changes in the economic/social cluster. As in model 1, Ashanti, Brong Ahafo, Eastern, Greater Accra, Northern, Upper East, Upper West, and Volta regions still had overcrowding contributing much to the quality of houses compared to ownership in all the three models. However, there were noticeable changes for the Western and Central regions. In the case of the former, ownership was ranked first when housing quality was assessed from both the environmental and economic/social perspective (model 4 and model 2, respectively). In the case of the latter, ownership ranked first in economic/social perspective (model 2) and second in the rest.

As indicated above, the aim of the analysis is to see how changes in clusters modify the final evaluation scores of alternatives. The various perspectives resulted in some changes in the rankings for some alternatives which can be seen in the models under their various rankings. Only substantial changes will be discussed here. For the Brong Ahafo region, Sunyani Municipal performed well when environmental cluster weights are increased by moving from rank 22nd in model 1 to 13th in model 4. This change in ranking can be attributed to the fact that Sunyani the regional capital is located within this district, hence it enjoys better sanitation compared to the other districts. This is reflected in the highest score recorded by the district when it came to the variable mode of solid waste disposal.

The Sunyani Municipality reported the highest frequency of collection of solid wastes from households and dumping of wastes in public containers. Berekum also moved from 21^{st} in model 1 to 15^{th} and 16^{th} in models 2 and 3, respectively. Kintampo South, Asunafo, and Atebubu districts all dropped a rank in model 3 from their rank in model 1, and further dropped two ranks in model 4. Kintampo South dropped from 20^{th} in model 1 to 21^{st} in model 3 and 22^{nd} in model 4.

In the Ashanti region, Atwima Nwabiagya district moved from 24^{th} in model 1 to 21^{st} in model 3 and to 22^{nd} in model 4. An interesting case was Mampong Municipal. It ranked 11^{th} according to the results of models 1 and 3, moved to 10^{th} in model 4, but dropped to 17^{th} in model 2 when the importance of economic/social cluster was increased. This drop in rank can be attributed to the higher performance on this cluster by districts in the region.

Within the Central region, Effutu Municipal performed well when the environmental cluster weight was increased by moving from 16^{th} in all the previous models to 11^{th} in model 4. This change is not unexpected; the district is one of the two most urbanised districts in the region. Together with Cape Coast Metropolis, they are the highest performing districts when it comes to issues of environmental sanitation in the region.

The Western region had Wassa Amenfi East moving from 11^{th} in model 1 to the 7^{th} position in model 2 and 9^{th} in models three and four. Whiles Sefwi Akontobra and Aowin drop rank in model 2. The former fell to 8^{th} in model 2 from 7^{th} in model 1, with the latter dropping to 9^{th} from 8^{th} in model 1.

For the Eastern region, Kwahu West, Akyemansa, Lower Manya, and Suhum-Kraboa Coaltar all recorded some changes in their various rankings. Kwahu West moved from the

19th in model 1 to 16th in models 3 and 4. Lower Manya moved from the 20th in model 1 to 17th in models 3 and 4. Akyemansa and Suhum-Kraboa Coaltar districts also dropped their respective ranks. Akyemansa from 16th in model 1 to 18th in models 3 and 4, whiles Suhum-Kraboa Coaltar drops to 20th in models 3 and 4 from 18th in model 1.

Regarding the Greater Accra region, which seems to present interesting cases throughout the analysis, Weija (Ga South) Municipal moved from 5th in model 1 to 3rd in model 3. Ga East Municipal also moved from 6th in model 1 to 4th in model 3. Dangbe East also dropped from 4th in model 1 to 6th in model 3. It was realized that the major changes in the ranks of the alternatives in the district happened when housing quality was assessed with an increase importance of the physical cluster. The Ga East district received the second highest score on the housing services indicator (Tema ranked first). For example, concerning the type of toilet used by households, the district had the second share of flush toilet, aside Tema. In addition, the district also has the second highest share of exclusive bathroom for households and the highest percent of households who use gas as cooking fuel (53.9%). Further, it is also among the four districts which doesn't have compound housing prevailing. Hence, these can be attributed to the move in rank of the district when the physical cluster is weighted high as the district performed well on most of the indicators used to operationalize this cluster. With Dangbe East, the drop can be attributed to the fact that the district had the highest occupancy of hut buildings (either on the same or different compound) in the region which are made of less durable wall materials. In addition, about 45% of households have no toilet facilities. All these factors could be suggested as the reason for drop in rank as the physical criteria seem to be contributing poorly to the quality of dwellings in the district. Regarding the Northern, Volta, Western, Upper East, and Upper

West regions, there were no changes in the ranks of the alternatives in all the three simulations.

5.5 GIS Integration

In order to examine the spatial patterns of housing quality, the overall housing quality weights from the ANP model were exported into GIS for visualization. Four housing quality classes were defined using an equal classification ranging from low, moderate, high and highest quality. The class thresholds were selected by subdividing the range of values that occur in the area (among districts in a region) under analysis into equal intervals. The classification was based on the normalized by cluster weights for the alternatives. The shading pattern utilizes an increasing density of shading to reflect an increasing level of housing quality. Figures 5.1 to 5.10 displays the housing quality maps obtained from each simulation.

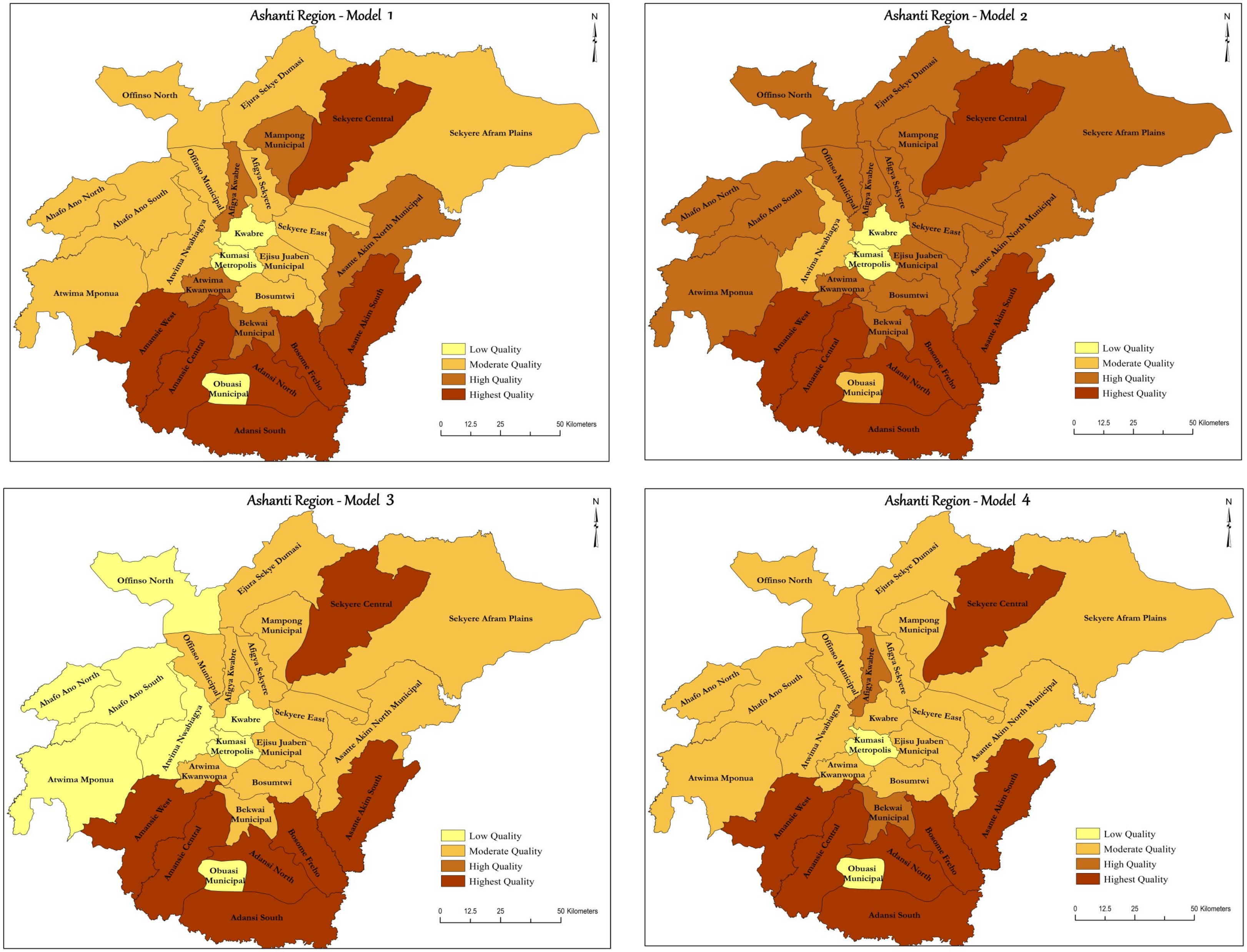


Figure 5.1: Spatial Variation of Housing Quality for the Ashanti Region.

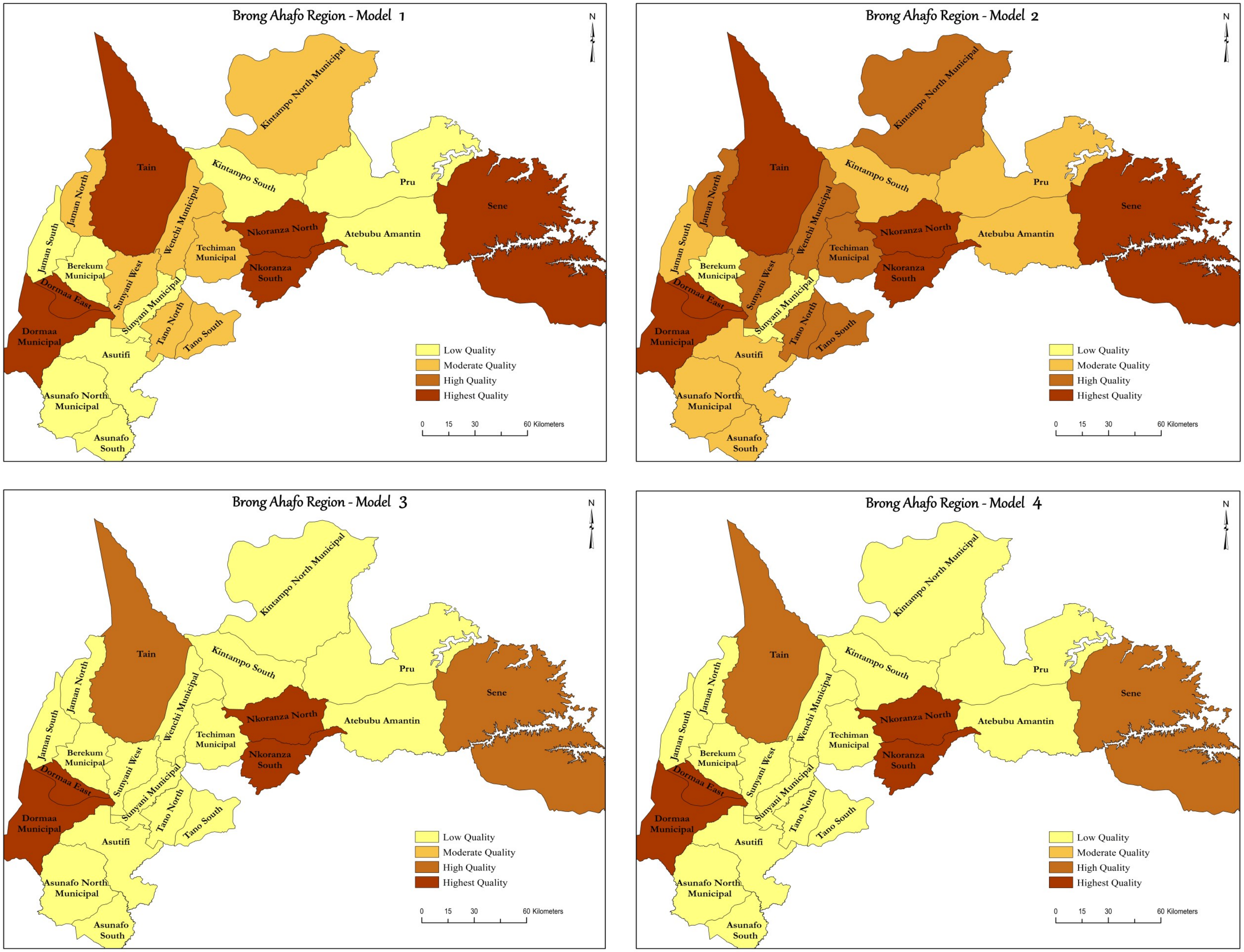


Figure 5.2: Spatial Variation of Housing Quality for the Brong Ahafo Region.

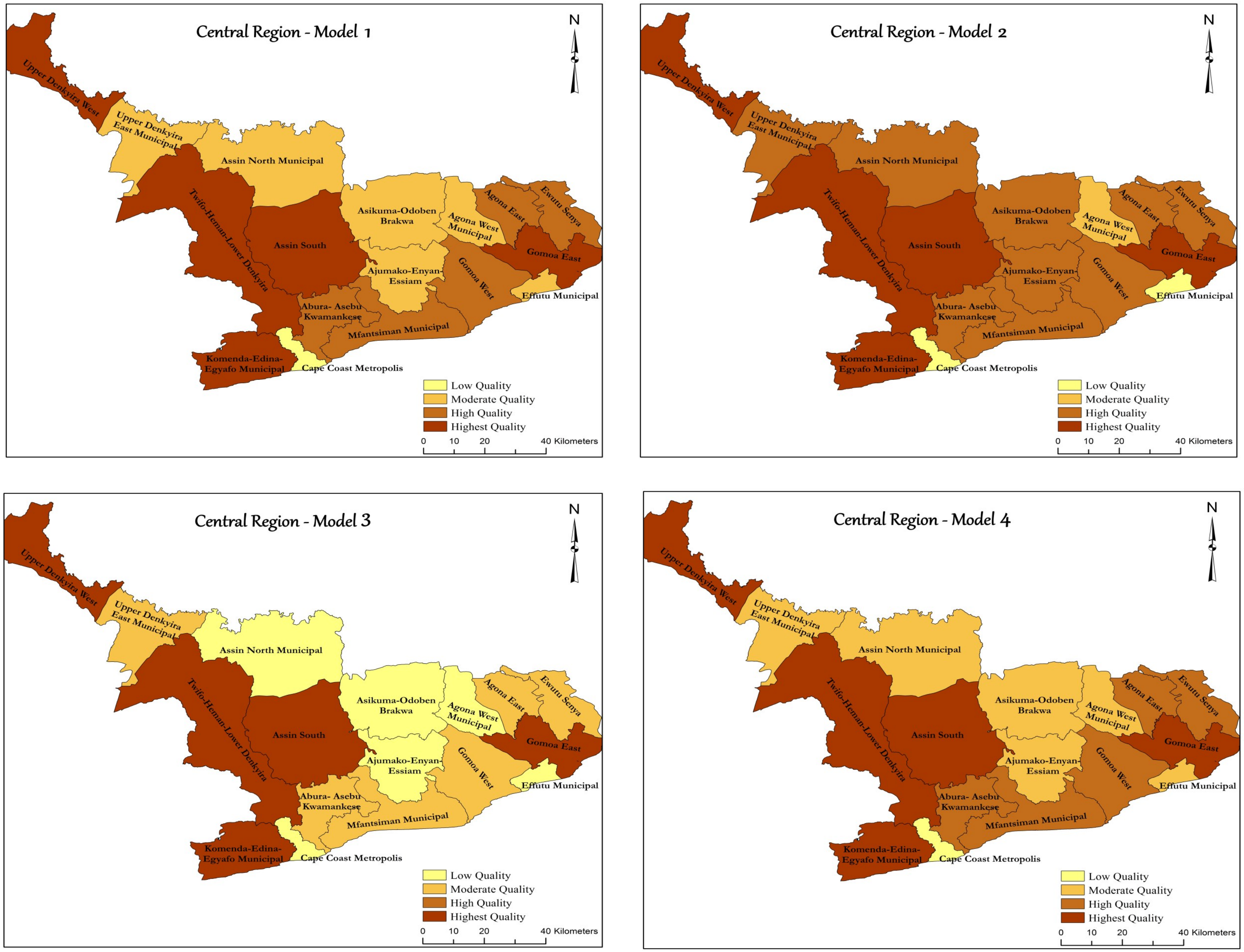


Figure 5.3: Spatial Variation of Housing Quality for the Central Region.

