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The Use of Object-Oriented GIS for Traffic Police Services in AR-RASS City

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Abstract

The expansion of a nation's road and transportation systems is crucial to that nation's economic development. Social interaction and economic growth happen because of these road networks within and between regions. It is among the most important ways to measure an area's social, economic, and business growth. This research deals with the problem of applying object-oriented GIS to the traffic road network in AR-RASS City. In contrast, it investigates the flexibility of object-oriented GIS in the analysis, measurement, and processing of traffic congestion based on data on traffic and spatial and temporal information in different ways. The planning and spatial evolution of the road networks in the study area was examined. The study used a descriptive-analytical approach by collecting data and information through various methods (reference books, periodicals, and websites). Also, through a primary method (the design question method), it was evident from the discussion that the new system of object-oriented GIS can be an essential reorganization of roads and traffic. While handling this system and the problems plaguing traffic management, this new system helps avoid all the difficulties that have been pending for many years within AR-RASS City. The study results show an immediate and urgent need for improvements and required changes in the road network, such as the construction of new roads. To increase the density of the road network, which gives another important and better prediction for the standards of the road network in AR-RASS City?

Keywords: Object-Oriented GIS; Traffic police Services; AR-RASS City; Global position system (GPS); Digital Map

1 Introduction

Countries pay special attention to their road networks because they are an essential part of the infrastructure that helps the economy grow and provides security and strength [1][2]. Road networks in cities are a conventional form of transportation that significantly interest many study communities [3][4]. With the city's population and car ownership expected to continue rising, traffic congestion is a pressing issue that must be addressed through research into urban road traffic networks. Transportation infrastructure is a human activity closely tied to place, highlighting its relevance in population activities. To make the idea of movement real, we need to build roads that go from one place to another. Transportation activities and decisions about how to use land often have a lot in common. For example, the way land is used and how easy it is to get to different places and destinations, which in turn affects how people travel and how much they travel. The road system, a component of the transportation system, is a particular land use that raises demand for transportation [5]. The vehicle is integral to land use planning because it makes it easy for people and things to get where they need to go. It also connects financial services to the transportation system and infrastructures, like bus stops, gas stations, and places to park cars. Poor roads and infrastructure in AR-RASS city caused traffic jams and made it harder to get from one place to another, which is the most important goal of the transport network. In general, trips took longer and required more work because the way land was used changed. This problem can be solved by rethinking land use and looking at other plans [2]. The most significant development in GIS over the past

ten years has been implementing the concept of object-oriented GIS. Data abstraction, which typically deals with algorithmic programs involving complex

complex data structures, has been linked to the advent of object-centered design. The fact that the data model is now object-centric rather than geometry-centric, as it was in the past, is perhaps the initial advantage of this field. As a result, the representation of reality no longer includes different geometric shapes connected to specific tables, but rather the phenomena are represented as they are, with all their attributes, interactions, and relationships, no matter how complex, a single object category in the database [6][7]. Object-Oriented Programming views a software system as a collection of "objects" with an identity, a state represented by member variables, and a behavior expressed by methods [8]. Instead of functions and procedures, OOP uses objects and class group items. The majority of contemporary programming languages are object-oriented, including PHP, Java, and C/C++. Every computer technology field uses object-oriented concepts. Object-oriented technology benefits more than only developers. IT professionals are applying technologies. That's why we hear so much about Object-Oriented Database Management Systems, OOPL, OOSD, OOSA, OOGIS, and others. GIS models complex objects using object-oriented technology and GIS. data models have three forms: vector data models depict geography as points, lines, and polygons; Raster models are arrays of cells that contain numeric values; The origins of triangular irregular networks (TIN) are a model of contiguous 3D coordinates (x, y, z) arranged in a grid of non-overlapping triangles. OOP implements object notions immediately rather than mimicking them with older languages. TIG RIS, Small world GIS, Geo Star, and Laser Scan's GAE are examples of object-oriented systems [9]. The objectives:

1. To investigate the role of GIS in the context of a load, measure, and manage traffic congestion based on traffic, location, and time on different highways.
2. To evaluate the system's incorporation into traffic enforcement and response to the needs of owners of both public and private cars about road conditions and traffic congestion at specific locations and times.
3. To figure out how well the system can direct transportation by gathering spatial and temporal data and information and figuring out the best way to get from one site to another in the city quickly and with less traffic. We should evaluate this in conjunction with the previous two steps.

