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Street Geometric Network

Case study centre of Khartoum(Sudan)

[1]*Abd Elrahim Elgizouli Mohamed Ahamed*, [2]Khalid Abuelgasim Ahamed Shimmo

[1]*(Associate Professor) Dep. of Civil Eng., Engineering College, Karary University ,Sudan*
[1]*E-mail: aelgizouli1954@gmail.com*

[2]*Sudan-Karary-Elwaha*

Abstract

The main objective of this paper is to use the powerful Geographic information system and remote sensing to generate a geometric network for street in Khartoum center, for the purpose of management of the street network with in transportation system of the city. The data used in this paper was satellite image from Google earth and digital map from Ministry of Infrastructure, Department of Roads and Bridges.
The present research comes to the conclusions that the Powerful geometric network has been designed and manipulated for the study area, within the GIS environmental and the geo-database
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shows great flexibility and powerful management facilities in production solutions for the real world problems concerning the traffic flow direction and motion distribution, such as the best route and the closest facility. The developed model is dynamic, so it could be modified, updated and subjected to further query processes among the study area.

Kea wards: GIS, Geometric-Network, Geo-Database.

1.Introduction:

Khartoum is the capital of Sudan nationalism and it includes three cities, are Khartoum, Omdurman and Khartoum Bahri. The construction and development of street networks is the most important strategies of the country, especially in the capital and this is for the easiest of movement within and man agreement of the state facilities. Where the first planning of street of Khartoum is done by the English Colonia (Kitchener) and he has been implemented it in the form of English flag, and make the area of the grand mosque the centre of the city. Then has been planning the street of Khartoum after independence by Greco Company. Since that time it continued to modify and increase the capital streets. By the reason of the economic conditions and increasing of immigration to the capital the population growth up faster and the capital become larger, and the street are extended to all its districts.
Then the problem is the movement between these streets especially from the parties to the center. Where traffic jams and slows traffic motion, which led waste of time or use long way to access to the desired location. The geometric network is one of the GIS applications to manage the transportation network of the street to solve the flow of the traffic through the Geometric network and offered solution for the best use of the street easily without lost much time [4]. One of

it is characterize is to offer tracking system in the network and obtaining the flow of the traffic in the network.

The main objective of this study is to use the Geographic information system and remote sensing techniques to generate a geometric network for streets in Khartoum center, for the purpose of street network management within transportation system of the city.

2.Geometric Network:

Geometric networks offer away to model common networks and infrastructures found in the real world. A network is a system of interconnected elements, such as lines connecting points. Examples of networks include highways connecting to cities, streets interconnected to each other at street intersections, drainage network streams and watercourses interconnected to each other at their intersection and sewer and water lines that connect to houses[4]. Connectivity is inherently important in order to travel over the network. Network elements, such as edges (lines) and junctions (points), must be interconnected to allow navigation over the network. Additionally, these elements have properties that control navigation on the network. Geometric networks consist of edge network features and junction network features, and a junction feature might be a valve. Edges must be connected to other edges through junctions. Edge features are related to edge elements in the network, and junction features are related to junction elements in the logical network. Geometric network have connectivity rules that control which network objects can properly connect to each other, with geometric network connectivity rule is updated whenever add or remove any network feature (Figure1).

1.1 Geometric Network Components:

A geometric network is built within a feature dataset in the geo-database. The feature classes in the feature dataset are used as the data sources for network junctions and edges. The network connectivity is based upon the geometric coincidence of the feature classes used as data sources. The basic components of the geometric network are edges, junctions. Edge is a feature which has a length through which some commodity flow edges are created from line feature classes in a feature dataset and correspond to edge elements in a logical network. There are two types of edges in a geometric net work these are simple edge and complex edge Simple edges are always connected to exactly two junctions, one at each end. Complex edges are always connected to at least two junctions at their endpoints but can be connected to additional junctions along their length.

Junction is a feature that allows two or more edges to connect and facilitates the transfer of flow between edges. Junctions are created from point feature classes in a feature dataset and correspond to junction elements in the logical network.