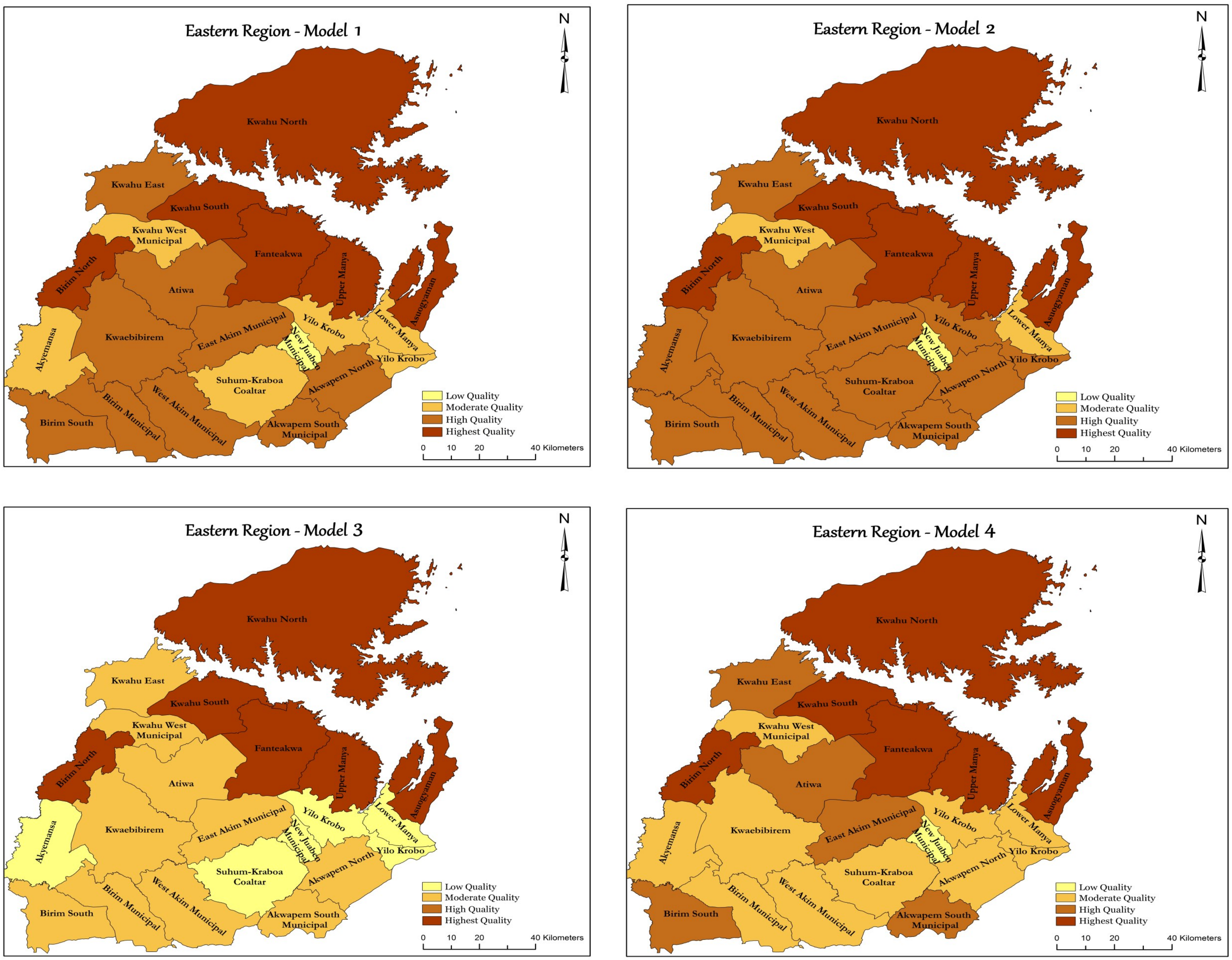


Figure 5.4: Spatial Variation of Housing Quality for the Eastern Region.

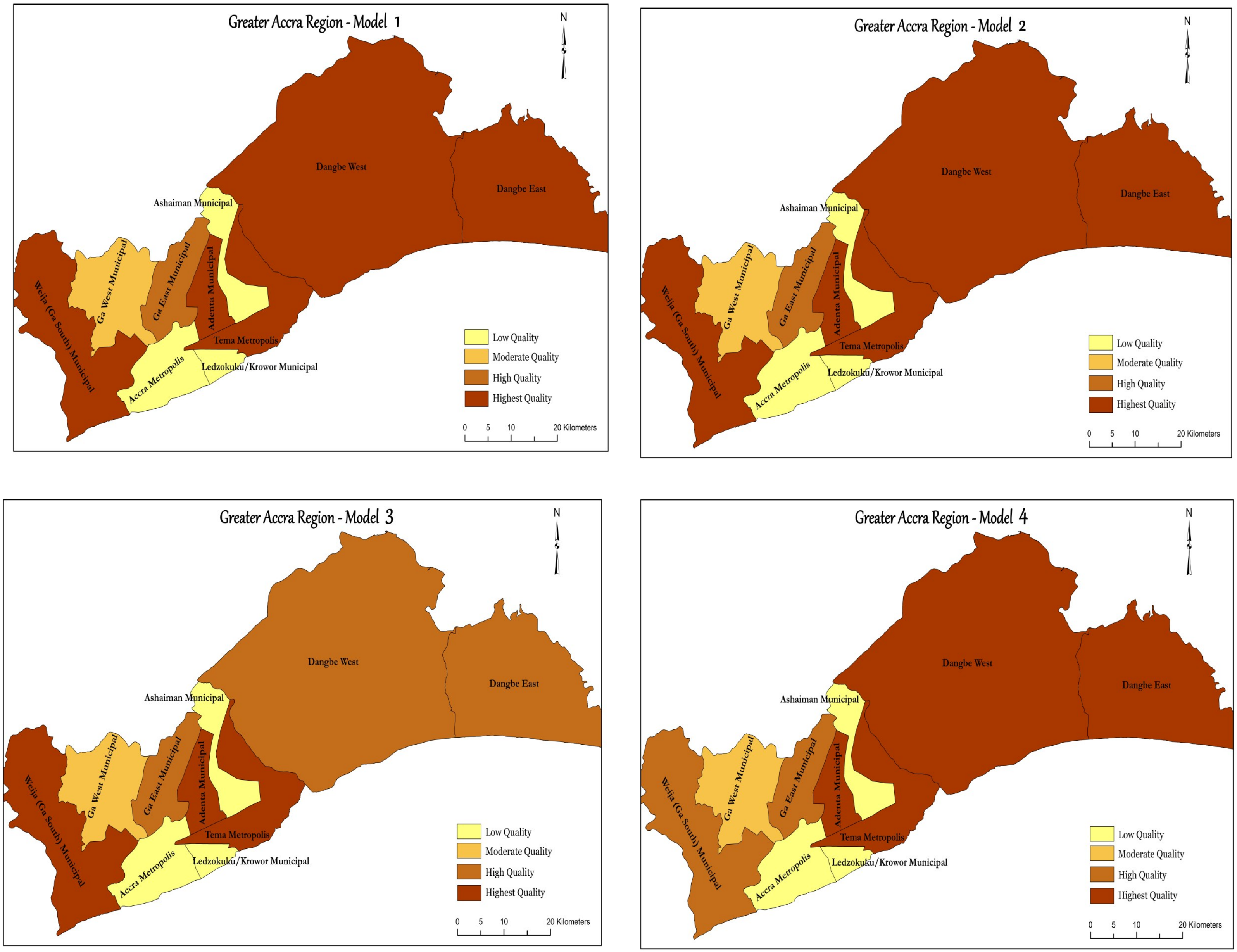


Figure 5.5: Spatial Variation of Housing Quality for the Greater Accra Region.

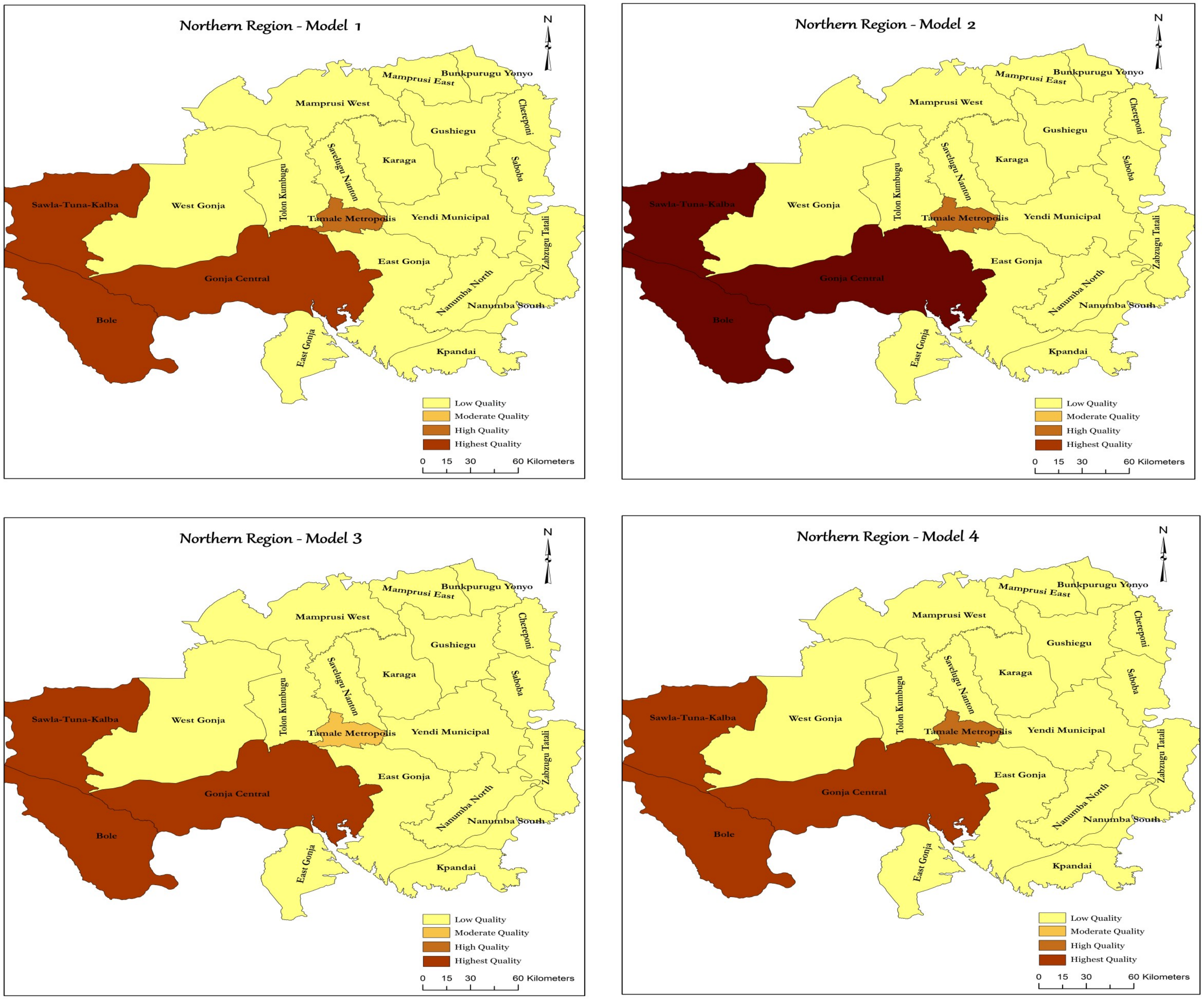


Figure 5.6: Spatial Variation of Housing Quality for the Northern Region.

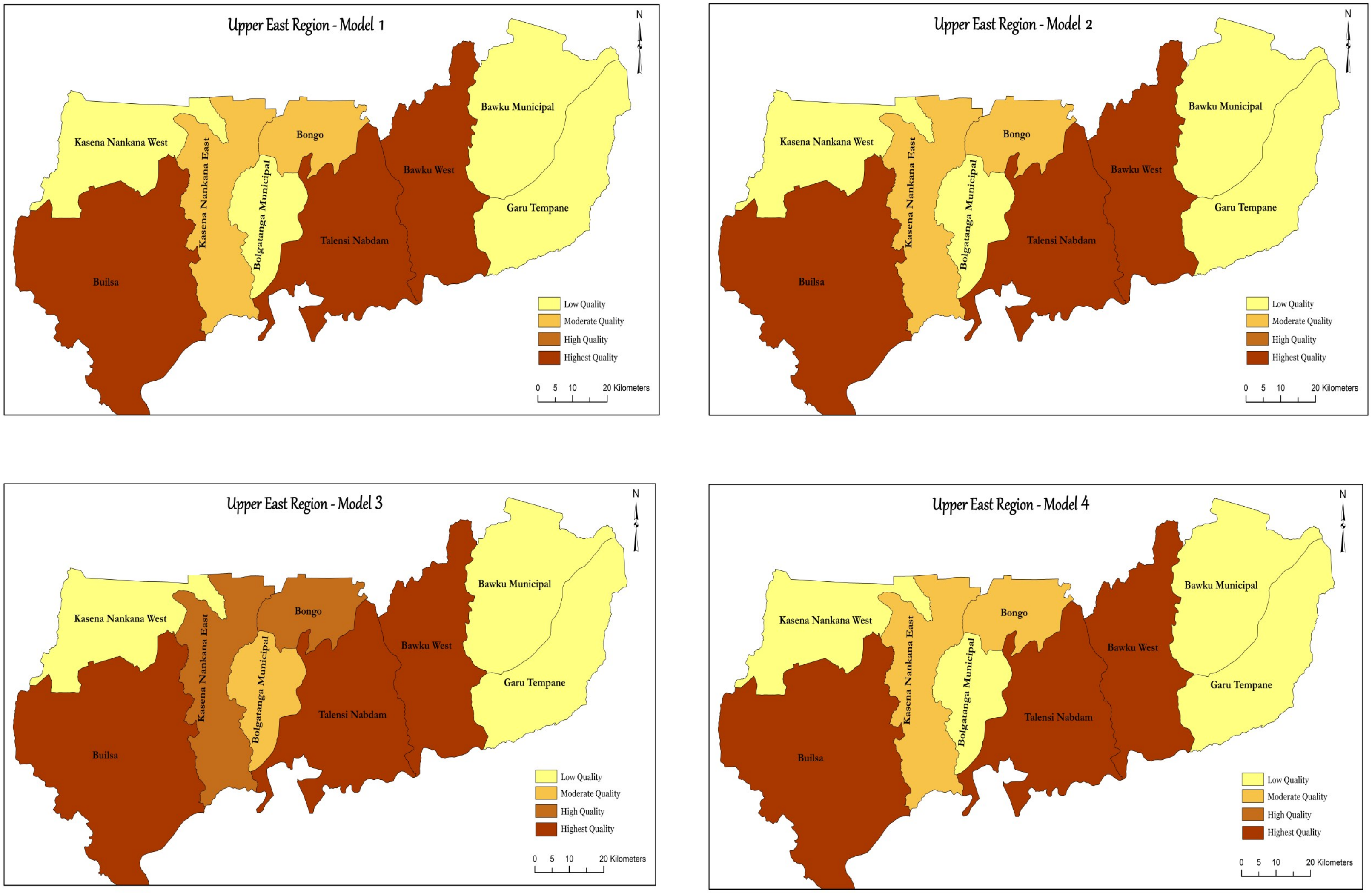


Figure 5.7: Spatial Variation of Housing Quality for the Upper East Region.

