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MANAGEMENT OF MUNICIPAL PROJECTS USING GEOGRAPHIC INFORMATION SYSTEMS GIS

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Master's Thesis

Supervisor

Prof. Dr. Tuncer CELIK

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Nagham AL-SURAIFI

Signature

DEDICATION

To my supervisor, Prof. Dr. Tuncer.CELIK, I offer him my sincere gratitude, appreciation and prayers for health and long life because he did not delay in guiding and directing me as he was very credited with accomplishing this work.

I do not forget to thank the co-adviser (Dr. Qasim Al-Omari), who continued to follow and guide me despite his work and responsibilities at the University of Dhi Qar.

Then I dedicate the result of my work and effort to my mother and father who helped me with all their might in achieving my dream of obtaining a master's degree.

Then I do not forget to thank my brothers and sisters who were and still are my strength and to all the friends and loved ones who helped and influenced the completion of this work.

ABSTRACT

MANAGEMENT OF MUNICIPAL PROJECTS USING GEOGRAPHIC INFORMATION SYSTEMS GIS

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The phenomenon of lack of service provision has become one of the most important problems that Iraq is currently suffering from, especially municipal services and infrastructure services, which negatively affected the lives of citizens, and it was necessary to find ways to manage these projects based on real databases. This study aims to prepare an advanced administrative system via the Internet that allows the management of municipal projects while working on the establishment of a central data bank containing a set of specialized maps that represent the state of infrastructure services in the city of Al-Rifai in Iraq.

Geographical studies benefit today from the developments achieved by the human mind in the field of technology and information, as they have contributed to enriching it with more advanced methods in preparing and representing maps, the most important of which is the technology of geographic information systems. To solve many of the ordeals of those interested in this field.

In order to keep pace with the progress and to have the largest number of maps available online, (ArcGIS Online) was used. It is an online system that allows storing geographical data, creating workgroups, assigning certain permissions to group members, allowing the creation of private or public groups, and providing seamless access to data. And in order to communicate between all members of the project simultaneously, the Collector program was used, which is one of the methods of fieldwork that determines the quality of the collected data and the value of the results. Thus, it was considered a new method of management as it provides decision-makers with detailed data that can be quickly referenced and represented spatially, and this helps to make the appropriate decision, and it also allows access to accurate and clear information about the volume of services provided and the future need for them, which helps in preparing clear plans with Determining priorities for the implementation of service projects and determining the areas that should be given importance in implementation before other areas, as well as the possibility of setting budgets for the costs of these projects.

Keywords: Project Management, Infrastructure Services, GIS, RII, WASPAS.

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ABBREVIATIONS

BIM	:	Building Information Modelling
GIS	:	Geographic Information System
WASPAS	:	Weighted Aggregated Sum Product Assessment
RII	:	RELATIVE IMPORTANT INDEX

1. INTRODUCTION

Infrastructure services are the basis of urban processes and are essential for the birth and growth of cities. Any development in every country in the world that is achieved based on the viability of infrastructure and any failure or deficit of service may cause the city to become paralyzed or not able to function properly. Therefore, the infrastructure of any country is the first step that must be successfully overcome to reach the top of progress and development.

As infrastructure assets age and deteriorate, municipalities face growing problems, which are exacerbated by limited infrastructure renewal funds These difficulties have resulted in enormous pressures on municipalities to enhance the efficiency with which they manage their resources Infrastructure inventory may be increased by implementing more efficient and sustainable practices. Infrastructure has traditionally been associated with the state as the first sponsor to provide services to its citizens through investment in public spending that is financed through federal budgets in most developing countries. This is due to the fact that these projects require large sums of money that the private sector may not be able to access or finance alone on the one hand, and the lack of return on investment on the other.

Infrastructure is becoming more complicated as time goes on. Management techniques led to the creation of a variety of different areas of expertise. Among and across municipal organizations, knowledge, skills, and duties Departments such as water, sewage, and road management are examples of this. It was as a consequence of this that a condition of process fragmentation was established, as a result, tremendous inefficiency has developed, especially as a result of the due to the massive amount of complicated information that must be produced and traded, as well as the difficulty in streamlining and organizing. These processes are dependent on one another. Municipalities have made significant progress during the previous two decades. significant efforts have been made in the implementation of software solutions to solve the rising complexity of the procedures involved in infrastructure management.

Iraq is considered one of the first countries that took an interest in infrastructure projects since the eighties, but Iraq suffered due to the war and the economic blockade imposed several years ago, and the deterioration of the security, economic and political conditions Significant decline in the performance of state-owned enterprises (whether industrial or service providers) due to the systematic destruction and looting that destroyed the majority of these vital infrastructures. Instead, the problem was viewed in this light as it included infrastructure facilities, as well as to obsolescence of devices and equipment used in these facilities, as well as improper use of those facilities by their users, especially in the case of highways and bridges. Thus, we can see That despite the increase in world oil prices and Iraq's access to large reserves of foreign exchange, the country has inherited a heavy legacy in this field. However, we can also see a lack of insight by economic planning professionals, as the facilities are in poor condition. It is clear that the infrastructure has not received much attention and, if it exists, most of the financial allocations have been compromised by corruption in failed or bogus government contracts, which has resulted in a huge challenge in the field of infrastructure, especially when it comes to it. To rehabilitate and maintain or establish new projects in the fields of electric power generation, roads, and water supply. In order to keep pace with technological developments in the twenty-first century, water, sanitation, communications, and ports must be modernized.

This left Iraq struggling to find solutions that would help revamp its crumbling infrastructure, an area that experts say will help alleviate one of the country's major shortcomings in managing the cumulative economic crises that have built up since the United States invaded the country nearly two decades ago.

It was necessary to establish a project management mechanism on the basis of real databases, which should include both completed projects and ongoing projects that will help in planning future projects. Although many of these projects have been completed, most of them have not reached the required level. Decision-making in municipal infrastructure management is essentially an integrated process that requires the integration of a wide range of data, procedures, and software systems to be effective[1]. So, tools had to be adopted to help manage those projects through integrated and real-world databases that could link spatial data to metadata. This is a geographic information systems GIS.

These allow for a high potential for spatial data utilization in addition to metadata in the project management process. The Geographic Information System (GIS) is the fundamental data system for infrastructure development and construction. It allows engineers to exchange geographic data without transferring data files of diverse formats, versions, and content. Geographic Information System (GIS) technology is quickly being examined for application in numerous infrastructure projects [2].

Using GIS to enhance the quality of planning functions and gain insight into the structure of a successful GIS deployment, by examining and drawing insights from prior case implementations of related technologies [3]. The key conclusion is the need of a strong education in project management, as well as the organization of a large amount of training, in order to develop GIS professionals with managerial abilities[4].

Dr. Roger Tomlinson, a Canadian scholar from the 1960s, was the first to propose and execute GIS. A geographic information system (GIS) is a computerized hardware-software system that collects, stores, manages, computes, analyzes, and displays information on geographically dispersed characteristics and occurrences[5]. It has been extensively used to depict and study a broad range of geographical phenomena and processes, as well as to resolve planning, decision-making, and administrative challenges involving geographic landscapes, and it continues to be used today[5].

After many decades of development, geographic information systems (GIS) have matured into a mature and autonomous scientific subject that is widely used in the earth sciences[5][6][7], environment sciences[8], computer sciences[9][10], life sciences[11], medicine & public health[12][13], landscape ecology[14].

1.1 THE STUDY PROBLEM

Wars, siege, and corruption have all played a role in the deterioration of infrastructure services, as well as the reduction in government financial allocations and the lack of a strategic vision for some of those in charge of developing and planning future projects. As a result, Iraq is facing a shortage of municipal services, which includes extending sewage networks, potable water networks, and paving streets, as well as Networking rainwater drainage networks.

Municipalities are suffering significant levels of inefficiency and financial strain as a result of their old infrastructure that is underperforming[15].

Despite the implementation of many of these projects, most of them do not live up to the required level, which makes the benefit from them relatively little, either because of reworking them more than once to overcome errors or because of addressing implementation problems that were not considered the priorities of implementation such as laying sewage and water networks Then the roads. Increasing challenges are being faced by municipalities as infrastructure assets age and deteriorate, as budgets for infrastructure renewal fall short, as renewal deficits grow in size, as demand levels rise, and as new requirements to comply with stricter environmental and accounting regulations come into effect[1][16][17][18]. This has put significant pressure on governments to enhance the efficacy of their infrastructure inventory management by implementing more efficient, long-term and proactive asset management techniques," says the report.[1]. The use of software solutions to deal with the rising complexity of infrastructure management processes has been a significant expenditure for municipalities over the past two decades.[1][19][20]. While studying problems connected to infrastructure projects is important, it should be highlighted that very little attention is devoted to the products of these initiatives, despite their importance.[21].

Hence, we can summarize the research problem as follows:

i. The absence or weakness in specifying the effective factors that can evaluate the success and fail in projects. this problem lead to weakness in monitoring and control the projects.

ii. the absence of methods or tools to determine the importance of the success and failure factors which considered as crucial to the successful completion of infrastructure projects.

iii. the absence of methods or tools to specify or implement a decision matrix for alternatives or choices in order to develop alongside appropriate assessment criteria.

1.2 THE OBJECTIVES OF THE STUDY

The research attempts to achieve several goals, as explained as follows: -

a) to specify the success and fail parameters of road construction projects.
b) to apply a significant method to determine the importance of the succeed and failure factors.
c) to specify an effective method to make the suitable decision for alternatives or choices.

1.3 THE IMPORTANCE OF THE STUDY

The importance of research is embodied in the exploitation of modern technology represented by geographic information systems for the purpose of managing service projects since these projects directly affect the daily lives of citizens. In order to emphasize the notion of "smartness" during the planning stage, a Geographical Information System (GIS) is utilized to plan and anticipate the utility infrastructure requirements for increasing and rising communities[22]. As the smart city takes shape, the idea of smart development is being incorporated into construction management in order to encourage smart development in construction while also increasing the efficiency of construction management.[23].

As a new management method, it provides decision-makers with detailed data that can be quickly referenced and represented spatially, and this helps to make the appropriate decision based on that data. Priorities for the implementation of service projects and determining which areas need to be given greater importance in implementation before other areas, as well as the possibility of setting estimated budgets for the costs of these projects.

Financing is the heart of any project, whether it's an industrial or service one. It helps to increase production capacity, build new projects, or improve other existing ones, if the funds are used properly and effectively, away from corruption and nepotism. The drop in investment funds due to the drop in international oil prices has led to a lot of projects being put on hold, or failing, because they don't have enough money.

In the debate over the best approach to plan, there are many different points of view, but integration and usage of geographic information systems (GIS) in an organization is becoming more popular.[3].

In urban planning, geographic information systems (GIS) are only one of the structured computer-based information systems that are capable of integrating data from multiple sources to offer the knowledge essential for successful decision-making[24]. The design, development, and execution of a GIS work are all time-consuming processes that should not be underestimated in their complexity. The project-based approach, appropriate preparation, and strong leadership are required[25].

The process of studying, classifying, and analyzing infrastructure services requires huge amounts of information and data, whether it is about jobs within the city and its characteristics, or about the population, various economic activities, environmental aspects, and land use, and this is what GIS provides as being GIS stores manage, analyzes, manipulates, and displays geographical data [26]. GIS is a powerful tool for the treatment, production, and application of spatial information in municipal infrastructure projects management and decision-support systems based on GIS. Geographic information systems (GIS) may be used to organize, analyze, and evaluate all kinds of data, from the smallest to the largest scales [27][28].

1.4 THE LIMITS OF THE STUDY

It represents the spatial and temporal boundaries of the study area, where the spatial boundaries were represented in our study in the city of Al-Rifai, which is one of the Iraqi cities located in southern Iraq and affiliated to Dhi Qar Governorate. The city of Al-Rifai was established in 1880. Al-Rifai District is the largest district in Dhi Qar Governorate and comes in area after the district of Nasiriyah. There is a project for the future to make Al-Rifai District the nineteenth governorate in Iraq.

The city is located in the northern part of Dhi Qar Governorate on the highway linking the cities of Nasiriyah and Kut. It is 85 km away from the governorate center and 95 km away from the city of Kut. 306 km from Baghdad, the capital of Iraq.

Al-Rifai city includes several administrative units (Qal'at Sukkar, Al-Fajr, Al-Nasr). It is bordered on the north by Sukkar Castle, 17 km away from it, on the east by Maysan Governorate, on the south by Al-Nasr, 22 km away, and on the west by the governorates of Qadisiyah and Muthanna.

Al-Rifai city is located in the center of five governorates, distributed in a star-like manner, at close distances from the city center. The city of Al-Kut is located in the center of Wasit Governorate, 95 km to the north of the city. In the eastern direction of the city, at a distance of 115 km.

The city of Nasiriyah, the center of Dhi Qar governorate, is located at a distance of 85 km south of the city. As for the city of Samawah, it is 88 km away in the western direction of the city, which has earned it a good strategic location because it is a link between its administrative units and the centers of the governorates that surround it from directions It is different and represents the center of the road node connecting these areas, which made it a center for the gathering of residents and services that formed the nucleus of the first city in its first phase.

As the city's area was (728 hectares) until 2014, the project of expanding the basic design of the city was implemented to cover the population's need for housing units until 2038, when its total area became (2500 hectares) after adding (1772 hectares) and (12 residential areas) amounting to Its population is about 155 thousand people.

This city was chosen for the application of our research, as it contains many implemented projects and projects in progress, and this city is divided by a river into two parts called the Garraf River. It also passes by a public road linking the southern and central governorates, in addition to the presence of a large university established in 2011 named after Sumer University (which includes several faculties, including the Faculty of Medicine, the Faculty of Law and the Faculty of Agriculture).

The College of Basic Education, the College of Science), and an oil field that has made the city's developments, notably road and infrastructure, as diverse as possible.

The city of Al-Rifai appears to be floating on a large block of oil, as was demonstrated by the exploratory teams of the seismic survey, which discovered huge amounts of crude oil under the surface of all the city's lands. And the Malaysian oil company (Petronas) extracted more than 100,000 barrels per day, and work is continuing to enhance the field in order to increase production to more than 230 thousand barrels per day within two years after the start of operation.

As a result, we felt the need to shed light on this city and find solutions to the lack of services available to its residents and about the lack of time represented by the study years, which are three years (2022, 2021, 2020) on the other hand, the data and information collected in the past were taken advantage of and harnessed for the purposes of the study.

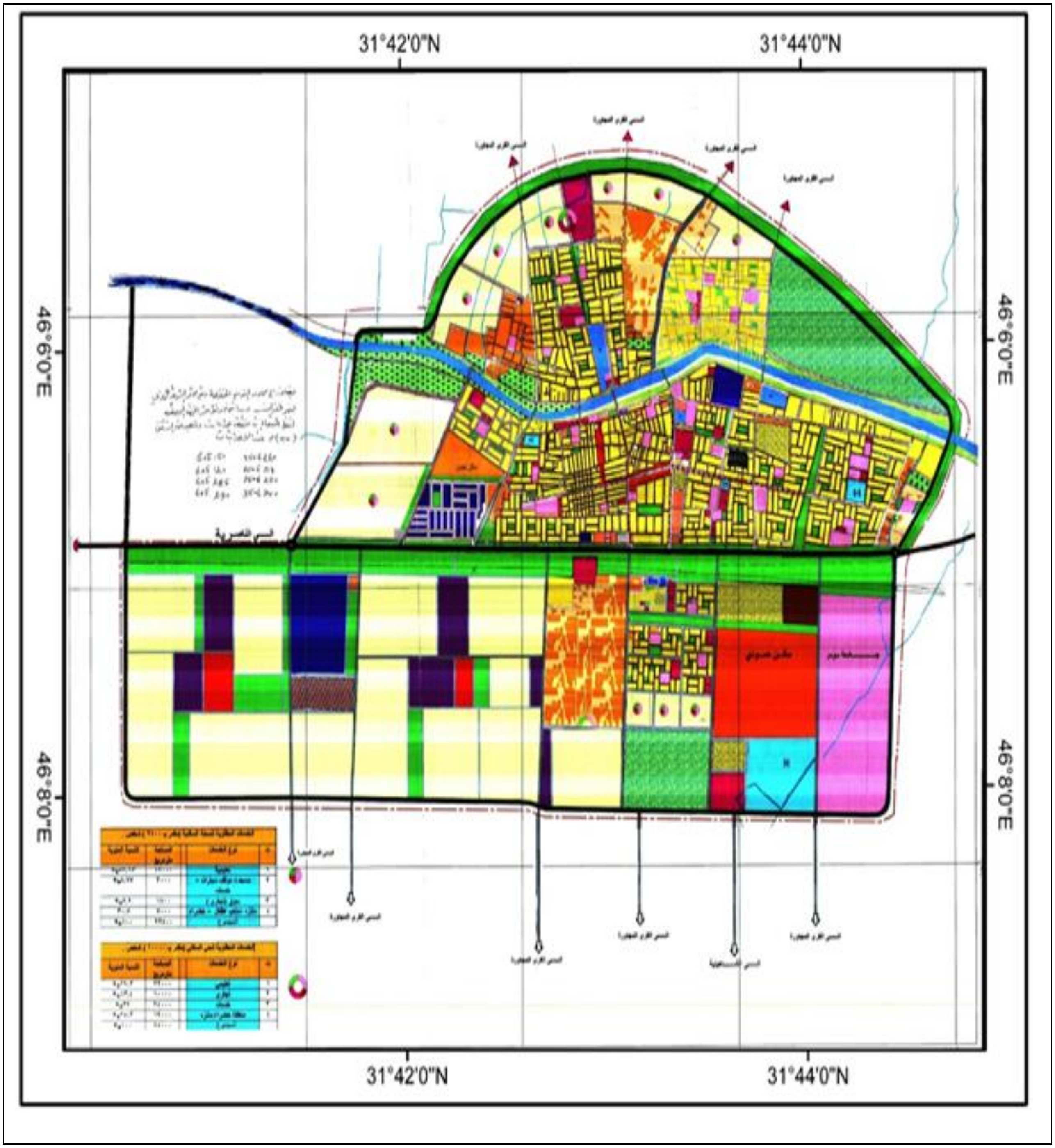


Figure 1.1: The Basic Design of Al-Rifai City

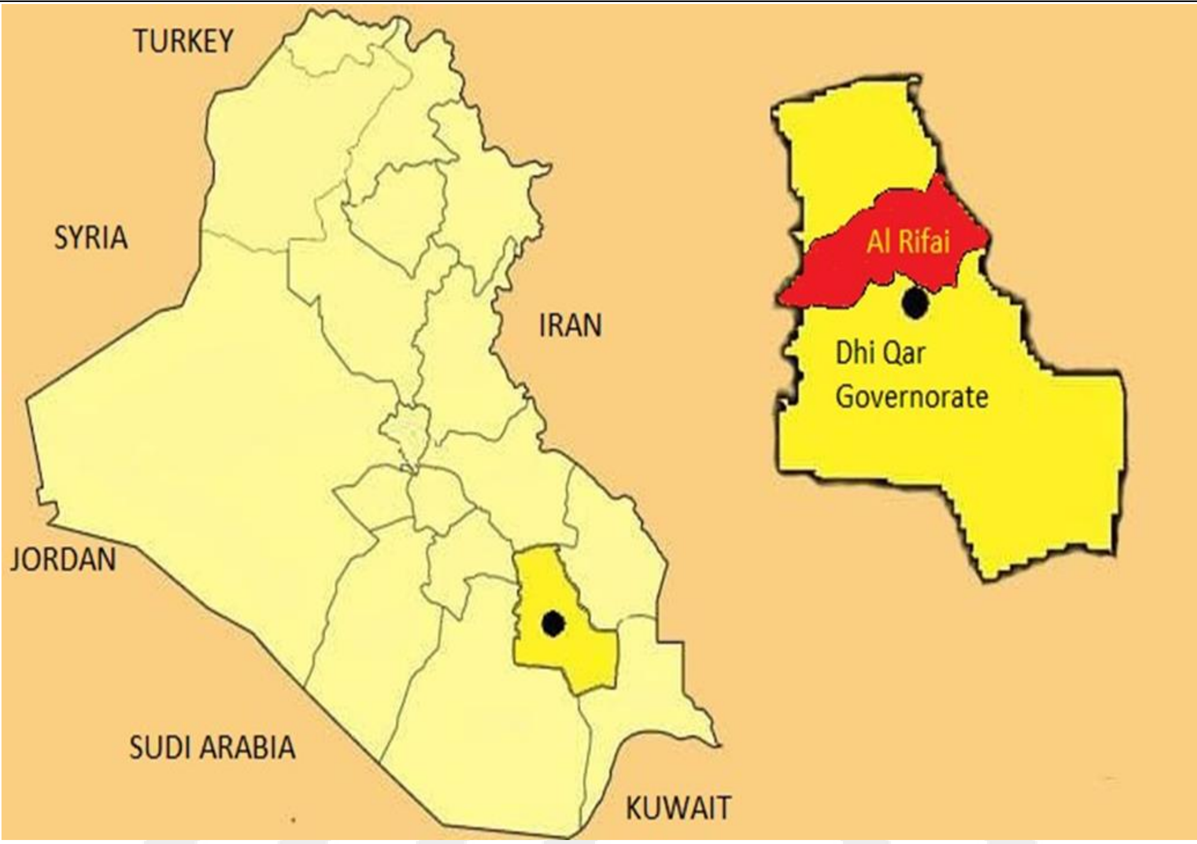


Figure 1.2: The Location of Al-Rifai City in Relation to the map of Dhi Qar Governorate

1.5 THE JUSTIFICATION FOR THE STUDY

The justifications for the study can be summarized as follows:

a) The operations of providing infrastructure services to urban residents are among the necessities that you are ready to pay attention to achieve integrated and balanced economic and social development and improve the quality of life. It will be difficult to plan and manage infrastructure projects in the new era of globalization and economic freedom [2]. Accordingly, this study came to shed light on this vital sector of population services.

b) The geographical position of the city as it contains a large university called Sumer University, which has several specializations, including the Faculty of Medicine and Pathological Analysis, the Faculty of Computer Science, Management, Economics, Agriculture, Law, and others, in addition to the presence of several oil fields and foreign companies, which makes it a commercial city that receives all nationalities.

1.6 ORGANIZE YOUR SEARCH

This research consists of five chapters, the first chapter includes the introduction, the research problem, its objectives, and its importance, in addition to the research justifications and the limits of the study.

The previous studies come in the second chapter, while the third chapter includes the research methodology. The fourth chapter contains the results and discussion, and the conclusions and sources come in the fifth chapter.

2. LITERATURE REVIEW

A) In the year 2020, the writers (Hatamleh RI et al) used GIS in the solid waste collection process, and it was conducted in (Al-Nuzha district) in Irbid city.

This project aims to conduct an experimental study to assess current collection techniques and create new ones that are based on geospatial data and may assist enhance the efficiency of collection processes while working with limited resources in the Great Irbid Municipality[29]. Where the author concluded that GIS (GIS). offers a solid foundation for truck route planning and is a very useful decision support system [29][30][31][32][33][34].

