



Managing the Engineering Projects Through the GIS ToolsA.M. Abdel-Wahab^{1,*}, O.M. Malek²¹Assist Prof., Civil Engineering Department, National Research Centre, Egypt²Assist. Prof., Dept. of Civil Engineering, Higher Technological institute, 10th of Ramadan City.

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ABSTRACT

Nowadays, large cities, such as Jeddah city, has a considerable number of projects in different locations. So, there is a crucial need to implement a comprehensive and fully integrated Project Management Solution (using Primavera Enterprise suit), to include all projects under construction or newly awarded in one centralized database. In this context, the integration between Primavera data in spatial database is necessary. This proposed solution will support the Stakeholders to properly assign staff to mitigate the risks predicted to accomplish the project within time and within estimated budget. In this sense, the importance of this research, which seeks to find a state-of-the-art IT solution, which automates all Enterprise Project Management System procedures and formalities and provides linkage to geographic information systems programs ArcGIS to transform conventional project management data output and reports into information within geographic/location context. Thus, visualizing project management output such as linear/Gantt charts and/or tabular project related to work status, comments, and flags and associate this information in presence of maps and layouts. The current research introduces a complete integration solution to achieve a link and a connection between attribute data were coming from EPMS Primavera(P6) and Geographic spatial data (location) by using GIS software.

1. Introduction

The most of big cities around the world have government agencies that supervise the day-to-day municipal activities of the city. So, the Jeddah Municipality is the administrative body that carries out various municipal activities in Jeddah Province, such as maintaining the city's infrastructure, maintaining roads, and establishing many projects and public services for the city. Therefore, Jeddah Municipality has a number of projects distributed over various locations within Jeddah.

The current research target is to integrate the enterprise data management system coming from Primavera with geographic information systems software (ArcGIS tools). This will enable the viewing of attribute data of the Project Management program, which describes the project organization of time and costs and resources through the works to be completed by using different project indicators CPI (cost Performance Indicator) and SPI (Schedule Performance Indicator) using geographic information systems

[1,2].

Also, the research aims to transform the conventional project management, data output into data related to geographic/location for every project. Thereafter, visualizing project management output such as linear/Gantt charts and/or tabular project related to work status, comments, and flags and associate this information in presence of maps and layouts. The business initiatives for integrating GIS and PMS systems is to add the location aspect to many project management system activities such as knowing projects locations, locating detailed work items, activity costs and progress, and leverage the analysis and visualization capabilities of GIS in supporting decision makers [3].

In this context, ArcGIS is the tools used as the GIS client software within which the link between the location maps for Jeddah and the project management exported activities data took place. ArcGIS will be used to present the project management activities on the map, classify the aspects of these activities (cost, progress, etc....), and visualize every indicator on the map by their location. Base map for Jeddah includes many layers such as Municipalities and

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Districts.....ect. Other layers are introduced for the purpose of integration such as streets, bridges, tunnels, and storm water. Activities stored in Primavera apply to this data; each activity has a cost, progress, and other project management aspects. After the link between Geographic locations and activities aspects is established, the map is classified and directed with a predefined color scheme to achieve the most suitable presentation to support decision makers.

2. The link between EPMS and GIS

The idea of this research is to extract data from the PMS program (Primavera) into an intermediate schema, link this schema to map locations, and then visualize the project management activities on the map through GIS Tools.

2.1. The link targets

The aim is to transform conventional project management data output and reports into information within geographic/location context. Hence, visualizing project management output such as linear/Gantt charts and/or tabular project related to work status, comments, and flags and associate this information in presence of maps and layouts. Moreover, the research aim is to design and implement procedures to transform composite and interlaced project management (PMS) related data output and reports (typically available from project management computer packages. Primavera is proposed by utilizing the powerful tools and procedures within of Geographic Information Systems (GIS) to enhance PM outputs and reports.

Thus, resulting in a multitude of relevant and expressive geographic displays, thematically mapped visual formatted outputs and geospatial analyses (typically available from Geographic Information Systems packages, are proposed by using ArcGIS tools). Examples outputs from GIS will be; thematic maps of project phases, regions/districts with expressive color codes, flags, labels and management comments for various project situations and work status,

providing strong visual displays and realistic analyses of projects phases and status.

2.2. General objectives

There are two general objectives to be achieved in this endeavor, namely:

To present project related information in forms and presentations, in presence of information technology conducive environment, that transcend boundaries between groups/personnel with different backgrounds and/or interests involved in a project, e.g. engineering and non-engineering, technical and managerial, and specialists and stakeholders' groups/personnel.

To instill project related practices, in presence of information technology tools, that does not focus only on the delivery of project specifics to a specialized target group, but rather expand to provide further insight and appreciation of any given project information among members of single and/or multiple groups, and at the same time allowing for, unified and consistent, cross-information assimilation among members of different groups of an organization.

2.3. Specific objectives

There are five specific objectives are given next:

- ✓ To provide project managers / engineers with spatial approach, tools, and techniques.
- ✓ To integrate GIS with the proposed IT solution.
- ✓ To assist in project site and design selection processes throughout the organization in presence of GIS.
- ✓ To enhance project management practice throughout the organization in presence of GIS.
- ✓ To support asset management practice throughout the organization in presence of GIS.

3. Study Area

The Jeddah city, Kingdom of Saudi Arabia has area about 5000 km² but the urban area is covering about 1500 km². Figure (1) shows the Index Map of Jeddah.



Figure 1: The Index Map of Jeddah.

4. Methodology

This section describes the technical solution and techniques to link projects management’s activities of construction projects within Jeddah to visualize the progress, costs, and other aspects on the Map to support decision makers. The solution relies on exporting data from Primavera into an intermediate schema, link this schema to map locations, and then visualize the project management’s activities on the map. On the other hand, an

integrated solution to link data management projects system with geographic information systems to transform Database attribute data systems used for project management through the Primavera program to be compatible with a Geo-database of geographic information systems using (Intermediate-Schema). It was then summoned to the GIS to prepare maps showing, (ArcGIS) via the Visual data as illustrated in Figure (2) performing the following solution methodology.

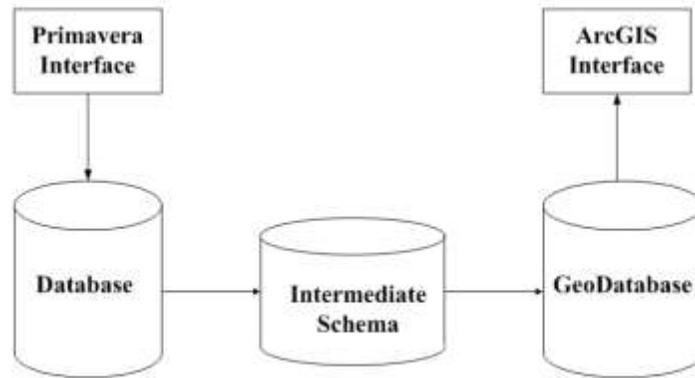


Figure 2: Performing solution methodology.

4.1. Methodology Related to Project Management Software Primavera P6

The following steps will illustrate the research methodology to achieve its objective related to Primavera Project Management Software: -

- i. The project inside the Primavera system is created by using the Critical Path Method CPM to elaborate the Critical Path,

which indicate the earliest early start and the earliest early finish of the project [4].

For every project's category adopt is proposed by Work Break down Structure (WBS) as per methodology submitted before to the delivered documents to the department lately as shown in Figure (3), [5].

