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Review Article

Uses and Applications of Geographic Information Systems

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Abstract

Nowadays, the Geographic Information System (GIS) technology has become more popular and is now widely used in earth sciences and environmental. It is a huge and rapidly growing industry and market all over the world, with huge demand for knowledge, experience, information, data, and GIS software products. Project managers, environmental scientists, legislators, activists, and the public are curious about what is the technology of the GIS, and how it can help them with cases or projects. Professionals of GIS are interested in learning of basics of earth sciences and environmental to apply GIS technology in these sciences and other related disciplines. This paper start from the introduction about GIS and various applications, and these applications divided into Overlay of layers, Land Information, Utilities and Infrastructure, Environmental, Archaeology, Natural Hazards, Military, Oceanography, Water Resources, and Agriculture. Finally, we are trying to give conclusions about this research. This paper gives an overview of the application and uses related to GIS. GIS techniques are very useful for various kinds of applications such as for Education, Medical, Tourism and Archeology, Urban Planning, Temperature, water harvesting, Change Detection, and Business. So the use of GIS is the most interesting research topic in recent years.

Keywords: Geographic Information System, Agriculture, Water Resources, Military, Education.

INTRODUCTION

Geographic Information System (GIS)

The main difficulties that we face in the world now pollution, overpopulation, deforestation, natural hazards, all have a decisive geographic dimension. also, the problems locale, have a geographic ingredient that can be expressed using the technology of geographic information systems, whether getting on the best soil for crops growing, determining the range of home for imperiled species, or exploring the reliable system to dispose of dangerous waste. On the other hand, determine the best location for schools, choose the best way, and know the extent of disease. The precise analysis of spatial data by geographic information systems can provide insight into these difficulties and propose methods in which they can be treated.

Geographic information systems are considered the most accurate and exciting technology. Geographic information systems are a special type of information system in which the data source is a database of spatially feature and procedures to collect, store, retrieve, analyze, and display geographic data [1]. Also, geographic information systems are a group of software, hardware, and processes that are used for collecting, storing, and analyzing geographically referenced data. Then, this data will be presented through the geographic information systems system [2]. Another definition for geographic information systems, that it is a tool used for saving, regaining, and offering together non-spatial and spatial data in a rapid, proficient, and organized manner [3]. In other terms, geographic information systems are defined as a data-base system kind, a computer-supported cartographic application, and mapping, a comprehensive tool for spatial analysis [4].

The data acquired through the GIS is then utilized to represent different issues. An additional definition of a geographic information system is a program used for presenting, interpreting, and preparing the results that relate to the surface of the earth. This program will maintain the process, analysis, making, and display of the maps [5]. Making of the maps and geographical analysis is not new, but geographic information systems work these tasks properly and quicker than do the conventional methods. And, before using geographic information systems (GIS), only some persons had the skills to use geographic information to help for decision making and solving problems [2].

Nowadays, geographic information systems are employing hundreds of thousands of people

globally, geographic information systems are learned in high schools, colleges, and universities everywhere of the globe, hence considered as a multi-billion-dollar industry [6]. The principal aim of this research is to review the researches that have examined the applications and uses of Geographical Information Systems (GIS) in many different fields such as, determining the best location for schools, choose the best way, know the extent of disease, distribution of the schools, and the hospitals, furthermore other services.

Applications of Geographic information systems

Overlay of Layers

Geographic information systems can use to joining the layers that available for any area, to create an overlay that can be used and analyzed using the same system. Such overlays and their analysis entirely and process of the decision-making that involves, among others [7]:

1. Selection of sites
2. Make of simulation to environmental impacts such as creating a view of the perspective of the terrain
3. Planning of response emergency, such as link the network of the roads and information of earth science to explain the effects of a possible earthquake.

Land Information

Geographic information systems can manage land information via the enabling of data generation and preservation of these data for records, planning, and use of land. Geographic information systems make input, retrieval, and updates, of data such as records of tax, land-use plan, and zoning codes more accessible than the paper-map era. The typical uses of geographic information systems in the management of land information, involve register of land managing, registering the titles to land holdings, creating a plan of land-use and cadastral mapping (as shown in the figure below) and zoning maps, etc. It also involves political and administrative boundaries, the cover of soil, and transportation [8].