2 Literature review

2.1 The Role of Object-Oriented Programming (OOP) in Modeling of Geographic Information Systems (GIS)

When creating new technologies for software development, software developers can no longer ignore the geographic information system (GIS) market due to its enormous growth in popularity. The idea of object-oriented programming (OOP), which includes GIS and software modeling in general, has completely changed the software development business. This article describes how to model a GIS program using the ideas found in Object-Oriented Programming Languages. The report dissected the ideal characteristics of GIS software using secondary source materials and a case study approach to assess the applicability of OOP in GIS modeling. Additionally, the features of existing GIS

modeling software have been thoroughly examined and the use of several OOP principles and methodologies has been discovered. Arc GIS, a GIS program, is used as a case study to demonstrate how closely geographic information systems software models resemble OOP implementation languages like C++, Java, and C#. Even if there were still certain GIS-related problems that could not be fully addressed by the software available today, the study discovered that OOP ideas were especially relevant to GIS modeling [9].

2.2 Object-oriented data model of municipal transportation

The issue of adequate transportation is consistently one of the primary challenges that every major city worldwide must confront. Using geographic information systems (GIS) to manage municipal transportation is rapidly becoming an essential trend. Additionally, the data model serves as the foundation for the transportation information system. The design of the system must give careful consideration to the data's arrangement as well as its storage. In addition to being able to fulfill the needs that transportation navigates, the data model must be capable of producing pleasing visual effects and managing and maintaining traffic information. In object-oriented theory and practice, roads are segmented and intersected at crucial spots. This research examined the corridor, marking, signs, and other transportation facilities, as well as their interaction with the segment and intersection, to create a municipal transportation data model to fulfill vehicle navigation, visual, and transportation needs. And management. Also, the research organizes various transportation data. The experiment indicates that this data model meets traffic control system application requirements [10].

2.3 Identification And Analysis of the Recreational Behavior Forms and the Needed Recreational Space Using Integrated Spatial and Object-Oriented GIS: Concepts and Statements

In recent years, Polish coastal recreation areas have changed how people spend their leisure time and how much place they need. This study tackles how to quantify and analyze these changes. Spatial knowledge helps determine what individuals do for fun and how much room they need. We believe integrated object-oriented Geographic Information Systems (GIS and decision-support technology should incorporate all geographical data. This study argues that existing theoretical methods, which focus on specifics and details, do not provide direction on their usage or evaluation. They don't understand spatial information processes or create appropriate data models. New GIS methods using object-oriented structures and expert system principles will help users comprehend GIS better. To depict spatial phenomena, a data model or object-oriented model that closely matches the user's understanding of the geographical object is likely the most important. Our research shows that most Polish users in this subject cannot immediately access information. They must employ SWOT analysis, which GIS does not offer. According to what has been seen, the identification and analysis of recreational behavior and corresponding recreational space must be defined as a systemic approach in which: (i) the recreational space requires an object, (ii) its state is defined by its values, and (iii) its utility is defined by its characteristics. The technique describes recreation space characteristics/services. Matrix and digital mapping are used to assess recreation space utilization. To build such a system, many organizational changes need to occur. It is shown that in many GIS, applications, organizational factors, not technical ones, determine their future and make way for new spatial analysis techniques [11].

