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MODELING OF SPATIAL MONITORING MAPS OF THE MOVEMENT OF RAILWAY TRAINS IN EGYPT

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ABSTRACT:

In light of the huge amount of data and information on railway trains; the problem is no longer storing this data and building a database for it, but rather the problem is how to deal with it and the management systems and treatment of both temporal and spatial aspects in order to help overcome the problems of the facility.

The idea of cartographic and spatial modeling of train movement comes as a result of frequent accidents and irregular train movement on the one hand, and the difficulty of citizens dealing with scheduled data related to train times. Geographical Information Systems (GIS), Global Coordinate System (GPS), Global System for Mobile Communications (GSM), and Database Management Systems (DBMS), in order to build and manage a new kind of database, which are databases of moving objects, which through processing, cartographic representation, and management allow Interactively animated object paths and streamlines.

The study showed that it is possible to manage the operating system of railway trains by building a spatial and electronic database for its network of lines, stations and slides. to overcome its problems as soon as possible; Due to the ease of dealing with data in its digital form and quickly extracting results in the form of interactive maps, this system can be used to manage the railway network, address its crises and reduce risks, in addition to creating an interactive electronic atlas that contains a large number of maps instead of tabular data, which facilitates Retrieving data electronically and allowing continuous change in it by the competent authorities, and inquiring about this data by travelers.

Key words: *cartographic modeling, spatial monitoring, train movement, railways.*

INTRODUCTION:

Railways are considered one of the vital transportation infrastructures that greatly affect economic, environmental and social developments. The main responsibility of any government is to provide security and safety for its citizens, communities and properties. This can be achieved by making good use of all available tools and technologies that will help manage efforts and propose solutions. In times of crisis, spatial information systems and their methods represented in spatial and cartographic modeling are extremely important for national security and the management of public institutions and utilities, as they are used in analysis, planning and proper management of all problems and reduce their bad results, when studying the railway network operation system and trying to develop it and reach levels Advanced, this requires concerted scientific and institutional efforts and the integration of the relationship between them in order to contribute to the improvement of the operating system through sound management and standing on the level of its performance and reducing the effects of deficiencies resulting from its problems.

PROBLEM STUDY:

The problem of the study is crystallized in two main axes that can be formulated as follows:

In light of the growth and development of cities, the railway network has penetrated most cities and villages, and the authority has allocated some ports for the passage of individuals and vehicles, and crossing without these places has become punishable.

Millions of citizens, employees, workers, and students, go to railway stations seeking their interests, and most of them use more than one train journey to reach their workplaces. Hence, organizing the movement of trains and punctuating their schedules has become important, and any deviation from the train schedules set and organized for its movement will result in Serious problems and damage to the interests of citizens, and despite that, there is a lack of discipline in the arrival and departure times of trains.

OBJECTIVES:

- **Proposing solutions to the problem of railway accidents and irregular train times through a systematic and objective study with a geographical framework and thought, a spatial analysis of its vocabulary, measuring the extent of benefiting from geographic information systems techniques, and the possibility of developing an ideal model to improve the regulatory framework for the railway network in Egypt.**
- **Creating an interactive atlas of the movement of trains to show the dates and times of their departure and arrival in a cartographic manner, in a way that helps passengers in a comprehensive, unified view of all trains, their movement, and the trips that they make through the stations, and helps in selecting and determining the appropriate trains for trips.**

METHODOLOGY:

In order for the study to proceed as planned, it adopted two main approaches: the System Approach and the Applied/Problem Approach. The problem is the effects of the problem, monitoring its causes and presenting its solutions. In order to follow this methodology, the study relied on the cartographic modeling method in the geographic information systems environment as one of the applied approaches to information modeling in both its spatial and temporal parts, in addition to Automatic Vehicle Tracking or Location AVL systems. A system to determine the geographical location of the vehicle or to send important information about it to a place where it can be used. Various information such as speed, air pressure, weight, temperature, etc. can be sent to the control and monitoring rooms or the concerned party. Be satellite or GSM mobile communication systems.

