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Enhancing artificial intelligence in advanced database systems for Baghdad's urban transportation management

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ABSTRACT

The issue of transportation in Iraqi cities, particularly Baghdad, is multifaceted and intricate, largely due to the horizontal expansion that puts pressure on services and exacerbates traffic congestion and bottlenecks. The ever-growing population and lack of regulation regarding vehicle imports further compound the situation, making urban transportation in Iraq a challenging problem to address. The digital revolution has ushered in a new era of civilization, marked by significant advancements in communication technology and information systems. This transformation has led to the widespread adoption of communication and information technology in various sectors, including transportation management. However, the successful implementation of digital transportation initiatives requires the collection and organization of extensive data, which is then used to develop graphic and visual software technology, create communication networks, and define new functions for visual and audio files. In this digital age, transportation management has evolved into an interdisciplinary field that leverages the insights from various scientific domains to develop and produce digital maps. The primary objective of digital organization is to recreate reality in a virtual environment, enabling the manipulation of images and the seamless integration of locations beyond geographical boundaries.

Keywords: Artificial Intelligence, Advanced Database, transportation in Iraqi cities

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1. Introduction

Geographic information systems (GIS) have played a crucial role in addressing transportation problems and crises by regulating land use for transport purposes. By analyzing various data, GIS highlights issues and helps develop necessary solutions. GIS databases store data and information on spatial phenomena (points, lines, and areas) based on a specific mapping system that enables spatial analysis and efficient utilization of data for quick and accurate location-based results. The advancement of satellite systems, particularly GPS technology, has significantly impacted the transportation sector. Modern GPS systems provide a wealth of information, such as distance, speed, time, positioning coordinates, and land elevation data, which can be integrated with GIS programs[1]. This combination is essential for improving transportation infrastructure, driving assistance, road maintenance and construction, and identifying accidents and hazards through digital control systems. Additionally, GPS technology contributes to vehicle theft prevention by enabling automatic engine shutdown and monitoring vehicle movements. Advanced control systems linked to global positioning systems allow for speed and fuel monitoring of multiple vehicles simultaneously. These systems can also provide the shortest route for vehicles, adjust their course, and reduce response times through digital control centers that integrate GIS and GPS technologies. In this study, a model for an integrated database of road types in Iraq was developed, with the aim of improving transportation organization and maintenance, reducing traffic accidents, expediting

disaster response, and aiding in the rescue of injured individuals. The model also helps determine the nearest ambulance points by constructing layers based on detailed maps, accurate satellite images from Ikonos 7 and Quick Bird 2 in 2014 and performing spatial analysis on geospatial data specifically designed for the transportation sector. These applications were implemented through GPRS tracking and digital TB signals, which could be received as messages on mobile devices or via digital control systems. The research began by addressing the problem, its objectives, and its significance, followed by the theoretical framework, research procedures, discussion, findings, conclusions, and recommendations. The city of Baghdad, second only to Cairo in terms of size, experiences severe traffic congestion and disorganization in its transportation modes. This research seeks to answer several key questions:
First question: Why is Baghdad plagued by inadequate management in the transportation sector?
Second question: How do application programs, such as GIS and global positioning systems (GPS), contribute to organizing transportation in Baghdad?
Third question: Can these systems effectively reduce traffic congestion and vehicle theft through central control centers that regulate the transportation sector, minimize fuel, and time waste, and contribute to sustainable development, among other benefits?

2. Material and methods

The research aims to employ modern digital techniques to transform paper maps from a rigid format to a digital one, assigned to a specific coordinate system. It also seeks to establish a comprehensive database for the transportation sector in Baghdad, exploring the potential benefits of integrating global positioning systems with tracking devices to manage transportation and reduce conflicts in the city's transportation sector. Services encompass any work done by individuals or communities for the benefit of others. The goal is to develop practical approaches, provide digital maps, and create a massive database that can help solve transportation problems in Baghdad, manage the transportation sector more efficiently, and reduce the waste of effort, energy, and money in traffic congestion. This can also guide private and public transportation sectors towards collective contributions to the transport sector and promote sustainable development. Building a geographical database for roads through geographic information systems and GPS technology is important. A geographical database is a collection of files interconnected through the network distribution of information stored in GIS. This database contains logical data as well as map-derived data and other databases, such as boundary relationship data and databases derived from spatial visualization. A geographical database is an extensive, organized, and structured set of data stored in computer memory using a specific logical system. It possesses unique keys that allow searching for the required data, retrieving it for further development, and then returning it to its memory location.

System software assists in the operation of computer hardware and operating system components, including device drivers, operating systems, service modules, help programs, and framework systems that allow users to open multiple programs simultaneously in their own windows. The primary goal of system software is to simplify the complexity of computer peripherals, such as communication devices, printers, projectors, readers, keyboards, etc. Additionally, system software manages the allocation of computer resources, such as memory and processing time, in a secure and stable manner, making it easier for application developers to create new software without worrying about the underlying hardware. The process of creating a spatial database involves several stages:

The first stage is collecting and inputting information, data, and maps. This stage involves gathering spatial information on roads and internal streets from relevant government departments, as well as collecting and correcting maps of different scales based on the Muscat Mercator projection with a precise reference (UTM) WGS84 through GIS programs.

The second stage is processing data, information, and maps. During this stage, the data table is prepared using Arc Catalog GIS, and layers are built based on geographical phenomena. The table is then created for use in the ArcGIS program, and maps and satellite images are corrected according to accurate reference coordinates (UTM) WGS84.