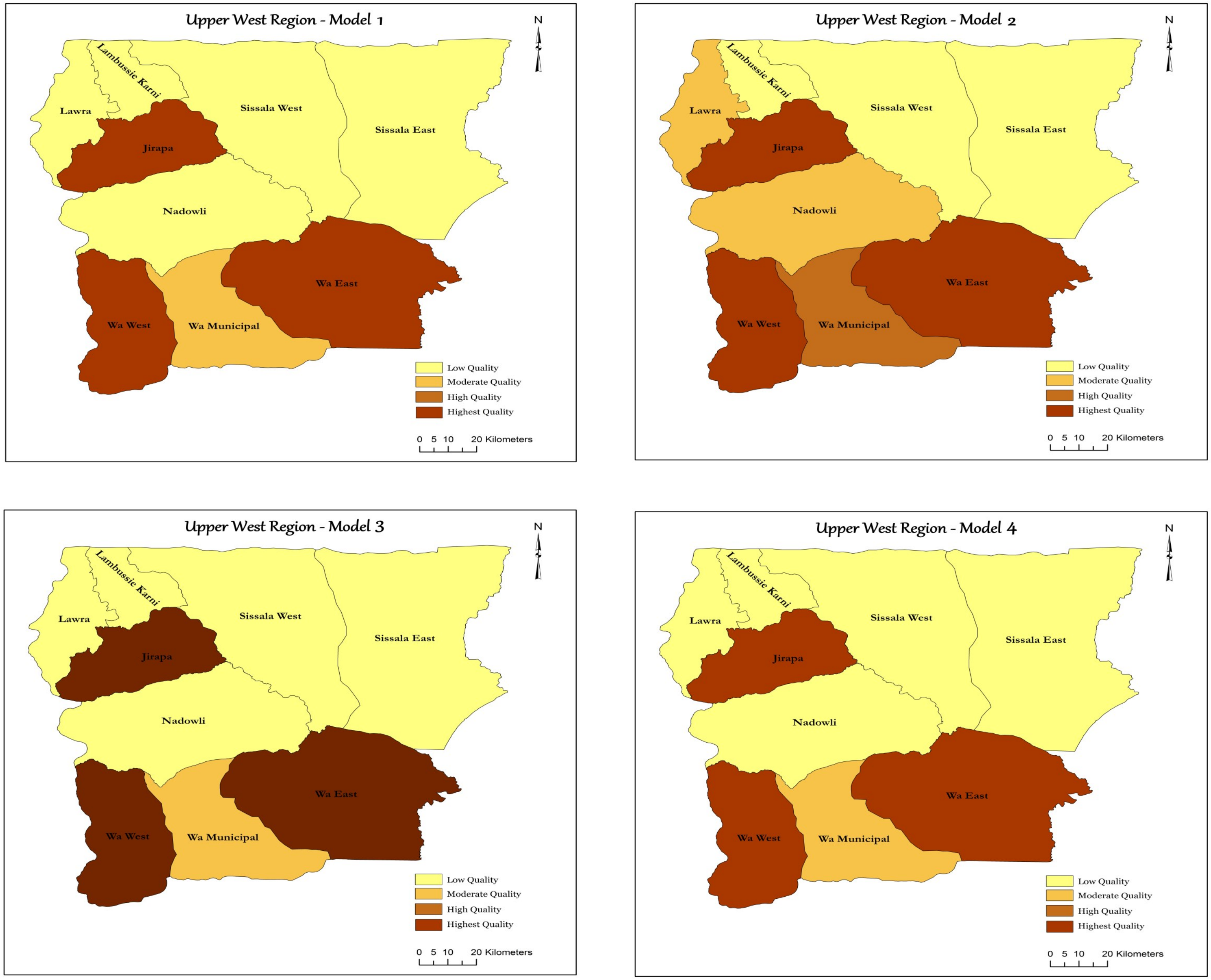


Figure 5.8: Spatial Variation of Housing Quality for the Upper West Region.

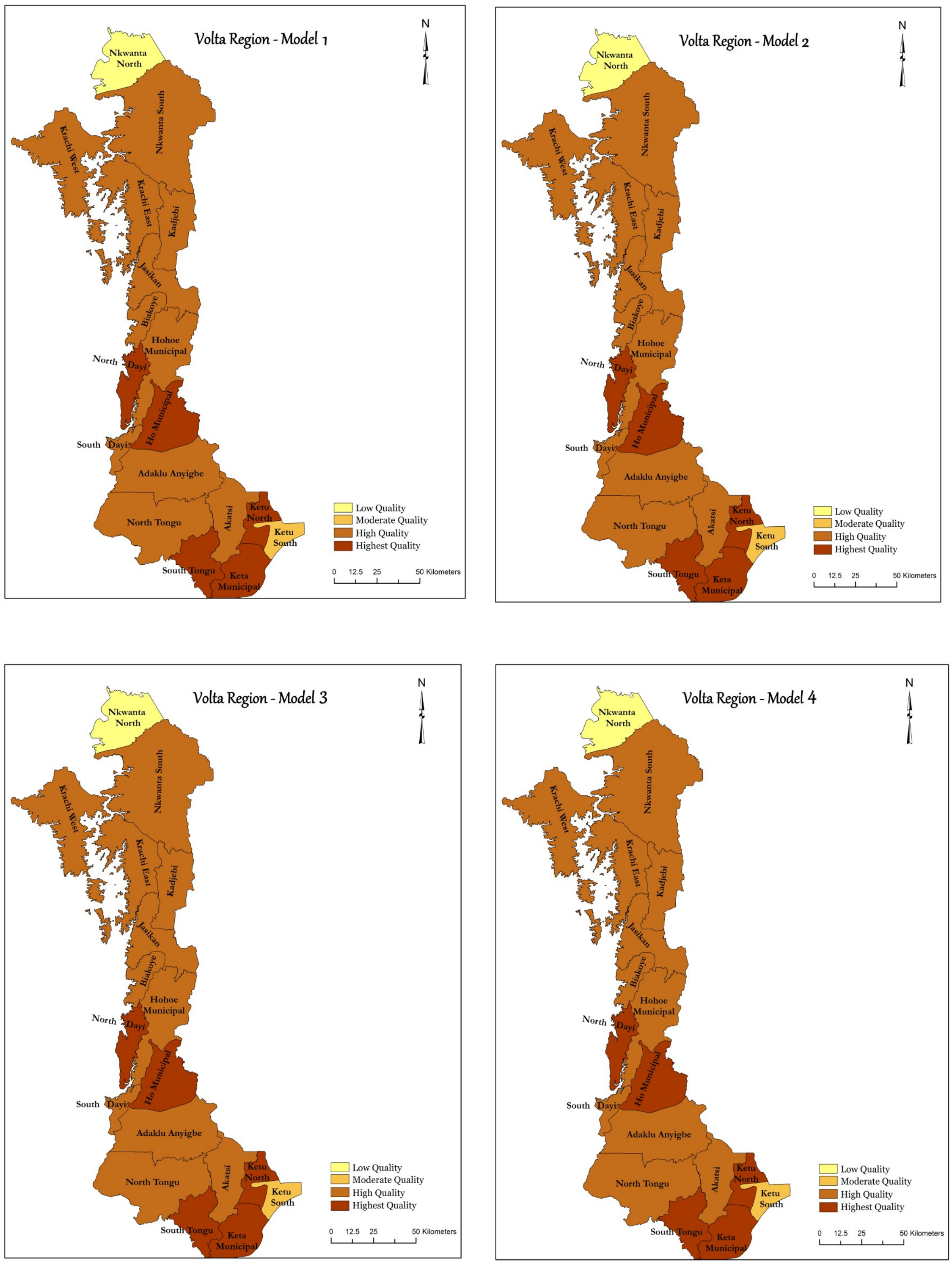


Figure 5.9: Spatial Variation of Housing Quality for the Volta Region.

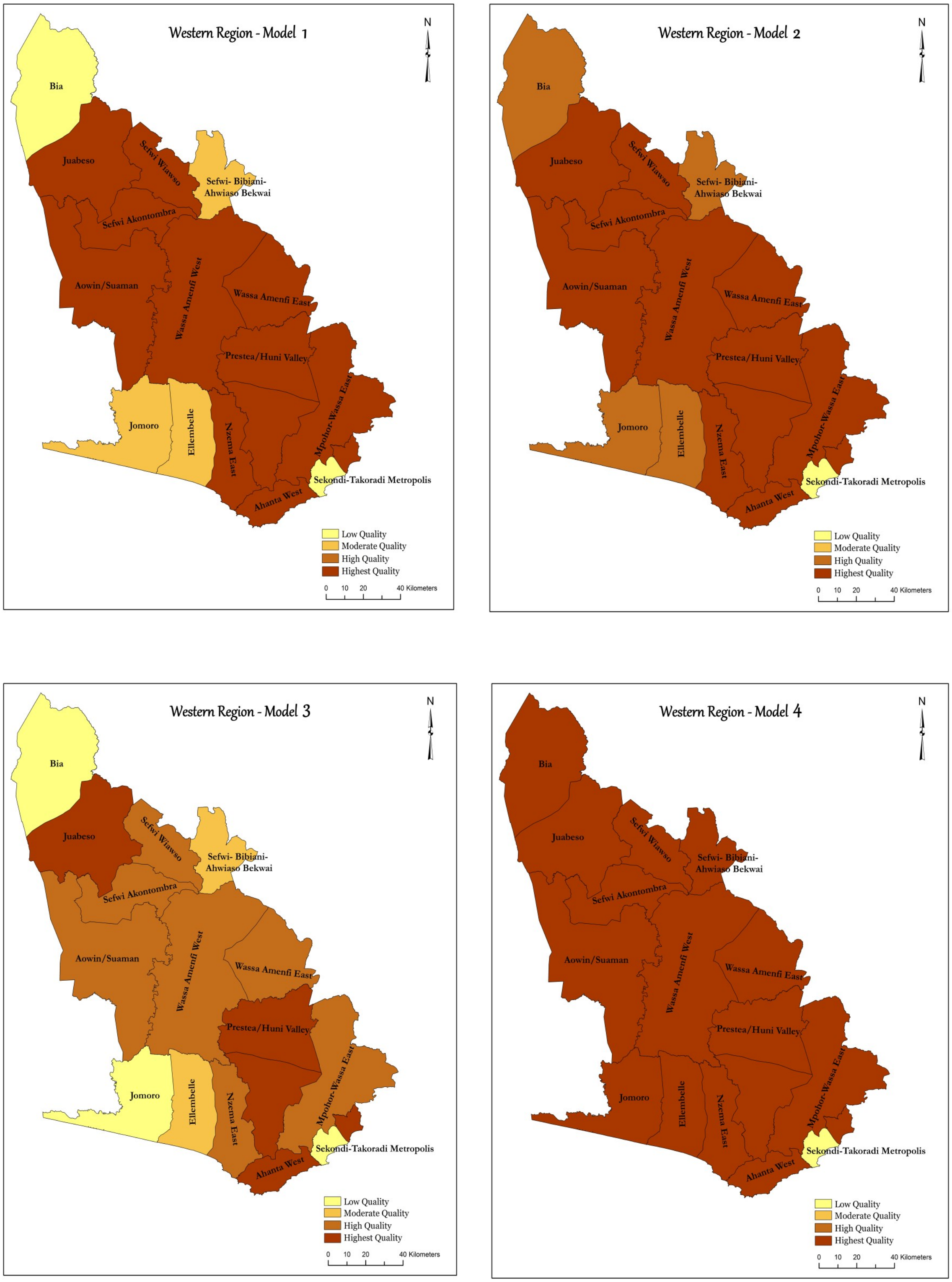


Figure 5.10: Spatial Variation of Housing Quality for the Western Region.

The visual examination of these maps indicates that the spatial patterning of residential quality in the study area is influenced by the factors or criteria that are prioritized in the assessment. It can be observed that when the physical criteria is prioritized by weighting it higher than the rest, eight out of the ten regions experienced changes in their spatial patterning of housing quality apart from the Volta and Upper East regions. In model 2 when the economic/social cluster is prioritized changes to five regions (Ashanti, Brong Ahafo, Eastern, Western, and Central) occurred. Similarly, the spatial patterning of housing quality changed in the Ashanti, Brong Ahafo, Eastern, Greater Accra, and Western regions when environmental factors were weighted higher than the other factors. These changes in pattern suggest that the physical aspects of housing seem to have a major impact on the quality of housing in the study area, compared to the economic/social and the environmental factors. Prior research has shown that the physical aspects of housing are a major determinant of housing quality. Studies such as (Aderamo & Ayobolu, 2010; Amao, 2012; Jiboye, 2011; Muoghalu, 1991) all identified or established a relationship between variables and indicators related to the physical aspects of housing as influencing housing quality. For instance, in an empirical study, Aderamo and Ayobolu (2010) identified factors such as internal facilities, major materials for roofing and materials for external walls, the type of toilet and bathroom facilities available, and the source of lighting in the house when centrally provided electricity is not available as the most important factors that account for housing quality in Ilorin, Nigeria. All these factors relate to the physical aspects of housing. As identified in previous research, the physical aspects of housing in Ghana affect its quality. The quality of housing in Ghana is influenced by the structural quality and the availability and adequacy of housing services and infrastructure.

Although the criteria prioritized seems to have modifications in the spatial patterns of housing quality in the study area, it was noticed that the Volta and Upper East regions had no substantial changes in their spatial patterns generated by the three models. This consistency shows how similar the districts in these regions are in relation to aspects of housing.

5.6 Summary and Conclusions

This chapter presented the results of an integrated GIS-ANP framework to evaluate housing quality at the district level in Ghana. It examined the factors that contribute to the quality of housing in the study area and the underlying reasons for the differential contribution to housing quality. This was followed by a scenario analysis whereby housing quality was assessed from three different perspectives by prioritizing the different criteria clusters to see how they impact the overall quality of houses in Ghana. It can be argued that the lower contributing factors to the quality of houses in Ghana are environmental sanitation, measured in this study by modes of solid and liquid waste disposal, housing services and structural quality of the dwellings. However, the three top contributing factors are housing density used as an indicator for amount of open space, types of dwellings and household density used as a measure of overcrowding. The classifications of these factors according to their importance is based on the fact that they are found in the ranks in most of the regions in the various models. Based on the findings from this study, it is argued that the physical aspects of dwellings impact negatively on housing quality followed by environmental sanitation. Two out of the three indicators (structural quality and housing services) used to operationalize the physical cluster ranked among the least three factors in most of the regions for the models regardless of the cluster that was prioritized. It was further revealed that the facilities that are available in a dwelling determines greatly the housing quality of dwellings. Therefore, the dwelling facilities factor can be recognized as the major determinant of housing quality in Ghana. This factor is inherent in the unavailability of housing facilities.

From the scenario analysis, it can be deduced that the contribution of the various factors used in evaluating the quality of dwellings was subject to the perspective that is being prioritized in the evaluation process, although housing services have been consistent as poor contributor irrespectively of the perspective. Based on the findings of this study, it can therefore be argued that there is substantial spatial variability of housing quality between the districts and regions of Ghana.

CHAPTER 6
SUMMARY AND CONCLUSIONS

6.1 Introduction

This chapter begins with an overview of this study and the main findings of the research. It highlights the advantages of adopting an ANP-based framework to assess housing quality as well as the limitations of the method. Finally, the chapter gives some directions and suggestions for future research and recommendations.

6.2 Overview of Study and Strengths of the ANP-based Framework

This study proposed an ANP-based framework for assessing housing quality and integrating the framework into a GIS environment. The framework was demonstrated using an assessment of housing quality at the district level in Ghana. Housing quality was evaluated based on three groups of criteria: physical, socio-economic and environmental. The 2010 Ghana Population and Housing census data on tenancy arrangement, housing characteristics and amenities were used.