LITERATURE REVIEW:

The study of cartographic modeling and railway trains was not the subject of independent research, but all that was mentioned about them did not exceed fleeting references. One of the most important studies that dealt with the subject of railways was a study by (Abduh, 1986) entitled "Railway Transport in the Arab World", and a study by (Ezz El-Din, 1990).) on "Railway Transport in the Kingdom of Saudi Arabia, a Geographical Study", and a study (Makki, 1999) entitled "Railway Transport in the Kingdom of Saudi Arabia, a Study in the Geography of Transport". Non-geographers dealt with it from the economic, urban, political, technical and engineering aspects, such as the study (Howkins, 1996) titled Geography of Railways and the Determination of Polish Borders (1918-1930), and the study presented by Zheng and Cao (2021)) on

the subject of the impact of building high-speed railways on relations Spatial in the urban agglomeration of Guanzhong Plain, and A study (Alotaibi et al., 2021) entitled Investment in Transport and Access to Railways and Their Dynamic Effects on Regional Economic Growth, a study (Frédéric and Amparo, 2021) entitled Geography of Rail Transport, and a study (Fang et al., 2021) entitled Implications New Silk Road railways on local development, and one of the most important foreign studies that dealt with railways as a topic and was not applied spatially, and dealt with spatial modeling of transport networks and spatial intelligence, a study (Ingleby and Mitchell, 1992) entitled Proving the integrity of the railway signaling system that includes geographical data, and a study (Mark, 2003) entitled Internet, map monitoring and site privacy, a study (Awad and Hazem, 2012) entitled: Geographic Information Systems and Railway Management, and a study (Marcel, 2014) entitled: Railway Infrastructure Management using Geographic Information Systems, and a study (Oosten , 2015) entitled: "Railway stations and network geography", a study (Bengt et al., 2015) on the subject of information systems for cooperation in operational train traffic control, and a study (Kotik ov, 2017) GIS modeling of a complex intermodal road network and its traffic regulation, a study (Hind, 2019) mobile phone maps, and a study by Clarke, 2019)) entitled Geospatial Intelligence, and a study (Campbell et al., 2019) about Detecting and mapping traffic lights from Google application images using deep learning and GIS, a study (Song et al., 2020) titled GIS - Based Multi-criteria Rail Design with Environmental Spatial Considerations, and a study (Valentino and Agostino, 2020) which provided a new index for evaluating the level of safety performance of railway transport systems, and a study (Luan et al., 2020) titled Distributed Analysis and Optimization for Real-time Traffic Management of Large-scale Rail Networks, and a study (Hui, 2021) entitled Analysis of Flow Field Characteristics along the railways, and a study (Rivera and Dick, 2021) entitled "Illustrating the effects of moving masses on the behavior of rail traffic flow using basic graphs," and a study (Oliver et al., 2021) entitled "Railway stations as part of Navigating the concept of a smart city.

DISCUSSION AND RESULTS:

[1] A proposed system for managing railway trains:

The railway operating system can be managed by using geographic information systems technology (GIS), the global coordinate system (GPS), communication systems and information transmission technology, and this is done according to the following system.

• Building a geographic database for the railway network at the level of the Republic, determining the locations of train stopping stations, and determining the locations and coordinates of the railroad crossings and outlets.

Determining the railway lines, movement directions and density, defining the stations of the railway trains, the scheduled time for starting and the estimated arrival time according to the speeds specified in the scheduled speed schedule, and determining the journey time.

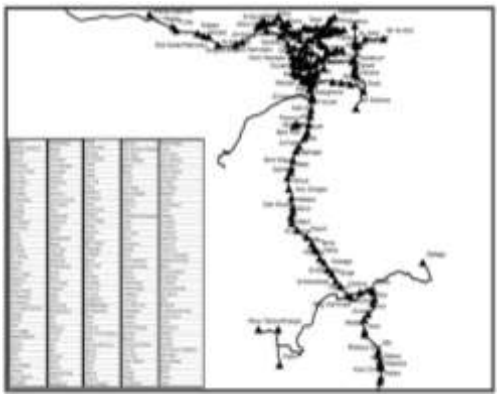

Figure (1): Spatial database of the railway network in Egypt

After building the network, an electronic database of the railway network, its stations and slides is available, and the electronic system of the railway network in Egypt is linked to the web. Where a website (GIS Web Application) is created to help benefit from the electronic database that has been created, and after completing the theoretical aspect, the study suggests applying the following system for managing the railway network in Egypt.