1.2 Geometric Network Models:

The net work can be directed or in directed. Directed model systems each edge has affixed direction of flow, such as river network flowing downstream inside hydrologic channels. Elements on the network have no choice in travel decision, flow direction is determined by the network characteristics alone. In directed model systems with no preferred direction flow, such as street, elements on the network make their own travel decision. Network can be planar or non-planar [3]. The planar connected on two-dimensional plane at junctions, without any crossing edges. On-planar has edge that cross on street network, non-planar can model abridge over a road. Geographic data commonly comes in planar and non-planar form, planar data allows using elevation level information to model crossing street (Figure 2).

1.3 Transportation Network:

Transportation networks are undirected networks. This means that although an edge on a network may have a direction assigned to it, the agent (the person or resource being transported) is free to decide the direction, speed, and destination of traversal. For example, a person in a car traveling on a street can choose which street to turn onto, when to stop, and which direction to drive. Restrictions imposed on a network, such as one-way streets or "no U-turn allowed", are guidelines for the agent to follow. This is in stark contrast to the utility network [8].

2. Methodology

Khartoum was selected as study area for this research work (figure 3).It is the capital of Sudan with population about seven million. Study area lied between latitude 15 00 00 – 16 00 00 and longitude 31 30 00 -33 000 and contained seven localities. The geology of the study area is almost flat and there stones of high resistance to weathering and climate conditions, some scattered hills, generally they were stones layers above the surface. The metrology of the study area is experiences same desert climate with three well-marked season, cold winter from November to March ,hot summer from March to July and Autoum from July to October. Forest and nature vegetation were classified by Mr. Harrison and Jackson (1958) as desert contained Acacia Tortits Maerua crasifalia scrub .

2.1 Software and Hardware:

Software is collection of computer programs instructions cause the hardware (the machines) to do work. GIS software is the processing engine of the GIS technology, and essential component for building and developing operational GIS system. It integrated collection of computer programs that implement geospatial processing functions. The main key parts of any GIS software are the information model which defines the classes of objects that can be represented from the domain of the interest and how they behave and interact, than the data manager is commonly implemented as data base management, also process functions (tools) is the functions for data input, retrieving, modeling, query, analysis, and visualization, and lastly interfaces include user interfaces and application programming interfaces [3]. The essential functions of GIS software are data acquisition, data query, geographic data base, data management, data analysis and presentation. There are many different GIS software packages available today. All packages must be capable of data input, storage, management, transformation, analysis, and output, but the appearance, methods, resources, and ease of use of the various systems may be very different. Today's software packages are capable of allowing both graphical and descriptive data to be stored in a single database, known as the object-relational model. Before this innovation, the geo-relational model was used. In this model, graphical and descriptive data sets were handled separately. The modern packages usually come with a set of tools that can be customized to the user's needs. Hardware is tools and implements consist of the components that can physically be handled, the physical component or devices are connected to computer or standalone, specifically the physical device that providing the functionality to acquire, handle, display and retrieval the geospatial data within GIS environment [2]. The hardware components include standard data acquisition devices(survey equipments, remote sensors, scanners, digitizers and GPS),standard output device(display units, plotters, printers and others),standard processing device(central process unit, processing sub-system), technical equipment needed to run a GIS including a computer system with enough power to run the software, enough memory to store large amounts of data [6].

3. Procedures:

The procedures of this research work consist of three phases .The first phase is concerned with data acquisition. Phase two is the building of geodatabase of the street. Generation of GIS model and building the street geometric network of study area is in last phase.

3.1 Data Acquisition:

Data acquisition is the step of collection data and preparing it to use within GIS environmental. This step begins with planning to the source witch data will be collected. Digitizing is the core of this data acquisition, it is the process of converting feature in the map to digital form to use with GIS activity. The process was very tedious and time consuming, digitizing all layering of layers with their attributes, the descriptive data of the streets and urban of the study area. The study area, Figure 4 to Figure 6 shows output of the digital thematic layers.

3.2 Building Geo-database:

The geo-database is one of the strong important outcomes of this research, personal geo-database which is used for the study area has been modeled and represented as geometric features. The main component of the generated geo-database is one dataset and five feature classes. A projected coordinate system is defined on a flat, two-dimensional surface. Unlike a geographic coordinate system, a projected coordinate system has constant lengths, angles, and areas across the two dimensions. A projected coordinate system is always based on a geographic coordinate system that is in turn based on a sphere or spheroid. The projected UTM coordinate system was selected to model the study area, Figure 3 and 5 show the basic specification of the feature dataset of the study area.