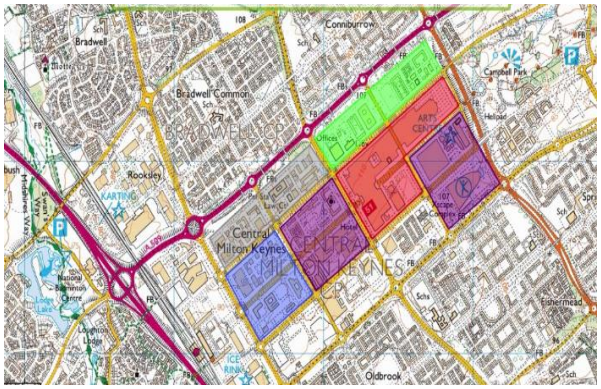

Fig-1: A plan of land-use and cadastral mapping

Utilities and Infrastructure.

Technologies of geographic information systems are widely used for the planning and management of public services (as shown in the figure below). The typical uses of geographic information systems involve the management of the following utilities: gas, electric, water, telecommunication, roads, sewering network (as shown in the figure below), facilities of TV/FM, analysis of hazards, dispatch, and services emergency. Typical data that input involves a street network, demographic data topographic data, and boundary of the local government [9].

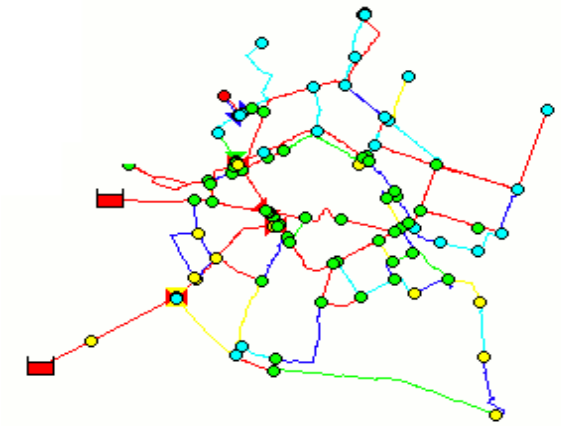

Fig-2: A plan of sewering network.

Environmental

The geographic information systems have the ability for applying a variety of applications of the environmental field that extend from the simple query, inventory, analysis of map and overlay, to decision-making systems that be complex. Include such as modeling of the forest, monitoring, air/water quality modeling, mapping of the environmental zones, analysis of the interaction economic, change geological & hydrological, and meteorological. The data environmental that must be input into geographic information systems involve elevation, the cover of the forest, hydrogeology coverage, and soil quality [5].

Archaeology

Archaeology has used geographic information systems in a variety of ways as a spatial system, where, use the applications of geographic information systems as database management for records archaeological, with the added advantage of being handy to design instant maps in the simplest level, It has been performed in the management of cultural contexts, where sites of archaeological are foretold using statistical models based on-site locations that previously identified. Also, it has been used as a tool in intra-site analysis and to simulate changes in past landscapes (as shown in the figure below) [10].

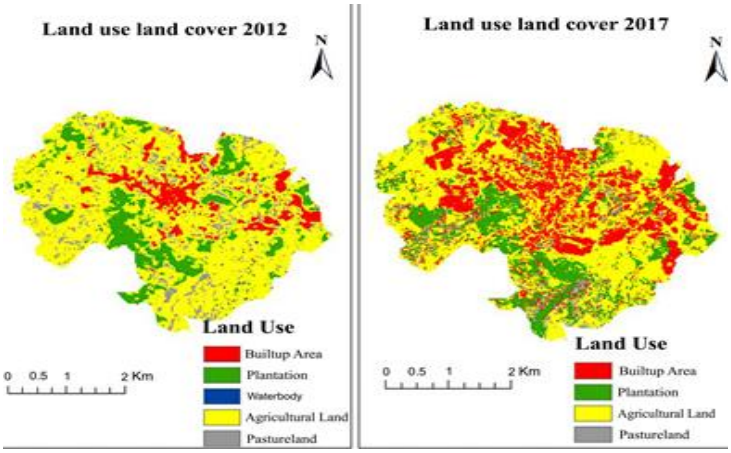

Fig-3: Show the changes in past landscapes for five years

Natural Hazards

The geographic information systems can study areas exposed to floods (as shown in the figure below), earthquakes, storms, cyclones, fire, drought, volcano, soil erosion, and landslides, therefore, it can accurately predict future accidents [11].