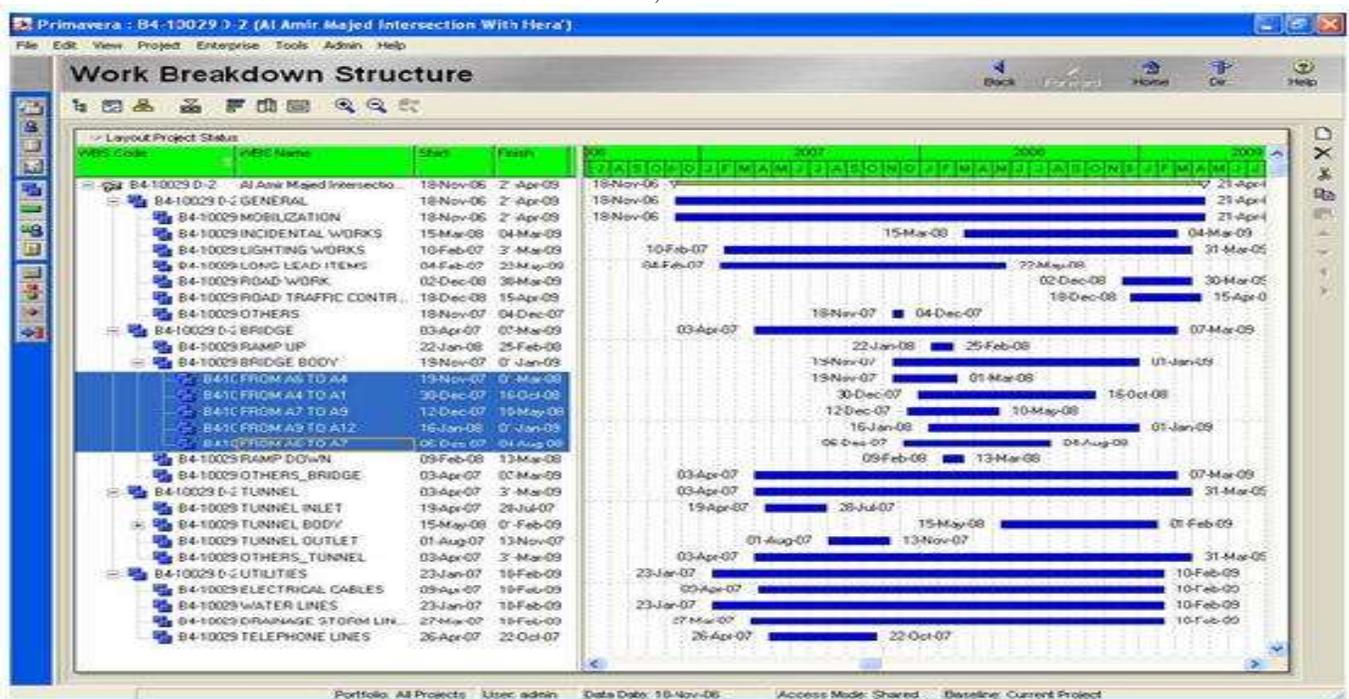


Figure 3: Work Breakdown Structure.

ii. Under each WBS, detailed activities are created which give objectives achieved as shown in Figure (4).

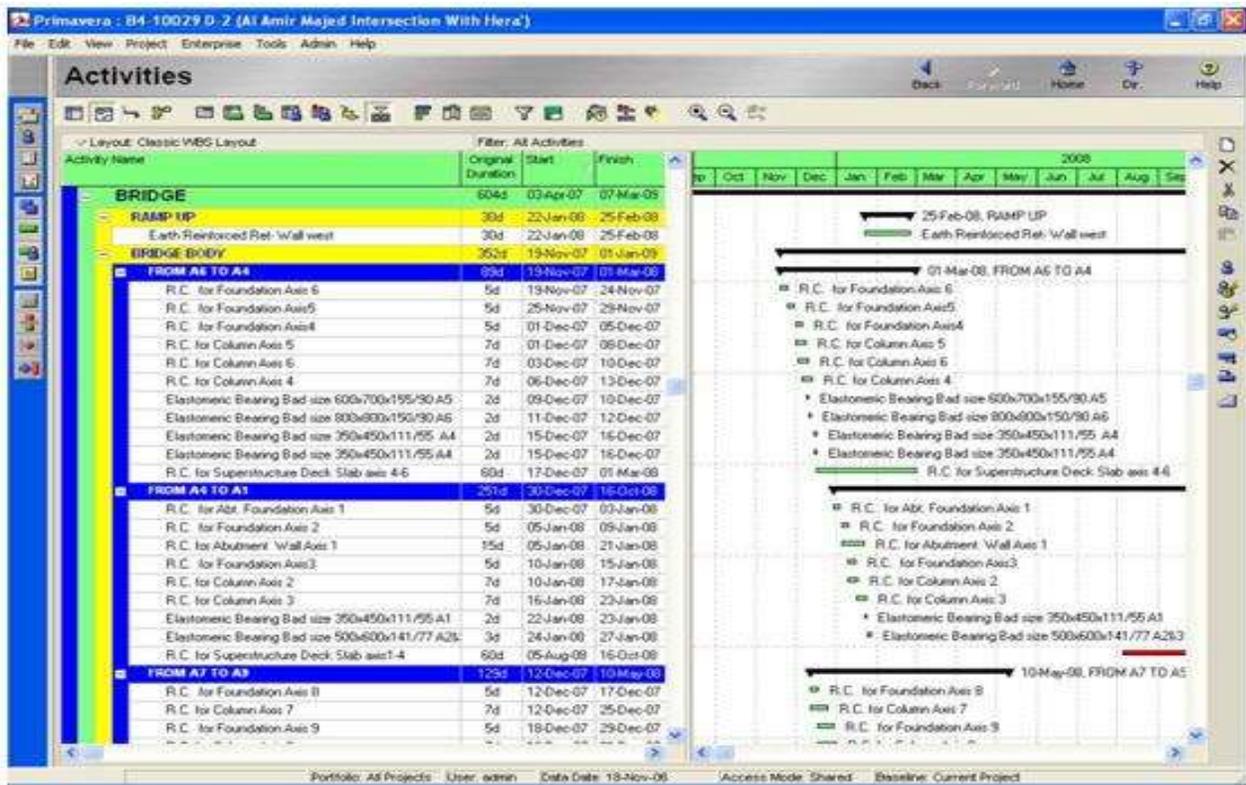


Figure 4: Create detailed project activities.

iii. Those activities should be loaded with necessary resources to get the job done within the estimated duration; and any lack of resource or resources overloaded shall impact the duration

of the project and delay might occur as shown in Figure (5), [6].

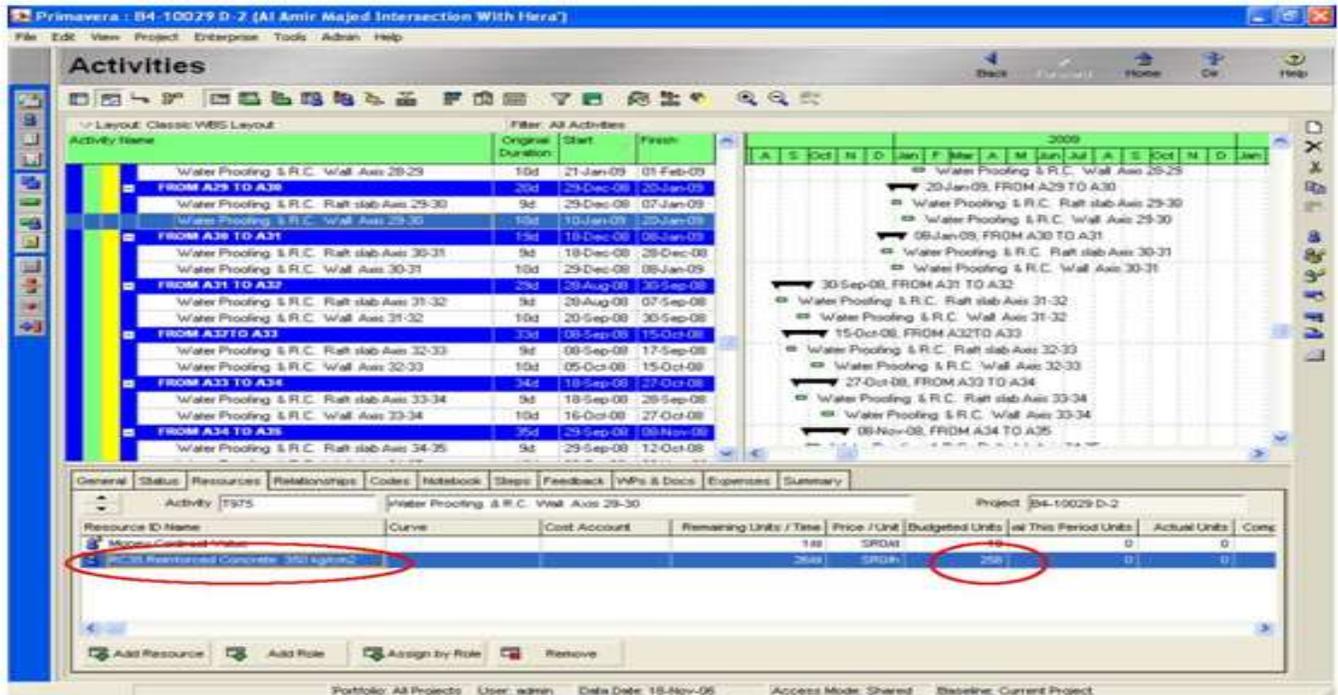


Figure 5: Resources allocated on the activities like Reinforced Concrete.

iv. After adjusting the time schedule and reviewing the resource availability, the schedule is copied to get the Baseline (Target) schedule to compare the progress over the project at any time of the life cycle as shown in Figure (6), [7].