2.4

The efficacy of present RESs in Khuzestan, Iran, was assessed using FAHP and GIS [12]. This study employed accident high crash zone data from the department of roads, health, statistics, forensics, police centers, surveying and geology, remotely-sensed, and GPS. Location services using automobile GPS data require this preprocessing. A novel online map matching method substitutes GPS locations with a probabilistic route prediction model [13]. [14] demonstrate a wireless environmental monitoring device that collects data from public transit. Complete the Smart City idea by sharing LoRaWAN network infrastructure with trash management and traffic monitoring. Find north in the head: geographic reference frame and map orientation. Geovisuali

Geovisualization and cartography use spatial reference frames. Changing humans' body-centered, egocentric reference system to object-centered, allocentric is tough. [15] [16] Use government open data and GPS technologies to construct an image-based traffic assistance agent with user-friendly interfaces to offer real-time traffic intelligence to users and relevant government agencies. Users may access cross-platform services on mobile browsers without installing the app. [17] used machine learning and spatial analysis to examine Luzhou traffic infractions. Hotspot maps for several violation categories were created in Arc map Geographic Information System (GIS) using frequency-based nearest neighborhood cluster algorithms to prioritize and execute treatment options. Create spatial and non-spatial data from primary and secondary sources. Live GPS and traffic camera data increase road data documentation and safety. GIS is used to map health infrastructure, assess accessibility and delivery barriers, and define healthcare facility locations. Assess Mysore's public healthcare accessibility using gis. Mysore health care infrastructure and services were assessed using GIS. The city benefits from ecologically friendly transportation that minimizes urban traffic. GPS and GIS are used to find shared motorcycle parking locations[18] [19][20]. [21] updates the state-of-the-art of important disaggregated and aggregated travel demand factors with MaaS. Cellphones, smartcards, GPS, and locations of interest aid surveys.

3 Materials and methods

Object-oriented GIS analysis tools were used to determine land and road use patterns and describe their characteristics. Using methods like surveys, statistical space analysis, and areas' topographical studies. This includes the best way to use land and how to evaluate it to figure out how cities will grow in the future and the role of the road network in the study area, which helps solve the problem. The research method depends as follows:

1. A description and compilation of data.(The images were digitized using ArcMap software)
2. Organizing and presenting the data.
3. A description of the data.
4. Data analysis and decision-making.

3.1 Location of the AR-RASS City Units

AR-RASS is one city in the Qassim region of Saudi Arabia. It covers an area of approximately 1600 square kilometers. AR-RASS city has a perfect geographical location, as it is located in the middle of latitudes 25–52 and longitudes 31–43, and it has

been a known city since ancient times. The city of AR-RASS has many small areas and well-known villages. I consider it a cultural and commercial center of the surrounding Badia of the presence of the markets, retail centers, civilization, and institutes [22]. About 385 kilometers separate AR-RASS City from Riyadh, the country's capital [23][24]. Figure 1 shows the location of the city. Figures 2 and 3, respectively, show the layer of administrative boundaries of the city's neighborhoods and the road network. Figure 4 shows the merging of the two layers of administrative boundaries of neighborhoods with the layer of the road network. Figures 5 and 6 also show the tables of road names and the names of the city's neighborhoods within the system.

3.2 Routes

AR-RASS roads are paved, and there is adequate and adequate lighting. To enhance traffic flow and people's mobility, the Municipality of AR-RASS is currently engaged in a project called "Structural Streets." Along the path taken by Prince Faisal bin Meshaal, the project will link the Northern Ring Road to the Southern Ring Road. The municipality is working to permanently connect the internal Southern Ring Road, which is currently used to connect the Eastern Ring Road to the Western Ring Road.

3.3 Population and Demographic Indicators

The method involves using GIS to evaluate the road network within the designated research region. For a GIS-based evaluation of an urban road network, you must collect data sources, digitize the web, build a transport network database, extract the network structure, and so on. In this study, Arc GIS 10 was used. These data came from different places, such as road and intersection titles, population, and automobiles. In addition, comprehensive data was available, including sector maps for AR-RASS city at a resolution of 1:1000, maps of the basic layout at a scale of 1:600.000, and satellite photos from the Quick Bird U.S. Satellite, boasting an accuracy of 60 cm. The process of digitizing all the roads, encompassing major thoroughfares, connecting streets, and minor roads, was carried out using satellite imagery. Furthermore, all the required measurements have been taken.

3.4 Spatial Statistical Analysis

We used the following stages as the foundation for the statistical study of the road network.