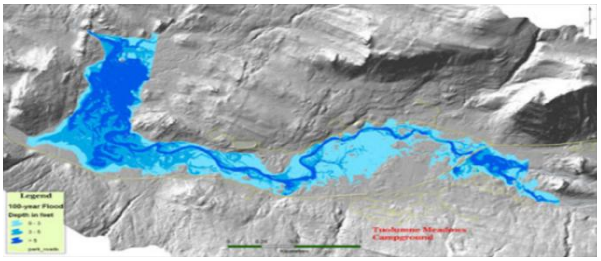

Fig-4: Show the areas exposed to floods

Military

Geographic information systems offer a practically unique ability to combined geographical data and analyze them, which further enhances and develops the intelligence base for operations of defense [12].

Oceanography

Geographic information systems enable the study of the change of sea-level (as shown in the figure below), the temperature of the sea surface, marine population, and coral reef ecosystem [13].

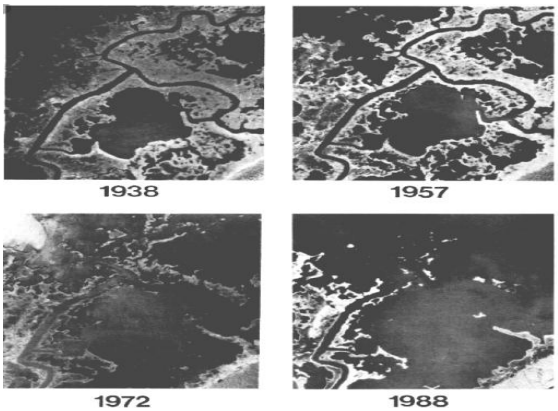

Fig-5: Show the sea-level for deference years

Water Resources

Geographic information systems enable the spatial representation of resources of groundwater, quality of waste, management of the watershed, water pollution, and surface water management [14].

Agriculture

The use of geographic information systems and GPS in the production of agriculture. Exactness agriculture is a catch-all expression that describes using technologies of geographic information systems and GPS to manage specific field areas. Technologies of exactness agriculture use information from various sources to aid farmers in decisions making about crop production and management based on the variability of the potential of production inside fields [5].

LITERATURE REVIEW

Geographic Information Systems in Education

The researcher has been used geographic information systems to conduct the process of documenting the locations of schools and plots of land then mapping them, thereafter doing spatial analysis to improve the decision-making and planning process in the Ministry of Education in the State of Kuwait. From the results of spatial analysis in the geographic information systems it was found there is a large percentage of neighborhoods that do not have schools according to the minimum standards of the Ministry of Education standards and for all academic levels as follows: About 70% of the residential areas do not have any kindergarten or primary school, while 48 43% and 43% of them do not have a middle school for girls and boys, respectively. This gave the decision-maker the ability to prioritize taking quick treatment procedures to solve the problem. In the final, the researcher presented the results in the form of objective maps showing the reality of educational services and for all stages in the study area. The researcher explained that geographic information systems have the ability and efficiency to assess the reality of the state of services educational and giving a clear picture to those who take the decision and planners understand the problem and find appropriate solutions to it and according to priorities [15]. On the

other hand [16], Used geographic information systems in assessing the current status of girls 'schools in the city of Makkah Al-Mukarramah by establishing a comprehensive database that allowed them to build an appropriate model by using the spatial statistical treatment in the ArcGIS program by calculating both the closest neighbor, the average site, the standard distance, the service range, intersection, and regression, as Satellite images were used after the engineering correction to locate some schools. The results showed that the distribution of schools to residential neighborhoods is not fair according to the population density and the need for more than a third of schools to change their locations, as they are inappropriate according to the convenience model that was built based on ten criteria given different weights according to their importance. Also [17], Sought to know the reality of educational services in the city of Diwaniyah and to identify the size of these services and their spatial distribution and efficiency compared to the size of the population in them and whether these services achieve a spatial and quantitative efficiency? Then how much does the city need from educational services today and in the future in line with the population growth and the change that will occur in their qualitative and age composition in the future? The functional approach was adopted in addition to the descriptive and quantitative (analytical) approach, with the use of some statistical methods such as population projections and the site concentration ratio to enhance the description and analysis process. The study concluded that there was no equitable distribution of educational institutions among the neighborhoods of the city compared to the population size of residential neighborhoods, as they increase in some neighborhoods and decrease or no longer in others. While [18], Used geographic information systems to develop the necessary plans to achieve the goals of the International Conference on Population and Development and the Millennium Development Goals regarding the education sector and access to literacy education for all persons between the ages of 15 and 24 years. The research included two neighborhoods of the city of Abuja in Nigeria, Karaki, and Woyos, and for the primary and secondary school stages, the purpose of the research was to provide accurate, useful and fast data to achieve the above-mentioned goal. As it was identified schools that suffer from overcrowding in its classrooms and schools that lack some needs such as laboratories, libraries, and Internet lines, as the distance between schools and the bus transport station was measured, and the results were produced in the form of maps and tables to help decision-makers to develop plans that lead to achieving the desired goals.