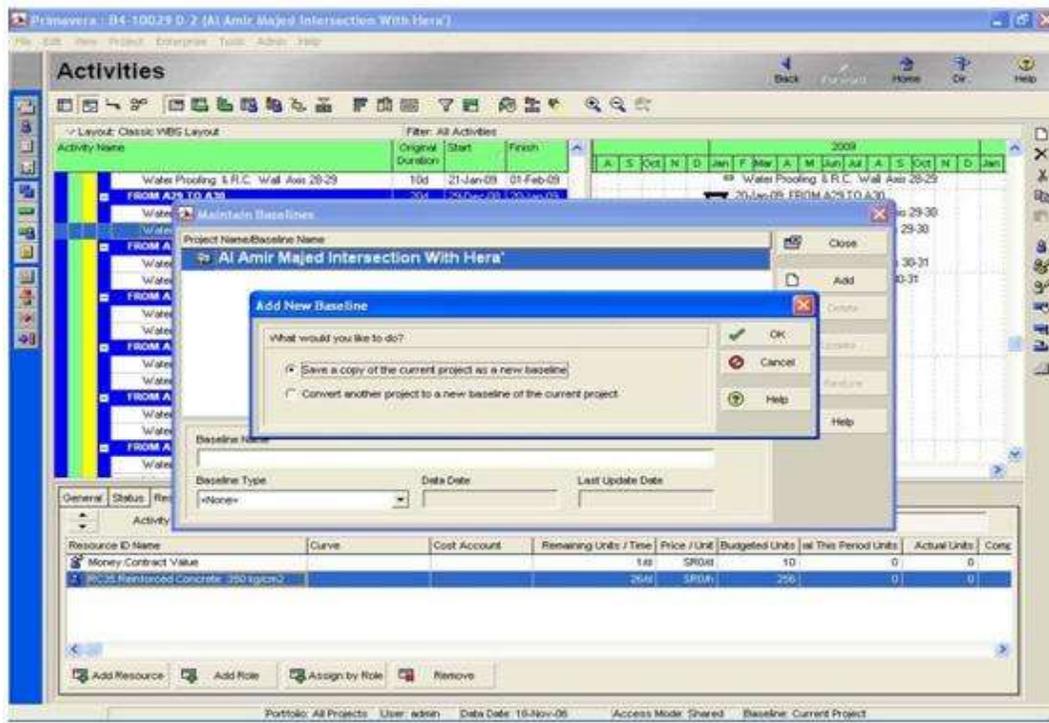


Figure 6: Schedule to compare the progress over the project at any time of the life cycle.

iv. Execute regular update to the current schedule, time every week month, bi month, as required as shown in Figure (7). and resource wise on timely manner on regular basis,

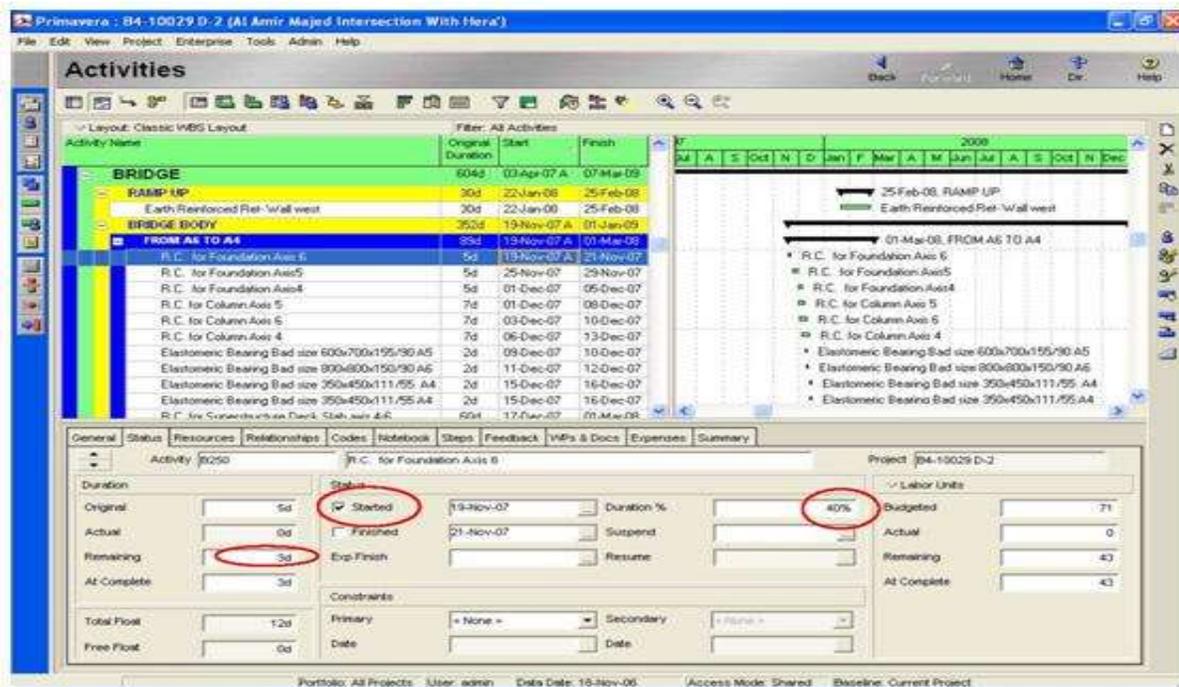


Figure 7: Schedule, time and resource wise on timely manner.

vi. Create lay out matching the needs from GIS program and data model proposed in the Primavera system including all dates,

budgets and indicators as shown in Figure (8).

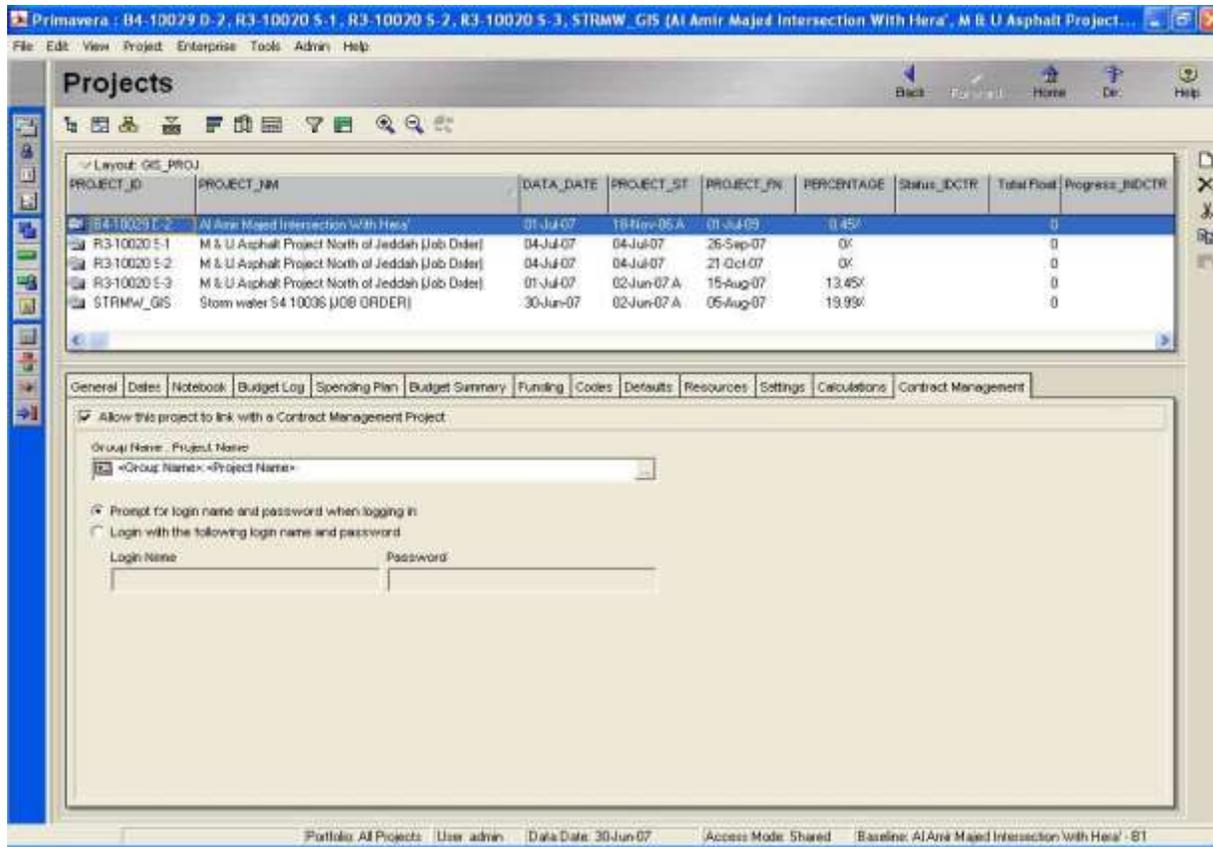


Figure 8: Create Primavera Layout.

vii. Import the lay out with all associated columns information to Microsoft excel before preliminary step before transfer it

to Microsoft access as shown in Figure (9). Also, figure (10a) shows color code for Primavera indicator.

