Sudan University of Science and Technology

College of Graduate Studies

Computer Science and Information Technology

Integration of Geo-Marketing and (Geographic Information Systems and Openstreetmap) to Identify Prospective Marketing areas for Balad Bank

تكامل التسويق الجغرافي و (نظم المعلومات الجغرافية و خريطة الشارع المفتوح) لتحديد مناطق التسويق المحتملة لبنك البلد

A Thesis Submitted In Partial Fulfillment of the Requirements of Master Degree in Computer Science

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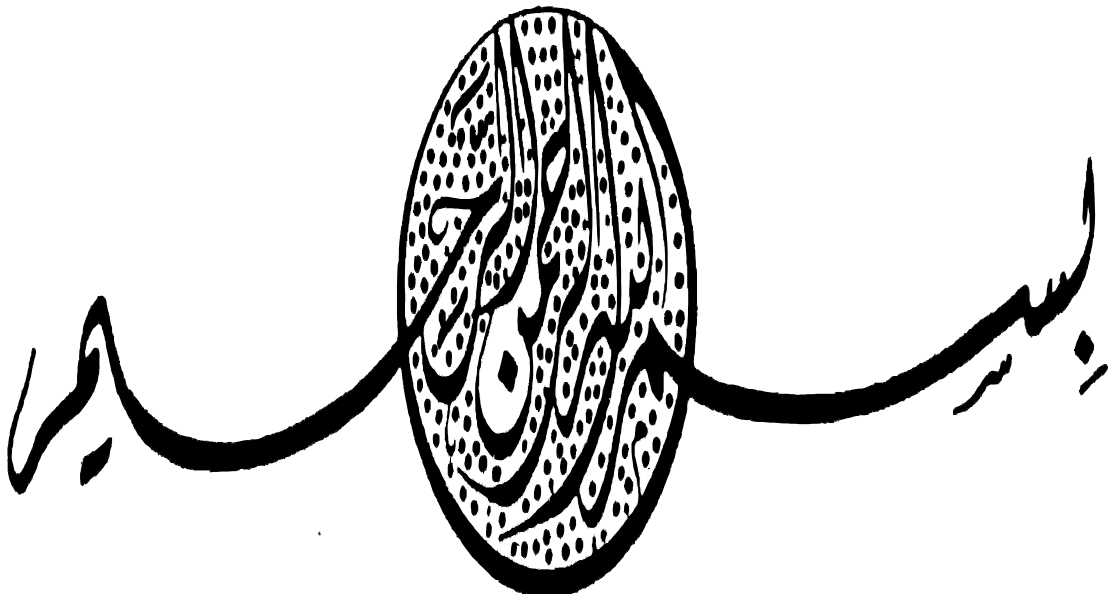

الآيـــــــــــــــــة

قال تعالي:

(الْحَمْدُ لِلّهِ رَبِّ الْعَالَمِينَ (2)**الرَّحْمَنِ الرَّحِيمِ** (3)**مَالِكِ يَوْمِ الدِّينِ** (4) **إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ** (5)**اهْدِنَا الصِّرَاطَ الْمُسْتَقِيمَ** (6)**صِرَاطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ عَلَيْهِمْ وَلَا الضَّالِّينَ)** (7)

صدق الله العظيم

DEDICATION

To my support, backbone, my family

To my Father soul, Martyrs of the Motherland, Allah have mercy on them

This work is for you

ABSTRACT

This Study illustrates how Geographic Information Systems can be used to expand Bank Services (create branch's) into new market areas using Open Street Map Data .

Bank branch optimal location is one of most significant strategic issues in the competitive market especially for private banks, because of the global competition and high customer expectations. The Conducted case study here is for Balad Bank as a one of Banks have least expansion in Khartoum City.

This study presents a Geographic Information System (GIS) based model for locating suitable sites for making new branches by using data sources. Also, Maximal Covering Location Problem (MCLP) was used to select branches that the maximum demand might be reached within a pre-specified target travel time. The criteria were restricted through demographic attributes, competition, transportation, flexibility and cost in GIS mapping approach.

OpenStreeMap data was embedded into ArcGIS software was used to get interactive maps for Khartoum City. Thus visualized the current locations of banks and offer an analyses of the surrounded environment. This supports competitive marketplace analytics, by allowing users to visualize where customers are located and analyzing demographic, psychographic and urban facilities accessibility .

A correlation analysis processes of the site selection against demographic variables and other criteria helped to identify locations and determine if these locations would be suitable for market expansion. Finally, the results illustrated the efficiency and applicability of the proposed integrated method.

المستخلص :

توضح هذه الدراسة كيف يمكن استخدام أنظمة المعلومات الجغرافية لتوسيع الخدمات المصرفية بإنشاء فروع في مناطق(سوق) جديدة باستخدام بيانات خريطة الشارع المفتوح.

يعد الموقع الأمثل لفرع البنك أحد أهم القضايا الإستراتيجية في السوق التنافسي خاصة بالنسبة للبنوك الخاصة ، بسبب المنافسة العالمية وتوقعات العملاء العالية دراسة الحالة التي تم إجراؤها هنا تخص بنك البلد باعتباره أحد البنوك الأقل توسعًا في مدينة الخرطوم.

تقدم هذه الدراسة نموذجًا قائمًا على نظام المعلومات الجغرافية (GIS) لتحديد المواقع المناسبة لإنشاء فروع جديدة باستخدام مصادر البيانات. أيضًا ، تم استخدام (Maximum Covering Location Problem MCLP) لتحديد الفروع التي يمكن الوصول إلى الحد الأقصى للطلب فيها خلال وقت الوصول المستهدف والمحدد مسبقًا.

تم تقييد المعايير من خلال السمات الديموغرافية والمنافسة والنقل والمرونة والتكلفة بنهج رسم خرائط نظم المعلومات الجغرافية .

تم تضمين بيانات خريطة الشارع المفتوح OpenStreeMap (OSM) في برنامج ArcGIS للحصول على خرائط تفاعلية لمدينة الخرطوم توضح المواقع الحالية للبنك وتقديم تحليلات للبيئة المحيطة. يدعم هذا تحليلات السوق التنافسية ، من خلال السماح للمستخدمين بتصور مكان تواجد العملاء وتحليل إمكانية الوصول إلى المرافق الديموغرافية والنفسية والحضرية.

ساعدت عمليات التحليل التي طبقت بالبحث لاختيار الموقع مقابل المتغيرات الديموغرافية والمعايير الأخرى في تحديد عدد من المواقع وتحديد ما إذا كانت هذه المواقع ستكون مناسبة للتوسع في السوق من قبل البنك . وأخيرًا ، أوضحت النتائج كفاءة وإمكانية تطبيق الطريقة المتكاملة المقترحة.

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Thesis layout:

Chapter one contains three main headlines: the first is the introduction of research, the second give the problem statements and the third are dealing with project objectives.

Chapter two contains main headlines: the first one about the Theoretical Framework, and the second is the Literature Review.

Chapter three contains the following headlines: the first about the Community of Research, the second is the System Description, and the third one is Selected Methodology and Techniques.

Chapter four contains the system requirements, analysis and design for the study area Khartoum City. Many figures illustrate the global, regional and local maps.

Chapter five contains tow headlines: the simulations and the results of the thesis Chapter sex contains three main headlines: the conclusions, limitation and recommendations.

The last Chapter main headline was the References .

LIST OF FIGURES:

LIST OF TABLES :

LIST OF ABBREVIATIONS:

Abbreviation	Definition
GIS	Geographic Information System
OSM	OpenStreetMap
ODbL	Open Database License
OSMF	OpenStreetMap Foundation
ANP	Analytic Network Process
MCLP	Maximal Covering Location Problem
MCDM	Maximal Covering Data Model
MKIS	Marketing Information System
QGIS	Formerly “Quantum GIS”

CHAPTER 1

INTRODUCTION

INTRODUCTION

PROBLEM STATEMENTS

PROJECT OBJECTIVES

1.1 Introduction

In the developed world the technology is moving rapidly towards the future, companies face new challenges and adaptations in order to retain their brand and customer's. Here comes just a snippet of buzzwords used in daily business life. Saving time, money, and resources by truly understanding where the largest concentrations of customers are located, what they are buying, to what extent they are willing to travel, their lifestyle characteristics, and much more.
Using geographical information analytics enable marketers worldwide to see the wide scope, becoming more agile and alert, seizing new market opportunities, and staying ahead of the competition. All of this led to the need of Geographic Information System(GIS) technology.

The integration of geographical intelligence with various aspects of marketing, including sales and distribution is called Geomarketing. which deal with the data processing, of GIS with the marketing mix , 4 P's (place,product,price, promotion). Place is one of the main problems in Marketing. An incorrect decision of location-determination promotes a series of sequential errors in the marketing mix. This means that the 4 P's are deeply related and depend one on the other.

If for example a store is opened in the wrong place, all others P's [price, product and promotion] will have to be reviewed [Costa 2004].

The core base of Geomarketing is the digital map; it can either make or break the concept. Equally important, though, is the association of data with these maps using some place-based components.

Here the OpenStreetMap is used as an open-source community mapping project that uses a combination of satellite images and human input to survey and document the world. It is a Wiki-Style project for digital mapping all over the world. It is called The Free Wiki World Map, which is a collaborative project to create a free editable map of the world. The digital map is always handy for various purposes. It can be used in navigation, research, development of customer's location based applications.

This project is one of the first few projects used OpenStreetMap in Khartoum.

The idea is be focusing on mapping the banks location existence and the future best places depending on market analysis, customer analytics and urban facilities accessibility .

The Marketing Departments in Banks are supported by this analysis and to forecasting the direct marketing, identification and targeting the best customers using maps (the best location).

1.2 Problem Statements

There are essentially needs growing daily for using Geomarketing techniques specially for Banks to get a competitive marketplace.

This is where Geographic Information System (GIS) technology comes into the game, allowing to visualize where customers are located by analyzing demographics

and spending characteristics for accurate customer segmentation using OpenStreetMap data of Khartoum City.

1.3 Project Objectives

1) The main goal of this research is to focusing on the benefits of using an open source data, here we prefer OpenStreetMap data over a commercial data source such as Google Map or Apple Map.
The maps will provide an effective visualization and immediate understanding of strategic marketing opportunities. In particular will

- Apply Decision Analytics to prove research and analytical methods that examine both quantitative and qualitative aspects of the locational issue under consideration .
- Contribute to further mapping and developing openstreetmap data in Khartoum.

2) To Give insight into the concept Geomarketing shown and insurer its importance as anew discipline and its reflecting in the banks field.

CHAPTER 2

LITERATURE REVIEW

THEORETICAL FRAMEWORK

LITERATURE REVIEW

2.1 Theoretical Framework

This project is one of the first few research's in our country focusing on using GIS in the Marketing field (Geomarketing) using OpenStreetMap (OSM) data.

In the following we are the Geomarketing techniques, especially for Banks, have been used to get a competitive marketplace based on locations which are presented by OSM data (see Figures 1 and 2). This visualization demonstrates the potential of geographic information system (GIS) technology just to show, where customers are located by analyzing demographic and other characteristics for accurate customer segmentation. Here the OpenStreetMap data is used especially for Khartoum City. Therefore, the strength of using OSM in the Marketing field for banks is presented in two areas:

(1) The real bank location in the map, and

(2) Carrying out a location analysis depending on demographic and customer segmentation methods, driven by geographic and psychographic characteristics and commercial areas.