Determining the coordinates of railway stations and placing a GPS device to track the movement of trains between stations separately and linking them to a unified network to determine the location of the train in relation to the stations, and embodying this on a map based on the electronic database, and this appears through a software window inside the train stations to determine the location of the trains on the railway network and its arrival time in relation to the station coordinates, and this application helps to overcome the problem of irregular railway train times; So that the actual time of arrival is known to everyone, which helps in taking this decision on the part of the citizen. As for the administration, it helps to make decisions regarding train problems and malfunctions. In the event that the train is late, the device automatically apologizes to the citizens for the train being late. Its appointment is every five minutes and the actual time of arrival is alerted so that passengers are not harmed.

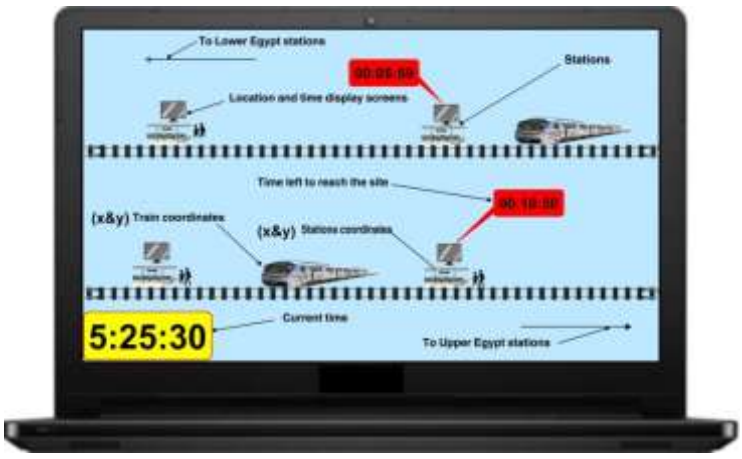

Figure (2): A window showing the movement of the train inside the stations

The coordinates of the slides are determined along the network with the provision of a tracking device for the trains to know their coordinates. When the train's coordinates approach the coordinates of the slides, the sound alert, the light signal, and the countdown of the train's approach to the slides are made through the stop watch shown on the screen. It should be noted that each Transactions are not done by specifying the time and time period, but rather by specifying the

coordinates and their approach distance, and all of this appears through a window placed at the sliders.

• GIS units are provided in all railway control areas at the level of the Republic and are connected to a unified network to activate the role of modern technologies in serving that facility, by specifying the coordinates of all railway trains and following up the speed of trains on the electronic map, using the digital map, the electronic base and sensing programs After and communication systems, thus the railway network in the republic has an electronic database available at the Office of the Controller and Planning in Cairo.