3.2.1 Building Street Geometric Network:

A wizard guides the user though the process of naming the network dataset and specifying the network element sources defining connectivity policies and groups incorporating turns and applying network attributes and, lastly specifying the properties for driving directions that can be created by some of the network solvers. Once the network dataset is generated, the logical network must be built before creating the network dataset, decide whether it will be geo-database. A geo-database, based network dataset can support multiple sources and can take advantage of other geo-database components such as subtypes and topology. A multimodal network is best modeled using a geodatabase-based network dataset. Once the dataset is located in the geo-database, they could be participated in spatial relationship called geometric network .A Geometric network is defined by ESRI as topologically connected of edge and junction features that represent linear network such as street or hydrologic systems. Street geometric network of the study area is built from network dataset(figure 7).

3.2.2 Network Analysis:

This is the final analysis and the result is the main issues of the research work witch show the magic of GIS in the application of the geometric network. Using two cases to visualize network analysis, the first is finding the best route using a network dataset and the other is finding the closest fire stations.

3.2.3 Finding the Best Route:

In analyst window contains empty lists of Stops, Routes and Barriers categories, by add the stations from 1 to 5which will be creating the best route and five distributed barriers witch show error on the street that cannot used. The program then calculates the nearest network location and this case we use the best route to find the shortest route. The network symbolizes the stop with the located symbol. The stop will remain selected until another stop is placed or until it is unselected. The located stop also displays the number, (Figure 8) show the solution of the case.

3.2.4 Finding the Closest Fire Stations:

In this case we will use the closest facility to find the closest fire stations that can respond to a fire at short time, also generate the fastest route from each of these fire stations that will be provided to each driver of the fire engine. The two red cycles was the fire stations and the red square is the position of the fire, (Figure 9) shows the solution of the case.

4. Conclusion and Recommendations:

4.1 The present research work comes to the following conclusions:

Powerful geometric network of street has been designed and manipulated for the study area. Within the GIS environmental the geo-database with dataset and feature classes have been created to represent the realty of the geographic features in the study area.

The GIS model in the application of the geometric network has been subjected to different cases to evaluate their potentiality for meeting the essential requirements.

The model show great flexibility and powerful management facilities in production solutions for the real world problems, concerning the traffic flow direction and motion distribution, such as the best route and the closest facility.

The model was found to be high-tech alternative for producing different thematic maps of solution for the study area.

4.2 Recommendations:

The developed GIS model as well as generated street geometric network should be subjected to further process to cover more land cover and land use in the study area.

The model should be extended to cover whole of the city.The attributes data model of the system should be expanded to hold additional descriptive data to offer control room for producing solution for different real world problems.More statistic and spatial analysis should be applied to the quilts and accuracy of the geographic features.

The developed model is dynamic, so it could be modified, updated and subjected to further query processes among the study area.