The third stage involves building spatial and descriptive databases and updating them with corrected network data and global positioning system data. This stage requires converting spatial data into vector data (points, lines, areas) for all features of the corrected web map image, utilizing GIS building software such as ArcGIS 9.3. Modern cartographic methods are used to examine the features of the objective point, line, and area, and draw them based on the date of the preparation of the objective paper map, which serves as the basis for representing what is present in the reality of the map area.

Figure 1. Location of study area from Iraq and Baghdad governorate

To update spatial and descriptive data, two factors are essential: satellite imagery of the study area for the year of modernization, which provides 80% of the study's validity, and a field survey mechanism that contributes 20% of the study's validity. Land surveying techniques using modern technology, such as global signature technology, can be used to map the site, converting spatial data from points to lines and areas, where an area consists of more than three points. Satellite receivers are used to update the spatial data, which is then converted to a map based on the corrected network data image at the time of the production of the paper thematic map. GIS programs are used to update all the descriptive data according to the objective map's purpose and scale. This process results in updated spatial and descriptive data. To create descriptive databases reflecting the reality of a given case, mobile GIS technology can be employed to ensure accuracy and efficiency in converting data to the computer. This technology can improve the accuracy of the work done by the exhibitor innovator, saving time, and ensuring that data is correctly inputted into the system. However, there are some limitations to this research. Substantive boundaries were identified, and programs implemented through technical software (GIS) were used. Spatial boundaries were set to the city of Baghdad, which was divided into 14 municipalities based on Map 1. Finally, the temporal limit for the research was set to 2017.

Application software: is designed to perform specific tasks and provide general useful functions on a computer system. These functions may include word processing, electronic tables, databases, drawing programs, presentation tools, multimedia and engineering drawing, accounting and financial software, and design software. As Mohammed Bilal Zuabi notes in his 2007 work (p50), application software is an essential component of modern computing, providing users with the tools they need to carry out their work efficiently and effectively. To operate computer equipment, software is needed, which is a set of sequential instructions that tell the computer what to do. Software can be a single program or a set of programs, data, and stored information, and is built from knowledge, planning, and examination. The programmer is responsible for creating the software by using their understanding of how the computer works to set up a set of instructions that perform useful functions. These instructions are regularly checked and modified to ensure that they produce the desired results. There are two types of software: system operating software and application software. Examples of the former include programming languages, translators, and operating systems like DOS, Windows, Linux, and Unix. System software is responsible for operating the computer and preparing it for work, providing a user interface for running other programs, managing resources and tasks like memory management, input and output units, CPU, and secondary storage management, as well as file management, organization, copying, and transfer. Application software, on the other hand, includes programs like word processing software, electronic tables, databases, presentation and multimedia software, accounting and financial software, software for drawing, design, manufacturing, and transportation regulation. These programs are designed to perform specific tasks and provide useful functions to the user. In the stage of employing geographic information systems, various software programs and tools are used to manage spatial data and create maps, including ArcGIS, QGIS, Google Earth, and others. These programs use various methods to collect, process, and analyze spatial data, allowing users to create accurate and detailed maps for various purposes, from urban planning and land management to disaster response and environmental monitoring.

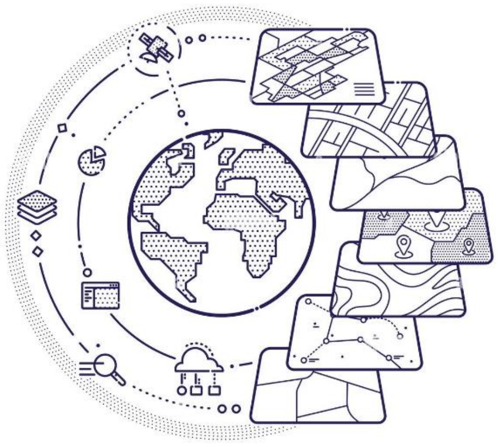


Figure 2. Geographic Information System Linking System with the Global Information Network.

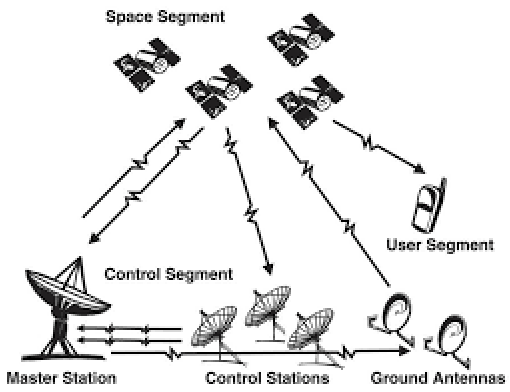


Figure 3. GIS integration with the Global Positioning System.

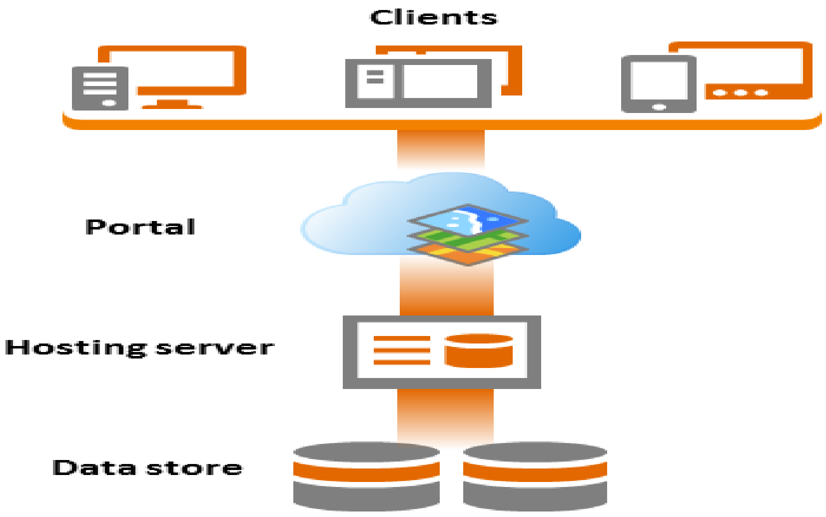


Figure 4. Connecting the computer systems according to the WEB Server network with geographic database Source: ESRI, ARCGIS Query, Users, MANUAL, USA, 1999.