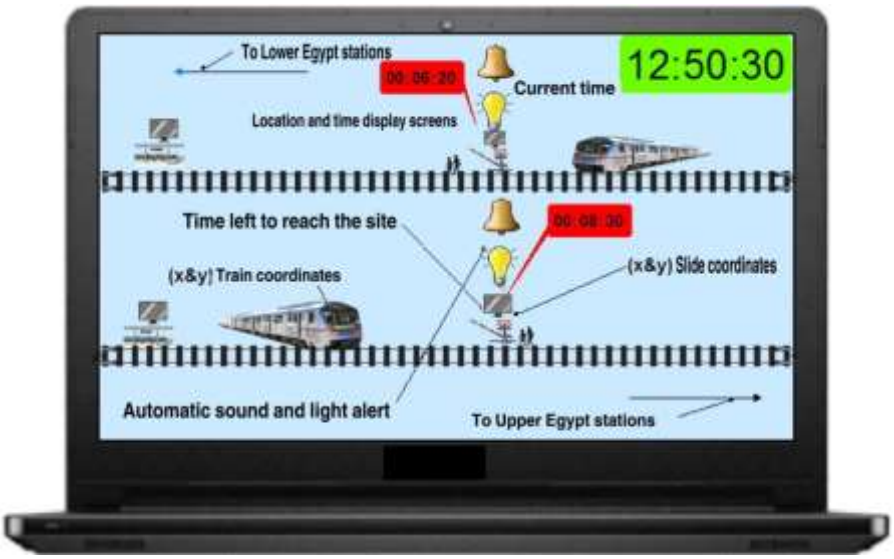

Figure (3): A window showing the movement of the train and its location near the two slides

s been pointed out in the past and recently that the simultaneous sequence of train movement can be done using the global coordinate system, but the extent of benefiting from this tracking has not been indicated. It is also worth mentioning that the above has been tested to the extent of its implementation and the implementation mechanism has been known and the Authority can Railways in the Arab Republic of Egypt may take advantage of this to manage its organization and at a small financial cost that does not exceed more than building a spatial database and two display screens for each (station, two slides, and a dangerous site).

The electronic management system for railway trains is based on the integration of geographic information systems ((GIS), the global positioning system (GPS), and the global system for mobile communications (GSM), on spatial databases covering the railway network, using (GIS) technology, and it is transmitted via network (GSM).

Source: (ARC GIS 10.5)

Fgure (4): Components of linking (ARC GIS 1.5) with mobile devices and display screens