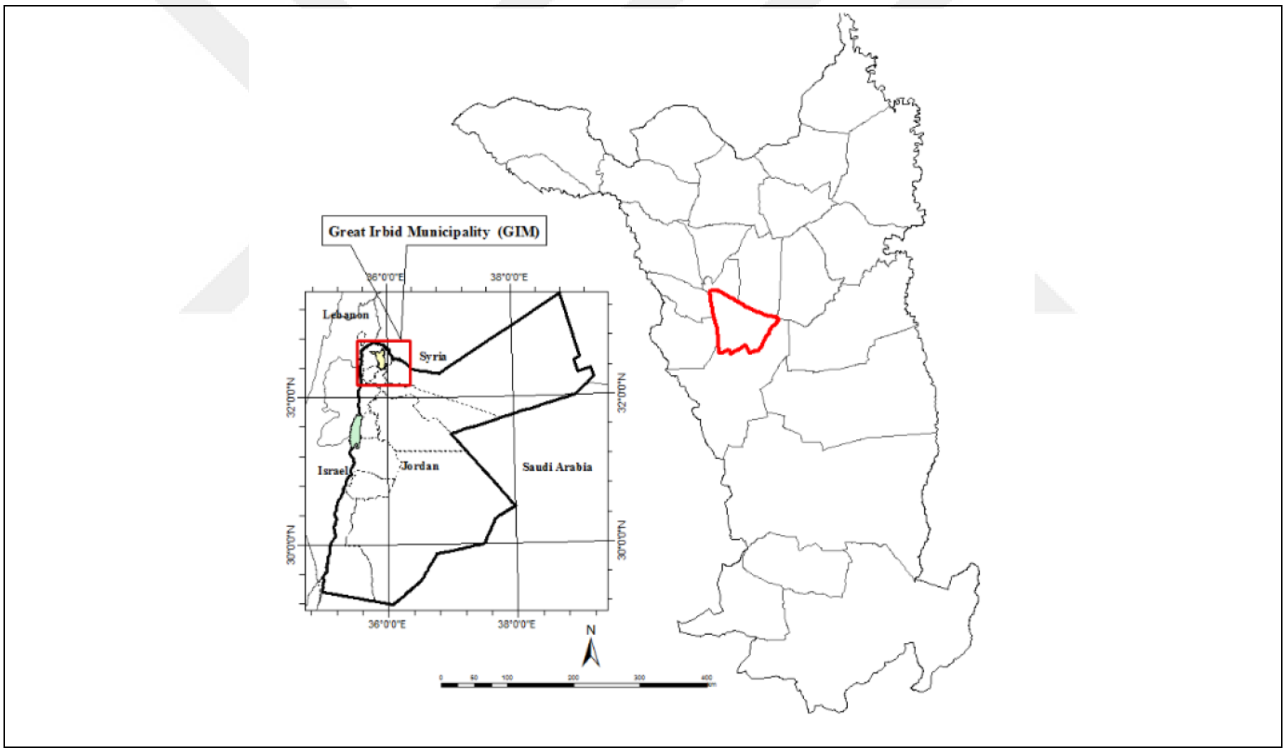


Figure 2.1: Study Area Al-Nuzha Northern Jordan [29]**.**

Where the areas were split into three regions: the eastern, western, and southern areas. The GIS team monitored the routes in each location in order to conduct an assessment. The findings are discussed in further detail in the following sections.

In the eastern part of the region, there were five routes. Each route has a beginning point and an ending point, with the latter perhaps serving as the starting point for the following route. Having conducted a two-day tracking procedure on each route, the conclusion was obvious: several abandon bins in the vicinity had been left unattended by the trucks, which indicated that they had not been unloaded Figure 2.2.

Figure 2.2: Location of Abandon Bins and Current Routes [29].

In addition to dropping garbage at the landfill and conducting maintenance and management duties, the truck left the area. 21081.7 meters is the total length of the subarea's points. For a few bins in the western area, the truck must go a long way.

The rate of waste buildup throughout the day was particularly high in the northern section of the western region, owing to a high level of residential and commercial activities that need more attention. In the southern area, two routes have been traced, one of which goes beyond the boundaries of the al-Nuzha region. As seen in Figure2.3, these routes forsake a substantial number of bins situated in the southern area's western and eastern regions.

Figure 2.3: Two Routes, One of Which Goes Beyond the Boundaries of the al-Nuzha region [29].

It is important to construct extra bins in the southern region since rubbish is piling up in mounds because there aren't enough bins. These stacks of materials were physically placed onto the vehicle.

When opposed to rush hour traffic, these hours are rather calm and peaceful. Therefore, the study was done using the shortest possible distances, with the assumption that cost reduction is not impacted by the time at which it is collected. As a result of this study's alternative route recommendations, garbage collection in the three subareas analyzed may be modified, controlled, and managed better. All the existing routes were used and altered to ensure that the collecting procedure reached all of the containers. This strategy also aimed to improve the system's efficiency by reducing the distance between consecutive stops.

In the region of Al-Nuzha, a comparison between the existing routes and the optimized ones , as shown in Table 2.1

Table 2.1: Comparison between Proposed and Current Routes

Area	Proposed Length (m)	Current length (m)	Difference (m)	Percent of abandoned bins
Eastern	21460.9	21081.7	379.2	26 %
Western	12861.2	20395.5	-7534.3	1%
Southern	15236.9	10962	4274.9	43%
Total	49559	52345.7	2880.2	25%

B) As the world's urbanization accelerates, cities must become smarter in order to keep up with the times. Because of the rapid increase in urbanization, new initiatives are required in order to deal with the problems of urban living, which include a rising population, high energy consumption, resource management, and other issues. As a result, governments all over the globe began developing strategies to make current and upcoming cities smarter and more sustainable in order to combat climate change [22][35]. So, by 2020, the authors (Mohamed Marzouk and Ahmed Othman) determined that increased growth necessitated the implementation of a cap-and-trade system to help utilities better manage their infrastructure requirements. He outlined a strategy for developing and executing projects that included BIM and GIS. Plan ahead for future infrastructure requirements based on the varying demands of various types of utility infrastructure in the early stages of a city's development, municipal planners and administrators benefit from a variety of methods to growth. When decisions are made at this level, they have a huge influence on the future. As a result, A city's future growth and overall performance are strongly influenced by the decisions made throughout these stages [22].

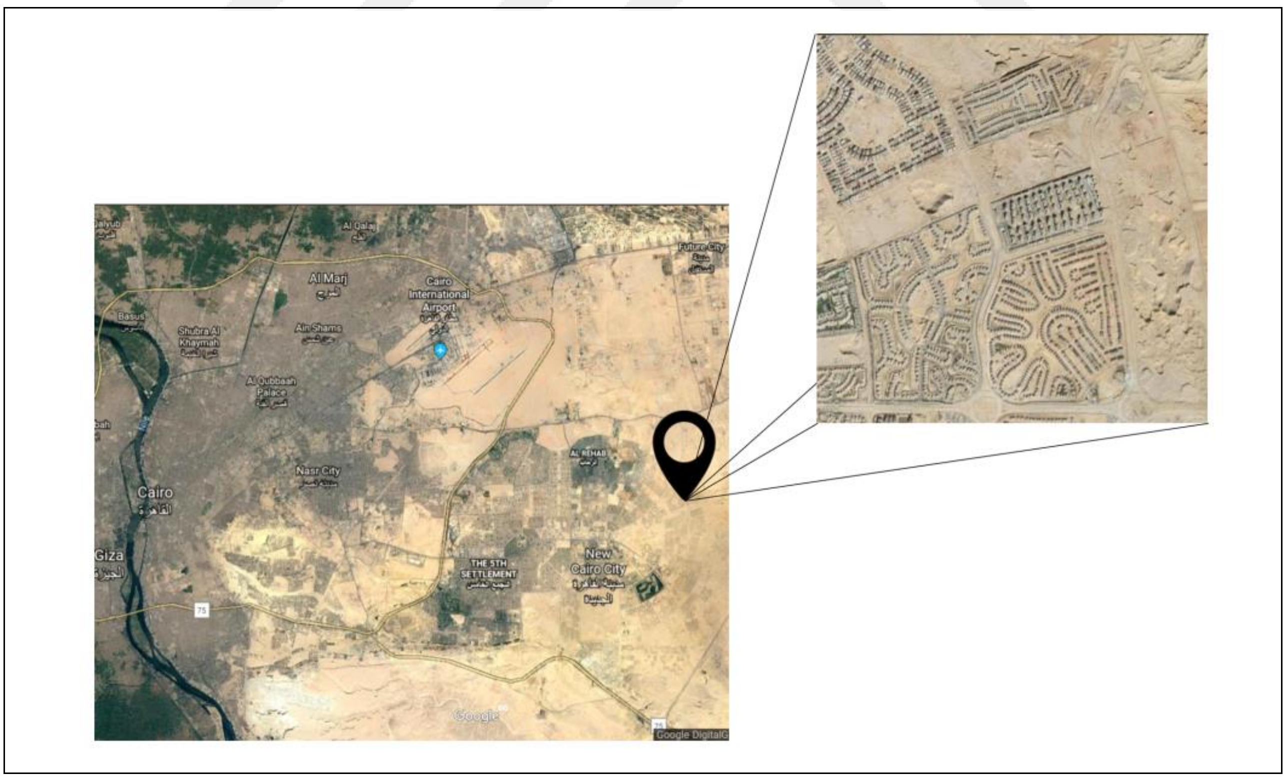


Figure 2.4: Study Area (New Cairo – Egypt) [22].

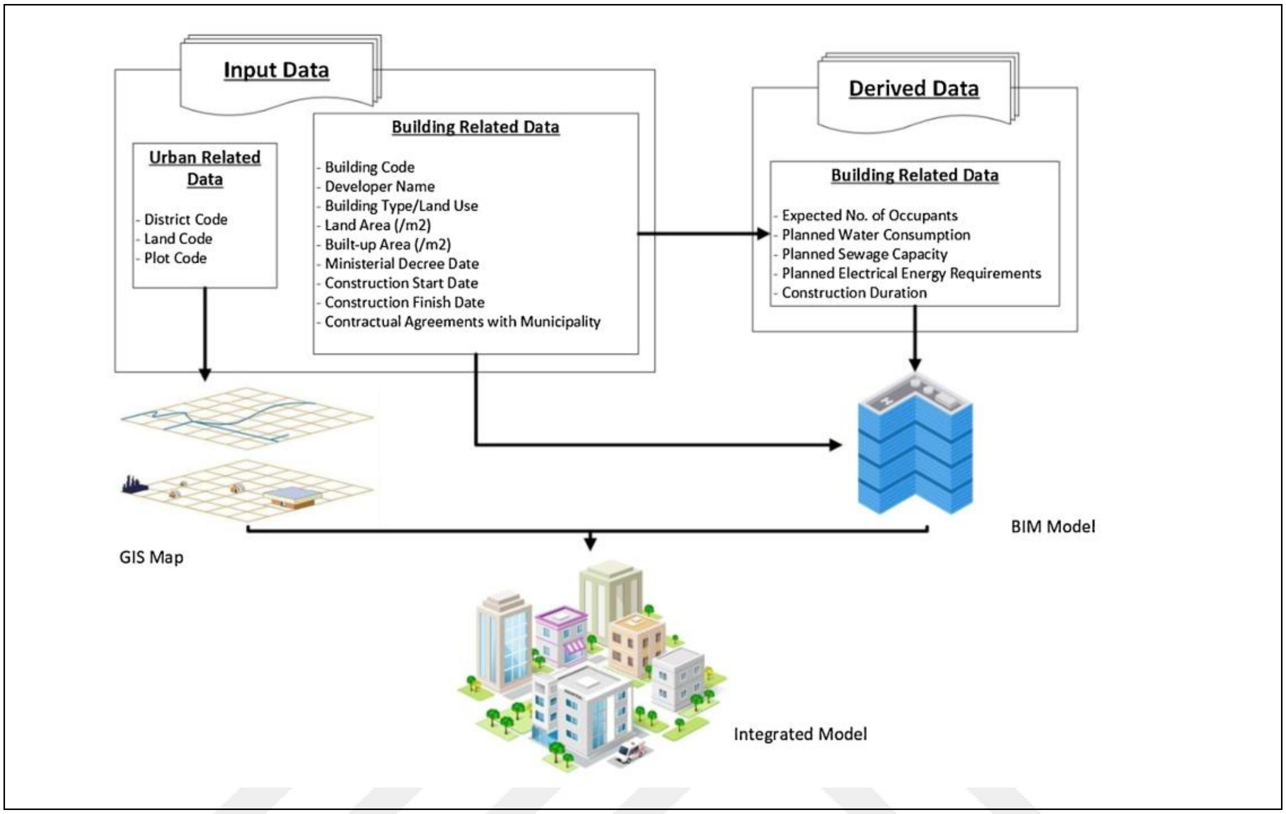


Figure 2.5: Database Developed to BIM and GIS [22].

Alterations to the city's land use or strategic objectives have the potential to significantly affect the need the city will have for these activities over the next several years. The suggested structure is utilized to assist in decision making on the requirements for utility infrastructure in order to achieve a more intelligent and sustainable city expansion. [36][22]

In the utility infrastructure area, which includes power, water, and drainage infrastructures, the proposed framework focuses largely In order to drive home the point, the total amount of electricity consumed by the model under examination includes both heating and cooling. The goal of this framework is to close the research gap that exists in the idea of Smart Cities. According to the literature, only a few Smart Cities efforts are focused on the early stages of city development. While the majority of Smart City programs and practices focus on city operations on a day-to-day basis, they overlook the stages of city planning and growth. To construct smart and sustainable cities and communities, city planners believe that a strong emphasis should be placed on this throughout the process. Those in development as well as cities in growth are affected by this phenomenon. Early consideration of inhabitants' infrastructure requirements may aid in the development of a prosperous community and the provision of many of the smart and sustainable city characteristics. On top of that, BIM has not yet realized its full potential in terms of its use at the municipal level. In order to model buildings, evaluate their performance, and simulate them, BIM is often used. However, only a few of studies have looked at how BIM may be used to its full potential at the municipal level.

For a smart city idea, BIM might provide the physical and geographical framework. Certainly, BIM cannot do this on its own, but rather via the integration of a wide range of data sources. [22][36] . When data on consumption, occupancy, land use and other factors are included into a city's model, it may improve the accuracy of predictions made by city planners, operators and managers about the city's performance, growth and future development. Construction and infrastructure projects are the primary focus of most BIM implementations. The use of BIM in city planning and development may help to foster a more sustainable environment.

C) Using GIS in 2020, author Vijay Kr Bansal examined the spatial features of construction planning and came to the conclusion that the evaluation and inspection of project-specific data available in a number of forms is an essential component of construction planning. The abundance of data makes it tough to employ throughout the planning process. Because of this, the structured planning database's GIS capabilities have been assessed in order to ensure that information stored and used promptly to support the strategic planning.

GIS capabilities Refinement and retrieval of data from the planning database can be done through visual and non-visual querying. Graphic and non-graphic approaches may be used to aid in building planning in GIS contexts. By keeping an eye on the surrounding environment, GIS helps planners and specialists to analyze the environmental effect of a building design. As a consequence, the execution of a plan and its participation in the surrounding environment are both understood in the GIS-based construction planning process. Using Geographic Information Systems (GIS), it is possible that building design will undergo radical changes that are currently unimaginable [37]. At this point in the strategic planning, a building planner needs to imagine the site amenities and proper workspace while bearing in view the constraints of space and time [37][38].

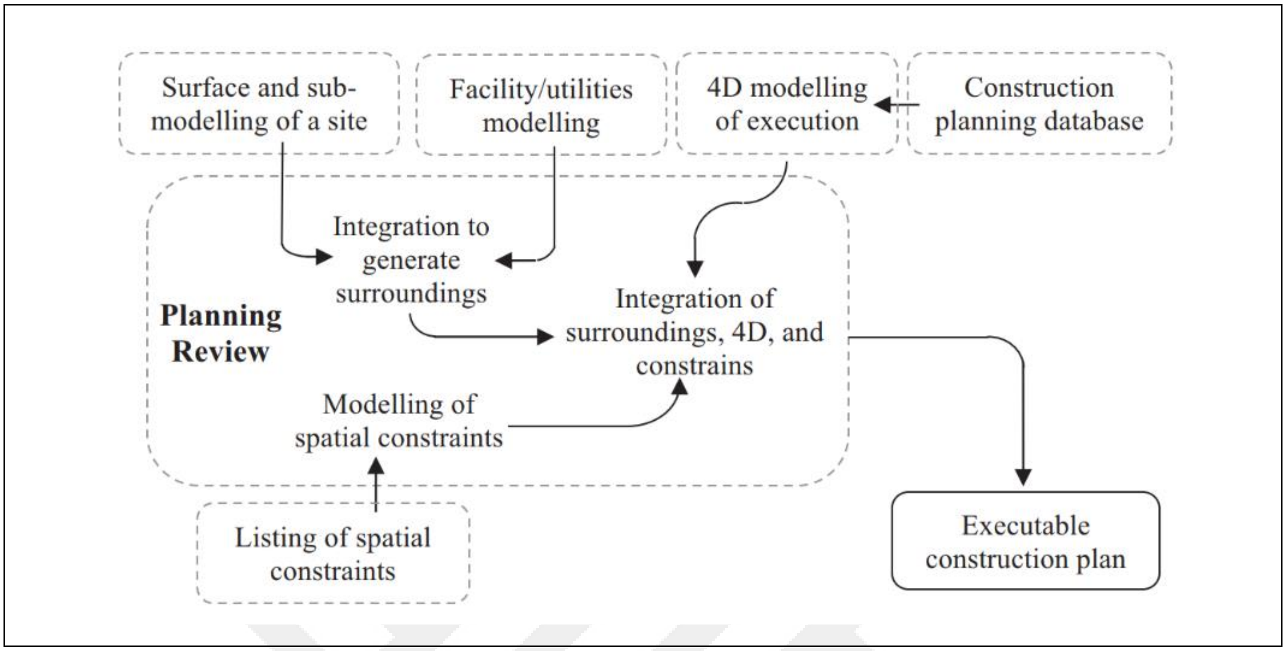


Figure 2.6: Methodology for Doing Research to Aid in the Planning of Building Projects [37].

When developing a construction plan, using Geographic Information Systems (GIS) may assist planners in making more precise planning decisions. To generate an executable construction plan, it may be desirable to have a 3-dimensional model of the structure, as well as topography and adjacent facilities, a 4D implementation sequences, database management, and geographic analytic capabilities all integrated into a single GIS platform.

It is possible to model geographical restrictions on construction sites using GIS. Geographic Information Systems (GIS) are presently underrepresented in the literature when it comes to geospatial analysis that aids in the planning of construction projects. This study's goal was to see whether geospatial analysis using Geographic Information Systems (GIS) might help builders avoid making this mistake. The present study focuses mostly on 2D analytical skills since the database management methods used in Geographic Information Systems (GIS) do not allow 3D databases. As a consequence, the GIS industry has an urgent need for 3D spatial analytic tools that are easy to use. [39][37].

While GIS primarily provides two-dimensional topological analysis, research may also be pushed on improve three-dimensional topological analysis capabilities. This study used a geographic information system (GIS) for construction scheduling, although the GIS scheduler is not equivalent to the current scheduling software [40][37].

As a result, new functionality, such as those found in scheduling software, are required. Long-term solutions begin with recognizing the difference between designing a building in isolation from its surroundings and designing a building connected to its surroundings.

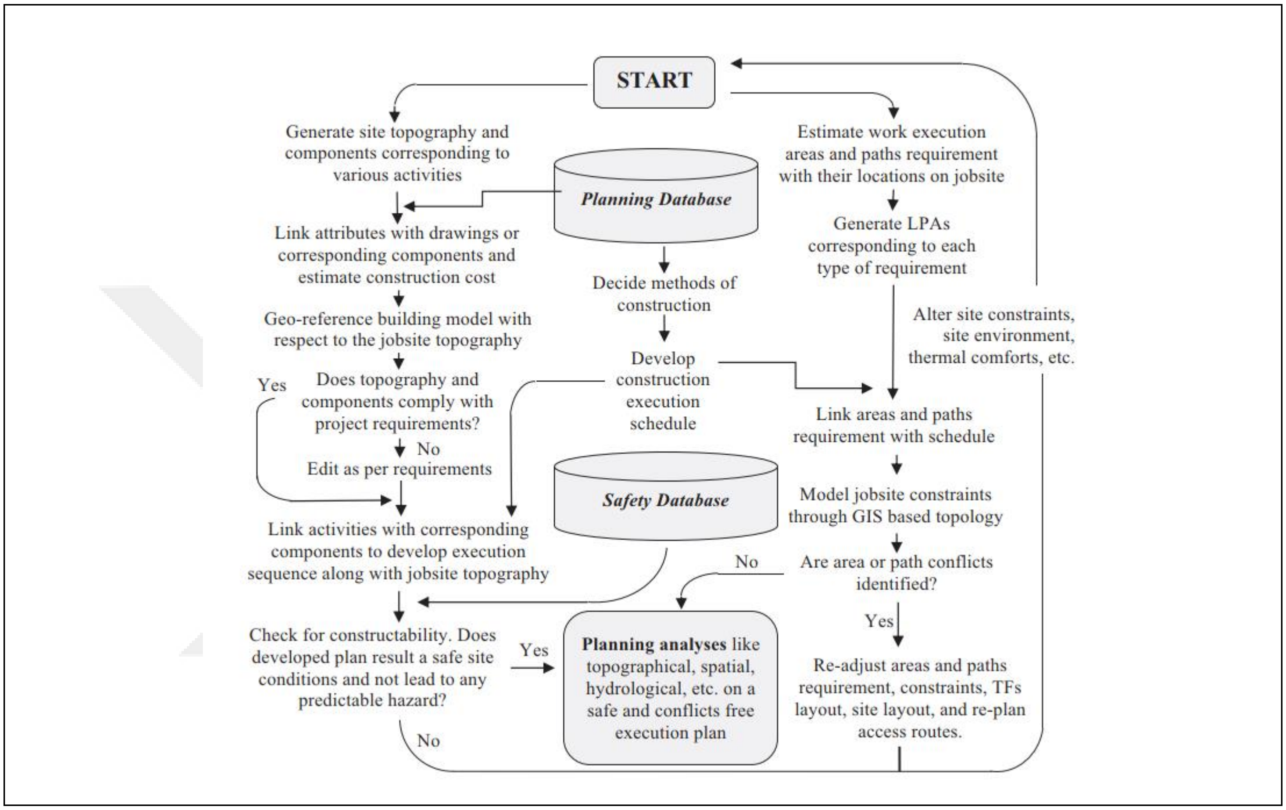


Figure 2.7: The developed Geographic Information System-based Construction Planning Process [37].

D) 2018, the authors (Wan nor Fa'aizah Wan Abdul Basir et al.) created a common model for documenting and storing all details about structure in a unified system and sharing it between the architect, contractor, and construction manager, as well as the project lifecycle details, using a set of shapes that form a structural model that includes all the data.

Geographic Information Systems (GIS) can also combine data sets to produce and analyse relevant data and translate existing digital data into a format that meets the user's demands. GIS and BIM, in this opinion, can be used in conjunction to give a more methodical construction platform for projects [41]. Because of the wide range of individual features and capabilities available, GIS and BIM have emerged as formidable platforms in the construction sector. However, each platform has its own set of flaws. In order to address the issues outlined above, GIS and BIM must be integrated. 3D analysis and geospatial queries like evaluating distances, the most economical path, and the best place for a specific situation are some examples of geo-referenced data [42][41].

When it comes to this kind of analysis, building information modeling can't perform it, but it does have a detailed list of entity descriptive data for the structure and a 3d that Geographic Information Systems don't have [43][41]. Aside from interoperability issues, GIS and BIM differences necessitate extra investigation. Numerous incompatibilities exist between them, including geographic scale, degree of resolution, geometry depiction methodologies, collection and storage ways, as well as semantics incompatibilities [41][43][44][45].

Diverse ways have been used to address this problem, and various outcomes have been achieved [46] According to the authors, there are 3types distinct types of integration of Bim models:

a) Application-Level:

At the software level, integration procedures are frequently based on reconfiguration or rebuilding, in which the existing Geographic information system or Building information modeling tools are either updated via patch management or completely overhauled to incorporate one maybe more new capability. This strategy is frequently both costly as well as inflexible[44]. The works listed below are examples of works that made use of the application-level technique. A Building information modeling integrated model was created to improve the show up of the building logistics management. In this project, a visual module for Building information modeling has been created in order to show the accessibility of building supplies. That application gives direct doors estimates from a variety of sources found around the Internet. Spatial analysis techniques such as analysis software and feature evaluation were used to determine the most cost-effective supply chain logistics solution [42].

For the purposes of this research, an in-depth look of the study government's current composition as well as its job division was undertaken, along with a discussion of the multilayered study method and the demonstration instances [47].

b) Process Level

As an example of a process-level integration method for BIM and GIS integration, the OWS-4 [48] One example is a project that makes use of Provider Architecture to enable the involvement of the Building information model and GIS software in jobs that require the abilities of both systems while maintaining both systems' live and unique state. Rather than concentrating on the application level, this method enables greater flexibility. However, the issues of data integration in this manner have not been fully handled at the basic data level in order to guarantee interoperability across various systems as of yet.

