Optimal Site Selection for Primary School Development Using Location-Allocation Analysis: A Case Study of Adama City, Ethiopia

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Thesis submitted to department of the Architecture Engineering

School of civil Engineering and Architecture (SoCEA)

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Geoinformatics Engineering

Office of Graduate Studies

Adama Science and Technology University

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Adama, Ethiopia

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Thesis submitted to department of Geomatics Engineering school of civil Engineering and Architecture (SoCEA). And Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Geoinformatics Engineering

Office of Graduate Studies

Adama Science and Technology University

May, 2024

Adama, Ethiopia

DECLARATION

I declare hereby this research thesis entitled "Optimal Site Selection for Primary School Development Using Location-Allocation Analysis: A Case Study of Adama City, Ethiopia

is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this proposal have been duly acknowledged through citation.

Raji Eba Balina ____________________ ________________

Name of student Signature Date

RECOMMENDATION

I, the major advisor/supervisor of this research proposal, hereby certify that I have closely advised/supervised the student while developing this proposal and read the draft thesis/dissertation proposal entitled Optimal Site Selection for Primary School Development Using Location-Allocation Analysis: A Case Study of Adama City, Ethiopia prepared under my guidance by Raji Eba Balina. Therefore, I recommend the submission of the proposal to the department for further review and evaluation.

Dr. Dejene Tesema Bulti	____________________	_______________
Major Advisor/Supervisor	Signature	Date

APPROVAL SHEET

I/we, hereby certify that the recommendation and suggestion given by the proposal review committee are appropriately incorporated into final thesis/dissertation proposal entitled "Optimal Site Selection for Primary School Development Using Location-Allocation Analysis: A Case Study of Adama City, Ethiopia" by Raji Eba Balina

Dr. Dejene Tesema ________________ ___________

Major Advisor/Supervisor Signature Date

APPROVAL OF BOARD REVIEWERS

We, the undersigned, members of the board of reviewers of the Thesis open defense by Mr. Tewodros Demeke Birhane have read and evaluated the Thesis/dissertation proposal entitled "Optimal Site Selection for Primary School Development Using Location-Allocation Analysis: A Case Study of Adama City, Ethiopia" and assessed the understanding of the candidate about the proposed research. This is therefore, to certify that the thesis/dissertation is accepted and we recommend the implementation of proposal.

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Final approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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Office of postgraduate studies, Dean Signature Date

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LIST OF ACRONYMS

ACLA	Adama City Land Administration
ACEO	Adama City Educational Office
AESO	Adama Education statistical office
CSA	Central statistical Agency
DBF	Data Base File
DEM	Digital Elevation Model
DXF	Digital Interchange Format
GIS	Geographical Information System
GCP	Ground Control Point
GPS	Global Positioning System
MoE	Ministry of Education
MCA	Multi Criteria Analysis
MCDA	Multi Criteria Decision Analysis
LA	Location Allocation
LULC	Land Use Land Cover
NNA	Nearest Neighborhood Analysis
SAAN	Service Area Analysis Network
TIFF	Tagged Image File Format

ABSTRACT

Primary school is among the most basic needs of the public and directly related to Resident's. So This study aims to select suitable site for the development of primary school in Adama city, Ethiopia using geospatial technology and location allocation analysis. To enhance access of all school age population in the same area. The spatial Statistical Analysis, locational quotient and nearest neighborhood analysis method for spatial distribution, concentration and pattern respectively at the level of city. The level of accessibility investigated by using road network service are analysis in terms of Distance spatial analysis except for digital Elevation model and land use the rest data were through the Proximity analysis .The new school facility are selected by Location allocation analysis in Arc GIS. The data used for this study; such as Road networks, existing primary school facilities, population density, Slope, manufacturing site and land use land cover data. The result of location allocation Analysis at standard distance 2.5km provided 78930 points are allocated which equals to 89.14%.and Service Area 82175 (92.9%) population nodes are bounded. un-allocated demand nodes 9612 and 6367 for LA and SA from 888452 respectively10.86% demands are outside this limit for these demands the study have been identified as Very High suitable, High Suitable, Medium suitable to select suitable site for Primary School facilities development respectively. the study also identified low suitable and very low suitable site respectively in this study; nine(9) spots are chosen for candidate site .From these spots five (5) additional site are selected by using suitability and overlaying analysis method ,to validate these selected suitable site. And the study recommended: City administration was before establishment of any public service center shall make pre and post facility and customer link studies.

Keywords: Suitability, Accessibility Spatial Distribution, Primary school, Location allocation Analysis

CHAPTER ONE: INTRODUCTION

1.1 Back ground of the study

Education is still a critical issue in developing countries. However, it is suffering from serious problems; including continuing school dropouts. In its quest for growth, these countries are working to achieve a minimum level of education for their population. Appropriate spatial distribution of school locations and highly efficient accessibility boost the improvement of the educational process. To get satisfactory results in this respect, GIS location allocation models are important tools theoretically and practically. Bonsa, A. T., Yadavalli, P. K., & Omprakash, H. M. (2022).

Educational service is one of the essential public services that must be provided to residents. Where the education considers one of the most significant associated sectors with the construction of the future and the achievement of the renaissance and overall development, because of its direct links to political reality and the economic, social and cultural sectors. Thus, governments are striving to provide educational institutions of all levels (kindergartens, schools, universities) to accelerate progress and prosperity, where the Progress and people's development are measured by available services to the population. It does not depend on an amount of these services only. Conversely, the quality of these services and their conformity with the international standard and planning Specifications are considered more significant. Chali, G. T., Taverniers, M., & Legesse, G. (2021).

The planning and distribution depend on several criteria like distance, population and land use. Also taking into account the urban expansion in those areas and assessment of needs the future population in respect of educational services. Spatial data analysis problems usually involve a broad range of possible alternatives and same evaluation criteria. Alternatives often evaluated by some individual's decision-maker, managers and stakeholders. Woldetsadik, A. A. (2018).

Educational services planning includes a broad range of educational planning and management issues; it relates the resource allocation and efficiency in the provision of services to improve the effectiveness of education. Therefore, spatial analysis is a tool commonly used to detect relationships among schools and pupil's distribution in the particular area used to the successful implementation and advantages of applying the GIS technology for education planning and decision-making process. The use of GIS technology based modelling for decision support system has develop the school site selection model that is presented in this research. The study and its result illustrate created new capabilities and advance assistance to the planning process. GIS is not only an analytical tool but also a tool to assist planners and administrators to make decisions and it is realizing the ground reality visually. Therefore, GIS-based analytical technology has strong possibilities to provide the sustainable solution for. Spatially related problems. Hence, the research is capable to increase the opportunity of access

According to (For & In, 2019) Al-Sabbagh, T. A. (2022). to The preparation of an Egyptian code for the selection of school sites as international standards often do not accept the application to some areas, to help researchers in Egypt to identify the multi criteria for school site section, and it is best to put each country's own standard code for the establishment and selection of sites of different services, including schools of all kinds. The preparation of a spatial information centralized bank at the state level that provides information on the extent to which each required. Region needs a particular type of school, the excess density in each region and the quality of education

The citizens desire high quality services, and the public administrations wish to supply public services with a high degree of professionalism, in conditions of efficiency, effectiveness and economy for using the resources. In supplying public services, the local public authorities and institutions have the duty to perform their activity in the achievement of the general interest, applying the principles of good governance(Seyoum, 2020)

The political focus of primary education and its related implementation have placed Africa on track to achieve full enrollment by 2015. A significant number of African countries have excelled in this regard through committed policy interventions and adequate resource allocations. Ethiopia had a low initial net enrollment rate. (50 percent in 1990), but this now the purpose of proceeding with this research problem is not to elaborate the primary education crisis in our capital but to raise mechanisms on leveling accessibility and coverage so that each primary school is accessible to the student population in the city at proper space with minimum distance cost particularly of the interest area. Tesfaye, G. (2018).

Adama City, located in the Oromia Region of Ethiopia, serves as a major economic and transportation hub, connecting the capital city of Addis Ababa with other regions of the country. With a rapidly growing population and expanding urban infrastructure, Adama City plays a pivotal role in Ethiopia's socio-economic development. The city's strategic location along key transportation routes and its vibrant commercial activities have attracted migrants from various parts of the country, contributing to its population growth and urbanization.

Primary education serves as the cornerstone of a nation's development, providing children with essential knowledge, skills, and values necessary for personal growth and societal progress. In Ethiopia, primary education is recognized as a fundamental right and a key priority in the government's efforts to achieve sustainable development goals. Access to quality primary education not only enhances individual opportunities but also promotes social inclusion, reduces poverty, and fosters economic prosperity. Debele, F. A. (2015).

Despite the government's efforts to expand access to primary education, Adama City faces several challenges in the provision of quality education. Limited infrastructure, including classrooms, textbooks, and teaching materials, poses barriers to effective teaching and learning. Additionally, disparities in educational outcomes persist, particularly among marginalized communities and rural areas. These challenges underscore the need for targeted interventions to improve the accessibility and quality of primary education in Adama City.

Spatial analysis techniques, such as Geographic Information Systems (GIS) and location-allocation analysis, offer powerful tools for informed decision-making in education planning. By integrating spatial data on population distribution, infrastructure, and socio-economic indicators, policymakers and planners can identify priority areas for investment and optimize resource allocation. Spatial analysis enables the identification of optimal locations for school sitting, ensuring equitable access to education and enhancing educational outcomes.

1.2 Statement of the Problem

In Adama City, Ethiopia, there exists a need to improve the accessibility and quality of primary education by strategically selecting optimal locations for the development of new primary schools. However, the spatial distribution of existing primary schools may not adequately serve the population, leading to disparities in access to education. Additionally, challenges such as population growth, demographic changes, and limited infrastructure may further exacerbate the problem. Therefore, there is a need to address the following research questions to identify suitable sites for primary school development and ensure equitable access to education for all residents of Adama City:

The purpose of this study is to assess the spatial distribution of existing primary schools in Adama City, Ethiopia, and identify optimal locations for the establishment of new primary schools. By evaluating accessibility, demographic characteristics, and infrastructural considerations, the study aims to provide evidence-based recommendations to policymakers and urban planners for enhancing the accessibility and quality of primary education in Adama City.

The Government is investing a huge amount of money in developing selected social services, making the prioritization and allocation of these limited resources an important issue in the public sector. The partial allocation of different social services, particularly educational centers in urban areas is a significant challenge for decision makers and planners in the urban sector due to the broader tension in land use trade-offs between different activities or services.

The trend of public services delivery upon realistic scientific studies is not yet fully developed in Ethiopia. The demographic explosion in developing world countries has created a tremendous pressure on resources and public facilities (Ahmed M. W. Abdel-Latif, 2007

and the quality of educationfacilityofthesociety.

Despite the growing population and increasing demand for public services in Ethiopia, the trend of public service delivery based on realistic scientific studies is not yet fully developed. The demographic explosion in developing countries, including Ethiopia, has created immense pressure on resources and public facilities. This rapid urbanization and population growth necessitate the development of infrastructure and the provision of adequate services for residents. However, the current spatial distribution of public services, such as schools, health centers, and recreational facilities, leads to spatial inequalities and limited accessibility in certain areas. Previous studies have focused on suitability analysis and spatial data analysis of public service locations, but there is a lack of comprehensive research addressing the geographical site selection for public services. Specifically, in the case of Adama City, there is a shortage of primary schools, resulting in overcrowded classrooms and difficulties for students living in peripheral areas to access education. Therefore, there is a need for a systematic and evidence-based approach to address the challenges associated with the geographical site selection of public services, particularly in Adama City, to ensure equitable access and improve the quality of public service delivery.

1.3 Objective of the study

1.3.1 General objective

The general objective of this study to select suitable site for the development of primary school in Adama city, Ethiopia using geospatial technology and location allocation analysis.

1.3.2 Specific objective

This study aims to answer the following research questions:

- To evaluate the spatial distribution and accessibility of existing primary schools in Adama City.
- To identify optimal sites for new primary school development using location-allocation analysis.
- To validate the selected sites through suitability analysis to ensure they meet the criteria for sustainable and effective primary education provision in Adama City.

1.3.3 Research Question

This paper will answer the following research question

- How is the spatial distribution of existing primary schools in Adama City, and what is the level of accessibility they provide to the population?
- What are the optimal locations for new primary school development in Adama City, based on demographic characteristics and infrastructural considerations?
- Do the selected sites for new primary schools meet the criteria for sustainability and effectiveness in providing primary education within Adama City?

1.4 significance of the Study

The study addresses the critical need to improve access to quality primary education in Adama City, particularly for marginalized communities and underserved areas. By identifying optimal locations for new primary schools, the study aims to reduce geographical disparities in educational access and promote equity in educational opportunities. By strategically sitting new primary schools based on demographic characteristics, transportation infrastructure, and land availability, the study seeks to create learning environments that are conducive to academic success. Improved access to quality education has the potential to enhance educational outcomes, leading to better academic performance and increased opportunities for socio-economic advancement.

The findings of the study provide valuable insights for policymakers, urban planners, and educational authorities in Adama City. By incorporating spatial analysis techniques into education planning processes, policymakers can make informed decisions regarding the allocation of resources and the prioritization of interventions aimed at improving primary education provision.The study contributes to the achievement of Sustainable Development Goal 4 (SDG 4) on quality education by addressing the need for inclusive and equitable education for all. By ensuring that primary education is accessible to all residents of Adama City, the study aligns with broader efforts to promote lifelong learning opportunities and foster sustainable development.

The study enhances the capacity for spatial analysis within the local context by demonstrating the application of GIS and location-allocation analysis techniques to education planning. By building technical expertise and promoting the use of geospatial data in decision-making processes, the study empowers local stakeholders to address complex challenges in education provision effectively.

1.5 Scope of the study

This study geographical bounded in Ethiopia Oromia region state in Aadama city the scope of this study is examining the pre, ongoing and upcoming construction of public primary school facilities in terms of suitability analysis. Based on spatial locations, additional locations are designated for further schooling to manage distance and time cost disproportion. Locational

Judgments of the chosen sites are made through spatial analysis in terms of distance from existing schools it deals with extracting general information about how to locate the primary schools through location-allocation analysis in the ArcGIS environment.

CHAPTER TWO: LITERATURE REVIEW

2.1 Site Selection

Site selection is the process of examining multiple options and assessing their relative advantages and disadvantages. Site selection comes after the needs assessment is completed. If you select a site before the needs assessment, you may compromise on key design aspects due to site limitations. Everest, T., Savaşkan, G. S., Or, A., & Özcan, H. (2024).

2.1.1 Site selection analysis

Is the process of blending financial, demographic, and geographical research and data to identify the best location for your business, public service During a site selection process, businesses go through a detailed assessment to understand the potential advantages and disadvantages of a location. A real estate firm or a company's real estate department may lead the site selection process, including leadership team members, data analysts, real estate investment managers, and even the tax and accounting unit. The site selection team will develop selection criteria and examine various quantitative and qualitative inputs to discover prospective sites that can help the company accomplish its long-term goals.(Pugh K et al., 2023)

2.1.2 The importance of site selection

Investing in a thorough site selection process takes time, but the rewards are significant. Businesses that assess logistical issues and market and submarket characteristics of the planned site increase their customer reach and commercial potential, setting themselves up for success. Including location data, such as foot traffic data and migration pattern data, in your evaluation can help you streamline your site selection analysis, whether you're a retailer searching for a new location, a franchisee determining where to invest, or a real estate developer investigating options for your next project. Location data can provide insight into how many people are visiting a specific area, the demographics of those visitors, their cross-shopping habits, and their home and work locations. Without a proper examination of these critical aspects, you might choose a location that doesn't align with your target customers, or that has a declining population of your target customers. To make the best site selection decisions, you need to know where people are and how they move. For example, if people continually move away from an area, while the location may be inexpensive, there won't be any consumers around to commercialize the opportunity. Unicast gathers GPS data from smart phones where users provide opt-in consent. The data is analyzed and contextualized to provide accurate location intelligence for understanding population flows, foot traffic trends, consumer behavior and more. (PughKetal.,2023).

2.1.3 Responsibility for Site Selection

Selecting and developing a school site should be an organized and rational process that is based on adequate and accurate information about the school program and the local community of the school under consideration. Good practice requires that site selection be done by a committee of competent people. The task requires the coordinated effort and special skills of a team made up of school administrators, teachers, community members, public officials, architects, engineers, landscape architects, town planners, and legal consultants. All these people and their leader should be reporting directly to a local educational administrator or to an official of the Ministry of Education appointed for the purpose. Ali, F., Bennui, A., Chowdhury, S., & Techato, K. (2022).

2.1.4 Criteria for Site Selection

After the committee has been constituted, it will be good for the members to develop some criteria on which to base the selection of the potential site. They should familiarize themselves with the nature of the educational program for the site. They should note the types of the outdoor learning experiences and recreational activities that will take place at the potential site. Note should also be taken of the interests of the community members in regardtorecreational and other social activities. approach.Younes, A., Kotb, K. M., Abu Ghazala, M. O.et al, (2022).

They should also prepare a list of some technical requirements or general criteria in respect of the desirable features and characteristics of good school sites. These criteria together with the noted features of the educational program for the site constitute a set of standards or desirable characteristics against which the potential sites will be evaluated. The general criteria on which any potential site should be evaluated should include the following: safety and security, size, accessibility, noise level, location, topography, soil conditions, shape, utilities, and, if the site is to be purchased, the cost.

to: It may be necessary to spell out the details regarding some of these criteria to all members of the team in order to enhance objectivity in evaluation. Some of the critical ones include but not limited

SafetyandHealth

Safety and health are undoubtedly the most important consideration in the selection process. In regard to this, the committee should be familiar with any existing health and safety codes in the state, region or country.

In all, the potential site should not be near any airport, high tension transmission lines, railroads, busy motorways, high pressure natural gas and water pipe lines, noisy places like markets and industrial establishments, facilities with hazardous air emissions and places with bad odor, toxic substances and other health hazards.

Size

The sufficiency of the potential site for the proposed programme and buildings, including the outdoor and recreational activities, is also a critical consideration. The site should also have scope for expansion in order to accommodate future programmes and possible increases in school enrolment. The size of a suitable site should be determined solely by the nature of the present and anticipated future programmes and this size should be met with the initial site acquisition. This is necessary in order to avoid early obsolescence of the buildings and also to ensure that expansion of the school facilities will not be obstructed by the buildings and other structures that may be constructed close to the school by members of the community.

2.1.5 Location and Accessibility

Are other important considerations in school site selection especially in regard to schools for young children. The school on a potential site should be easy to be reached by all children. Children must not descend valleys, walk through a stream or climb some hills before reaching their school for obvious reasons. The site location should not be a difficult terrain like a hill, a valley or swampy place. The limitations imposed on the educational programme by such locations are obvious. The adequacy of the potential site will be enhanced if it is located where water sewers and other utilities can be provided easily.

Other location considerations are equally important. The potential site should be located and developed in proper relationship with the existing and proposed physical facilities, such as libraries, parks roads and hospitals among others in the community.

Cost

In those areas where school sites are usually purchased, the cost factor is also a serious consideration. It should be borne in mind that in such places the school must compete with commercial, industrial and other establishments for land. So, the cost of land will always be on the increase. It will, therefore, payoff to purchase early before the need becomes critical. The committee should bear in mind that the cost of landscaping and developing the site adds to the cost of acquisition. Purchase of places that will attract high landscaping costs should be avoided if possible. In sum, members if the committee should understand the rationale behind why some sites should be selected or rejected based on the established criteria,In real life, no site will have all the desirable characteristics or meet all the established criteria. If there are many sites to select from, it may be necessary to prioritise them in order of the desired attributes. This task will be facilitated by making use of a worksheet to score the alternatives sites. The use of such an instrument enhances objectivity in arriving at the final choice to be made and recommended to the appropriate Ministry officials (Dr. Olga C. Alonsabe2011)

The school site should be located in an area that is accessible for students who will likely attend the school. Schools provide unique place making opportunities to support and strengthen town centers, and enhance the local character. It is important that the school is located where joint use opportunities are the greatest to ensure benefit to the local community who may utilise school facilities:School sites are important community assets that fulfill a role beyond student education during school hours. School facilities are often used by the wider community to host events such as weekend markets, polling booths, evacuation centres and extracurricular sporting activities, to name a few. It is important that when planning for new schools, the location of the school site considers these functions also. There are many opportunities for schools to be jointly developed or share facilities with the community, to ensure more efficient use of space and provide quality social infrastructure. School sites are generally best located close to residential areas which generate student population, and near town centers, where joint/shared use opportunities are greatest and facilities are easily accessed by the community.

2.2 General Review of related literature

This chapter deals with the literature review part of the study. It includes: analyze suitable location for public service (education)Through Location allocation globally and locally. The study which studied on primary school in Egypt by Al-Sabbagh A, (2022) investigated Spatial decision making goes through several levels: National, Regional, and Positional. It's a mixture of many factors such as; Spatial, Economic, Political, Social and Environmental. Despite the care shown by the state when setting planning standards for educational facilities locations, those standards are often ignored and not used. It may be disregarded in favor of other factors.

Education is an authentic right that all countries care about for their citizens, especially at the early stages. Yet, that right face many restrictions, among them: Financing, Planning and Manpower, in addition to spatial restrictions related to the difficulty of reaching the educational facility. s addressed from several points: Social, Economic and Political. Recently, government reports indicating the negative effect of spatial factors in increasing school dropouts. Geographical studies in Egypt that dealt with that topic within the geography of education are still biased in a specific direction that addresses issues such as: the quality of educational, the number of classes, the density of students and the geographical distribution of schools.