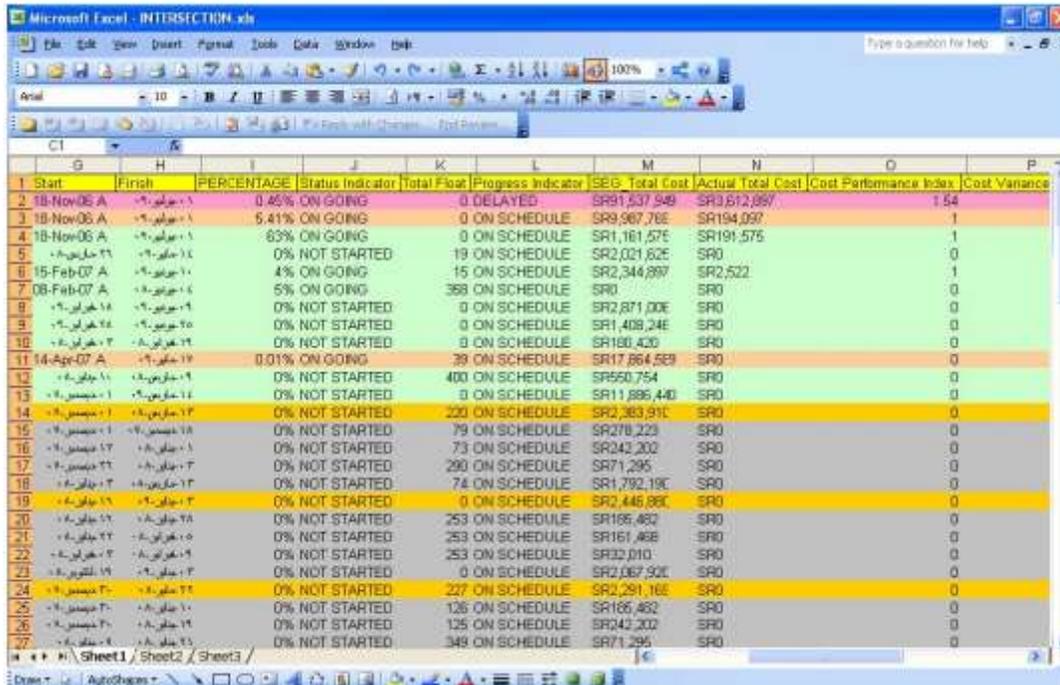


Figure 9: Import the lay out with all associated columns information to Microsoft Excel.

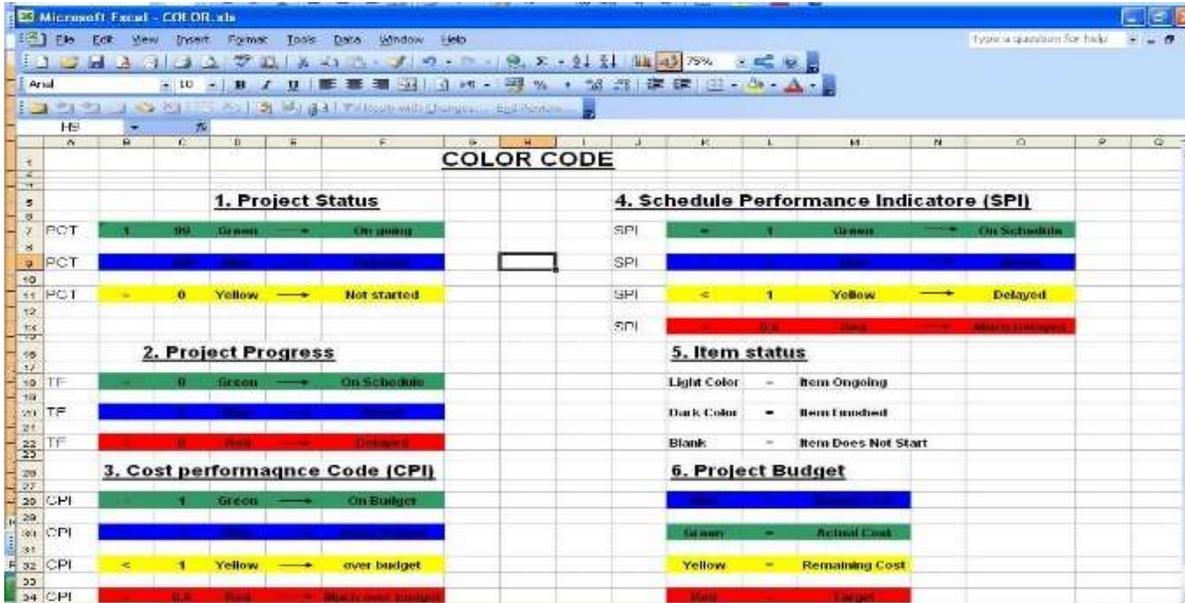


Figure 10a: Create color Code for Primavera Indicator.

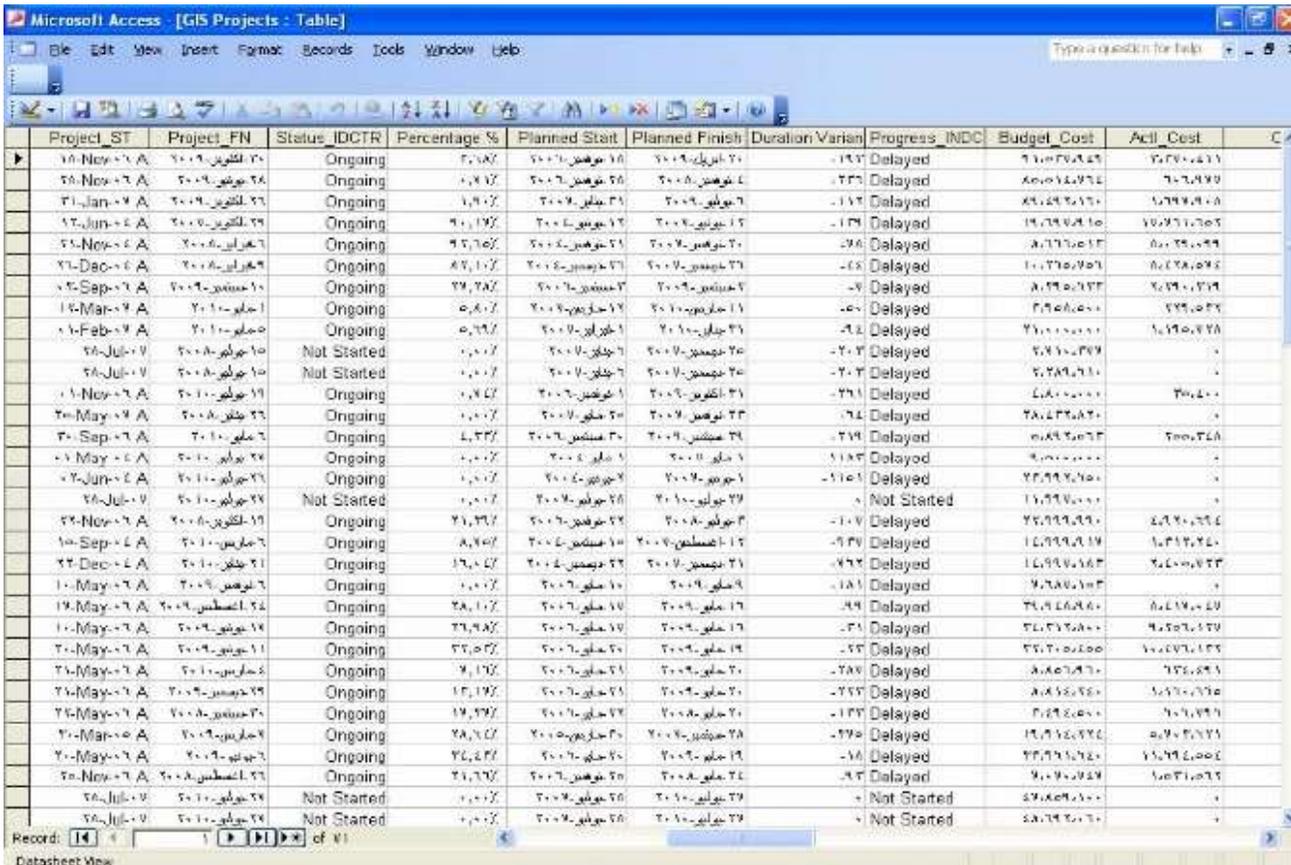


Figure 10b: Import the excel file into the Microsoft access.

viii. Import the excel file into the Microsoft access, now it's ready to be used in the GIS to elaborate the progress on visual basis as shown in figure (10b).

4.2. Methodology Related to Data Base Design (data modeling).

Segmentation methodology is the methodology applied to segment or divide data (geographic location and attributes) into different levels in order to present activities aspects (cost, performance, etc ...) exported from Primavera on a map [9]. The methodology suggests the different levels for presenting

construction activities aspects (road asphalt's cost, pipeline construction percentage of completion, bridge body R.C. Foundation Cost Performance Index) on the map. Segment levels are presented on the map as a location on top of which the activities' aspects are presented and classified based on a predefined color scheme.