The province center includes a range of facilities such as government departments, public buildings, major shopping centers, fuel stations, and vehicle maintenance centers, as well as the judiciary, among others [2] . To ensure efficient service provision to the current and future population, it is essential to have digital maps containing accurate and updated spatial and descriptive data, as well as advanced equipment and programs. Spatial analysis of this data can help calculate the efficiency of existing services and plan for future services, considering population growth and the capacity of streets to absorb this growth. The integration of spatial and descriptive databases and the preparation of future are crucial for providing all services and preparing the system for integration with other institutions and technologies such as operating room management systems (CAD), AVL/FM systems, accident early warning systems, mobile GIS, and ALI/ANI (location of the caller requesting emergency service) [3, 4] .

1.1. Internet information system

Geographic Information Mapping is a technology that involves the creation of maps, charts, and digital tables that display analysis processes and the relationships between spatial variables, using geographic data associated

with databases [5]. The use of an Internet portal has revolutionized the access and interaction with digital map data from government departments and institutions. By standardizing access to these data through centralized centers, significant savings in time and costs have been achieved [6] . This technology uses servers such as a specialized server and an Internet server, which allow users to browse data acquired from the Internet. After establishing a geographic information center on the Internet, users can access information about the center and its services, as well as details about the spatial and descriptive data it provides, including titles, general services, and satellite images [7] . Please refer to Figure 2 for further information.
http://www.argusint.com/DHV/landuse.htm
To build an organized and digital information project for the transportation sector in Baghdad, which can provide efficient emergency and traffic services for immediate ambulance, civil defense, and government agencies, several requirements need to be fulfilled.
Firstly, organizing and solving the problems of the transportation sector in Baghdad requires the establishment of the National Information Center (NIC) of the Ministry of Transport. The NIC must provide IT services to all sectors of the ministry, including traffic, police, and individuals. The proposed NIC headquarters is in Baghdad, and it must have ten sub-centers, as proposed by ARC GIS ANALYSIS, considering the spatial coverage, street density, and number of vehicles. Video 1 shows the regional areas throughout Baghdad, which are related to the main NIC at the Ministry of Transport in Baghdad through wide area networks (WANs) (see Figure 3 and Figure 4).
To achieve these goals, the following steps have been outlined:
Firstly, GPS devices equipped with GIS technology should be used to manage spatial population information. This should be handled by a trained and specialized workforce, responsible for updating and adding relevant information that may not be apparent through visual observation alone. Figure 5 shows one of the most pressing issues facing planners, which is the subdivision of large residential units into several smaller housing units. This is a common problem with censuses, as many large homes with an area of 800 square meters are converted into multiple residential units, sometimes with additional units built randomly on green areas and orchards.
Secondly, the system should be fully operationalized and implemented as a prototype in a specific area of Baghdad. Applications will be expanded and detailed for various sectors, including the command-and-control center, civil defense, traffic, public sector cars, and transport management. This will involve setting up operating rooms with various devices and systems, including the most crucial ones are:

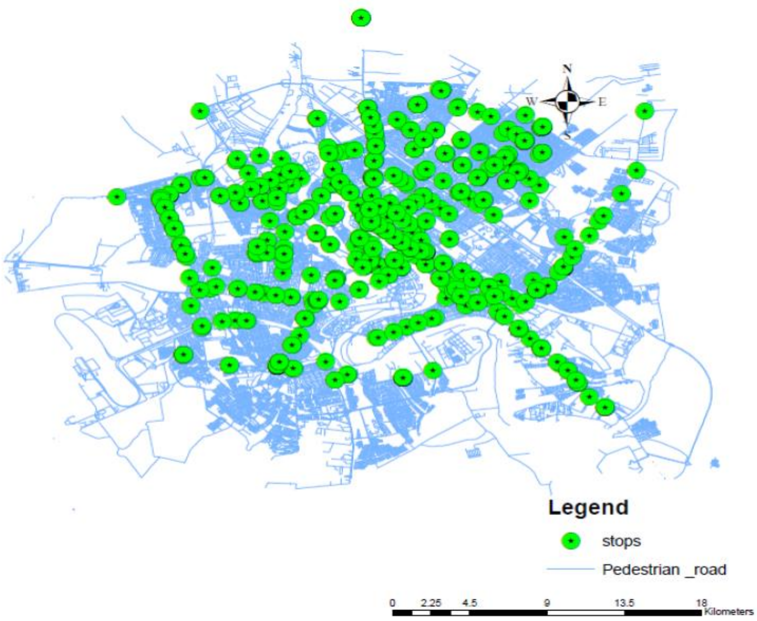


Figure 5. Visible 1 Sign the headquarters and sub-centers for the organization of transport in Baghdad Source: From the work of the researcher based on the data of the Ministry.

1.Computers with dual screens designed for crisis receivers, radio personnel, and room officers.
2.High-resolution satellite imagery and digital maps.
3.Advanced server-compatible LCD screens.

4.A Crisis Management System (CAD).
5.An AVL (Wheel Tracking and Management System) to WAN connectivity to the central system.