The GIS application model demonstrates the efficiency of GIS in the suitability analysis and the assessment of land use suitability, wherefore, the educational facilities have to be located in positions far from land uses that would have an influence on the pupil health, pupil safety, and quality of education. This phase was begun with acquiring, repair and analysis data to find out the weaknesses in the prior distribution. The proposed GIS model presented a solution for identifying the most suitable location for constructing the new schools to stop making the same mistakes in the distribution of new schools,

According to (Richard & Ogba, 2016), Selecting suitability location for siting new secondary schools in the study area the secondary data, settlement data, and land use/ land cover was needed to perform analysis. The condition for siting new secondary school was that it should be built close to settlements without secondary school.

Different constraints and factors were considered for suitable site selection of new high school construction in Amhara Region. Road width, noise level, 5km radius of existing high schools, protected areas including 200 meter buffer, Lakes and Dams including 100 meter buffer, major

Rivers in Amhara Region including 50 meter buffer; and minimum area size of the proposed new high school construction sites (at least 3 hectares) were considered as constraints; while, number of students, slope, road access, power access and water access were considered as factors or criteria. Then a MCA model was built to analyze all constraint maps and factor maps by giving them different weights, and to get the final high school construction suitability map. Generally, the most important limiting factor for suitable site selection for construction of new high schools in Amhara Region is number of students. Power access and water access were the least important limiting factors. However, Telecommunication access is common limiting factor for suitable site selection for new high school construction in region(Ayele et al., 2018).

According to (Eshetu, 2016), investigated in Addis Ababa on yeka sub city by using location allocation analysis There is no planned mode of school distributions in the demanding environment of the community so that schools are highly concentrated at infrastructure and utility filled areas where as rare number of schools are seen in other areas of population. This situation intern caused some parts of the population remain unreachable while the others are bounded by high potential of coverage and accessibility. It is apparently that GIS analysis has shown how much is miss-planning of primary school locations along the populated community.

This can effectively help MoE decision makers to take an immediate action towards distribution of primary schools and the urgent needs for either establishing new schools or relocation of others to provide complete services and easy accessibility to the community. And Therefore GIS based LA and Spatial analysis are the best methods of finding locations that are most suitable for new school sites and other related public services. Governments can consider such scientific studies before the area is developed to districts, towns and cities.

2.3 Research Gap

In particular few researches have been conducted using GIs technique in our country from these in amahara region (Ayele et al., 2018) statedthe school site selection analysis have been by Multi-Criteria Analysis Method (MCAM) using Arc GIS software and GIS models and according to(Eshetu, 2016),making analysis and find results on how to balance distribution of the primary schools and selecting suitable site by using location allocation in yeka subcity is done. All the previous researchers are done well insight for suitable site selection in their studies. But it’s not enough. Because As far as the researcher reviewed there were no works done regarding GIS-technique location allocation analysis on primary school suitability in the study area Although Adama city is highly growing city now today many public service needed with suitable location. Many population flowed from other town and rural area by different Couse to this city. For these population or settlement school on suitable location is big Issue. However; this paper will analyze how the formerly construct primary school in Adama City by using location-allocation and Network analysis. And will identify where and how many new primary schools shall be established in Adama city.

2.4 Methodology Analysis Review

The tabulated research below is which done by different methodology to select suitable site for public services; locally and globally.

2.4.1 Multi criteria Analysis Method

According to kahalid Ahmed (2018) and Hasan et al, (2019) the similar method used in their study. In this study The GIS-based multi-criteria analysis special analytical method has been used to develop the school site selection model by using land sat image and qualitative data. Its result illustrate the successful implementation and advantages of applying the GIS technology for education planning and decision-making process. The use of GIS technology based modelling for decision support system has created new capabilities and advance assistance to the planning process. As a result, it was possible to identify most suitable for locating schools in the area. Where the study area divides according to the proposed criteria and weights to three classes good, medium and bad. Hasan et al 2019 sited the research was developed to exhibit a simplified method of multi criteria decision making (MCDM) and Fuzzy memberships in GIS environment with integrating GIS and AHP. They used data gathered from different sources with different formats, in the first step of MCDA, Environmental criteria, socio- economic criteria, questionnaire and literature to ascertain best landfill sites for Shiraz County, located south of Iran. The weight of each criterion was determined based on expert's knowledge with use of analytical hierarchy process (AHP). As the result of this study: The six suitable areas for landfill in Shiraz county is 1.003% of total area equal to 8710 ha and AHP and Fuzzy memberships has a great potential and ability for landfill site selection. Based on the both above research they has good sited concept.

2.4.2 Multi-Hierarchy and Multi-Constrained Configuration Model

Accordin to Jie et al (2020) sited in their study they uses Multi-Hierarchy and Multi-Constrained Configuration Model to locating public service facilities in an urban comprehensive Xuanwu Lake Park in Nanjing, China their data is primarily obtained from three characteristics:field interviews and survey data, network big data, and spatial information data. In this study, the service facilities of the park were classified into multiple levels based on the site selection of the facilities by integrating and processing current data with the use of ArcGIS and MATLAB to obtain the corresponding optimal scheme. For evaluating each level with respect to the construction quantity, accessibility, service area, and service object were also identified in this study. As a result The AHP was used to evaluate the quality of service (including service satisfaction and service capacity, among other factors) and accessibility (including walking satisfaction and prediction of the visitor population covered). User ratings for each facility point were assigned based on the questionnaires. The weighted calculation, which was based on the weight given by the expert scoring system, was conducted to obtain the score of each facility point. This study sought the optimal solution from multiple aspects, including coverage area, served population, and node distance. The solutions in which the low-hierarchy facility points were treated using ArcGIS's maximum coverage area and the high-hierarchy facility points were treated with the maximum population flow.

2.4.3 GIS-SLEF Model Analysis (-Based Location Suitability of Educational Facilities)

That assimilates acquired data could be implemented to identify most proper locations for schools. This identification of prospective locations is a prerequisite to assess multiple aspects such distance, time, cost, and perils dependent on multicriteria. The GIS_SLEF methodology involves modeling with the ArcMap Model Builder (MB) to identify most suitable locations in the study areas based on a proximity of existing schools in this study the data used Satellite image, schools and land use, network roads as, districts and zone boundary and etc. to identify the most suitable areas where new schools can be established? In Mukalla Yemen.the result of this study GIS-SLEF has applied to districts of the study area. It produced a heat map illustrates high and low density, therefore, the hinge value represents the best locations, it is easy-to-understand and intuitively. However, the density area with high value considers the available best locations to build a new elementary school in the study area. GIS-SLEF model presented a solution for identifying the most suitable location for constructing the new schools to stop making the same mistakes in the distribution of new schools, also suggest an alternative location for existing schools Waleed Lagrab, And Noura Aknin 2005.

2.4.4 Location allocation Analysis

Tamer Ali Al-Sabbagh ,2020; Abdulkader et al .,2021 Mindahun wondesen E ,2016 and Abraham Gebreselassi T 2021 all above research has used Location allocation analysis .By using different data in different location and deferent year to Improving accessibility primary school, Optimizing location for Health center, Selection suitable site for primary school and Establishment of new health center.so in their study the objectives were analyzed through GIS environment: (i) Location-Allocation Models: Minimize Impedance, Maximize Coverage Minimize Facilities and (ii) Statistical spatial analysis. The data they uses fo0r this research: School location, Location Map Road, GPS Coordinates of Schools, Road network, Residential area, Parcel Maps, Demographic data and etc. The study results showed that developing countries should adopt spatial decision support models during the localization process, showing its role in improving the selection of public facilities locations, especially with the spread of decision support models that have become more popular with the maturity of GIS software.

2.5 Justification

Based on the above researches I try to choose the LOCATION ALLOCATION ANALYSS methodology to select suitable site for primary school. Because location allocation is do not select only the site .it can minimize total distance, minimizing largest distance, maximize profit, minimizing combination of travel distance and facilities operation and etc. so these all are needed for my study. Location-allocation Analysis aim to locate the optimal location for each facility. Allocating a number of people for each facility, according to the inputs of each model. How to find a point (school) among three points (people) at which the least distance between it and such points can be achieved? Location-allocation Analysis will be useful in the localization of some public facilities such as: hospitals, schools and libraries. Highly efficient accessorily is the dominating element. Location-allocation models in GIS are divided into seven main problems.

The P-median: approach from the location-allocation model was used to determine the best places for additional different facilities. (Locate ware houses)

✓ To optimize some given measurable objective function, the method includes picking a set of sites.

✓ The P-median method is appealing because the shorter the overall weighted travel distance.

✓ Facilities are located such that the sum of all weighted costs between demand points and solution facilities is minimized.

✓ This problem type is traditionally used to locate warehouses, because it can reduce the overall transportation costs of delivering goods to outlets.

✓ the minimize impedance problem without an impedance cutoff is ordinarily regarded as more equitable than other problem types for locating some public-sector facilities

✓ The P-median problem minimizes the weighted distance between customers and providers; the location-covering problem (LCP) minimizes the number of services needed to cover all demands and the maximal location-covering problem (MCLP) maximizes demand within the optimal distance or time period by locating a specified number of services

Maximize coverage: For determining the covered and non- covered facilitate demand points

✓ It chooses facilities such that all or the greatest amount of demands is within a specified impedance cutoff

✓ Maximize Coverage Facilities are located such that as many demand points as possible are allocated to solution facilities within the impedance cutoff.(Locate fire stations)

Minimize Facilities: For facilities determining the minimum.

✓ It chooses the minimum number of facilities needed to cover all or the greatest amount of demand within a specified impedance cutoff**.**

✓ Minimize Facilities are located such that as many demand points as possible are allocated to solution facilities within the impedance cutoff; additionally, the number of facilities required to cover demand points is minimized.(locate fire station without budget limit)

Maximize Attendance: Facilities are chosen such that as much demand weight as possible is allocated to facilities. (Locate stores without competitors)

Maximize Market Share: A specific number of facilities are chosen such that the allocated demand is maximized in the presence of competitors. (Locate store with competitors.)

Target Market Share: Target Market Share chooses the minimum number of facilities necessary to capture a specific percentage of the total market share in the presence of competitors. (Locate store with competitors but without budget limit.)

From these types: P-median method is the best method it's used to determine the best places for additional different facilities. (Locate ware houses), appealing because the shorter the overall weighted travel distance.it will be for school site selection.

2.6 Location Allocation Analysis in GIS

There have been ample new developments in the location-allocation literature. Of special interest to this dissertation research is the integration of location-allocation Analysisand geographic information systems (GIS) Location-allocation Analysis is a frequently used set of techniques for solving a variety of locational problems, some of which can be politically sensitive. The typical application of a location-allocation model involves locating facilities by selecting a set of sites from a larger set of candidate sites, with theselection procedure being a function of "optimality" in terms of the allocation of demand to the selected sites.By Monica Pratt et al (2014), Location-allocation analysis is described as a tool in the ArcGIS Network Analyst extension which determines an optimal location for one or more facilities that will service demand from the surrounding population.

Classical location allocation problem like P-median problem is same as minimal impedance where both case the objective is to minimize the sum of distances from demand points to facility. This problem type is used to locate private facility like warehouse and also public facility like library, Museum and airport in order to reduce the distance or driving time from facility to demand. By reducing distance the solution wants to reduce the transportation cost. To implement emergency rescue center location like fire station, police station in order to cover maximum distance, maximize coverage type problem is used. If the objective is to cover 100% demand for emergency support this solution will help to model it. In minimizing the facility the output of the solution will be the optimal number of facilities to cover all the demand. The difference between minimizing facility and maximizing demand problem is in determining the number of facility. In maximizing demand the number is predefined where in other type the solution finds the minimum number. These two type solution can be used in hierarchical order. With the assumption of demand weight will decrease in relation to the distance between the facility and the demand point, facilities are located(Eshetu, 2016).

Common Terminologies

Finally, the following terminologies are of special concentration throughout the location allocation of the primary schools. They are described by Arifin (2011) as follows:

1. Facility: - is used in location allocation problem to define an object whose spatial position is optimized through model or algorithm considering interaction with other pre-existing objects. In many location allocation models, one of the properties of the facility is the number of new facilities that need to be established in the area of interest. Thus a single facility problem inside the location allocation model needs to establish only one new facility considering the existing facilities. This is very simple instance of location allocation model. Multi facilities inside location allocation model are more common where more than one facility is located simultaneously. Another important property of facility is type. Facility type includes the capacity of the facility and the services of the facility. Facility can be characterized as capacitated and incapacitated considering how much demand it can meet. If facility can supply an infinite demand then it is incapacitated and when facility's capacity is limited then it is capacitated. Facility can also be classified depending on the number of service it is providing. A facility can provide only one type of service or a group of services. Example of a single service facility is food shop which only provide food and example of multiple services is general hospital that provides multiple health supports. Cost is another property of facility though which location allocation models can be differentiated. Facility cost can be two types. One is fixed cost and another is variable cost. Fixed type of cost depends on the establishment expense of facility. Variable cost has a relation with service delivery.

2. Demand or Customer: - the second essential component of location allocation algorithm is demand which is also known as customer. A demand or customer is a person who needs accessibility to a service or to a supply of a good. Since location allocation problem is connected with satisfying demand, it is important to know their distribution, quantity and behavior. If we consider demand distribution in space, it can be assigned uniformly over the area or network. It can be assigned to specific point (geocoded) over the area. It can be assigned on the centroid of the area. However, it can also be assigned randomly to simulate the problem over the area if there is no real data. Another hindrance of depicting reality into the research is using demand I the location allocation model. In the classical location allocation, demand is used as weighted value in the nod or in the smallest unit of continuous space. Weighted demand means the aggregation of some customers on one point. Since the location allocation is NP hard problem, if the size of the demand decreases, it makes the decrement of computational complexity. When the quantity of the customer is very large, for example a million, then it is better to use weighted demand. The demand of the customer can also be either deterministic or stochastic. In case of deterministic, there is prior knowledge of demand while it is used into the model. In other case, demand will vary depend on the type or service of facility.

3. Location or space: - the third essential component of location allocation problems is space or location. There are three types of representation of space in location allocation problem. These are discrete, continuous and network based. In discrete space model, it is assumed that there is a prior knowledge of the candidate or potential sites. Since some best locations are selected from pre-selected potential locations, it is also referred as selected location model. Decision makers make the choice of candidate sites due to geographical or economical factor. Examples of these factors are zoning regulation, presence of structure and land availability etc. some of the location allocation problems deal space as continuous. One or more continuously varying coordinates determine all the possible site locations. These continuous site locations are normally considered in Euclidean space. It is also known as site generation model. Because there is no presumption of potential sites for the model, rather appropriate site generation is done as an output by the model. Another type of representation of space network based. Network space depends on graph-theoretic approach. Model using these approach can solve problem with much larger size. A network with either continuous or discrete space is considered in this type of space or location. Continuous network considers links of network for a continuous set of candidate locations. In discrete network, new facilities are only placed in the nodes. In space there can be some forbidden area where site selection or site generation should not be done in the model. Similarly some areas cannot be used due to some restrictions. For example new facilities may not be built over water body or park. Site selection or generation over these areas should be avoided due to ineligibility.

Network Analysis

Network analysis is a set of analysis techniques used with networks. Network Analyst is the ESRI extension that performs network analysis in Arc Map. Network Analyst uses network datasets Types of analysis: - Route - Service areas - closest facility - Origin-destination cost matrix A set of interconnected line entities whose attributes share some common theme primarily related to flow Network lines define relationships between nodes Flow types: - Data - Objects – Materials. – finding driving directions between two points.

P-Median Model

This kind of modelling is used in the context of existing available health care facilities and underlying demographic demand to determine the best places for new services, e.g., a new site for a maternity center. Mathematical programming techniques are used for location-allocation modelling, where the programming can be defined as a collection of computational methods for solving optimization problems. This kind of models have been used in health care decision-making to determine the best place for a new facility, ensure that resource locations are sufficient to satisfy the needs of the network and to lay out the improved paths to health facilities in communities

CHAPTER THREE: MATERIALS AND METHODS

3.1 Description of the Study Area

Adama City is extending between geographic coordinates of at 8° 30′ 52.1172″N latitude and 39° 16′ 9.3252″ E longitude at some 95 Kilometers away from Addis Ababa City. The maximum elevation of the city is 1712 meters above mean sea level. Owing to its geographical proximity to international port of Djibouti within the distance of about 777 Kilometers, the city is one of the preferred destinations for trade and industry and Adama city has excellent development potential and is expected to play a significant role in the systematic and integrated development of the nearby urban and rural areas due to its strategic location along the railway line that connects the port of Djibouti with Addis Ababa and at the intersection of major routes to Addis Ababa, Arsi, Harar, and other hinterland areas of high economic importance. And also additional expressway was constructed due to this travel time from Addis Ababa (Tulu-Dimtu) to west Adama 60km which was minimized travel to 45 minutes. Its Boundes by Boset Woreda in East ,Lume woreda ithe North-west,Duga Bora in the south-west,Dodo Tana Sire Wereda in the south and Shenkora and Minjar in the North.

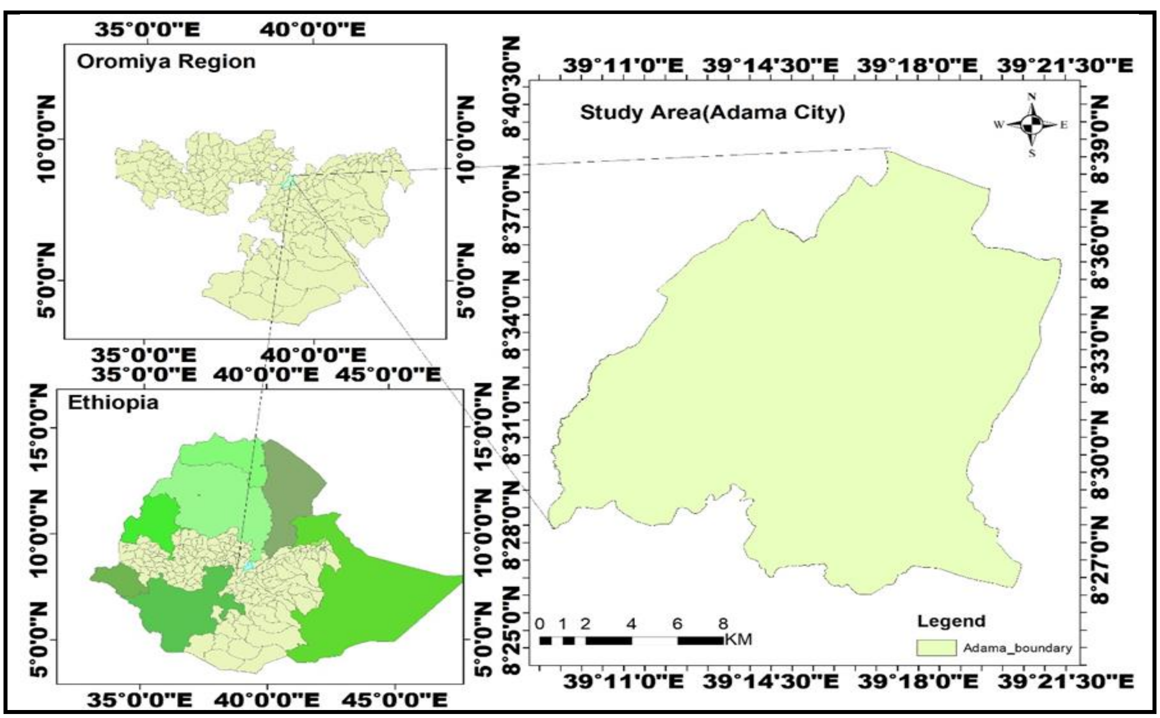

Figure 3. 1 Map of Study Area

3.2 Physical characteristic of Study Area

A) Topography

Adama forms a special zone and Oromia an is surrounded by east Shewa Zone. It is located at 8° 35′ 00″N and8° 36′ 00″and 39° 11′ 57″ E to39° 21′ 15″ E.at an elevation of 1620meters,95km southwest of Ethiopia Capital, Addis Ababa.The city sits between the base of an escarpment to the west and the great rift valley to the east.

B) Climate

The area has regional steppe climate, which is the classification given to the current whether. Precipitation is sparse in Adama all year round. in Adama the yearly average temperature is 20.7C, or 69.3F, every year. About 371mm (14.6in) of precipitation falls. There are several difficulties in accurately classifying the summer month in the Adama region due to its Moderate Climate

3.3 Land use Classes of Adama City

Several land use types are recognized in irregular mixed appearance with one another throughout the whole study area. Before school location allocation is made, it’s important to identify every part of the area. Under study and for what purpose its used because it helps to isolate where the demand (request) for the health center exists and where there is not, where the demand is high and where it is low,etc.