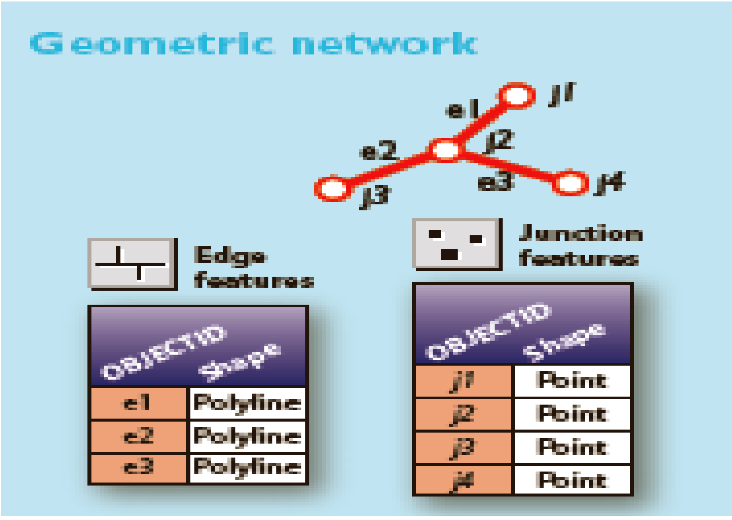


Figure 1: Geometric Network

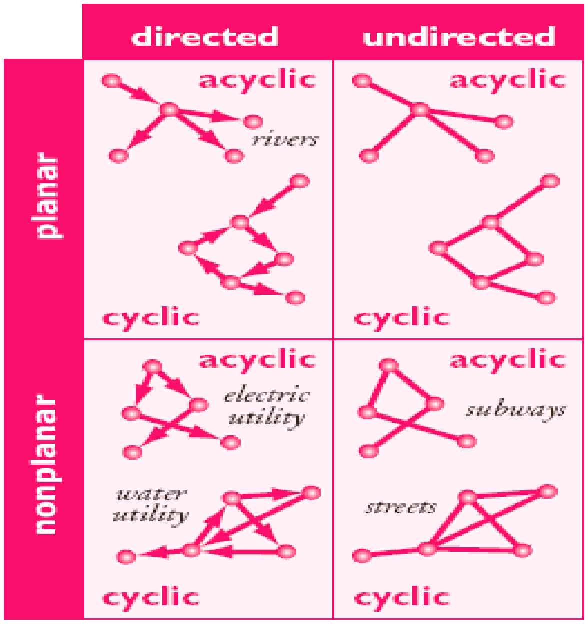