In the following the use of Esris's **ArcGIS analysis methods.**

2.1.1 OpenStreetMap (OSM)

The preferation of using OSM free map data in our project instead of Google map, has the following advantages:

(1) The geo-data of OpenStreetMap is free and include no technical or illegal restrictions. The OpenStreetMap license for data is under the Creative Commons Attribution-Share Alike 2.0 license , which should not cause any restrictions to the users.

(2) OSM(see Figure 1)is a wiki-like collaboration, or a grassroots movement, to provide an editable map of the world using data from portable GPS devices, aerial photography and other free sources . People from anywhere in the world can edit the data and can make a new contribution. We are free to upload new geo-tracks of different attributes, update it, create new layers, and maintain our own layer in OSM, which can be used later for mobile apps and other usage.

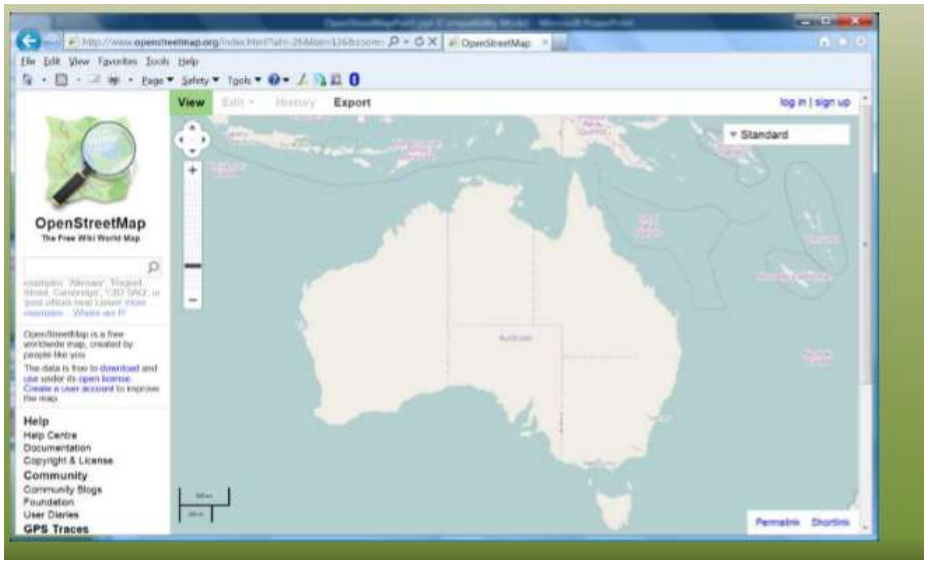

Figure 1: Human Interface of the OpenStreetMap Portal [15]

(3) OSM is not owned by anyone, which is both amazing and unprecedented. Currently, there are more than 400,000 registered OSM contributors or users growing every day, and this number has been growing exponentially in the past few years (see Figure 3). For the first time in human history, researchers can obtain street data of the entire world for analysis and computations. This analysis and computation can provide deep analytical insights into cities and our environments for sustainable development. This opportunity is significant and is very different from what is possible with Google Maps, Apple Maps or Microsoft's Bing Maps. Google Maps allows mashups, but its licensed and copyrighted data, that prevents us from obtaining analytical insights. We cannot learn how cities or regions have been sprawling outward by exploring only Google Maps. Instead, we need to perform analysis and

computations to quantify the level of urban sprawl. In this regard, OSM, rather than Google Maps, freely provides a rich data source for researchers to use and to understand our cities and environments through advanced spatial analysis and computing. This understanding can be extended for spatial planning, e.g., redeveloping parts of a city or restricting further development of some parts of a country. In other words, OSM data can be analyzed to obtain knowledge in various forms or patterns, structures, relationships, and rules for spatial decision making. For instance, how is urban sprawl related to economic activities, population density and public health issues such as obesity? (see Figure2).

Figure 2: OSM Data Model[15]

(4) With the increasing growth of smart phones, demands for different digital map that will bring about a revolutionary change in the lifestyle and economy of our country. However, there is need for updated digital maps, thus OpenStreetMap is the ultimate solution for this demand (see Figure 3).

Figure 3: OSM versus Google Map

The OSM data have a very short update cycle because of the volunteered data collection, which makes it superior compared with other Web Map Portals (e.g. Google Map).

A further point is the Open Access feature of OSM: Everybody can download, edit and integrate OSM data in local, regional and global analyses (see Figure 4).

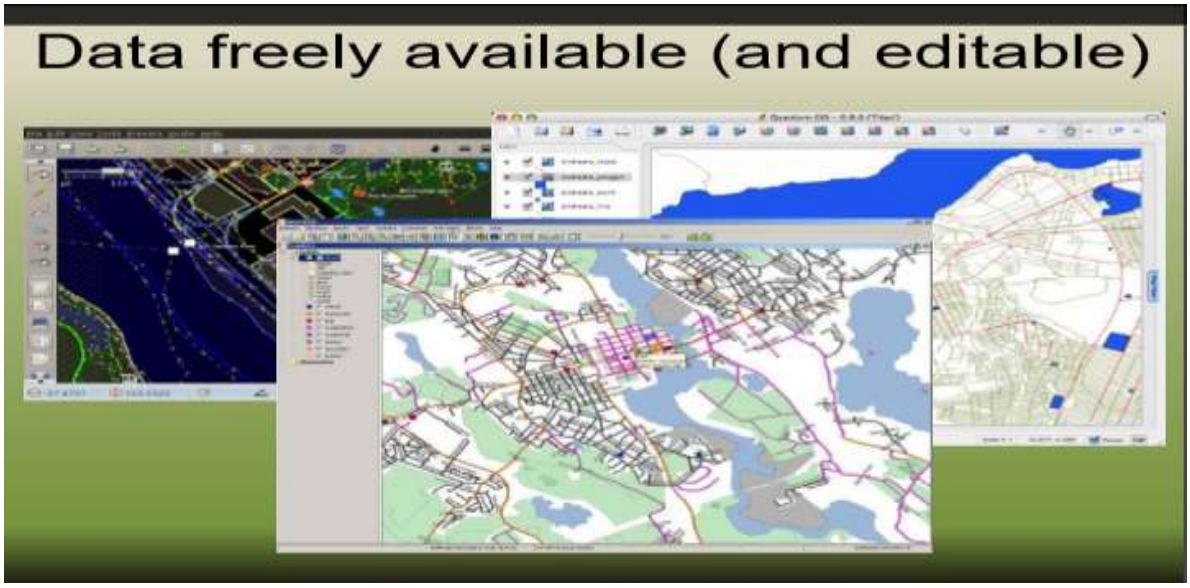

Figure 4: Download and Editing OSM Data

And last but not least OSM data can be displayed on a great variety of mobile devices: Smart phones, GPS trackers, tablets, navigation systems, and many more (see Figure 5).

Figure 5: OSM data displayed on many mobile devices[15]

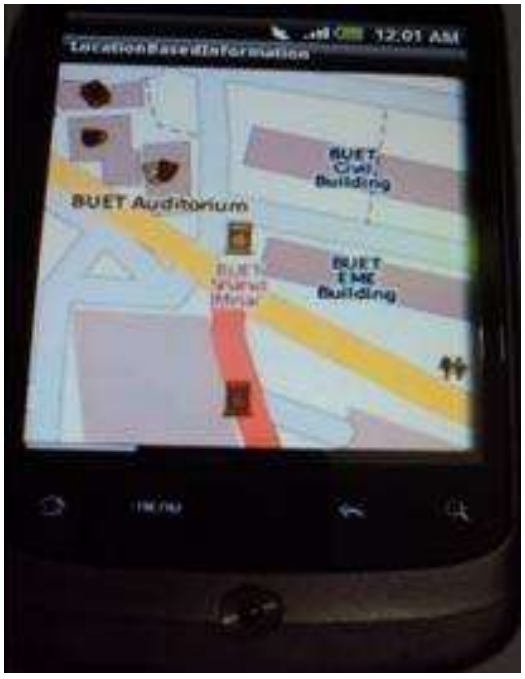

Figure 6: Showing the Location Map [15]

Figure 7: A List of Points of Interest around the Location[15]

2.2 Literature Review

To be able to fully understand the topic, we will review and discuss some of previous related works and studies .This will provide us with the right perspective from which a better analysis can be derived later on.

2.2.1 Review of Prior Studies

Our discussion of related work focuses on two aspects(1) OpenStreetMap : benefit of using , its quality and fitness-for-use issues.(2) Geomarketing and the use of GIS in marketing specific in the main commercial sectors .

Case 1: Title of Study : Jacob B. Johnson (2017): Using GIS as a Marketing Decision Support System to Help Amari Studios Locate New Customers and Effectively Direct Marketing and Advertising Effort.

This paper examined the research problem: “Can GIS be used as a marketing decision support system to solve the “geo-marketing issue. For the business to grow it needs to know what type of customer it serves and where to find more of them . For this case They analyze demographics to locate census blocks having the highest concentration/percentage of company defined target market. a colored maps was created not only revealed an abundance of business potential

within Amari Studios' current service area, but also identified some high potential areas located outside of the service area.

The findings of this study demonstrate there is a very large market for the services that Amari Studios has to offer allowed for the creation of a

marketing decision aide also indicates using GIS Scholarly market research and analysis techniques combined with GIS technology helped Amari Studios

profile, analyze, segment, and locate customers, and may also help facilitate the acquisition and retention of new customers) .

As a result I agree with this study in term of using GIS as a marketing decision support system to help company to locate new customers and effectively direct its marketing and advertising efforts and gave a better understanding of where its ideal customers are located . This helps affirm ideas of Geographic Information Systems' usefulness in business decision-making by adding a spatial component to the decision process.

It should be noted that this study was conducted focused on segmentation (demographic or customers who will served by a company). The authors of [1] assessed spatial coverage and ground-truth positional accuracy for a town census block and Google map displayed in Arc map , little attention has been paid to road network data and other criteria like universities and youth recreational areas. otherwise For the

campaign they focusing on outdoor advertisement and they ignore social media methods as a way of advertising .

Case 2:

Title of Study: Liming ZhangID, Dieter Pfoser (2019): Using OpenStreetMap point-of-interest data to model urban change.

This study examining the accuracy and coverage of OSM in term of POI found that it compares favorably to other more authoritative data sources. 60% of the

OSM POIS could be matched with high accuracy. They was Using statistical

models that exploit the power law relationship of various factors in relation to population, able to relate coffee shop POI data to urban housing prices.

The models that they derived allow to show that even though OSM POI data (coffee shops) might be incomplete, i.e., not all coffee shops are recorded in a timely matter, such data can still be used in urban analytics research. It is also interesting to observe that the estimated growth function decodes a generic process of urban change and shows that coffee shop data can be an important geo-social indicator.

Case 3:

Title of Study: Rajib Chandra Das, (2014) .Location Based ATM Locator System Using OpenStreetMap

The study was about android based smart phone application developed on OpenStreetMap (OSM). ATM locator provides the visualization of locations on the map of the application to users, gives the distance of nearest ATM booth or fast track and user's current location using Haversine formula and the shortest path between them using Dijsktra's algorithm. I agree with this study in term of supporting Using OpenStreetMap (OSM) because it is a free and editable map. Anyone can update any location or amenity voluntarily. There is no legal or technical restriction on it whereas Google map has some restrictions.

Case 4:

Title of Study: Noorsazwan Ahmad Pugi,…(2016)[4]Determination of New Bank Branch Location Using GIS Approach.