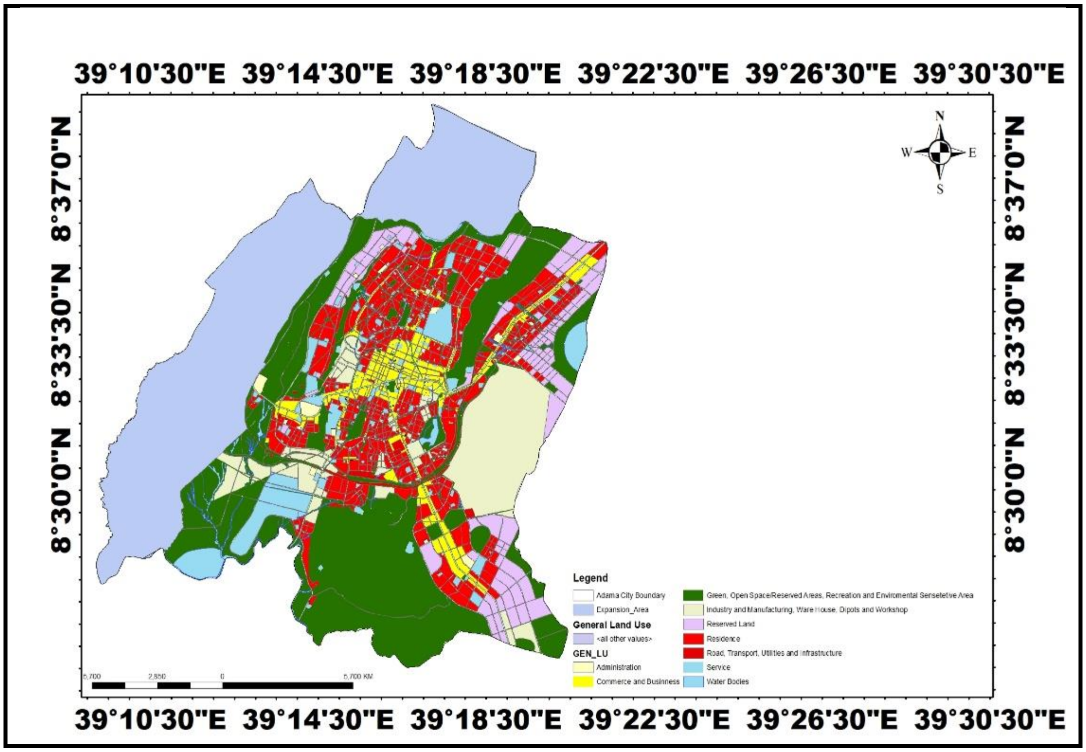

Figure 3. 2: Land use Land Cover plan Map of Adama city

Source: Adama City Land Administration

3.3.1 Road Network

One of the most important land use types to be studied in this research work is the road network existing in the study area. A road is A transportation route that determine the degree of importance of another land use type by increasing the accessibility of that area. There are four Categories of Roads connected in the city these are in the table below.

Table 3. 1: Road Category

No	Road	Code Used	Area(sq.m)
1	Principal Arterial	RTU –(PA)	2.65
2	Sub arterial	RTU-(SA)	2.62
3	collector	RTU-(C)	3.67
4	Local Road	RTU-(L)	7.34

Source: Adama city Land administration.

3.4 Image classification

It’s Important to convert image data to thematic data the objective of image classification procedure is to categorize automatically all pixel in an image in to land use / land cover classes the image data was processed in ERDAS Imagine 2015 and standard image processing techniques. And classification was used for the analysis of satellite imageries.

3.5 Slope, Hill Shade, Aspect, And LULC of the Study Area.

Land scaping has a big factor in analyzing. DEM data from Earth Explorer used to generate slope, hill shade, and aspect map of the study area and satellite image 10m resolution also used from USGS earth explorer for LULC of study area.

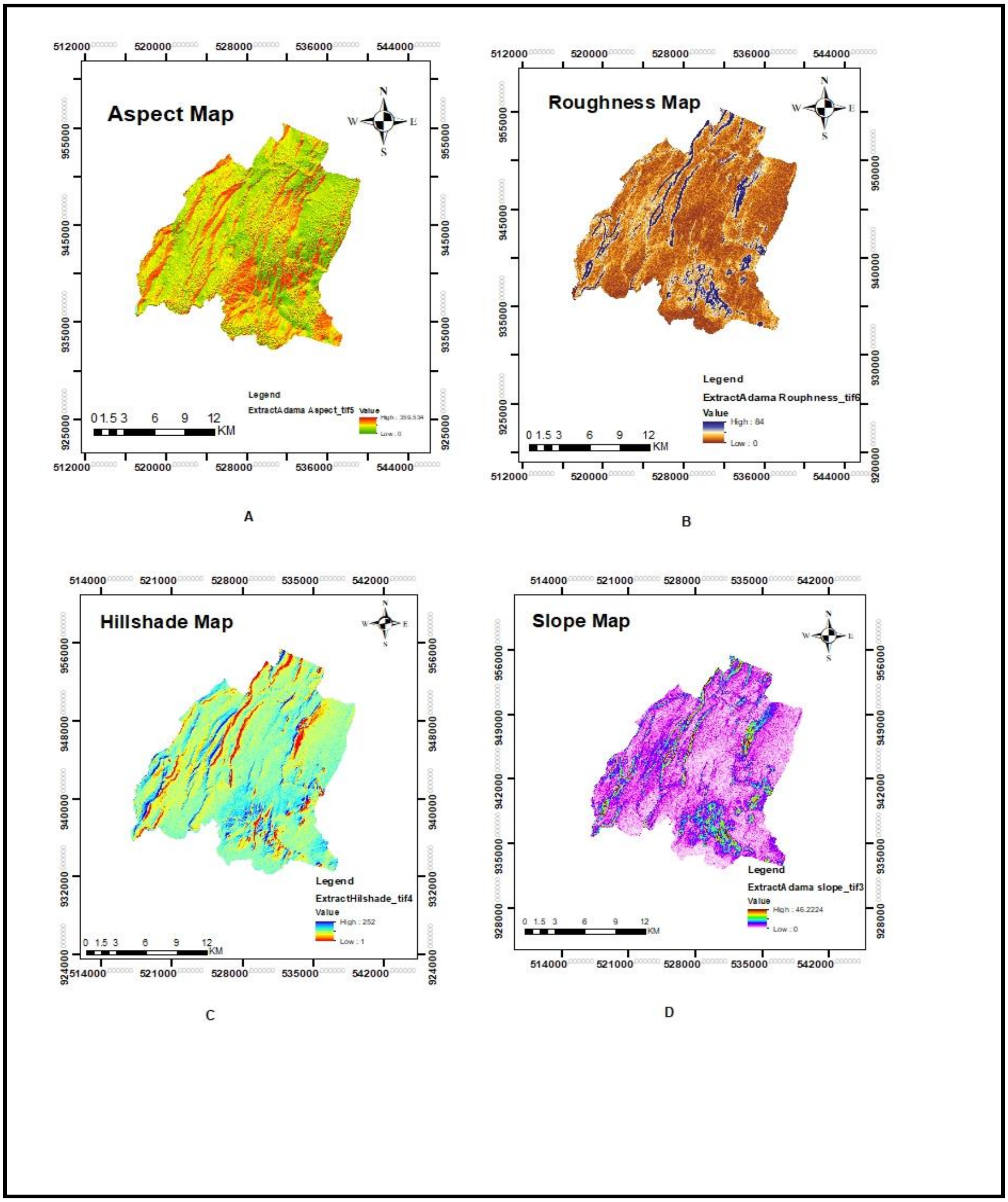

Figure 3. 3: A) Aspect B) Roughness C)Hill shade D)Slope Map

3.5Data source and collection Method

3.5.1 Data source

This Study used data from both primary and secondary sources, include both spatial and non-spatial data from actual field work and secondary data. The table below describes the data required, the types of data used in the study, the formats and where the data were gathered from and the year of data recorded are detailed shown in Table3.3.

Table 3. 2: Data source, collection Method and their uses

NO.	Data	Sources	Data Type	Uses	year
1	Satalite Image (land sat-8) Res:10m	USGS	TIFF	Identfying LULC	2023
2	Road Network	Adama city cadastral office	Shape file	Modify existing road Network	2018
3	Parcel map	Adama city cadastral office	Shape file	Distinguish residential from others	2023
4	Administrative map	ACCO	Shape file	For defining the study location	2023
5	population data	Adama city Education office(ACEO)	Excel	To know subject population	2023
6	Existing school location	Adama city Education office(ACEO)	Coordinate X,Y,Z	To analyze distribution of existing school	2023

Table 3. 3: Existing primary school name and their Location

NO.	SCHOOL NAME	WEREDA	SUBCITY	STUDENTPOPN	X-COORDINATE	Y-COORDINATE	ELIVATION
1	Abdii Boruu	Goro	Bole	486	529232	946474	1681
2	Abaaboo	Goro	Bole	632	529733	947187	1683
3	Adaamaa Boosat	Bika	Lugo	3514	529474	943266	1670
4	Adaamaa Faanaa	Aba Gada	Gada	444	530167	944592	1684
5	Bisiqqee	Goro	Bole	922	529185	947359	1681
6	Bokkuu Kuraabboo	Bokku shsnan	Bokku	259	529745	940449	1685
7	Burqaa Bokkuu	Bokku shanan	Bokku	6159	530583	940357	1680
8	Coqonuu	D/Adii	Bole	21	527252	946537	1679
9	Daabee Qocee	Dabe soloke	Dabe	729	522938	941638	1682
10	Dhakaa Adii	D/Adii	Bole	670	531398	948325	1687
11	Gadaa Birmajii	D.Arara	Bole	2514	530651	945108	1688
12	Gadaa Melba	Goro	Bole	3076	530049	945848	1685
13	Gadaa Robale	Barecha	Bokku	1386	530592	943778	1689

14	Gadaa Michillee	Dagaga	Dambala	2280	528476	944559	1684
15	Gadaa Kilolee	Gurmu	Gada	4782	527894	943209	1681
16	Hiddaasee	Badatu	Gada	410	529115	944834	1683
17	Hundee Guddinaa	Goro	Bole	652	529427	945561	1681
18	L/K/D/Simee	Irrecha	Dambala	4227	527602	943235	1680
19	Luugoo	Gara Lugo	Lugo	2992	528590	941517	1688
20	M/A/sirreessaa	Goro	Bole	378	529890	945253	1687
21	Malkaa Adaamaa	M/Adama	Dambala	1047	525685	938009	1682
22	Malkaa Hiddaa	M/Adama	Dambala	830	525991	937753	1689
23	Migiraa	Migira	Bokku	1213	530697	942244	1684
24	Odaa	Goro	Bole	3570	530841	947612	1681
25	Qidduus Quraan	Odaa	Gada	879	528886	944675	1684
26	Saqaqalloo	D/Adi	Bole	778	530777	949482	1682
27	Seenaa Sabaa	Goro	Bole	746	528530	947464	1689
28	Solloqqee Kurfaa	Dabe soloke	Dabe	2017	533652	943808	1680
29	Soolee	D/Adi	Bole	1029	533448	947796	1687
30	Urjii Adaamaa	Badatu	Gada	1842	529369	944385	1684

3.5.2 Method of Data Collection

Methods of data collection involve primary data and secondary data collection. To obtain all documents for the study numerous strategies are used formally and informally in the data gathering procedure. There two types of data collection procedure used.

These are: Primary and Secondary data collection

Primary data collection

Field data is obtained by conducting direct surveys of the field such correcting existing school coordinate point this can be done with use of smartphone GPS application by comparing X,Y,Zexisting school coordinate with the accuracy of 2 m These coordinate points of the location is used for distribution of existing primary school in study area.

Secondary Data Collection

Data obtained from other source such as existing primary school coordinate, Total school amount, student population data in adama city is from ACEO (Adama City Education Office) The ancillary data will be used in this study are Boundary of the city, Road data, Adama city Land use map, study area ortophoto from Adama city cadastraloffice, Satellite Imagery with (30m) Resolution from USGSand CSA population data of the city Confirmed from ACSA (Adama City Statistical Agency).

3.6 Software and Material Used

The software and material used in this study were selected based on their capability to solve existing problem.in achieving the predetermined problem objectives. To achieve the objective of the study different software and material were used. Image processing and classification activities on the satellite image were performed using software such as The Arc GiS 10.8 software package was also used to Land use classification of the study area location allocation….factor map development.

Table 3. 4: Software and Material Used

NO.	Software Name	Version/sources	Purposes
1	Arc GIS	10.8	Data storage,Process,Map preparation
2	Google Earth		Verification of timely updates images
3	MS-Office	2013	Writing papers and reporting results
4	Excel	2013	Storing X,Y,Z coordinate Data

3.7 Method of data Analysis

3.71 Research Design

The conceptual Design of the Research become an important Issue that researcher Followed to conduct the research become an important issue to be clearly defined to visualize the whole image of the work. Both quantitative and qualitative research approaches are implemented to product the spired information or result which when combined Known as The mixed Approach. Even though the quality side has more weightage to the final result of the analysis, it’s not manageable without the involvement of the qualitative side. The inspiring purpose of this research is to see suitable primary school location in Adama City with minimum distance and time.

3.7.2 Data preparation Methods

Two significant action are undertaken in this subtopic. Firstly adjustments for errors, irregularities and absence. Secondly preparation of the refined data for the preconditions of the analysis part Therefore, data editions like corrections, modifications, deletions, substitutions etc. were made deeply during data preprocessing. These task of data preparation is categorized into two phases as follows.

Frist stage: Schools common in both attribute and spatial reference from all of the sources are selected and reserved and those with no spatial reference frame particularly that are observed from CSA data are omitted. In addition to these sources of data, lastly both spatial are gathered physically going to where the schools are located in the whole study area. The outcomes of the effort came up with missing schools on the data sources because of their newly introduction to the school market and services which is realized mostly on private sector. Beside this, during instrumental data gathering it could be recognized that there are also some inappropriate location of schools particularly those owned privately. Most of private owners of schools have lack of their own places for only training purpose, they use houses and land properties owned by other citizens in the society whose land use classes are used for residential purpose by means of contract in the form of rent. Such schools have no firm ground to stay and serve for years at the same location and thus make positional change from place to place.

Second Stage: This stage works on readjustments and changes of the road network data and the land use of the study area raw network data that are originally received from the sources cannot be directly applied as an input for the analysis. Therefore it was obligatory to change from the original file format to the format type supposed to use. After all editing activities are finished Adama City network Topology (i.e. geodatabase Topology) is built. The topology is controlled by some rules incorporated in it for further refinements of interconnections of all the lines participated in it. If any line in the topology violates one of the rules involved, it is displayed in one of the three errors attributed to any kinds of topological structures and that are; Area errors, Line errors and point errors if the topology is built from the combination of all area, line and point features.

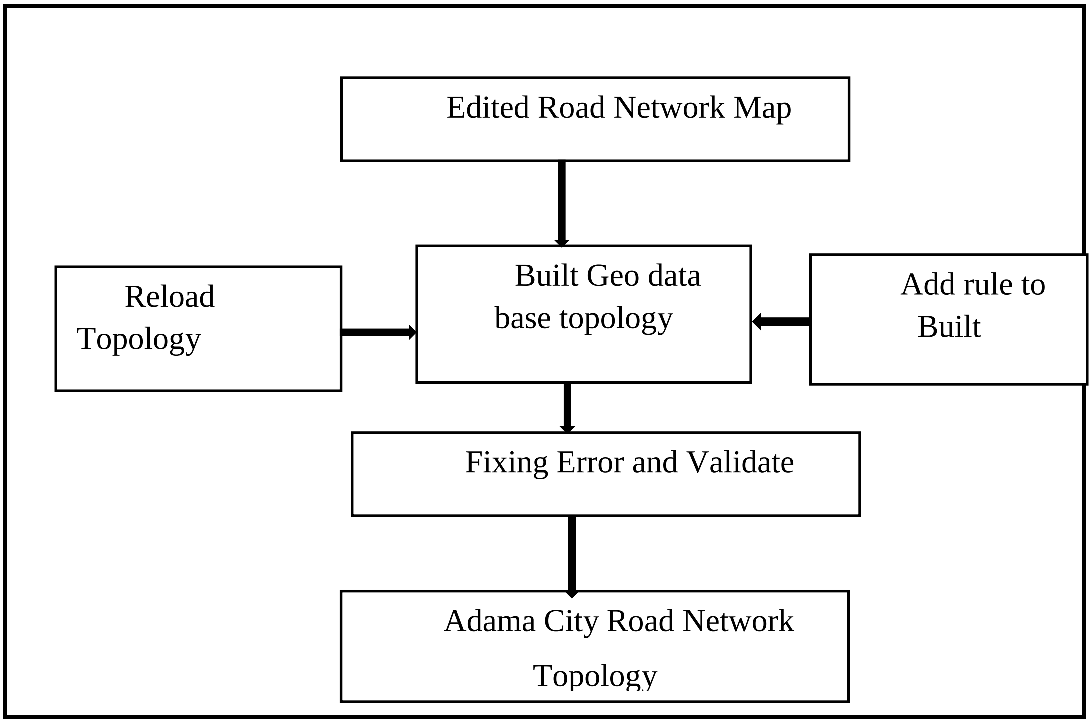

Figure 3. 4 Geodatabase Topology

The next step is to build a network dataset which is used directly as an input for the analysis part. And the network dataset is the pillar on which the analysis is made. Network can be created either from only involved line features or including both points and areas in a similar fashion made in the topology. There are some elements that are simultaneously created with network dataset. These elements are junctions, edges, turns, restrictions, stops, barriers and centers. In this study only the three elements are used (Junctions, Edges and Turns)

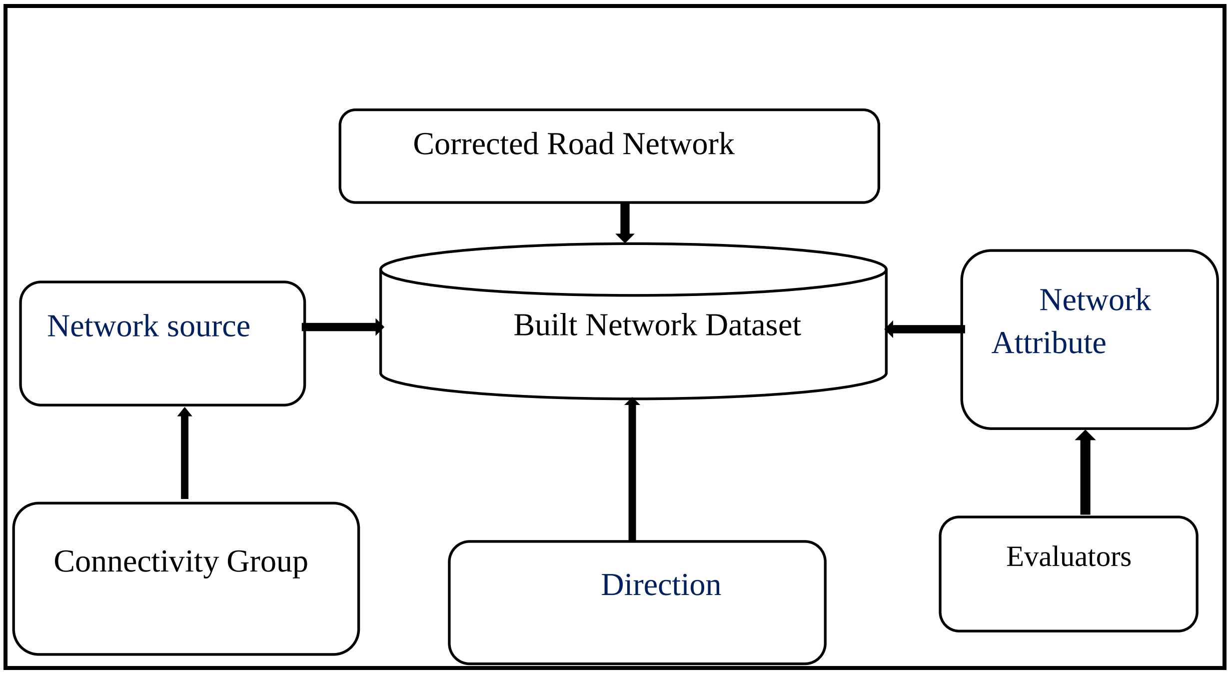

Figure: 3. 5 Network Dataset Work Flow

3.8 Spatial Distribution

In assessing spatial distribution, the primary school facility in the study area, all the facilities were determined and mapped, and the distribution pattern of the school facilities was mapped on Arc-Map environment to show the distribution pattern. With each school facilities located as point feature, the attribute data of each facilities which were already compiled in MS Excel. To determine spatial distribution, additionally I use Nearest Neighbor Analysis method. (NNAM).

3.8.1 Nearest Neighbor Analysis

Nearest neighbor analysis examines the distances between each point and the closest point to it, and then compares these to expected values for a random sample of points from a CSR (complete spatial randomness) pattern. CSR is generated by means of two assumptions: 1) that all places are equally likely to be the recipient of a case (event) and 2) all cases are located independently of one another.

Input

You'll be asked to enter the input data file, which should contain N rows of X, Y coordinates, and W values. Make all W values equal to 1, representing points.

Analysis

The null hypothesis of CSR is tested using the Z statistic (standard normal variate). A negative Z score indicates clustering; a positive score indicates dispersion or evenness. The Z statistic is calculated using the formula below.

Formula

a. The mean nearest neighbor distance

$$\bar{d} = \frac{\sum_{i=1}^{N} d_i}{N} \quad [1]$$

where N is the number of points. d_i is the nearest neighbor distance for point i.

b) The expected value of the nearest neighbor distance in a random pattern

$$E(d_i) = 0.5\sqrt{\frac{A}{N}} + \left(0.0514 + \frac{0.041}{\sqrt{N}}\right)\frac{B}{N} \quad [2]$$

where A is the area and B is the length of the perimeter of the study area.

c) The variance

$$Var(\bar{d}) = 0.070\frac{A}{N^2} + 0.037B\sqrt{\frac{A}{N^5}} \quad [3]$$

d) The Z statistic

$$Z = \frac{\bar{d} - E(d_i)}{\sqrt{Var(\bar{d})}} \quad [4]$$

Equations [2] and [3] contain a correction factor to account for the boundary effect based on Donnelly (1978).