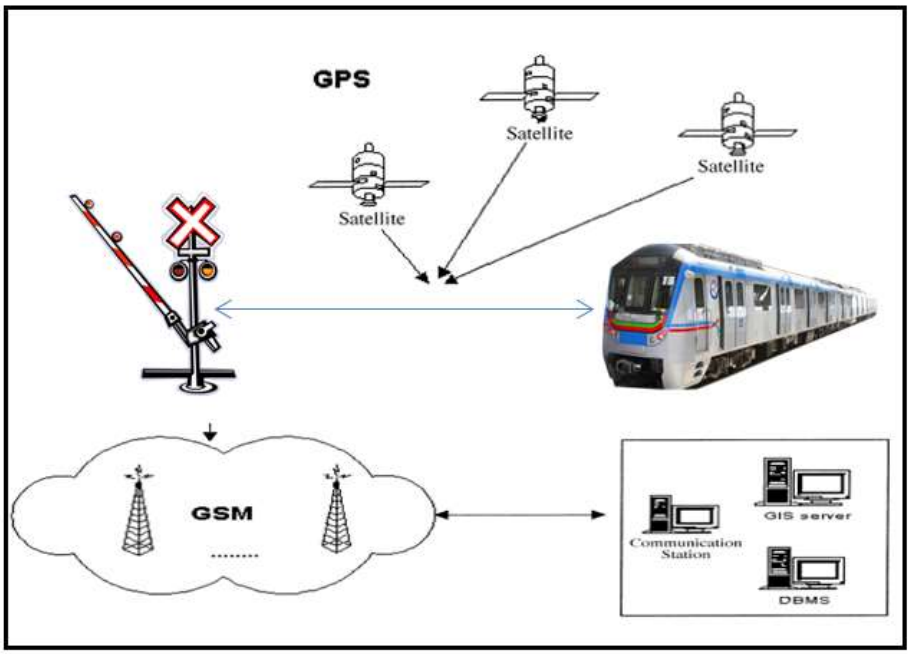

Figure (5): Components of the proposed system for operating railway trains

With regard to the shape of the two slides and its closing mechanism, it is in the form of an electronic door on both sides of the railway line, with a height of 160 cm. It closes automatically with a motor linked to the electronic system. so that it closes the first stage in front of cars; Only cars from inside are allowed to exit, and those outside are not allowed to enter. After closing in front of cars, a part of it that is no more than 50 cm wide is left for 50 seconds in front of pedestrians, which is the period during which a citizen can cross between the two sides of the railway, then it is closed so that pedestrians are not allowed to pass. from one side of the railway to the other; But it opens automatically for citizens who are from the inside between the gates of the two slides, which achieves the highest levels of security and safety, and this is done in the presence of surveillance cameras on both sides of the slides in a way that allows monitoring the situation, and it should be noted that despite the simplicity of the previous idea on the one hand, and the technological development On the other hand, this is amazing in the developed world countries, but this proposal is a remedy for previous defects and problems, according to the available limited material capabilities.

Figure (7): The network's electronic database, which is proposed to be managed

Figure (8): A telephone application with the General Administration.

Figure (9) a telephone application with drivers

At the end of the study, its results and a summary of its idea are presented in a mobile application, which can be carried on a mobile phone or a tablet designed to be with railway drivers, helping them to communicate and know the locations of trains. This application can also be made available to passengers. So that it helps them to know the actual time of the arrival of the trains that they see by doing zoom out)) on the map and specifying the number of the train to be known.

By pointing at the train (Select train) and pointing at the station (Select Station), the coordinates of the train appear and change with the movement, and the time of arrival and the remaining time appear on the station. The application can also be developed in a way that provides all means of convenience and ease of use for its users.

It is possible to achieve the maximum degree of financial profit from this project by establishing a railway advertising company, which works to publish all kinds of paid advertisements and other things that are intended to be advertised through screens located inside stations and trains. This is done during periods between train advertisements, and this is handled by a specialized company that coordinates the advertisement through display screens within the Egyptian railway system.

[2] Interactive electronic atlas of train traffic:

The capabilities available in the interactive electronic atlas of railway trains are as follows:

- **Statement of the movement of railways, as it shows the movement of 1,100 trains on 27 railway lines on flowcharts showing the departure station, the arrival station, the stopping stations, the time taken from one station to another, and the total time of the trip.**
- **Choose the line to know the time of the trains on it from the general electronic atlas of the movement of railways.**
- **Choose the time of the train that you want to know exactly. It also helps to know the train that will depart from the station during the coming minutes, by displaying it in a separate window inside the main window, where it is possible through the electronic atlas displayed on the screen to inquire about the location of a train at a certain time, for example the traveler By typing the train number, a new map appears in the atlas in the query window, showing him the location of the train at the moment of the query, the time of departure from the station, the time of arrival, and the time of the journey.**
- **The electronic atlas helps to know the movement of trains to and from the station in which the traveler is located across the different directions, and it is preferable that this be limited to the main station in each governorate. to the High Dam, or from Assiut to Cairo in separate flowcharts showing all the details of each train.**
- **The electronic atlas allows knowing the locations and stations that trains are supposed to be at at any given hour on a specific line, meaning that the locations of all trains on the Cairo-High Dam line can be known at twelve noon, so the locations of all trains appear on the map once.**
- **The atlas provides the possibility of independent inquiry about a specific train in terms of the number of carriages, the type of carriages, and reservation data in terms of the number of tickets reserved, and the number of tickets remaining. Through the atlas, after the approval of the Railways Authority, the citizen can inquire about the possibility of reservation in a train before going to the window Reservation, provided that the reservation is made from the reservation counter and not by the citizen himself, and this ensures non-interference in the affairs of the Authority on the one hand, and the psychological comfort of the citizen on the other hand.**
- **The electronic atlas of the movement of railways can be displayed in a mobile application, under the name (Egypt Railways Atlas). the tickets.**