This paper Similar to my challenge to has a successfully achieved to determine the best location to place a new branch for Bank X.

The process used can be divided into three stages; planning, implementation, and decision stage. The planning stage was focused on the data methods and analysis. For the implementation stage, geospatial database was created and model was build, produced final Map which

used In the decision stage, the location of new branch of Bank X was investigated based on the suggested criteria from the bank itself and location of other banks(competitors). Spatial modeling and Euclidean distance methods supported in the ESRI's software ArcGIS. Were used to obtain the desired decision. The result was Four recommended locations for new Bank X branch location was successfully determined.

a weakness in their approach is the absence of additional criteria such as land costs, building availability, transportation availability , health ,education institutions availability and infrastructure such as telecommunications.

It should included in order to get best locations for Banks . also a little attention to demographics, they focusing in the density only ignore the segmentation issue .

In order to maintain the accuracy and make the data more global, city base map needs to be updated.

CHAPTER 3

METHODOLOGY AND RESEARCH PLANNING

RESEARCH COMMUNITY.

SYSTEM DESCRIPTION

METHODOLOGY AND RESEARCH PLANNING.

SELECTED METHODOLOGY AND TECHNIQUES

3.1 Research Community

The area selected for this study is Khartoum City, the capital of Sudan, which is situated on latitude 15° 33 N, and longitude 32° 31 E. It is located in the middle of the populated areas in Sudan and is the almost northeast center of the country. The geographic position (lat, lon) lies between 16° latitude North and 15° latitude South and 21° longitude West and 24° longitude east. Khartoum City is covering an area amounting to 20,736squarekm (12884 sqMiles), between the West Bank of the River Nile. The city is stretching from the North: Khartoum Bahri, Shendi, River Nile State, from the East: Kassala, Kassala State, Port Sudan, Red Sea State and North East Blue Nile, from the West: White Nile, Omdurman, North Kordofan and Northwest Omdurman, Northern State, and from South: Wad Madani, Al Jazirah (state) and Southwest Ed Dueim, White Nile State. The geographic location is shown in figure 9.

Figure 8: Khartoum City

Figure 9: Khartoum State (OSM)

3.1.2 Topography

Khartoum is located at level elevation 382 meters (1,253,28 feet) above sea level, above the plain flat ground surface with a slight slope towards the River Nile punctuated by hills and rocky protrusions and sand dunes scattered - it is giving the image of a flat terrain with minor ripples. The two Niles (blue and white) are the most important natural phenomenon of Khartoum, where they meet at Almogran point

3.1.3 Population

Khartoum's population has grown to over 5 million people. Khartoum locality is considered as a dense populated area, where the population is approximately 5,274,321 according to the 2008 census"http://www.citypopulation.de " (see Figure 10).

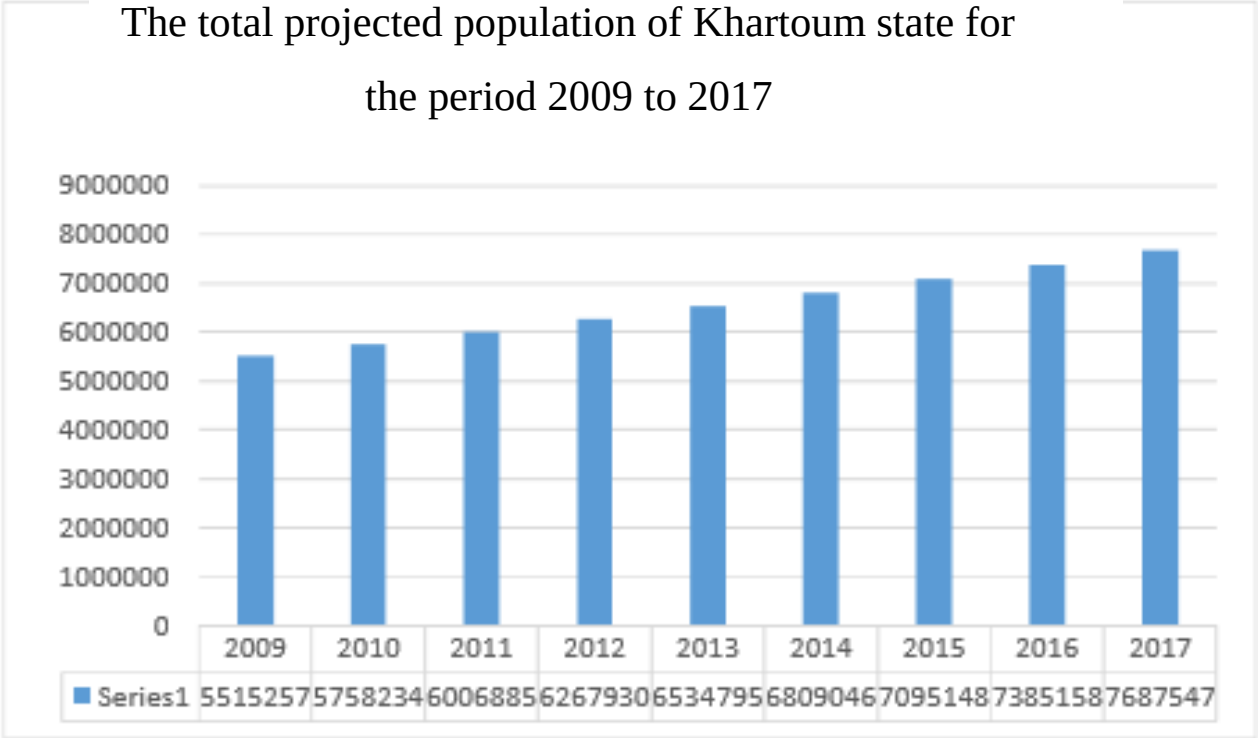

Figure 10: The total projected population of Khartoum state for the period 2009 to 2017

3.2 System Description

Our problem is haw to find the best site for location of bank branches. It is a significant concern for the banks to find the best and optimum location for branching to increase their profitability and market share. Covering consumer demand is the other important factor, that bank branches are facing.

Khartoum City contains 32 Banks – all defined by Sudan Central Bank - with more than 700 branches distributed among different locations in the city .

This study will implement a methodology for Balad Bank as a one of a few private banks with a limited number of branches

Selection will choose Khartoum “Center City as small area to get more accurate results.

The criteria were restricted through demographic attributes, competition, transportation, and the flexibility of OSM mapping.

The study is expected to illustrate how OSM data can be used to show entire locations and help to estimate the best ones, e.g. where are existing buildings of banks and branches, where should they expand their future marketplaces using map data. In general to see if it would be suitable for market expansion depending on a special demographic analysis and data processing using Esri’s ArcGIS . . Finally, the results expected to show the efficiency and applicability of the proposed integrated method.

3.2.1 Software and Tools

3.2.1.1 ArcGIS (v 10.2)

ArcGIS is a Geographic Information System (GIS) for working with maps and geographic information. It is used for creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

The ArcGIS v10.2 includes a Geoprocessing environment, that allows execution of traditional GIS processing tools (such as clipping, overlays, and spatial analyses), in interactive mode or from any scripting language that supports COM standards. The ESRI version is called *Model Builder* and it allows users to graphically link Geoprocessing tools into new tools called models (similar to ERDAS IMAGINE software). These models can be executed directly or exported to scripting languages, which can then be executed in batch mode (launched from a command line), or they can undergo further editing to add branching or looping.

3.2.1.2 OpenStreetMap

The web site of OSM is a collaborative project to create a free editable map of the world, using a crowdsourced approach. Two major driving forces behind the establishment and growth of OSM have been restrictions on use or availability of map information across the world and the advent of inexpensive portable satellite navigation devices. GPS enabled smartphones based on iOS (72 million Iphones worldwide) or Android (One billion users worldwide) make it easy for users to contribute to crowd sourced OSM data and easy to export locations as an image in *.png format. OSM is open data, licensed under the Open Data Commons Open Database License(ODbL) by the OSM Foundation (OSMF).

3.3 Research Methodology

In a GIS analysis project, a variety of tasks that can be grouped into four basic steps.

(1) The first step is to convert a question, such as “Where is the best place for a new building?” or “How many potential customers are near this store?” into a GIS database design and an analysis plan. This involves breaking the question into logical parts, identifying what layers of data will be needed to answer each part, and developing a strategy for combining the answers to each part of the question into a final answer.

(2) The next step is to create a database that contains the geographic data required to answer the question. This may involve digitizing existing maps, obtaining and translating electronic data from a variety of sources and formats, making sure the layers are of adequate quality for the task and making sure the layers

(3) are in the same coordinate system and will overlay correctly, and adding items to the data to track analysis result values. Personal workspaces of file based data and personal geodatabases are used to organize the GIS project geodatabases.

(4) The next step is to analyze the data. This usually involves overlaying different layers, querying attributes and feature locations to answer each logical part of the question, storing the answers to the logical parts of the question, and retrieving and combining those answers to provide a complete answer to the question.

(5) The final step in a project-based analysis is to communicate the results of the analysis, usually to people who do not use GIS and who have different levels of experience in dealing with maps. Final Maps, reports, and graphs are all used, often together, to communicate the answer to the question.

3.4 Selected Methodology and Technique

o Three ArcGIS desktop applications have been used : ArcCatalog, ArcMap, and ArcToolbox to do the work. ArcCatalog is the application for managing spatial data holdings, for managing database designs, and for recording and viewing metadata. ArcMap is used for all mapping and editing tasks, as well as for map-based analysis. ArcToolbox is used for data conversion and geoprocessing.

ArcCatalog:This module lets you find, preview, document, and organize geographic data and create sophisticated geodatabases to store that data. It provides a framework for organizing large and diverse stores of GIS data. Different views of data help to quickly find what we need, whether it is in a file, personal geodatabase, or remote RDBMS served by ArcSD.

ArcMap: In ArcMap, can view, edit, and analyze the geographic data , query spatial data to find and understand relationships among geographic features, and can create charts and reports to communicate our understanding with others.

Also With ArcMap, can create maps that integrate data in a wide variety of formats including shapefiles, coverages, tables, computer-aided drafting (CAD) drawings, images, grids, and triangulated irregular networks (TINs).

ArcToolbox :this is a simple application containing many GIS tools used for geoprocessing.

- The methodology for the site selection considers layers and criteria that influence the location of a building. Figure 19 illustrates that the available process contains six steps to identify and assess the results.