3.8.2 Location allocation of Primary School

Location is often considered the most important factor leading to the success of a private- or public-sector organization. Private-sector organizations can profit from a good location, whether a small coffee shop with a local clientele or a multinational network of factories with distribution centers and a worldwide chain of retail outlets. Location can help keep fixed and overhead costs low and accessibility high. Public-sector facilities, such as schools, hospitals, libraries, fire stations, and emergency response services (ERS) centers, can provide high-quality service to the community at a low cost when a good location is chosen. The ArcGIS Location-Allocation analysis layer offers seven different problem types to answer specific kinds of questions, including questions like those posed in the two examples above. The seven problem types are the following: Minimize impedance, maximize coverage, maximize capacitated coverage, minimize facilities, maximize attendance, maximize market share and Target market share. In this case it is tried to undergo the former one (or Minimize Impedance problem type). There are three important input Data set require to work Location Allocation Analysis. These are:

Existing School

All the government Primary schools currently working in the area that are well-known serving for grade level from One up to Eight (Grade 1 – 8). The schools are also attributed by names, reference coordinates, specific woreda in which they relatively exist, ownership and Grade levels. In addition to this, the enrollment each school made in the 2015 E C received from Adama City Education office is considered as Capacity for the school. This is assumed as one determining factor to know the degree at which the requirement for additional schools in the locality when compared with the demand points.

1. Demand Points

A demand point is typically a location that represents the people or things requiring the goods and services your facilities provide. Demand points could also represent business customers. If you supply businesses with a high turnover of inventory, they would be weighted more heavily than those with a low turnover rate. Demand points can override the distance cutoff for the location-allocation problem type. This is useful if some demand points have different needs or behavior. For instance, when prepositioning ambulances, it may be acceptable to reach everyone within four minutes, except for areas with a high-density of elderly people, such as senior centers, which require a faster response time of two minutes. Under this study the demand points are points that represent student population whom the school facilities are believed to give services. Demand points are originally portions of land use that resulted from the combination of residential and mixed residential land use classes where almost all population of the sub-city use them for the residential purposes. After identifying all the land use land cover types of the study area, land parcels that shield areas for human residences are extracted by ArcGIS system tools and converted to identity points each representing each parcel.

2. Existing Road Network Dataset

Frist the network dataset is very important for the network analyst tools to work on the problem types under it (i.e. for new route, service area, closest facility, OD cost matrix and new vehicle routing problem types including New Location Allocation. It is developed from both the local and structural roads through the City.

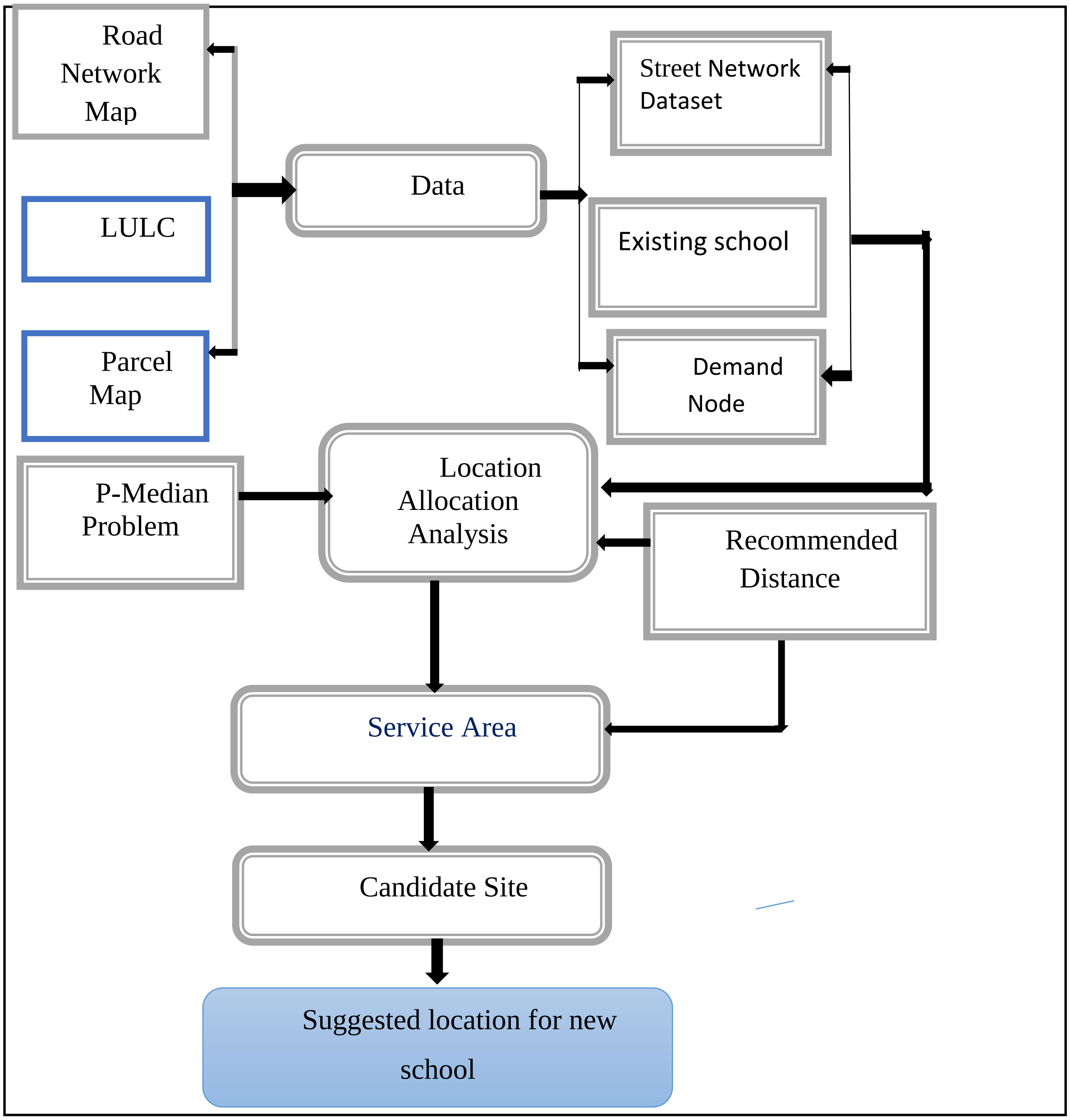

Figure3.6 Suggesting Site Work Flow

3.9 Service Area Using Analysis Network

Network Analyst is an extension to ArcGIS. Thus, must enable the Network Analyst extension prior to performing any network analysis.In this step the network dataset layer must be built. And current school locations based on which boundaries of each individual school service are must be generate. Then By adding the network dataset toArc

Map; when an analysis layer is created, Network Analyst can bind the analysis layer to the network dataset.so This is a technique that develop distinction area for the school facility service and the student population that want school services around its locality. How Ever to create service area demand points are not compulsory in such a way that unevenly shaped polygons around the facility are generated from the service based on the nature of the geometric pattern of road network.

3.9.1 Candidate Site selection

Under this I try to good sites for introducing new additional school facilities At this point one can decide where demand nodes are strong and where it is the revers, where are demand points that are beyond the impedance cutoff (Default breaks) so that they are unreachable (hardly reachable). Therefore ones the candidate sites are roughly suggested wherever there are tendencies, the above analyses are revised. The candidate sites that meets all the criteria fully or partially are selected on the basis of the input data and the density of demand points through the study area.

3.10 Select Suitable Location using spatial Analysis

The optimal location term is behaviorally difficult to define since a location can be suitable from a viewpoint and unsuitable from another viewpoint. Optimal locations attract the interest of various sciences: regional sciences, economics and operations research etc. So that, the matter is not related to geography only, but other sciences share the same interest .et al (Ali Alsabagh) 2020 however Further analysis is made from the suggested school locations result from the Location allocation and service area analysis as input using the ArcGIS Spatial Analyst extension tool. This is done because in the former methods only rough suggestions are given regarding locations that are recommended to be candidate. In addition to this, the capacity of existing schools with the student population size is also determined from the result obtained before proceeding with this portion. So the main purpose to use spatial analysis is examining the recommended and relocating or validating suitable areas with respect to the existing conditions.So the main purpose to use spatial analysis is examining the recommended and relocating or validating suitable areas with respect to the existing conditions. The inputs used in this part of analysis method are different from the ones used for Location allocation except for existing primary schools and population data used as demand points. In order to conduct the analysis six requirements are listed below:

1. Suggested site
2. Existing primary school
3. Elevation Data
4. Existing Noise
5. Existing Population
6. LULC Map

Table 3. 5: Criteria for Suitable Site Selection

Factor	Setting
Suggested Site	Sites that are very nearest to suggested sites have highest tendency for schooling.
Existing Primary School	These are schools that are working currently and also used in the location allocation analysis part. Away from existing school (>=500m)
Slope	Better (0-15%)
Existing Noise	The nearer away from the noise(200-500m),better
Existing Population	collection of peoples or residents from which students are outspread
Land Use Land Cover Map	The Land use Considered To analysis in format, availability and use

Source: Prepared by Authors from Different literature.

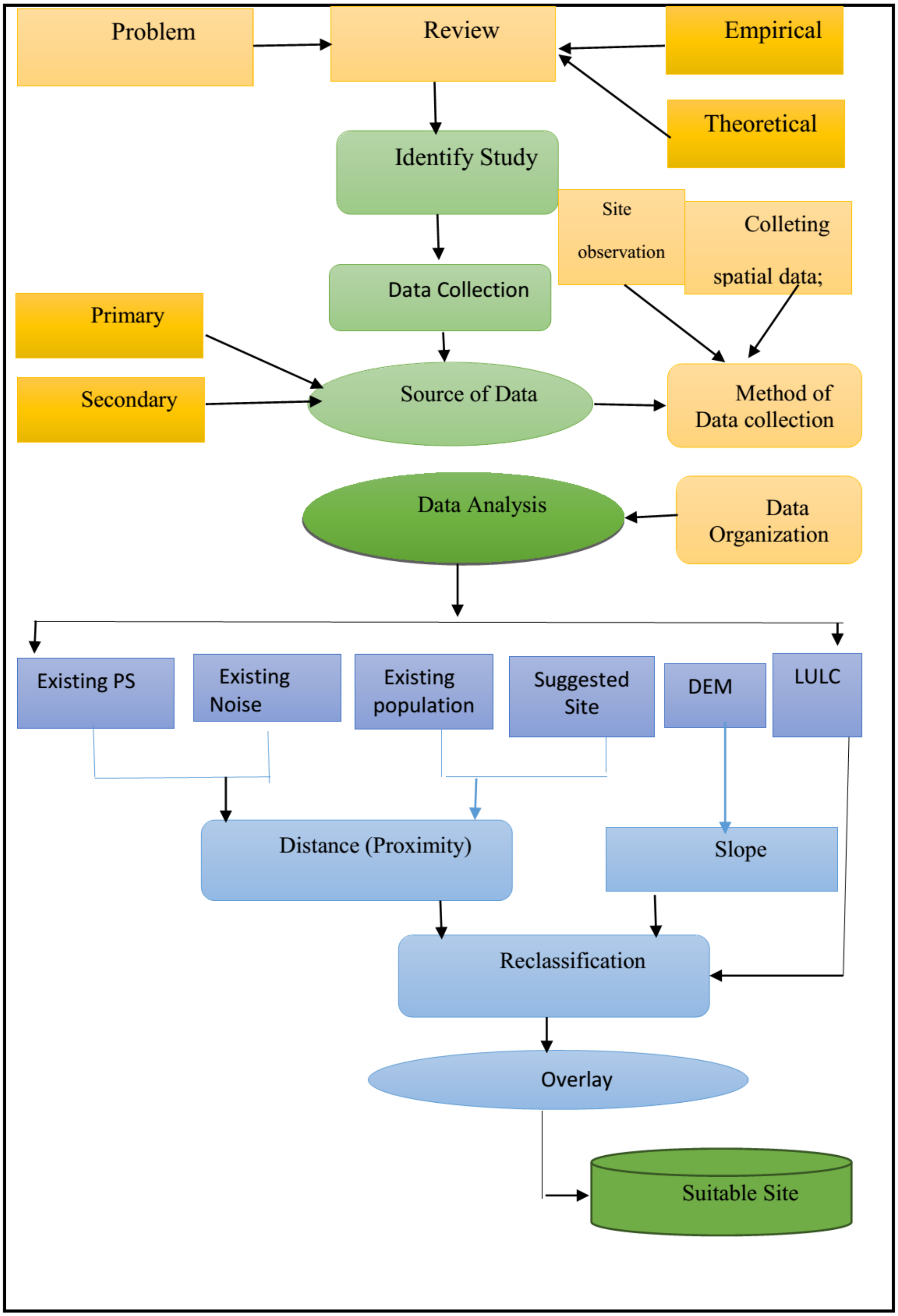

Figure 3. 7 Methodological Work Flow

CHAPTER FOUR: RESULT AND DISCUSSION

4.1 Introduction

The chapter tried to deal with the data in order to answer the stated questions formulated earlier starting from approximate assumptions up to the most reliable solutions that even stakeholders can apply to action. Relevant data analyses using the predefined methodology and consecutive techniques of location allocation and spatial analysis are employed. Descriptions of the results in the form of information are briefly arranged. Discussions are provided to meet the purpose of the study and the objectives set briefly at the start of the study. Finally the intended and refined greatest output of the research that is the most suitable school sites are selected. These are sites for schools that in combination with the existing schools can steadily serve the demanding communities

4.1.1 Land use Land cover Classes of Adama city

A land use classification is a classification providing information on land cover, and the type of human activity involved in land use. It may also facilitate the assessment of environmental impacts on and potential or alternative uses of land. There is several land use types are recognized in irregularly mixed appearance with one another throughout the whole study area. According to information from Adama city land administrative, there is about much class number of land use types identified in city such; Built up, Green and open area, Reserved, water body, Road and expansion area.

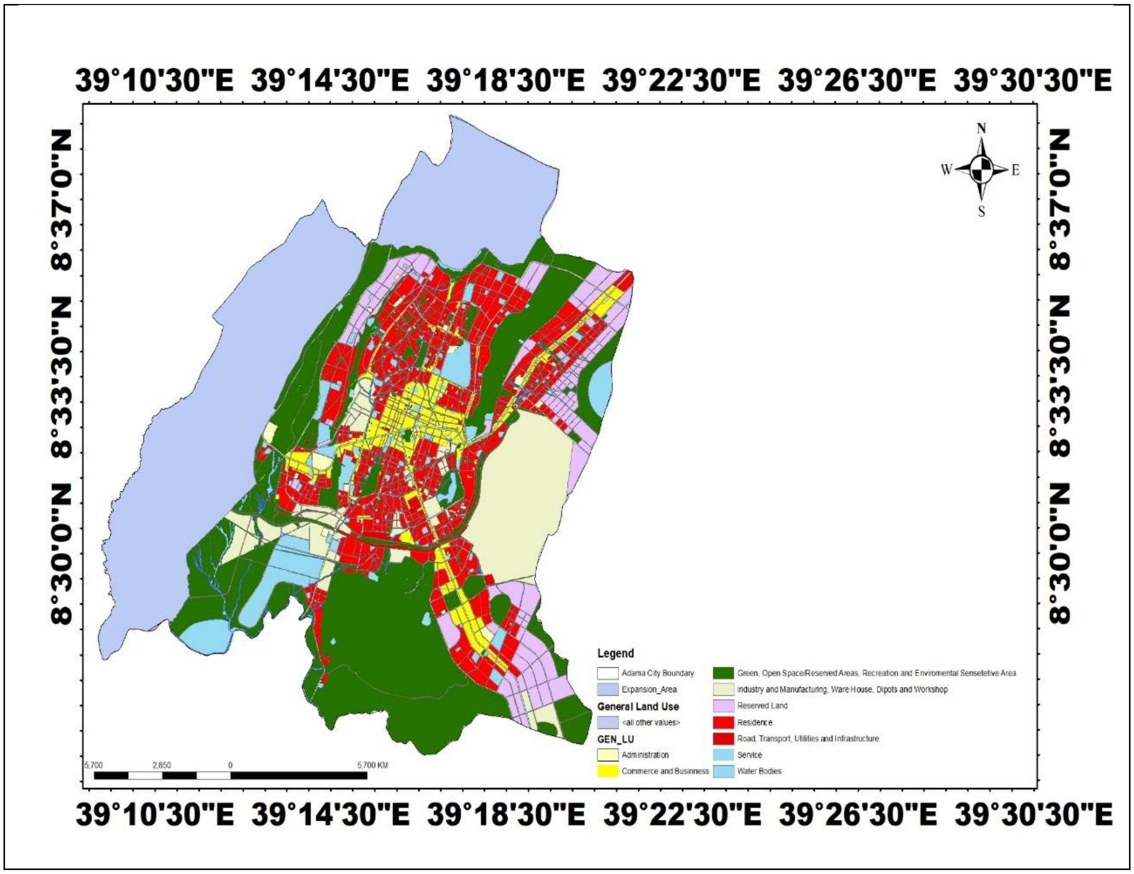

Figure 4. 1: Land Use Land Cover Class plan map

Table 4. 1: Area Covered by Each Land use Cover

NO	Land use Types	Code Used	Area(Sq.km)	Percentage%
1	Residence	R	42.58	14%
2	Commercial and Business	CBA	26.16	8%
3	service	S	5.88	2%
4	Green, open space, Reserved Areas, recreational and environmental, sensitive area	EA	56.44	18%
5	Administration	AD	6.96	2%
6	Industry,Manufucturing,were house, Depots and workshop	P	12.66	4%
7	Road, transportation,Utlities,and infrastructure	RTU	7.43	2%
8	Others	WB	154.85	50%
9	Total		312.99	100%

4.2 Coverage of primary school in Adama city

The extent to which the existing schools in the locality are serving the surrounding community is important issue to know before further analysis. It is also significant to identify location of each existing school in terms of infrastructures and population. Based on the current facts, there are 30 public schools in the City.As quantified in statistics of 2023 academic year by Adama Education Office general children 1-14 age is:8, 87514 regular students were enrolled in all ages from grade 1 – 8.G. 88542 student is outstretched from residential parcels. Spatial parcel map data from Adama cadastral office 2023 with modification).Based on statistics of enrollment per each school for the same year 2023 prepared by AEO, there were 52484 both regular students. Enrolled in 30 primary schools in Adama City. Which means 1682.8 students per each school if evenly distributed without any restriction. So when compared with capacities per each school in the former year2023 in relation with enrollment and the residential plots from which demand for school is supplied, accessibility and coverage are reached within existing schools without any requirement. But the problem for these assumptions to come true is lack of even distribution of schools in the city. This intern caused another problem to access and coverage of the schools due to many reasons among which some are irregular land scape of the city, Plan less developments of schools; especially those owned privately, uneven residential areas of school population and the community, uneven access to transportation network or road access, capacity and type difference among the schools etc.

4.3 Primary school distribution Pattern in Adama City

The figure below shows :output of pattern of schools in Adama City based on the search radius of 2.50 km. From this fact, road network is one of the most influential factor that determined the distribution. In the figure, from the five classes of roads, asphalted portion is sampled to see how the road affects access and coverage of facilities. Therefore, it is clear that all schools are densely built where there is ease of access of sufficient road network is available and in reverse the facilities are rarely found at areas where the network is available in low range. Similar situations happen to the schools in terms of residential areas,

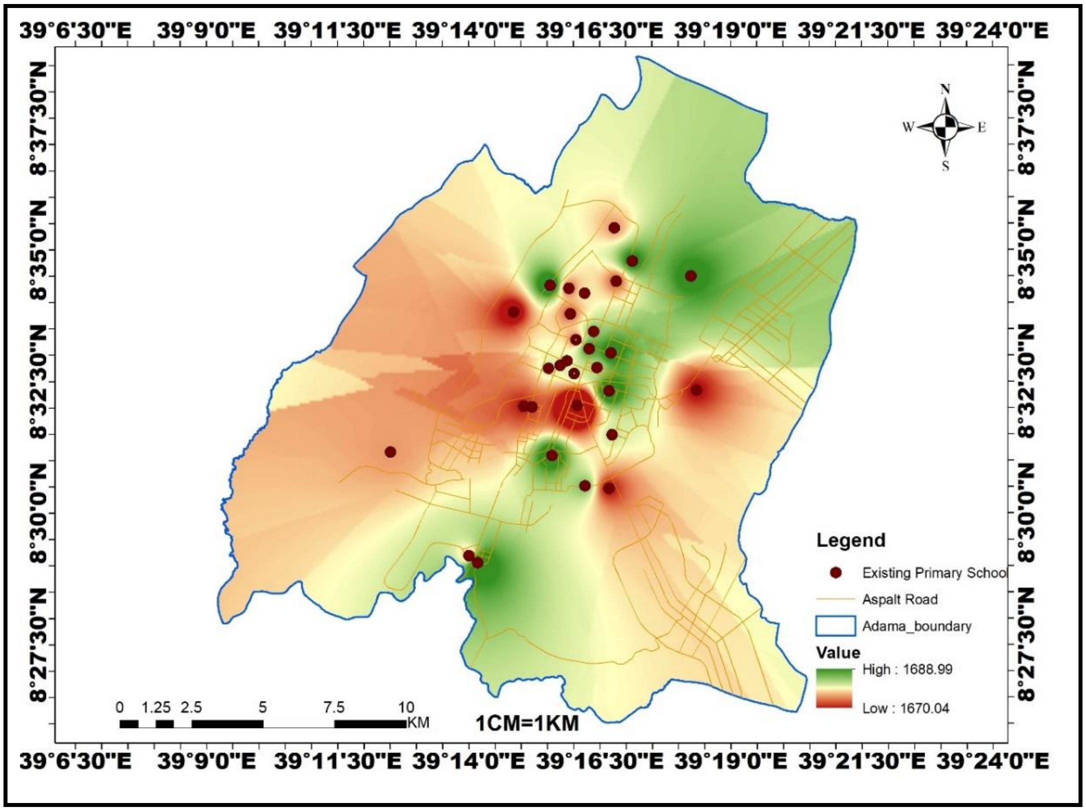

Figure 4. 2: Spatial Distribution pattern of Existing school

4.4 Road Network Map in the study Area

Generating the road network map is the primary part of the analysis for service area coverage in terms of distance, to produce the closet facility, to determine level of suitability in the study area.in this stage try to work on re adjustments and changes in the road network data and the land use of the study area.so its obligatory to change from the original file format to the formal type supposed to use. Arc GIS Network Analysis uses the road network to find its analysis result. But Adama city road network data were available in only area shape files. Hence; Asphalt road, secondary road and local road the center line of this network data set are traced from the existing and digitized using editing tools in arc map. After all editing activities are finished Adama city road network topology (i.e. geodatabase topology) is built.