Figure (10): A window to divide the railway lines

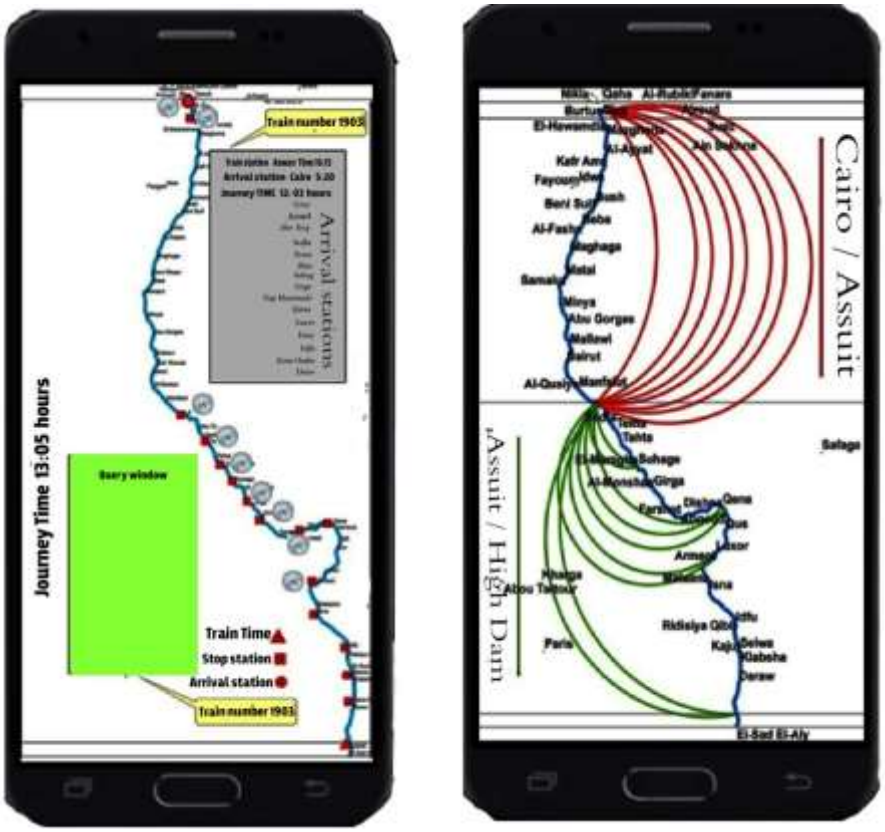

Figure (11): Train movement from Assiut Station. Figure (12): Inquiry about a train from the station

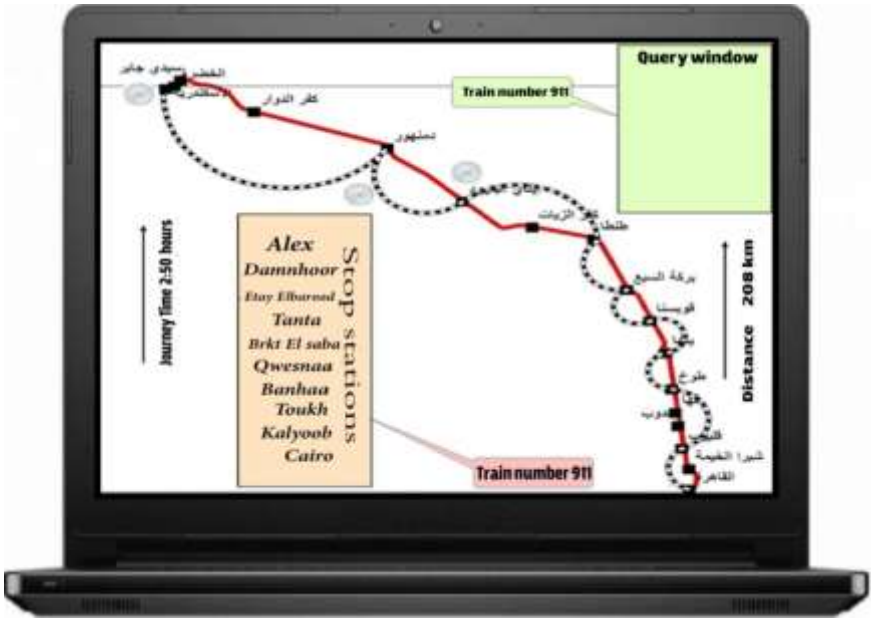

Figure (13): To inquire about a specific train on a specific line (Cairo - Alexandria)