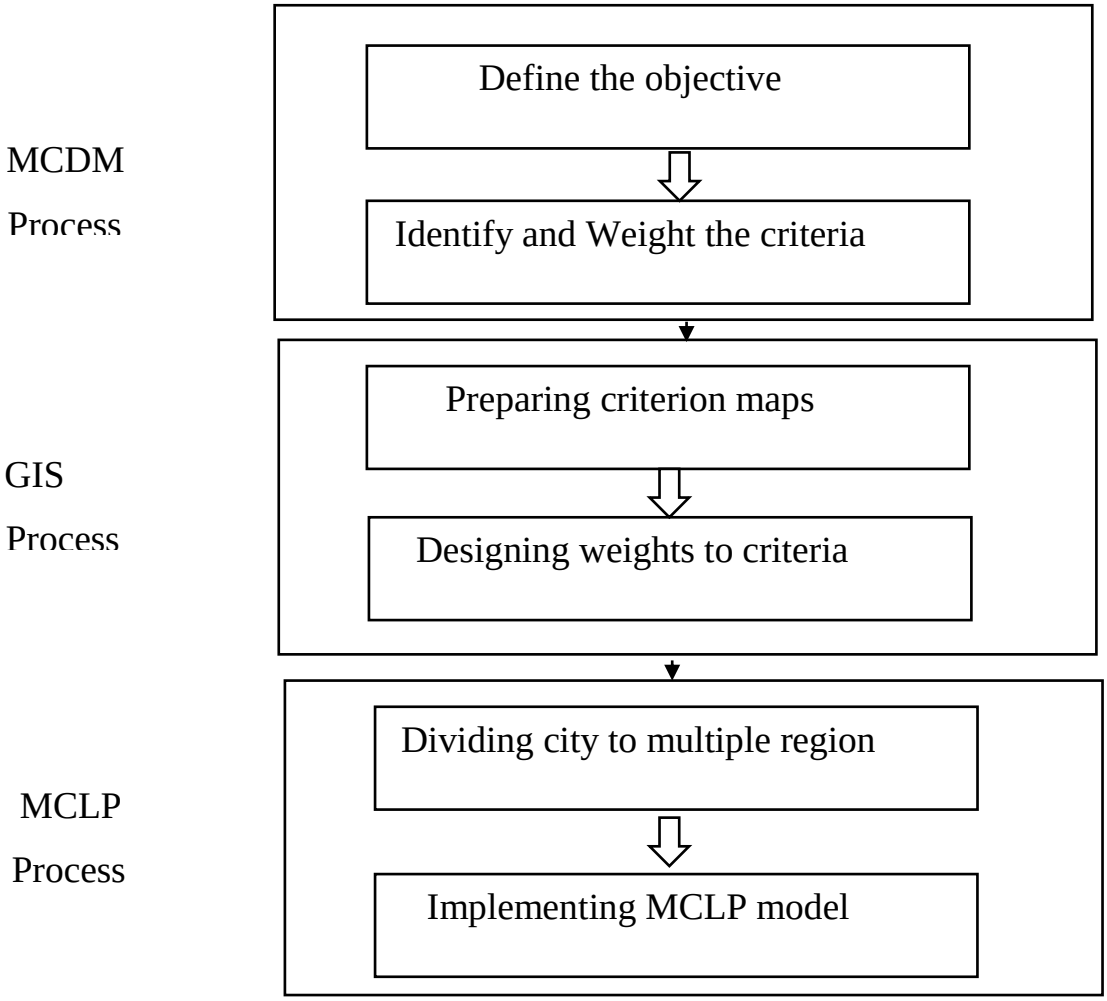

Figure 24: The methodology

The suitable building locations are general areas, where decision makers are satisfied. All processes are conducted to select a general area, that is further narrowed down into a few identifiable locations. Figure 20 shows the working model of the developed GIS-based methodology.

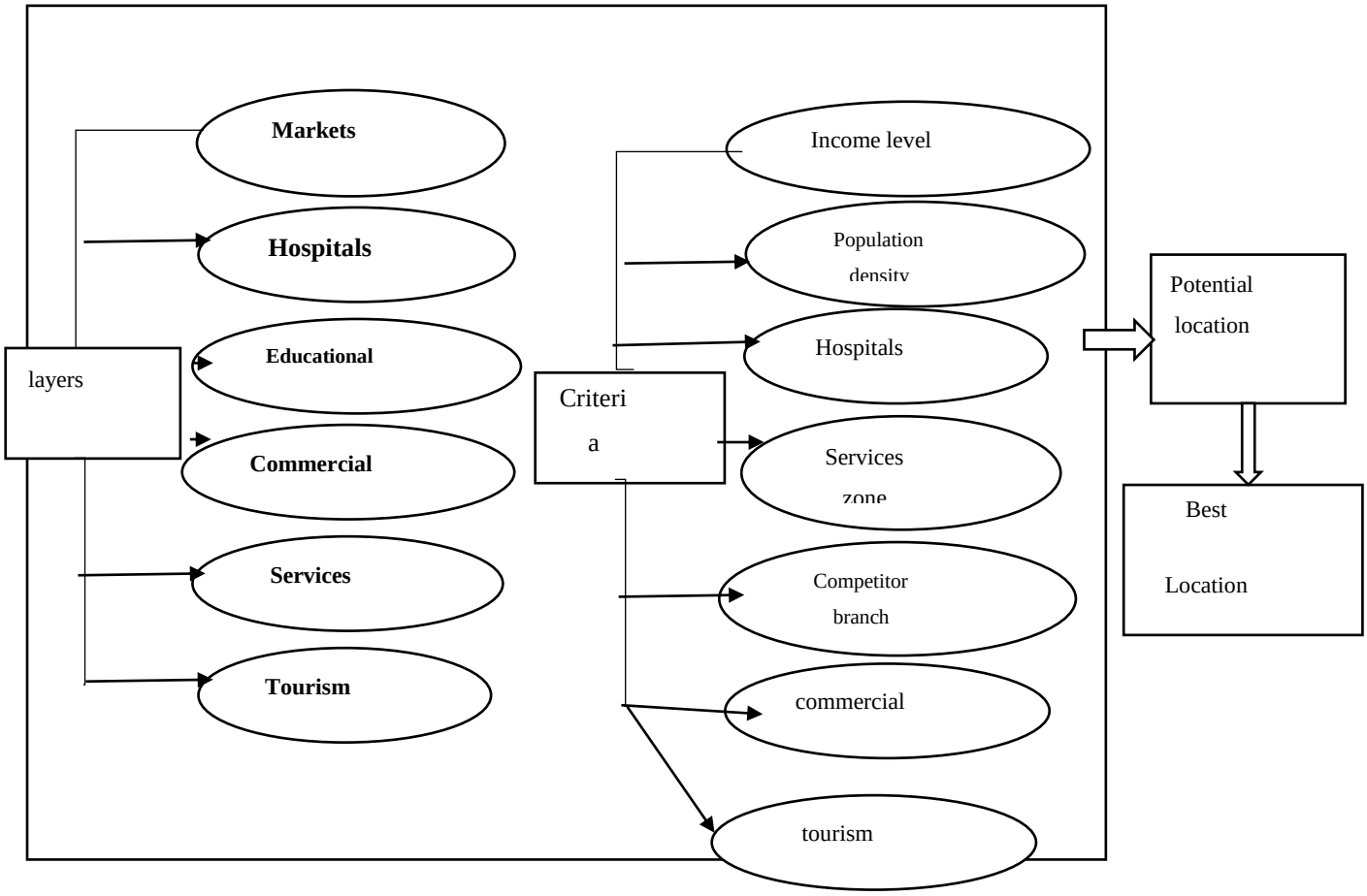

Figure 25: GIS-based model, developed to implement the methodology

CHAPTER 4

SYSTEM ANALYSIS AND DESIGN

MAPS OF THE STUDY AREA

SYSTEM DESIGN

4.1 Maps of the Study Area

First of all we generate several maps of the study area using Esri's ArcGIS functionalities. Figures 11 to 17 display different Levels-of-Detail (LoDs), to demonstrate the resolution of our research. An advantage of OSM is the availability of these LoDs, which help to bring the locality close to the user. LoD 0 is the map of Sudan (see Figure 11).

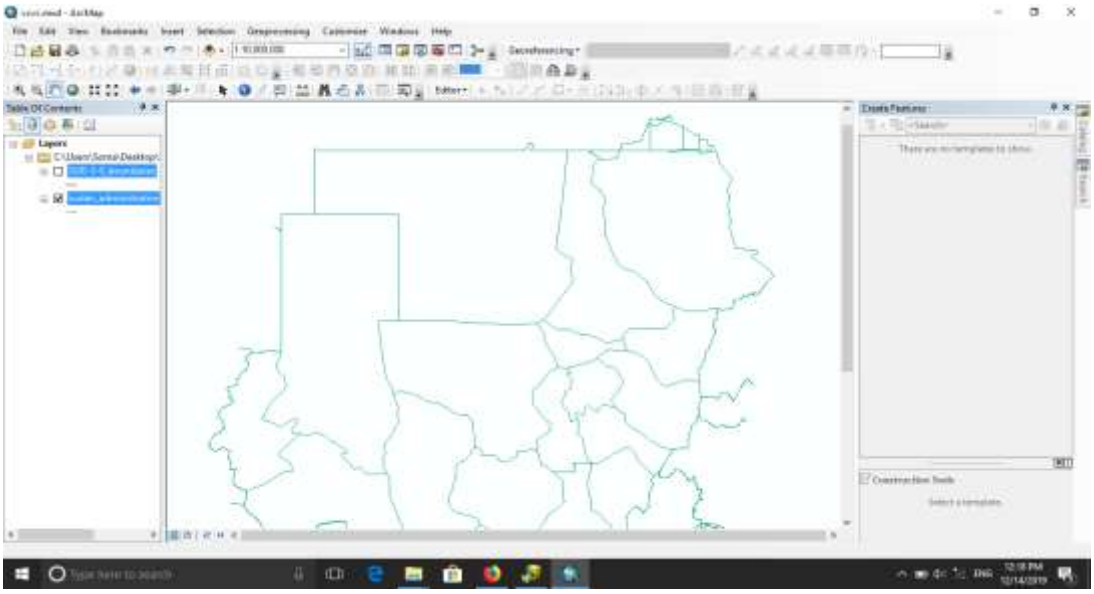

Figure 11: Map of Sudan (Source: OSM data)

Khartoum State is displayed in Figure 12, which we name LoD 1.

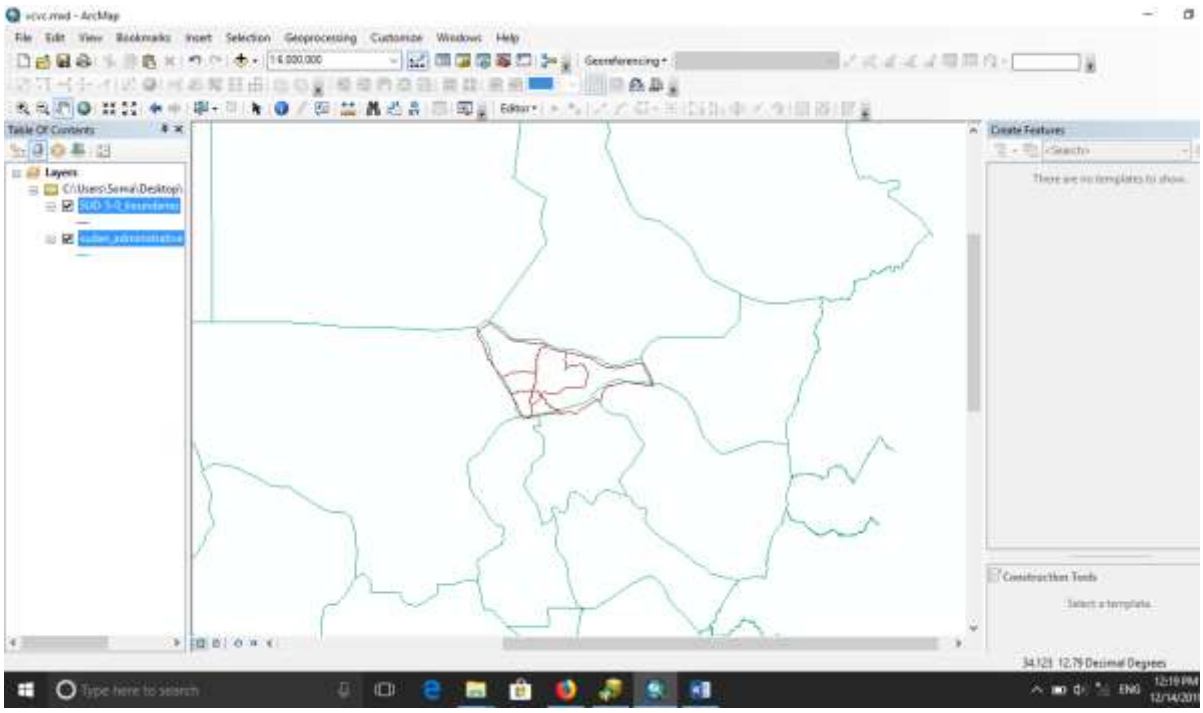

Figure 12: Map of Khartoum State (Source: OSM data)

The OSM road database, which is an important infrastructure for our research, is shown in Figure 13. Roads are the main facilities for people to move from A to B, especially in Sudan. This might be different in developed countries, in which we have besides roads railway lines for public transportation systems (e.g. Metro, S-Trains, Street-cable cars, etc.). This first global view onto the road database of Khartoum State we call LoD 2.