The authors (2015) proposed a system design for merging BIM data successfully into a geographic information scheme building services systems. This proposed program would segregate geometrical data from data relevant to critical qualities associated with the geometry. It is possible to extract and transform the properties required for each use-case perspective from Building information modeling to GIS data using the Digest, Convert, (ETL) idea, that selects uniform information from a database and loads it into the warehouse by changing raw data further into suitable form or formation [49].

in (2016) Ebrahim et al. investigated the potential applications of search facility technologies to enable search facility compatibility between current GIS and BIM. As indicated in the literature, the connection setup technique proposed in this research is based on interoperable data formats and standards, as well as querying of heterogeneous information sources.

While data aggregation between BIM and GIS continues to be a substantial problem, so does information exchange and data interchange from these two zones. While artificial or structural approaches do not completely facilitate the flow of meaning and geometrical data from Building information modeling to Geographic information system or vice - versa, they do provide some advantages [50].

c) Data Level:

At the level of data integration, a number of different technologies have been utilized in order to combine BIM and GIS. Using an Application (API) on both ends of the data transmission process, such as ESRI ArcSDE, it is possible to share data between the Building Information Modeling

(BIM) program and the Geographic Information System (GIS). Tools such as FME and the one that was just discussed have the capability to convert in a matter of seconds between various formats of geographic information systems and building information modeling. One of the most significant flaws of this method is that it requires constant geometric translation, might result in the loss of semantics, and ignores relatively insignificant aspects such as utilities and linkages.

According to CityGML, however, moving data between systems requires a simultaneous translation of the geometrical and linguistic information. Due to the conceptual misalignment between the two systems, it is difficult to edit one dataset without simultaneously modifying the other, and vice versa.

E) In 2016, the author (SeongJin Kim and Hyun Ok) discusses the use of Geographic Information Systems to facilitate the online exchange of various papers associated with projects, contracts, and operations between federal agencies and construction firms that implement street and rivers. Workers are anticipated to be presented with the suggested plan. By merging bim models and spatial information motion, it is possible to visualize construction status, including cost, and to decrease on-site man-hours and work by quality education functionality to everyone. This study is planned to give users visualization of the construction state as well as effective in saving; it will also facilitate information search and choice by analyzing difficult and objective data[51].

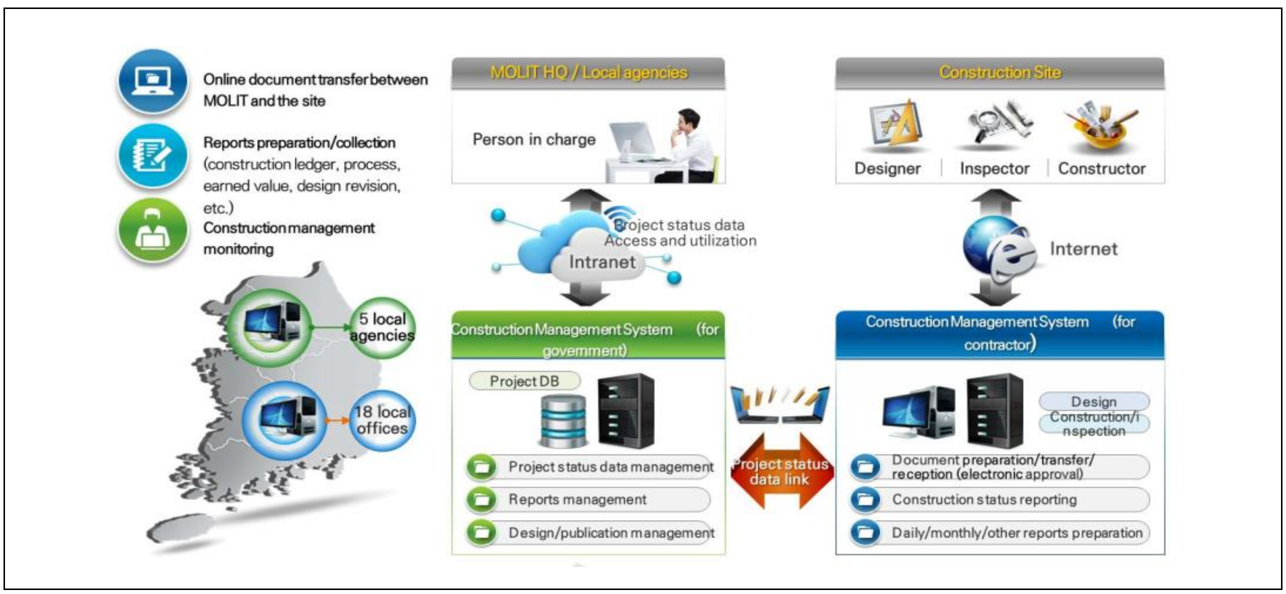


Figure 2.8: The Construction Management System concept [51].

For the last decade, the Construction Management System, a data model that enables the public sector's planning and control, has given text-based data services, and user concerns about the system's fragmented data systems and use have escalated. To address these challenges, this research offered an approach for system enhancement through the incorporation of geographical information in order to provide visual information services. Numerous information systems that make use of geographical information were investigated and evaluated, including the current construction management system and several others that do not. Along with GIS utilization and system enhancement objectives, it was recommended that future architectural development of the Construction Management System be considered. According to the study's findings, integrating location data into Construction Management Systems will provide users with a visual representation of the building status, such as cost, by combining project documents and feature space. It will also make it easier to find information while searching for it and to make decisions based on complex and objective data analysis. Additionally, it may be utilized to provide a few data services based on spatial big data collected from a variety of sources.

It will be necessary later on, when spatial information-based improvements have been made to the operations of a construction management system, to conduct research into the exploitation of spatial information based on large-scale construction project information.

F) In the year 2014, the writers (R. Panchal, A. Jain, and D. Sarkar) discuss the introduction of Geo-enabled Project Planning and Management may benefit greatly from the use of a (GIS). Gathering geographic information that is essential for maintaining control over the project's timeline and budget can be done through the application of project management that is connected with GIS. GIS provides precise information about the project and enables real-time monitoring of the operations of the project-by-project managers and anyone participating in the effort. At any point during the project, the client as well as the project manager can make use of various visualization tools in order to monitor the project's costs and events [52]. It is likely that those involved in a construction project will benefit from this style of presentation because it enables them to witness the project's progress naturally, hence reducing the likelihood of delays occurring during the project. It is possible to keep track of the available resources, as well as the costs associated with maintaining the supply, with the assistance of a system. The use of a Geographic

Information System (GIS) can be of considerable assistance in the accomplishment of geo-enabled project planning and management [53].

The purpose of this study was to evaluate the benefits of utilizing GIS in the management of building projects and to present those evaluations. ArcGIS, Microsoft Project, AutoCad, and Visual Studio are going to be used to combine Geographic Information Systems with Project Management. This is going to enable the project manager monitor and keep track of the progress that is being made on the construction project. The difficulties of establishing and maintaining effective project control makes the job of any construction manager more challenging. Having the capability to visually represent information is extremely beneficial to any endeavor. Displaying the building's state and sequence in three dimensions is one of the project's aims; this will be accomplished while maintaining consistency with a well-defined CPM work plan. When working on a construction project, it would be beneficial to have a more natural way to see how far the project has progressed. This would reduce the likelihood of unanticipated delays and time overruns occurring. In addition, a tracking system can be constructed in order to keep track of the available resources, as well as the expenses and supplies that are required for the project. The progression of the project through the various system apps is depicted in the following image. Additionally, the engagement with the system is shown through the use of this method.

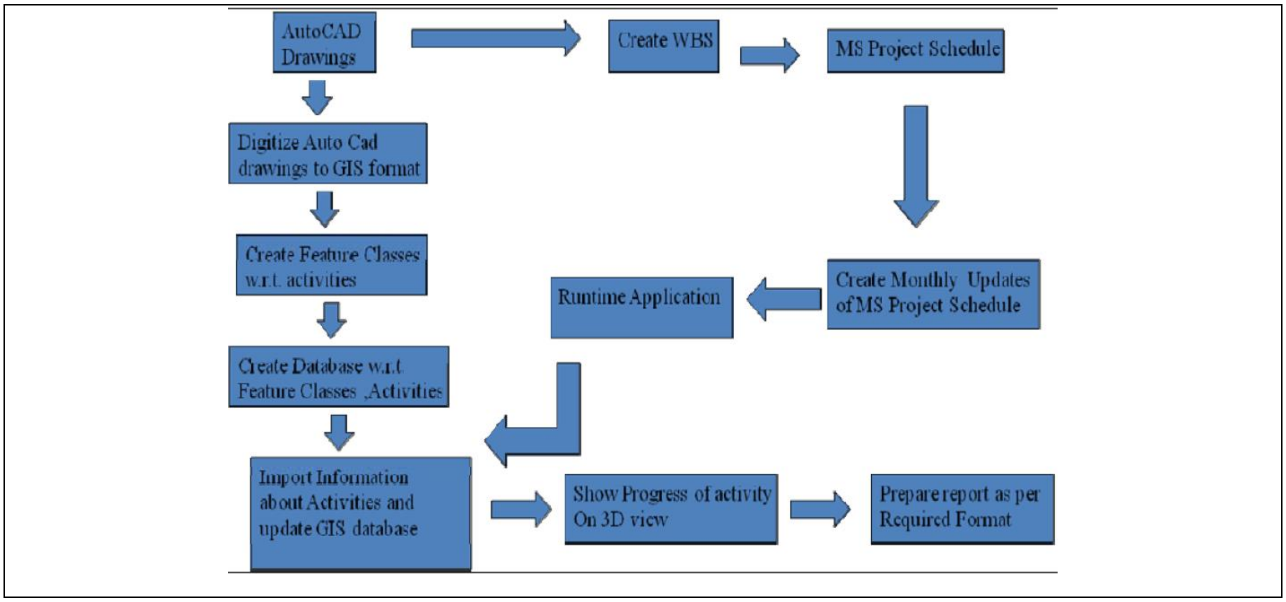


Figure 2.9: Flowchart Depicting the Integration of Project Management and Geographic Information Systems [52][53].

The goal of this research is to investigate ways for creating a GIS-based four-dimensional building model and simulating it in monitoring the construction site's activity. The ArcGIS program is used to produce various phases of the building process and activities at different locations across the world. The schedules were created using Primavera P3 and were then connected to the GIS layers using the GIS layers as a reference. [54][52].

G) In the year 2013, the author (Sandip N Palve) found that using GIS provides a large amount of data that can be easily accessed through a map-based interface. It also helps in keeping track of all the essential data, which is useful for project management. When we start new projects, we are responsible for ensuring that they are completed on time and within budget. It is common for large projects to be complex and need close supervision, coordination, and management on an ongoing basis. Geographic Information Systems (GIS) leverage location as the cornerstone of data management to organize project information[2].

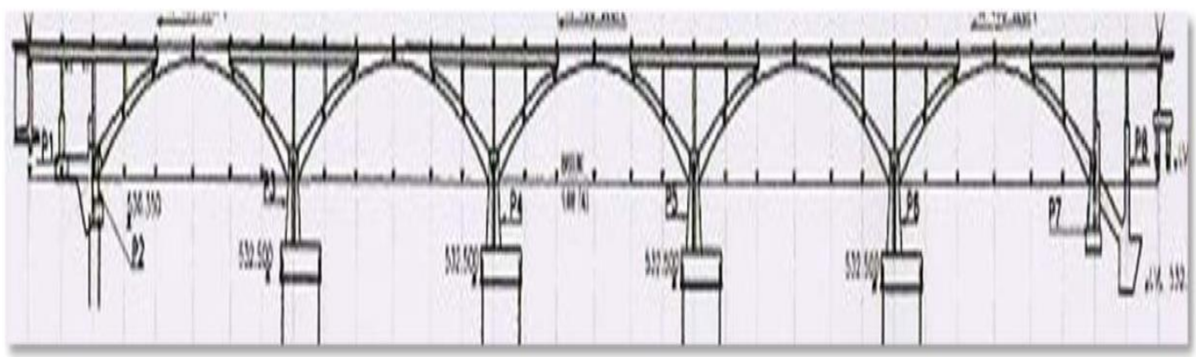


Figure 2.10: The Bund Garden Bridge AutoCAD Drawing [2].

Planning and managing infrastructure projects in the new age of globalization and economic liberalization would be a difficult challenge that would need the development of new talents and a new strategy. The infrastructure projects of emerging nations must be enhanced since they are vital to the country's socio-economic growth and development.

GIS provides a plethora of information that is readily accessible via a geographical interface. It also aids in the organization of all important information for the purpose of project tracking. When we start new initiatives, we are responsible for ensuring that they are completed effectively and efficiently. Projects of this magnitude are often complicated, requiring meticulous monitoring, coordination, and administration. When it comes to managing project information, Geographic Information Systems (GIS) employ location as the cornerstone of data management.

GIS software allows customers to engage with data in a more dynamic manner. Clients may see change across time and place to find patterns and trends, as well as distribute information to engineers, managers, and field-based workers using 3D modeling.

3D modeling tools provide pre-defined objects that make the creation, routing, and connection of bridge building in 3D much easier than it would be otherwise. It is possible that these technologies will considerably enhance the coordination of design and construction activities.

When dealing with complicated design and construction difficulties, this approach may be employed to help overcome them. When it comes to producing coordinated and constructible designs and building sequences, 3D technologies provide substantial advantages since they allow project managers to see exactly where they are in the process. These technologies contribute to the improvement of the overall quality of building projects.

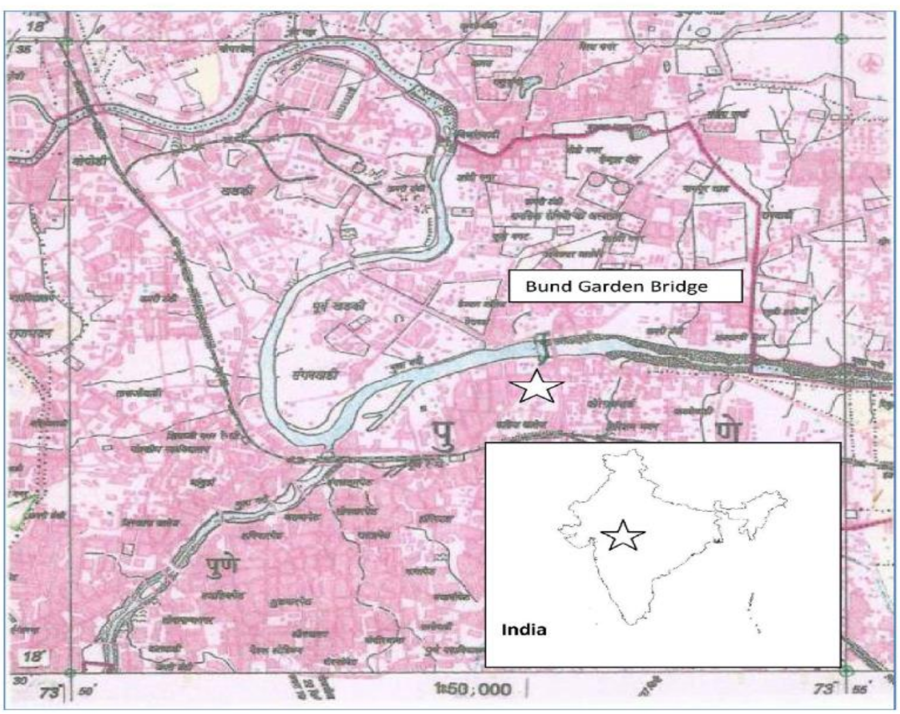


Figure 2.11: The Bund Garden Bridge Near Yerawada, Pune, India [2].

H) In the year 2012, the writers (Tushith Islam and Osama Moselhi, F. ASCE) conclude Asset dependency determination methodologies are not available in municipal infrastructure management systems. The model established in ArcMap GIS was implemented using a mix of built-in methods and scripts written in Python. By creating a mechanism for clearly defining links between assets in a geospatial context, optimization of integrated asset management can be achieved at the network level, rather than on a case-by-case basis, as in the case of individual projects. By using a case study, we demonstrated how the results may be applied to improve municipal infrastructure management programs It will then be feasible to deal with the problems in a way that reduces rework and minimizes disruptions in the process [55].

Figure 2.12: (A) Road Network (B) Water Network (draw by GIS)

An area in Quebec's Pointe-de-Sainte-Foy in the St. Foy district was studied using the model because data for both the Streets network and the water main connection were available. The correctness of the input data is critical to the model's performance, and for the sake of this research, it is assumed that the data is accurate. As the last point to mention, it is possible that the actual project scope differs somewhat from the anticipated project scope.

I) Using GIS, the author (V.K. Bansal) discussed the creation of a safety database that might be used to assess overall safety in 2011.

The writer employed GIS-based navigational 3d graphics in the safety strategic planning, which encourages a simpler comprehension of the building phase and anticipates places and actions with a higher factor effect of accidents. Updating 3D parts, creating and maintaining CPM plans, GIS advanced analytics, and viewing of surrounding topography all take place in a single environment, increasing the efficacy of safety planning.

And as a result, Poor safety on the job site causes employees and their families to be in constant physical and psychological distress, which has a negative impact on the project's economic viability by raising direct and indirect expenses.

Worker fatalities and injuries in the construction industry are higher than those in other sectors, and as a result, their protection is of greater importance than that of employees in any other industry.

Along with time, money, and quality, jobsite safety is a critical factor in deciding a project's success. Finally, planning is an integral component of execution planning from the start; it is critical to maintaining a connection between safety advice and the execution timetable [56].

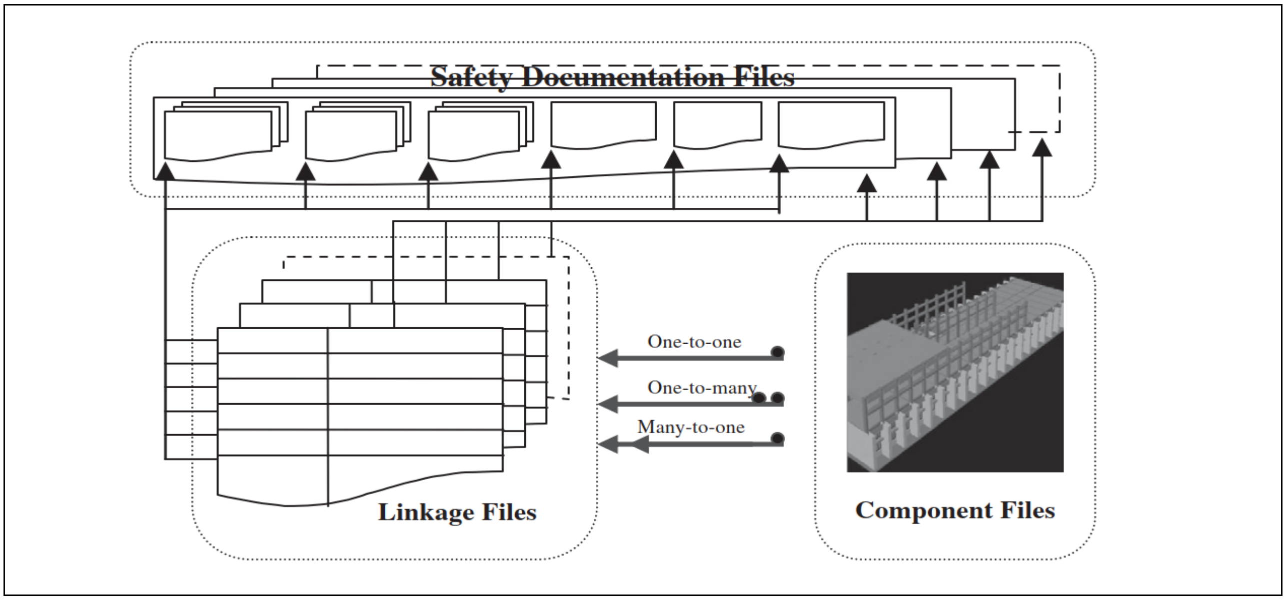


Figure 2.13: The Exchange of Data between the Generated Safety Database and the Building Model's Components

Safeguarding components or activities is made more practical by integrating safety law regulations and experts' suggestions with actions or components. Construction industry experts responsible for planning construction operations and implementing worksite safety programs have found the fast retrieval of information from the safety database to be quite beneficial. Using Geographic Information Systems (GIS) in conjunction with a safety database assists in detecting safety factor effects and gathering pertinent information. The technique that was established was proven to be beneficial in determining what safety precautions are required when, where, and why. According to the findings of the study, choices made by the project manager and the designer have a direct influence on the safety of employees. Workers' safety must be considered by the project manager and the designer as a fraction of the process of designing and planning; as a result, their engagement for safety specialists must be promoted to ensure that workers' safety is taken into consideration.

They are more accountable for the safety of their employees. They must be made aware of the different methods by which their designs and judgments might contribute to the improvement of site safety. It is imperative that all stakeholders participating in a building project understand that safety is a shared responsibility. Safety planning has thus been integrated into every stage of the design process.

Construction projects that must be viewed in relation to their surroundings benefit from geospatial analytic skills and GIS-based safety training. Additionally, GIS can be utilized to fulfill a range of project requirements at various stages of the project's lifespan, including construction safety planning.

J) It was necessary to create a computer model to represent the construction process. using (4D) modeling or (BIM) modeling was advocated by scholars (V. K. Bansal and Mahesh PAL) in 2012. (BIM). While 4D and BIM technologies may be able to give a visual representation of the strong involvement, they lack the ability to create and update schedules, modify 3D components, model topography, and do geographic analysis in a single platform. GIS software has been used to construct CPM scheduling programs and 3D model components that incorporate CPM processes. A dynamic interface between scheduling activities and GIS 3D components has been developed. This link identifies missing information and logical problems in a project schedule. These technologies are a little tough to use, and the representation that they give cannot be readily adjusted [40][57]. GIS helps planners swiftly assess a schedule's constructability.

Data management capabilities of GIS were also utilized to update and maintain the building source data so that construction projects can be planned more effectively and efficiently [40].

GIS abilities for CPM planning were homed in this work with a focus on improving the visualization of constructability on a computer screen by connecting activities in the produced chart with the required 3-dimension components. Project works and their associated 3-dimension components were dynamically linked to make it easier for schedule flow issues and lost activities and logic problems to be identified. The Environmental Systems and Studies Institute's ArcView 3.2 and ArcGIS 9 GIS software were used in this project to create a Four-dimensional system that combines a CPM plan with a 3D model and topography all inside a single GIS environment (ESRI)

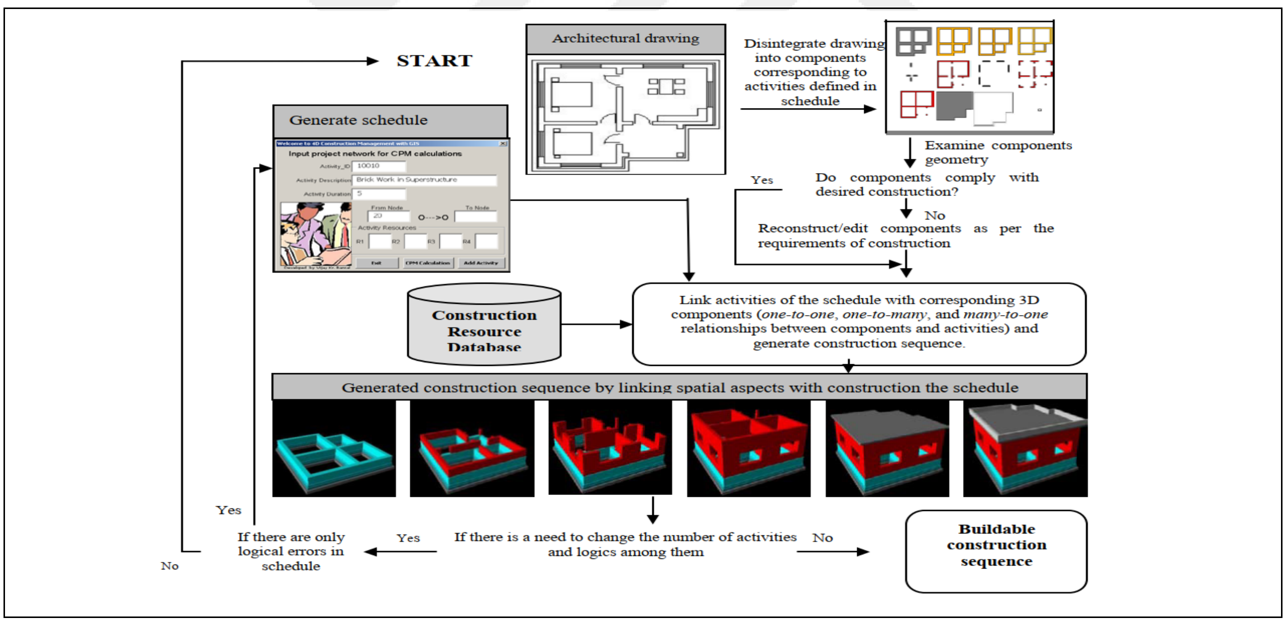


Figure 2.14: The Architecture for Creating, Connecting, Visualizing, Evaluating, and Correcting a Building Schedule.