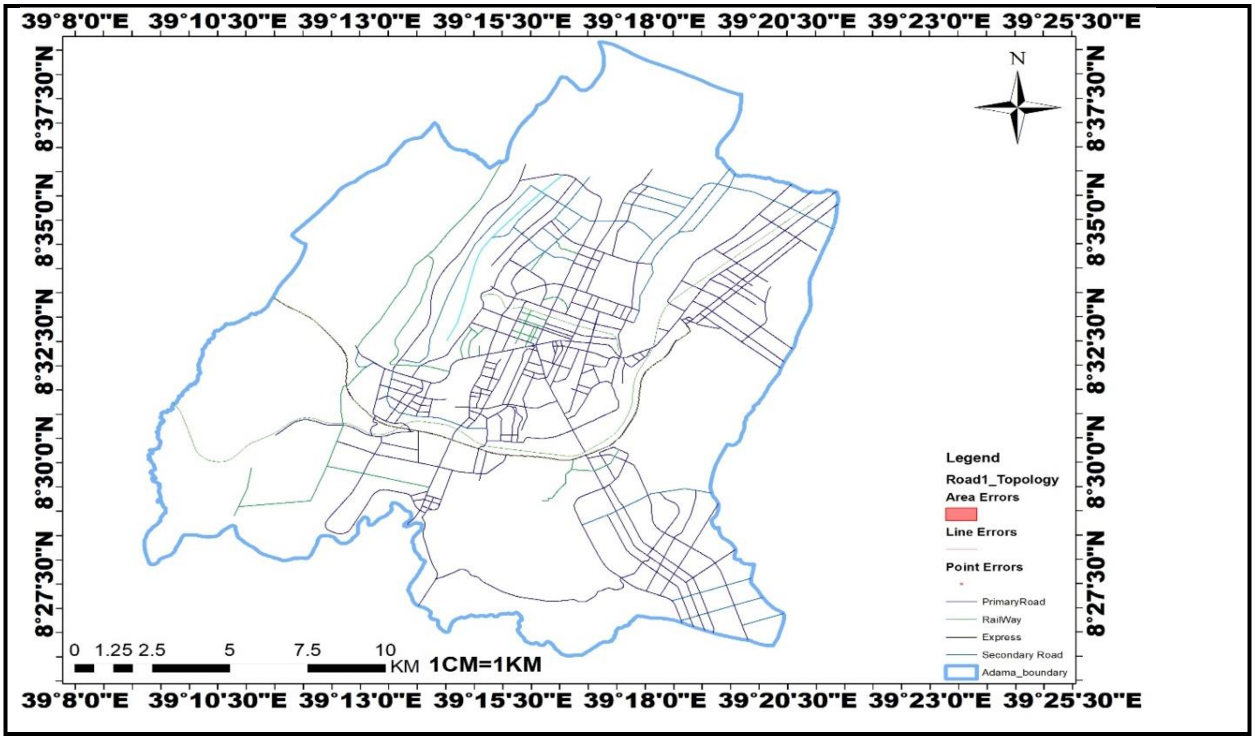

Figure 4. 3: Road network Topology Map

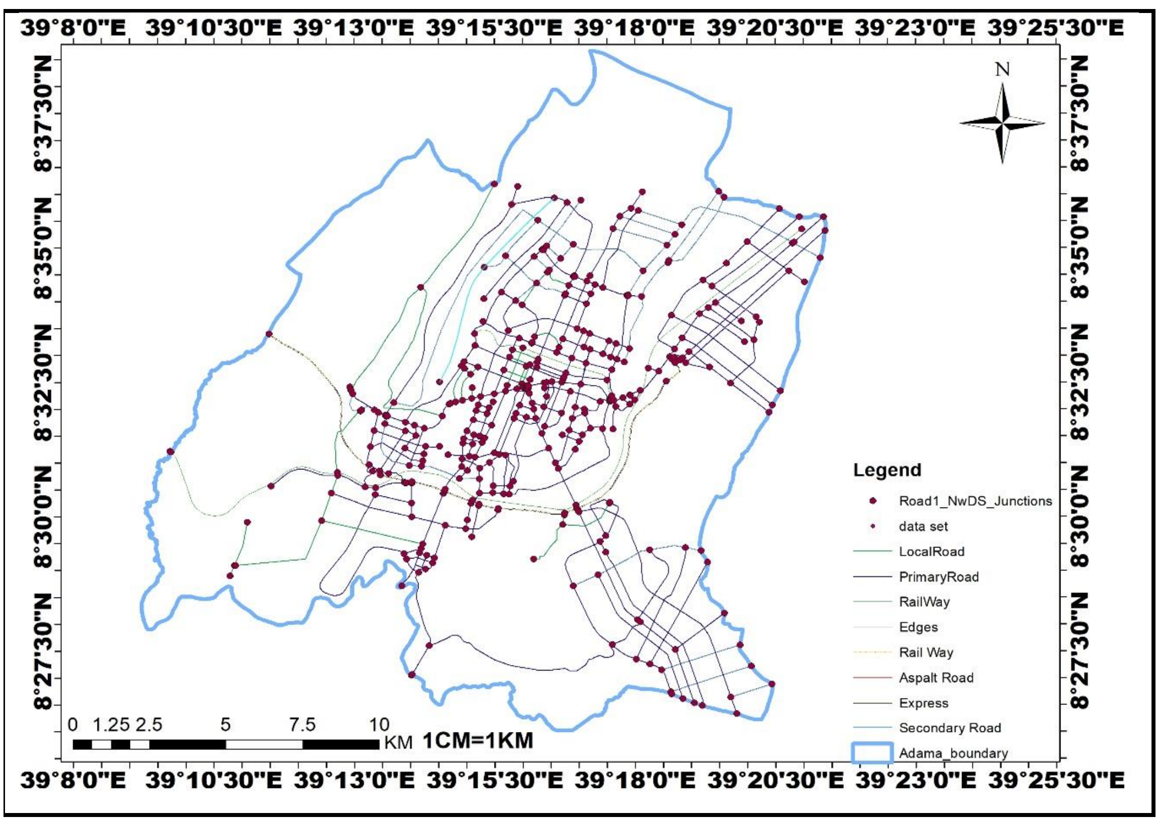

Figure 4. 4: Network Dataset map

In Fig.4.4in the legend content, the three error symbols are not seen in the map because the Street Network Topology is free from any type of error The street Network is topologically pure in its connectivity and the next step is to build a network dataset which is used directly as an input for the analysis part. And the network dataset is the pillar on which the analysis is made. Network can be created either from only involved line features (i.e. street data) or including both points and areas in a similar fashion made in the topology. There are some elements that are simultaneously created with network dataset. But the importance of the elements depend on many factors such as traffic flow, over passes, tunnels, complexity of the roads and their hierarchy etc.

4.5 Location Allocation Analysis Results of Primary Schools in Adama

The problems to be studied with the help of ArcGIS network analysis, location allocation is undergone through the study area of the whole Adama city and overview of the results tells different aspects of accessibility and coverage made below. The analysis investigated the state

of demand-facility interrelationship in terms of distance in five scenarios (0.5km, 1.5km, 2.5km, 3.5km, 4.5km distances) and comparison of results are organized to solve location and access problems in order to meet the objectives set at the very beginning of the study. In addition to this, service area analyses for each school are made in the same way as location allocation using distance variables. The main intention of the researcher to use service area analysis beside the Location allocation is to address that the school supply coverage is best described using service area analysis while accessibility is preferably interpreted using location allocation analysis.

4.6 Distance Based Analysis

Distance is a cost attribute used as impedance for the network analysis settings. Two of the impedance cut off values are 0.5km and 1.5km which are below the allowable search radius 2.5km maximum acceptable distance as per the recommendation of the standard. while the rest two are 3.5 and 4.5 which are above the radius. On this basis the 0.5km impedance cost is set between the demand nodes and school services. Then solving for this resulted 52431 demand nodes allocated (59.27%) within the given limit from the school facilities. Similar progress is followed to the rest distance variables and 68754(77.27%) nodes at 1.5km, 78930(89.705%) at 2.5km, 86510(97.705%) at 3.5km and 88446(99.89%) at 4.5km are located to the nearest schools.

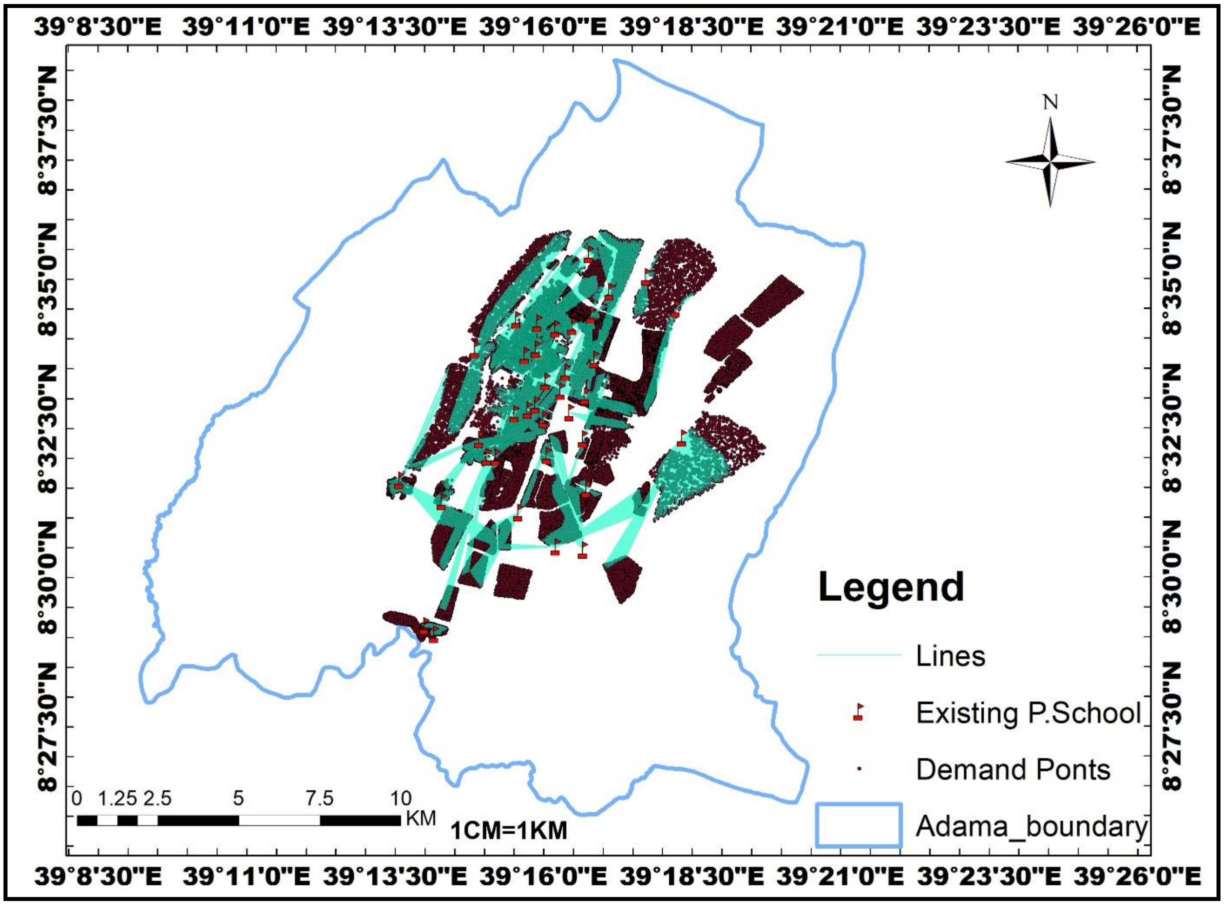

Figure 4. 5: LA Analysis Result 0.5KM Impedance Cutoff and Scarcity Area

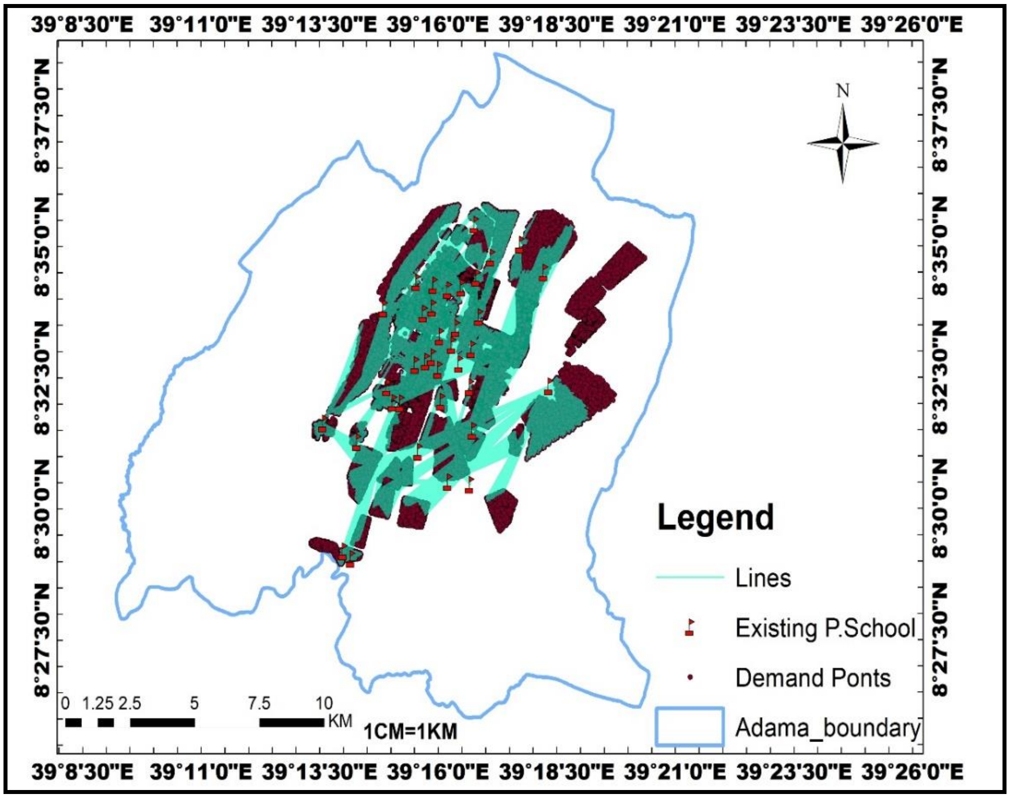

Figure 4. 6: LA Result 1.5KM Impedance Cutoff and Scarcity Area

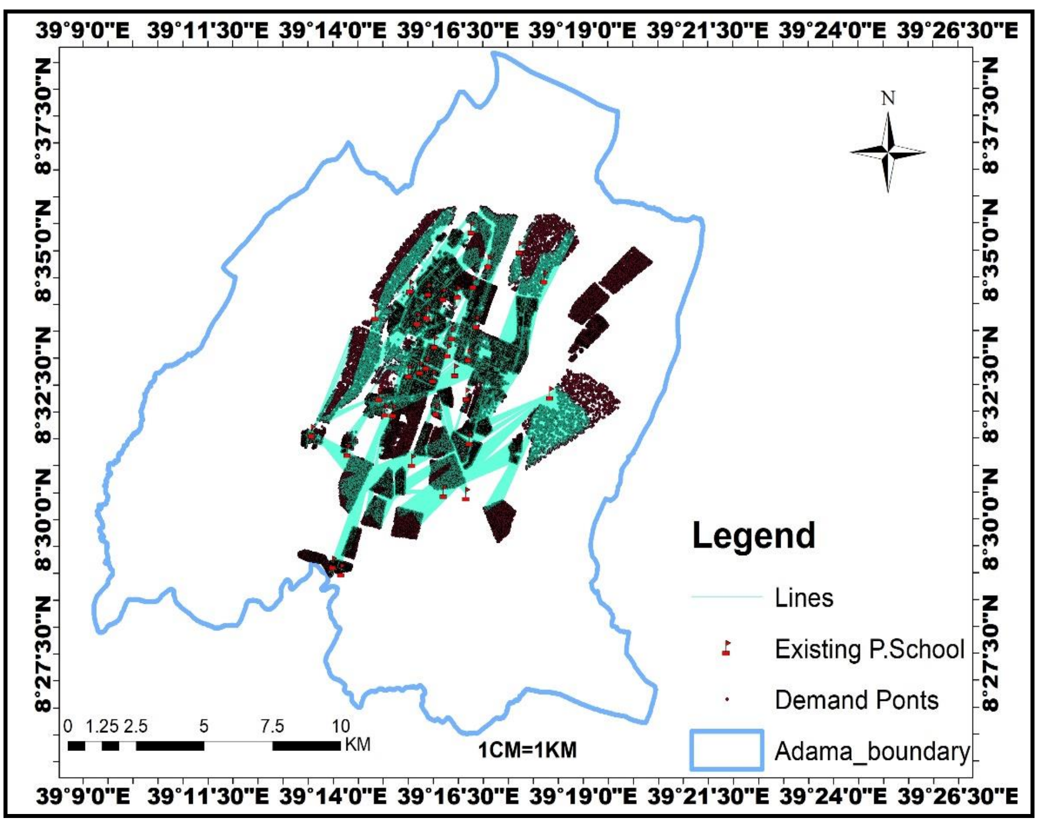

Figure 4. 7: LA Analysis Result 2.5KM Impedance Cuttoff And Scarcity Area

From the above (Fig4.5,4.6,4.7), each line in cyan color with hidden demand node at one of its end and symbolized school node at another shows the gap between the service and the demand node (student home) that attend the service. The lines are at different lengths and those with short lengths describe that the students are close to the services while the longer distances show students are far from the services. It is also observed that nodes with long lines are frequently seen in the central, Northern and Eastern part of the area where primary school provision is low. The reverse is true where the schools are abundant and as a result the students can get their school near to them. Longer lines show longer distances taken by students along roads from the area to school sites that are in the 2.5km limit. Students beyond this limit are left unallocated to the facility. Therefore based on these in Fig. 5.7, the central and northern parts of the city population because they are beyond the set limit, they are left unallocated nodes. This intern implies that there is need for new schools to be built in these area.

4.6.1. Service Area Analysis

Service areas are also generated the same way made in the LA analysis except it creates concentric polygons around the facilities based on the given network. Population nodes that are involved in one of those polygons is known to be accessible to the facility from the result in relation with the network. To identify this coverage amount, **distance** cost attributes are evaluated in five different magnitudes of intervals known as default breaks. Three break values are assigned in both distance 0.5, 1.5, 2.5, 3.5 and 4.5 kilometers for distance).

4.6.1.1. Distance Based Service Area

In this phase of generating service areas for the facilities, the cost attribute employed is distance. Five scenarios are laid here the same way made for the distance based analysis of location allocation in the above by taking the standard recommended distance of 2.5 km into consideration. Based on this, 0.5 km for the first, 1.5km for the second, 2.5km for the third, 3.5km for the fourth and 4.5km for the fifth scenario are selected to generate the results. In the 0.5km service area, 58640 population parcels are included from the total that amounts 66.22%. Therefore, it tells that 58640 of population can access the existing 30 schools in a walking distance along the preferable road network (road that takes to proximate school destination). Secondly, a 1.5km distance scenario is used and after solving for the problem the result implies there are 78456(88.69%) population nodes are enclosed in it. The remaining 10086 nodes are left over to the third distance scenario where the median value 2.5km is used as the default break (impedance) value. Then solving for 2.5km outstretched service area, 82175 (92.9%) population nodes are bounded and 6367nodes are not trapped to the service area that expands 2.5km away from the facility along the existing road network.The main objective of analyzing these situations are, to find areas that are left unreachable by nearest primary schools in Adama City and as a result to introduce additional primaryschools in the scarcity area.