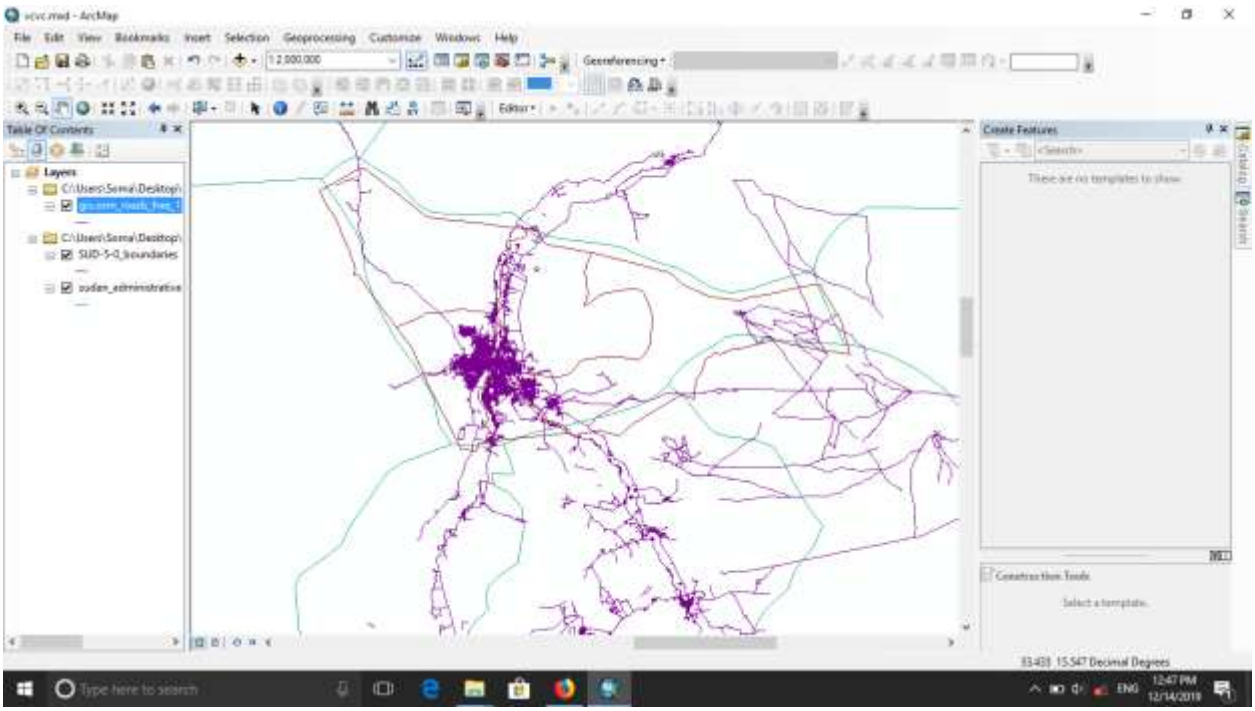

Figure 13: Global view onto the road database of Khartoum State (Source: OSM data)

The real advantage of a GIS is the zoom-in and zoom–out function. The more we zoom in, the more detail we will see on the display. Thus we show Khartoum City with all its roads in Figure 14, which is LoD 3 and the Study area in Figure 15, which contains LoD 4.

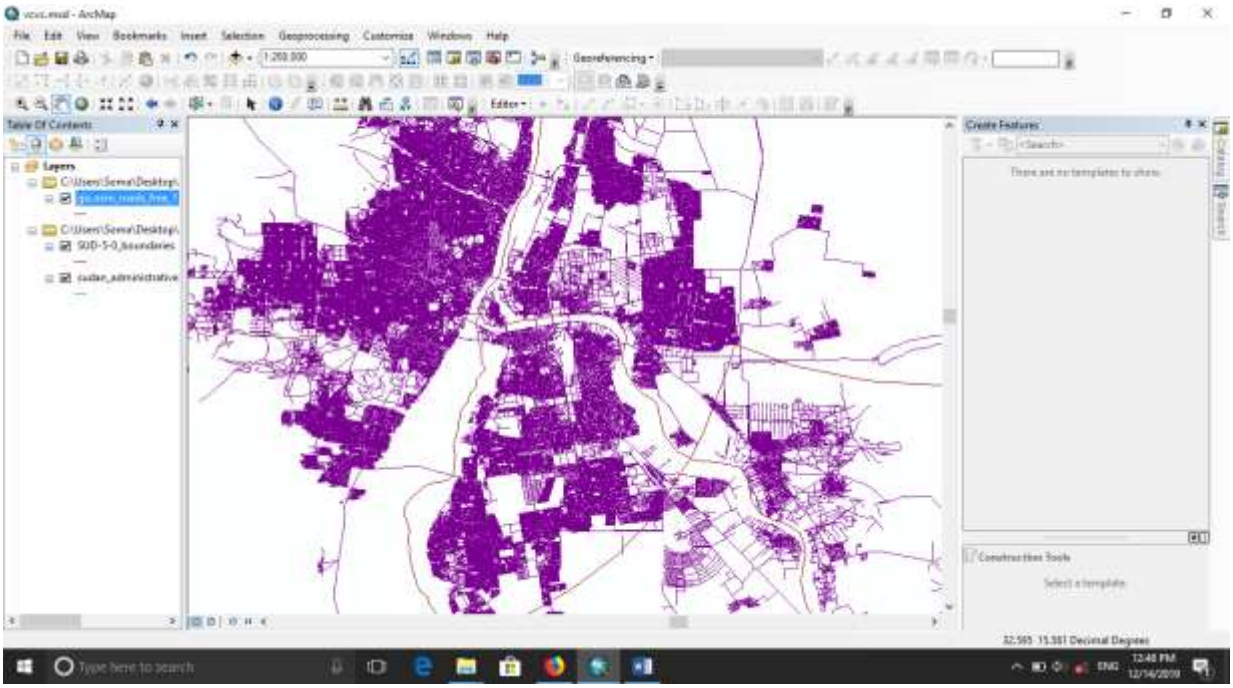

Figure 14: Khartoum City and its roads

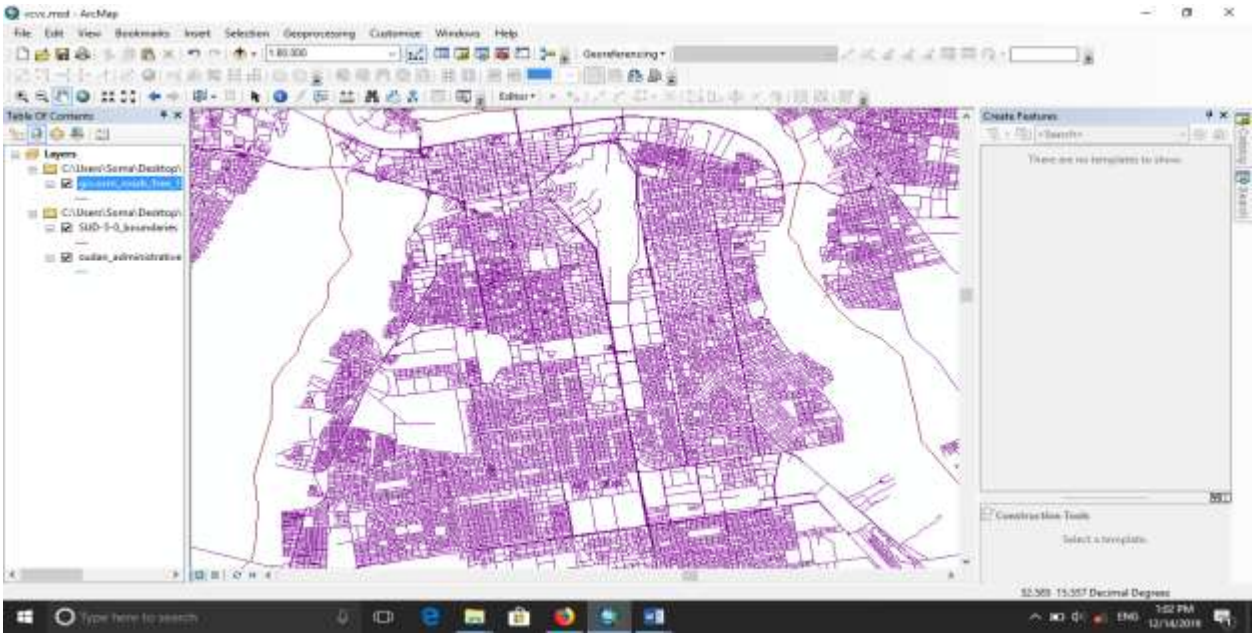

Figure 15: Present Scenario of the Study Area located in Khartoum City

The main roads of the study area are depicted in Figure 16 – called LoD 5.