Thirdly, the process of creating and preparing digital maps using a GIS system is a crucial step in implementing a GPS system. Designing and constructing the infrastructure for managing transportation systems requires a geographic database as well as hardware, software, information, and personnel, along with base maps, layers, servers, and databases [8]. During the pilot phase, the main databases of several classes were developed, including:

1. Administrative boundary lines with names (such as the borders of Iraq's provinces, districts, neighborhoods, and stores in Baghdad).
2. Baghdad Municipality's boundary layer within Baghdad Governorate.
3. Layers depict the streets of Baghdad city with their respective names, including international roads, external streets, main streets, secondary streets, and tertiary streets. Refer to Map (2) for details.
4. Layered railway stations and stops with their respective names.
5. Layer depicting the locations and names of bridges within Baghdad city.
6. Layers representing the Tigris River and the water channels are present in Baghdad city.
7. Layer depicting the locations of the ministries' centers within Baghdad city.
8. A map representing the land usage patterns.

1.2. Building a digital geographic database for the study area

The foundation for all activities, processes, and analyses performed in Geographic Information Systems (GIS), such as map production to aid decision-making, information retrieval, and spatial analysis, is the design of the geographic database. This design, including the geographical data model, is carefully developed through scientific methods [9] . The Map Layer, also known as the cartographic information layer, is a collection of information that includes one variable or spatial phenomenon within the study area, referred to as a Coverage[10] . The classes within the database are carefully constructed to achieve these objectives thus:

Figure 6. Layers of land use for the city of Baghdad

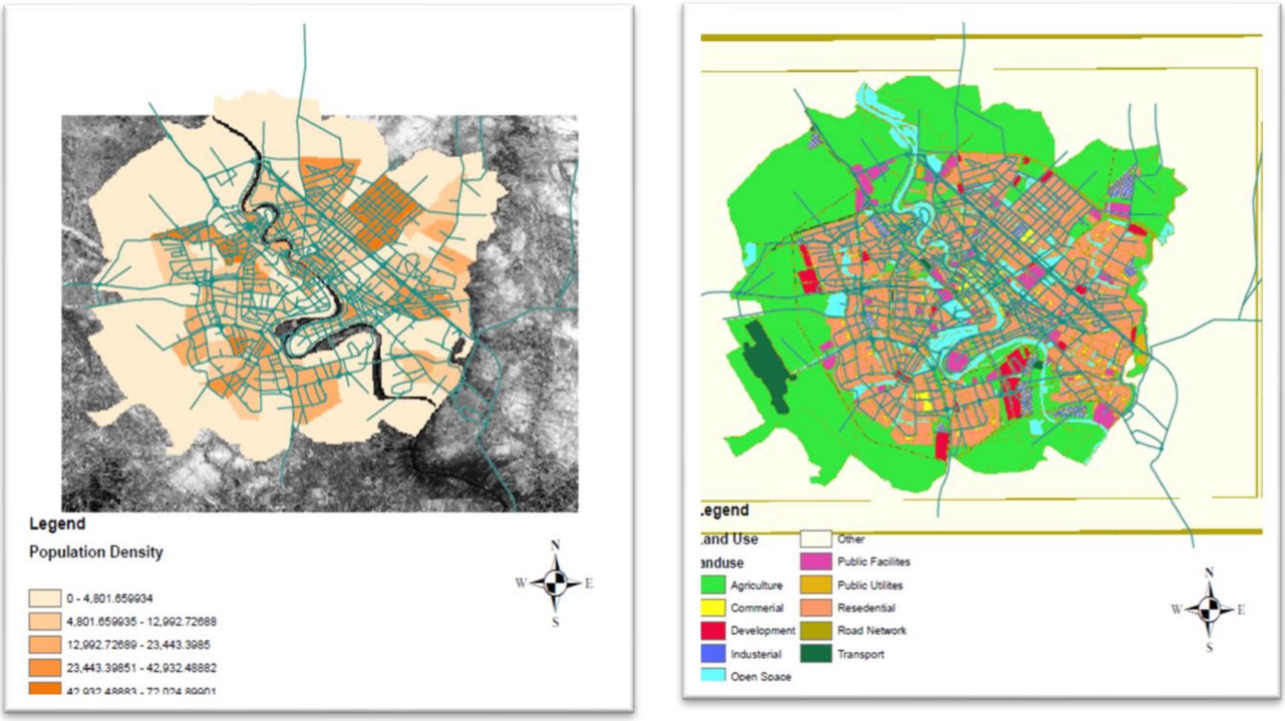


Fig. 7. Represent transport networks and boundaries of municipalities, neighborhoods, and shops in the study area. of Transport for 2016 and viewed the US satellite Quick Bird with a spatial accuracy of 60 cm.

1. Layer depicting districts.
2. Layer displaying layers.
3. Layer depicting blocks.
4. Layer showing roads and streets.
5. Layer representing services.
6. Layer representing residential areas.

To prepare for linking to databases during fieldwork, the layers mentioned above should be customized through coding to enable identification and handling by both GIS software and other statistical division software. Figures 6-8 depict the applications of the geographic database in managing transportation and traffic regulation of vehicles. There are numerous applications that GIS databases can provide us with, leveraging the spatial signature feature in coordinate systems through GPS technology.