Below are the different segments levels used:

- Project level
- Municipality level
- District level.
- Feature level (Road, Bridge, Tunnel, Utility 'Area', Storm Water 'Road').

❖ *Data Model*

Data model represents the model of the intermediate schema that should be linked to the location layers. The intermediate schema should act as a container for the activities data exported from P6E. The intermediate schema will be implemented in Microsoft Access format (MDB file). The data model diagram below represents the conceptual model, logical data model and physical Data model. Description about different fields introduced in the data model is included within this section. Figures (11a, b and c) show Data model conceptual, logical, and physical Data model design respectively.

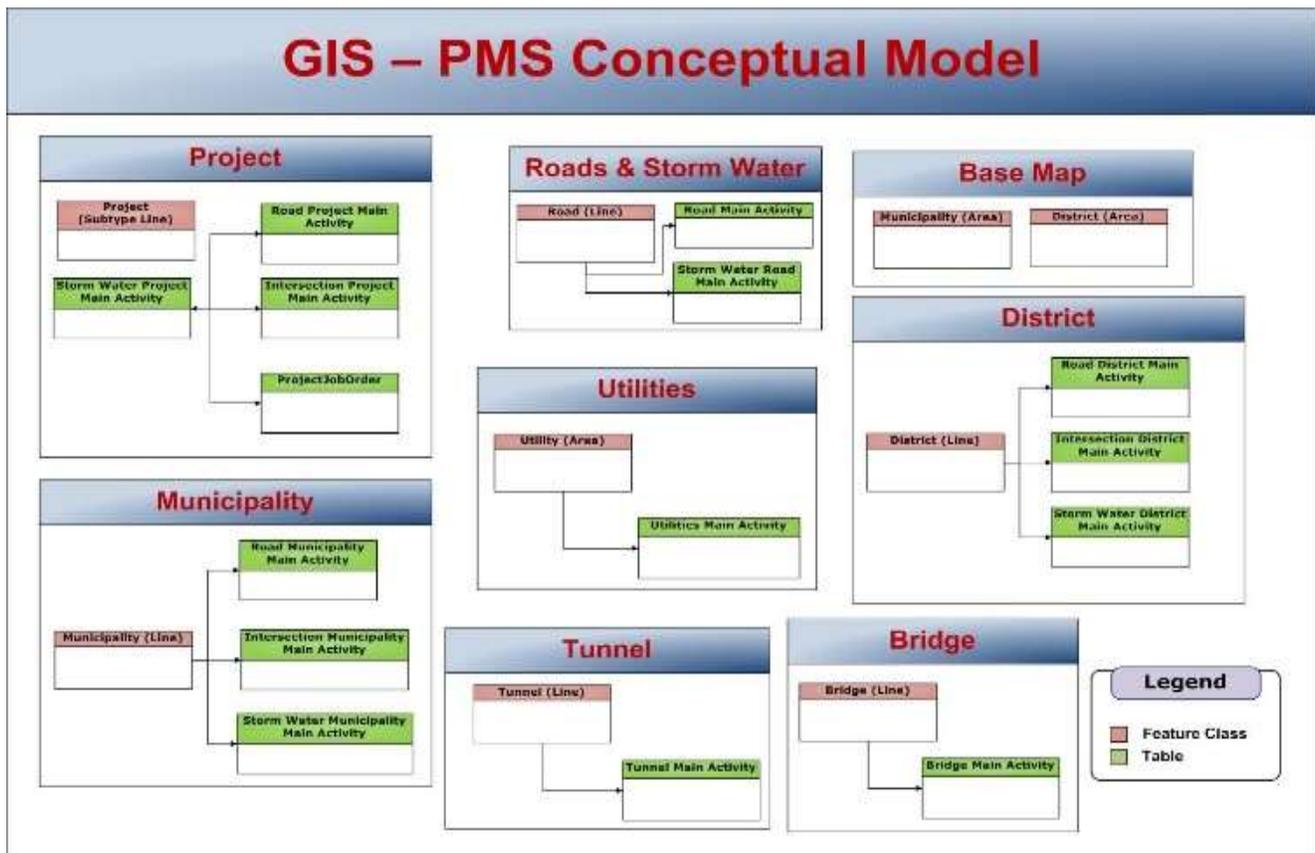


Figure 11a: Data model conceptual design.

GIS – PMS Logical Model

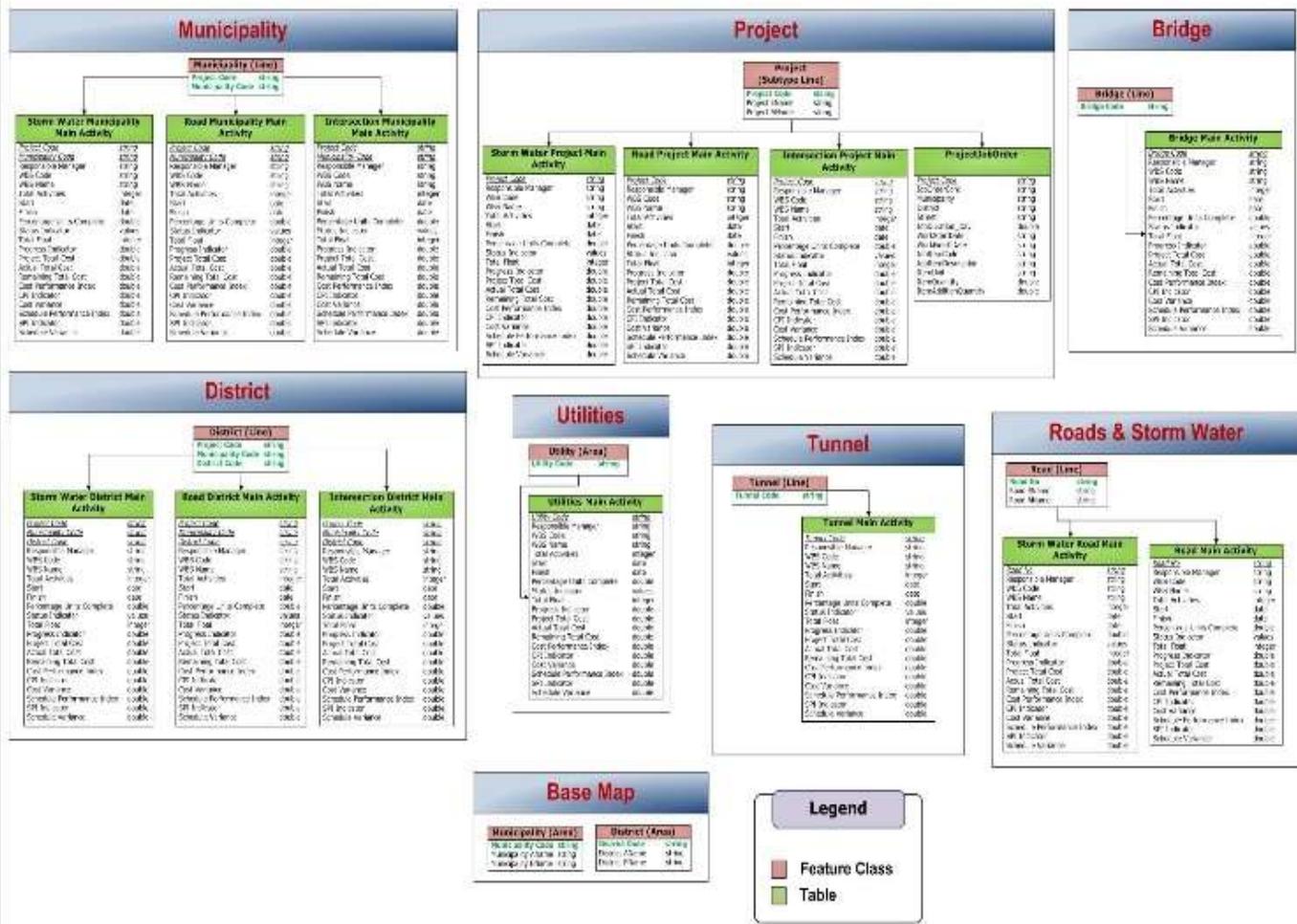


Figure 11b: Data model Logical design.