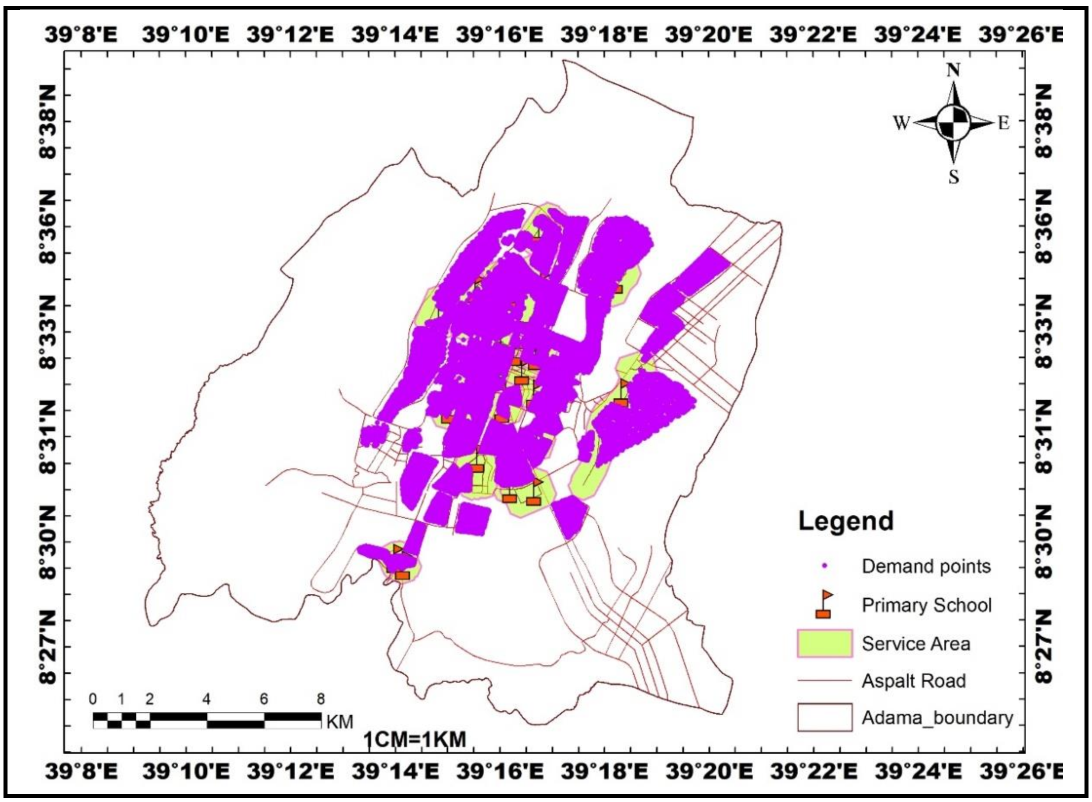

Figure 4. 8: SA Analysis Result at 0.5 Break value and scarcity Area

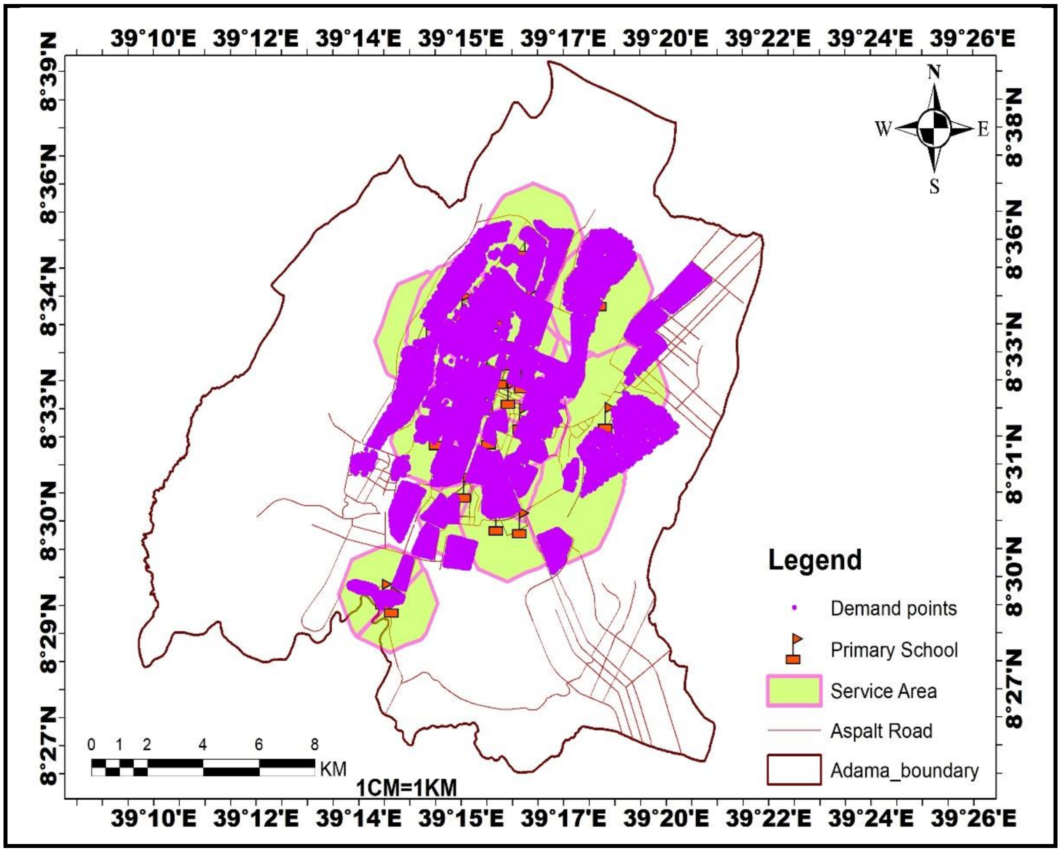

Figure 4. 9: SA Analysis Result At 1.5 Km Break Value And Scarcity Area

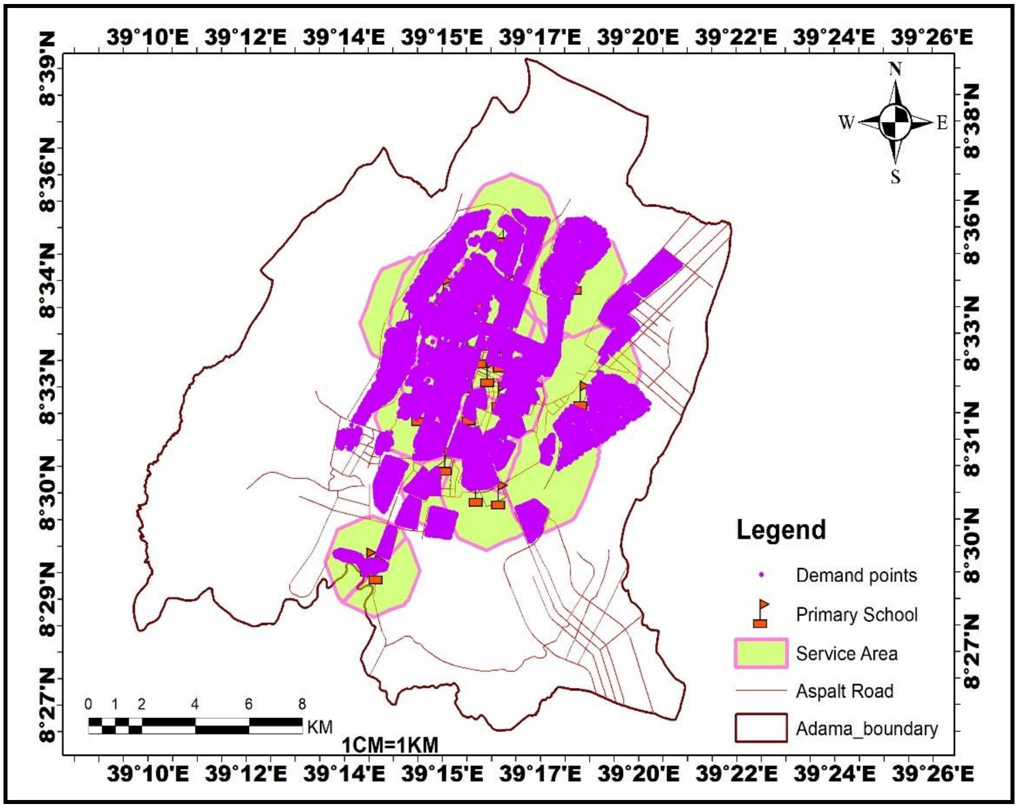

Figure 4. 10: SA Analysis Result 2.5 Km break value and scarcity area

Table 4. 2: LA and SA Analysis Result in terms of Distance

Cost attribute	Cost value	Location Allocation			Service Area		
		Located Node	Percent %	Unallocated Node	Located Node	Percent%	Unallocated Node
Distance KM	0.5	52431	59.27	36111	58640	66.22	2902
	1.5	68754	77.65	19788	78456	88.69	10086
	2.5	78930	89.144	9612	82175	92.903	6367
	3.5	86510	97.705	2032	87652	98.99	890
	4.5	88446	99.89	96	88528	99.98	14

4.6.2: Candidate site selection for new school

From the LA and SA analysis in 2.5km impedance value,9612and 6367 student nodes respectively are far from school (out of range). Because of this, to reach these population by school access another additional schools must be constructed in their area. So based on the scarcity are candidate locations are proposed for new schools.

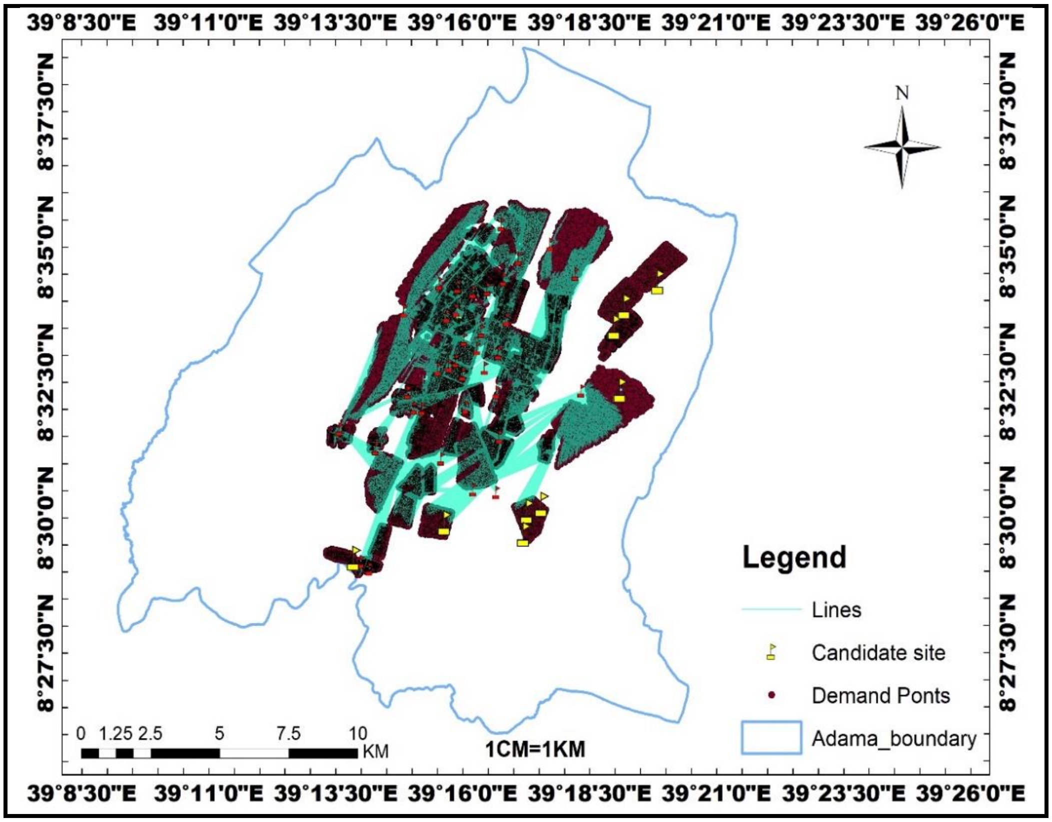

Figure 4. 11: Candidate site for primary School as result of LA and SA

On the above figure the school sites symbolized in Yellow color are planned to be at points where they are built and believed to give service to the remaining population that are beyond the distance from the existing 9 spots are projected to be school places but this does not mean that at all points, schools should be constructed. As can be seen they are known by candidate sites such that the most optimal ones that essentially serve the demand nodes should be selected from them. On the basis of remaining population (unallocated nodes) from the LA and SA outputs at 2.5km impedance value which are respectively 9612 and 6367 in Table 4.1, 5 candidates are proposed again to be reselected (Chosen) from among the potential sites. The five chosen sites are known only after resolving the LA analysis in the same way that has been performed at 2.5km impedance cut off for the existing schools. In this case candidate sites are loaded to the facilities tool option in the network analyst.

4.7 Optimizing school site

In Ethiopia, as mentioned above developed standard and used for public school site selection have weakness which mean not deliver enough and detailed information for each parameter standard. So that in this thesis the standard used by a researcher for each parameter are taken from various previously conducted researches by different scholars for suitable site selection for public school.

The chosen sites as a result of LA and SA might be disallowed if they are evaluated in terms of suitability due to elevation (slope) factors, land use land cover factors, noise factors and population factors etc. Therefore, studying from these aspects is compulsory to either validate or relocate the sites. The mechanisms used for solving this problem is provided by spatial analyst extension of ArcGIS.Spatial analysis methods of decision making requires the input data to be changed in a valid format to come to the desired result. Therefore rasterizing is the process from which participating data are converted from either vector or from raster to a raster form that is required. So the raw elevation data is changed to slope.

Existing schools, existing noises , population and suggested sites for new schools are point data that are originally in the vector format. Euclidean distance toolset from the spatial analyst tools changes these into raster format. It is distance because it calculates the proximity for each pixel in the output raster from the existing source data within an extent of Adama city in this case.The listed input datasets are already prepared. Reclassification is made by giving similar Surface slope is divided mostly into four common ranges based on the steepness of the surface which are flat (0-5), Rolling or gentle (5 -25), mountainous (25 - 50) and escarpment (>=50). But for the matter of ease of analysis in this study, terrain slope is reclassified into constant intervals of five 1 (0 -5), 2 (6-15), 3 (16 -25), 4 (26 -35), and 5 (36 -47).

Intervals that are at high degree values show mountainous or escarpment areas and are not comfortable to build schools. Because of this, areas of such slope values are not selected. On the other hand areas from zero to gentle slope will be the most suitable. This implies suitability increment is the reverse of slope increment. For this study six parameters were identified to Map suitable sites for primary school. These criteria are proximity to existing school, Land use, population density, road, slope and Noise. All parameters are supported by known source. Thematic map of all parameters illustrated above each Euclidean distance calculated for six criteria data set. After Euclidean distance has been done, the reclassification for each parameter was computed. Each reclassified suitability map of parameters is ordered from the most suitable to unsuitable.

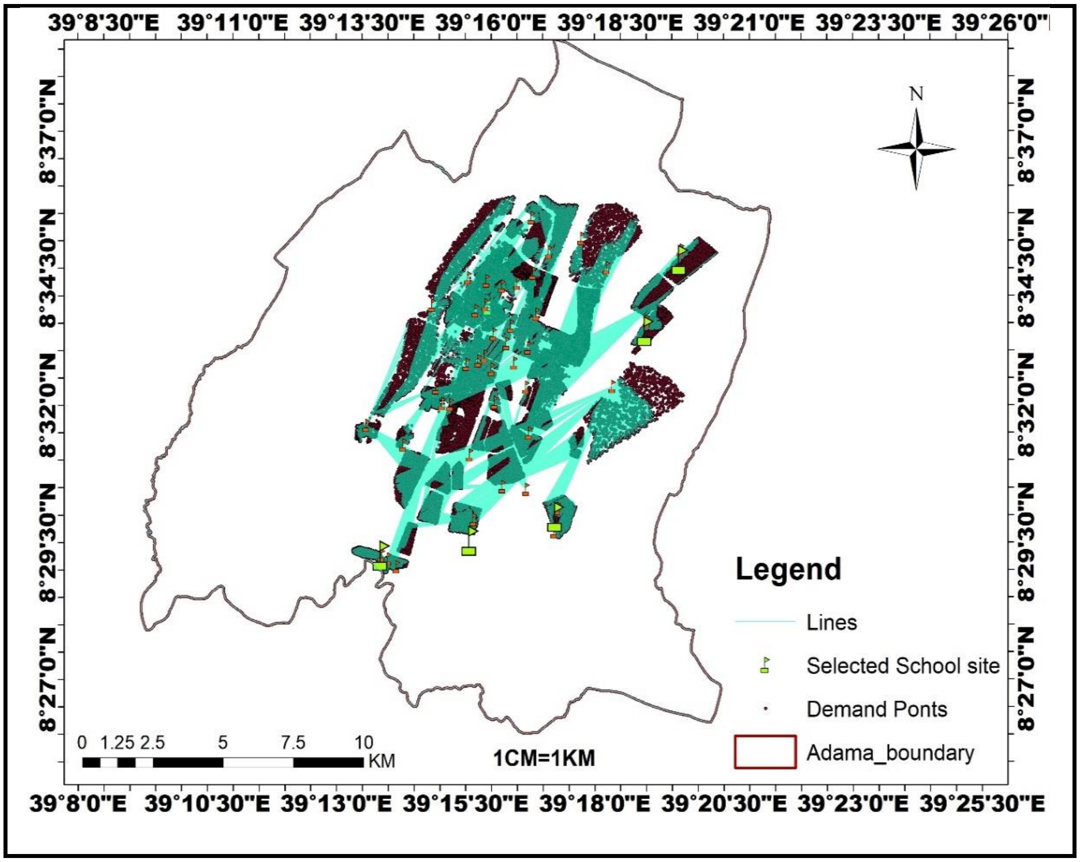

Figure 4. 12: Selected suitable site for Primary school

4.8 Reclassified Standardized Map of determinants

The reclassified and proximity Distance map of the slope, Existing school, population density, distance from main road, noise site and Land use land cover maps are shown below:

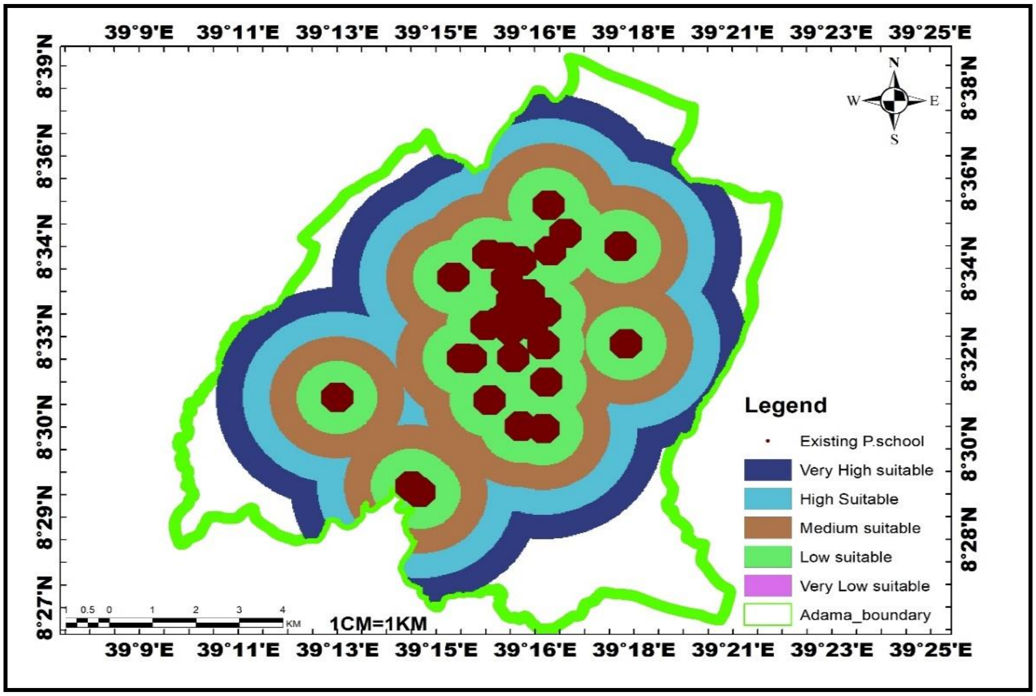

Figure 4. 13: Proximity distance from existing school

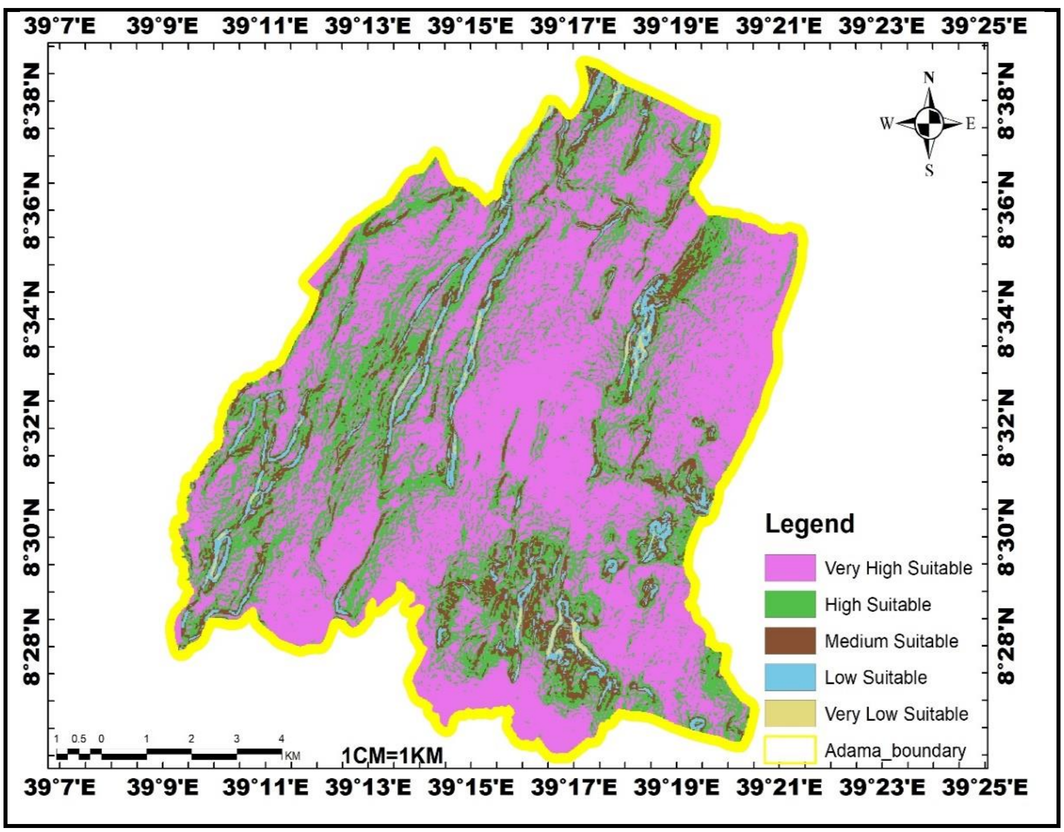

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Figure 4. 14: Reclassified slope Map