Using the framework to assess housing quality allowed for the interdependences between elements of the evaluation problem to be accounted for. It also provides the possibility of assessing effective relationships of each criterion on each other and on the final goal through the form of a network. Also, the GIS-ANP framework was able to prove the ‘where’, in addition to ‘what’ and how ‘much’. That is, where the dwellings with high or low housing quality in the country at the districts are, what factors are contributing to quality of dwellings and how much they are contributing, whether low or high? Based on the weighing scheme of the ANP method, the contributions of the various factors to the overall housing quality of districts and the relative importance of all the elements that play an influence can be identified. Further, because there does not exist a generally accepted technique for deriving a single index for housing quality, it becomes difficult to evaluate the individual attributes of the dwelling units due to the difficulty of establishing a weighting scheme for combining the attribute measures into a single index. However, with the adoption of the ANP-based framework, this issue was overcome due to the pairwise comparison scale inherent in the ANP method that allowed weighting of the various attributes of the housings on a common scale. In addition, the ANP procedure can be executed using a computational software (Super Decisions), and the results indicated that this software makes the computations easier and reduces the possibility of computational errors.

Due to the intrinsic spatial nature of the housing quality evaluation problem, the ANP-based framework was coupled with GIS. While the results from the ANP method allows for ranking the districts as well as identifying which factors are contributing more or less to housing quality, mapping the results provides a tool for examining spatial patterns of housing quality. ArcGIS was used to visualize the results of ANP. The GIS capabilities help in identifying the districts which have the lowest housing quality scores and which districts need urgent attention. This allows for area-based housing interventions to be directed towards specific district or region. The results from the study show that GIS can be effectively integrated with the ANP method and was successfully applied in evaluating housing quality at the districts in Ghana.

6.3 Limitations of the ANP-based Framework for Housing Quality Evaluation

There are some limitations of the ANP method. The main drawback, especially in the practical application of ANP, is the large number of comparisons that need to be done. The greater number of comparisons is exacerbated by the number of evaluation criteria. This leads to complexity in the weighting procedure, which makes it difficult for the decision maker to comprehend the decision outcomes if they are not familiar with the method. Further, in cases where there are several alternatives in the decision model as in this study, the pairwise comparisons become quite demanding. The computational software for the ANP method enabled the performance of the pairwise comparisons and hence made the procedure less chaotic, but it was found that the software can only solve problems involving 30 or less decision alternatives.

There is the potential presence of uncertainties in any multicriteria decision/evaluation problem. These uncertainties arise in two ways: (1) incomplete or incorrect information about the decision problem, and (2) uncertainties might result from the inherent assumptions of the method (Malczewski, 1999; Voogd, 1983). In this present application, given to a certain extent the deterministic nature of the decision problem; i.e., the number of alternatives is known and fixed, and the criteria are objective indicators measured on a quantitative scale, the amount of uncertainty in this study is limited to the specification of weights and measurement errors present in the data. Sensitivity analysis, which is a method for dealing with uncertainties was employed to test the robustness of the evaluation. This process was used to test whether changes in cluster weights modify the rankings of the alternatives. Although there were changes in the rankings for some regions, the position of the different alternatives in the rankings did not change much. As a conclusion of this analysis, we can state that the results obtained are sufficiently stable.

6.4 Implications and Recommendations

The results from this study provide an aggregate picture of housing quality at the districts in Ghana. The implications of the findings of this study are of significance to housing policy and residential development in Ghana. One significant feature regarding the outcome of this study among several others is that, housing quality factors are contributing differently to housing quality among the districts and regions in the country, especially based on the emphasized perspective in the evaluation. This finding indicates that different districts and regions have a distinct set of housing quality determinants which are peculiar to them. Therefore, knowledge of relevant factors that affect residential and neighbourhood quality of districts can serve as a useful guide to housing developers and agencies in their decisions on housing and neighbourhood improvement in the country especially at the districts. By considering the outcome of this study which essentially provides relevant information about the factors that are contributing to the housing quality of each district as well as districts that are performing poorly on housing quality, it is possible to direct interventions to tackle the specific areas of deficiency in terms of housing for these districts. Further, the findings of housing services and environmental sanitation contributing poorly to housing quality in the country confirms the poor or deplorable conditions of housing facilities in the country as well as issues related to solid waste management. The need thus arises for efforts towards the incorporation of housing quality standards in the planning and design of aspects of housing development in Ghana.

Lack of access to housing services, structural sustainability of building materials and environmental sanitation accounts for poor quality of housing in the study area. Housing services in the country are either inadequate or mostly of the poorest quality in many of the cases in which they exist due to high sharing rate that results in poor conditions of the facilities. Most of the houses are characterized by poor access to water, poor or non-existent drainage and poor sanitation, inadequate cooking, bathing and toilet facilities. Housing improvement depends on the successful implementation of a series of measures that include: enforcements of standards related to the provision of basic housing infrastructures such as toilet facilities, and cooking spaces by the relevant agencies and departments such as the Ministry of Works and Housing. By requiring all landlords to provide these basic facilities. Although bye-laws have been passed requesting landlords to provide toilet facilities in houses, such laws are not enforced, resulting in a major proportion of households resorting to public toilets due to lack of this facility in their housing. Efforts should also be directed towards upgrading the existing housing facilities which are of low quality. Since these are of critical importance to the quality of dwellings in the country.

Further, the finding of this study also underscores the need for the improvement of the overall housing environment through effective waste management strategies and the provision of basic infrastructures. Environmental sanitation is poorly contributing to the quality of houses in the study area. The provision of facilities required for achieving good disposal systems are measures that favour good environmental quality. Therefore, investment should be made in solid waste disposal and drainage modes in the country as the physical environment of the dwellings impact the quality of housing, which further influences the health of households. The outcome of such interventions and efforts towards ensuring quality of residential environments would be beneficial to the people and society at large.

6.5 Research Contribution and Recommendations for Future work

This section concludes the study by presenting contribution of this study and future research. The main purpose of this study was to evaluate housing quality using the ANP method. The major contribution of this study is with regards to the advancement of the application areas of the ANP method. The study developed an ANP-based framework for evaluating housing quality and integrated it into GIS. The implementation of the spatial ANP technique to housing quality evaluation gives an originality value to the present research because it represents the first attempt to apply spatial ANP for housing quality evaluation. The study has established the applicability of the suggested framework in evaluating housing quality. This framework is adaptive as it uses housing datasets derived from national database i.e. national census to assist with housing policy making and intervention. Further, this research being the first to attempt an evaluation of housing quality at the district level in Ghana provides insight into the spatial patterns of housing quality at the districts in Ghana. As well as the housing quality indicators that impact the quality of housing in the various districts. As a result, accounting for the imbalances in housing quality among the districts. Altogether, these issues are of importance to housing intervention and development in Ghana.

Despite the successful implementation of the proposed framework for assessing housing quality in Ghana, there are still a number of opportunities for expanding the study and for validating the results. Future works should endeavour to incorporate expert opinion into the weighting and assessment phase of the decision problem to see how their opinions impact on the results of this study. In this study, the GIS integration with ANP is limited to data visualization. Future studies should implement the full integration to provide the analytical capabilities of GIS-ANP for examining spatial patterns.

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APPENDICES

Appendix 1: Rating Model

ALTERNATIVES (DISTRCITS)			Weights												
			0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769	0.0769
	Totals	*Priorities*	**Bathing Facility**	**Cooking Fuel**	**Cooking Space**	**Water Supply**	**Toilet Facility**	**Lighting**	**Housing Type**	**Outer material**	**Tenureship**	**Household Density**	**Solid Waste Disposal**	**Drainage**	**Housing Density**
Abura-Asebu-Kwamankese	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Accra Metropolis	0.641	0.006	0.333	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.333
Adaklu Anyigbe	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Adansi North	0.718	0.006	0.333	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Adansi South	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Adenta Municipal	0.744	0.006	0.333	1.000	0.333	0.333	0.500	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.667
Afigya Kwabre	0.731	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Afigya Sekyere	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Agona East	0.641	0.006	0.333	0.333	0.333	0.667	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Agona West Municipal	0.641	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	0.500	0.500	0.500	1.000
Ahafo Ano North	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Ahafo Ano South	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Ahanta West	0.756	0.007	0.333	0.333	1.000	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Ajumako-Enyan-Essiam	0.641	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Akatsi	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Akwapem North	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Akwapem South Municipal	0.731	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Akyemansa	0.692	0.006	0.333	0.333	1.000	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Amansie Central	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Amansie West	0.667	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000

Aowin/Suaman	0.705	0.006	1.000	0.333	1.000	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Asante Akim North Municipal	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Asante Akim South	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Ashaiman Municipal	0.641	0.006	0.333	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.333
Asikuma-Odoben Brakwa	0.654	0.006	0.333	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Assin North Municipal	0.654	0.006	0.333	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Assin South	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Asunafo North Municipal	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Asunafo South	0.654	0.006	0.333	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Asuogyaman	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Asutifi	0.628	0.005	0.667	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Atebubu Amantin	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Atiwa	0.731	0.006	0.333	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Atwima Kwanwoma	0.731	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Atwima Mponua	0.654	0.006	0.333	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Atwima Nwabiagya	0.692	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	0.500	0.500	0.500	1.000
Bawku Municipal	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Bawku West	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Bekwai Municipal	0.756	0.007	0.667	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Berekum Municipal	0.667	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	0.500	1.000	0.500	0.500	1.000
Bia	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Biakoye	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Birim Municipal	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Birim North	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Birim South	0.731	0.006	0.333	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Bole	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Bolgatanga Municipal	0.641	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000

Bongo	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Bosome Freho	0.731	0.006	1.000	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Bosumtwi	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Builsa	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Bunkpurugu-Yunyoo	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Cape Coast Metropolis	0.692	0.006	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.667
Chereponi	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Dangbe East	0.705	0.006	0.333	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Dangbe West	0.731	0.006	0.333	0.667	0.333	1.000	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Dormaa East	0.782	0.007	0.667	0.333	1.000	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Dormaa Municipal	0.744	0.006	0.667	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
East Akim Municipal	0.756	0.007	0.667	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
East Gonja	0.577	0.005	0.333	0.333	0.333	0.333	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Effutu Municipal	0.692	0.006	0.333	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	1.000
Ejisu Juaben Municipal	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Ejura-Sekyedumase	0.641	0.006	0.333	0.333	0.333	0.667	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Ellembelle	0.756	0.007	0.667	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Ewutu Senya	0.679	0.006	0.333	0.667	0.333	0.333	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Fanteakwa	0.654	0.006	0.333	0.333	1.000	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Ga East Municipal	0.769	0.007	1.000	1.000	0.333	0.333	1.000	1.000	1.000	1.000	0.500	1.000	1.000	0.500	0.333
Ga West Municipal	0.718	0.006	0.333	1.000	0.333	0.333	1.000	1.000	0.667	1.000	0.500	1.000	1.000	0.500	0.667
Garu Tempane	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Gomoa East	0.731	0.006	0.333	0.667	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Gomoa West	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Gonja Central	0.603	0.005	0.333	0.333	0.333	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Gushiegu	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Ho Municipal	0.731	0.006	0.333	0.333	0.333	1.000	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Hohoe Municipal	0.692	0.006	0.333	0.333	0.333	1.000	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000

Jaman North	0.667	0.006	0.667	0.333	0.333	0.667	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Jaman South	0.718	0.006	0.667	0.333	1.000	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Jasikan	0.667	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Jirapa	0.679	0.006	1.000	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Jomoro	0.718	0.006	0.667	0.333	1.000	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Juabeso	0.731	0.006	1.000	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Kadjebi	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Karaga	0.628	0.005	0.667	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Kasena Nankana East	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Kasena Nankana West	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Keta Municipal	0.744	0.006	1.000	0.333	0.333	1.000	0.500	0.500	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Ketu North	0.667	0.006	0.333	0.333	0.333	0.667	0.500	0.500	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Ketu South	0.641	0.006	0.333	0.667	0.333	0.333	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Kintampo North Mucipal	0.641	0.006	0.333	0.333	0.333	0.667	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Kintampo South	0.577	0.005	0.333	0.333	0.333	0.333	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Komenda-Edina-Eguafo-Abrem	0.731	0.006	0.333	0.667	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Kpandai	0.628	0.005	1.000	0.333	0.333	0.333	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Krachi East	0.603	0.005	0.333	0.333	0.333	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Krachi West	0.679	0.006	1.000	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Kumasi Metropolis	0.667	0.006	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.333
Kwabre East	0.654	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	0.500	0.500	0.500	0.500	1.000
Kwaebibirem	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Kwahu East	0.718	0.006	0.667	0.333	1.000	0.667	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Kwahu North	0.603	0.005	0.333	0.333	0.333	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Kwahu South	0.782	0.007	0.667	0.333	1.000	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Kwahu West Municipal	0.692	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	0.500	1.000	0.500	0.500	1.000
Lambussie/Karni	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Lawra	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000

Ledzokuku/Krowor Municipal	0.667	0.006	0.333	1.000	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.333
Lower Manya	0.692	0.006	0.333	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	1.000	0.500	0.500	1.000
Mampong Municipal	0.731	0.006	0.667	0.333	0.333	1.000	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Mamprusi East	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Mamprusi West	0.628	0.005	0.667	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Mfantsiman Municipal	0.705	0.006	0.333	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Mpohor-Wassa East	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Nadowli	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Nanumba North	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Nanumba South	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
New Juaben Municipal	0.692	0.006	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	0.667
Nkoranza North	0.667	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Nkoranza South	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Nkwanta North	0.628	0.005	1.000	0.333	0.333	0.333	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Nkwanta South	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
North Dayi	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
North Tongu	0.603	0.005	0.333	0.333	0.333	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Nzema East	0.718	0.006	0.333	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Obuasi Municipal	0.705	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	0.500	1.000	1.000	0.500	0.667
Offinso Municipal	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Offinso North	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Prestea/Huni Valley	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Pru	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Saboba Chereponi	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Savelugu-Nanton	0.628	0.005	0.667	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Sawla-Tuna-Kalba	0.731	0.006	1.000	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Sefwi Akontombra	0.705	0.006	1.000	0.333	1.000	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000

Sefwi Bibiani-Anhwiaso-Bekwai	0.756	0.007	0.667	0.333	1.000	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Sefwi Wiawso	0.769	0.007	1.000	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Sekondi -Takoradi	0.731	0.006	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	1.000	0.500	1.000	0.500	0.667
Sekyere Afram Plains	0.615	0.005	0.333	0.333	0.333	0.333	0.500	0.500	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Sekyere Central	0.641	0.006	0.333	0.333	0.333	0.333	0.500	0.500	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Sekyere East	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Sene	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Shama	0.731	0.006	0.333	0.667	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Sissala East	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Sissala West	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
South Dayi	0.641	0.006	0.333	0.333	0.333	0.333	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
South Tongu	0.667	0.006	0.333	0.333	0.333	0.667	0.500	0.500	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Suhum-Kraboa Coaltar	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Sunyani Municipal	0.718	0.006	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	0.500	0.500	1.000	0.500	1.000
Sunyani West	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Tain	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Talensi Nabdam	0.705	0.006	1.000	0.333	1.000	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Tamale Metropolis	0.795	0.007	0.667	0.667	0.333	1.000	0.500	1.000	0.667	1.000	1.000	1.000	1.000	0.500	1.000
Tano North	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Tano South	0.705	0.006	0.667	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Tarkwa Nsuaem Municipal	0.705	0.006	0.333	0.333	0.333	0.667	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	1.000
Techiman Municipal	0.731	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Tema Metropolis	0.885	0.008	1.000	1.000	0.333	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.667
Tolon-Kumbugu	0.603	0.005	0.667	0.333	0.333	0.333	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Twifo-Hemang-Lower Denkyira	0.718	0.006	0.333	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Upper Denkyira East	0.718	0.006	0.667	0.333	1.000	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Upper Denkyira West	0.718	0.006	0.333	0.333	1.000	0.667	0.500	1.000	1.000	0.500	1.000	1.000	0.500	0.500	1.000