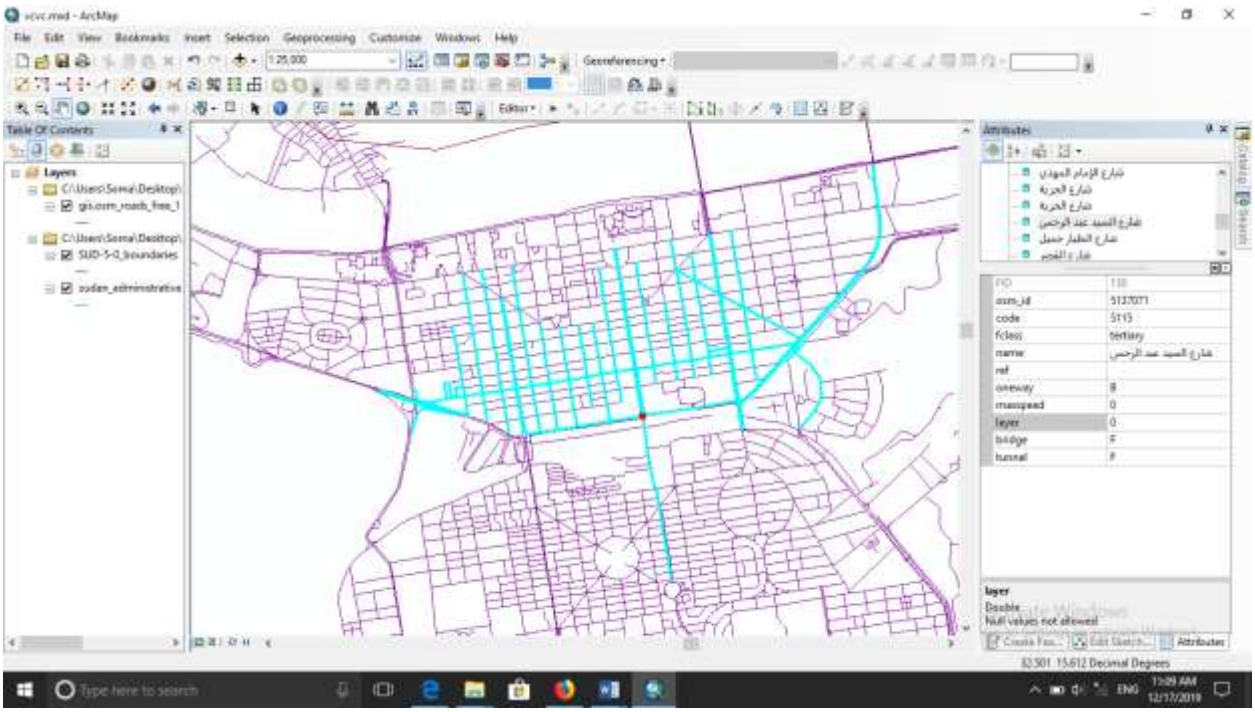

Figure 16: Main roads in the study area of Khartoum City

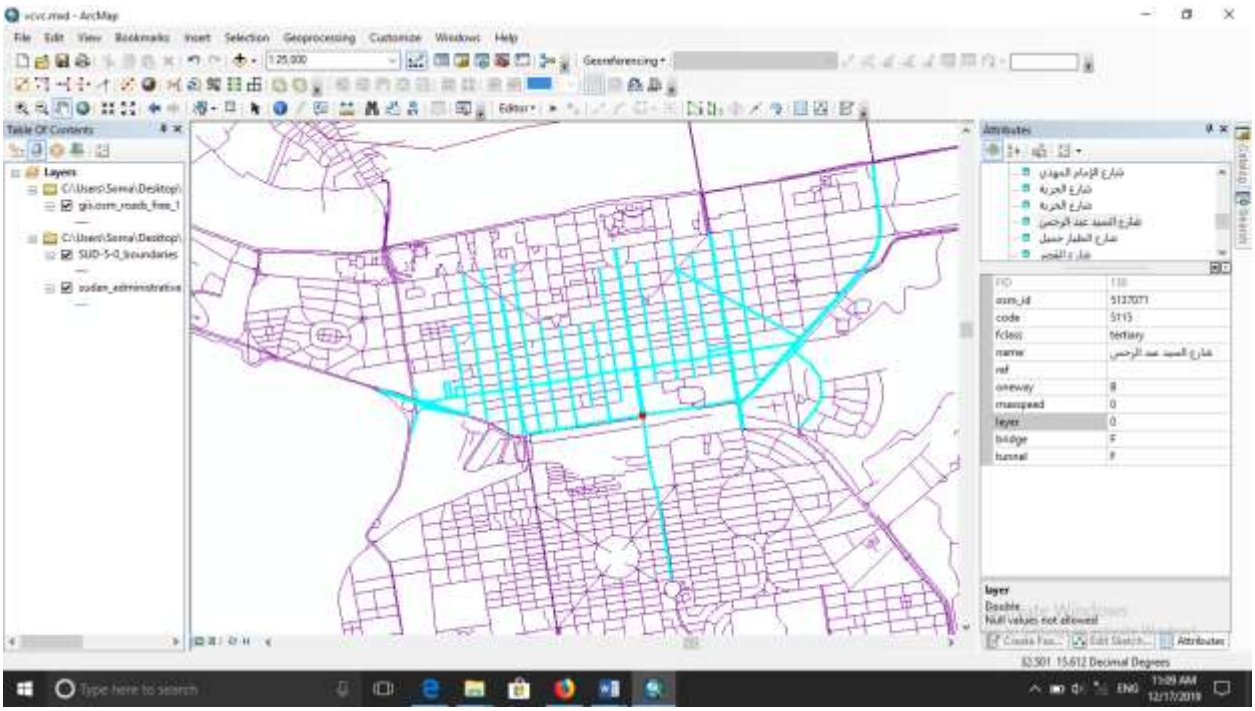

Figure 17: current location of bank 'head and mean branch

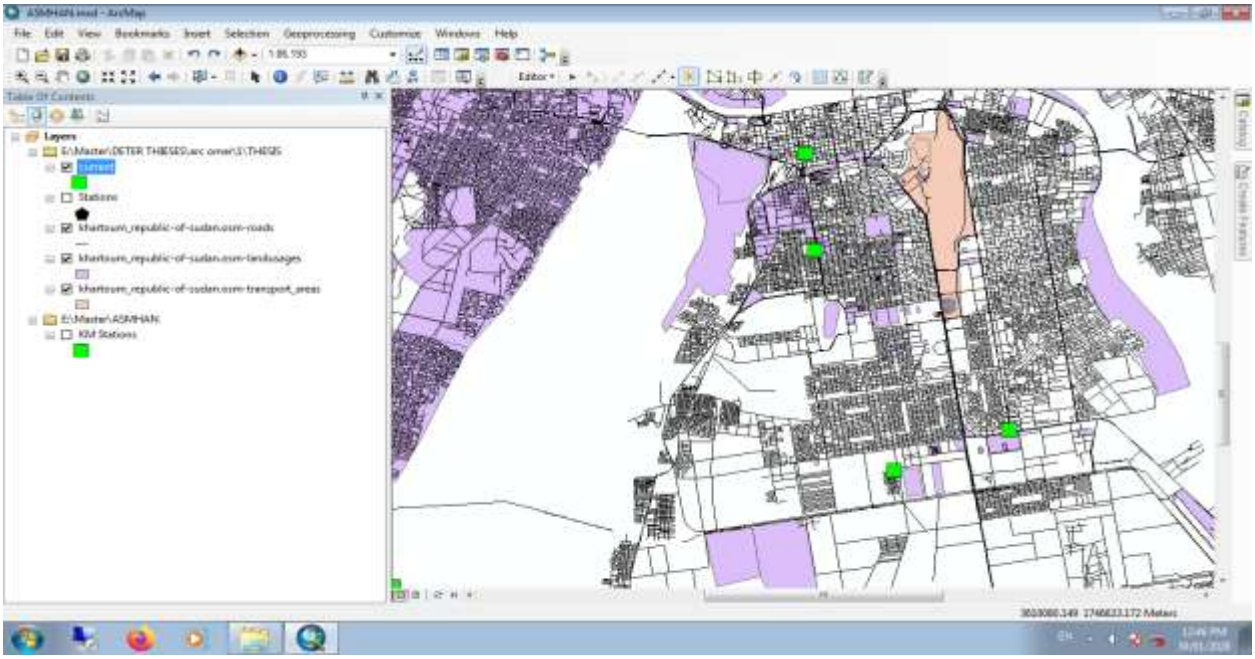

Figure 18: current branches

In order to realize our research, the following steps have to be accomplished:

1. With OSM data we produce maps of Khartoum visualizing existing banks locations. This visualizations help the decision makers to see a big view of the situations.

2. By a spatial GIS analysis areas are to be defined that have a particular demographic makeup to support virtual visualizations using a desktop computer.

3. In more detail, the spatial data should find areas with high gross revenues, in both commercial and social parts.

4. Identify the locations of target populations for services and to allocate facilities and resources to serve the target populations most effectively.

5. Using ESRI ArcGIS software for targeting potential customers, analyzing site locations, assessing the competitive environment, and forecasting potential growth using and examine main important criteria.

4. 2 Analysis and Design

For our System Design we have selected 13 places (see Table 1) having impact factors of 7 different classes.

Table 1: Places and Impact Factors

No	Place	Market	Hospital	Educational	Commercial	Services	Tourism	competitors
1	Arabi Market	■	■	■	■	■	■	■
2	Sajanna	■			■	■		■
3	Jabra		■	■	■	■		■
4 5	Shabby sowge	■	■	■	■	■	■	■
6	Mahali	■	■		■	■		■
7 8	Markazi sowge	■			■	■		■
9	Khartoum 2	■			■	■	■	■
10	Soba		■	■	■	■	■	■
11	Khartoum Airport				■	■		
12	Bori	■	■	■	■	■		■
13	Afraa Mall	■					■	

*Black color : positive result, White color: negative result

4.2.1 Mapping

First we made a small experiment. We edited online OSM data of Khartoum City, to look for a virtual new branch, which could found in the map before. The geographic coordinates are given below.

(*under account asmahan79@gmail.com website: http://www.openstreetmap.org/relation/192789 , Khartoum Map Longitude and latitude: 15.5933250, 32.5356500*)

4.2.2 Location Analysis

In the analysis experiments four directions of Khartoum City are considered: North, South, East and West. The site locations are to be analyzed such to assessing the competitive environment, and forecasting the potential growth. Here are using the many citeria (see section 3.4) finding the best future branch locations for Alblad Bank.

4.2.3. Processes

First of all using criteria from the literature review and apply of the Analytic Network Process (ANP) to obtain the criterion weights. In the next step Arc GIS for Desktop 10 is creating the GIS layers to be used for the analysis. The GIS layers represent each of the criteria. To

manage the analysis, it has to be made sure that sufficient GIS data are available, otherwise further GIS layers are required to be developed. In map making step preparation, multiple geographic layers are aggregated to produce maps, that show the suitability of the land for searching the new bank branch.

Finally, the maximal covering location problem (MCLP) is to be applied, to select the branches fulfilling maximum demand, to be reached within a pre-specified target travel time.

For the study area Khartoum City, the research client Balad Bank provided incident data for the period: 1st January 2018 to 31st June 2019. Further data were supplied by the Municipality, thus each GIS layer may contain the density of each criterion.

The techniques and approaches of existing standards have not been highlighted any type of aspect required for site selection. Thus, will find issue highlights for the identification of various aspects, that may facilitate construction and planning professionals in locating facilities appropriately.

4.2.4 Objective Definition

The first stage in managing a multi-criteria evaluation analysis is to define the objective of the analysis. In this research, the objective is to present a model for locating the new bank branch.

4.2.5 Identification and Weights of the Criteria

In this step the important criteria in locating the new bank branch are determined in six clusters and twelve criteria including: Population Characteristic (Population density, Income level), urban facilities accessibility (Hospital and medicine vicinity, Business center vicinity, Hotel and tourism center vicinity, Office and company vicinity, Parking vicinity) and competition (competitor branch vicinity). Also, weights of each criteria were determined by a group of municipal staff using the pair wise comparison matrix of the Analytic Network Process. The inconsistency rate of the pair wise comparison matrix was controlled to be less than 0.1.

4.2.6 Preparing the Criterion Maps

After establishing Khartoum City GIS maps from the municipality, the criteria layer would be extracted. Secondly, the GIS vector layers are being made for all of the eleven considered criteria. Thirdly, all of the

vector layers are to be converted to raster format as the GIS software used to manage the analysis is a raster-based.