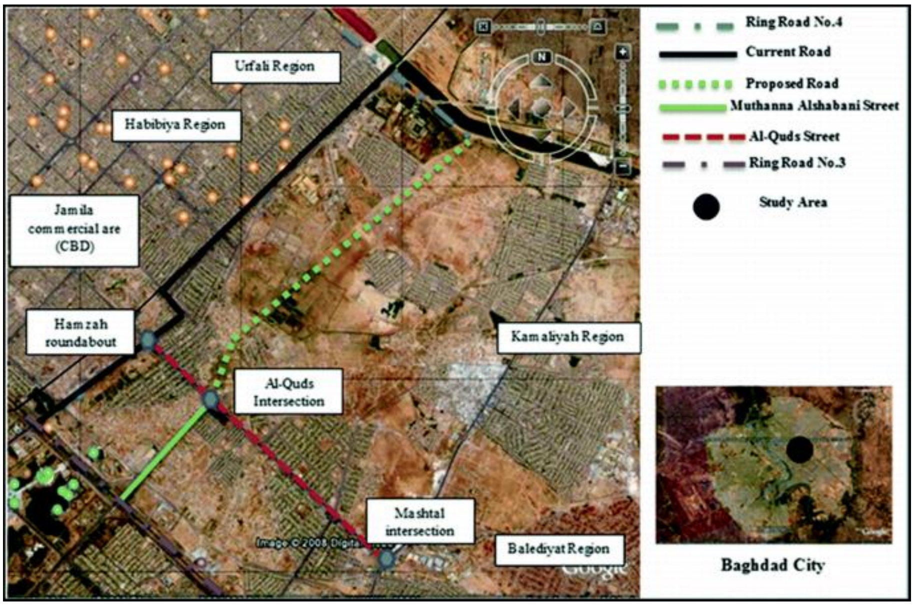


Figure 8. Main and secondary roads and alleys in the study area within the municipality of the people.

The development of transport management equipment has been made possible through the utilization of databases, GPS technology, high-resolution satellite imagery, and digital maps created using GIS programs. Although these systems may vary in name and type of services provided to the user, they share a common working principle. Subscription plans, types of services, and the type of device connected to vehicles may also differ based on the user's requirements and the device's features. This research aims to explore the potential of these devices and their ability to enhance transportation and human comfort, while also contributing to sustainable development. These services include devices for tracking both people and vehicles [11] . One example of such an application is the experience of using GPS and GPRS to track vehicles and people in Iraq.

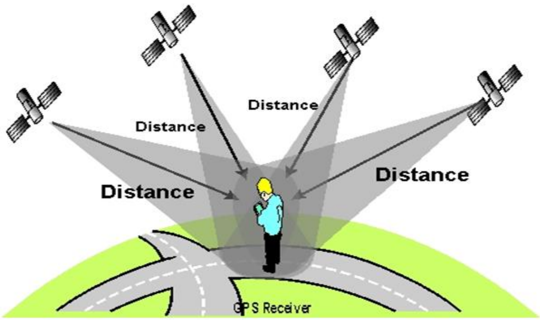


Figure 9. The principle of the operation of tracking systems based on the global signature system and the GIS

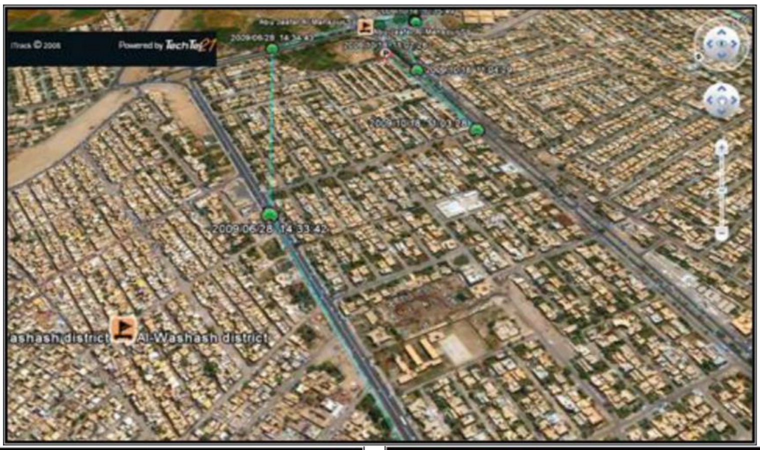
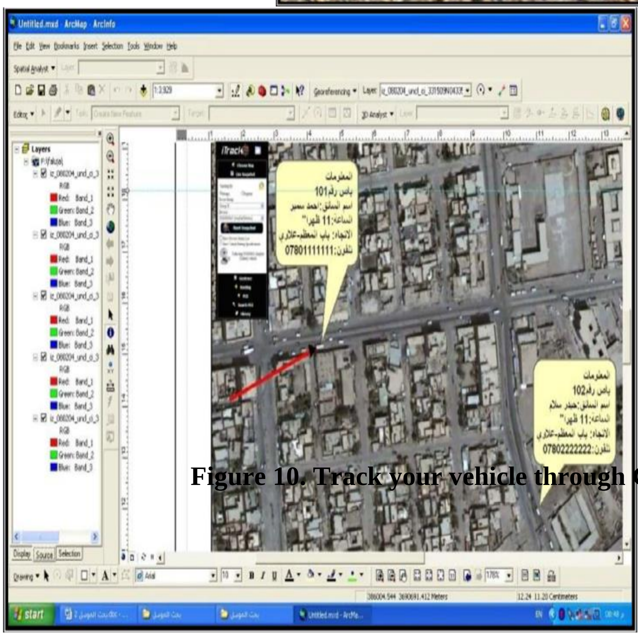


Figure 10. Track your vehicle through Google Earth. Signature system and the GIS.