Upper Manya	0.628	0.005	0.333	0.333	0.333	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Wa East	0.731	0.006	1.000	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Wa Municipal	0.731	0.006	0.667	0.667	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
Wa West	0.731	0.006	1.000	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Wassa Amenfi East	0.705	0.006	1.000	0.333	1.000	0.333	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Wassa Amenfi West	0.679	0.006	0.333	0.333	1.000	0.667	0.500	0.500	1.000	0.500	1.000	1.000	0.500	0.500	1.000
Weija (Ga South) Municipal	0.731	0.006	0.333	0.667	0.333	1.000	0.500	1.000	1.000	1.000	1.000	1.000	0.500	0.500	0.667
Wenchi Municipal	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
West Akim Municipal	0.679	0.006	0.333	0.333	0.333	0.667	0.500	1.000	0.667	1.000	1.000	1.000	0.500	0.500	1.000
West Gonja	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Yendi Municipal	0.603	0.005	0.333	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Yilo Krobo	0.667	0.006	0.333	0.667	0.333	0.667	0.500	1.000	0.667	0.500	1.000	1.000	0.500	0.500	1.000
Zabzugu-Tatale	0.654	0.006	1.000	0.333	0.333	0.667	0.500	0.500	0.667	0.500	1.000	1.000	0.500	0.500	1.000

Appendix II:
Final Priorities (Limiting and Normalized by Cluster Priorities) for the Districts by Regions

ASHANTI REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Adansi North	0.04795	0.022622	3	0.04467	0.021553	3	0.0527	0.024217	3	0.04662	0.022112	3
	Adansi South	0.04759	0.022453	5	0.04445	0.021449	5	0.05217	0.023971	5	0.0463	0.021959	5
	Afigya Kwabre	0.03612	0.017038	9	0.03765	0.018166	9	0.03457	0.015887	9	0.03606	0.017104	9
	Afigya Sekyere	0.0358	0.016887	17	0.03746	0.018072	16	0.03409	0.015666	17	0.03578	0.016967	17
	Ahafo Ano North	0.03188	0.015042	23	0.03508	0.016926	23	0.02836	0.013033	24	0.03222	0.015281	24
	Ahafo Ano South	0.03205	0.015121	21	0.03531	0.017039	21	0.02853	0.013108	22	0.03233	0.015332	21
	Amansie Central	0.0476	0.022455	4	0.04446	0.02145	4	0.05217	0.023974	4	0.04631	0.021961	4
	Amansie West	0.0475	0.02241	7	0.0444	0.021422	7	0.05203	0.023908	7	0.04622	0.02192	7
	Asante Akim North Municipal	0.03595	0.016958	12	0.03759	0.018139	11	0.03417	0.0157	12	0.03601	0.01708	12
	Asante Akim South	0.04758	0.022445	6	0.04444	0.021444	6	0.05214	0.023959	6	0.04629	0.021952	6
	Atwima Kwanwoma	0.03608	0.017021	10	0.03763	0.018155	10	0.03452	0.015861	10	0.03603	0.017088	11
	Atwima Mponua	0.03333	0.015724	20	0.03709	0.017896	19	0.02977	0.013678	20	0.03314	0.015718	20
	Atwima Nwabiagya	0.03013	0.014216	24	0.02918	0.014077	24	0.02885	0.013256	21	0.03231	0.015324	22
	Bekwai Municipal	0.03666	0.017293	8	0.03797	0.018322	8	0.03538	0.016259	8	0.03655	0.017335	8
	Bosome Freho	0.04848	0.022871	2	0.04498	0.021705	2	0.0535	0.024582	2	0.0471	0.022337	2
	Bosumtwi	0.0358	0.016889	16	0.03746	0.018074	15	0.0341	0.015669	16	0.03578	0.016969	16
	Ejisu Juaben Municipal	0.03581	0.016894	15	0.03747	0.018077	14	0.03412	0.015676	15	0.03579	0.016973	15
	Ejura-Sekyedumase	0.03449	0.016272	19	0.03581	0.01728	20	0.03271	0.015031	19	0.03489	0.016546	19

	Kumasi Metropolis	0.02064	0.009735	27	0.01723	0.008314	27	0.02212	0.010165	27	0.02251	0.010676	27
	Kwabre East	0.02522	0.011898	26	0.02178	0.010508	26	0.02438	0.011201	26	0.02944	0.013963	25
	Mampong Municipal	0.03595	0.01696	11	0.03737	0.018032	17	0.03437	0.015793	11	0.03605	0.017096	10
	Obuasi Municipal	0.02729	0.012876	25	0.02664	0.012855	25	0.02773	0.01274	25	0.02747	0.013029	26
	Offinso Municipal	0.03581	0.016894	14	0.03747	0.018077	13	0.03412	0.015676	14	0.03579	0.016973	14
	Offinso North	0.03189	0.015045	22	0.03508	0.016928	22	0.02837	0.013038	23	0.03223	0.015284	23
	Sekyere Afram Plains	0.03551	0.016752	18	0.03729	0.01799	18	0.03366	0.015467	18	0.03552	0.016845	18
	Sekyere Central	0.05106	0.024086	1	0.04656	0.022464	1	0.05723	0.026295	1	0.04945	0.023452	1
	Sekyere East	0.03583	0.016901	13	0.03747	0.018081	12	0.03414	0.015686	13	0.0358	0.01698	13
ECONOMIC /SOCIAL	Crowding (household density)	0.51764	0.08566		0.50677	0.124822		0.52966	0.079372		0.5256	0.053766	
	Ownership	0.48236	0.079823		0.49323	0.121485		0.47034	0.070483		0.4744	0.048528	
ENVIRON-MENTAL	Amount of open space	0.84511	0.132895		0.84795	0.12274		0.84379	0.077543		0.84364	0.20005	
	Sanitation Facilities	0.15489	0.024357		0.15205	0.022009		0.15621	0.014356		0.15636	0.037078	
PHYSICAL	Dwelling type	0.49035	0.100769		0.48627	0.061488		0.49788	0.14874		0.48729	0.090791	
	Housing Services / Infrastructure	0.12014	0.024689		0.12006	0.015181		0.12057	0.036021		0.11985	0.02233	
	Structural Quality	0.38952	0.080048		0.39368	0.04978		0.38155	0.113988		0.39287	0.073199	

BRONG AHAFO REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ATERNATIVES	Asunafo North Municipal	0.03792	0.017944	19	0.04172	0.02017	19	0.0338	0.015594	20	0.03824	0.018187	21
	Asunafo South	0.03841	0.018177	15	0.04202	0.020315	15	0.03452	0.015928	16	0.03869	0.018399	17
	Asutifi	0.03811	0.018036	16	0.04184	0.020227	16	0.03408	0.015725	17	0.03842	0.01827	18
	Atebubu Amantin	0.03792	0.017944	17	0.04172	0.02017	17	0.0338	0.015594	18	0.03824	0.018187	19
	Berekum Municipal	0.03669	0.017363	21	0.03481	0.016829	21	0.03596	0.01659	15	0.03925	0.018666	16
	Dormaa East	0.06372	0.030153	1	0.05718	0.027646	1	0.07257	0.033483	1	0.06144	0.02922	1
	Dormaa Municipal	0.05862	0.027742	3	0.05412	0.026168	3	0.06502	0.029997	3	0.05681	0.027016	3
	Jaman North	0.04321	0.020447	12	0.04489	0.021705	12	0.04164	0.01921	12	0.04305	0.020474	12
	Jaman South	0.03948	0.018684	14	0.04267	0.02063	14	0.0361	0.016656	14	0.03966	0.018859	15
	Kintampo North Municipal	0.04301	0.020355	13	0.04478	0.021649	13	0.04135	0.019079	13	0.04288	0.020391	14
	Kintampo South	0.03781	0.017894	20	0.04165	0.020139	20	0.03364	0.015522	21	0.03815	0.018142	22
	Nkoranza North	0.05734	0.027136	4	0.05334	0.025791	4	0.06313	0.029128	4	0.05565	0.026466	4
	Nkoranza South	0.06244	0.029547	2	0.0564	0.02727	2	0.07069	0.032614	2	0.06029	0.02867	2
	Pru	0.03792	0.017944	18	0.04172	0.02017	18	0.0338	0.015594	19	0.03824	0.018187	20
	Sene	0.05663	0.026798	6	0.05256	0.025411	6	0.06231	0.028746	6	0.05512	0.026215	6
	Sunyani Municipal	0.03523	0.016673	22	0.02943	0.014228	22	0.03333	0.015379	22	0.04291	0.020405	13
	Sunyani West	0.04363	0.020647	8	0.04515	0.02183	9	0.04226	0.019497	8	0.04343	0.020655	9
	Tain	0.05706	0.027002	5	0.05317	0.025708	5	0.06272	0.028936	5	0.0554	0.026344	5
	Tano North	0.04363	0.020647	9	0.04515	0.02183	10	0.04226	0.019497	9	0.04343	0.020655	10
	Tano South	0.04363	0.020647	10	0.04515	0.02183	11	0.04226	0.019497	10	0.04343	0.020655	11
	Techiman Municipal	0.04403	0.020837	7	0.04539	0.021948	7	0.04285	0.019771	7	0.0438	0.020829	7
	Wenchi Municipal	0.04352	0.020596	11	0.04515	0.02183	8	0.04191	0.019334	11	0.04347	0.020674	8
ECONOMIC /SOCIAL	Crowding (household density)	0.53347	0.089006		0.52134	0.128983		0.54468	0.082508		0.54354	0.056193	
	Ownership	0.46653	0.077837		0.47866	0.118426		0.45532	0.068973		0.45646	0.047191	
ENVIRON-MENTAL	Amount of open space	0.87078	0.137354		0.87106	0.126345		0.87109	0.080379		0.87019	0.206917	
	Sanitation Facilities	0.12922	0.020383		0.12894	0.018703		0.12891	0.011895		0.12981	0.030867	

PHYSICAL	Dwelling type	0.51513	0.104163		0.51337	0.063684		0.52033	0.15343		0.51188	0.093809	
	Housing Services / Infrastructure	0.13509	0.027316		0.13694	0.016987		0.13296	0.039207		0.13537	0.024808	
	Structural Quality	0.34978	0.070728		0.34969	0.043379		0.34671	0.102236		0.35275	0.064646	

GREATER ACCRA REGION		**Model 1**			**Model 2 (Scenario 1)**			**Model 3 (Scenario 2)**			**Model 4 (Scenario 3)**		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Accra Metropolis	0.0529	0.02474	10	0.04543	0.021807	10	0.05153	0.023378	10	0.06173	0.029031	10
	Adenta Municipal	0.13771	0.064401	2	0.13872	0.066593	2	0.1441	0.065372	2	0.13051	0.061379	2
	Ashaiman Municipal	0.05302	0.024795	9	0.0455	0.02184	9	0.0517	0.023457	9	0.06184	0.029081	9
	Dangbe East	0.12195	0.05703	4	0.13548	0.065035	4	0.10635	0.048248	6	0.12386	0.058251	4
	Dangbe West	0.12231	0.057198	3	0.13569	0.065138	3	0.10689	0.048491	5	0.12419	0.058405	3
	Ga East Municipal	0.10836	0.050672	6	0.09858	0.047325	6	0.12184	0.055274	4	0.10471	0.049244	6
	Ga West Municipal	0.08732	0.040833	7	0.08939	0.042911	7	0.08063	0.036578	7	0.09176	0.043152	7
	Ledzokuku/ Krowor Municipal	0.05428	0.025383	8	0.04625	0.022201	8	0.05358	0.024308	8	0.06298	0.029618	8
	Tema Metropolis	0.14112	0.065995	1	0.14076	0.06757	1	0.14919	0.067681	1	0.13361	0.062837	1
	Weija (Ga South) Municipal	0.12103	0.056598	5	0.12421	0.059625	5	0.1342	0.060883	3	0.10482	0.049297	5
ECONOMIC /SOCIAL	Overcrowding (household density)	0.59504	0.09701		0.58338	0.142582		0.60505	0.088612		0.60288	0.060647	
	Ownership	0.40496	0.066022		0.41662	0.101823		0.39495	0.057842		0.39712	0.039949	
ENVIRON-MENTAL	Amount of Open Space	0.47005	0.073272		0.49159	0.070796		0.45708	0.041473		0.46136	0.108487	
	Sanitation Facilities	0.52995	0.08261		0.50841	0.073217		0.54292	0.049261		0.53864	0.126661	
PHYSICAL	Dwelling Type	0.42717	0.091174		0.42651	0.056101		0.43403	0.134176		0.42111	0.081679	
	Housing Services / Infrastructure	0.1005	0.021451		0.09992	0.013143		0.10047	0.031059		0.10111	0.019612	
	Structural Quality	0.47233	0.100814		0.47357	0.062291		0.4655	0.143906		0.47778	0.09267	

CENTRAL REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Abura-Asebu-Kwamankese	0.05707	0.026926	9	0.06036	0.029132	8	0.05429	0.024946	9	0.05649	0.026792	9
	Agona East	0.05687	0.026833	10	0.06024	0.029073	10	0.05401	0.024813	10	0.05632	0.026708	10
	Agona West Municipal	0.04645	0.021918	15	0.04537	0.021895	15	0.04412	0.020272	15	0.04982	0.023628	16
	Ajumako-Enyan-Essiam	0.05094	0.024033	14	0.05669	0.027362	14	0.04521	0.020773	14	0.05089	0.024135	15
	Asikuma-Odoben Brakwa	0.05123	0.024171	13	0.05687	0.027448	13	0.04564	0.02097	13	0.05115	0.024259	14
	Assin North Municipal	0.05123	0.024171	12	0.05687	0.027448	12	0.04564	0.02097	12	0.05115	0.024259	13
	Assin South	0.07439	0.035098	5	0.07073	0.034138	5	0.08067	0.037064	5	0.07188	0.034089	5
	Cape Coast Metropolis	0.03088	0.014572	17	0.02482	0.011978	17	0.03357	0.015422	17	0.03427	0.016253	17
	Effutu Municipal	0.04412	0.020816	16	0.03703	0.01787	16	0.04076	0.018728	16	0.05456	0.025876	11
	Ewutu Senya	0.05707	0.026926	8	0.06036	0.029132	9	0.05429	0.024946	8	0.05649	0.026792	8
	Gomoa East	0.08078	0.038114	2	0.07456	0.035984	2	0.09013	0.041412	2	0.07772	0.036857	2
	Gomoa West	0.05712	0.02695	7	0.06039	0.029147	7	0.05437	0.024981	7	0.05654	0.026814	7
	Komenda-Edina-Eguafo-Abirem	0.08078	0.038114	1	0.07456	0.035984	1	0.09013	0.041412	1	0.07772	0.036857	1
	Mfantsiman Municipal	0.05766	0.027204	6	0.06072	0.029305	6	0.05516	0.025344	6	0.05702	0.027043	6
	Twifo-Hemang-Lower Denkyira	0.07523	0.035496	3	0.07125	0.034387	3	0.08191	0.037634	3	0.07264	0.034449	3
	Upper Denkyira East Municipal	0.05295	0.024983	11	0.05793	0.027957	11	0.04817	0.022133	11	0.0527	0.024994	12
	Upper Denkyira West	0.07523	0.035496	4	0.07125	0.034387	4	0.08191	0.037634	4	0.07264	0.034449	4
ECONOMIC /SOCIAL	Overcrowding (household density)	0.50519	0.084311		0.49253	0.121819		0.51901	0.078683		0.51438	0.053262	
	Ownership	0.49481	0.082578		0.50747	0.125514		0.48099	0.07292		0.48562	0.050284	
ENVIRON-MENTAL	Amount of Open Space	0.85496	0.134463		0.85878	0.124341		0.85376	0.078453		0.85234	0.202113	
	Sanitation Facilities	0.14504	0.022811		0.14122	0.020447		0.14624	0.013438		0.14766	0.035013	
PHYSICAL	Dwelling Type	0.49465	0.100916		0.49322	0.061777		0.50037	0.148636		0.49051	0.090781	
	Housing Services / Infrastructure	0.14139	0.028846		0.14419	0.01806		0.13903	0.0413		0.14095	0.026086	
	Structural Quality	0.36396	0.074254		0.36259	0.045416		0.36059	0.107115		0.36855	0.068209	