K) When it comes to the management of infrastructure services, Dana J. Vanier, the author, provides a summary of the benefits that can be gained by using a geographic information system (GIS) in 2008. GIS data may be obtained more quickly and easily using a variety of geospatial technologies and characteristics, GPS being one of them.

as a basis for the creation of decision-making aids to serve as a foundation (GIS). They are encouraged to make use of GIS as a tool that will aid them in prioritizing the maintenance and replacement of capital assets [26].

It is possible that using Geographic Information Systems (GIS) in the decision-making process for government construction projects may be advantageous; nevertheless, GIS cannot be the primary force behind the necessary research. For a number of different reasons, the geographic and mapping communities are unable to provide the engineering descriptions and definitions of "features" that are present on GIS maps. These are now absent in existing GIS applications and implementation. GIS elements include not only the physical infrastructure assets that are already there, such as roads, stormwater ditches, and bridges, but also hierarchical networks, object class divisions, data attributes, and 3D components, in addition to time-degradation mechanisms. GIS elements include: [26] Experts in civil infrastructure are tasked with researching the aforementioned issues and coming up with workable solutions, in addition to constructing and supplying frameworks to extend the geographical component of GIS.

L) In the year 2008, A study conducted by a group of researchers (Mokhtar Azizi Mohd Din, et al.) at the University of Malaya in Malaysia employed GIS and multi-criteria decision-making (MCDM) approaches to analyze and pick the best landfill site from a selection of potential locations, according to their findings. In this study, the AHP Analytical Hierarchy Process was used to determine the weights of the studied criteria, and the (WLC) Linear Combination method was used to calculate the suitability index (Si) for each of the studied sites. Several criteria were adopted, including surface water factor, residential areas, railways, iron, flood areas, distance from swamps, archaeological areas, the slope of the site, soil type, land use, road provision for the site, and urban areas, and each of these criteria was studied through a geographical layer that represented this criterion after all sites that were excluded were excluded. Do not meet the initial conditions of the site's required land area. The use of Geographic Information Systems (GIS) helps enhance site selection analysis. As a tool for site selection, Geographic Information Systems (GIS) are well-suited since they have the capacity of managing enormous amounts of geographical data derived from a variety of sources [58].

Figure 2.15: Location of The Study Area [58]

The selection of assessment criteria or characteristics required for landfill siting is the first step in the procedure described here. All of these characteristics have been established in accordance with local requirements, such as the Town and Country Planning Department (TCPD) guideline for waste disposal location and the Department of Environment guideline for waste disposal site (DOE). Additional information on landfill siting has been gathered from international practices such as the Environmental Protection Agency (EPA) of the United States, as well as reviews of relevant publications. All of the data related to these parameters was obtained from the appropriate agencies; however, not all of the parameters were included in this research owing to a lack of data availability for all of the parameters. As a result of this research, eleven (11) parameters for landfill site selection have been identified. These parameters are as follows: surface water, residential areas, railways, flood-prone areas such as swamps, archeological or historical sites on the site, slope, soil type, land use and road accessibility as well as urban area.

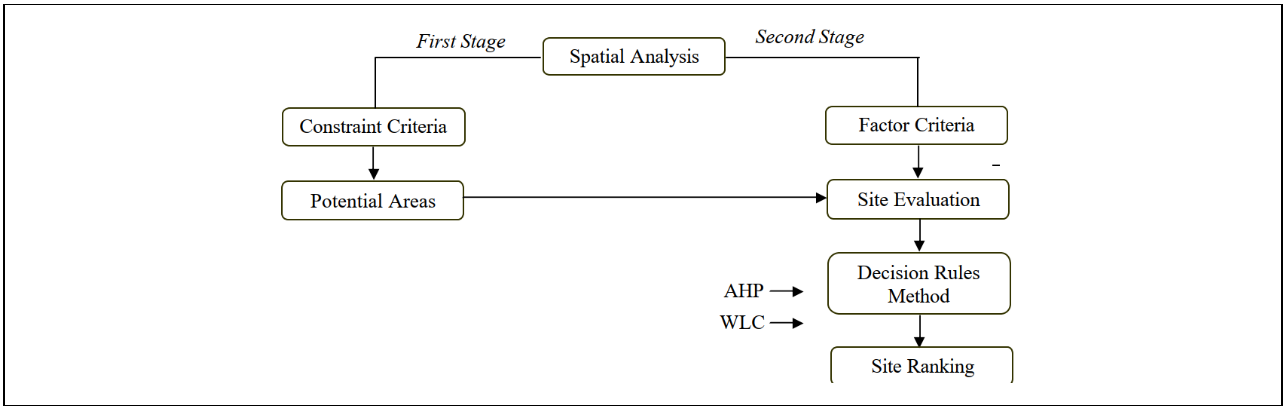


Figure 2.16: GIS Spatial Analysis Flow Chart [58]

M) In the year 2018, authors (Sharma, Sunil, Bansal, VK) used GIS in scheduling and planning construction projects. And they concluded that Geospatial information systems (GIS) are required for site-based planning because they require constant knowledge of the site. For roadway data that includes both spatial and non-spatial information, (GIS) are important. As a result of Geographic Information Systems (GIS), scheduling and cost estimation is linked to a single system.

The usage of Geographic Information Systems (GIS) may assist to improve the analysis of site selection. Geographic Information Systems (GIS) are well-suited as a tool for site selection since they have the capability of handling vast volumes of geographical data gathered from a wide range of sources, making them an excellent choice [59].

It is feasible to display and analyze data from several sources using GIS capabilities in order to keep both spatial and non-spatial information for roadway information on a unified platform. The integration of several components of highway construction planning into a single system, including topographical modeling, job scheduling, and cost estimation, has been made possible by Geographic Information Systems (GIS).

The rate at which tasks are accomplished in steep terrain is significantly influenced by geographic variations in the terrain. A productivity reduction zonation map was generated by combining topographic, geological, and hydrological data recorded in a Geographic Information System (GIS) with other data sources. This map was used in allocating different production averages to jobs in various sections of the project during its duration. Job execution planning and the generation of a graphical location-based plan are built into GIS, so there is no need to purchase separate scheduling software in order to complete the task. Accessing project data and a worktable in the same setting makes it easy to update the schedule as soon as project data changes, which saves money and time. This saves time and effort for the planners while guaranteeing that the timetable is updated on a regular basis for the participants. QWATHE real-world experiment proved how quickly a place design can be produced entirely within GIS [59].

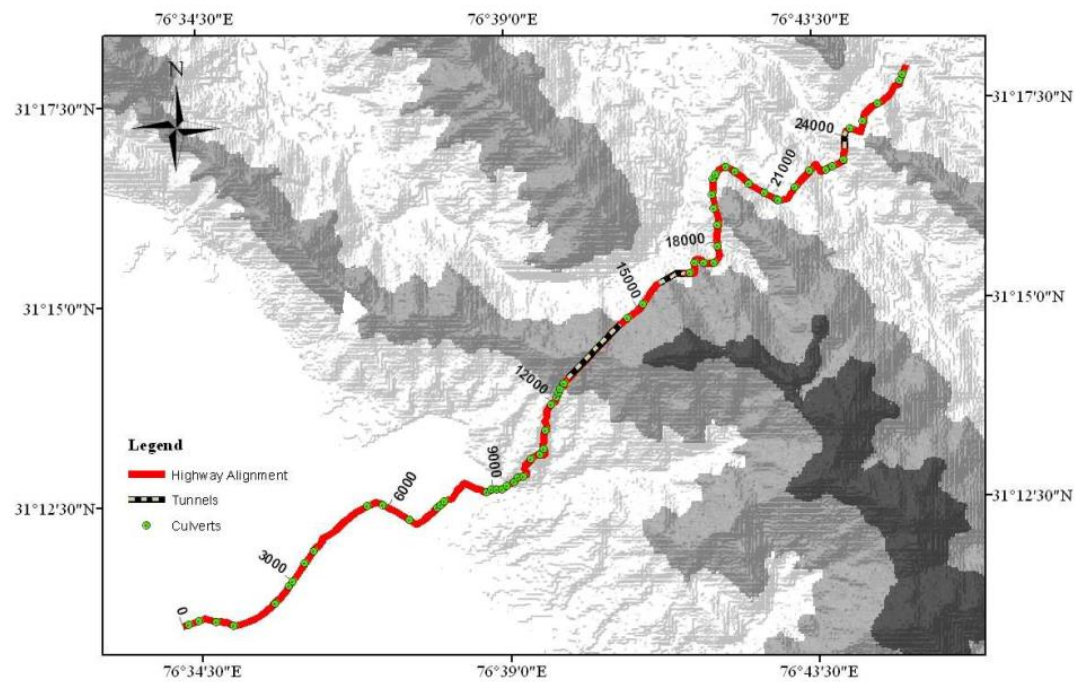


Figure 2.17: Construction Elements The Highway Alignment [59]

N) In the year 2019, The author (Joshua C Jones) evaluates the project management strategy used in the development of Geographic Information Systems (GIS) as a primary function of planning organization in this search. Using the applications of relevant previous cases studies, this analysis examines how Geographic Information Systems (GIS) can improve quality planning functions and provides insight into the structure of successful GIS implementation. As technology advances, Geographic Information Systems (GIS) are becoming more and more integrated into the planning process. The incorporation of this technology into planning organizations, as well as the following attention being given to it, is almost inevitable [3].

If we are talking about the data that is used by a planning department, one aspect that might influence the amount of time and work necessary for a GIS installation is the current format of the data that will be handled with the new solution. These conclusions will have a significant influence on the amount of time and money required to complete the implementation. Building plans may be received in a paper form by a planning department during a permission application, requiring significantly more processing in order to extract attribute information and geographic data for logging into a systems database later on.

A GIS implementation might seem to be a duplicate of current procedures if it is not preceded by thorough understanding of those processes and the selection of an appropriate solution.

For the aim of data administration and the planning process of the university, Al-Balqa' Applied University developed their own Geographic Information System (GIS) from scratch. The implementation procedure included the development of the database, the design of the GIS system architecture, the selection of data types (spatial, tabular, and image), and the eventual implementation of the system. However, when combined with an understanding of the data to be employed as well as the translation of that data, a successful GIS deployment can be accomplished. The University was aware of the requirements of the new system as well as the requirements of the old environment, which enabled them to estimate the labor involved in the conversion and installation. This is a critical component of any effective geographic information system [3].

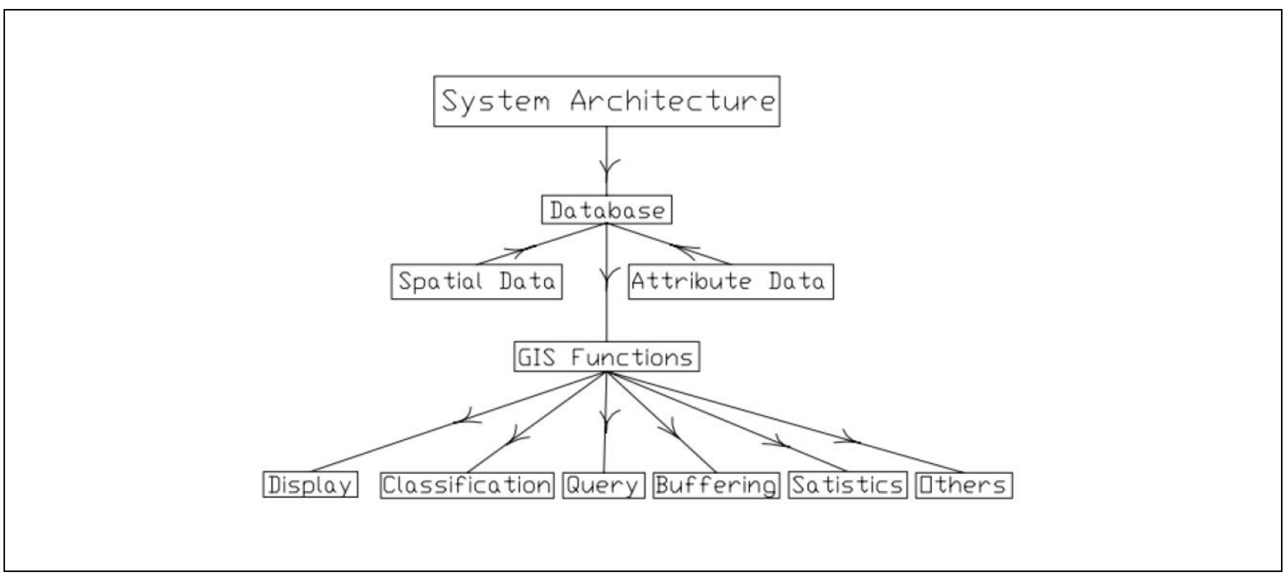


Figure 2.18: Al-Balqa’ University Applied GIS System Architecture [3][60]

It is expected that leaders and decision-makers in these businesses will use this realization to motivate them to gain insight into the most effective methods of integrating GIS in their organizations. Having this awareness should spur leaders and decision-makers in these businesses to pursue the objective of getting insight into the most appropriate techniques of GIS deployment for their particular company [3].

O) According to the author VIJAY KOLAGOTLA, In 2009, a way of combining project management and GIS was implemented, and it was acknowledged as an integral component of the solution required for the enormous construction industry, which spans several operations. Clients, site engineers, and construction project managers can benefit in the following ways from this strategy:

Those whose job title is "PROJECT MANAGER" (All the information needed to decide is available in one place, making it easier for project managers to keep track of large projects and keep track of costs and materials utilized on the job site).

After collecting as much information as possible, you are able to keep an eye on the project site and purchase dollars or resources. You are able to provide contractors with advance notice of the start of their project. This will help you determine how much additional material will be necessary. There are numerous ways to reduce the amount of material need to be purchased. You can place an order for precisely what you require).

CLIENT (Having a clear picture of the project's development in three dimensions lets the client see where significant expenses have been incurred)”[53].

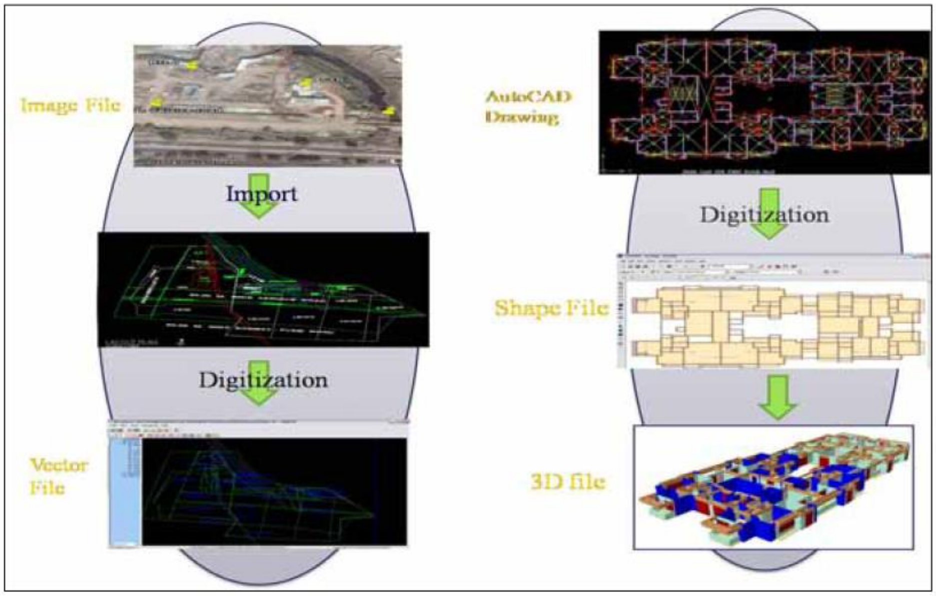


Figure 2.19: Migration of Raw Data into GIS [53]

P) In 2019, a group of authors (Matthias Pietsch and colleagues) used computer software such as desktop geographic information systems, mobile geographic information systems, and web geographic information systems. These tools were used in a landscape architecture studio to assist in the calculation of well-known procedures for the evaluation of educationally ecological services and the avoidance of soil erosion, as well as the creation of narrative maps in ArcGIS Online. A thorough description is provided of the implementation, including narrative maps for telecommunication and participation in distance education programs, among other things. The writers make an attempt In order to assess what type of potential they have, ecosystems and landscapes are documented and examined [61].

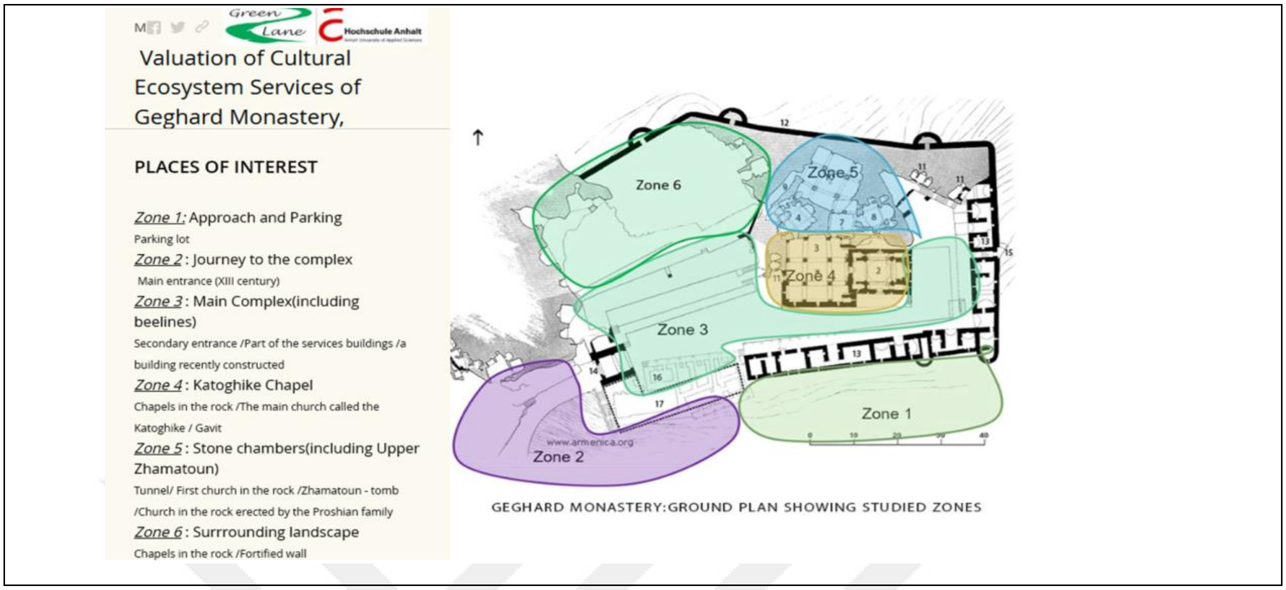


Figure 2.20: Zones of the Gerhard Monastery by ArcGIS Online

Q) During 2016–2017 Scientists from the Adam Mickiewicz University in Pozna (Poland), Faculty of Biology, performed field investigations in the vicinity of Bielawy's Kujawy Mining Plant in order to better understand the local environment (Fig. 2.21).

Collector for ArcGIS and ArcGIS Online are two examples of mobile applications and web-based mapping platforms that can be used by researchers conducting biotic information field surveys. Developing a comprehensive fauna and flora database as part of the Scientific objectives of the project necessitated the evaluation of mobile app capabilities as part of the working group.

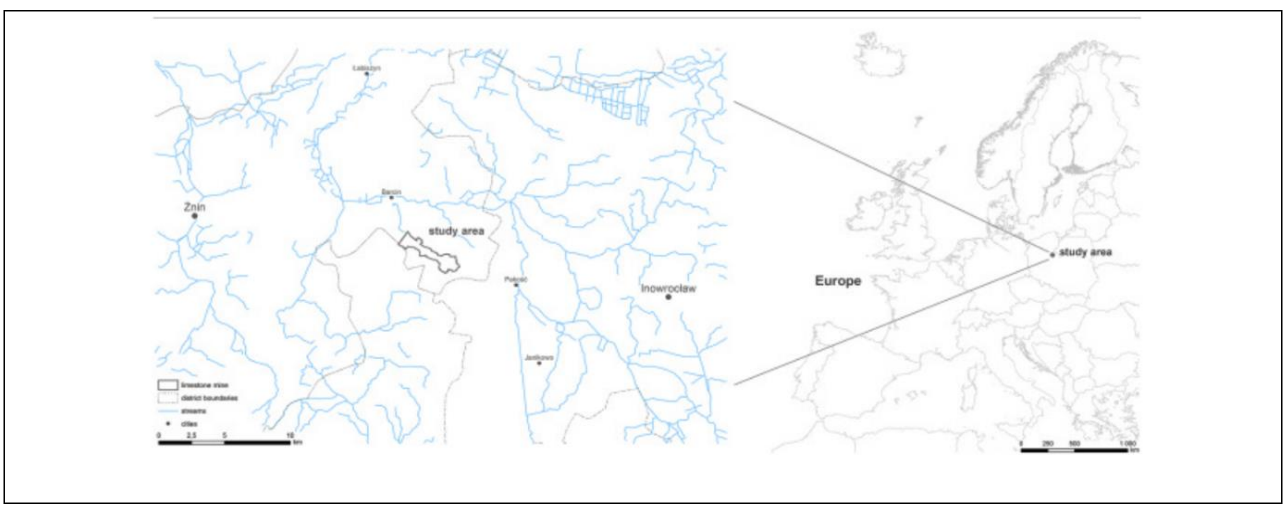


Figure 2.21: Study Area

The objective of the project was to develop a best management practice (BMP) and a 500-meter buffer zone for a region that had been heavily impacted by human activity, namely an open-cast limestone mine. As part of the mining process, an ecological inventory of a following categories of organisms was conducted: terrestrial and aquatic vascular flora, mosses and algae, butterfly and orthopteran species, odonates, fish and amphibian species, birds and mammal types. For the first time, plants were also documented. Each occurrence site had to be described in detail in the field in addition to the location of each distinct occurrence site. For all the numerous kinds of species, there were close to a hundred different qualities. For example, the vascular flora of terrestrial environments was inventoried for the following characteristics: abundance, species name, collection date, habitat type, author, and the global ID. Figure 2.22) This map depicts the distribution of vascular plant habitat types in of terrestrial habitats in the mining region.