Determine the density of the city's road system about its size: The density of the roads is calculated by multiplying the length of the roads by the city's area and dividing the result by 100.$D = (\sum L/S) * 100\%$ (1)

where D = Density, ∑L = Length, and S = area.

Figuring out how dense the road network is about how dense the population is: The population is the most important factor in how well the road system works and how easy it is to get to for business. $D = (\sum L/P) * 10000$ (2)

where D = Density, ∑L = Length, and P = Population.

Road density as a percentage: $D = (\sum L/V) * 1000$ *(3)*

where D= Density, ∑L = Length, and V Vehicles.

It is possible to compute the average number of proper cars: $M = P/VN$ *(4)*

Where M = mean occupants per vehicle, P = population, and VN = Vehicle number. [1][2].

Utilizing the Neighborhood Link Method, the distribution pattern of the roadways was examined. The continuous quantitative criterion used to determine the road network's spatial distribution serves as the basis for this measurement. GIS software was utilized to analyze statistical factors. To measure the real distance between each station and the adjacent station to determine the spatial distribution pattern of the road network. $R = 2D\ X\ (\frac{N}{A})\mathbf{2}$ (5)

where R= Value of a local link, D= Actual distance between stations, N= number of stations on the road network, and A = Area. [1][25]

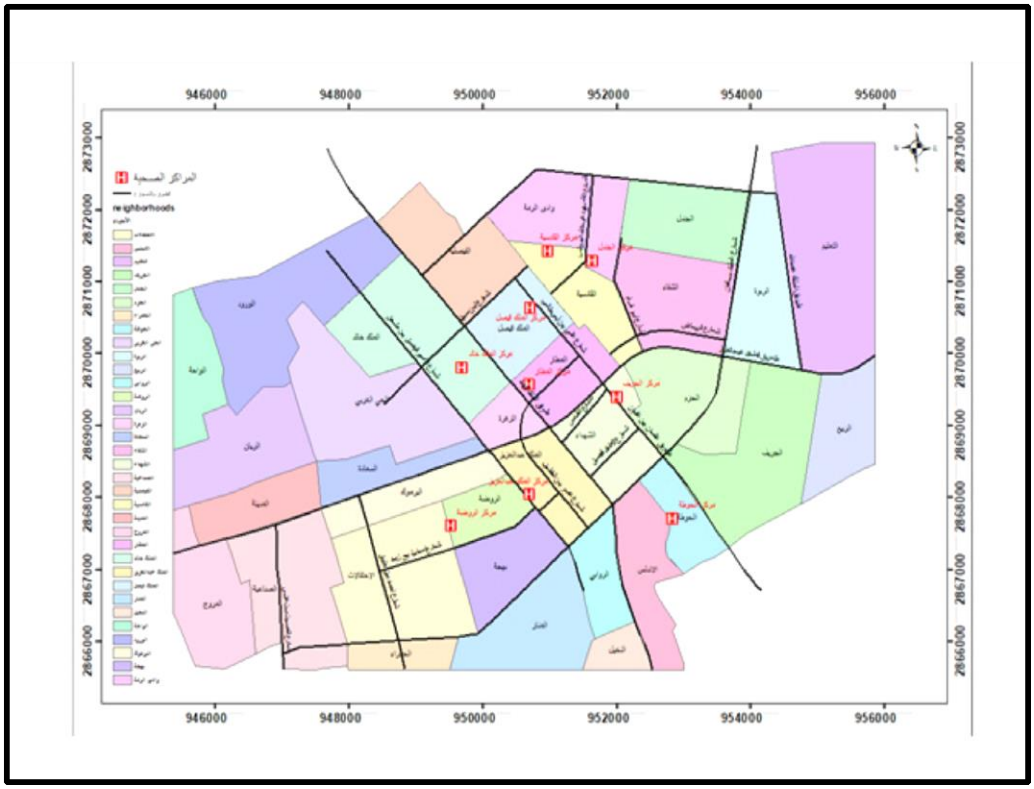
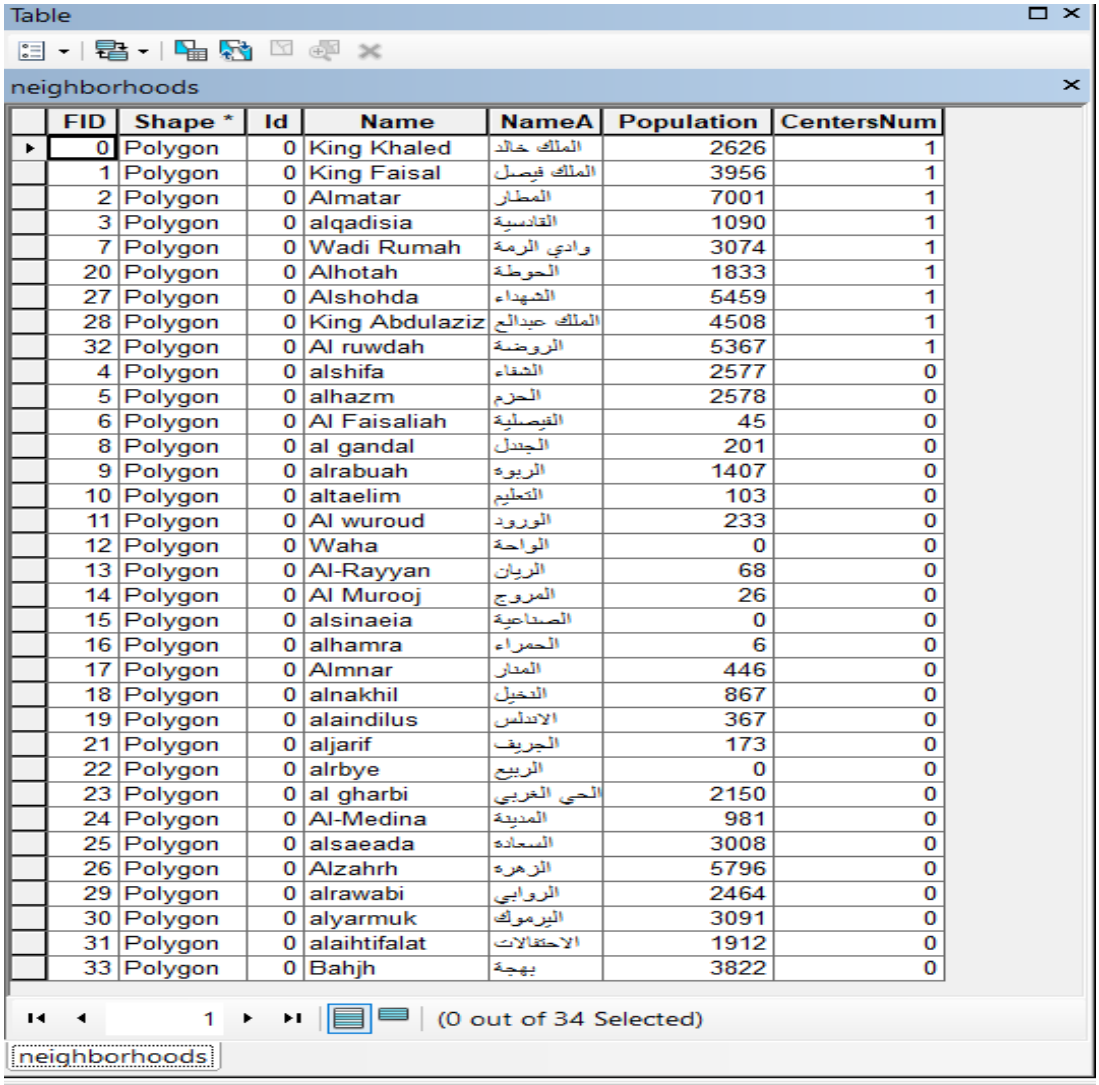


Fig. 4. Road layers and neighborhood boundaries.