Geographic Information Systems in Medical

The researcher has been used geographic information systems to map the locations of public and private clinics in the state of Malaysia to help plan health services by calculating the neighborhood link scale within ArcGIS spatial analysis tools to find out the distribution pattern of medical clinics, The study showed that the distribution pattern of public clinics was well spread, which indicates the efficiency of the Ministry of Health's plans to provide health services while the distribution pattern was clustered (cluster) in urban areas for private clinics, reflecting the impact of being private projects seeking to achieve profits versus providing health services [19]. Whereas [20], Dealt with evaluating the efficiency of health services in the city of Muqdadiya, and through the adoption of geographic information systems techniques in analyzing the spatial data of public health centers in the city, the study concluded that the city of Muqdadiya in Iraq suffers from a lack of distribution of health services spread throughout its neighborhoods and that the centers in it serve neighborhoods nearby them, which led to the uneven population size that the health center serves, and it was found that health centers suffer from a lack of medical staff. Moreover [21], showed possibilities of spatial analysis in geographic information systems that were used to perform an analysis of the distribution of public services in the city of Makkah Al-Mukarramah. where the study included health, religious, commercial, sports and security services, given that the fair distribution of services in the city is a primary goal for planners because it ensures that what the population aspires to in a decent and comfortable life. The efficiency of the services provided relates to several factors, including service availability, number of establishments, their distribution, and accessibility. The researcher focused on the spatial distribution of services as the most important among them because it gives a clear picture of the planners to determine the precise locations of future services. The results showed that the total educational, health, religious, commercial, and security services in the city and sports services have a positive relationship with the population. Where the study recommended that planners and decision-makers consider the results of the study to improve the distribution of public services in the city.

Geographic Information Systems in Tourism and Archeology

The researcher has been used spatial analysis to distribute tourism services in the city of Jericho and learn about their density, using geographic information systems that can conduct spatial and statistical analyzes to reach accurate results in a short time by building a geographic database for the city, where a base was created Data for tourist sites and services inside the city of Jericho, which are used to analyze the reality of tourism use and planning within the city. The results of the spatial analysis showed that the density of tourist sites and services was very high in the city center, and the results of the analysis also show weakness and randomness in the distribution of tourism services in the city [22]. Further [23], Examine the extent to which the sites of distribution of cultural and entertainment

services in the Nablus governorate comply with the established standards globally, to form a clear vision for the distribution of those services to residential communities in them. The study shows that there is a gap in the population in the Nablus governorate, where there are 9 population centers whose population did not reach 1000 people, which impedes the fair distribution of services in them, and most services were concentrated in Nablus city center, and the study recommended the necessity of adopting proposed growth areas to prepare the opportunity for rural communities towards strategic and developmental planning to relieve pressure on the services stationed in Nablus, and also recommended the necessity of establishing a transportation network between rural communities, especially to the proposed growth areas to reduce pressure from Nablus city center. Plus [24], This study aimed to use geographic information systems in the process of spatial analysis of tourist areas, and this study reached the most important results, geographic information systems are an effective tool and technique in analyzing tourist sites by providing an accurate record that includes all heritage sites; which contributes to protecting these heritage sites and provides effective control and spatial analysis Advanced. Too [25], Covered the importance of using geographic information systems in planning tourist sites, Where geographic information systems were used in the analysis process, and the researcher concluded that geographic information systems are an integrated unit that complements each other in the site analysis process in studying the absorptive capacity and tourism movement within archaeological sites by building several models and databases for the study area.