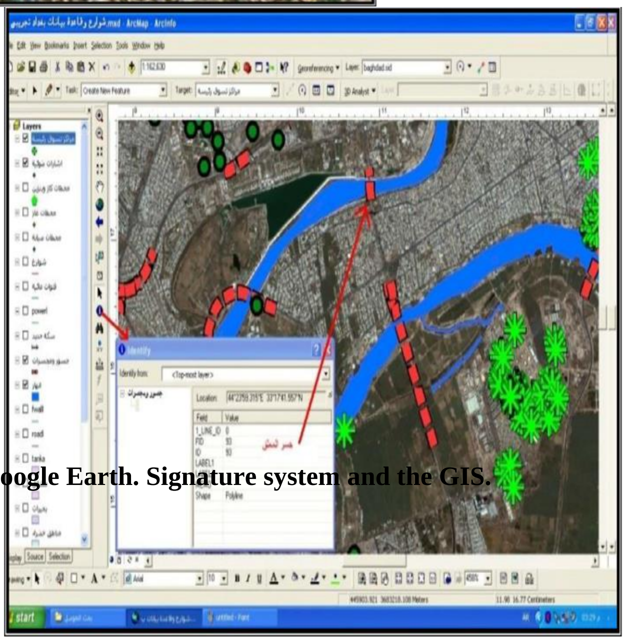


Figure 11. The process of obtaining direct ‘‘information from the central tracking device.

Figure 12. Direct inquiry for any digital teacher within the geographic databases.

2. Results

Although the application of these techniques is not new globally, it is a recent development in Iraq, and its implementation is limited and confined mainly to the private sector that uses GPS and GPRS (General Packet Radio Services). The process of locating a vehicle using Google Earth (Iraq digital map) can be accomplished directly or through pre-prepared layers of Baghdad. The user can also select the type of digital maps to be used for tracking the vehicle, as shown in Figure 9. The system can display and track the vehicle's movement in real-time and historical data in case of theft. Additionally, the system is equipped with sensors that provide useful information for storage and analysis:

1- Compute the distance traveled by the vehicle.
2- Determine the status of the vehicle, whether it is parked or moving.
3- Assess the engine's condition, whether it is working or not.
4- Provide continuous safety by monitoring children or the driver through car audio.
5- Monitor the speed at which the vehicle is traveling (refer to Figure 10).
6- Generate instant and accurate reports that can be downloaded and printed in various file formats or on paper for future reference.
7- Identify the vehicle's work area, such as Baghdad. If the vehicle departs from the specified area, a report or alert is sent.
8- Determine the vehicle's location and speed using GPS.
9- Provide real-time vehicle tracking, update every second, or track the vehicle based on the beneficiary's request with specific dates.
10- Enable special tracking to monitor the vehicle or fleet of vehicles using a unique secret number.
11- Implement an integrated and user-friendly system that identifies the driver and is easy to install and operate.
12- Establish rules and alerts that specify the vehicle's route on the map.

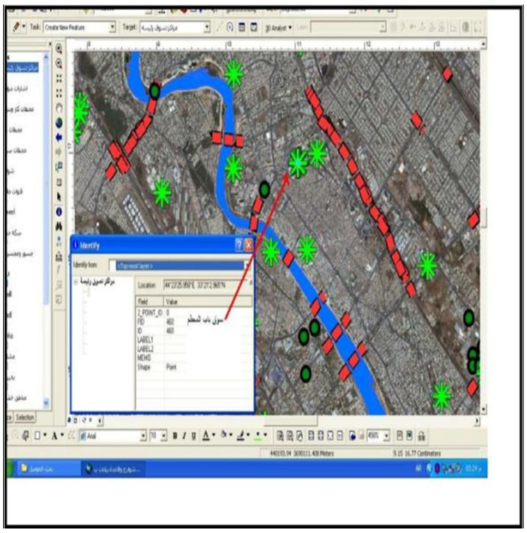


Figure 13. Direct inquiry about any street within the geographical databases.

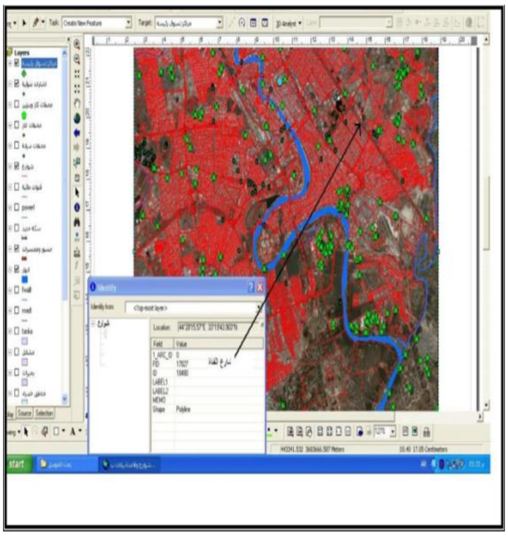


Figure 14. Direct inquiry about any intersection within the geographical databases.

13- Identify the vehicle's location and speed and suggest less crowded roads for the vehicle.
14- Use a desktop calculator or mobile phone to track vehicles anywhere in the world.
15- Group vehicle tracking services can be offered for institutions and companies with fleets of various vehicles.

16- Display the vehicle's status when it is parked, in operation, or in motion, including its speed during movement.
17- Monitor the driver's speed and generate a report or alert if the driver exceeds the specified speed limit.
18- Record all vehicle details such as engine number, vehicle number, type, and model into the information system (refer to Figure 11).
19- Obtain complete control over highways with reports on patrol hours, daily, weekly, and monthly traffic lines (refer to Figure 12).
20- Achieve savings ranging from 15% to 40% on fuel, spare parts, vehicle consumption, and annual renewal fees.
21- Identify regular and irregular drivers and generate reports on speeding incidents based on location and time (refer to Figures 13-17).
22- Identify vehicles with excessive fuel or spare parts consumption above the normal rate.
23- Create sub-accounts within the main account for distributing control functions to facilitate the subscriber's management.