4 Results and Discussions

They performed building levels of analysis using the data represented on the research area map. Four layers separate each layer; however, the road layer, which stands for the layer that contains the routes, connects the layers. Considering the average speed of roads and the amount of time needed to find the best way between two spots, such as police and accident sites, as well as hospitals, The classifications contain tables of their results from statistical processes, including traffic streets that have been classed as most severe and as cases of injury, whether an injury has resulted in death, and other categories.



Table

neighborhoods

FID	Shape *	Id	Name	NameA	Population	CentersNum
0	Polygon	0	King Khaled	الملك خالد	2626	1
1	Polygon	0	King Faisal	الملك فيصل	3956	1
2	Polygon	0	Almatar	المطار	7001	1
3	Polygon	0	alqadisia	القادسية	1090	1
7	Polygon	0	Wadi Rumah	وادي الرمة	3074	1
20	Polygon	0	Alhotah	الحوطة	1833	1
27	Polygon	0	Alshohda	الشهداء	5459	1
28	Polygon	0	King Abdulaziz	الملك عبدالع	4508	1
32	Polygon	0	Al ruwdah	الروضة	5367	1
4	Polygon	0	alshifa	الشفاء	2577	0
5	Polygon	0	alhazm	الحزم	2578	0
6	Polygon	0	Al Faisaliah	الفيصلية	45	0
8	Polygon	0	al gandal	الجندل	201	0
9	Polygon	0	alrabuah	الربوه	1407	0
10	Polygon	0	altaelim	التعليم	103	0
11	Polygon	0	Al wuroud	الورود	233	0
12	Polygon	0	Waha	الواحة	0	0
13	Polygon	0	Al-Rayyan	الريان	68	0
14	Polygon	0	Al Murooj	المروج	26	0
15	Polygon	0	alsinaeia	الصناعية	0	0
16	Polygon	0	alhamra	الحمراء	6	0
17	Polygon	0	Almnar	المنار	446	0
18	Polygon	0	alnakhil	النخيل	867	0
19	Polygon	0	alaindilus	الاندلس	367	0
21	Polygon	0	aljarif	الجريف	173	0
22	Polygon	0	alrbye	الربيع	0	0
23	Polygon	0	al gharbi	الحي الغربي	2150	0
24	Polygon	0	Al-Medina	المدينة	981	0
25	Polygon	0	alsaeada	السعاده	3008	0
26	Polygon	0	Alzahrh	الزهره	5796	0
29	Polygon	0	alrawabi	الروابي	2464	0
30	Polygon	0	alyarmuk	اليرموك	3091	0
31	Polygon	0	alaihtifalat	الاحتفالات	1912	0
33	Polygon	0	Bahjh	بهجة	3822	0

1 (0 out of 34 Selected)

neighborhoods

Fig. 5. Table of roads

Table

Streets

FID	Shape *	StreetName	NameAR
0	Polyline	King Fahd Road	طريق الملك فهد
1	Polyline	King Abdulaziz Road	طريق الملك عبدالعزيز
2	Polyline	Prince Faisal bin Mishal St	شارع الأمير فيصل بن مشعل
3	Polyline	King Salman Street	شارع الملك سلمان
4	Polyline	Othman bin Affan Road	طريق عثمان بن عفان
5	Polyline	Ibn Sina Street	شارع ابن سينا
6	Polyline	Ali Bin Abi Talib Street	شارع علي بن أبي طالب
7	Polyline	Al Quds street	شارع القدس
8	Polyline	King Faisal Street	شارع الملك فيصل
9	Polyline	Omar bin al-Khattab Street	شارع عمر بن الخطاب
10	Polyline	Ahmed Bin Hanbal Street	شارع أحمد بن حنبل
11	Polyline	Osama Bin Zaid Street	شارع أسامة بن زيد
12	Polyline	Riyadh Street	شارع الرياض
13	Polyline	Omar Bin Abdul Aziz Stree	شارع عمر بن عبدالعزيز
14	Polyline	Abu Tammam Street	شارع أبو تمام
15	Polyline	Al Hussein Bin Ali Street	شارع الحسين بن علي
16	Polyline	King Abdullah Road	طريق الملك عبدالله
17	Polyline	Al Shaheed Abdullah Al Ho	شارع الشهيد عبدالله الحوشا