Geographic Information Systems in Urban Planning

The researcher, Dealt with the impact of the unplanned growth of urban areas on environmental behavior. Where in the city of Kut, there are many dispersed areas such as the neighborhood of Al-Jawadeen, Al-Hakim1, and Al-Hakim2, etc. Informal or random housing consider is one of the most negative phenomena that challenging larger cities due to the encumbrance on economic and social development. In this research, geographic information systems were used to study the spatial and temporal changes of this phenomenon from 2005 to 2017 then estimate the proportion change in each period and the difference in the areas of irregular overtaking between other regions. The research concluded that the official sector designs prepared for these areas lack basic standards for residential neighborhoods, which include side streets, a mosque, a kindergarten, a school, and the local market. Street width is also different. Maximum width of 6 meters, kindergarten services, mosque, and school. Not all buildings in these areas have official building permits and they lack building controls. These areas lack regular networks of infrastructure services [26]. Also [27], Get to know the trends in the field of integration of geographic information systems in urban and regional planning in North America, And explain the relationships and factors that have a fundamental function in the influence of geographic information systems in planning. This study dealt with the experience of North America in the applications of geographic information systems in planning at the state level, then the region, then the urban areas, then on the neighborhoods. She then discussed the transformations that resulted from the interaction of GIS with planning. This study is considered one of the first researches that highlighted the importance of geographic information systems and their high ability to process data in all levels of planning. Furthermore [26], Used geographic information systems (GIS) to analyze the size of the random and unofficial population problem in the city of Baghdad, with its qualitative and quantitative dimension, as has been using a sample from the degraded informal residential areas in Baghdad, places which are three different and distinct sites in terms of place and time, then made a descriptive analysis by accreditation on various sources of information, the researcher has concluded that complex problems such as the problem of unofficial urban degraded residential areas need to be dismantled and built hierarchically to solve them. Also, the results showed, the studied sites differ in terms of locational, legal, social, and economic characteristics of them, and therefore the variation in the appropriate method of dealing with them. Also [28], Dealt with the mechanism of spatial planning of mosques using geographical information systems, as well as conducting analysis and evaluation of the reality of spatial distribution of mosques through the comparison with planning standards for mosques in other study cases. The research has demonstrated the importance of urban design and its significant impact on the role of mosques and their relationship in the field of planning with members of society, as well as the importance of using geographic information systems and urban design through choosing the best places to set up future mosques, based on the standards that have been concluded from many studies in this field. It is possible to apply these standards anywhere in the Gaza Strip to reach the best solutions. Else [29], Identify patterns of land use for analysis and evaluation, and to detect the factors affecting them, and then to create a spatial analytical model that simulates a set of algorithms attached to the Arc GIS program to choose a green area in the city. The study also aimed to show the efficiency of the geographic information systems technology in improving Decision-making in the city of Deir El-Balah.

Geographic Information Systems in Temperature

The researcher, Dealt with temperature in Palestine during the last century from 1901-2000 to show global warming by using geographic information systems. The researcher divided the data into two equal periods, and temperatures were tested between 1950-1951 and 1950-2000. The study aimed at identifying the variation in temperature of Palestine, in addition to

showing the direction of temperature and heating of heat in Palestine. To explain this, the researcher used in his study the mathematical model of analysis, where he used time series analysis, linear analysis, and linear correlation coefficient. The researcher reached results from it, that the first and last three decades of the last century were distinguished by an increasing trend in temperature. The greatest thermal was positive in both summer and spring by 1.2 ° C / 100 years, while in autumn and winter their temperature increased by 0.3 and 1.9 ° C / 100 yr. But Palestine temperatures for the whole period increased by 0.9°C [30]. Over and above [31], Examined the mean temperature test, the average minimum and maximum temperatures, and the thermal range of Gaza City using geographic information systems, wherein this research, daily temperature ratios were used for the period from 1976 to 1995 to discuss the change in Gaza temperatures and one of the most important findings of the study was the presence of changes clear in temperatures. As for the average temperature, it showed an increasing trend in high temperatures in most months and seasons and in the whole time. As for the degrees of great temperature, there was no change in its direction. Whereas, minimum temperatures indicated an increasing pattern of temperature. And the heating of heat appeared more clear and more distinct since the mid-eighties. The researcher concluded that GIS has the strength and high efficiency of knowing and calculating temperature ratios. Moreover [32], Used a Geographical Information system to create maps of temperature that could show the distribution of the air temperature and difference between two periods of time (past and recent) in various stations that cover the governorates of Iraqi. Where the researcher has been used as a method of spatial interpolation. This method considers known temperature values in a specific location to estimate a continuous map over a specified interval of time. The results of this research showed no notable increase in the average values of air temperature, still, the sites of high air temperature values are growing during the hot and cold months of the year.

Geographic Information Systems in water harvesting.