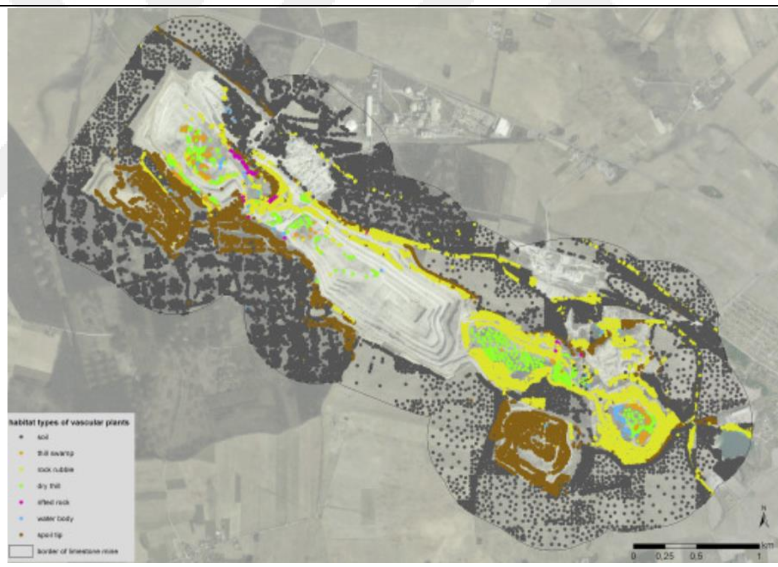


Figure 2.22: The Distribution of Vascular Plant Habitat Types in of Terrestrial Habitats

Polygons and transect lines were used to map the distribution of particular organism groupings, in addition to a collection of points representing their presence. The investigators obtained 47 507 points across the whole mining plant area, which represented vascular plants found in terrestrial environments Figure 2.23):

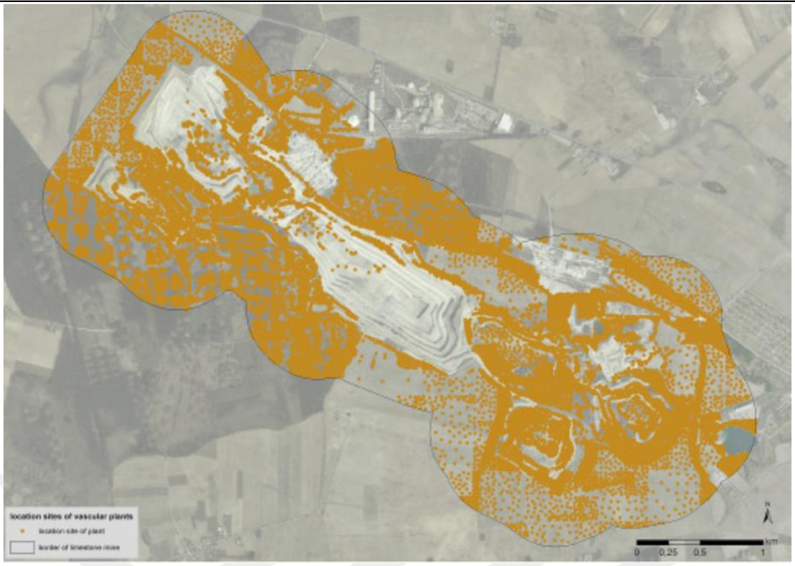


Figure 2.23: The Distribution Plants of Terrestrial Habitats

R) In 2019, a bridge model was created in the program Revit by a group of authors (Junxiang Zhu and colleagues) to assess the proposed OSA before it was implemented. The slab, the beam, and the column were all modeled separately. The real bridge may be found at Rockingham, Western Australia, and is administered by the Western Australia Main Roads department. An IFC file was first generated from the bridge model after being exported using EXPRESS. In order to link BIM and GIS, the two systems need to exchange data with one another (GIS). When translating IFC (BIM) to shapefile, the Data Interoperability interface for ArcGIS (DIA) sometimes leads to geometric mistakes and the loss of geometric data (GIS). [62].

In order to convert the geometry of an IFC file into a shapefile, this project made use of a 3D data format that is known for its widespread adoption and usage. This format is called shapefile. An exhaustive study was conducted on the spatial configuration of the IFC system that allows, and an original approach for the production of many pitches was developed. according to what is depicted in Figure 2.24.

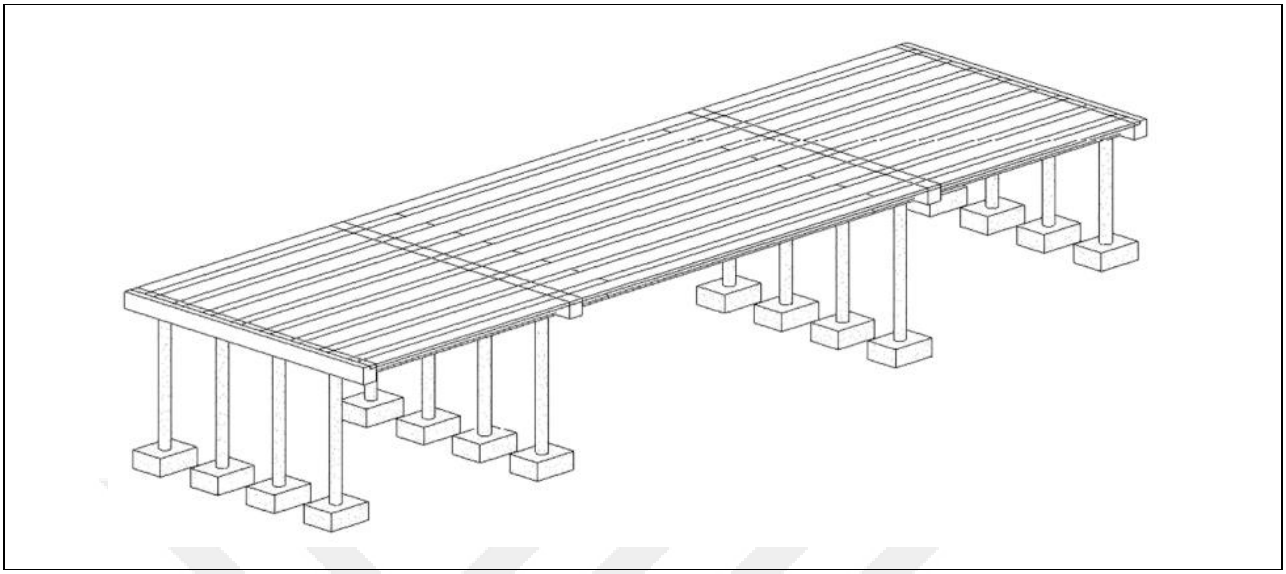


Figure 2.24: The Bridge Model that was Employed in This Study

AMG was created to automatically generate multipitch from a single source. parameters that are particular (swelling shape and path). An example of a use case was provided.

demonstratively illustrate one potential use for the resulting Shape Field.

The following are the major results of this study:

a) This can be done using open-source technologies but is far more efficient than the DIA's IFC to shapefile conversion. In the end, the shapefile may be utilized in a wider range of applications and is easier to maintain.

b) Geometrically, the transformation from IFC to shapefile is now one-way; however, the reverse translation with additional semantic information is theoretically achievable.

c) With the AMG, it is possible to build a qualified multipatch that is independent of the original ring order and extrusion direction. Patches may be formed with any ring, whether it is turned clockwise or counterclockwise. The resulting multipatches, on the other hand, may not be closed and hence have a limited usefulness.

d) In order to correctly modify geometry, it is necessary to perform a coordinate transformation of all three types. This includes the transformation from the local coordinate system of a site (T1) to the world's coordinate system (T2), as well as the translation between coordinate frame

(T3) (T3). They are virtually identical to one another in shape. However, they each perform a different purpose. T2 and T3 evaluate whether or not a geometry can be created appropriately, whereas T1 decides whether or not the geometric can be positioned in the appropriate location.

Shapefile is an essential format for integrating BIM with GIS data because it is extensively used to handle 3d model in the GIS industry and can also be easily exchanged with non-GIS 3D software programs like Sketchup. Other formats, such as.dgn, are not as well suited for this purpose. When shapefiles are used instead of CityGML, have no need to deal with the arduous LOD translation problem that occurs when CityGML is used. This is in contrast to the situation that arises when CityGML is used. Although the proposed method has the potential to advance BIM/GIS integration and provide assistance to the community, it is inefficient and needs to be improved.

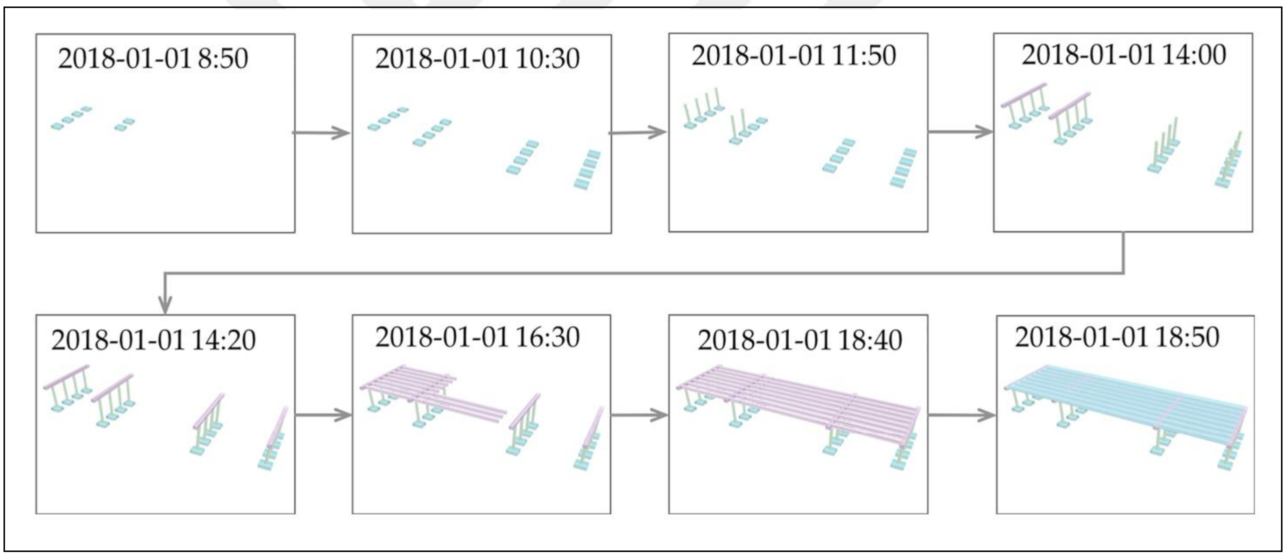


Figure 2.25: The Bridge Model

R) This study aims at evaluating the integrated use of 3D Geographic Information Systems (GIS) and building information modeling in order to organize knowledge. The results of the work were the construction of a 3D GIS-BIM process, which was examined on two different platforms.

In 2019, the authors Giusepina Vaca and Emanuela Quakerro of Author Managed will be able to employ the technology if it is made available to them. In the section titled "Methods and Materials," it is stated that two case studies were utilized in order to demonstrate the workflow of the integrated 3D GIS-BIM system. Figure 2.26 depicts a model of the Mandolesi residences that was constructed in Revit for the purposes of educational use. The objects and the data are included in the parametric model, which can be seen in Figure 2.27.

along with information from the Structure's File As a result of the existence of such a significant quantity of Using the data, the model generated gives a 'development level' that ensures the success of the project.

In Figure 2.28, a query regarding the "window" is shown. Depending on the details of the attributes that are associated with them, such as the degree of deterioration, the likelihood of replacement, and the degree of conformity of the replaced component. The following are the outcomes of the query: Green highlights have been added to the windows that needed to be replaced. They need to be replaced right away because they have experienced a great deal of deterioration and don't follow the rules. Given that the windows that were initially installed are in excellent condition, the windows that were intended to be replaced shouldn't have an orange tint. This is a novel and creative concept. The original windows are removed and recycled because they have severe deterioration and need to be replaced.

In this illustration, the color red denotes the object's position. The connection of 3D GIS and BIM allowed for the successful implementation of this query on each of the 77 buildings. Making it possible for the administration publique, who is the owner of all structures, to take control of the property as opposed to the traditional and periodic means, a global resolution with less time and money interventions

Additionally, a search can be done in the building's file to learn more about the general information that is there.

Statistics pertaining to cadasters, certifications, urban data, and authorizations for interior works. Consequently, the suggested technique provides for three degrees of knowledge depth: building, constructing, and maintaining. apartment, as well as a construction component of the system, will be configured in accordance with the present need.

provide the amount of information that is required: based on a cursory review of the documents concerning each structure and unit in all buildings, to a thorough investigation of the situation Materials and procedures utilized in a certain building element, as well as the amount of decay in that piece, are all examples of deterioration. Figure 2.29) depicts a request for information on an apartment as well as the maintenance that was performed.

It was possible to establish a way of work for the complicated integration of 3D GIS-BIM, and Structure's File as a result of the study findings. The implementation of the research in two case studies enabled us to draw attention to the advantages, limitations, and potential improvements of the study.

The integrated system was shown to be an economically feasible and long-term option for coordinating the knowledge process of current modern buildings and public historic ones after many testings. On the other hand, all of this depends on identifying the objectives of the activity, selecting essential information, and introducing reporting criteria that may be used to conduct a comparative analysis in the future.

As a consequence of making adequately 'educated', logical, and aware decisions, the maintenance activity is configured in this way: Such a system would be advantageous to the administrations since it would help organize data on public properties and provide a key to optimizing local services through proper planning of the operations on the actual real estate [63].

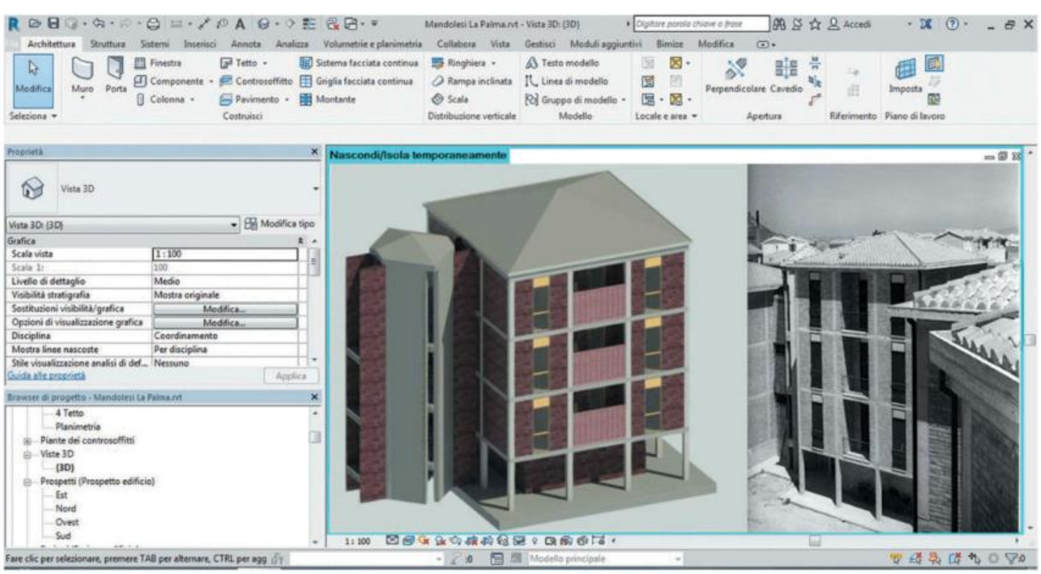


Figure 2.26: Instructive Model of the Mandolist Residences Using REVIT

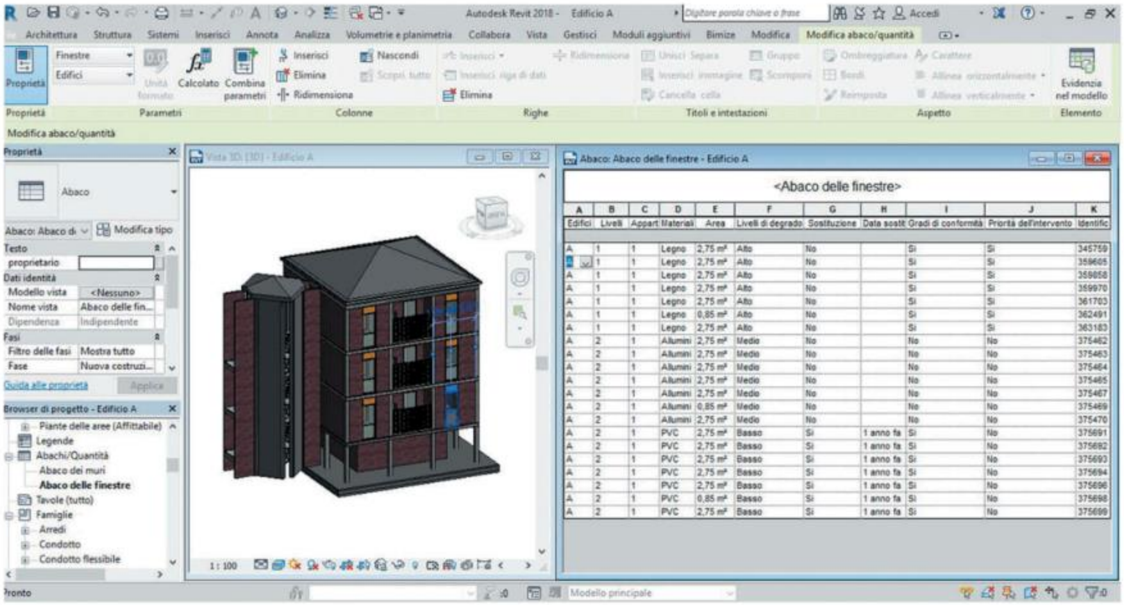


Figure 2.27: The Parametric Model, Includes the Objects and Data

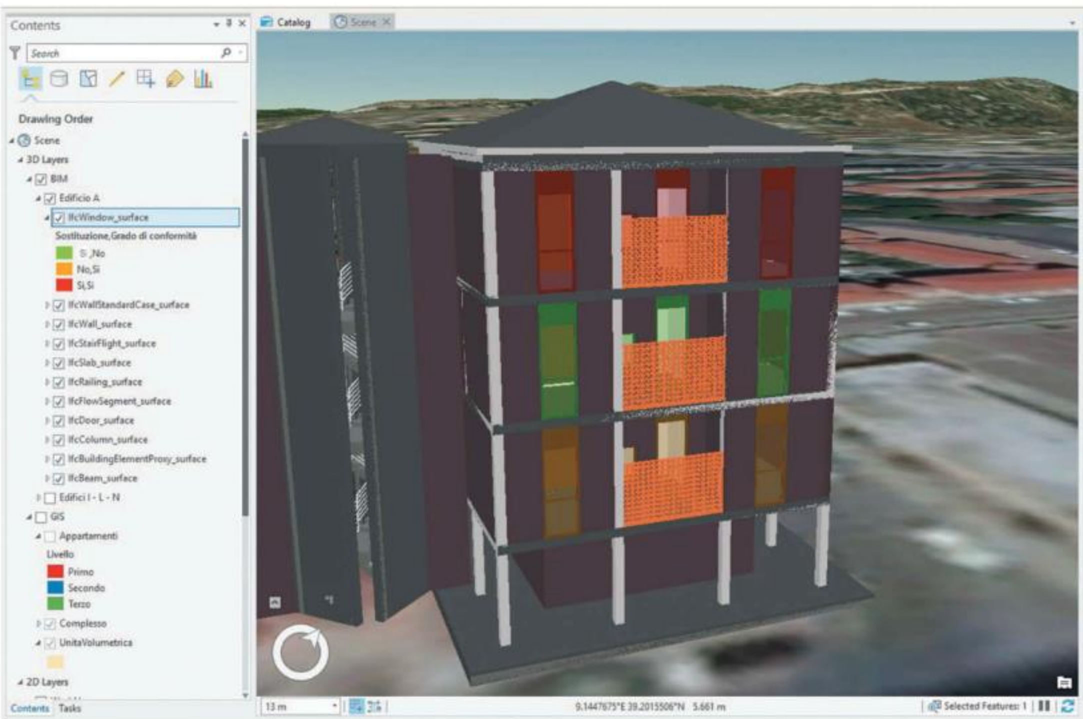


Figure 2.28: A Query Regarding The 'Window'

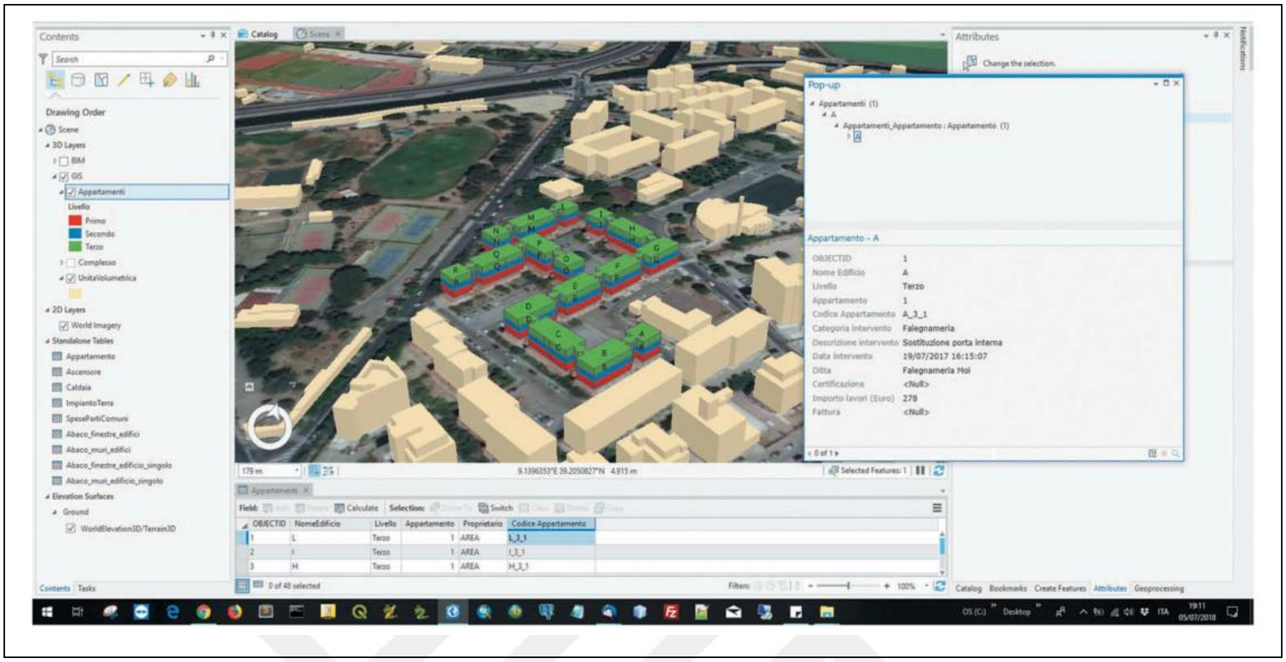


Figure 2.29: Information on An Apartment as Well as The Maintenance

3. METHODOLOGY

3.1 STAGES OF PLANNING PAVING AND CLADDING PROJECTS FOR THE CITY OF AL-RIFAI USING GIS

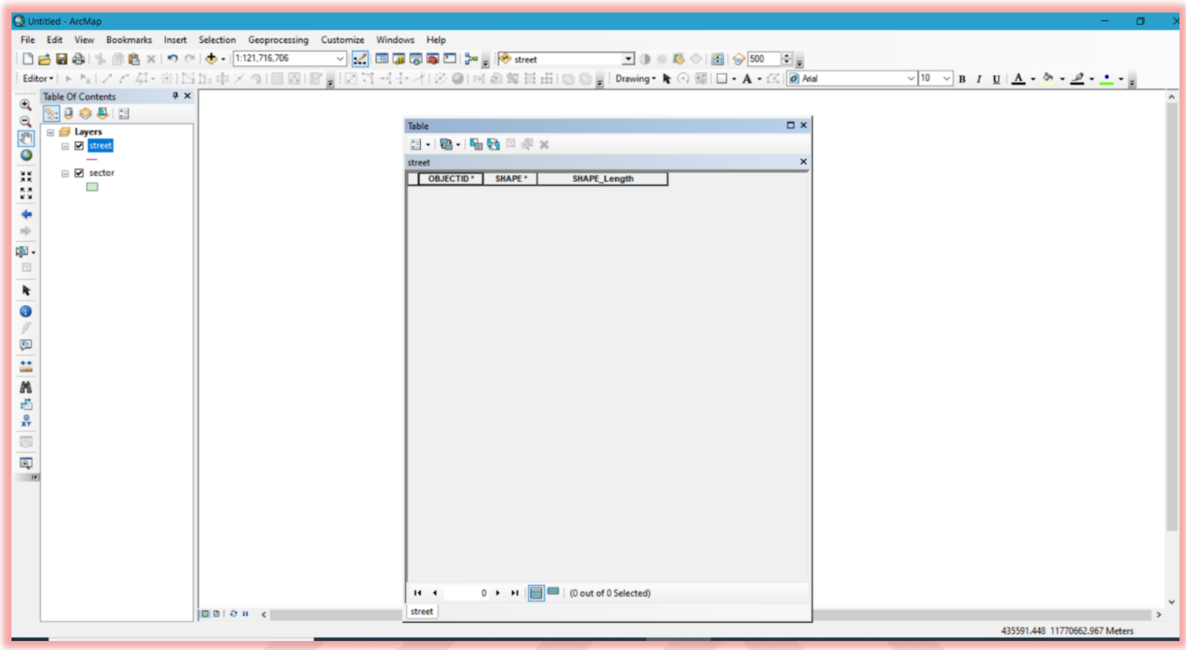
Because there is no integrated database on the preparation of streets and the types of services available in each location, the criteria for getting an integrated database for the city of Al-Rifai will be developed as part of the overall design for its establishment. The following are the steps that must be completed to acquire access to the database:

3.1.1 Database Preparation Stage

This stage included the preparation of the required database, which is used in the planning process for the implementation of projects in the city of Al-Rifai, as streets, parks, and schools will be drawn, to collect spatial information on its basis from the reality of the city. Databases are prepared in the GIS program.