Fig. 6. Table of neighborhoods

4.1 Classification of streets

The streets that are most likely to have accidents are in the following order:

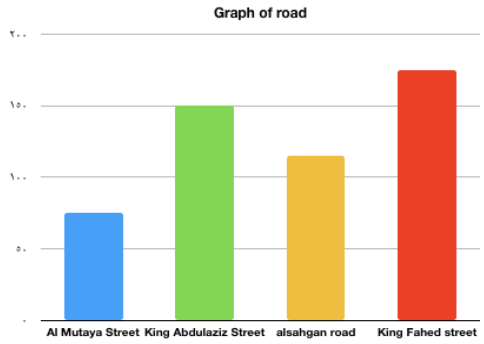


Fig. 7. Gravity-based classification of streets

The age groups driving the vehicles are classified into several types, as follows:

Table1 THE AGE RANGE DRIVING THE VEHICLES

Division	Age range
A	under 18 years old
B	18-30
C	30-40
D	40-50
E	50-60
F	Greater than 60

4.2 Classification of months most traffic accidents

In this category, accidents were divided according to their occurrence in the month observed, as shown in the figure below:

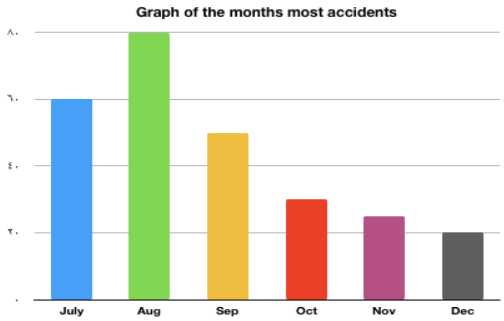


Fig. 8. Classification of months most traffic accidents

4.3 Accident classification in terms of the cause of the accident

Accidents were classified in this case according to the reason that led to the accident of negligence, recklessness, skipping, etc., as in the following figure.

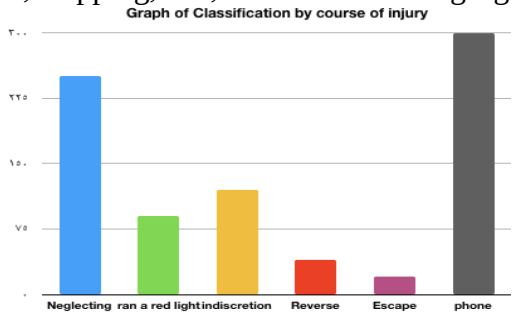


Fig. 9. Accident classification in terms of the cause of the accident.

After analysis, the following results were obtained.

1. Most accidents occur on King Fahd Street
2. Age group B (18-30) is the most common category of accidents
3. The car is the most class of vehicle for accident
4. August - the most month of accidents
5. It was found that the cases of serious injury more than deaths
6. The study found that negligence and phone use are the most common causes of accidents
7. The study found areas with a deficit in the hospital's coverage and the police station.

Table 2. POPULATION OF AR-RASS CITY [24].

City	Population								
	Saudi			*Non-Saudi*			*Total*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*	*Males*	*Females*	*Total*
Ar Rass	42104	42187	84291	18626	6634	25260	60730	48821	109551

5 CONCLUSION

This research used object-oriented GIS technology to produce maps. Link the service center layer and the main road layer in the study area to the road accident site layer. Then, classify the traffic accidents to identify some characteristics that aid the analysis. This will show the shortest distance between two places and the closest service center for the scene.

6 RECOMMENDATION

After the analysis of the study area, we reached a set of recommendations, the most important of which are the following:

1. Constant observation of equipment and road conditions.
2. To achieve the best outcomes and understand the causes of accidents, we advise studying, processing, presenting, and analyzing connected data through GIS.

3. Give the General Directorate of Traffic, the option to view analysis and visual processing through a Geographic Information System (GIS).
4. Holding training sessions and coordinating with the two leaders' intense training.

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