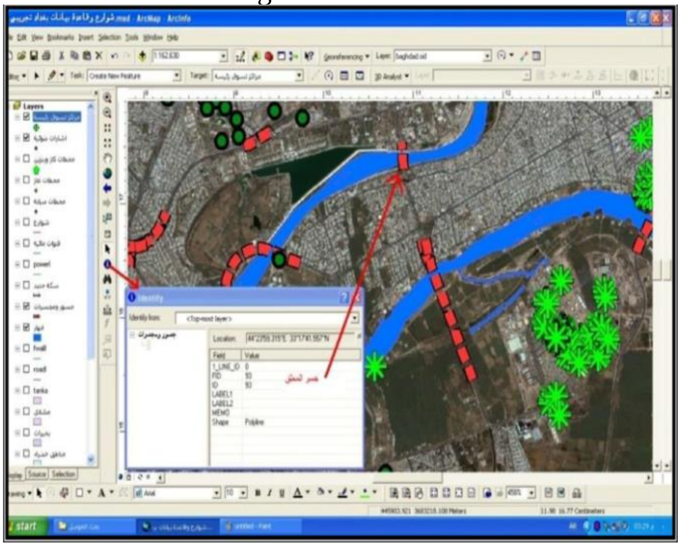


Fig. 15. Direct inquiry for any digital teacher within the geographic databases.

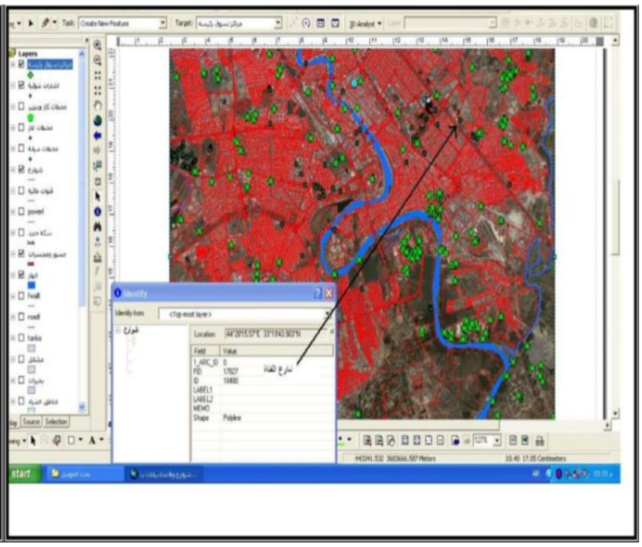
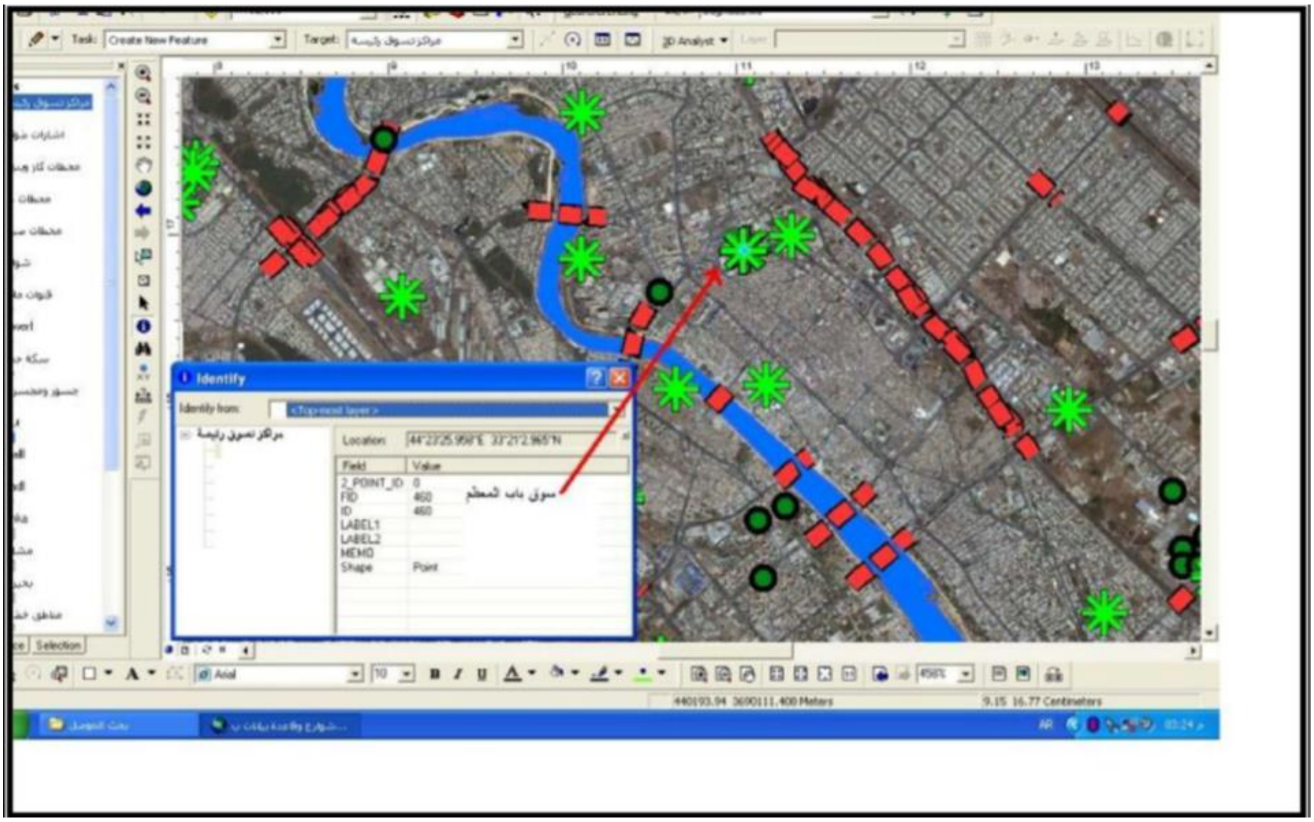


Fig. 16. Direct inquiry about any street within the geographical databases.