The researcher, Showed the efficiency of geographic information systems to estimate the quantification of surface water runoff of basins, in the eastern part of Diyala province, using geographic information systems. This research focuses on the process of estimating the size of the surface water runoff of a group of the seasonal flowing valleys in its area is (14666.1). These valleys flow from the high mountains the inside territory of Iranian towards lands Iraqi down to the downstream zone till Hor Al-Shwejahis. Geographic information systems have been used depending on the highest intensity of rain showers daily for 21 years. The conclusion showed the strength of geographic information systems to create a database containing a classification of land cover and the previous case for soil moisture and soil hydrological groups prevalent in the valleys that require in this study [33]. Furthermore [34], Dealt with the use of geographic information systems (GIS) to develop a water harvesting strategy in the semiarid area of Rajasthan, India. Through the digitization of Information on topography and soils to form the GIS database. Where land cover information was used that derived from remote sensing satellite data (IRS-1A) in the form of the normalized difference vegetation index (NDVI) and using a digital elevation model (DEM) to the estimation of water size. The results show the ability of geographic information systems and their application for planning of water harvesting over semiarid areas. Too [35], Using techniques of remote sensing to identify the potential locations for building structures of rainwater harvesting in the Bakhar watershed of Mirzapur District, Uttar Pradesh, India, and geographic information systems. based on different thematic maps as Landcover/Landuse, geomorphology, and lineaments, etc. were made using remote sensing. The researcher concluded that geographic information systems can identify suitable places for water harvesting.

Geographic Information Systems in Change Detection

The researcher, Dealt with the classification of agricultural land uses in the northern regions of the West Bank, using the digital processing of satellite data and geographic information systems, to prepare maps of agricultural land use classes and calculate their areas [36]. Also [37], Examined the detection of a land cover change in South Africa using geographic Information systems and Landsat and Mods visuals, to know the changes that occurred during different years 1991, 1997, 2000, 2004, and 2005, and by adopting vegetation parameters NDVI and downloading the main components PCA. The researcher concluded that geographic information systems can detect changes for different periods of years, and by relying on satellite images for the same study area. Else [38], Has been assessing the detection of a change in land use and land cover for a three-time series of 1984, 2000, and 2015 using remote sensing and geographic information systems, and the decline of sugar cane cultivation in Moomisa County, Kenya, by using satellite images from the Land Sat satellite and with a resolution equal to 0.6 cm after its geometric correction. While [39], Investigated the detection of land use and land cover change, in Southwest Deli, between 1977 and 2014, and using geographic information systems based on the Landsat Wires (IRS) satellite data to classify the uses of the Earth and ground cover by the supervisor and unsupervised classification with accuracy exceeded 90%.

Geographic Information Systems in Business

The researcher examined the strength and efficiency of geographic information systems and

highlighted the importance of geographic information systems in business. Despite the importance of geographic information systems technology in various applications, the researcher linked geographic information systems with other analytical tools in a way that provides support to commercial organizations in building strategic development plans. Where the researcher concluded through a study that geographic information systems (GIS) can help retail trade-in determining the best location for its next store, and it helps marketers find new future plans, also allows data to be presented, understood, interrogated, interpreted, and visualized in ways not possible in the rows and columns of the spreadsheet, and can be from during which to ask more questions, you can ask where, why and how. Also, GIS is so important for business works because most business challenges involve significant spatial elements and GIS allows decision-makers to take full advantage of spatial data resources [40]. While [41], The researcher considered to hold as a basis for generating awareness about the geographic information systems technology and theoretically exploring the possibility of exploring competitive and sustainable advantage to Managers of Retail and Faculty of Management. This paper also attempts to answer some of the market needs and try to identify the scope of innovative methods such as geographic information systems. It explains how geographic information systems can be used in conjunction with classic methods and new advanced tools to advance a new approach to business expertise. Also, a geographic information system technology supports answering the questions and solves the problems by looking at the spatial data on a real-time basis in a way that is fast understood then shared and displays information to confirm faster decision making.

CONCLUSION

The first benefit of GIS technology is increased productivity and rapid transformation. Increasing efficiency saves time, which translates to saving money. Applications of GIS improve the quality of life because they make things easier. GIS allows us to perform routine work, such as maintaining records of maintenance work or customer complaints, more efficiently. Geographic information systems tools have become easy to use and user-friendly. Local governments, facilities, and advisors use geographic information systems to analyze problems and recommend solutions in a fraction of the previously required time.

The geographic information systems can process multiple data from various sources and different bodies, in a group together, using various spatial statistical analyzes and pouring them into a single template to reach effective solutions that help in taking the appropriate decision.

Finally, it is hoped that this research has provided a clear vision of how to use the technology of geographic information systems to help planners for education and decision-makers to solve one of the planning problems and reach the best organizational decisions, with a clear methodology far from improvisation, thus opening the way for more research on it.

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