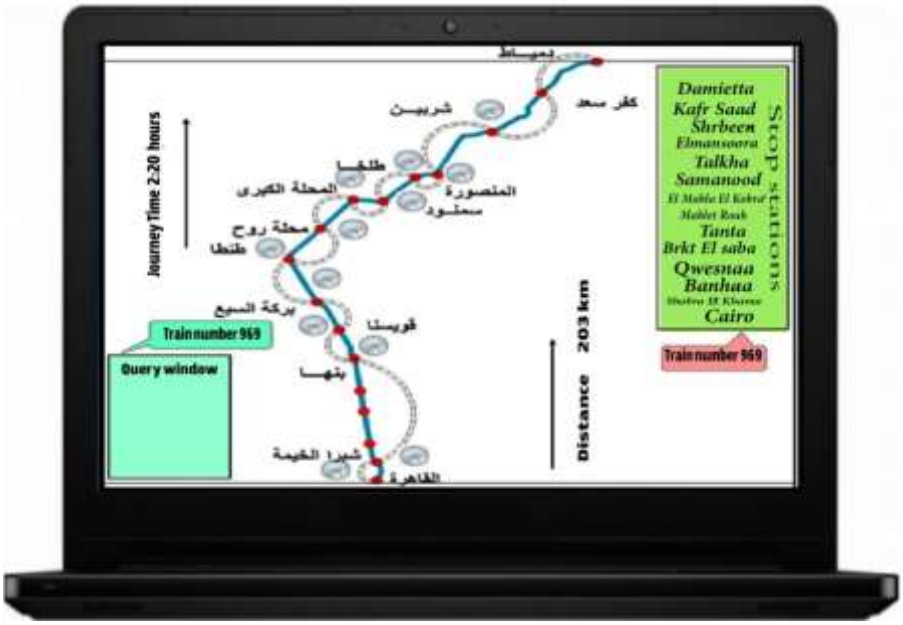

Figure (14): To inquire about trains from Tanta station on the line (Cairo/Tanta/Damietta)

CONCLUSION:

- **The study concluded with proposing a management system for railway trains and proposing solutions to the problem of accidents on its lines, and irregular train times, by building a geographical database, with a proposal for a system for closing the slides that works in a compatible manner within the framework of this system that allows the possibility of tracking the movement of all trains on all railway lines rails at the same time, and it tracks the status of all sliders and outlets in terms of closing and opening in a way that achieves high levels of safety.**
- **A train movement database was provided to create an interactive electronic atlas of train movement through the various stations in a manner that allows for the possibility of updating it. for railway lines, and 25 maps of train movement to different directions from the main stations, as well**

as 1100 independent maps can be extracted for each train separately showing everything related to the train in terms of departure hours, journey time, distances between the station and the next station, and the journey time (□), and it can be printed This maps and its production in paper format.

- The right to study an explanation of the applied stages of creating an electronic atlas for the movement of railway trains, which includes the stages of building the railway network and its stations, and the stages of building a spatial and temporal database for the movement of trains, which numbered 1100 trains moving on 28 railway lines in Upper Egypt and the sea, and it also includes a detailed explanation of the method Displaying the data in an animated manner that allows data retrieval and inquiring about it through database management and organization programs, especially Movie Maker, and an explanation of the design of a mobile application, under the name (Egypt Railways Atlas). The movement of trains in a cartographic manner, in addition to some capabilities available in a more accessible way than what is available in phone applications.

RECOMMENDATIONS:

• The Ministry of Transport, on behalf of the Railways Authority, rebuilds an electronic database for the railway network, showing stations, slides and transfer points and linking them to an electronic system in order to reach the proper management of the railway network, analysis and planning for its problems related to train schedules and slide accidents.

• Providing television screens inside railway stations, to show train times, and screens are placed on both sides of the slides to announce the train's arrival time near the slides and to alert citizens to take caution.