Figure 2: Geometric Network Models

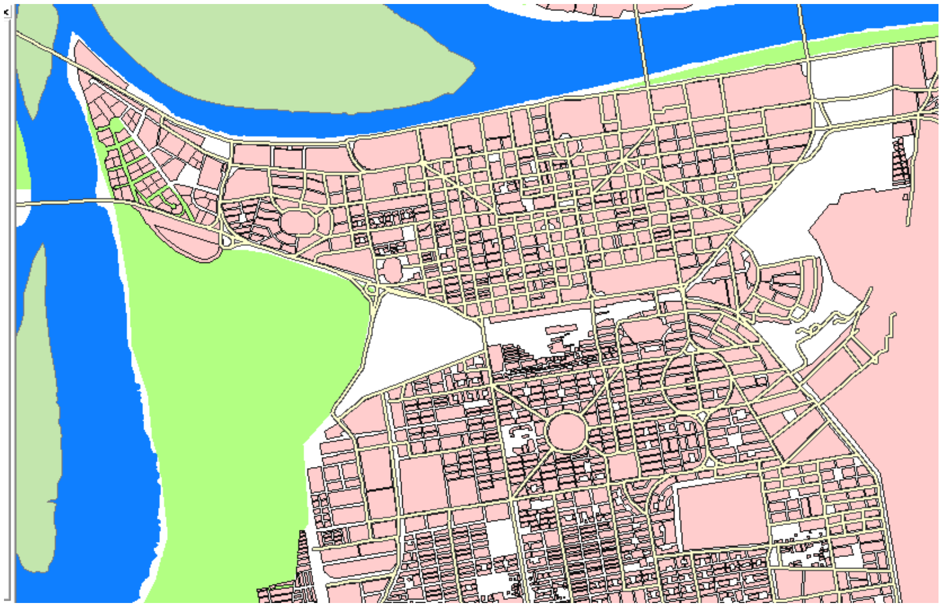


Figure 3: The Study Area

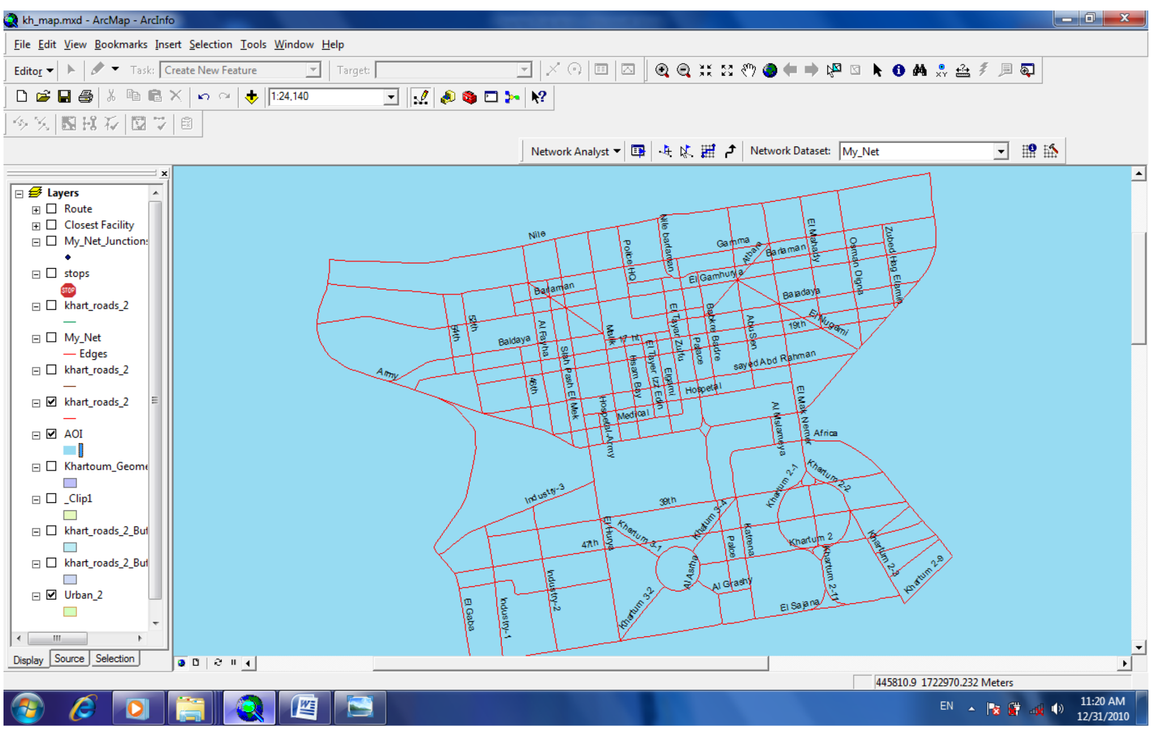