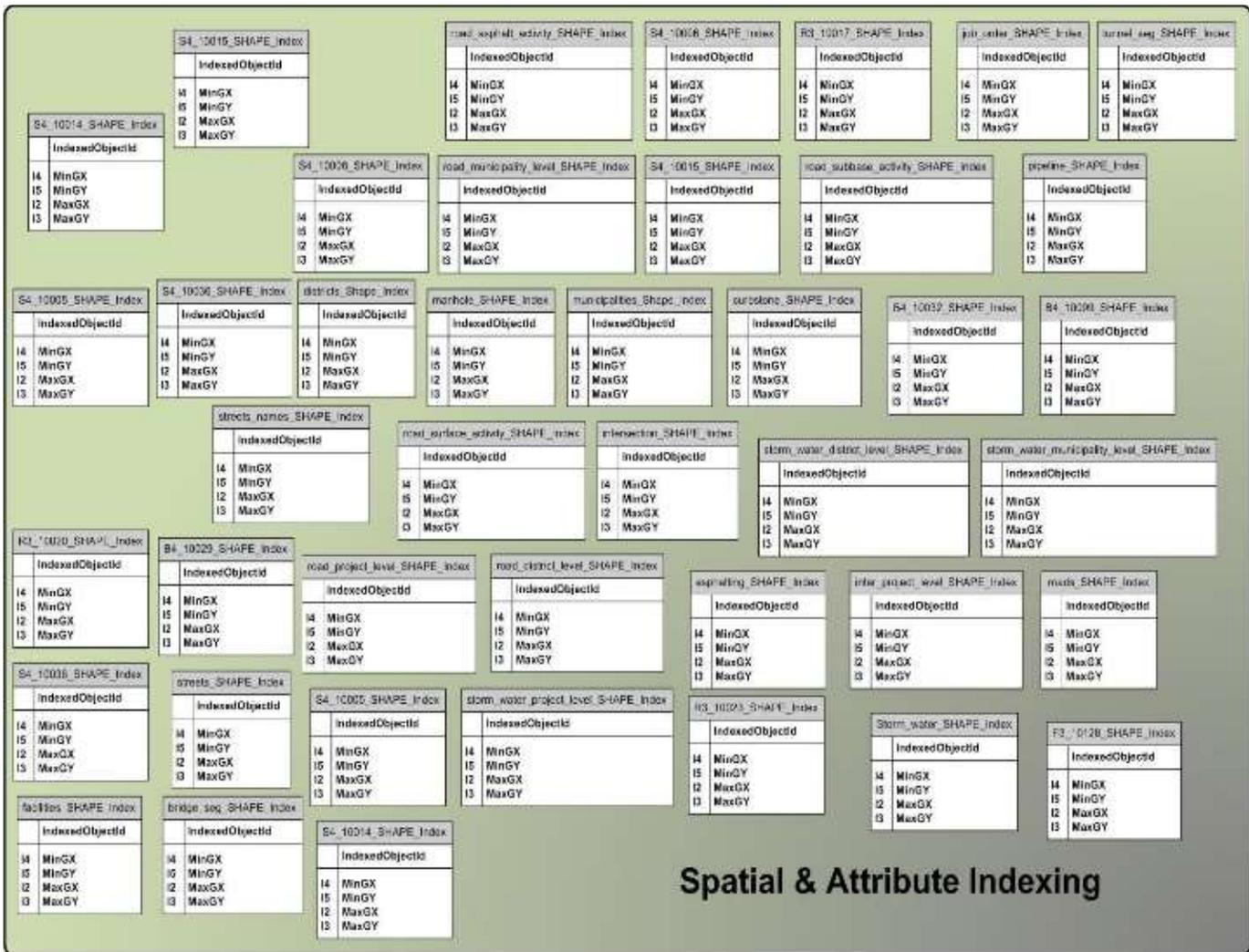


Figure 11c: Data model Physical design.

4.3. Methodology related to (GIS), ArcGIS Software.

After the previous two steps which were converted, the data was coming from Primavera through MS Excel and MS Access according to data model design which were related to ArcGIS Data format as following: -

- Project information such as (Project name, project number, the item associated with it project, the type of project, the contractor of the project.... etc).
- The duration of the project (The date of the beginning of the work, the date of the end of the work, the date of the beginning work expected, and the date of the end of expected).
- Project costs (the cost of the project and costs outgoing).
- Indicators of the scheduling of work:

- a) The progress of the project (Status Indicator).
- b) The state of progress of work (Progress Indicator).
- c) Proportion of what has been achieved (Percentage).
- d) The state of progress of work per period of time (SPI).
- e) The progress in the proportion of the costs (CPI).

4.3.1. Preparation Vector Layers for the Project Based on Jeddah Base-Map.

This section describes steps of the process to establish spatial information (Feature Classes) [10, 11]. In addition, it will define a unique number which used as a (GIS _ ID) to help to connect between data with each other, and then begin the process (Digitizing and drawing) in (Arc-Map) as shown in the Figures (12a, and b).



Figure 12a: Drawing Tools in ARCMAP software.

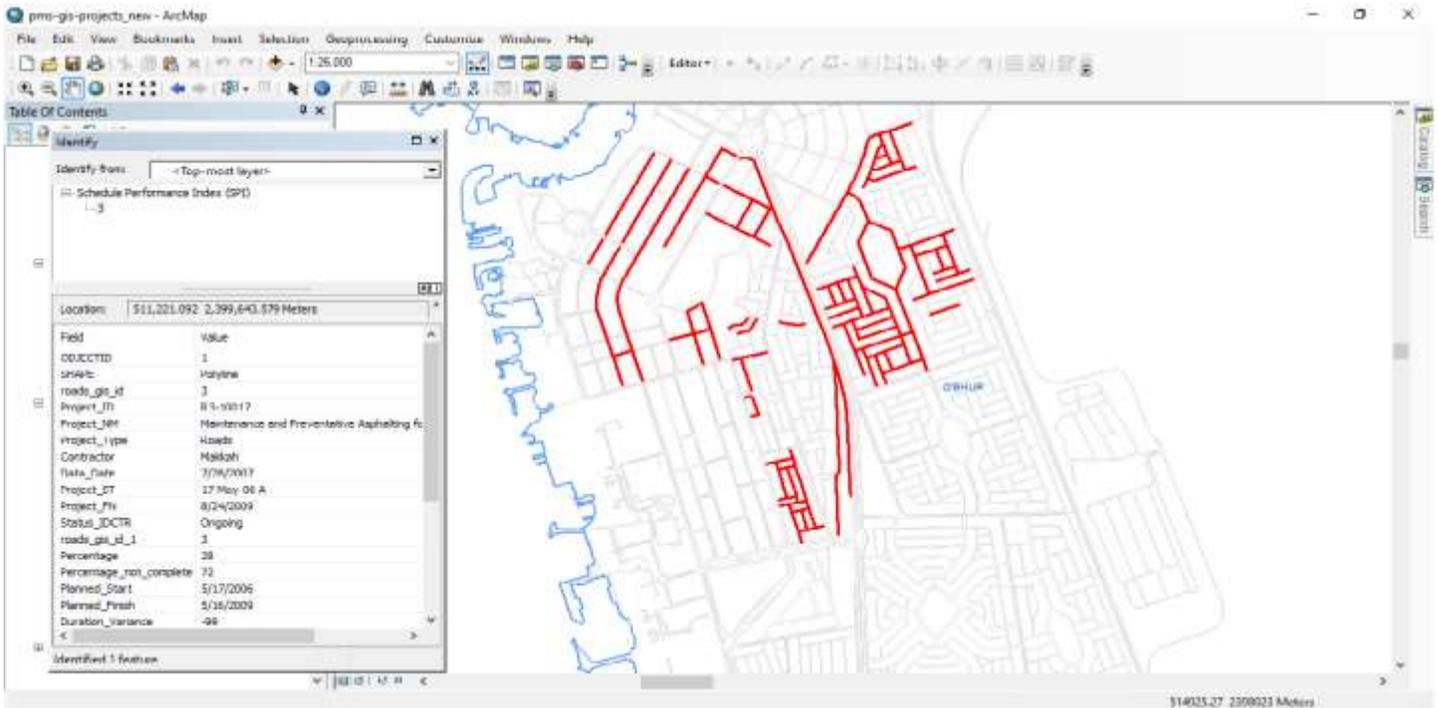


Figure 12b: Establishing a spatial- information vector layer for Road project.