Below, the program creates three columns automatically, namely, the first column (Object), the second column (Shape Length), and the third column (Shape), which includes the shape of the teacher and is represented in this search by the (Line) line that refers to the streets in this layer of the drawing, while the remaining columns indicate to the reality of each street in terms of width, length, tiling and other data shown in Table (3.1)

Table 3.1: Table in ArcGIS software



3.1.2 Layers Drawing Stage

The layer represents a group of areas on the surface of the earth that need to be dealt with and that are removed from the maps, considering the independence of the layer with a set of specifications and features that differ from other layers. In this research, only two layers will be dealt with as follows:

a) The streets layer consists of all the information about the city's streets with all the details required for planners.

b) The layer of public and private properties and real estate (built-up and non-built) and it consists of all the component parts of the foundation design for the city (residential, commercial, and green areas).

Each of the layers can be controlled in terms of showing and hiding them as needed through the program as well as conducting analysis and drawing operations and adding information to any layer, then the layers will be clarified with each other and will be installed on the aerial image of the city after completing its drawing, as each layer contains these Layers have their own information, and any information on the required layers can be shown and given a specific color and drawing scale as needed. The layers will be created through the program (ArcGIS 10.8) and then choose the secondary program (ArcCatalog) according to the steps below:

a) Open the program for creating layers, and the main interface of the program will appear.

b) Creating the two layers of streets, properties, and real estate and placing them in a file in the name of the project to be the beginning of direct drawing on the aerial photographs of the city.

c) Go to the drawing program (ArcMap) for drawing the basic design of the city, as the aerial image of the city is called, and then start the drawing process step by step, and we get fees matching in terms of information to the reality In addition to using a GPS device to take readings from the reality of the situation and match their locations on the map, the results were with high accuracy, which indicates the correctness of the information that will be produced after completing the drawings through the database. Figure (3.1) shows the Streets layers and Figure (3.2) layers of properties and real estate in the city

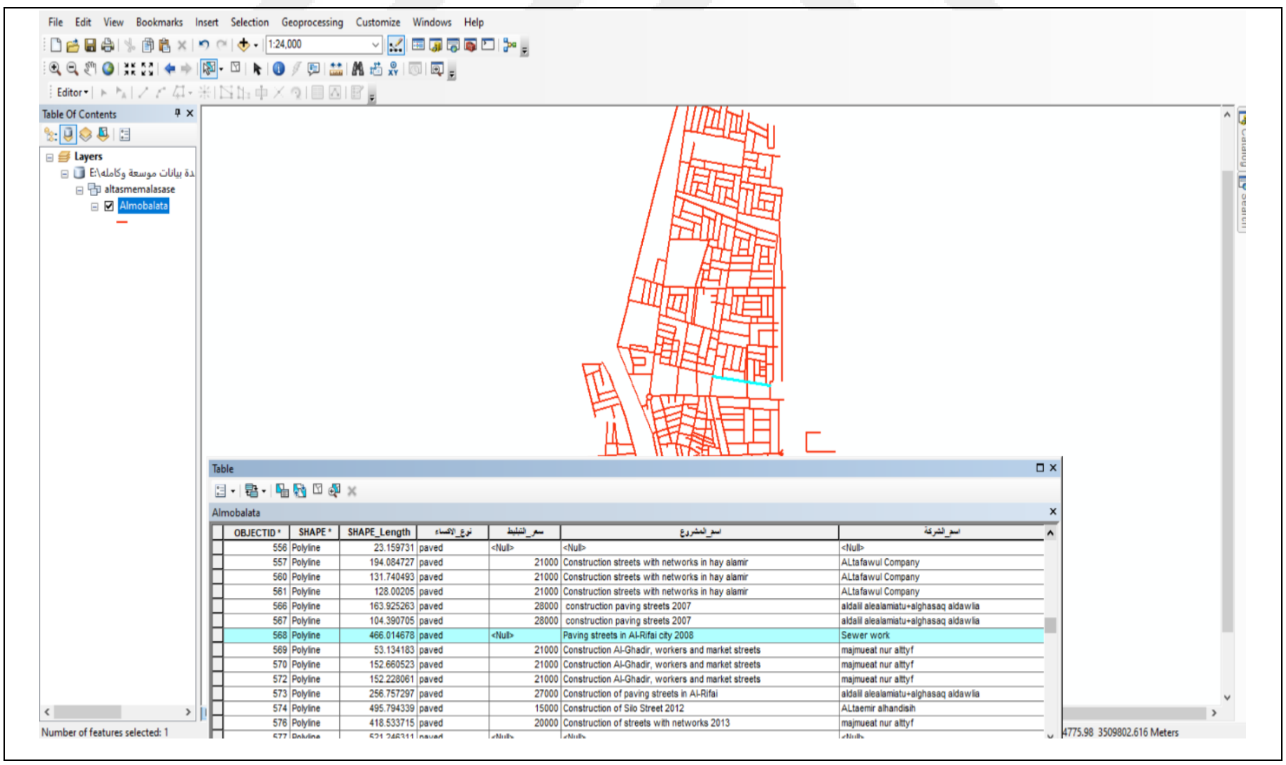


Figure 3.1: Street Layer in The City

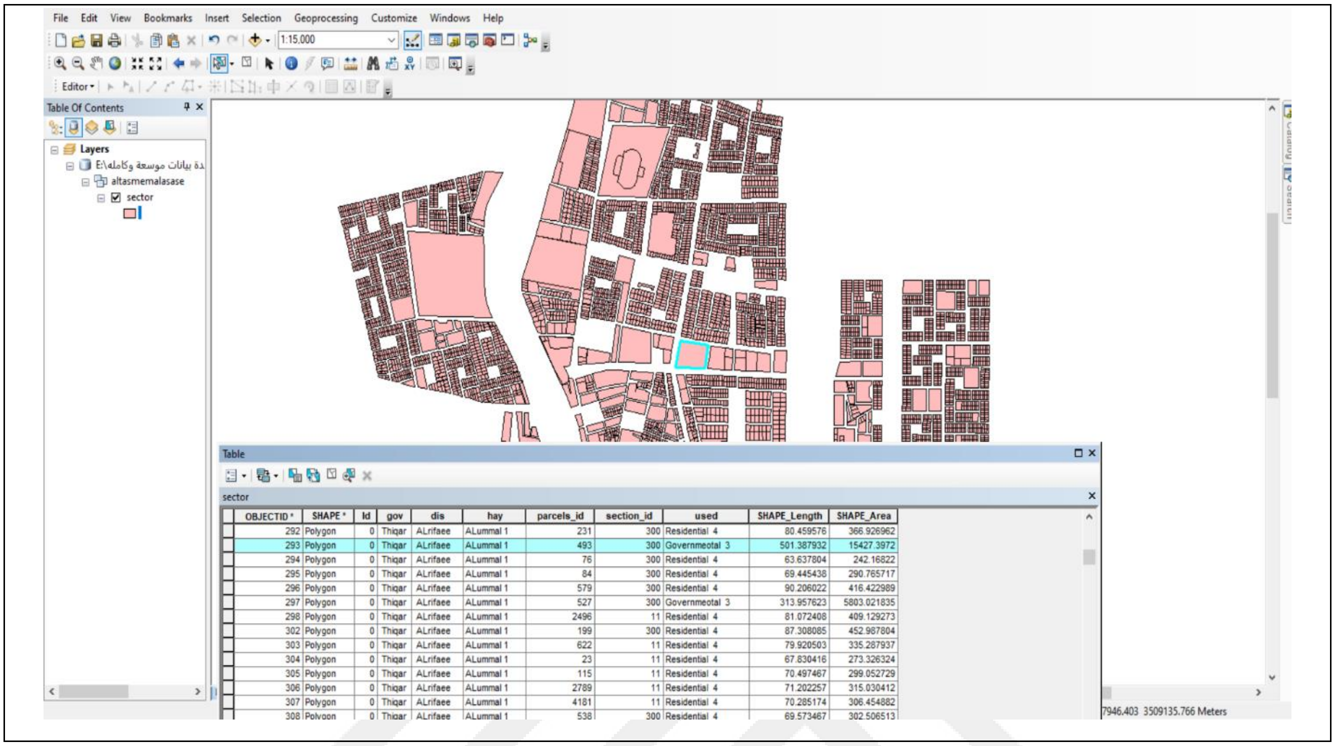


Figure 3.2: Layers of Properties and Real Estate in The City

d) After completing the process of drawing on the two layers, the aerial photographs are deleted and the resulting map is finished using the program's tools, and then directly enter the data obtained by the competent departments (water, sewage, and municipality), as the program, through those data, performs calculations and configures Databases for all parts of the basic design and are subject to update in the event of a change in streets and properties, as shown in Figure (3.3).

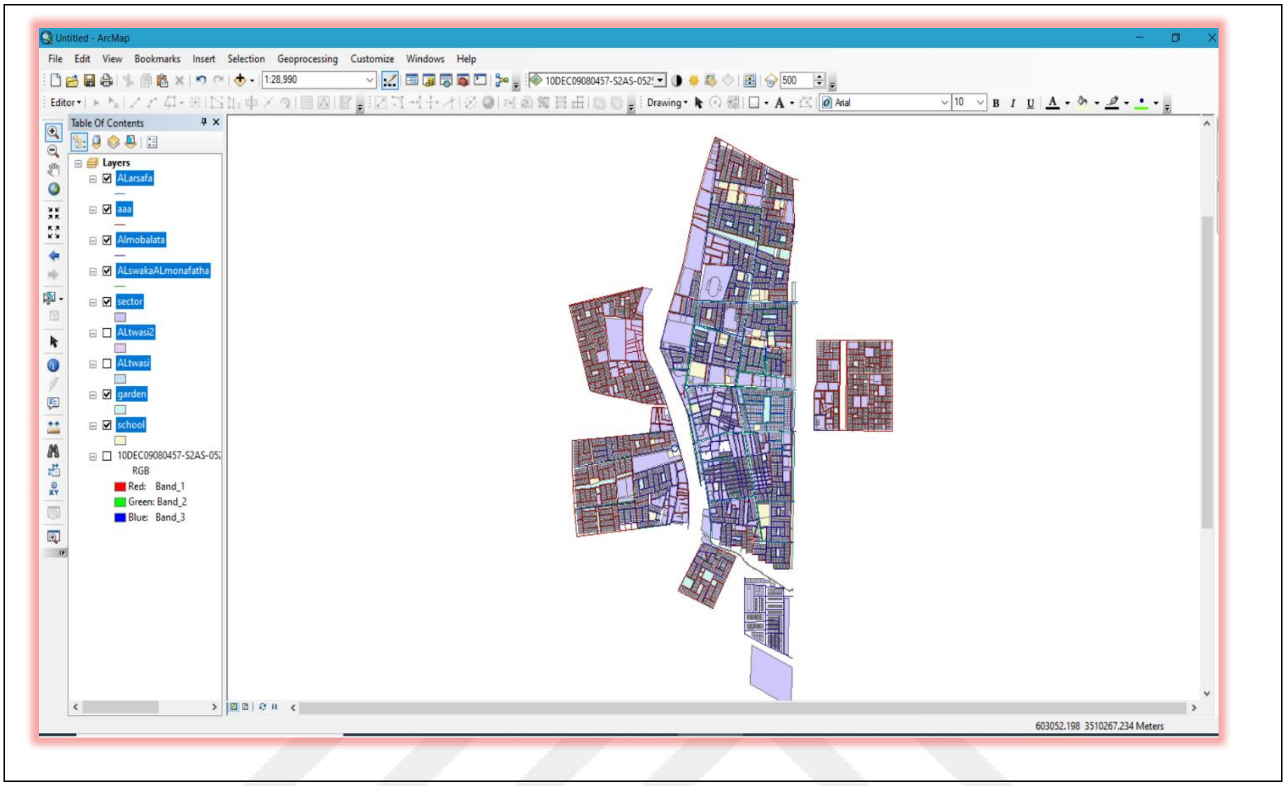


Figure 3.3: ArcGIS Interface

3.1.3 Data Entry Stage

the data was collected from the Directorate of Al-Rifai Municipality / Urban Planning Division, the Planning and Follow-up Division, and the GIS unit, as well as information about the state of the city and checked using a GPS device to determine the location. And city areas and the program were entered into the databases.

3.1.4 The Data Storage Stage

After completing the drawing of two layers with all their details, they were stored in the form of lines representing the paths of those roads, while the property layer was stored in the form of closed areas (polygons), which express the boundaries of those areas where each line entered in the map has a value Derived from the database that was prepared and entered the program.

3.1.5 Data Processing Stage

At this stage, data processing operations are performed and relationships are formed between those data by entering mathematical, computational, and statistical equations to obtain columns for other important data and linking them to the characteristics of each feature drawn inside the map, as there are many commands in the program that enable us From the production of new columns of data based on data obtained from the map and data entered into the program. After completing the processing and analysis, we get what we call the GIS Data Base, which belongs to the drawing layer that we drew.

3.1.6 The Stage of Displaying The Results

In the last stage of the ArcGIS 10.8 program for geographic information systems, we get the results. The process of displaying the results depends on the way the data was stored. In this research, maps of the city's areas were produced, and through the process of linking metadata and spatial data, where an integrated map was obtained. Included are the numbered streets and properties linked to the database, which shows all paved streets in each region and all of the unpaved streets that are not covered by public services. Tables will also be displayed with data for each region and its streets, the company that paved the street, and the year, as well as the names of projects and the number of completed streets for each project.

3.2 ADDITIONAL COMPLEMENTARY PROGRAMS TO THE GIS PROGRAM

After drawing all the layers and entering all the data such as the number of paved streets and their lengths, the companies executing the work and the names of the projects, we have a wide database through which we can manage all projects and companies and know the areas in which work is underway and the areas deprived of services, so we can make plans for the future in order to complete all the streets, but Here there are several commands that the program cannot provide, so we turned to ArcGIS Online to take advantage of the capabilities provided by the program.

ArcGIS Online is an online system that allows for the storage of vector and raster geographic data, the creation of workgroups, and the assignment of certain permissions to group members (such as the ability to read, edit, and share data; and group management) [64].

It is possible to create private groups by invitation only (Figure 3.4) or public groups open to everyone as part of the GIS program. Geoportals give seamless, integrated access to all geographic locations, allowing all institutions and the general public to sharing to and exchange data in a collaborative environment [65].

as well as allowing us to import data and layers (Figure 3.5) from ArcGIS or by sketching directly on the program, as well as enter and edit data directly within the program. Without the Internet, it is feasible to use pre-set designs and implement maps [40].

ArcGIS Online can be used to create applications, analyze data, share and collaborate among project members, and help access custom workflow applications, maps, and data from around the world. Maps and data are stored on a private infrastructure that is both secure and private.

It allows work supervisors to collaborate to create maps, scenes, apps, and notebooks among the members of the project.

ArcGIS Online contains everything you need to build web maps, three-dimensional web sceneries, web apps, and notes, as well as everything else. To explore and view your data, you can use the Map Viewer Classic, the Map Viewer, and the 3D Scene Viewer, which all provide access to a collection of base maps and smart styles. Aside from that, we also have access to templates and widgets for developing online apps that can be published to ArcGIS Online.

Additionally, ArcGIS Online provides an extensive variety of maps, scenes, data layers, and apps from the ArcGIS community, allowing your entire business to explore, understand, and measure geographic data. Locate suitable locations, enrich data, identify the closest, and summarize data using Map Viewer Classic's built-in analysis functions.

Using this software, we may publish data to ArcGIS Online as web layers. Esri's scale and cloud dynamically host these web layers as demand increases or drops, freeing up internal resources. In addition, layers can be added to a map and shared with others. Directly from ArcGIS Pro and/or online, we can share data with others via publishing.

Fieldwork is supported via ArcGIS Online. We can use built-in tools and programs to collect data, explore, coordinate, and monitor projects with the help of the software. Create offline map areas by creating map areas. After that, we set up sync so that offline editors could acquire the most recent map updates.

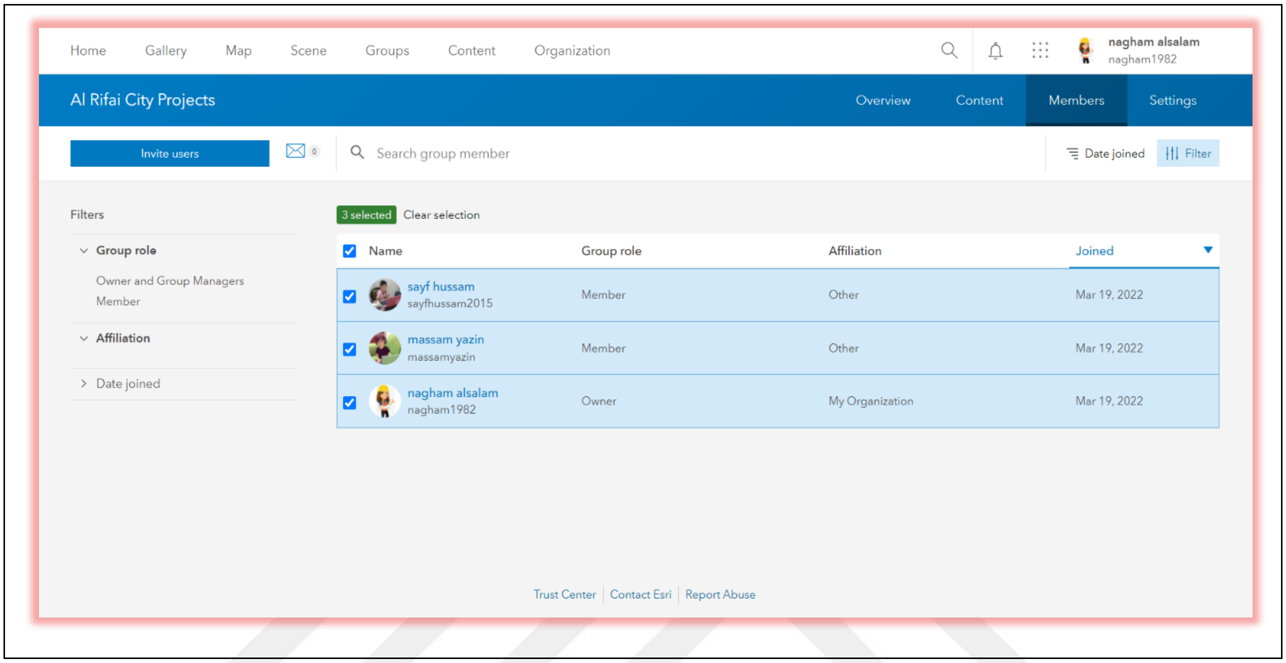


Figure 3.4: A Group in The Program ArcGIS Online

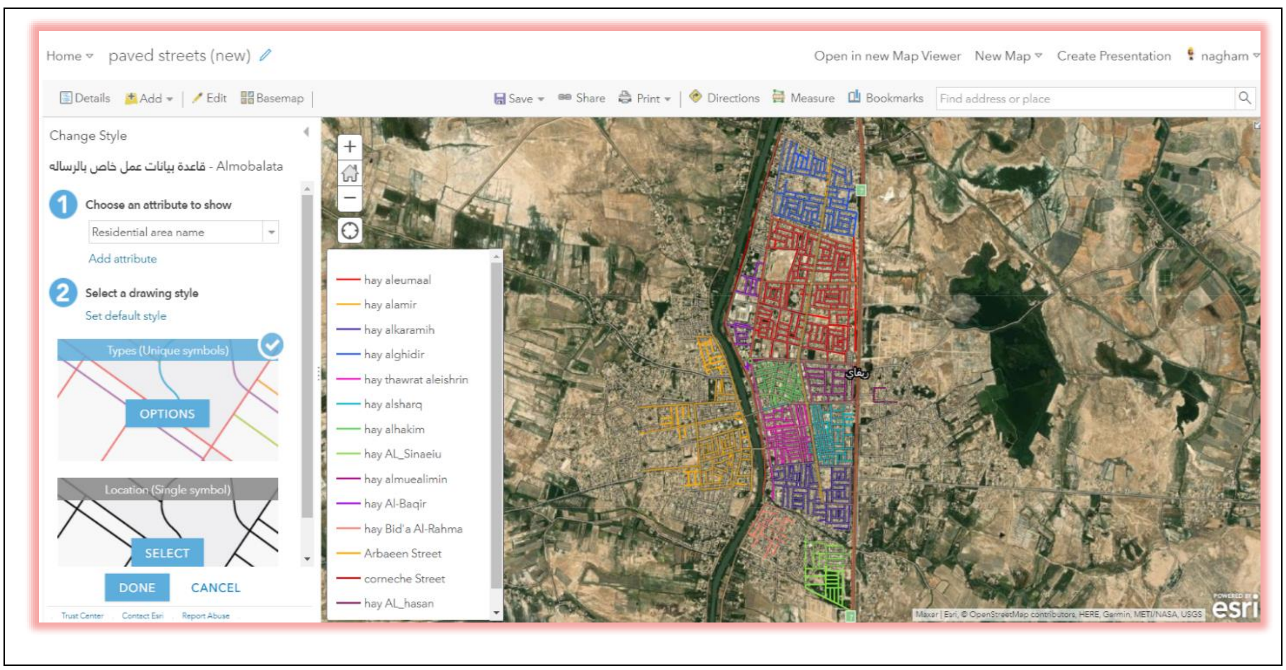


Figure 3.5: ArcGIS Online Interface

Regardless of the geographical scale at which the study is conducted, the geographic position and description of objects are critical components of field research. Throughout history, environmental researchers have used a variety of instruments and procedures to identify and record the location and description of observations, each with its own set of restrictions on its use. Recently, more and more prevalent digital approaches and new technology have piqued the attention of and gained favor among those working in the field of environmental research. Among these technologies are Portable devices that contain applications capable of drawing maps, determining locations, and entering and extracting data, which have been rising in popularity Its popularity has increased recently, particularly in developing countries Mobile devices with (Global Positioning System) capabilities, such as smartphones and tablets, are becoming increasingly common [64].

Because smartphones and tablets with GPS receivers built in have replaced dedicated handheld equipment like consumer-grade GPS (GPS) for tourism, field mapping has become considerably simpler and more accessible to a wider audience. It is nevertheless surprising to see how little attention is given to mobile devices and specialized field mapping software in the methods sections of research articles, despite the fact that they are becoming increasingly popular.

Such software might improve their efficiency, accuracy, and data quality, all of which could contribute to improved study outcomes.

In this work, we want to raise greater awareness of such technologies among environmental researchers, who may be able to benefit from employing specific software accessible for Portable devices. These programs may increase study efficiency, accuracy, and data quality, all of which may improve study results. Environmental researchers, who might benefit from utilizing specialised software accessible for mobile devices, should be made more aware of such technology, as well as environmental educators. Such software might improve their efficiency, accuracy, and data quality, all of which could contribute to improved study outcomes.

While on the job site, we use a phone application called the collector (Figure 3.6), In the field, Collector enables us to create an inventory of assets, take notes, and conduct inspections while on the job. which dramatically simplifies our work and allows us to take coordinates on the spot. After that, we can either share the maps with the entire group of engineers or keep them to ourselves as private documents.