Figure 4: Digitizing and Editing Street Names

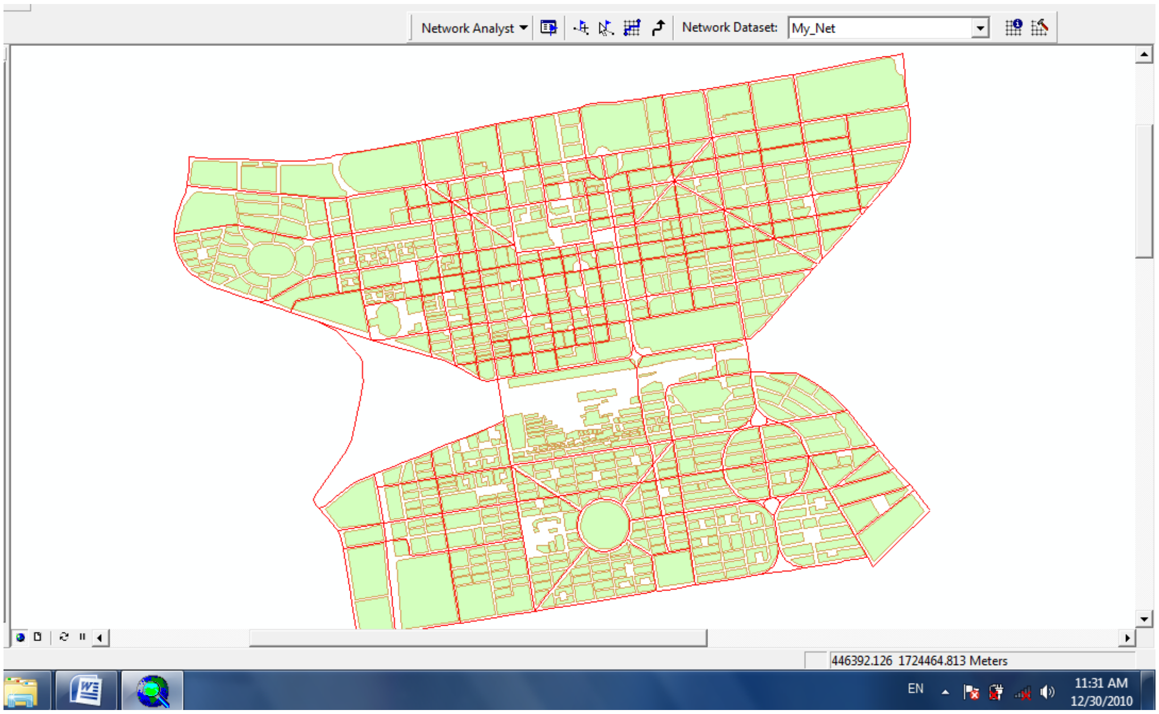
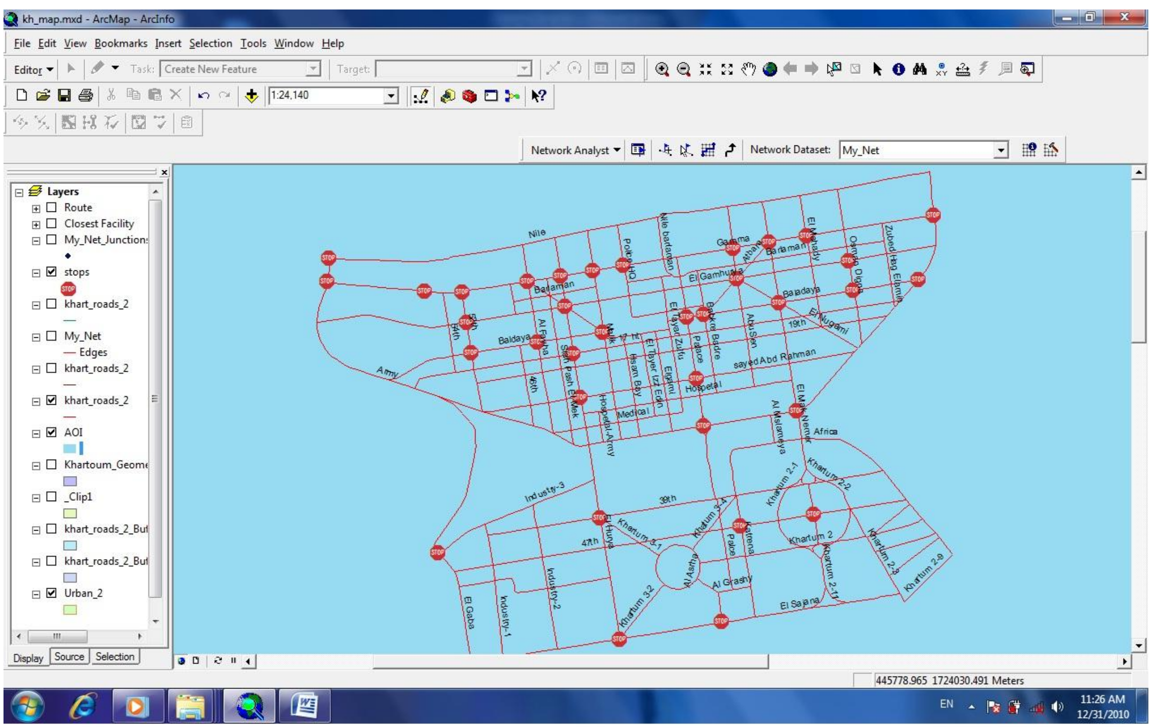