EASTERN REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Akwapem North	0.0451	0.021225	13	0.04747	0.022874	13	0.04267	0.019533	13	0.04511	0.021349	13
	Akwapem South Municipal	0.04571	0.021514	9	0.04785	0.023054	9	0.04357	0.019946	9	0.04567	0.021612	9
	Akyemansa	0.04071	0.019157	16	0.04483	0.021599	16	0.03615	0.016547	18	0.04113	0.019465	18
	Asuogyaman	0.06353	0.029898	3	0.05848	0.028177	3	0.07055	0.032292	3	0.06164	0.02917	3
	Atiwa	0.04571	0.021514	10	0.04785	0.023054	10	0.04357	0.019946	10	0.04567	0.021612	10
	Birim Municipal	0.04523	0.021285	12	0.04755	0.022912	12	0.04285	0.019616	12	0.04522	0.021403	12
	Birim North	0.06353	0.029898	2	0.05848	0.028177	2	0.07055	0.032292	2	0.06164	0.02917	2
	Birim South	0.04569	0.021505	11	0.04784	0.023048	11	0.04355	0.019933	11	0.04565	0.021603	11
	East Akim Municipal	0.04622	0.021751	7	0.04816	0.023202	7	0.04431	0.020284	7	0.04612	0.021827	7
	Fanteakwa	0.05907	0.0278	4	0.05579	0.02688	4	0.06396	0.029277	4	0.05759	0.027257	4
	Kwaebibirem	0.0451	0.021225	14	0.04747	0.022874	14	0.04267	0.019533	14	0.04511	0.021349	14
	Kwahu East	0.04613	0.021712	8	0.0481	0.023174	8	0.04422	0.020241	8	0.04604	0.021789	8
	Kwahu North	0.05732	0.026978	6	0.05474	0.026377	6	0.06132	0.028069	6	0.05603	0.026515	6
	Kwahu South	0.06488	0.030534	1	0.05937	0.028607	1	0.07232	0.033102	1	0.06301	0.029822	1
	Kwahu West Municipal	0.0393	0.018496	19	0.0374	0.018019	19	0.03834	0.017549	16	0.0421	0.019925	16
	Lower Manya	0.03857	0.018153	20	0.03703	0.017844	20	0.03701	0.016939	17	0.0416	0.019689	17
	New Juaben Municipal	0.02449	0.011524	21	0.0198	0.009541	21	0.02625	0.012014	21	0.02739	0.012964	21
	Suhum-Kraboa Coaltar	0.03995	0.018801	18	0.04437	0.021377	18	0.03504	0.016039	20	0.04045	0.019141	20
	Upper Manya	0.05838	0.027474	5	0.05538	0.026681	5	0.06291	0.028798	5	0.05697	0.026963	5
	West Akim Municipal	0.0451	0.021224	15	0.04747	0.022873	15	0.04267	0.019531	15	0.04511	0.021348	15
	Yilo Krobo	0.04028	0.018958	17	0.04457	0.021475	17	0.03553	0.016263	19	0.04075	0.019284	19
ECONOMIC /SOCIAL	Overcrowding (household density)	0.54509	0.089631		0.53457	0.131303		0.55353	0.08199		0.55466	0.056312	
	Ownership	0.45491	0.074801		0.46543	0.11432		0.44647	0.066131		0.44534	0.045214	
ENVIRON-MENTAL	Amount of Open Space	0.86174	0.135185		0.86427	0.124927		0.86078	0.078803		0.86016	0.203538	
	Sanitation Facilities	0.13826	0.02169		0.13573	0.019619		0.13922	0.012745		0.13984	0.03309	

PHYSICAL	Dwelling Type	0.47159	0.098123		0.46871	0.060001		0.47706	0.144354		0.46921	0.088488	
	Housing Services / Infrastructure	0.10897	0.022673		0.11047	0.014141		0.10706	0.032396		0.10935	0.020623	
	Structural Quality	0.41944	0.087273		0.42082	0.053871		0.41587	0.125838		0.42144	0.07948	

UPPER EAST REGION		**Model 1**			**Model 2 (Scenario 1)**			**Model 3 (Scenario 2)**			**Model 4 (Scenario 3)**		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Bawku Municipal	0.10881	0.051803	9	0.10973	0.053265	9	0.10764	0.050044	9	0.10904	0.052164	9
	Bawku West	0.11431	0.054424	2	0.11303	0.054863	2	0.11593	0.053899	2	0.11399	0.054532	2
	Bolgatanga Municipal	0.10988	0.052312	6	0.11037	0.053575	6	0.10925	0.050792	6	0.11	0.052624	6
	Bongo	0.11046	0.052589	4	0.11072	0.053744	4	0.11013	0.0512	4	0.11052	0.052874	4
	Builsa	0.11431	0.054424	1	0.11303	0.054863	1	0.11593	0.053899	1	0.11399	0.054532	1
	Garu Tempane	0.10892	0.051858	8	0.1098	0.053299	8	0.10781	0.050124	8	0.10914	0.052213	8
	Kasena Nankana East	0.11036	0.05254	5	0.11066	0.053714	5	0.10997	0.051127	5	0.11043	0.05283	5
	Kasena Nankana West	0.10898	0.051883	7	0.10983	0.053314	7	0.10789	0.050161	7	0.10919	0.052236	7
	Talensi Nabdam	0.11398	0.054266	3	0.11283	0.054767	3	0.11543	0.053666	3	0.11369	0.054389	3
ECONOMIC /SOCIAL	Overcrowding (household density)	0.53396	0.093179		0.51432	0.129782		0.55358	0.090081		0.5487	0.060335	
	Ownership	0.46604	0.081325		0.48568	0.122556		0.44642	0.072643		0.4513	0.049625	
ENVIRON-MENTAL	Amount of Open Space	0.875	0.138862		0.875	0.127419		0.875	0.081359		0.875	0.209298	
	Sanitation Facilities	0.125	0.019837		0.125	0.018203		0.125	0.011623		0.125	0.0299	
PHYSICAL	Dwelling Type	0.58153	0.110896		0.58208	0.067892		0.58083	0.162275		0.58167	0.100308	
	Housing Services / Infrastructure	0.24863	0.047414		0.24781	0.028904		0.24966	0.069752		0.24843	0.042841	
	Structural Quality	0.16984	0.032388		0.1701	0.01984		0.16951	0.047358		0.16991	0.0293	

VOLTA REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ATERNATIVES	Adaklu Anyigbe	0.05483	0.026448	14	0.05512	0.026972	14	0.05445	0.025809	14	0.0549	0.026578	14
	Akatsi	0.05483	0.026448	13	0.05512	0.026972	13	0.05445	0.025809	13	0.0549	0.026578	13
	Biakoye	0.05483	0.026448	15	0.05512	0.026972	15	0.05445	0.025809	15	0.0549	0.026578	15
	Ho Municipal	0.06116	0.029504	2	0.05891	0.028826	2	0.06399	0.03033	2	0.0606	0.029336	2
	Hohoe Municipal	0.05573	0.026883	7	0.05567	0.027237	7	0.0558	0.026448	7	0.05571	0.026971	7
	Jasikan	0.05524	0.026646	8	0.05537	0.027092	8	0.05506	0.026099	8	0.05527	0.026757	8
	Kadjebi	0.05484	0.026453	11	0.05513	0.026975	11	0.05447	0.025816	11	0.05491	0.026583	11
	Keta Municipal	0.06139	0.029612	1	0.05905	0.028892	1	0.06432	0.030489	1	0.0608	0.029434	1
	Ketu North	0.06026	0.029069	5	0.05837	0.028561	5	0.06264	0.029691	5	0.05979	0.028943	5
	Ketu South	0.04755	0.022938	17	0.05074	0.024827	17	0.04359	0.02066	17	0.04835	0.023405	17
	Krachi East	0.05467	0.026372	16	0.05503	0.026925	16	0.05421	0.025697	16	0.05476	0.026509	16
	Krachi West	0.05603	0.027028	6	0.05585	0.027325	6	0.05625	0.026661	6	0.05598	0.027102	6
	Nkwanta North	0.04235	0.020429	18	0.04763	0.023307	18	0.03574	0.016941	18	0.04367	0.021141	18
	Nkwanta South	0.055	0.026529	10	0.05522	0.027021	10	0.0547	0.025928	10	0.05505	0.026651	10
	North Dayi	0.06084	0.029348	3	0.05872	0.02873	3	0.0635	0.0301	3	0.06031	0.029195	3
	North Tongu	0.05484	0.026453	12	0.05513	0.026974	12	0.05447	0.025816	12	0.05491	0.026582	12
	South Dayi	0.0552	0.026629	9	0.05535	0.027082	9	0.05501	0.026074	9	0.05524	0.026741	9
	South Tongu	0.06043	0.02915	4	0.05847	0.02861	4	0.06289	0.02981	4	0.05994	0.029016	4
ECONOMIC /SOCIAL	Overcrowding (household density)	0.51309	0.085488		0.50536	0.125431		0.52125	0.078573		0.51931	0.05301	
	Ownership	0.48691	0.081125		0.49464	0.122769		0.47875	0.072166		0.48069	0.049067	
ENVIRON-MENTAL	Amount of Open Space	0.875	0.140697		0.875	0.128441		0.875	0.082948		0.875	0.211794	
	Sanitation Facilities	0.125	0.0201		0.125	0.018349		0.125	0.01185		0.125	0.030256	
PHYSICAL	Dwelling Type	0.66021	0.125573		0.66076	0.076458		0.65949	0.18497		0.66035	0.11343	
	Housing Services / Infrastructure	0.09174	0.01745		0.09205	0.010651		0.09137	0.025626		0.09182	0.015772	
	Structural Quality	0.24805	0.047179		0.24719	0.028603		0.24915	0.06988		0.24783	0.042571	

WESTERN REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Ahanta West	0.0667	0.031854	1	0.06413	0.031177	1	0.07	0.032723	1	0.06102	0.030309	1
	Aowin/Suaman	0.06155	0.029394	8	0.06103	0.02967	9	0.06231	0.029128	8	0.06031	0.029957	8
	Bia	0.04759	0.022725	16	0.0527	0.025619	16	0.04121	0.019267	17	0.05843	0.029022	16
	Ellembelle	0.05275	0.025191	14	0.05575	0.0271	14	0.0491	0.022954	14	0.05874	0.029177	14
	Jomoro	0.04804	0.022943	15	0.05298	0.025754	15	0.04188	0.019579	16	0.05849	0.029054	15
	Juabeso	0.06214	0.029675	5	0.06139	0.029845	5	0.06317	0.02953	5	0.06039	0.029998	5
	Mpohor-Wassa East	0.06124	0.029244	10	0.06084	0.029577	10	0.06185	0.028913	10	0.06026	0.029935	10
	Nzema East	0.06185	0.029534	6	0.06121	0.029758	6	0.06274	0.029329	6	0.06035	0.029978	6
	Prestea/Huni Valley	0.06602	0.031527	4	0.06371	0.030973	4	0.06899	0.032254	4	0.06092	0.03026	4
	Sefwi Akontombra	0.06155	0.029394	7	0.06103	0.02967	8	0.06231	0.029128	7	0.06031	0.029957	7
	Sefwi Bibiani-Anhwiaso-Bekwai	0.05296	0.025291	13	0.05593	0.027191	13	0.04923	0.023013	13	0.05916	0.029389	13
	Sefwi Wiawso	0.06067	0.028971	12	0.05994	0.029137	12	0.06128	0.02865	12	0.05975	0.02968	12
	Sekondi-Takoradi Metropolis	0.04168	0.019906	17	0.0398	0.019347	17	0.04318	0.020186	15	0.03942	0.019581	17
	Shama	0.06636	0.031689	2	0.06392	0.031074	2	0.06949	0.032487	2	0.06097	0.030284	2
	Tarkwa Nsuaem Municipal	0.06611	0.031571	3	0.06377	0.031	3	0.06913	0.032319	3	0.06093	0.030266	3
	Wassa Amenfi East	0.06155	0.029394	9	0.06103	0.02967	7	0.06231	0.029128	9	0.06031	0.029957	9
	Wassa Amenfi West	0.06122	0.029237	11	0.06083	0.029572	11	0.06183	0.028903	11	0.06026	0.029934	11
ECONOMIC /SOCIAL	Overcrowding (household density)	0.50931	0.086602		0.49564	0.123825		0.52283	0.081451		0.48979	0.06714	
	Ownership	0.49069	0.083435		0.50436	0.126006		0.47717	0.074337		0.51021	0.06994	
ENVIRON-MENTAL	Amount of Open Space	0.85134	0.135515		0.85237	0.12431		0.85052	0.079521		0.85258	0.288756	
	Sanitation Facilities	0.14866	0.023664		0.14763	0.02153		0.14948	0.013976		0.14742	0.049929	
PHYSICAL	Dwelling Type	0.59125	0.114256		0.58796	0.069493		0.59572	0.168722		0.58381	0.016053	
	Housing Services / Infrastructure	0.16856	0.032574		0.1717	0.020294		0.16461	0.046623		0.17526	0.004819	
	Structural Quality	0.24019	0.046415		0.24034	0.028407		0.23967	0.067881		0.24094	0.006625	

NORTHERN REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Bole	0.0748	0.035838	2	0.06473	0.031534	2	0.0877	0.0412	2	0.0721	0.034681	2
	Bunkpurugu-Yunyoo	0.04599	0.022034	5	0.04753	0.023153	5	0.04417	0.02075	5	0.04623	0.022237	5
	Chereponi	0.04592	0.022001	6	0.04749	0.023133	6	0.04407	0.020703	6	0.04617	0.022208	6
	East Gonja	0.04384	0.021007	20	0.04622	0.022518	20	0.04101	0.019267	20	0.04429	0.021306	20
	Gonja Central	0.07463	0.03576	3	0.06463	0.031486	3	0.08746	0.041087	3	0.07195	0.03461	3
	Gushiegu	0.044	0.02108	18	0.04632	0.022563	18	0.04124	0.019373	18	0.04443	0.021373	18
	Karaga	0.04441	0.021276	12	0.04657	0.022684	12	0.04184	0.019656	12	0.0448	0.021551	12
	Kpandai	0.0443	0.021224	14	0.0465	0.022652	14	0.04168	0.019581	14	0.0447	0.021503	14
	Mamprusi East	0.04487	0.021499	7	0.04685	0.022822	7	0.04252	0.019977	7	0.04522	0.021752	7
	Mamprusi West	0.04441	0.021276	13	0.04657	0.022684	13	0.04184	0.019656	13	0.0448	0.021551	13
	Nanumba North	0.044	0.02108	19	0.04632	0.022563	19	0.04124	0.019373	19	0.04443	0.021373	19
	Nanumba South	0.04483	0.02148	9	0.04682	0.02281	9	0.04246	0.01995	9	0.04518	0.021735	9
	Saboba Chereponi	0.04483	0.02148	8	0.04682	0.02281	8	0.04246	0.01995	8	0.04518	0.021735	8
	Savelugu-Nanton	0.04441	0.021276	11	0.04657	0.022684	11	0.04184	0.019656	11	0.0448	0.021551	11
	Sawla-Tuna-Kalba	0.07673	0.036765	1	0.06591	0.032108	1	0.09055	0.042539	1	0.07384	0.035521	1
	Tamale Metropolis	0.06133	0.029387	4	0.05845	0.028473	4	0.06192	0.02909	4	0.0635	0.030547	4
	Tolon-Kumbugu	0.04401	0.021085	17	0.04632	0.022566	17	0.04125	0.01938	17	0.04444	0.021377	17
	West Gonja	0.04401	0.021085	16	0.04632	0.022566	16	0.04125	0.01938	16	0.04444	0.021377	16
	Yendi Municipal	0.04401	0.021085	15	0.04632	0.022566	15	0.04125	0.01938	15	0.04444	0.021377	15
	Zabzugu-Tatale	0.0447	0.021415	10	0.04674	0.02277	10	0.04226	0.019856	10	0.04506	0.021676	10
ECONOMIC /SOCIAL	Overcrowding (household density)	0.52472	0.089717		0.51044	0.127888		0.53883	0.084713		0.53601	0.057046	
	Ownership	0.47528	0.081265		0.48956	0.122658		0.46117	0.072505		0.46399	0.049381	
ENVIRON-MENTAL	Amount of Open Space	0.8704	0.139013		0.87061	0.127235		0.87036	0.081779		0.87024	0.20931	
	Sanitation Facilities	0.1296	0.020699		0.12939	0.018909		0.12964	0.012181		0.12976	0.031211	
PHYSICAL	Dwelling Type	0.62042	0.117985		0.61743	0.071722		0.62542	0.174506		0.61854	0.106395	
	Housing Services / Infrastructure	0.17779	0.03381		0.18008	0.020919		0.17501	0.048831		0.17822	0.030656	
	Structural Quality	0.20179	0.038375		0.20249	0.023522		0.19957	0.055683		0.20324	0.03496	