Figure 4. 15: Proximity distance from Noise Area

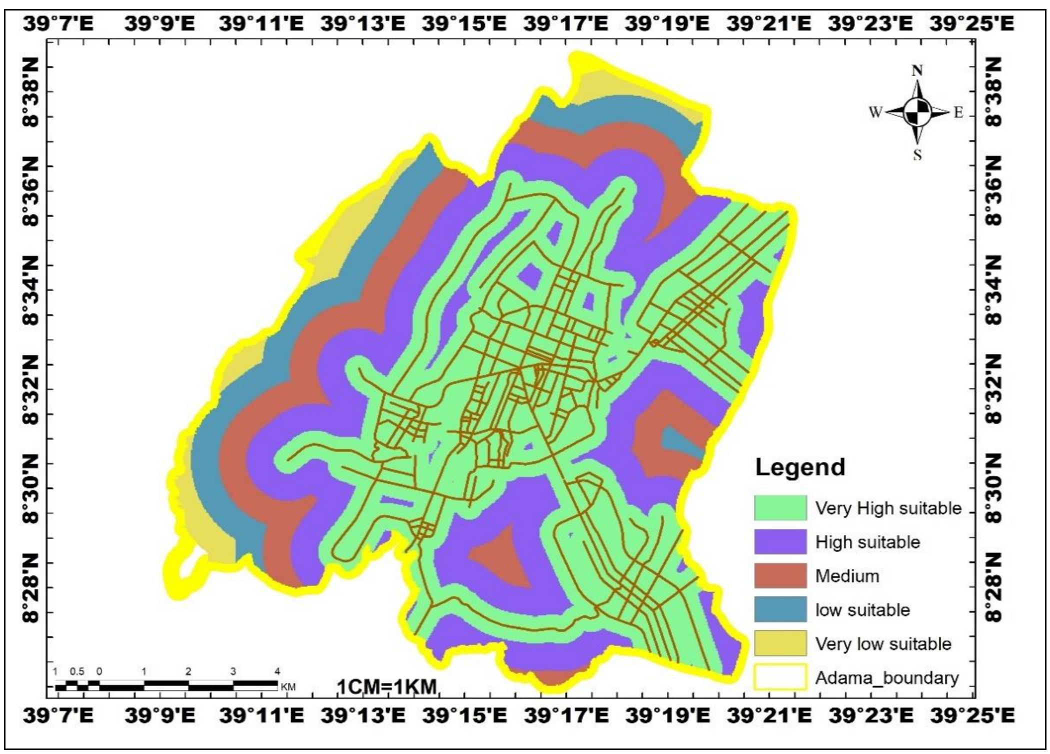

Figure 4. 16: Proximity Distance from Asphalt Road

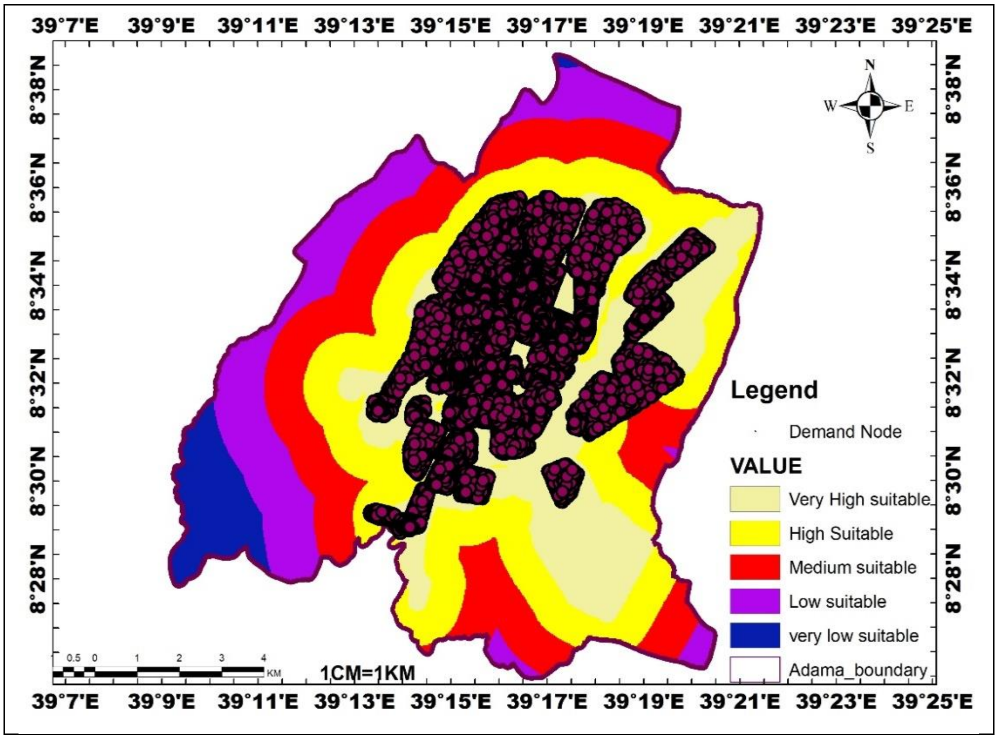

Figure 4. 17: Proximity Distance from Population

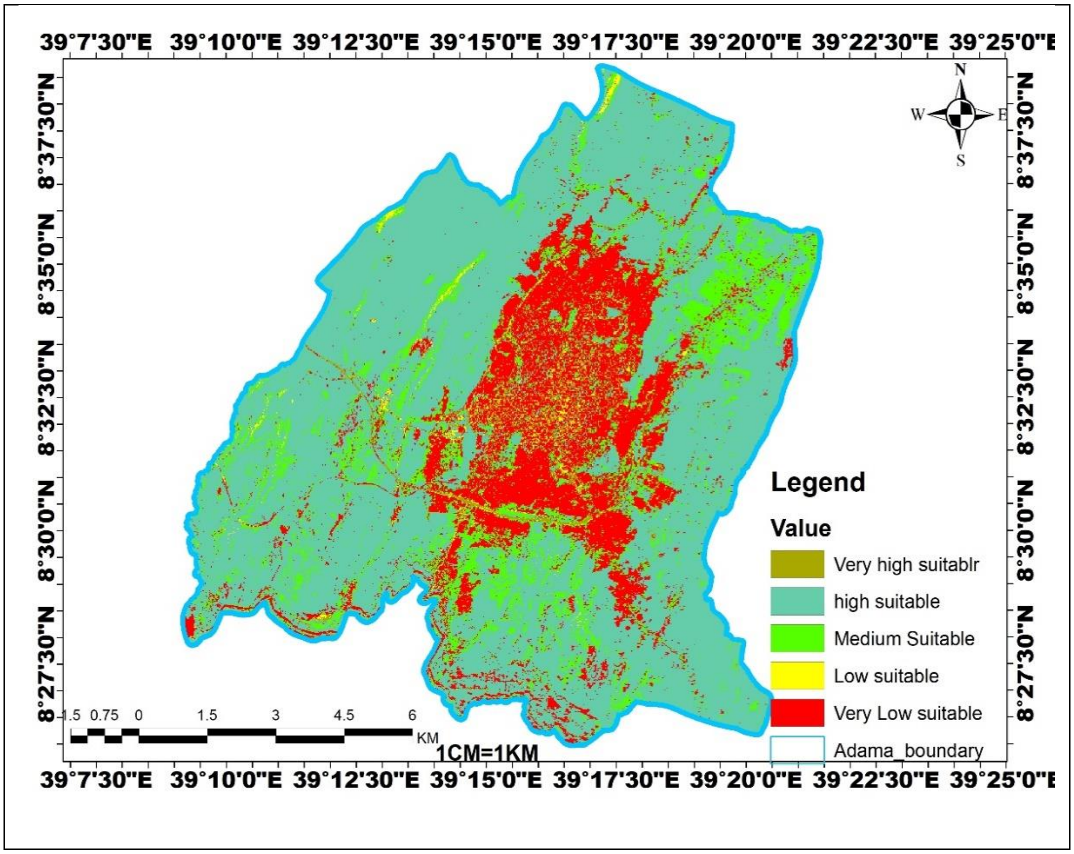

Figure 4. 18: Land Use land Cover Reclassed Map

4.9 Modeling suitability Analysis

The model builder in Arc GIS Analysis tools was used for primary school suitability Model. This is well known as flow chart technique.in the flow chart approach primary school suitability model was constructed from individual process of input data. By GIS technique and derived data which are then linked together. The suitability Model and integrated suitable site selection model. GIS packages and tools were used to facilitate different stage of evaluating suitable site for school site in Adama city. Including mapping of constraint map and factor, Combining factors Identifying school site and presenting Gis output to decision maker.

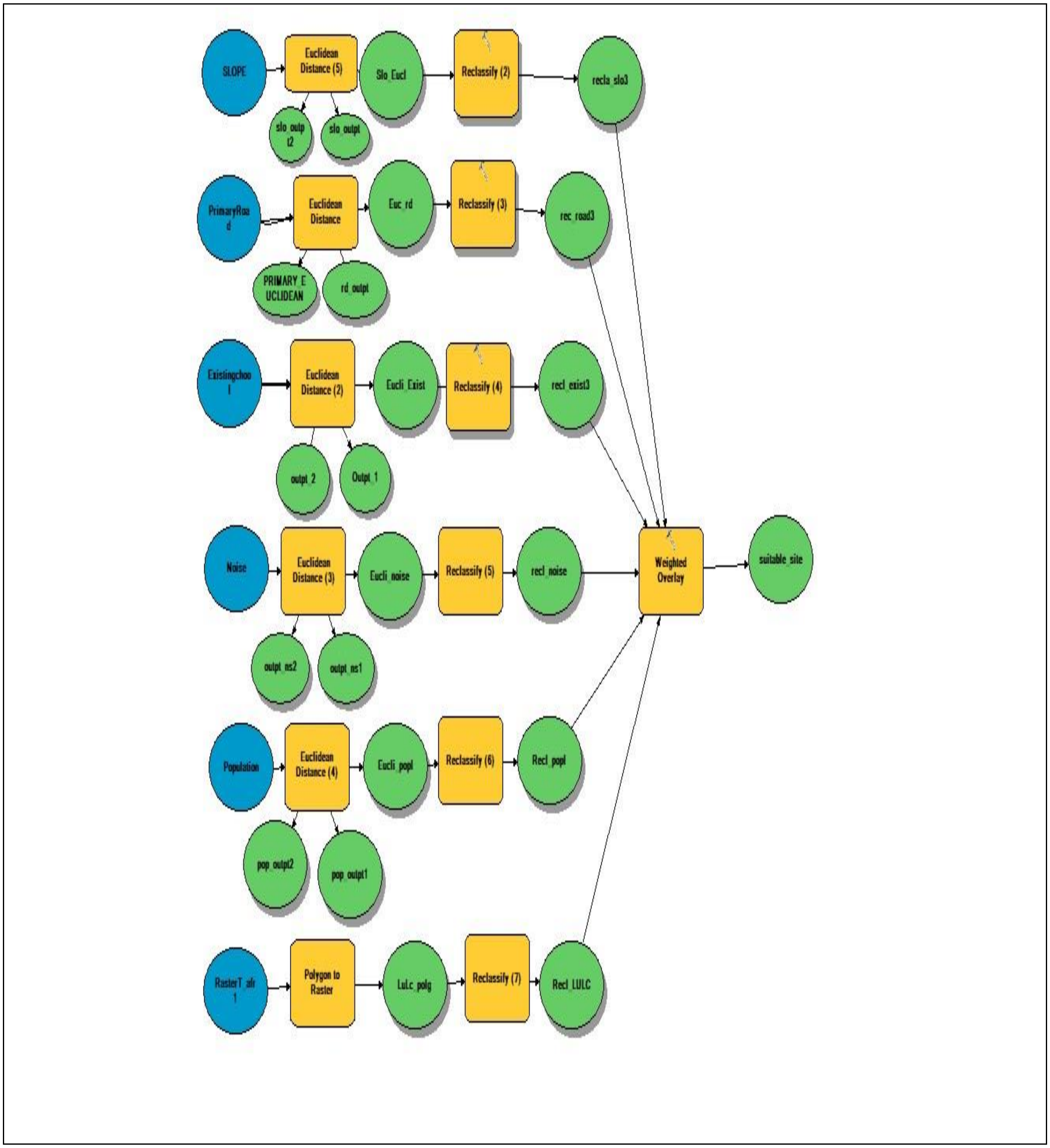

Figure 4. 19: Model Builder Work Flow of the spatial Analysis

Table 4. 3: Suitability Range Factor criteria for new primary school Site Selection

NO	Percent from slope	Suitablity	Score value
1	0^0 -5^0	S1	1
2	6^0 -15^0	S2	2
3	16^0 -25^0	S3	3
4	$26^{0\ -}35^0$	S4	4
5	35^0-47^0	S5	5
NO	Destance from Road	Suitablity	Score value for reclassiied
1	0-500	S1	1
2	501-1500	S2	2
3	1501-2500	S3	3
4	2501-3500	S4	4
5	3501-4500	S5	5
NO	Destance from Existing School	Suitability	Score value for reclassified
1	0-500	1	1
2	501-1500	2	2
3	1501-2500	3	3
4	2501-3500	4	4
5	3501-4500	5	5
NO	Destance from population	Suitability	Score value for reclassified

1	0-500	1	1
2	501-1500	2	2
3	1501-2500	3	3
4	2501-3500	4	4
5	3501-4500	5	5
NO	Destance from Noise site	Suitablity	Score value for reclassified
1	0-500	1	5
2	501-1500	2	4
3	1501-2500	3	3
4	2501-3500	4	2
5	3501-4500	5	1
NO	Land use clases	Suitability	Score value for reclassified
1	Built up	1	1
2	Green and open	2	2
3	Reserved Area	3	3
4	Water body	4	4
5	Road	5	5

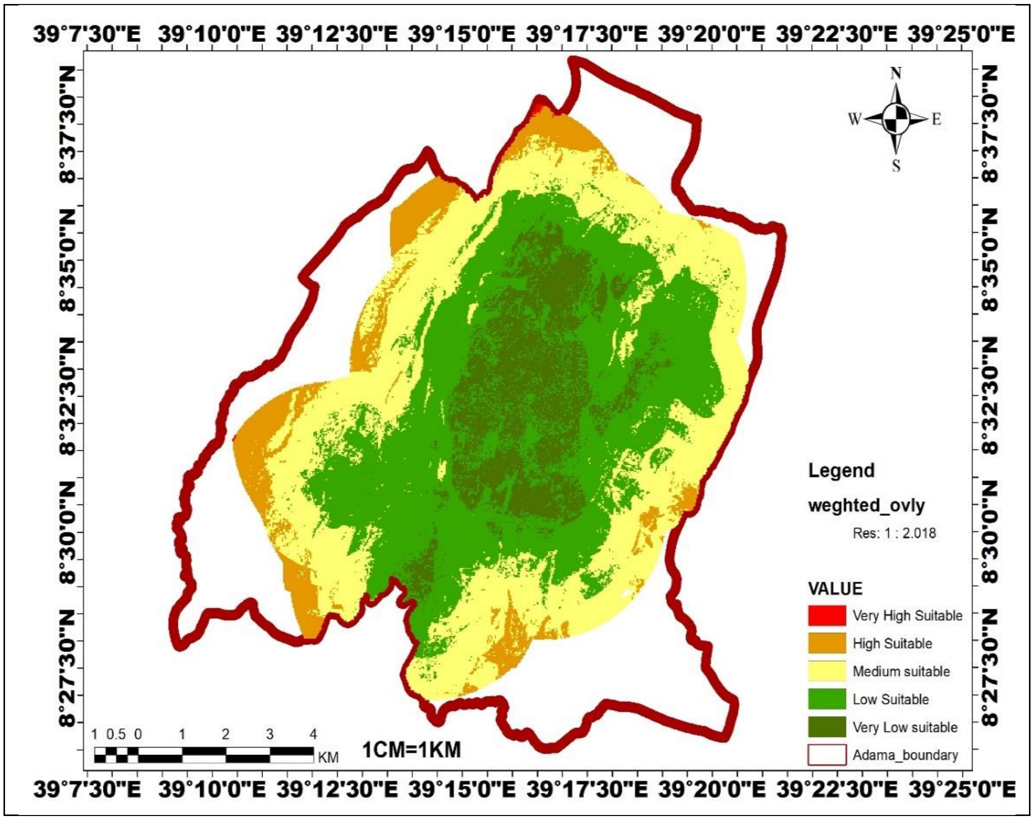

Figure 4. 20: Weighted Overlay Map

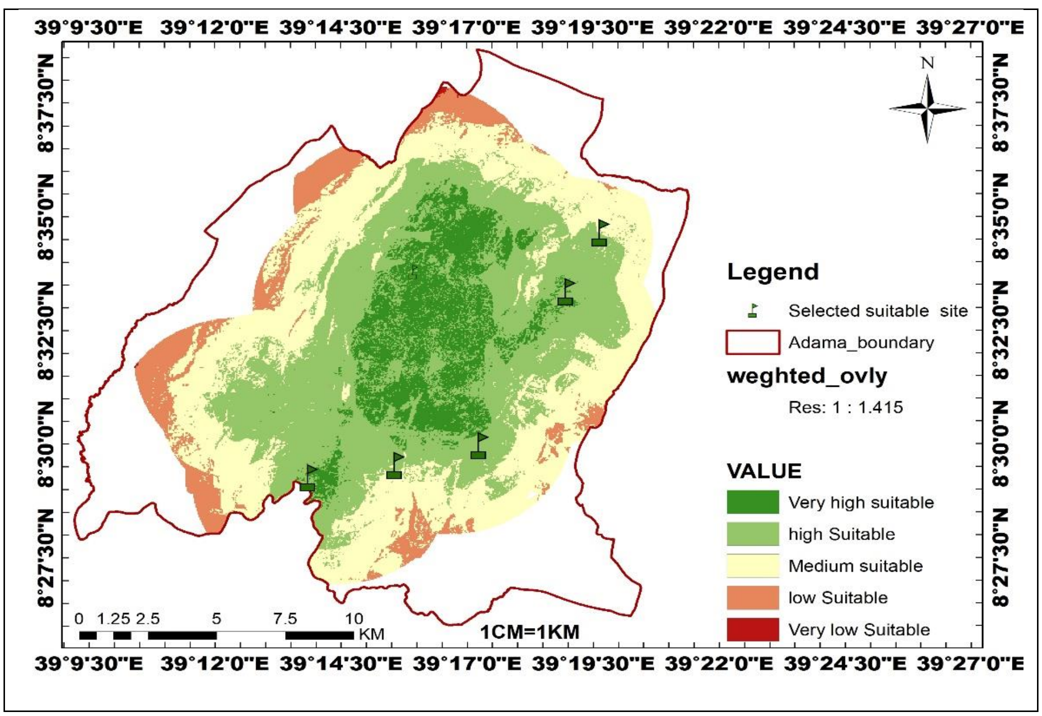

Figure 4. 21: Weighted over lay with selected Suitable site

4.10 Discussion

The main objective of conducting the research is to find results on how to balance distribution of the primary schools and how to establish the school services near to the population (Student) environment. Various factors are investigated in order to achieve the intended goals and objectives set for this study. It is seen through Fig. 4.2 & Fig. 4.3 that distribution is not uniform and instead they followed dense patterns of road networks and residential areas. Due to these reasons, on these figures school services are very dense or closely built central parts where peoples live sparsely are very rare. The development of these services should of course follow these dimensions but it does not mean that population groups that are dispersed do not share the service opportunities. Students from these society are attending their education by covering distances that are beyond the customary in the City. This distance variation could be observed from the LA and SA analyses results (Fig. 4.8 and Fig. 4.11) so that there are student population that are yet moving for more than 2.5km from their home to reach school destination.in our country standard 2.5km distance to be the minimum allowable cost value that is recommended to exist between two school facilities nearest to each other. But from the current situation where the limit is not currently practical in the City, schools are unevenly distributed. The first part of analyses compares results drawn from LA and SA of the same basic data set in five distance scenarios that is 0.5km, 1.5km, 2.5km, 3.5km and 4.5km variables between school services and demand points in Adama city. From this, above half (52431) nodes in LA and (58640) nodes in SA analysis) are allocated to the facilities from the 88542total demand nodes within 0.5km (Table 4.1). (68754)77.65%demand and(78456)88.69located on 05-1.5km distance in La and SA .The limit value (i.e. 2.5km) is used and the result provided 78930 points are allocated which equals to 89.14%. This implies the services can be taken as enough supply for the demand from the population of the City. But the un-allocated demand nodes 9612 and 6367 for LA and SA from 88452 respectively10.86% demands are outside this limit. *Therefore the main intention is to make this population accessible to primary school services within this limit or standard distance.*86510 demand that is 97.705% and (87652) 98.99% are located at 2.5km.-3.5 km distance in LA ad SA.(88446)99.89 demand (88528)99.98% are located at 3.5km-4.5km in LA and LA .The Last 4.5km search radius reduced the un-allocated points to 96 and

14 For LA and SA respectively. Based on this, the area in which un-allocated population beyond the limit distance lives is identified as Scarcity area.