Figure 5: Digitizing the Urban.



Figurer 6: Digitizing the Main Stops.

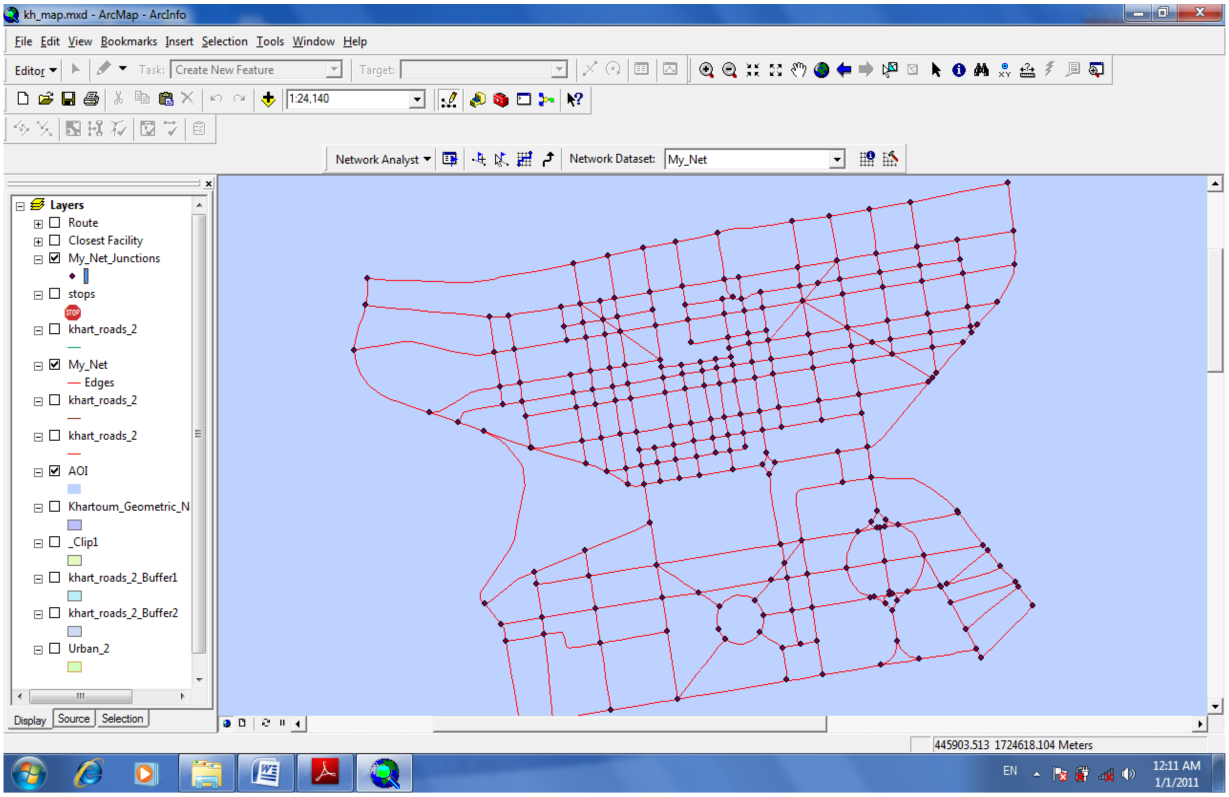


Figure 7: Street Geometric Network of the Study Area.