We are using the following criterion maps:-

1. Market
2. Hospital
3. Educations
4. Commercial
5. Services
6. Branches (current)
7. Coverage area buffer
8. Prospective areas

CHAPTER 5

Simulations and Results

5.1 Simulations

5.1.1 Designating Weights to Criteria Maps - the next step after analyzing the GIS map layers

Figure 21: Table of supposed points of interest

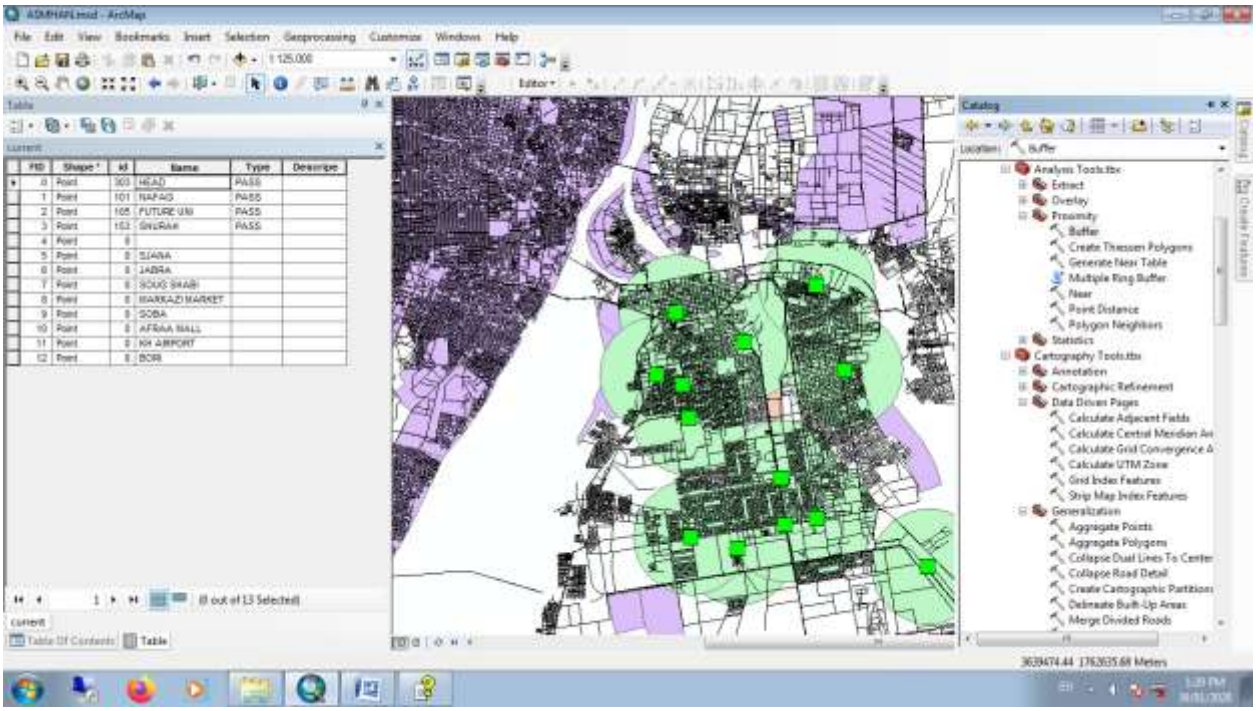

Figure 22: Buffer of 2km

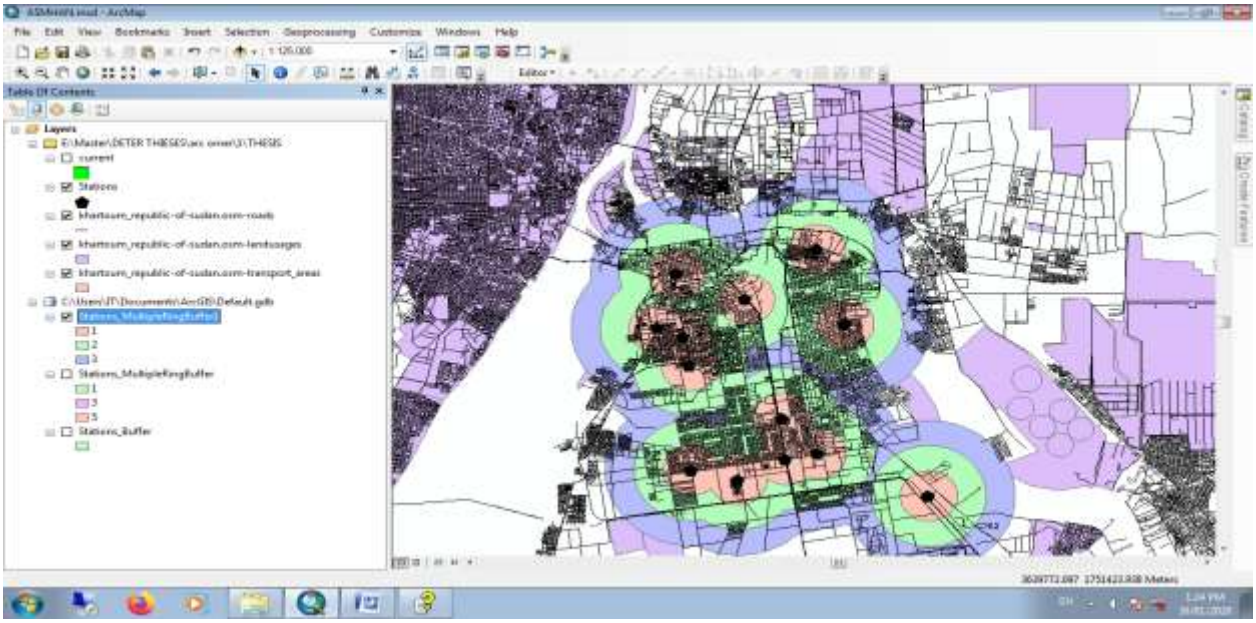

Figure 23: Multi buffers of 1,2,3km

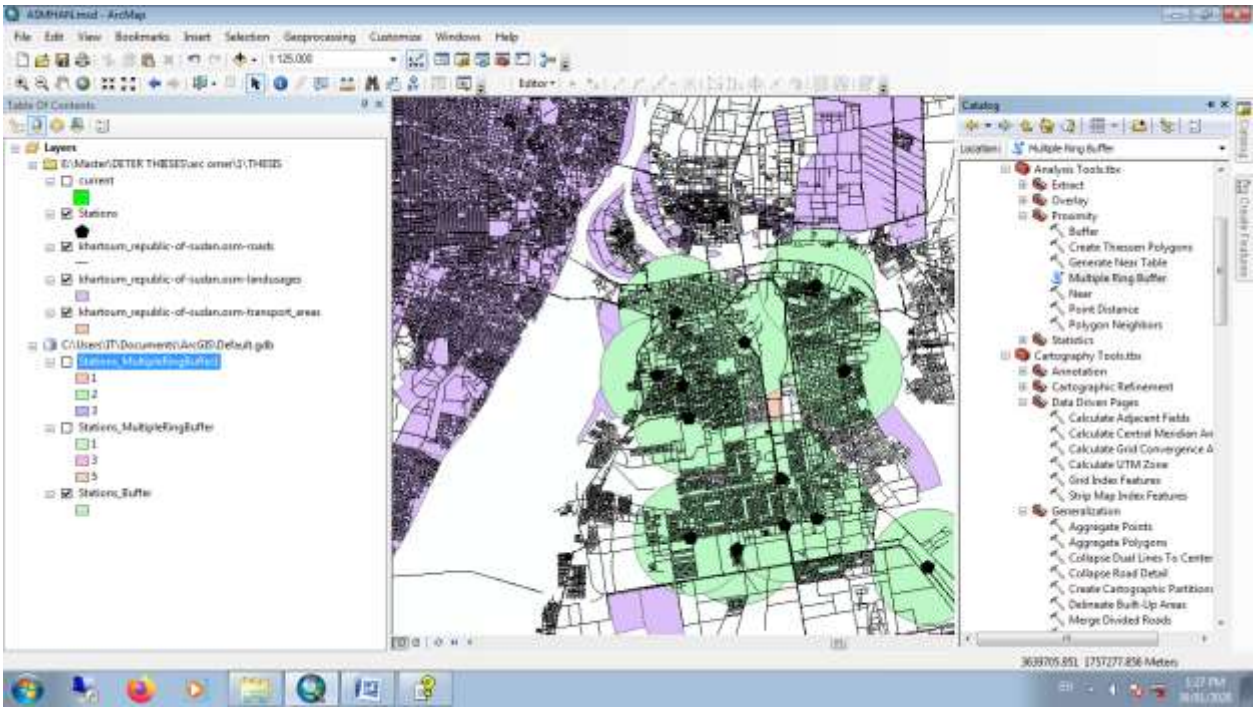

Figure 24: Services area of current branches and supposed places

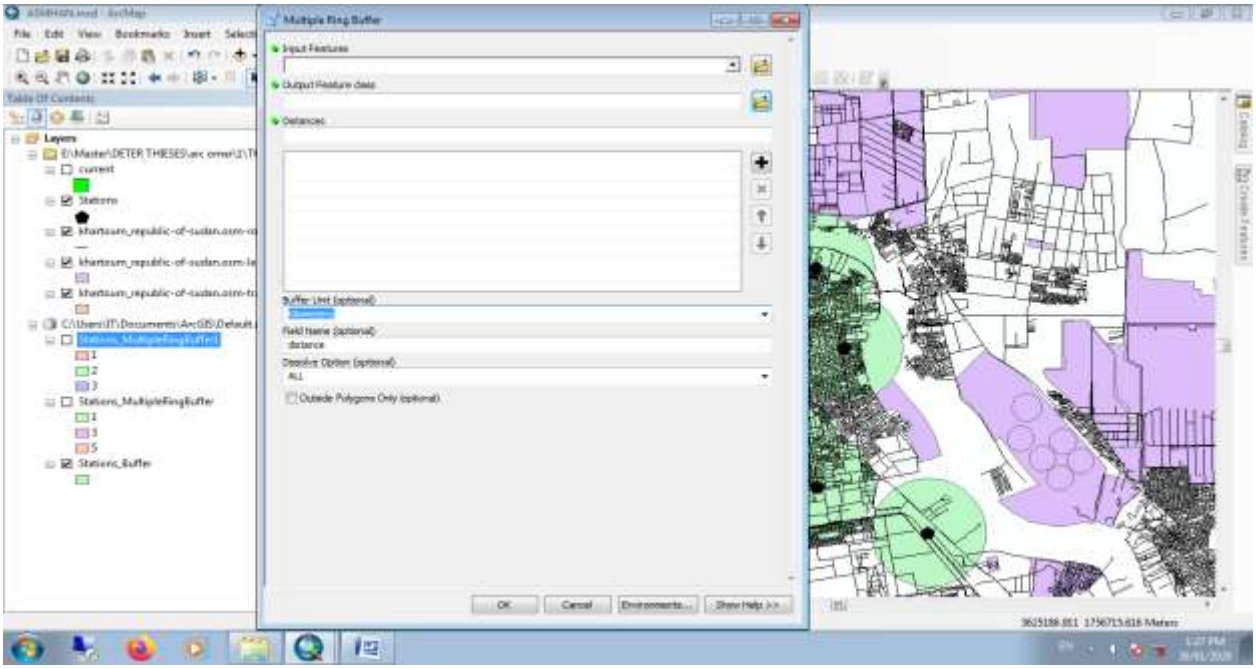

Figure 25: Buffer analysis

The buffers cover distances of 1,2 and 3km to the branch accessibility. Above of these distances the customer well face difficulties to get bank services. Thus we need to design a model to get the best location for new branches.

For this reason we allocate weights to criteria maps in the GIS software. We use the Esri ArcGIS for Desktop 10 to conduct the analysis and produce the map. The following steps, which are the technical steps, have been done according to Decision Support Wizard of Arc GIS.