4.3.2. Data Transfer and Connection between MS Access ArcGIS Layer

information is started with (MS Access) Data base as shown in Figure (13):

After the completion of the preparation of spatial information for the project in ArcGIS and then the process of linking spatial

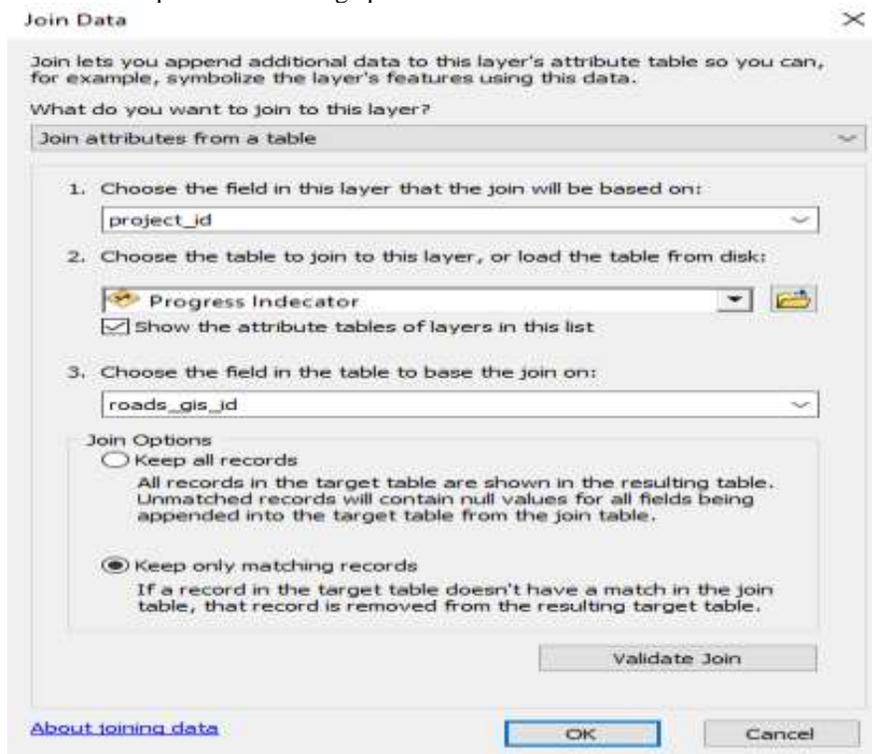


Figure 13: Join Data between MS access ArcGIS layer.

5. Analysis of the obtained results

This section will illustrate the final obtained results to help the stakeholder and the top managers to monitor all the running projects which were covered all over Jeddah Province. In this research the road project will be taken as example.

The following figures from (14 to 18) will show the must indicators to be monitored for stakeholders (key persons) such as

- ✓ Percentage of completion,
 - ✓ Progress Indicator,
 - ✓ Status Indicator,
 - ✓ Actual Cost, and
- Schedule Performance Index (SPI).

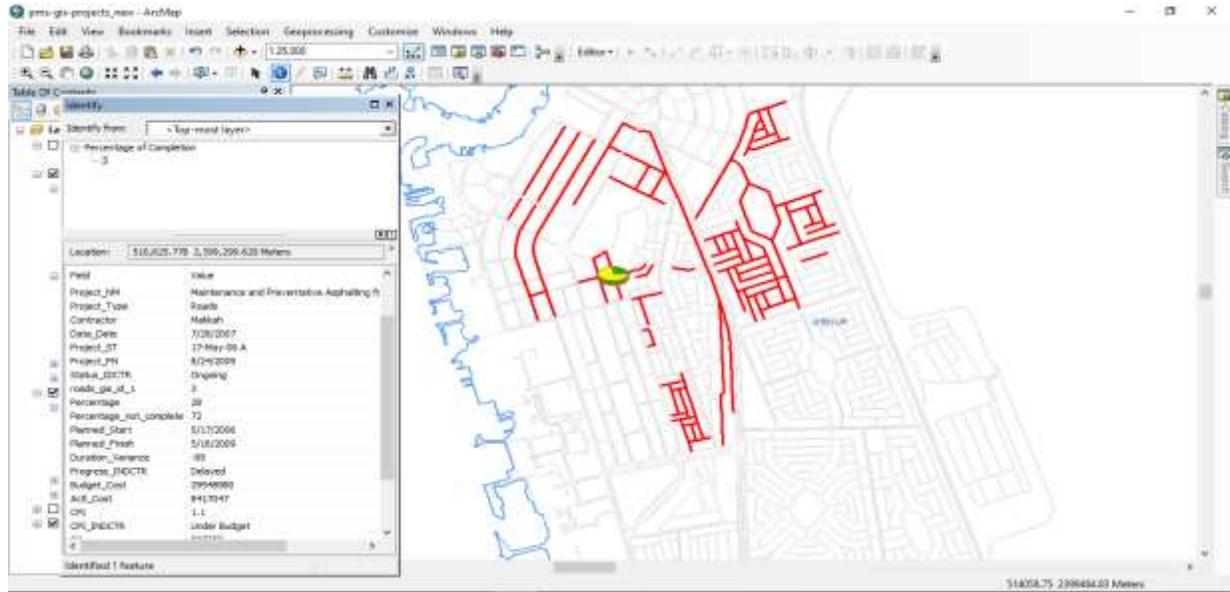


Figure 14: Percentage of completion for road project.

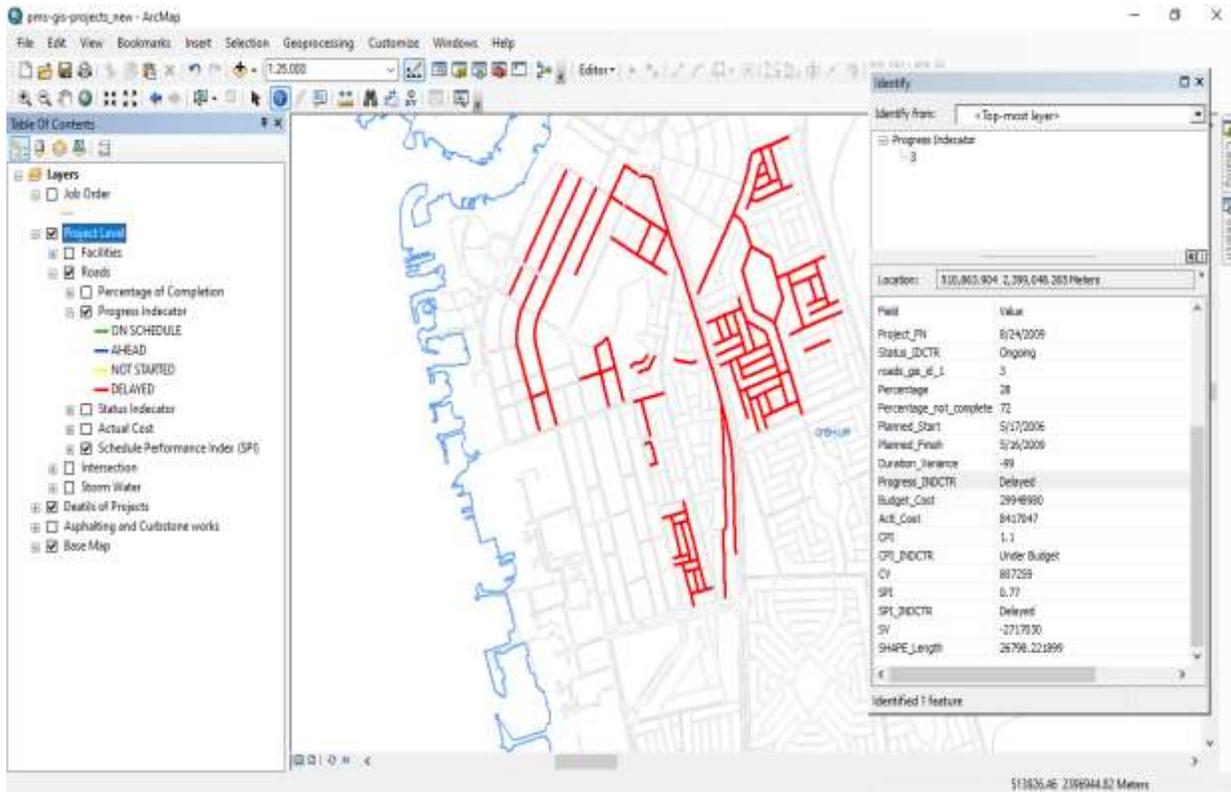


Figure 15: Progress Indicator for road project.