UPPER WEST REGION		Model 1			Model 2 (Scenario 1)			Model 3 (Scenario 2)			Model 4 (Scenario 3)		
		Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank	Normalized By Cluster	Limiting Priorities	Rank
ALTERNATIVES	Jirapa	0.13673	0.064978	3	0.12631	0.061208	3	0.1501	0.069718	3	0.1341	0.064034	3
	Lambussie /Karni	0.09309	0.044241	8	0.10033	0.04862	8	0.08398	0.039008	8	0.09491	0.045319	8
	Lawra	0.09678	0.045995	6	0.10258	0.049711	6	0.08939	0.041523	6	0.09824	0.046911	6
	Nadowli	0.09678	0.045995	5	0.10258	0.049711	5	0.08939	0.041523	5	0.09824	0.046911	5
	Sissala East	0.09235	0.043888	9	0.09988	0.0484	9	0.08289	0.038502	9	0.09424	0.044998	9
	Sissala West	0.09322	0.0443	7	0.10041	0.048657	7	0.08417	0.039094	7	0.09502	0.045373	7
	Wa East	0.14042	0.066731	1	0.12856	0.0623	1	0.15551	0.072234	1	0.13744	0.065627	1
	Wa Municipal	0.1102	0.052371	4	0.11077	0.053679	4	0.10905	0.050655	4	0.11037	0.052703	4
	Wa West	0.14042	0.066731	2	0.12856	0.0623	2	0.15551	0.072234	2	0.13744	0.065627	2
ECONOMIC /SOCIAL	Overcrowding (household density)	0.53324	0.092687		0.51427	0.129536		0.55133	0.08901		0.54793	0.059995	
	Ownership	0.46676	0.081131		0.48573	0.122345		0.44867	0.072436		0.45207	0.049499	
ENVIRON-MENTAL	Amount of Open Space	0.875	0.138609		0.875	0.127204		0.875	0.081286		0.875	0.208908	
	Sanitation Facilities	0.125	0.019801		0.125	0.018172		0.125	0.011612		0.125	0.029844	
PHYSICAL	Dwelling Type	0.56543	0.108869		0.55933	0.066089		0.57343	0.161228		0.56388	0.098257	
	Housing Services / Infrastructure	0.24008	0.046225		0.24343	0.028763		0.23579	0.066296		0.24092	0.041981	
	Structural Quality	0.1945	0.037449		0.19724	0.023305		0.19078	0.053641		0.1952	0.034014	

Appendix III: Unweighted Supermatrix

ASHANTI REGION (A)		ALTERNATIVES																
		Adansi North	Adansi South	Afigya Kwabre	Afigya Sekyere	Ahafo Ano North	Ahafo Ano South	Amansie Central	Amansie West	Asante Akim North Municipal	Asante Akim South	Atwima Kwanwoma	Atwima Mponua	Atwima Nwabiagya	Bekwai Municipal	Bosome Freho	Bosumtwi	Ejisu Juaben Municipal
ALTERNATIVES	Adansi North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Adansi South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Afigya Kwabre	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Afigya Sekyere	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ahafo Ano North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ahafo Ano South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Amansie Central	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Amansie West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asante Akim North Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asante Akim South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Atwima Kwanwoma	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Atwima Mponua	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Atwima Nwabiagya	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Bekwai Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Bosome Freho	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Bosumtwi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ejisu Juaben Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ejura Sekye Dumasi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kumasi Metropolis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwabre East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mampong Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Obuasi Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	Offinso Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Offinso North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sekyere Afram Plains	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sekyere Central	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sekyere East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic / Social	Crowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.125	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.875	0.500	0.500	0.500	0.500
Environ-mental	Amount of open space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Physical	Dwelling type	0.731	0.745	0.179	0.172	0.630	0.630	0.758	0.758	0.172	0.769	0.179	0.594	0.179	0.113	0.731	0.172	0.172
	Housing Services	0.188	0.156	0.113	0.102	0.218	0.218	0.151	0.151	0.102	0.147	0.113	0.249	0.113	0.179	0.188	0.102	0.102
	Structural Adequacy	0.081	0.099	0.709	0.726	0.151	0.151	0.091	0.091	0.726	0.084	0.709	0.157	0.709	0.709	0.081	0.726	0.726

ASHANTI REGION (B)		ALTERNATIVES										Economic / Social		Environmental		Physical		
		Ejura Sekye Dumasi	Kumasi Metropolis	Kwabre East	Mampong Municipal	Obuasi Municipal	Offinso Municipal	Offinso North	Sekyere Afram Plains	Sekyere Central	Sekyere East	Crowding (household density)	Ownership	Amount of open space	Sanitation Facilities	Dwelling type	Housing Services	Structural Quality
ALTERNATIVES	Adansi North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.046	0.011
	Adansi South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.026	0.011
	Afigya Kwabre	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.053	0.053
	Afigya Sekyere	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.034	0.053
	Ahafo Ano North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.015	0.011
	Ahafo Ano South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.040	0.039	0.030	0.018	0.015	0.011
	Amansie Central	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.026	0.011
	Amansie West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.020	0.011
	Asante Akim North Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.034	0.018	0.033	0.053
	Asante Akim South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.026	0.010
	Atwima Kwanwoma	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.051	0.053
	Atwima Mponua	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.048	0.039	0.030	0.018	0.025	0.011
	Atwima Nwabiagya	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.040	0.039	0.030	0.018	0.051	0.053
	Bekwai Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.084	0.053
	Bosome Freho	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.068	0.011
	Bosumtwi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.035	0.053
	Ejisu Juaben Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.035	0.053
	Ejura Sekye Dumasi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.035	0.039	0.030	0.018	0.015	0.053
	Kumasi Metropolis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.009	0.006	0.121	0.018	0.085	0.053
	Kwabre East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.010	0.040	0.030	0.018	0.051	0.053
	Mampong Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.039	0.040	0.030	0.018	0.051	0.053
	Obuasi Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.010	0.010	0.118	0.018	0.051	0.053
	Offinso Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.035	0.053
	Offinso North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.015	0.011
	Sekyere Afram Plains	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.010	0.054

	Sekyere Central	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.091	0.011	0.053
	Sekyere East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.040	0.039	0.030	0.018	0.036	0.053
Economic / Social	Crowding (household density)	0.500	0.500	0.500	0.500	0.875	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.500	0.500	0.500	0.500	0.125	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environ-mental	Amount of open space	0.875	0.143	0.875	0.875	0.333	0.875	0.875	0.875	0.875	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.125	0.857	0.125	0.125	0.667	0.125	0.125	0.125	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling type	0.205	0.113	0.179	0.179	0.179	0.172	0.625	0.199	0.471	0.172	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.073	0.179	0.113	0.113	0.113	0.102	0.137	0.068	0.059	0.102	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.722	0.709	0.709	0.709	0.709	0.726	0.238	0.733	0.471	0.726	0.000	0.000	0.000	0.000	0.000	0.044	0.205

BRONG AHAFO (A)		Asunafo North Municipal	Asunafo South	Asutifi	Atebubu Amantin	Berekum Municipal	Dormaa East	Dormaa Municipal	Jaman North	Jaman South	Kintampo North Municipal	Kintampo South	Nkoranza North	Nkoranza South	Pru	Sene	Sunyani Municipal
ATERNATIVES	Asunafo North Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asunafo South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asutifi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Atebubu Amantin	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Berekum Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Dormaa East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Dormaa Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Jaman North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Jaman South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kintampo North Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kintampo South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nkoranza North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nkoranza South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Pru	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sunyani Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sunyani West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tain	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tano North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tano South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Techiman Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Wenchi Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic / Social	Crowding (household density)	0.500	0.500	0.500	0.500	0.875	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.500	0.500	0.125	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500

Environ-mental	Amount of open space	0.833	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.800
	Sanitation Facilities	0.167	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.200
Physical	Dwelling type	0.630	0.540	0.600	0.625	0.172	0.455	0.731	0.167	0.333	0.205	0.614	0.758	0.462	0.630	0.773	0.113
	Housing Services	0.218	0.297	0.200	0.137	0.102	0.091	0.188	0.094	0.528	0.073	0.117	0.151	0.077	0.218	0.139	0.179
	Structural Quality	0.151	0.163	0.200	0.238	0.726	0.455	0.081	0.740	0.140	0.722	0.268	0.091	0.462	0.151	0.088	0.709

BRONG AHAFO (B)		Economic / Social		Environmental		Physical		
		Crowding (household density)	Ownership	Amount of open space	Sanitation Facilities	Dwelling type	Housing Services	Structural Quality
ALTERNATIVES	Asunafo North Municipal	0.047	0.049	0.045	0.040	0.022	0.019	0.011
	Asunafo South	0.047	0.049	0.045	0.040	0.022	0.044	0.011
	Asutifi	0.047	0.049	0.045	0.040	0.022	0.029	0.011
	Atebubu Amantin	0.047	0.049	0.045	0.040	0.022	0.019	0.011
	Berekum Municipal	0.047	0.007	0.045	0.040	0.022	0.051	0.080
	Dormaa East	0.047	0.049	0.045	0.040	0.109	0.100	0.080
	Dormaa Municipal	0.047	0.049	0.045	0.040	0.109	0.100	0.011
	Jaman North	0.047	0.049	0.045	0.040	0.022	0.029	0.080
	Jaman South	0.047	0.049	0.045	0.040	0.022	0.100	0.011
	Kintampo North Municipal	0.047	0.049	0.045	0.040	0.022	0.019	0.080
	Kintampo South	0.047	0.049	0.045	0.040	0.022	0.013	0.011
	Nkoranza North	0.047	0.049	0.045	0.040	0.109	0.033	0.011
	Nkoranza South	0.047	0.049	0.045	0.040	0.109	0.033	0.080
	Pru	0.047	0.049	0.045	0.040	0.022	0.019	0.011
	Sene	0.045	0.049	0.045	0.040	0.109	0.019	0.011
	Sunyani Municipal	0.008	0.007	0.045	0.154	0.022	0.100	0.080
	Sunyani West	0.047	0.049	0.045	0.040	0.022	0.051	0.080
	Tain	0.047	0.049	0.045	0.040	0.109	0.019	0.011
	Tano North	0.047	0.049	0.045	0.040	0.022	0.051	0.080
	Tano South	0.047	0.049	0.045	0.040	0.022	0.051	0.080
	Techiman Municipal	0.047	0.049	0.045	0.040	0.022	0.072	0.080
	Wenchi Municipal	0.047	0.049	0.045	0.045	0.022	0.033	0.080
Economic / Social	Crowding (household density)	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environmental	Amount of open space	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling type	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.000	0.000	0.000	0.000	0.000	0.044	0.205

CENTRAL REGION (A)		ALTERNATIVES																
		Abura-Asebu-Kwamankese	Agona East	Agona West Municipal	Ajumako-Enyan-Essiam	Asikuma-Odoben Brakwa	Assin North Municipal	Assin South	Cape Coast Metropolis	Effutu Municipal	Ewutu Senya	Gomoa East	Gomoa West	Komenda-Edina-Egyafo-Abirem	Mfantsiman Municipal	Twifo-Heman-Lower Denkyira	Upper Denkyira East Municipal	Upper Denkyira West
ALTERNATIVES	Abura-Asebu-Kwamankese	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Agona East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Agona West Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ajumako-Enyan-Essiam	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asikuma-Odoben Brakwa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Assin North Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Assin South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Cape Coast Metropolis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Effutu Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ewutu Senya	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gomoa East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gomoa West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Komenda-Edina-Egyafo-Abirem	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mfantsiman Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Twifo-Heman-Lower Denkyira	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Upper Denkyira East Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Upper Denkyira West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic /Social	Overcrowding (household density)	0.500	0.500	0.125	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.875	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.333	0.800	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.667	0.200	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Physical	Dwelling Type	0.081	0.205	0.195	0.594	0.594	0.594	0.758	0.113	0.179	0.195	0.462	0.195	0.462	0.172	0.731	0.333	0.731
	Housing Services	0.135	0.073	0.088	0.249	0.249	0.249	0.151	0.179	0.113	0.088	0.077	0.088	0.077	0.102	0.188	0.528	0.188
	Structural Quality	0.784	0.722	0.717	0.157	0.157	0.157	0.091	0.709	0.709	0.717	0.462	0.717	0.462	0.726	0.081	0.140	0.081

CENTRAL REGION (B)		Economic/Social		Environmental		Physical		
		Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Abura-Asebu-Kwamankese	0.069	0.065	0.062	0.043	0.027	0.030	0.091
	Agona East	0.069	0.065	0.062	0.043	0.027	0.020	0.091
	Agona West Municipal	0.010	0.065	0.062	0.043	0.027	0.030	0.091
	Ajumako-Enyan-Essiam	0.069	0.065	0.062	0.043	0.027	0.030	0.013
	Asikuma-Odoben Brakwa	0.069	0.065	0.062	0.043	0.027	0.044	0.013
	Assin North Municipal	0.069	0.065	0.062	0.043	0.027	0.044	0.013
	Assin South	0.069	0.065	0.062	0.043	0.135	0.046	0.013
	Cape Coast Metropolis	0.010	0.009	0.012	0.174	0.027	0.129	0.091
	Effutu Municipal	0.010	0.009	0.062	0.174	0.027	0.087	0.091
	Ewutu Senya	0.069	0.065	0.062	0.043	0.027	0.030	0.091
	Gomoa East	0.069	0.065	0.062	0.043	0.135	0.059	0.091
	Gomoa West	0.069	0.065	0.062	0.043	0.027	0.032	0.091
	Komenda-Edina-Egyafo-Abirem	0.069	0.065	0.062	0.043	0.135	0.059	0.091
	Mfantsiman Municipal	0.069	0.065	0.062	0.043	0.027	0.059	0.091
	Twifo-Heman-Lower Denkyira	0.069	0.065	0.062	0.043	0.135	0.087	0.013
	Upper Denkyira East Municipal	0.069	0.065	0.062	0.043	0.027	0.129	0.013
	Upper Denkyira West	0.069	0.065	0.062	0.043	0.135	0.087	0.013
Economic /Social	Overcrowding (household density)	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environmental	Amount of Open Space	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.000	0.000	0.000	0.000	0.000	0.044	0.205