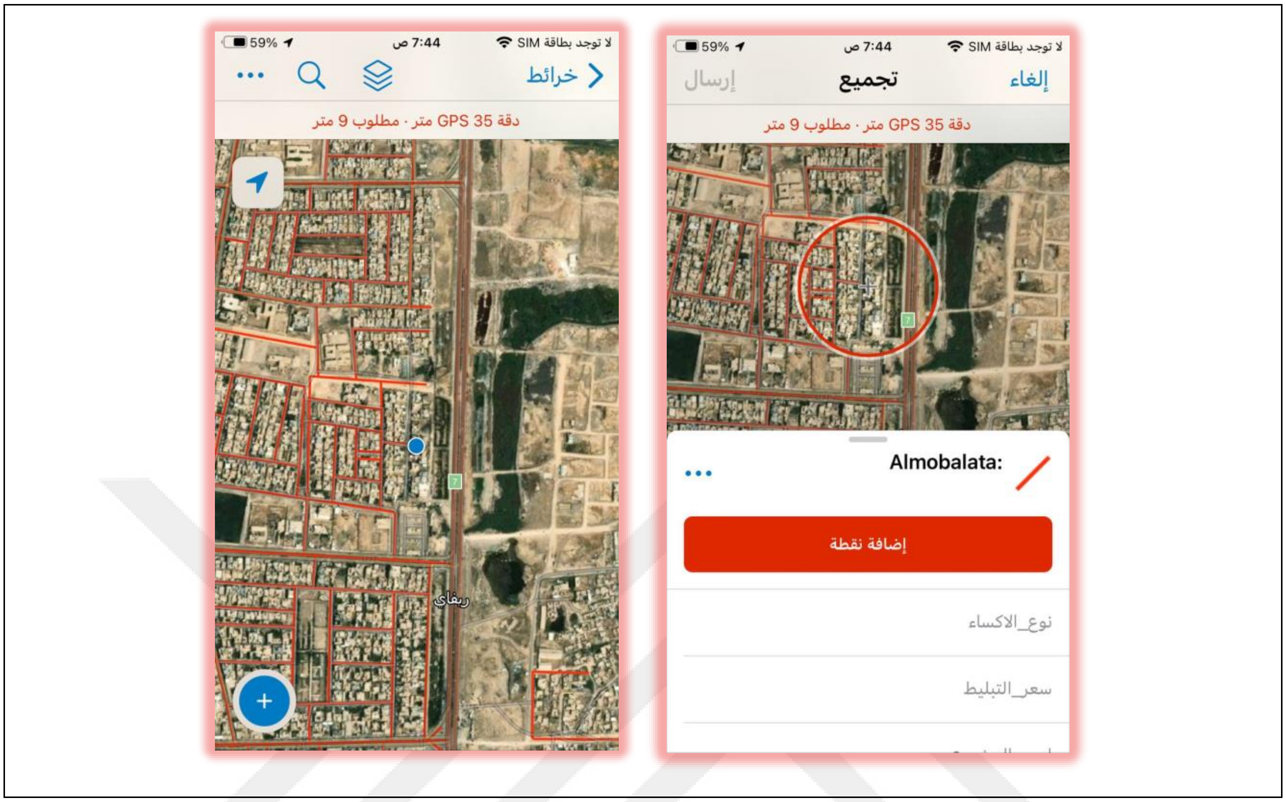


Figure 3.6: The Interface of The Collector Program

The Collector app is helpful for fieldwork when you are working in locations where there is no internet connectivity since offline maps allow you to set data in such areas.

Then we had access to applications, maps, and workflow data from around the world, as well as the tools they needed to get around the field. Data and maps can be configured to suit private planning and IT requirements by storing them in a private and secure infrastructure.

The mobile application for maps created by Esri for the ArcGIS online, Collector is obtainable for the iOS, Android, and Windows operating systems. More than 100 000 copies have been downloaded and installed, according to statistics from the Google Play Store. This program allows for both online and offline processes in the field, and it provides the option of mappings with the use of (Global Positioning System) or by manually entering the data relying on the map. For circumstances when we are unable to utilize GPS, such as when an item we wish to map is not immediately accessible and its position must be determined from the surrounding terrain, the latter is critical. A highly significant feature is the ability to build polygon and line features in addition to points, and these features may also have characteristics. This is one of the most essential and useful elements of the program.

After completing the drawing of the layers and entering all the data into the ArcGIS program, we go to ArcGIS Online and go to the map's portal, then we add the Base map, and then we add the layers and data that is created in ArcGIS and we modify it Figure (3.7) , then we go to the group portal and form a group that includes a group of engineers supervising the Projects and work is done in this group and modification from all parties. Discussion, participation, and work take place in this group. We can also work on the project site without the Internet, especially in areas that are not connected to the Internet.

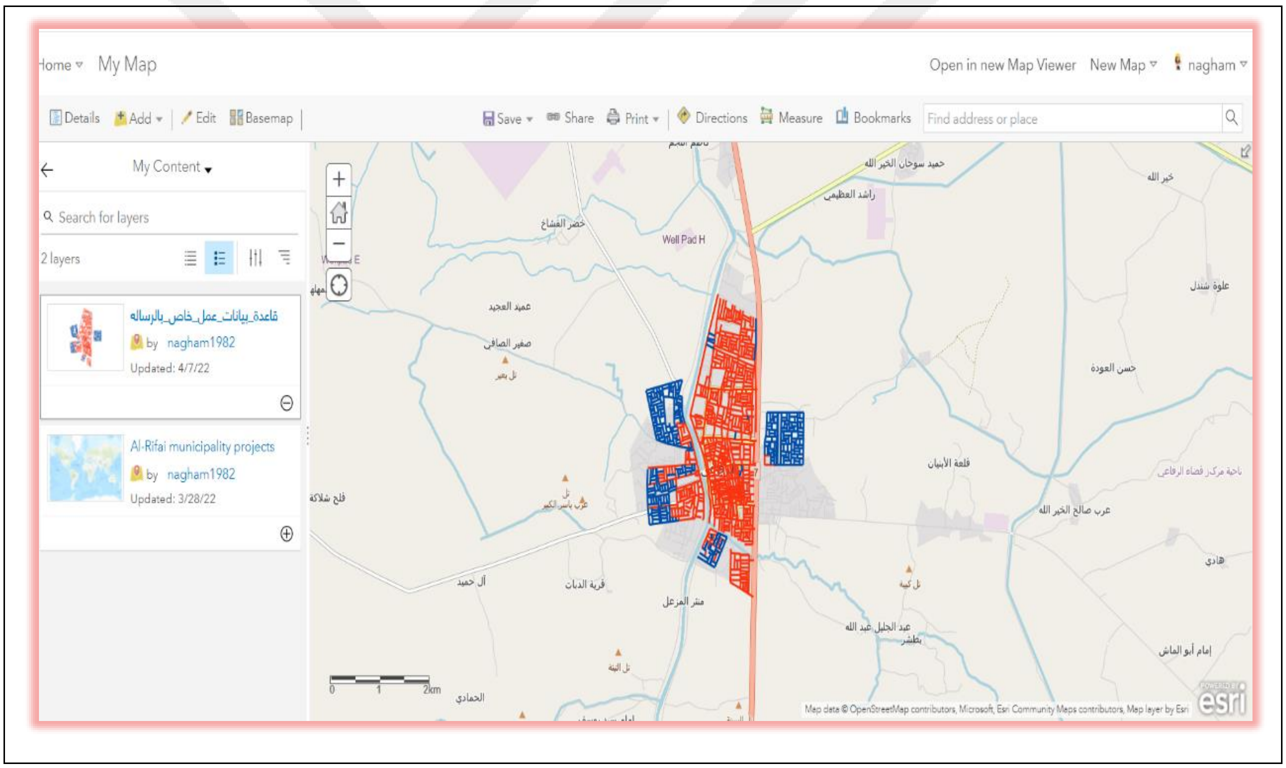


Figure 3.7: Add Layers to ArcGIS Online Program

After drawing all the layers and entering all the data such as the number of paved streets and their lengths, the companies executing the work and the names of the projects, we have a wide database through which we can manage all projects and companies and know the areas in which work is underway and the areas deprived of services, so we can make plans for the future in order to complete all the streets.

Where we used the data tables (table 3.2) and graphs in the Excel program, where we clarified the total of paved streets for each company (Chart 3.1) and the sum of the paved streets for each project (Chart 3.2) and the number of paved streets in each area (Chart 3.3).

Table 3.2: Table of All Data

OBJECTID	SHAPE_Length	paved type	paved cost	name project	company work	Region	paved year	paved width	x	y
1	665.9527536	paved	27000	Create the entran	Albahjat alealamia	hay almuealin	2009	8	605354.2	350979
2	242.8882513	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.6	605283.2	351012
3	310.1198668	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.7	605572.4	350995
4	345.1726081	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.7	605399.3	350988
5	238.5540742	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.5	605439.8	351000
6	245.0996863	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.6	605363.9	351000
7	190.6289685	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	5.4	605270.1	351007
8	180.5602185	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.6	605274.4	351004
9	159.3950574	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.7	605283.5	350996
10	132.9073441	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.8	605506.6	351003
11	132.9809887	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.5	605506	350996
12	81.63036368	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	5.8	605399	350983
13	67.68571658	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6	605406.1	351015
14	258.0693962	paved	25000	Construction of st	alfurat alealamiatu	hay almuealin	2008	6.6	605215.4	350991
15	485.879735	paved	15000	Paving and street	Sarah alajawid	hay aleumaal	2010		605462.5	351096
19	228.0338322	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.8	605264	351084
20	258.9736339	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	5.2	605601.5	351083
21	329.1216991	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.7	605438.1	351090
22	349.5785501	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	6	605425.5	351076
23	133.1403486	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.6	605354.9	351083
24	124.0652297	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	5.2	605308.5	351083
25	146.6125277	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.4	605554	351083
26	144.0547156	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.7	605506.6	351083
27	149.227198	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.9	605432.3	351085
28	154.8870164	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	5	605429.2	351081
30	61.24114704	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.6	605482.8	351093
31	61.2505004	paved	27000	Construction of pa	aldalil alealamiatu+alghasaq aldawlia	hay aleumaal	2008	4.6	605389.5	351093

company work	مجموع من OBJECTID
Aabir alkhalij + Zahw aleula	1797
Albahjat alealamia	5163
Albina' alsaeid	7614
Albina' alsaeid+ Mabani alnaasiria	12535
Al-Bunyan Company	4727
Al-Bunyan Company + Rawnaq aljanub	1526
aldalil alealamiatu+alghasaq aldawlia	10227
ALfurat alawst	2524
alfurat alealamiatu	1553
ALghasaq aldawlia	190
Al-Jawad Company	50536
ALlsaadiq alamin	785
ALrawabi alshaamikha	2451
ALrawaq alakhdar	3088
ALtaemir alhandisih	38482
ALtafawul Company	16463
Dhi Qar Shameat	3015
Difaf asia	586
majmueat nur alttyf	29608
municipal work	28068
Runaq aljanub	435
Sarah alajawid	3694
Sewer work	885
Yanabie akad	10996

Chart 3.1: Total of paved streets for each company

name project	Sum Streets
Construction streets of the hay aleumaal alabrar	2451
Construction Al-Ghadir, workers and market streets	17742
Construction of Al Noor Street	3088
Construction of Al-Rifai Corniche	2804
Construction of concrete streets	52061
Construction of concrete streets in hay Al-Hakim	1655
Construction of paving streets in Al-Rifai	9094
Construction of Silo Street 2012	7392
Construction of streets and Husseinieh in alhakim	903
Construction of streets in Al-Rifai city	6807
Construction of streets in Al-Rifai district	9411
Construction of streets in Al-Rifai district 2009	3124
Construction of streets in different areas	10374
Construction of streets in hay alamir 2012	10996
Construction of streets in hay Al-Ghadir	7614
Construction of streets in separate areas 2013	6769
Construction of streets in the hay almuealimin	2276
Construction of streets with networks 2013	10458
construction streets and networks in albidea	15085
construction streets in Al-Baqir and Al-Hussainiya	2547
Construction streets with networks in hay alamir	16250
Create the entrance and its branches	2937
Create the entrance to the stadium with the silo	2739
municipal work	23815
Paving streets in Al-Rifai city 2008	1173

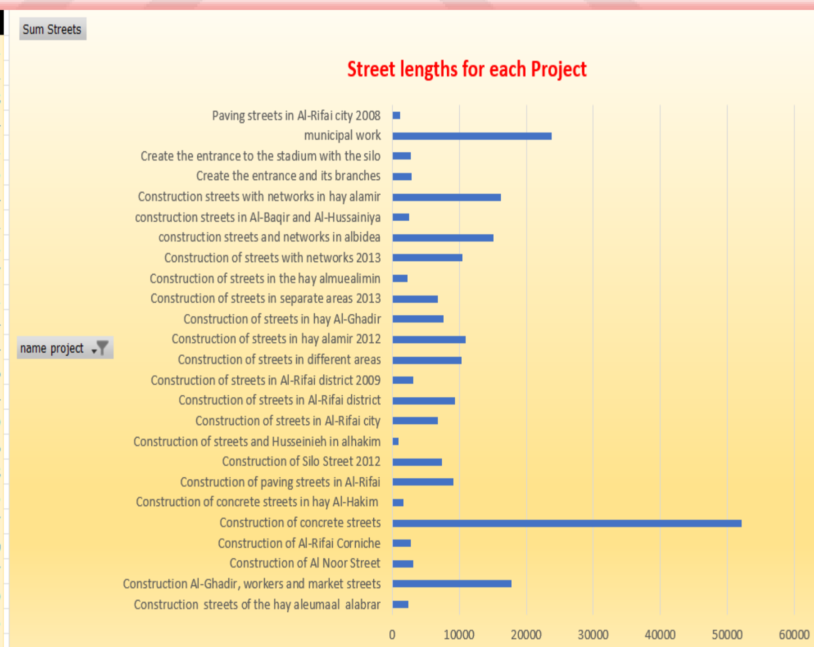


Chart 3.2: Sum of the paved streets for each project

Region	مجموع من SHAPE_Length
Arbaeen Street	3407
corneche Street	3693
hay aleumaal	25579
hay alsharq	7202
hay AL_hasan	499
hay AL_Sinaeiu	5803
hay alamir	15690
hay Al-Baqir	2512
hay alghidir	11934
hay alhakim	5307
hay alkaramih	10466
hay almuealimin	5221
hay Bid'a Al-Rahma	2793
hay thawrat aleishrin	8760

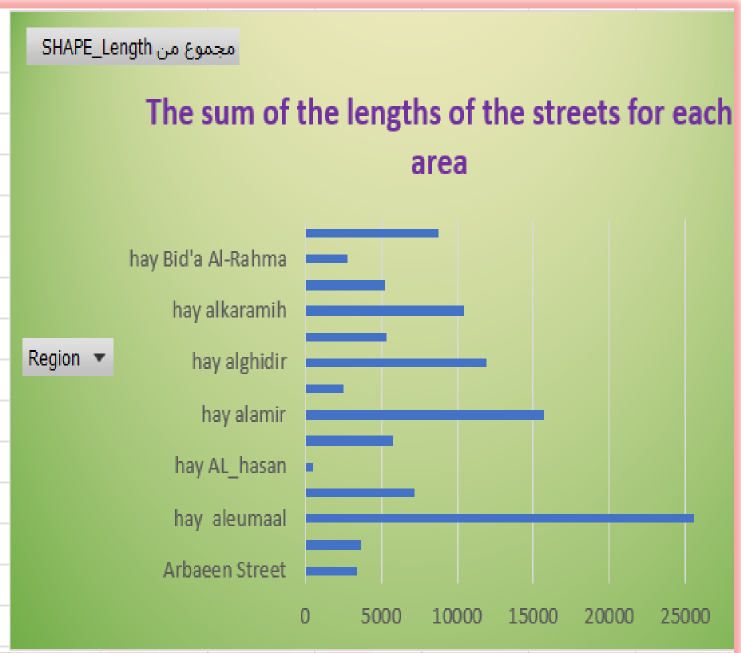


Chart 3.3: Number of Paved Streets in Each Area

We used the ArcGIS Dashboards application in order to present the results in a straightforward and understandable manner.

ArcGIS Dashboards is a web application that can be changed to fit the user's needs. It lets users share data by showing location-based analytics and data visualizations on screen. ArcGIS dashboards can help any organization that uses the ArcGIS platform make decisions, see trends, check on things in real-time, and share information with their communities.

Described as a "visible display of information on an organization's operations," a dashboard is a visual display of information on an organization's operations that helps managers, researchers, and other workers align their decisions with the organization's goals. Dashboards are typically available to a large number of decision-makers, each with its own set of requirements. Dashboards are sometimes made available to the general public in order to allow them to submit comments [79].

Using a dashboard, you can keep tabs on events, make decisions, share information, and spot trends. The goal of a dashboard is to display a variety of data in a single, easy-to-understand picture. It gives you a complete picture of your data and gives you the information you need to make swift decisions. Dashboards are part of the geographical information system, just like web maps and web layers. When browsing and searching for content, the Dashboard icon identifies certain objects within a company.

In order to design a dashboard, you have a variety of options to choose from. Using a dashboard, you can:

a) A one-stop review of all data that must be reported or decisions made.

b) follow up on the most critical information related to your daily operations.

c) Ensure that all of the project members focus on working by presenting and using the same data.

d) follow up on the level of the product, business, campaign or organization team, in real-time.

e) Informing communities of events, ongoing initiatives, and emergencies.

f) Create a custom view of the largest set of information to show you all the required settings

As events, events and other activities frequently change, certain dashboards have been built to keep you up to date on everything that's going on right now. For executives, engineers, and decision-makers who want to keep an eye on their company's KPIs and indicators, there are strategic options available. The analytic elements of some dashboards are used to identify data patterns and other data properties of relevance. In other cases, the purpose is purely informative, and the data is employed to convey a story.

For teams and individuals both inside and outside the company, dashboards are designed to be straightforward and easy to understand. Typical end-users include company presidents and executives, as well as senior managers in various departments, GIS specialists, and members of the local community.

As the name suggests, dashboards are made up of configurable features such as maps (which may be filtered), lists, charts, gauges, and indicators. There are numerous ways to stack or arrange items.

An excellent dashboard should have the following features:

a) Draw attention to areas that need to be highlighted.

b) Show the important items on a screen full of information.

c) Show performance measures accurately, clearly, And without ambiguity

Since most items are data-driven, they reflect the information you plan to display to your target audience. In this way, dashboards enable the presentation of an set of data to the intended audience by providing filtering tools.

In both processed and unprocessed settings, dashboards can be used. On a large screen at a facility like an operations center, unprocessed dashboards generally seem nicer and are more interactive than dashboards on desktops or tablets.

We will be able to distribute the dashboard to all team members once it has been completed. Dashboards can be shared publicly or privately, depending on your preference. In recent years, the dashboard has grown in importance [66].

Users' success with dashboards is only as good as their ability to use them effectively. Consequently, it is critical for developers to understand the final purpose of a dashboard when developing it in order to guide them through the development process. It is also advantageous for the developer to be aware of how and what types of data will be collected during the development process [66].

When we start creating the dashboard, we can arrange it in a way that makes it easier for us to understand all the details and show all the data and update it by all project supervisors.

Where we started drawing all the city streets and dividing here, all paved streets in unpaved streets, all data related to the streets were included, including the cost of executing companies, type of implementation and year of implementation (Figures 3.8, 3.9)

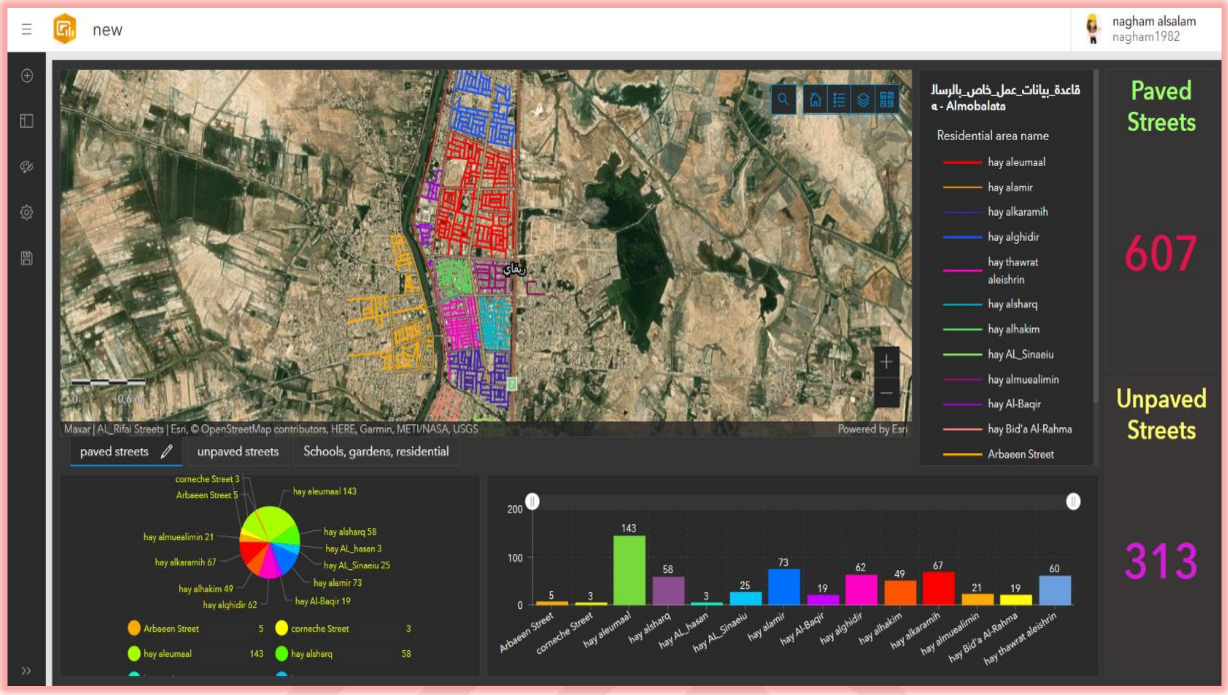


Figure 3.8: A Dashboard Showing All the Paved Streets of The City and all its Details

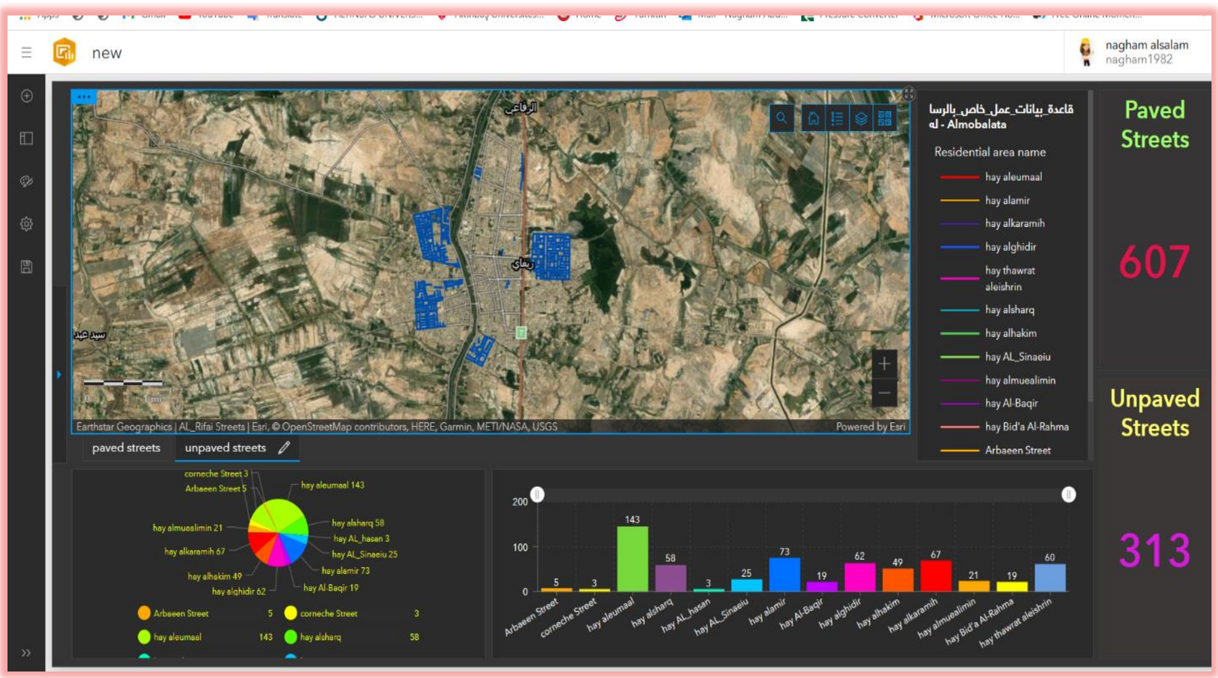


Figure 3.9: A Dashboard Showing all The Unpaved Streets of the City and All its Details

After that, we drew all the residential and government units, including schools, government departments and gardens (Figure 3.10).