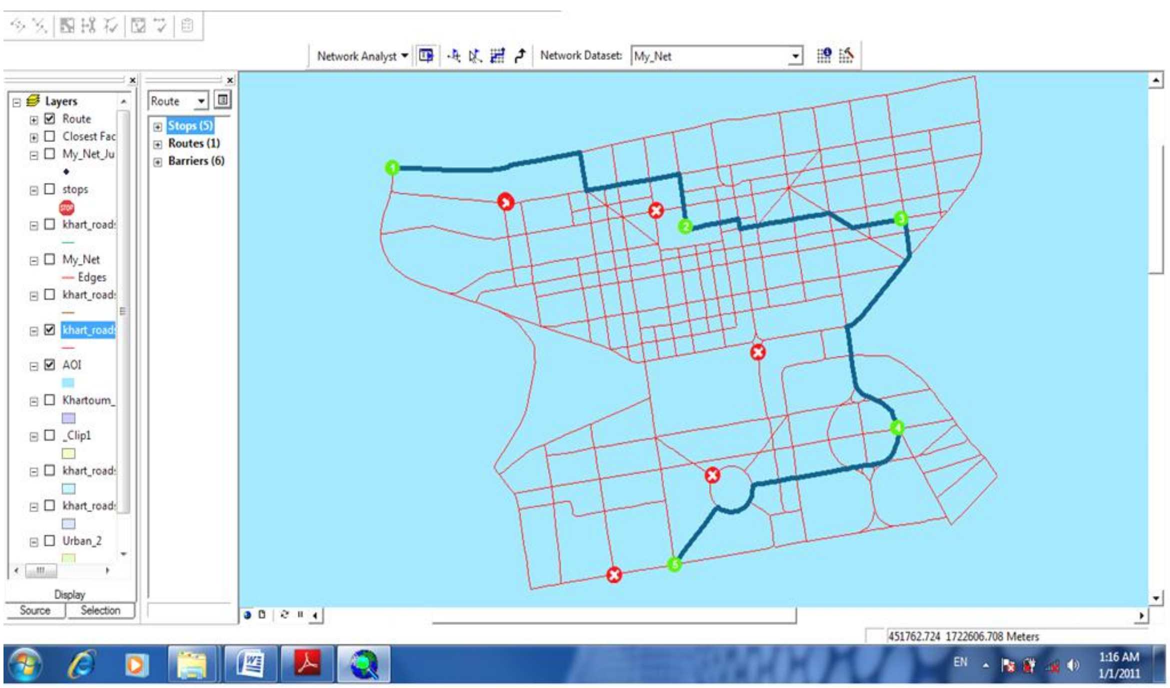


Figure 8: The Best Route

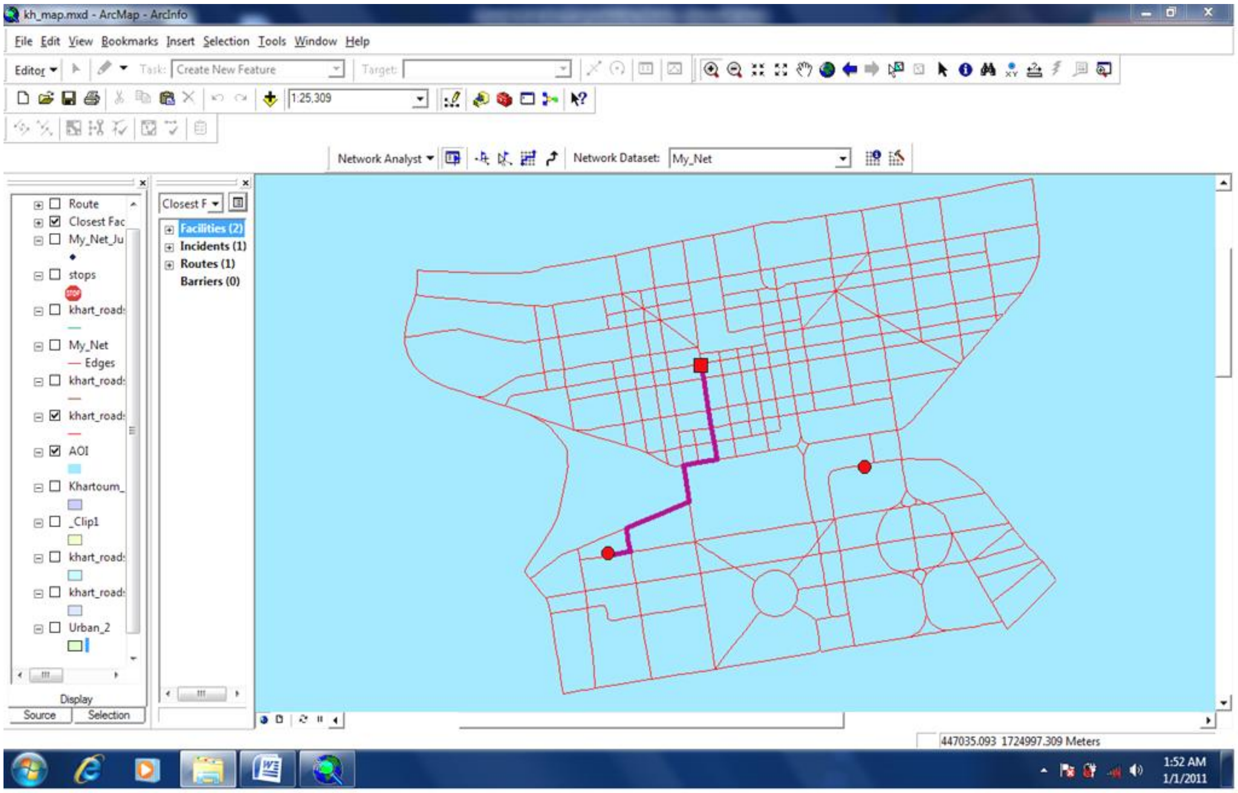


Figure 9: Closest Facility

Reference

1.Demers, Michael, N, 1996, Fundamentals of Geographic Information System, Textbook, Second Edition, John Wiley and Sons.

2.De by, Rolf, A, 2000, Principals of Geographic Information System, Textbook ITC.

3.N-W-Models GIS 6382 US-Dallas Brggs2008.

4.Help, Arc GIS Desktop, Geometric Network Copyright©, ESRI.

5.http://maic.jmu.edu/sic/gis/component.htm.

6.Jones, Christopher, B, 1998, Geographic Information System and computer cartography, Text book, COS Singapore.

7.Street Design Guidelines, November 2003 Public Works Department Engineering Division, Stockton.

8.Street design stander manual (2007) department of Transportation City of Greensboro, North Carolina.

9.Working with Arc GIS Analysis Copyright © 2005-2007 ESRI.

www-esri.com Arc User 2006 Building the Geometric Network

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