EASTERN REGION (A)		Akwapem North	Akwapem South Municipal	Akyem Mansa	Asuogyaman	Atiwa	Birim Municipal	Birim North	Birim South	East Akim Municipal	Fanteakwa	Kwaebibirem	Kwahu East	Kwahu North	Kwahu South	Kwahu West Municipal	Lower Manya	New Juaben Municipal
		ALTERNATIVES																
ALTERNATIVES	Akwapem North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Akwapem South Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Akyem Mansa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Asuogyaman	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Atiwa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Birim Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Birim North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Birim South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	East Akim Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Fanteakwa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwaebibirem	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwahu East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwahu North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwahu South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kwahu West Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Lower Manya	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	New Juaben Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Suhum-Kraboa Coaltar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Upper Manya	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	West Akim Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Yilo Krobo	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.875	0.875	0.500
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.125	0.125	0.500
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.333
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.667
Physical	Dwelling Type	0.195	0.179	0.528	0.462	0.179	0.172	0.462	0.179	0.113	0.773	0.195	0.179	0.777	0.455	0.179	0.179	0.113
	Housing Services	0.088	0.113	0.333	0.077	0.113	0.102	0.077	0.113	0.179	0.088	0.088	0.113	0.070	0.091	0.113	0.113	0.179
	Structural Quality	0.717	0.709	0.140	0.462	0.709	0.726	0.462	0.709	0.709	0.139	0.717	0.709	0.153	0.455	0.709	0.709	0.709

EASTERN REGION (B)		**ALTERNATIVES**				**Economic/Social**		**Environmental**		**Physical**		
		Suhum-Kraboa Coaltar	Upper Manya	West Akim Municipal	Yilo Krobo	Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Akwapem North	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.026	0.063
	Akwapem South Municipal	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.065	0.063
	Akyem Mansa	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.065	0.009
	Asuogyaman	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.110	0.026	0.063
	Atiwa	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.065	0.063
	Birim Municipal	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.040	0.063
	Birim North	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.110	0.026	0.063
	Birim South	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.063	0.063
	East Akim Municipal	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.096	0.063
	Fanteakwa	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.114	0.022	0.009
	Kwaebibirem	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.026	0.063
	Kwahu East	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.025	0.047	0.064
	Kwahu North	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.106	0.013	0.009
	Kwahu South	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.047	0.110	0.095	0.063
	Kwahu West Municipal	0.000	0.000	0.000	0.000	0.050	0.008	0.050	0.042	0.027	0.065	0.063
	Lower Manya	0.000	0.000	0.000	0.000	0.050	0.008	0.050	0.047	0.022	0.065	0.063
	New Juaben Municipal	0.000	0.000	0.000	0.000	0.007	0.008	0.010	0.154	0.022	0.095	0.063
	Suhum-Kraboa Coaltar	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.018	0.009
	Upper Manya	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.110	0.018	0.009
	West Akim Municipal	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.026	0.063
	Yilo Krobo	0.000	0.000	0.000	0.000	0.050	0.054	0.050	0.042	0.022	0.038	0.009
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environmental	Amount of Open Space	0.875	0.875	0.875	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.625	0.773	0.195	0.540	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.137	0.139	0.088	0.297	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.238	0.088	0.717	0.163	0.000	0.000	0.000	0.000	0.000	0.044	0.205

NORTHERN REGION (A)		ALTERNATIVES															
		Bole	Bunkpurugu Yonyo	Chereponi	East Gonja	Gonja Central	Gushiegu	Karaga	Kpandai	Mamprusi East	Mamprusi West	Nanumba North	Nanumba South	Saboba	Savelugu Nanton	Sawla-Tuna-Kalba	Tamale Metropolis
ALTERNATIVES	Bole	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Bunkpurugu Yonyo	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Chereponi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	East Gonja	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gonja Central	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Gushiegu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Karaga	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kpandai	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mamprusi East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mamprusi West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nanumba North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nanumba South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Saboba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Savelugu Nanton	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sawla-Tuna-Kalba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tamale Metropolis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tolon Kumbugu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	West Gonja	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Yendi Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Zabzugu Tatali	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.800
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.200
Physical	Dwelling Type	0.773	0.429	0.429	0.614	0.777	0.625	0.600	0.600	0.594	0.600	0.625	0.594	0.594	0.600	0.731	0.113
	Housing Services / Infrastructure	0.088	0.429	0.429	0.117	0.070	0.137	0.200	0.200	0.249	0.200	0.137	0.249	0.249	0.200	0.188	0.179
	Structural Quality	0.139	0.143	0.143	0.268	0.153	0.238	0.200	0.200	0.157	0.200	0.238	0.157	0.157	0.200	0.081	0.709

NORTHERN REGION (B)		ALTERNATIVES					Economic/Social		Environmental		Physical		
		Tamale Metropolis	Tolon Kumbugu	West Gonja	Yendi Municipal	Zabzugu Tatali	Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Bole	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.156	0.024	0.038
	Bunkpurugu Yonyo	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.107	0.038
	Chereponi	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.104	0.038
	East Gonja	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.016	0.038
	Gonja Central	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.156	0.017	0.038
	Gushiegu	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.023	0.038
	Karaga	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.040	0.038
	Kpandai	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.035	0.038
	Mamprusi East	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.060	0.038
	Mamprusi West	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.040	0.038
	Nanumba North	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.023	0.038
	Nanumba South	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.058	0.038
	Saboba	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.058	0.038
	Savelugu Nanton	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.040	0.038
	Sawla-Tuna-Kalba	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.156	0.106	0.038
	Tamale Metropolis	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.174	0.031	0.127	0.269
	Tolon Kumbugu	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.023	0.038
	West Gonja	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.023	0.038
	Yendi Municipal	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.023	0.038
	Zabzugu Tatali	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.043	0.031	0.052	0.038
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environ-mental	Amount of Open Space	0.800	0.875	0.875	0.875	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.200	0.125	0.125	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.113	0.625	0.625	0.625	0.594	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.179	0.137	0.137	0.137	0.249	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.709	0.238	0.238	0.238	0.157	0.000	0.000	0.000	0.000	0.000	0.044	0.205

UPPER EAST REGION		ALTERNATIVES									Economic/Social		Environmental		Physical		
		Bawku Municipal	Bawku West	Bolgatanga Municipal	Bongo	Builsa	Garu Tempane	Kasena Nankana East	Kasena Nankana West	Talensi Nabdam	Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Quality
ALTERNATIVES	Bawku Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.042	0.111
	Bawku West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.208	0.111
	Bolgatanga Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.074	0.111
	Bongo	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.091	0.111
	Builsa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.208	0.111
	Garu Tempane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.045	0.111
	Kasena Nankana East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.088	0.111
	Kasena Nankana West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.047	0.111
	Talensi Nabdam	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.111	0.198	0.111
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.625	0.429	0.594	0.594	0.429	0.625	0.594	0.625	0.429	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services / Infrastructure	0.137	0.429	0.249	0.249	0.429	0.137	0.249	0.137	0.429	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Quality	0.238	0.143	0.157	0.157	0.143	0.238	0.157	0.238	0.143	0.000	0.000	0.000	0.000	0.000	0.044	0.205

UPPER WEST REGION		ALTERNATIVES									Economic/Social		Environmental		Physical		
		Jirapa	Lambussie Karni	Lawra	Nadowli	Sissala East	Sissala West	Wa East	Wa Municipal	Wa West	Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Adequacy
ALTERNATIVES	Jirapa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.238	0.058	0.067
	Lambussie Karni	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.058	0.067
	Lawra	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.172	0.067
	Nadowli	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.172	0.067
	Sissala East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.035	0.067
	Sissala West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.062	0.067
	Wa East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.238	0.172	0.067
	Wa Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.048	0.100	0.467
	Wa West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.111	0.111	0.111	0.238	0.172	0.067
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.758	0.540	0.429	0.429	0.625	0.594	0.731	0.179	0.731	0.000	0.000	0.000	0.000	0.000	0.751	0.333
	Housing Services	0.151	0.297	0.429	0.429	0.137	0.249	0.188	0.113	0.188	0.000	0.000	0.000	0.000	0.000	0.205	0.333
	Structural Adequacy	0.091	0.163	0.143	0.143	0.238	0.157	0.081	0.709	0.081	0.000	0.000	0.000	0.000	0.000	0.044	0.333

VOLTA REGION (A)		ALTERNATIVES																	
		Adaklu Anyigbe	Akatsi	Biakoye	Ho Municipal	Hohoe Municipal	Jasikan	Kadjebi	Keta Municipal	Ketu North	Ketu South	Krachi East	Krachi West	Nkwanta North	Nkwanta South	North Dayi	North Tongu	South Dayi	South Tongu
ALTERNATIVES	Adaklu Anyigbe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Akatsi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Biakoye	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ho Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Hohoe Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Jasikan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Kadjebi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Keta Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ketu North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ketu South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Krachi East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Krachi West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nkwanta North	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nkwanta South	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	North Dayi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	North Tongu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	South Dayi	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	South Tongu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Physical	Dwelling Type	0.773	0.773	0.773	0.462	0.758	0.758	0.773	0.455	0.467	0.205	0.784	0.758	0.625	0.773	0.462	0.777	0.773	0.467
	Housing Services	0.088	0.088	0.088	0.077	0.151	0.151	0.088	0.091	0.067	0.073	0.081	0.151	0.137	0.088	0.077	0.070	0.088	0.067
	Structural Adequacy	0.139	0.139	0.139	0.462	0.091	0.091	0.139	0.455	0.467	0.722	0.135	0.091	0.238	0.139	0.462	0.153	0.139	0.467

VOLTA REGION (B)		Economic/Social		Environmental		Physical		
		Overcrowding (household density)	Ownership	Amount of Open Space	Sanitation Facilities	Dwelling Type	Housing Services	Structural Adequacy
ALTERNATIVES	Adaklu Anyigbe	0.056	0.056	0.056	0.056	0.061	0.034	0.019
	Akatsi	0.056	0.056	0.056	0.056	0.061	0.034	0.019
	Biakoye	0.056	0.056	0.056	0.056	0.061	0.034	0.019
	Ho Municipal	0.056	0.056	0.056	0.056	0.061	0.109	0.130
	Hohoe Municipal	0.056	0.056	0.056	0.056	0.061	0.109	0.019
	Jasikan	0.056	0.056	0.056	0.056	0.061	0.068	0.019
	Kadjebi	0.056	0.056	0.056	0.056	0.061	0.035	0.019
	Keta Municipal	0.056	0.056	0.056	0.056	0.061	0.127	0.130
	Ketu North	0.056	0.056	0.056	0.056	0.061	0.034	0.130
	Ketu South	0.056	0.056	0.056	0.056	0.012	0.034	0.130
	Krachi East	0.056	0.056	0.056	0.056	0.061	0.021	0.019
	Krachi West	0.056	0.056	0.056	0.056	0.063	0.091	0.019
	Nkwanta North	0.056	0.056	0.056	0.056	0.012	0.060	0.019
	Nkwanta South	0.056	0.056	0.056	0.056	0.061	0.034	0.019
	North Dayi	0.056	0.056	0.056	0.056	0.061	0.068	0.130
	North Tongu	0.056	0.056	0.056	0.056	0.061	0.021	0.019
	South Dayi	0.056	0.056	0.056	0.056	0.061	0.051	0.019
	South Tongu	0.056	0.056	0.056	0.056	0.061	0.034	0.130
Economic/Social	Overcrowding (household density)	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environmental	Amount of Open Space	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Adequacy	0.000	0.000	0.000	0.000	0.000	0.044	0.205

WESTERN REGION (A)		Ahanta West	Aowin/ Suaman	Bia	Ellembelle	Jomoro	Juabeso	Mpohor-Wassa East	Nzema East	Prestea /Huni Valley	Sefwi Akontombra	Sefwi Bibiani-Ahwiaso Bekwai	Sefwi Wiawso	Sekondi-Takoradi Metropolis	Shama	Tarkwa Nsuaem Municipal	Wassa Amenfi East	Wassa Amenfi West
		ALTERNATIVES																
ALTERNATIVES	Ahanta West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Aowin/Suaman	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Bia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Ellembelle	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Jomoro	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Juabeso	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Mpohor-Wassa East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Nzema East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Prestea/Huni Valley	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sefwi Akontombra	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sefwi Bibiani-Ahwiaso Bekwai	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sefwi Wiawso	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sekondi-Takoradi Metropolis	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Shama	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Tarkwa Nsuaem Municipal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Wassa Amenfi East	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Wassa Amenfi West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Economic /Social	Overcrowding (household density)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.125	0.500	0.500	0.500	0.500
	Ownership	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.875	0.500	0.500	0.500	0.500
Environ-mental	Amount of Open Space	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.857	0.333	0.875	0.875	0.875	0.875
	Sanitation Facilities	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.143	0.667	0.125	0.125	0.125	0.125
Physical	Dwelling Type	0.455	0.740	0.429	0.113	0.297	0.731	0.758	0.731	0.462	0.740	0.113	0.696	0.113	0.462	0.740	0.758	0.793
	Housing Services	0.091	0.167	0.429	0.179	0.540	0.188	0.151	0.188	0.077	0.167	0.179	0.229	0.179	0.077	0.167	0.151	0.131
	Structural Adequacy	0.455	0.094	0.143	0.709	0.163	0.081	0.091	0.081	0.462	0.094	0.709	0.075	0.709	0.462	0.094	0.091	0.076

WESTERN REGION (B)		Economic/Social: Overcrowding (household density)	Economic/Social: Ownership	Environmental: Amount of Open Space	Environmental: Sanitation Facilities	Physical: Dwelling Type	Physical: Housing Services	Physical: Structural Adequacy
ALTERNATIVES	Ahanta West	0.062	0.059	0.062	0.050	0.076	0.053	0.118
	Aowin/Suaman	0.062	0.059	0.062	0.050	0.076	0.042	0.017
	Bia	0.062	0.059	0.062	0.050	0.015	0.070	0.017
	Ellembelle	0.062	0.059	0.061	0.050	0.015	0.090	0.118
	Jomoro	0.062	0.059	0.062	0.050	0.015	0.090	0.017
	Juabeso	0.062	0.059	0.062	0.050	0.076	0.068	0.017
	Mpohor-Wassa East	0.062	0.059	0.062	0.050	0.076	0.029	0.017
	Nzema East	0.062	0.059	0.062	0.050	0.076	0.055	0.017
	Prestea/Huni Valley	0.062	0.059	0.062	0.050	0.076	0.023	0.118
	Sefwi Akontombra	0.062	0.059	0.062	0.050	0.076	0.042	0.017
	Sefwi Bibiani-Ahwiaso Bekwai	0.062	0.059	0.062	0.050	0.015	0.090	0.118
	Sefwi Wiawso	0.058	0.059	0.062	0.050	0.067	0.130	0.016
	Sekondi-Takoradi Metropolis	0.012	0.059	0.013	0.200	0.033	0.090	0.120
	Shama	0.062	0.059	0.062	0.050	0.076	0.034	0.120
	Tarkwa Nsuaem Municipal	0.062	0.059	0.062	0.050	0.076	0.023	0.120
	Wassa Amenfi East	0.062	0.059	0.062	0.050	0.076	0.042	0.017
	Wassa Amenfi West	0.062	0.059	0.062	0.050	0.076	0.028	0.017
Economic/Social	Overcrowding (household density)	0.000	0.000	0.000	0.000	0.000	0.875	0.000
	Ownership	0.000	0.000	0.000	0.000	0.000	0.125	0.000
Environmental	Amount of Open Space	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sanitation Facilities	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical	Dwelling Type	0.000	0.000	0.000	0.000	0.000	0.751	0.751
	Housing Services	0.000	0.000	0.000	0.000	0.000	0.205	0.044
	Structural Adequacy	0.000	0.000	0.000	0.000	0.000	0.044	0.205

Appendix IV: Curriculum Vitae

Name:	Lucia Kafui Hussey
Post-Secondary Education and Degrees:	Western University London, Ontario, Canada M.A. (Geography) 2012-2014 University of Ghana Legon-Accra, Ghana B.A. (Geography and Resource Development) 2006-2010
Honours and Awards:	Western Graduate Research Scholarship (WGRS), Western University 2012-2014
Related Work Experience:	Teaching Assistant University of Western Ontario 2012-2014 Teaching and Research Assistant University of Ghana 2010-2011