• The Railways Authority studies the proposed project to solve the electronic sliders crisis with the mechanism that has been explained and analyzes the negative and positive aspects of the project and uses expertise to establish it in the best way.

• Establishing an electronic operations room that monitors the exchange of information between the trains and the management room, and between the electronic management room and the light signals at the stations, and between the room and the sliders on the one hand.

• Starting the work of the mobile application and allowing citizens to download it for a fee. Citizens can also book train tickets through this application. It is also possible to download paid advertisements on the mobile application for a fee.

• The establishment of an administrative unit by the Railways Authority that builds the electronic system and provides devices, in addition to seeking help from those with expertise in the fields of project management, railway engineering and planning. Investors can also be used to finance the project in return for a percentage of the profit of the commercial operation of the project.

• Conducting other studies to analyze the movement of passengers within the railway stations and the geographical analysis of the movement and the suitability of train times with it, and to study the possibility of changing train times in a way that is commensurate with the movement of passengers.

• Establishing an advertising company inside all railway stations for unified paid advertisements to cover the cost of the project and bring financial profit, by displaying advertisements on the atlas inside the stations, and advertisements can also be displayed via the phone application.

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نمذجة خرائط المراقبة المكانية لحركة قطارات السكك الحديدية في مصر

د. أحمد علي أحمد علي

قسم الجغرافيا ونظم المعلومات الجغرافية – كلية الآداب- جامعة أسيوط

الملخص:

في ظل الكم الهائل من البيانات والمعلومات الخاصة بقطارات السكك الحديدية؛ لم تعد المشكلة تخزين هذه البيانات وبناء قاعد بيانات لها، بل أصبحت المشكلة في كيفية التعامل معها ونظم إدارتها ومعالجتها بشقيها الزماني والمكاني لكي تساعد في التغلب على مشكلات المرفق.

وتأتي فكرة النمذجة الخرائطية والمكانية لحركة القطارات نتيجة لتكرار الحوادث وعدم انتظام حركة القطارات من ناحية، وصعوبة تعامل المواطن مع البيانات المجدولة المتعلقة بمواعيد القطارات، وحاولت الدراسة وفق أسس علمية ومنهج جغرافي وتقني دراسة امكانات تحسين شبكة السكك الحديدية عن طريق النمذجة الخرائطية لحركة قطاراتها وتكامل علم الخرائط ونظم المعلومات الجغرافية (GIS) ونظام الإحداثيات العالمي (GPS)، والنظـام العالمي للاتصالات المتنقلة (GSM)، ونظم إدارة قواعد البيانات (DBMS)، وذلك لبناء وإدارة قاعدة بيانات تعد نوعاً جديداً وهي قواعد بيانات الأجسام المتحركة والتي من خلال معالجتها وتمثيلها كارتوجرافياً وإدارتها تتيح مسارات الأجسام والخطوط الانسيابية المتحركة بشكل تفاعلي.

وقد تبين من الدراسة أنه يمكن إدارة نظام تشغيل قطارات السكك الحديدية عن طريق بناء قاعدة بيانات مكانية وإلكترونية لشبكة خطوطها ومحطاتها ومزلقاناتها؛ للتغلب على مشكلاتها في أسرع وقت ممكن؛ نظراً لسهولة التعامل مع البيانات في صورتها الرقمية واستخراج النتائج بسرعة على هيئة خرائط تفاعلية، ويمكن الاستفادة من هذه المنظومة في إدارة شبكة خطوط السكك الحديدية والتصدي لأزماتها وتقليل المخاطر، إضافة إلى عمل أطلس إلكتروني تفاعلي يحتوى على عدد كبير من الخرائط بدلاً من البيانات المجدولة، يسهل استرجاع البيانات بشكل إلكتروني ويسمح بالتغيير المستمر فيها من قبل الجهات المختصة، والاستعلام عن هذه البيانات من قبل المسافرين.

الكلمات المفتاحية: *النمذجة الخرائطية، المراقبة المكانية، حركة القطارات، السكك الحديدية، مصر.*