Based on the results show that almost all locations can be shown to be “optimal” for the school facility location. The optimality of a set of sites obtained from LA analysis only pertains to a general set of zonal demand data and not necessarily to the true underlying demand structure. Therefore, in relation to the solution of LA analysis using combined data, it has a limited sense. Thus it has a clear implications for the use of spatial analysis technique to find the most reliable sites for school depending on the optimized sites by LA and SA analyses. Technique uses in this analysis is p-median problem the purpose of using the p-median problem type in LA in this study is to maximize primary school coverage in the focus area so that the walking distance for each student attending school is minimized. This possibly to be achieved using Euclidean distances, or network distances. The Euclidean distance method is used because of its simplicity and beside it helps to find the minimum possible distance and maximize efficiency in solving allocation of demand to facility problem in the vicinity area.

Depending on the spatial distribution analyses and the researcher selected new additional suitable site for primary school by using Network analysis in Arc GIs software.in selection Five site selection criteria are used.1.Land use land cover,2 proximity to the main road ,3destance from population,4 slope,5 existing school ,6 Distance from noise is to select suitable site for primary school in Adama city. The result shows after each raster output is further reclassified into common measurement scale values in order to let each participant factor have equal influence in creating the most suitable areas. For this study case, as can be observed from the consecutive figured maps displayed above a common measurement scale of is assigned for all participating inputs. Combination of the factors by means of overlay analysis resulted the final output aimed to be acquired. Put figure: Result weighted over lay with selected site.

CHAPTER FIVE: CONCLUSION AND RECOMENDATION

5.1 Conclusion

It is now to state the findings of a result of series of consecutive and different methodical testing of input data of primary school services and student population existing in Adama City. The results from Network analysis technique is brought the outputs to reach at the goals and objectives of the research based on which the following conclusions and recommendations are developed.

The study revealed that the Spatial Distribution in the study area which LA and SA analyses result indicated: in fig.4.8, 4.11 and of suitability analyses show that within distance cost of 2.5km more than 98.99% of the school population are accessible to school services currently existing in the study area. There is no planned mode of school distributions in the demanding environment of the community so that schools are highly concentrated at infrastructure and utility filled areas where as rare number of schools are seen in other areas of population. so additional school is required on area of the city around population size are high but school facility is rare and cost attribute values(distance whose beyond recommended.

In our country there is no firm separation of schools; from sources of noises recognized in educational standard. Therefore, city government is responsible to facilitate religious primary schools that provide regular education by providing separate area for schooling and on behalf, taking the nearest extra land portions owned by Religion Centers. Because it's difficult to keep locations of the current school away from noises.it would dominate with other land use types before land is occupied. In (Figure4.3) the GIs analysis result has shown along the populated community poor planning of primary school location. So for either establishing new primary school distribution this can help decision makers to take an immediate action. And to provide complete service easy accessibility to the community.

And the best method of finding new location for primary school are Gis based LA and Spatial analysis are the most suitable for choosing new school sites and relate to public service.so such scientific studies are required before the area of school is developed by government. It should be considered. In arc GIS function the main inputs for network analyst one is road network. The available road network in the study area is not uniform and has poor standard and its irregularly developed this could be affect LA and SA. this created big disorder in locating demand node to the facility.

The proposed method in this research is environmental, less time consuming and more productive than the traditional approaches to potential site selection for locating new school facilities in this case planer and decision maker s can reduce field vist and survey by mapping new additional the spatial location for Road network available in the Sub-City is not uniform and as well at very low standard. In the ArcGIS special function, one of the main inputs for network analyst is road network. This could negatively affect the LA and SA analysis because the road network in Adama City is irregularly developed. This created a big disorder in locating demand nodes to nearest facilities. school facility in Adama city.

5.2 Recommendation

The finding of this particular have shown that geospatial technology and GIS based on Network analysis are important tools for study to analysis spatial distribution to select suitable site for primary school in the study area. It is found that the following points must be recommendable issues to the respective government organs at the City.

➢ City administration was before establishment of any public service center shall make pre and post facility and customer link studies. And shall prepare ground for regular distribution of public service, infrastructures, controlling informal settlement area and human activity and land value through entire city will be balanced.

➢ Establishing the spatial plan department with Ministry of education is needed who will be responsible the for distribution of planning educational and educational services as well as applying the planning regulations according to the population growth and geographic features of the settlements.

➢ The construction of new schools also considers the distance and arrival criteria, as well as the population and school criteria, to meet the actual need for educational services in some neighborhoods of the study area.

➢ The redistribution of existing schools considers the distance and time of arrival requirements, as well as the demographic and school criteria for separating the original schools from other schools when selecting their locations.

➢ The city education office shall be prepared and organized properly and consistently the school data

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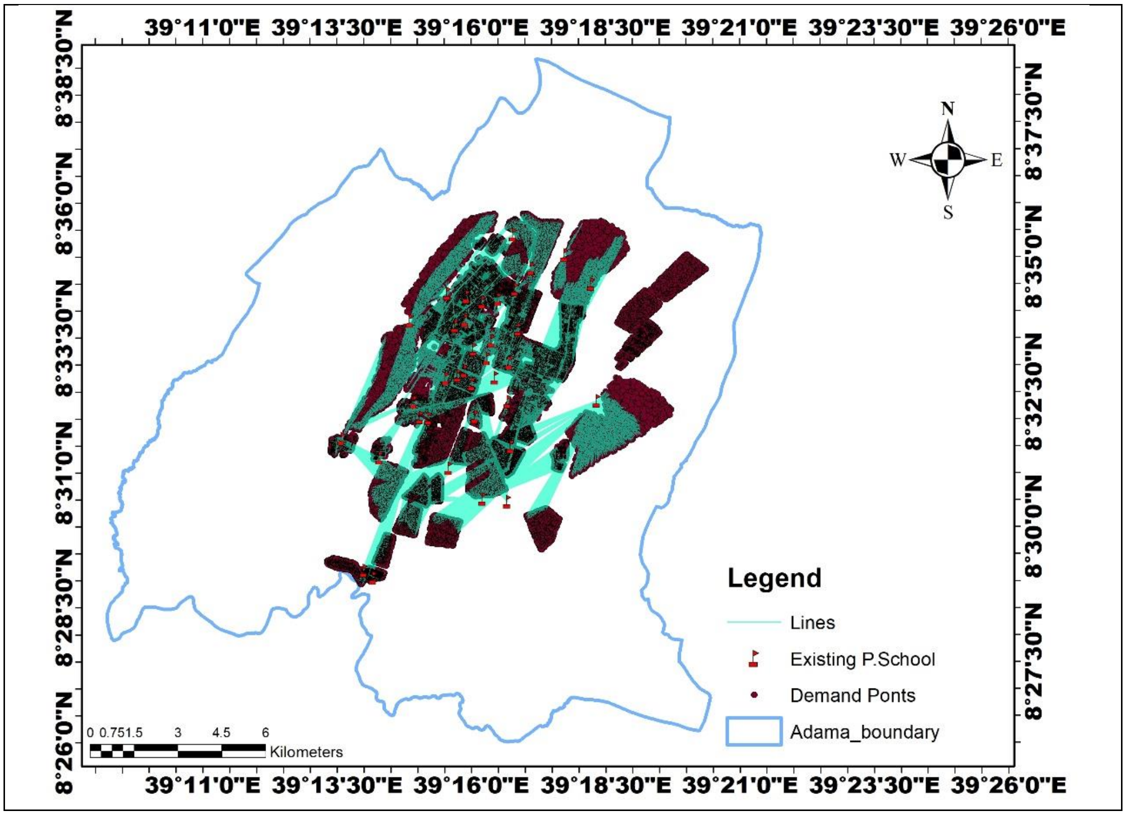
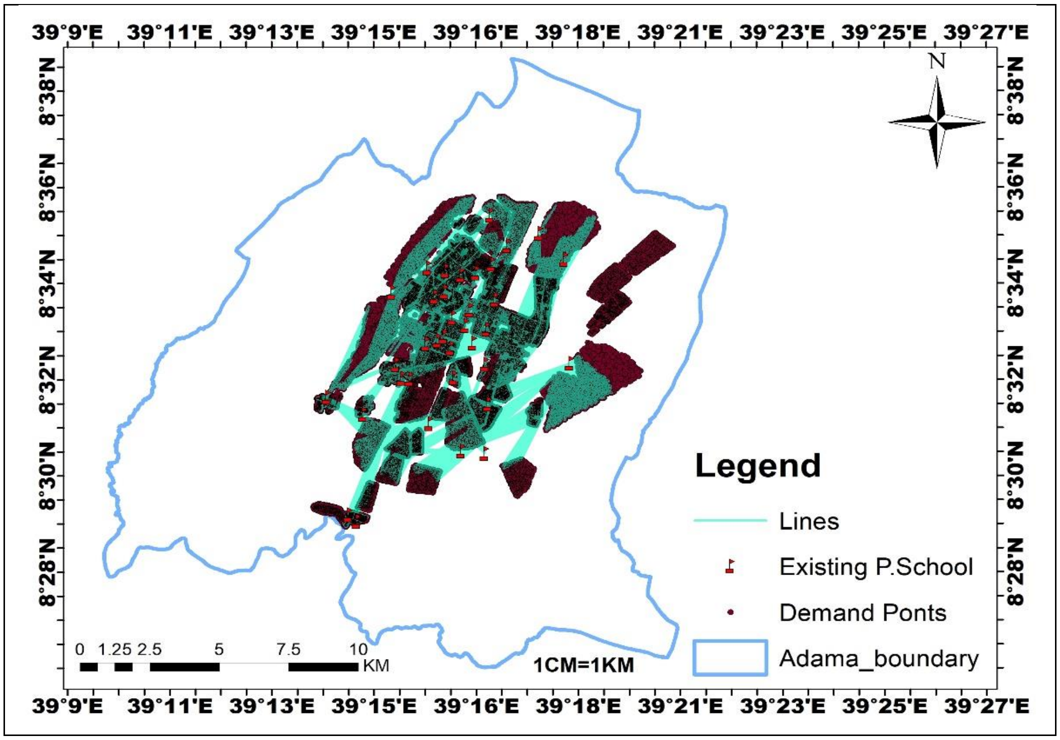
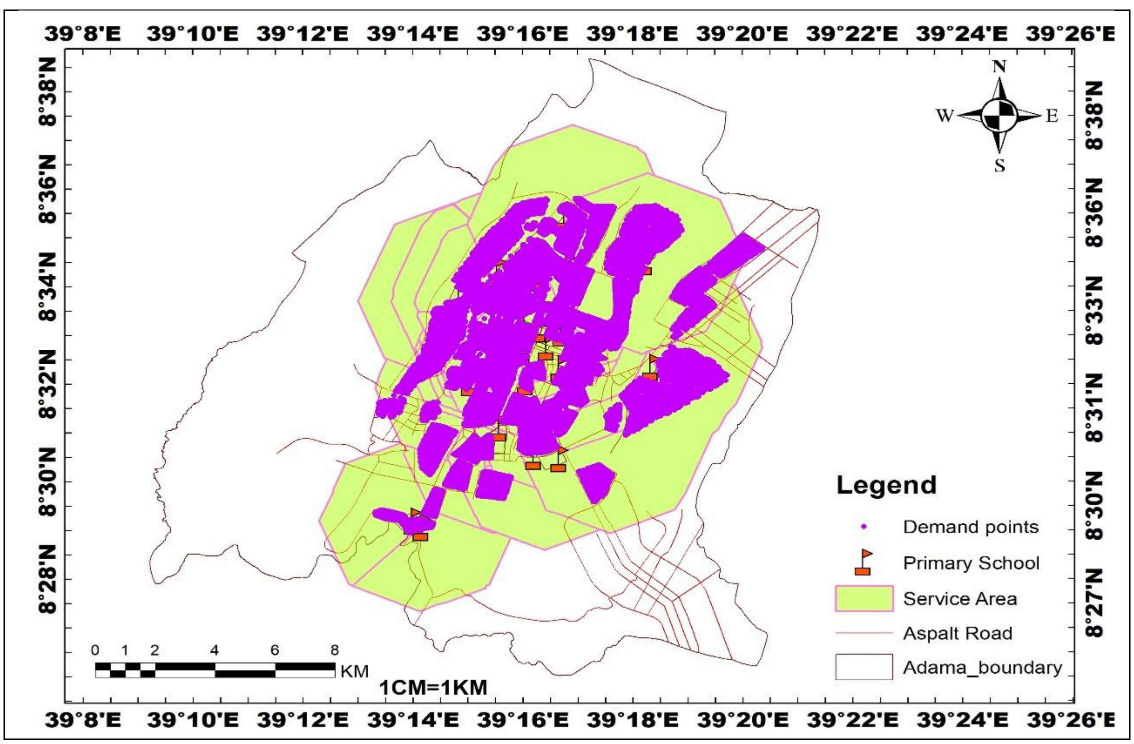
APPENDICES



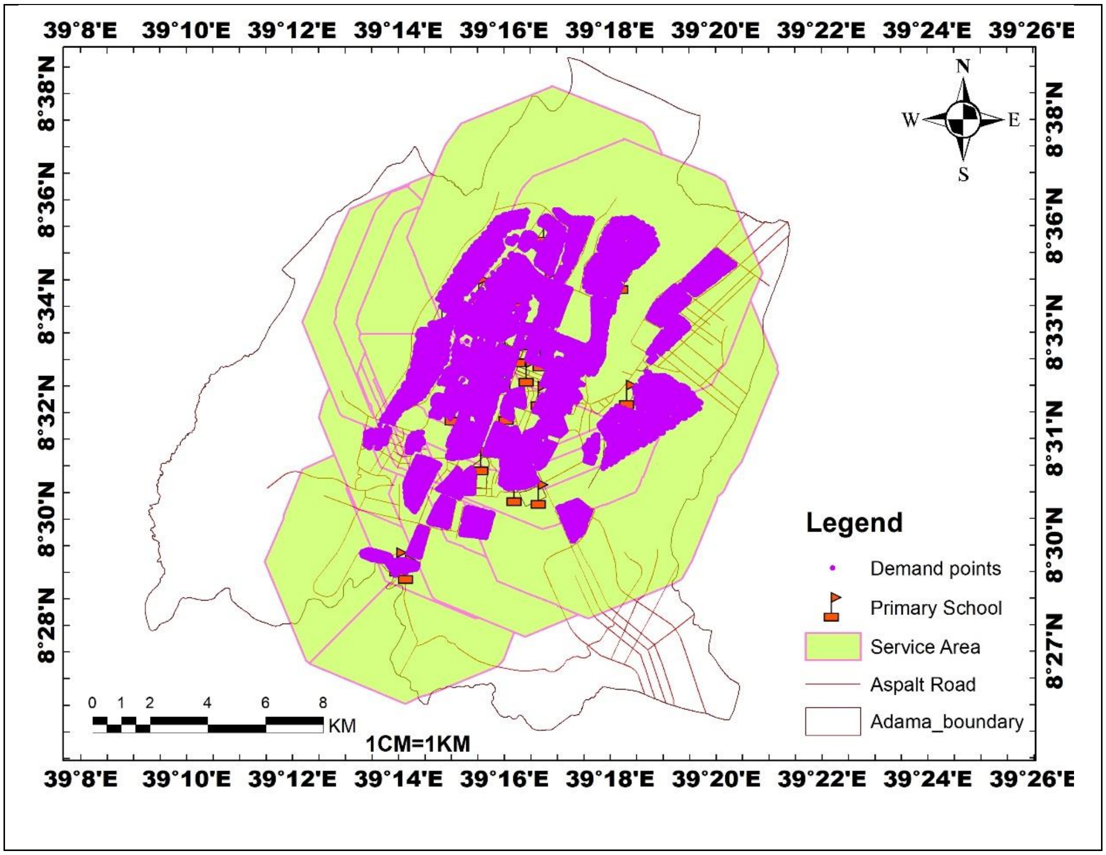
LA Analysis Result3.5km Impedance cutoff



LA Analysis Result4.5km Impedance cutoff



SA analysis result 3.5km impedance cutoff



SA analysis result 4.5km impedance cutoff

Location 1: From Aerial photo

Location 2: From Aerial photo

Location 3: From Aerial photo

Location: 4 From Aerial photo

Location: 5 From Aerial photo

Table: Coordinate of the Location

LOCATION	X-COORDINATE	Y-COORDINATE
1	525443	938125
2	528595	938626
3	531712	939723
4	535184	946189
5	537038	948107

Table: 2.1 Methodology Review

Author	Methods	Location and year	Data	purpose
Hassan et al 2019	**(MCDA)**	Shiraz city, Iran	MCDA, Environmental criteria, socio-economic criteria, questionnaire and literature.	Land fill site selection
Jie et al 2020	Multi-Hierarchy And Multi-Constrained Configuration Model	Nanjing, China	Field Interviews And Survey Data, Network Big Data, And Spatial Information Data.	Select Location of public service facility
Leykun et al 2018	MCAM	Amahara Region Ethiopia	The primary data collection from field and Secondary data were collected from sectorial offices for this study	Suitable site selection and road map preparation

Khalid Ahmed Ali 2018	MCDA	Al-Mahaweel	Land sat Image	Analysis for primary school site selsection
Waleed Lagrab, And Noura Aknin 2005	GIS-SLEF Model	Mukalla Yemen	Satalite image, schools and land use, network roads as, districts and zone boundary and etc	Suitability analysis for elementary school
Tamer Ali Al-Sabbagh2020	Location allocation	Mansura ,Egypt 2021	School location Location Map Road	Improving accessibility primary school
Abdulkader et al 2021	Location allocation P-median model	Jeddah (Saudi Arabia) 2021	Road network map, population distribution, health center location,	Optimizing location for Health center
Wondwossen Mindahun Eshetu 2016	Location allocation	Adis Ababa 2016	GPS Coordinates of Schools, Road network, Residential area,Parcel Maps, Demographic data and etc.	Selection suitable site for primary school.

Temesgen Abraham Gebreselassie 2021	Location Allocation	Adama 2021	Land Use Map Population Road Healthcare centers	Establishment of new health center

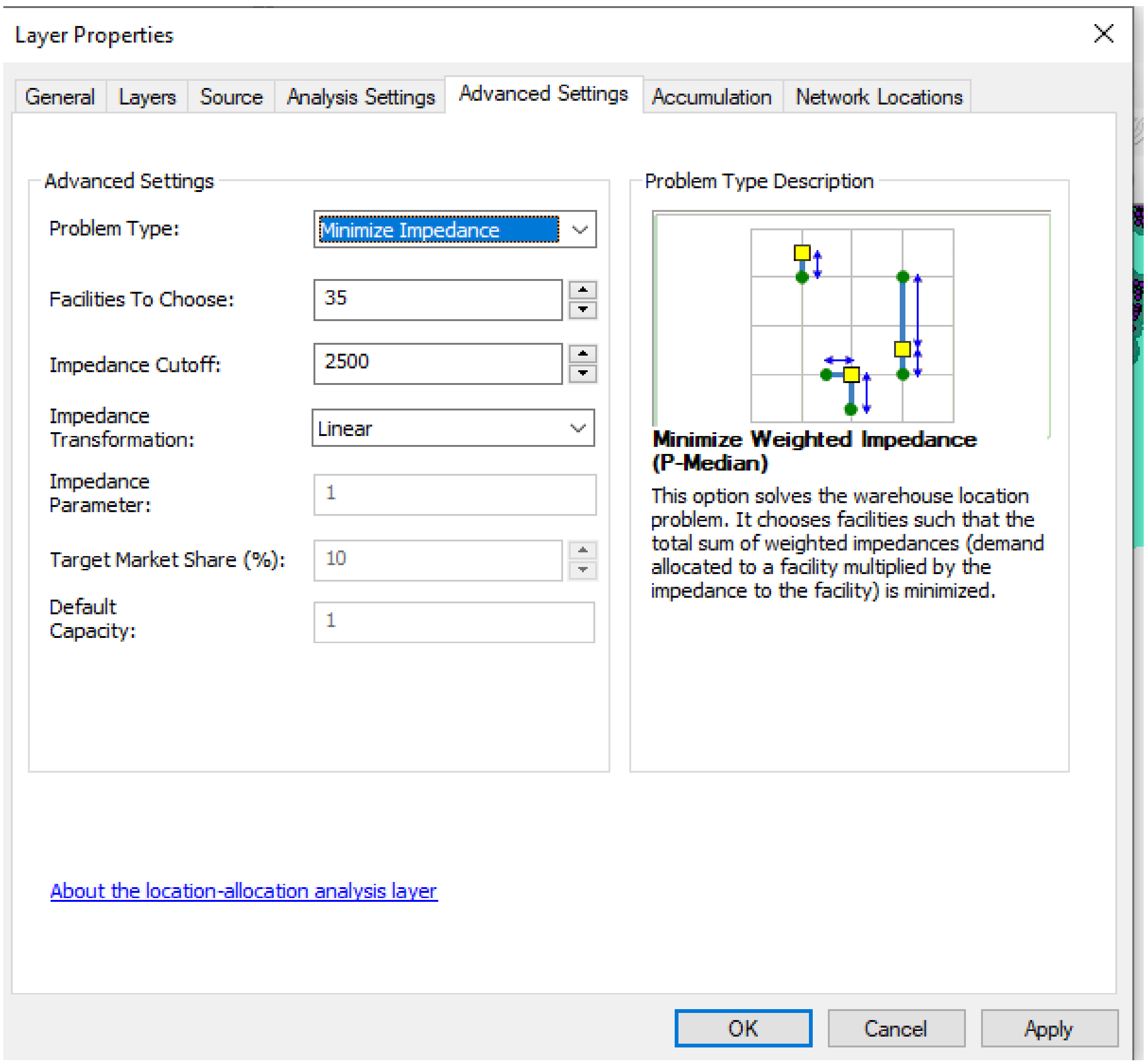


Figure: Location Allocation process output for candidate new site