The calculated weights were assigned to layers, and different layers of information were combined in ArcGIS software. The hierarchical decision-making structure for solving the location problem is very popular among decision makers. For example, Figure 26 demonstrates the hierarchical decision making structure which consists of 4 layers, and the main goals, in total 6 criteria, and 14 sub-criteria and layers.

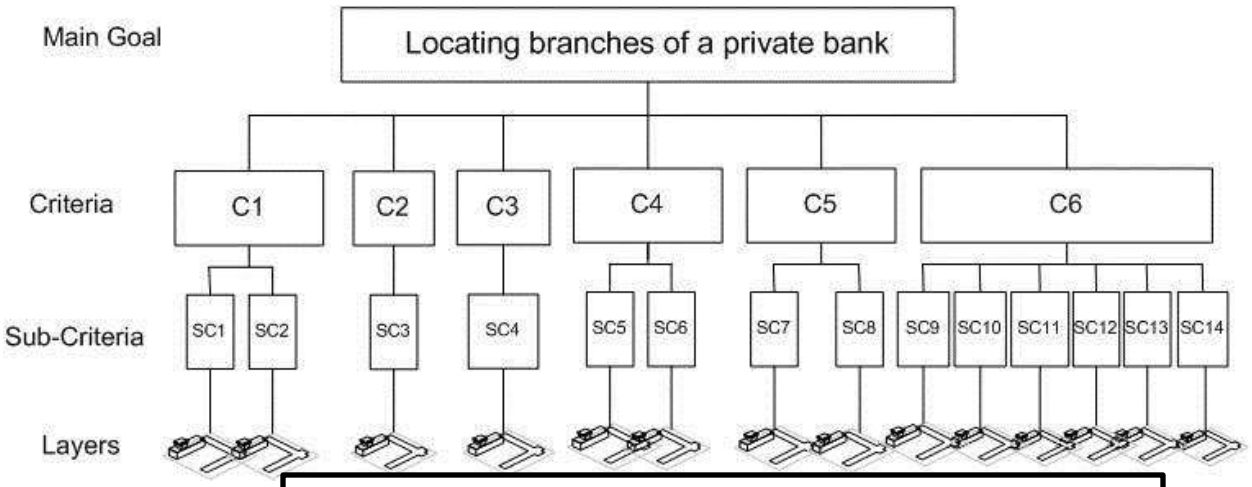

Figure 26: Hierarchical decision-making

According to the ANP approach, the thesis defines the weight of each criteria. To evaluate the located facilities, we demonstrates three classes: high suitable class, suitable class, and non-suitable class, and the value of them are 0.6, 0.4 and 0, respectively. According to Table 2, three classification values calculate the location of branches which are defined by using ARCGIS software. Finally, the importance of the criteria obtained in the previous step (Figure 26) is multiplied in its layer, and then all layers are multiplied with each other to getting the best locations for making the new branch. The criteria are shown in Figures 19 to 20.

Table 2. Classification of criterion distance to own bank branch

Criteria \ suitability	High suitable	Suitable	Non suitable
Main street	≤100m	100-500 m	≥500 m
Business center	≤100m	100- 250 m	≥250 m
Hotel and tourism center	≤1000m	1000-3000 m	≥3000 m
Office	≤250m	200-500 m	≥500 m
Competitor branch	100-200 m	≥200m	≤100 m
Familiar branch	≥1000m	500-1000m	≤500 m
Income level	High	Middle	Low
Cost of purchasing building	Middle	High	Low
Medicine center	≤100m	100-500m	≥500 m
Population density	≥500	200- 500	≤200
Parking	≤500 m	500- 1500 m	≥1500 m
Bus/taxi/metro vicinity	≤500 m	500- 1500 m	≥1500 m

5.1.2 Set of Candidate Sites

After analyzing the decision factors impacting the bank location, twelve criteria in Table 2 contribute to have suitable facility locations. To demonstrate and assess the results (see Figure 23) the criteria could be depicted. The criteria maps were transferred into point geometry and represented the covering points. All candidate sites were accessible to the state and were literally located. This guarantees that the input (GIS maps) and output (Optimal facility location) can be easily transported. Based on the preliminary selection of the potential sites for bank locations, the potential location of these candidate sites is shown in the map in Figure 23**.**

5.2 The Results

The results of the current study can be implied for managerial policy making as well as for theoretical perspectives. Based on the results, it was found out that there are excessive numbers of banks in the area under study at certain locations. Also, this study suggests how to choose the optimal and best location for a branch. The absence of appropriate planning criteria that can regulate the site selection will lead to serious consequences such as oversupply in bank locations and negative effects on the performance.

It is vital for educational decision-making to collect accurate, detailed, and updated statistical demographics and socio-economic information about Khartoum city.

The influence of surrounding developments on the city and its trade situation has significant effects on evaluation of the situation and imperative selected factors.

These considerations would definitely help in proper distribution of services. These data have to be reflected on accurate, updated, and detailed GIS maps to provide accurate planning decisions. However, in the bank sector, such decisions can only be achieved after setting various criteria to select sites, according to which strict regulations can be issued that ensure proper coverage of all areas to serve the city's customers and

residents. The method used in this study can also be used for developing other planning criteria; however, it has to be refined to plan all other services such as institutional facilities, transportation systems, social facilities, green areas, health and care services, residential areas, etc. This kind of planning can encourage social investment of the community to obtain a high level of sustainability and ensure the satisfaction of the public with the city's strategic plans.

Finely for the decision making ,the Best location of candidate sites is shown in the map (Figure 25), 8 optimal location to conduct new branch.

CHAPTER 6

CONCLUSIONS AND OUTLOOK

CONCLUSIONS

IMITATION

RECOMMENDATIONS

6.1 Conclusions

- This Thesis studied the Geo-marketing issue focusing on Khartoum city area locating bank branches in it based on the defined layers and criteria using OSM data and proposed integration between MCDM model represented by ANP with GIS to search the best location for construct a new bank branch, The model was implemented for Balad bank in Khartoum city.

- As a result of the research, it was found out that the proposed model is practical and effective for identifying suitable sites with respect to multiple criteria. Therefore, the proposed model could be used for locating the popular and accessible sites in cities such as locating health care centers, emergencies and hospitals, suppliers and factories, police stations and taxi and bus stations. The model used a combination approach of operation research and GIS instead of proposing some location empirically and ranking them with MCDM techniques.

And approved that :

- Using free OSM data as an alternative of other commercial maps will be a solution Because of Sudan Sanctions
- Editing OSM is simple by using OSM Contributor Mapping Tool.
- Using Geomarketing reduce cost, time, effort of organizations

- Accurate result of analysis technique for getting best locations

6.2. Limitations : This study faced with some limitations.

- One threat of this thesis is its limitation of growing and contributions of OSM in Sudan.

- The coverage of OSM data in rural areas is too coarse to be a sophisticated alternative for any other maps or application.
- Because of the rural problem of volunteers, who contribute to OSM data, this thesis could only make a contribution in an urban area – the city of Khartoum.
- Because of Sudan Sanctions, we face a problem to used other important GIS soft wares like ESRI online software.

- The main one was the lack of syndicated data available for the researchers in terms of banks field (other banks and the branches of Balad bank). Consequently, such limitations shifted the aim of the research from business-oriented and mathematical choice modelling towards GIS-based methods.

The other limitation of the study was the lack of unified and agreed-upon models for site selection.

6.3 Recommendations

- The open source community is being more and more enriched. That is why Wikipedia has become the world's greatest knowledge-base. OSM is emerging along the same way. Today it may be a small thing, but if its development goes on, in a few years it will become a part of people's life. To go forward it will make a revolution in geomarketing.

- This thesis is an initial effort to start Geomarketing journey using OSM data and aimed at providing useful help for people and organizations, giving them the ability to go beyond standard data analysis with tools to integrate, view, and analyze data using maps. Recommend to provide more future effort In this field

- Also new applications can be developed and used across an entire organization, which will benefit from the Internet and smart phone usage.

- Further hot issues are Business Intelligence, Market analysis, customer analytics, and site selections. These are businesses for which we have to combine geographic analysis for getting the best results.
- OSM application in Android and iOS devices is simple. This encourage mappers to make a contribution everywhere .

- Using Geomarketing techniques will shift from traditional ways of marketing depending on old methods or tools to accurate and realistic ways based on technology, like digital maps and software applications, which growing day after day .
- There is real need for new ways of market targeting using GIS tools, such as OSM, ESRI analysis tools, ArcGIS, etc. This thesis provides support in this way using OSM data for business analytics.
- Accurate model locations of existing and potential best areas are important for Banks and other situations .

- Analysis (Strength, Weaknesses, Opportunities and Threats) may help those, who would like to get an Executive Summary of the findings of this thesis.

- Finally a short SWOT analysis (Strength, Weaknesses, Opportunities and Threats) may help those, who would like to get an Executive Summary of the findings of this thesis.

7. REFERENCES

Ahmad Pugi, N., Zainol, H. and Mohamad, A.. (2016). *Determination of New Bank Branch Location Using GIS Approach*. [online] research gat. Available at: https://www.researchgate.net/publication/299486961_Determination_of_New_Bank_Branch_Location_Using_GIS_Approach (Accessed 9 April 2018).

Bennett, J. (2010) . *OpenStreetMap .E-book library* [online]. Available at:https://www.booktopia.com.au/openstreetmap-jonathan-bennett/ebook/9781847197511.html (Accessed: 10 September 2018) **.**

Church, R. and ReVelle, C.,(1974). *The Maximal Covering Location Problem*. [online] research gate. Available at:

ttps://www.researchgate.net/publication/280743478_The_Maximal_Covering_Location_Problem (Accessed 9 April 2020).

(Pfoser, D. and Zhang, L,. 2019). *Using OpenStreetMap point-of-interest data to model urban change*. [online] journal.pone , pp.1213

Quesada-Pineda, H., Brenes-Bastos, M. and Smith, R. (2017). *Assessing Geographic Information Systems Use In Marketing Applications For The Wood Products Industry*. [online] research gate. Available at: ttps://www.researchgate.net/publication/314493695_Assessing_Geographic_Information_Systems_Use_In_Marketing_Applications_For_The_Wood_Products_Industry (Accessed 9 April 2018).

(**Roghanian and Namazian**.2020) *A decision problem for bank branch site selection: A GIS Mapping perspective with Maximal Covering Location Problem: A case study of Isfahan, Iran*.]. pp 43-48 [online] research gate.

https://www.researchgate.net/publication/338316121_A_decision_problem_for_bank_branch_site_selection_A_GIS_Mapping_perspective_with_Maximal_Covering_Location_Problem_A_case_study_of_Isfahan_Iran(Accessed 4 April 2020)

Rifat, R., Moutushy, S. and H.S. Ferdous. (2012) *.'A Location Based Advertisement Scheme using OpenStreetMap*'. Bangladesh University of Engineering and Technology. Dhaka .Available at:

http://www.dgp.toronto.edu/~rifat/files/rifat_lba.pdf(Accessed: 1 December 2017)

(Source, 2012). *Queensland Surveying and Spatial Conference 2012 - Spatial Source*. [online] Spatial Source.Available at:

https://www.spatialsource.com.au/company-news/queensland-surveying-and-spatial-conference-2012 (Accessed 1 February 2018).

Verschuren, M.M.J.(2006). *Geomarketing.GIS&Marketing, the New Combination of Knowledge.* MSc thesis. Wageningen University and Research Centre. Netherlands Available at:

ttps://edepot.wur.nl/308865>.(Accessed: 20 February 2020).