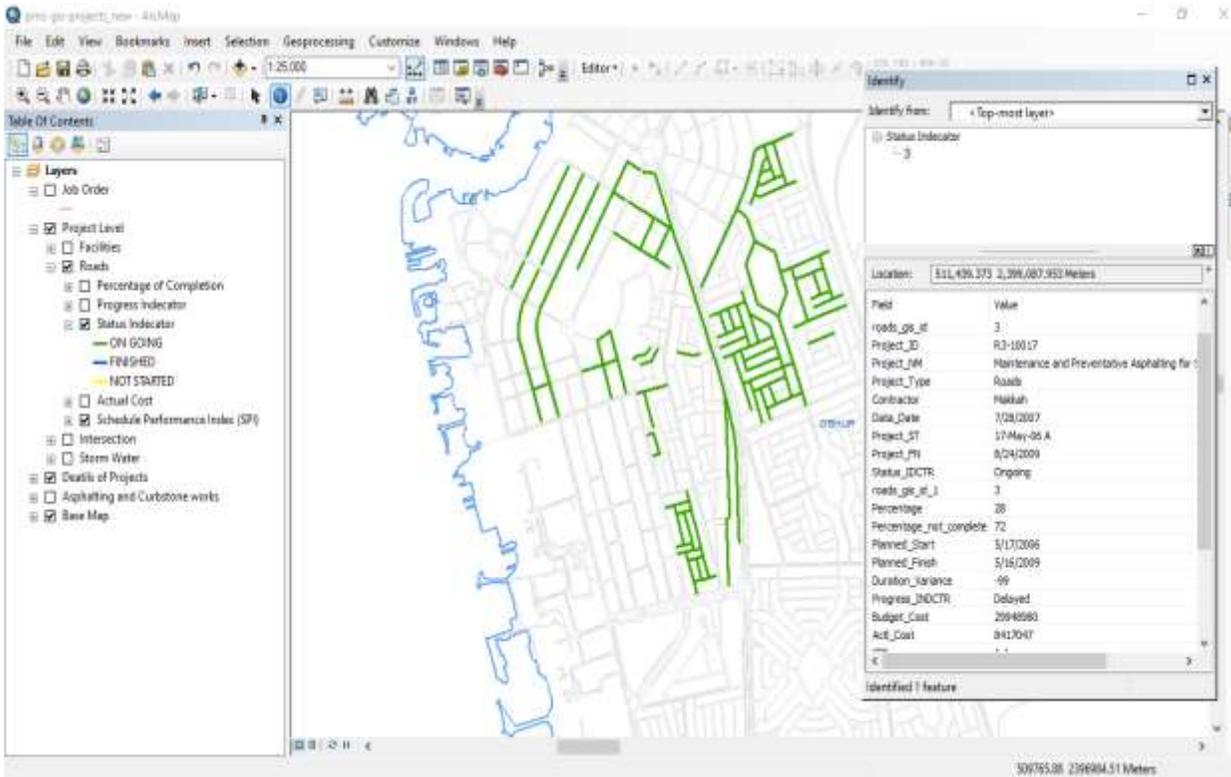


Figure 16: Status Indicator for road project.

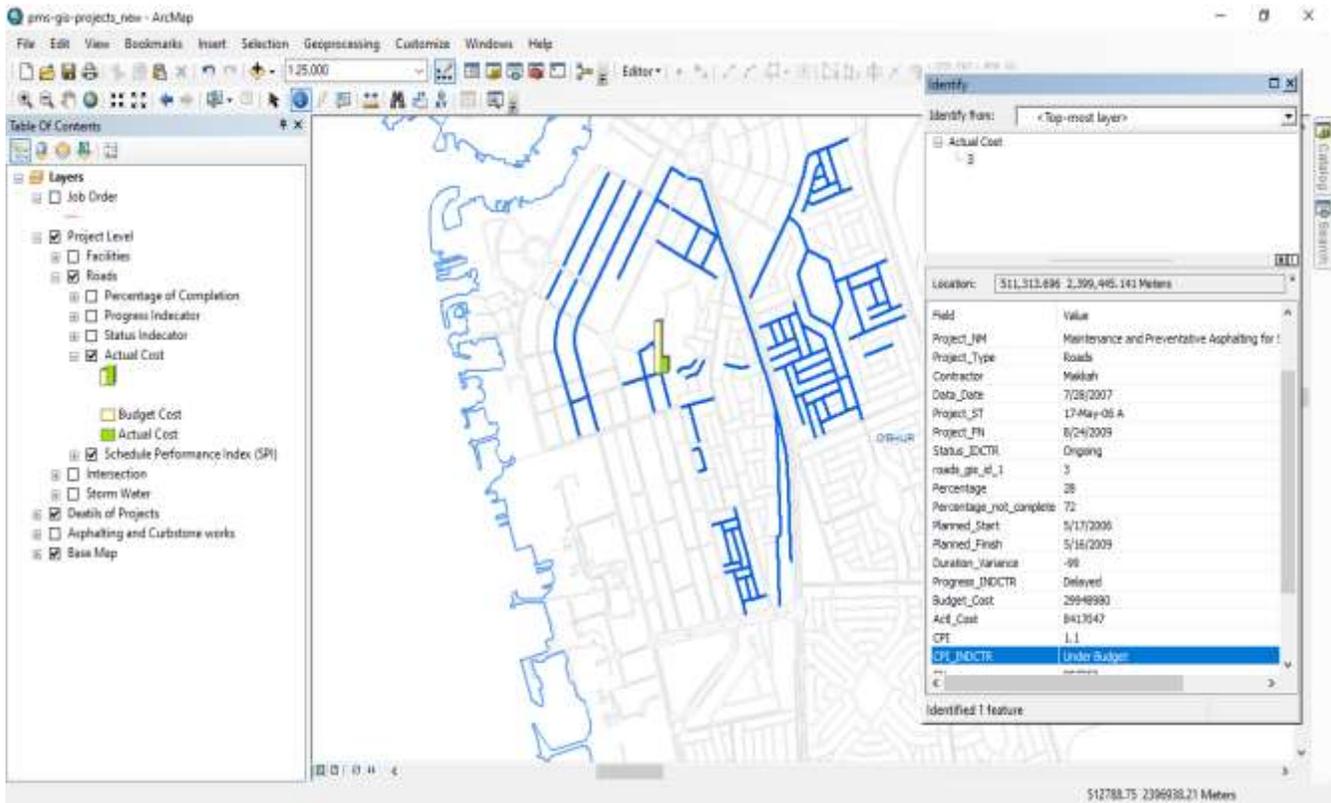


Figure 17: Actual Cost for road project.

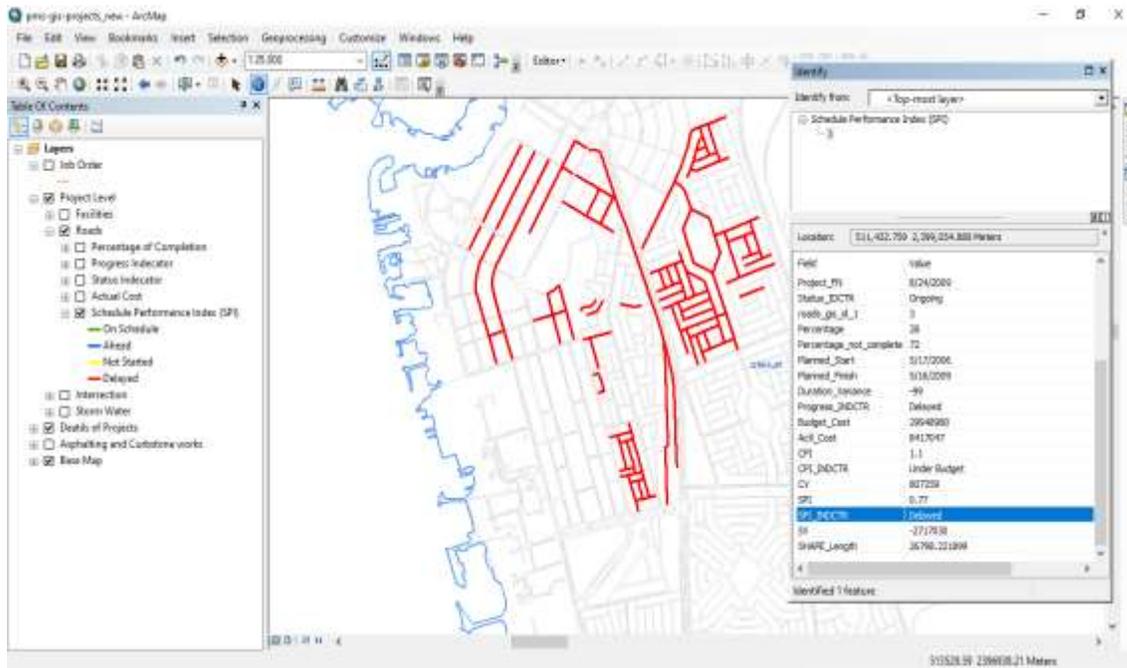


Figure 18: Schedule Performance Index (SPI) for road project.

6. CONCLUSINS

The current research has been based on developing an effective solution to work on linking engineering project management program data with geographic information systems and reviewing this on a representative on the map with various indicators to follow up the projects to support decision makers. The research found a solution to extract data from a project management program in an intermediate environment and then convert it to a geographical database. Accordingly, these data (indicators) have been linked to their geographical locations, and shown on the map. Also, the process of integrating GIS and PMS systems and adding them to the project location and many indicators of these projects which extracted from project management program. Finally, this integration process is helping to know the project location, identify the detailed work elements, activities, costs, project progress, and take advantage of the analysis and visualization capabilities of the GIS to support of decision-makers.

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Abbreviation and symbols

GIS	Geographic Information System
EPMS	Enterprise Project Management System
CPM	Critical Path Method
WBS	Work Break down Structure
MDB	Microsoft Access databases
SPI	Schedule Progress Index
CPI	Cost Progress Index