3. Discussion

A project aimed at organizing the transportation of employees within the Ministry of Municipalities. The project involves utilizing software and electronic archiving, as well as implementing a system to regulate the movement of transportation lines that transport staff. This will be achieved using GIS technology and the preparation of a digital database. A geographical database has been developed that includes the positions of employees located at the Ministry of Municipalities headquarters. The system is designed to reduce effort and time, as well as to minimize gasoline consumption. It also produces navigation maps that include nearby paths (refer to Figure 18). This information is derived from the work of the researcher and is based on unpublished data obtained from the Ministry of Municipalities, Directorate General of Planning and Follow-up.



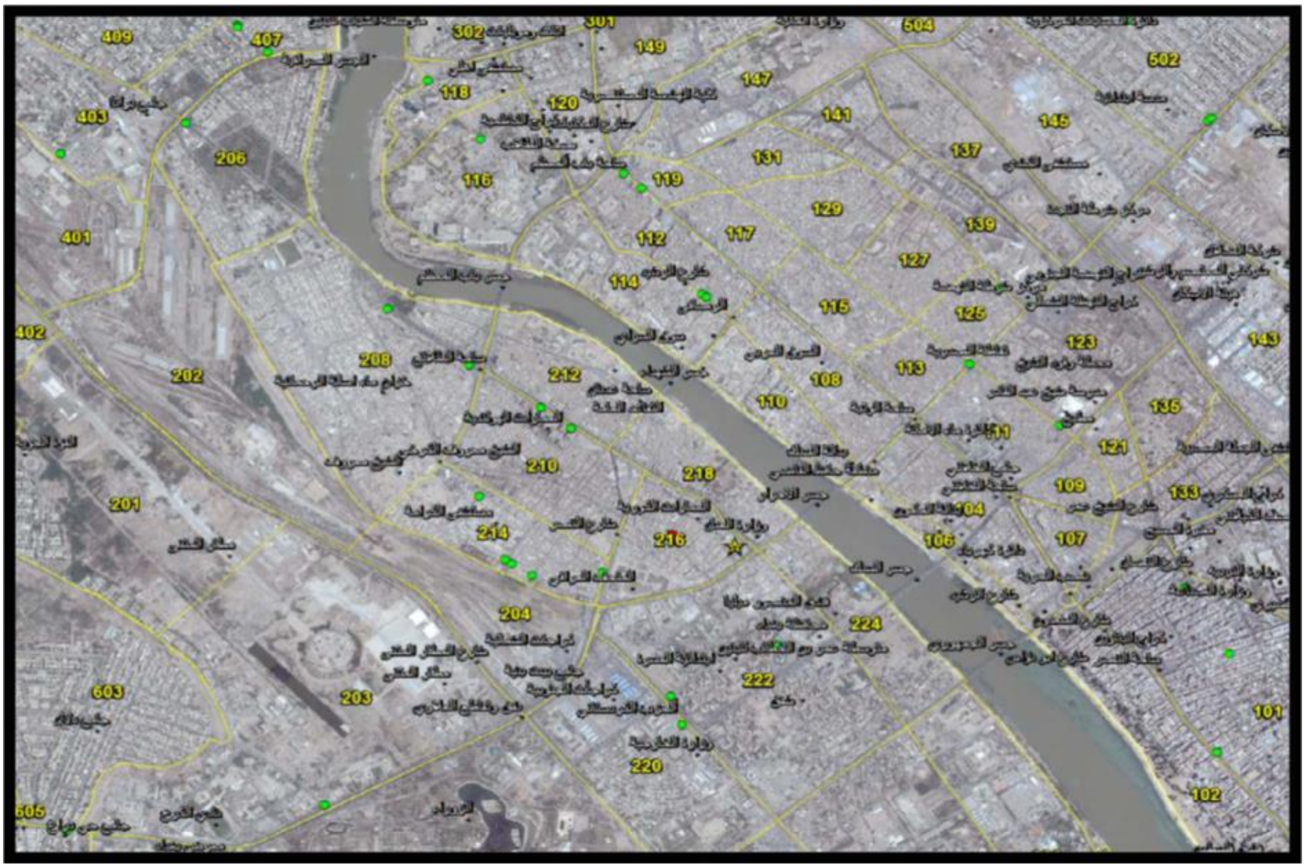


Figure 18. Implementation of the project to unify the lines of transfer of the ministry employees within the technical integration

5. Conclusion

The research demonstrates the capability of Geographic Information Systems (GIS) to represent geographical phenomena with ease, clarity, and high accuracy. The study suggests expanding the use of Global Signing Systems (GPS) to organize traffic and track vehicles in government departments. This technology reduces time and effort and provides accurate cartography at a fast pace. Implementing this system, supported by a geographical database, can contribute to sustainable development. Corrected digital maps, data, and information provide precise spatial location details that enable quick access to street layouts and fuel supplies for vehicles. This contributes to sustainable development. Integrating tracking systems and Geographic Information Systems (GIS) will create new potentials for the transportation sector, regulate public resources, and provide more comfortable transportation options for people. Implementing a vehicle traffic monitoring and control system can facilitate the introduction of new transportation modes in Baghdad, such as a metro or electrified tram.

Declaration of competing interest

The authors state that they have no financial interests or personal relationships that could have influenced the work reported in this paper.

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