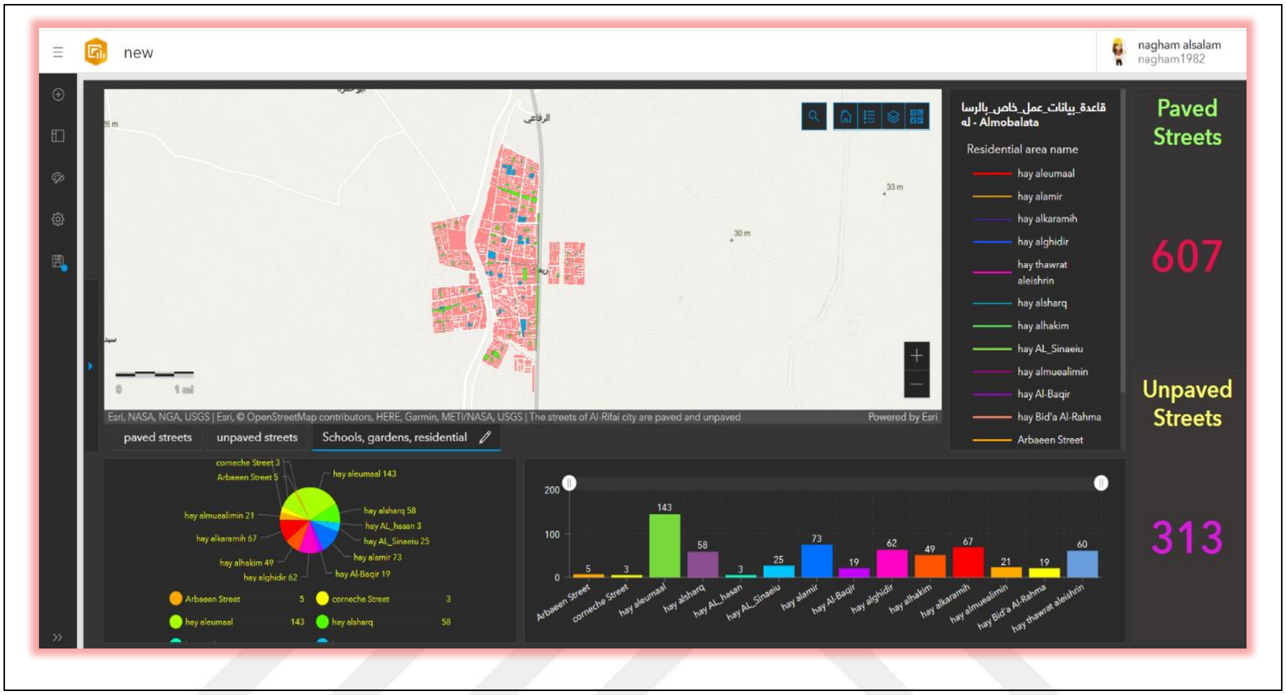


Figure 3.10: Residential and Government Units and Gardens

There are several tools available in the program, including:

Map legend, Serial chart, Pie chart, Indicator (Figures 3.11, 3.12, 3.13, 3.14)

It made it easier for us and everyone who wants to monitor the work to understand the details of the work more easily and flexibly.

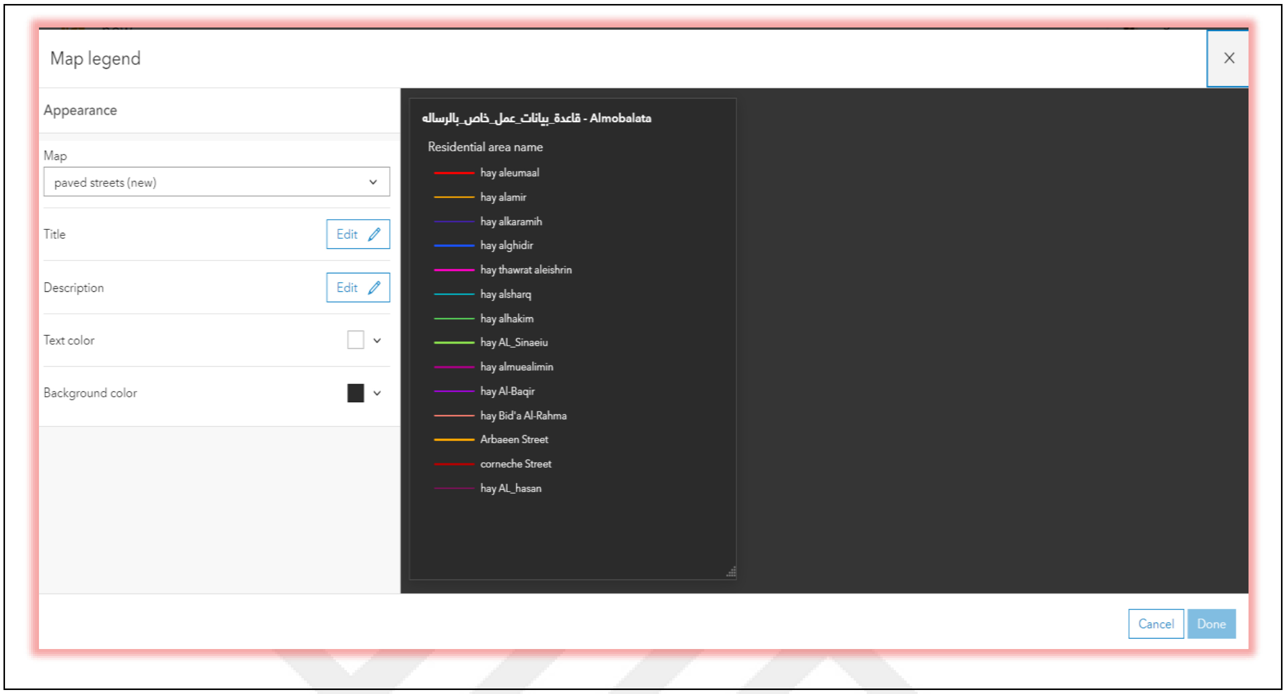


Figure 3.11: A Map Legend that Shows the Streets of Each Residential Area

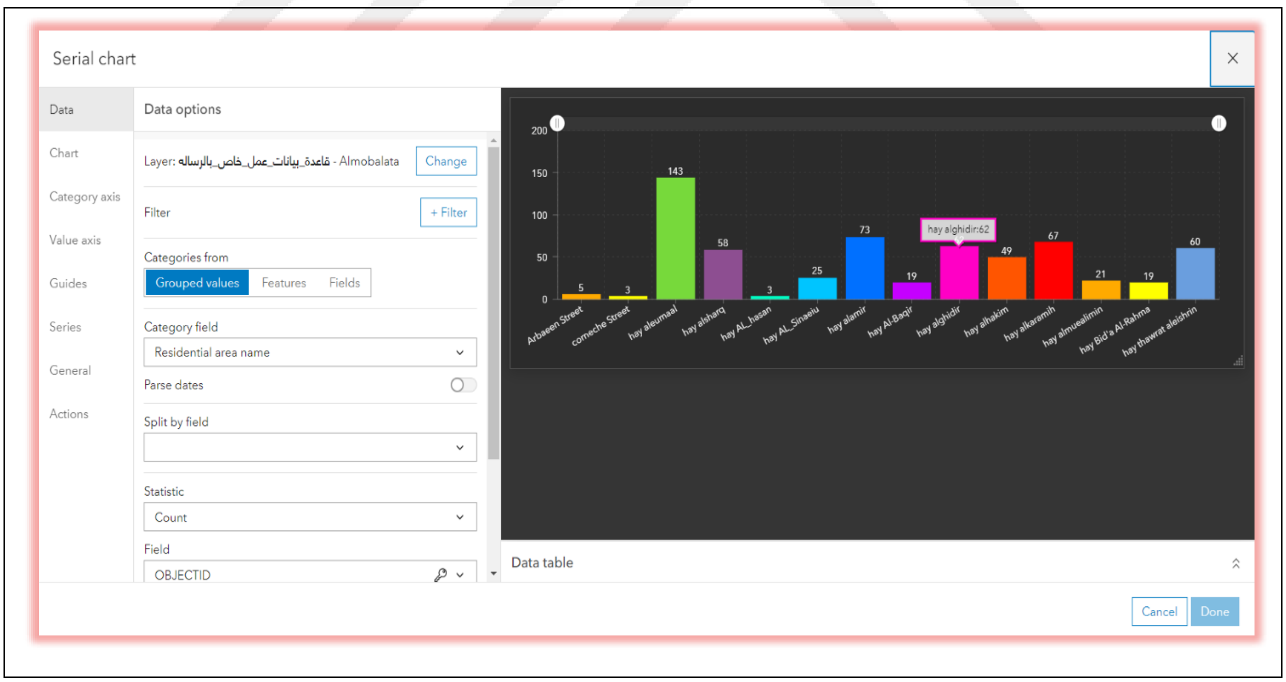


Figure 3.12: A Serial Chart Showing The Number of Paved Streets in Each Residential Area

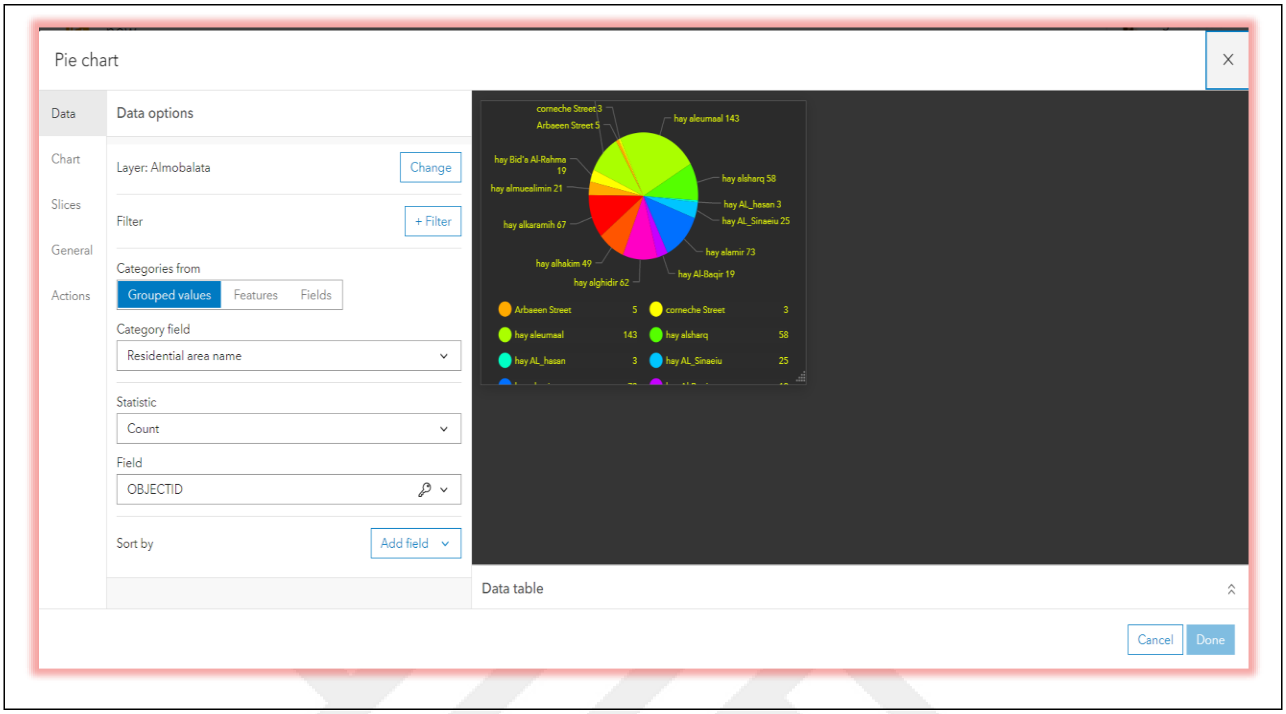


Figure 3.13: A Pie Chart Showing The Number of Paved Streets in Each Residential Area

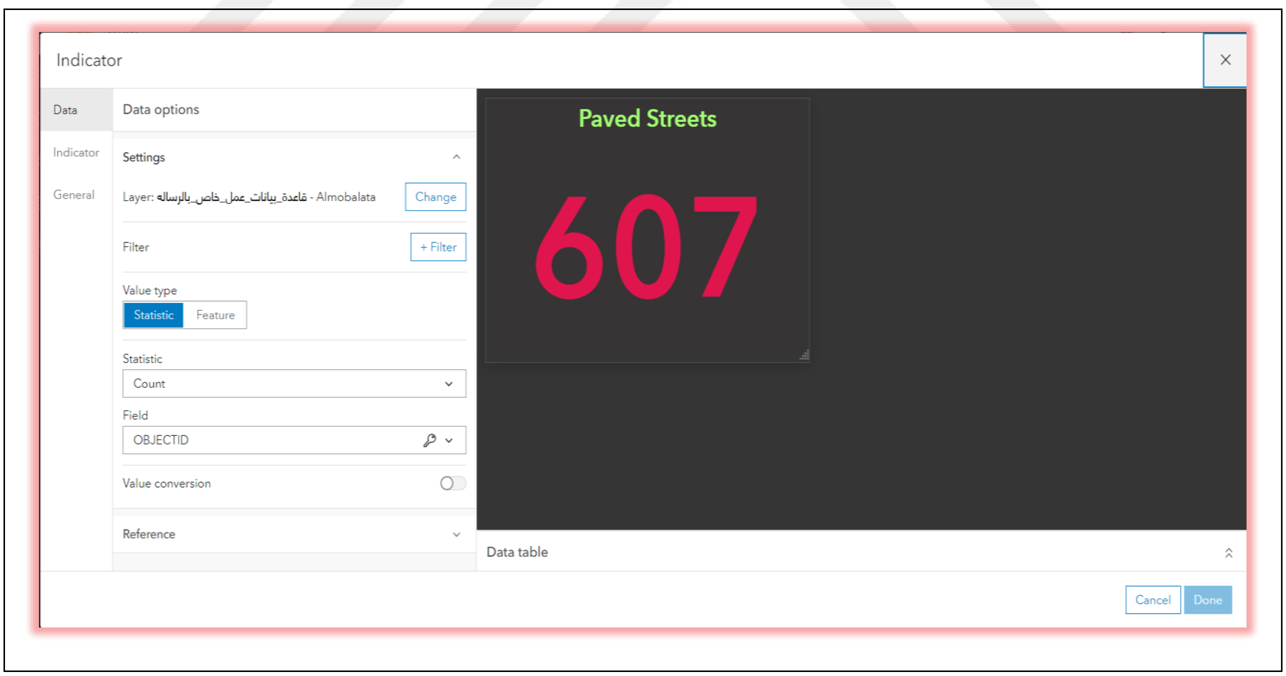


Figure 3.14: An Indicator Showing The Number of Paved Streets

3.3 THE EFFECTIVE FACTORS

Since Douglas et al. [67] surveyed a significant body of literature on the issue and offered an overall view on geotechnical concerns rather than concentrating on particular ones, this research utilized the success criteria found within. The 85 variables found by[68] have been described and tested by experts. The next step in our investigation will be to enlist the help of experts in assessing the potential dangers of upcoming transportation initiatives. An extensive literature search led to the creation of a comprehensive list of success indicators, and a questionnaire was developed to solicit responses from Iraqi infrastructure project professionals. These parameters are summarized in Table 3.3.

Table 3.3: Statistical Analysis of Success Factors [68])

No.	Success factors group
1	Project Management Factors
2	Procurement Related Factors
3	Client Related Factors
4	Design Team-Related Factors
5	Contractor-Related Factors
6	Project Manager Related Factors
7	Business and Work Environment Related Factors
8	Work Environment Related
9	Project related factors

Table 3.4: Statistical Analysis of Failure Factors [68]

No.	factor	No.	factor
1	Ineffective project planning and control	22	Delay due to sub-contractor work.
2	underestimation of time and cost	23	Inadequate experience of consultant.
3	Poor monitoring and quality control by regulatory agencies	24	Financial difficulties of contractor.
4	Poor design capacity and the frequent design changes	25	Changes in government regulations and laws.
5	Lack of available skilled personnel and technical experts	26	Delays in producing design documents.
6	Vulnerability to and ravaging environmental degradation and devastation due to wrong location.	27	Delaying delivering the site to consultant and contractor.
7	Designers and contractors inability to do the work	28	Financial difficulties of owner (Delays in progress payments by owner).
8	Frequent changes and inconsistence in government policy and priorityofficials. Colossal waste of resources in project implementation due to unacceptable design errors and mistakes	29	Delay in material delivery from the supplier.
9	Scarcity and lack of original materials requirement	30	Frequent equipment breakdown.
10	Prequalification procedure and corrupt government officials	31	Delay from obtaining sanctions from various authorities.

Continue to Table 3.4

No.	factor	No.	factor
11	Colossal waste of resources in project implementation due to unacceptable design errors and mistakes	32	Inadequate legal framework.
12	Project contract sum indirectly used to compensate political party big-wigs.	33	Lack of capable owners Improper planning and Scheduling.
13	Youth restiveness, and land ownership disputes	34	Insufficient data collection and Survey before design.
14	Litigations and court injunctions	35	Obsolete or unsuitable construction methods.
15	Inaccessibility and geo hazardous impassable terrain to the project site	36	Poor site management and supervision.
16	Financial and administrative corruption	37	Incompetence of project team.
17	Project scope creep with massive amount of change or variation orders	38	Shortage of manpower (skilled, semi-skilled, unskilled labor).
18	Capacity constraints in terms of construction equipment	39	Slow payment of completed works.
19	Mode of financing and payment for completed work	40	Bureaucratic administrative system.
20	delay in approving major changes in the scope of work by consultant	41	Lack of accurate historical information.
21	Rework due to error by contractor	42	Interest and inflation rates.

3.4 RANKING THE FACTORS

The fundamental purpose of this research is to identify the factor effect factors that are the most important and significant for the development of infrastructure projects. To successfully fulfill the rating, you will need a crew that is both trained and experienced. For the objectives of data gathering and analysis, the Delphi method provides the researcher with a tool that is flexible and open to change in order to meet the requirements of the project. The use of the Delphi approach can be justified in a number of different ways.

3.5 RELATIVE IMPORTANT INDEX (RII)

Throughout the factor effect management process, the judgments made are influenced not only by the magnitude and severity of the factor effect, but also by the factor effect of the decision makers. As a result, once the effects of the factor have been assessed, it is time to determine whether or not they can be tolerated. The degree of factor influence that a person, a customer, or a community is prepared to accept determines the decision that a decision-maker will make. Prior to make any decisions on the budget, the timeframe, the technological solutions, the building approaches, etc., it is vital to identify the degree of factor effect that is deemed acceptable. In order to make the most informed decisions possible during the earliest phases of the project, it is required to develop an early determination of the acceptable factor effect threshold. The permissible level of factor impact must be set in the project's factor effect policy. Acceptance of factor effects may be described as the extent to which a decision-maker is willing to accept a particular factor impact. Acceptance of factor impact is influenced by a variety of factors, including the individual's or organization's perception of factor effect, the decision criteria, and prior knowledge and experience with comparable decisions, among others. Acceptance of a factor effect refers to the method in which an individual or organization manages a factor impact. This idea can be categorized as factor effect aversion, factor effect neutrality, and factor effect taking. These may be described using the certainty equivalent, which refers to the expected value or quantity of resources that are certain to be accessible and are valued similarly to a potentially hazardous situation.[69][70]

A multitude of criteria impact the acceptability of the factor effect. In addition, the degree of acceptable factor effect varies widely amongst people, groups, and nations. This level is regulated by a variety of factors, including personal, technological, economic, social, and psychological factors. Acceptance of factor effect is determined by a range of factors, including prior experiences with factor effects, public interest, familiarity with various working techniques, etc. In contrast, the factor effect of project managers is frequently neutral or even positive, but the influence of individuals is generally negative. The fact that people' judgments of factor effect tend to follow a Gaussian distribution with a skew toward a lower readiness to accept factor effects is evidence that humans are intrinsically adverse to factor impact. When the amount of projected sacrifice or loss is relatively minimal, neutral factor effects might be assumed. In the majority of circumstances, establishing the degree of factor effect that individual or organization is ready to accept may be exceedingly difficult. As a direct result of this, more fundamental techniques must be used to define permissible factor impact bounds. A cost-benefit analysis should be conducted in order to identify the acceptable level of factor effect. The primary objective is to maximize the disparity between the entire benefits of the project and its total expenses. Consequently, the chance of failure and its implications are included into the total cost. Largely, the RII test on survey responses is applied to determine the influence of factor effect components. This is achieved by assigning each variable a factor impact value. The objective of this study's analysis was to determine the relative importance of the numerous factors considered as crucial to the successful completion of infrastructure projects. The score for each factor is calculated based on the total number of replies received from respondents. For RII calculation, the following formula was utilized:

$$RII = \sum (PiUi)/Nn \qquad (3.1)$$

RII = relative importance index

Pi = respondent’s rating of factor effect

Ui = number of respondents placing identical weighting/rating on the factor effect

N = sample size people responded to the survey

n = the highest attainable score for each factor effect

3.6 WASPAS (WEIGHTED AGGREGATED SUM PRODUCT ASSESSMENT)

The weighted aggregated sum product assessment (WASPAS) technique has been included into newly developed MCDM techniques. Zavadskas et al.23 saw it as a beneficial expansion of the SAW and WSM when it was introduced in 2012. The steps employed in this method are listed below. Alternatives or choices are developed alongside appropriate assessment criteria in the first step. The decision template is then provided in equation (1). Each row of a decision matrix or template corresponds to an option, whereas each column corresponds to a criterion (price, storage, data transfer speed, weight, volume and so on). Consequently, eij of the decision template "DT" (eij; i= 1, 2,..., a number of choices (n), j= 1, 2,..., a number of characteristics (m)) represent contributions.

$$DT = \begin{bmatrix} e_{11} & e_{12} & -- & e_{1j} & - & e_{1m} \\ e_{21} & e_{22} & -- & e_{2j} & - & e_{2m} \\ -- & - & -- & - & - & - \\ e_{i1} & e_{i2} & - & e_{ij} & - & e_{im} \\ - & - & - & - & - & -- \\ e_{n1} & e_{n2} & - & e_{nj} & - & e_{nm} \end{bmatrix} \quad (3.2)$$

Using linear normalization, the obtained data of "DT" are rendered dimensionless in

Step 3. Equation (2) for advantageous criteria, such as profit, and equation (3) for disadvantageous criteria, such as price. Compute the normalized decision matrix, NDMij, with the linear normalization approach, as illustrated in equation (2) for advantageous criteria, i.e., the superior value is desired, such as profit, and in equation (3) for nonbeneficial criteria, i.e., the inferior value is desired, such as cost. The equal weights method (EWM) and standard deviation method (SDM) are used in this research; the entire sum of all weights should equal one.

Step 5: A dual optimality criterion is used based on the SAW, which is shown in Equations below and the WPM, which is represented as in below:

$$Q_i^{SAW} = \sum_{j=1}^{m} (NDM_{ij} \times w_j) \quad (3.3)$$

$$Q_i^{WPM} = \prod_{j=1}^{m} (NDM_{ij})^{w_j} \quad (3.4)$$

The dual comparative significance of the alternative, i.e., performance index (Qi) based on SAW and WPM approaches, is computed as illustrated in the following equation:

$$Q_i^{WASPAS} = \lambda Q_i^{SAW} + (1 - \lambda) Q_i^{WPM} \qquad (3.5)$$

$$\lambda = \frac{\sigma^2(Q_i^{WPM})}{\sigma^2(Q_i^{SAW}) + \sigma^2(Q_i^{WPM})} \qquad (3.6)$$

Step 6: The performance index QWASPAS I of alternatives is assigned for final ranking, with the highest value of QWASPAS I at the top and the lowest value at the bottom.

3.7 SOFTWARE MATLAB R2018A

The initial stage is to identify and characterize all potential outcomes. This can be facilitated by a decision analysis tool, such as event tree analysis or a decision tree. The decision-making criteria must then be stated. As a last step in the examination of potential outcomes, each alternative option is evaluated based on the pertinent decision criteria. The final phase of the procedure is calculating the probability of each potential result. The decision criterion may then be utilized to rank the alternatives. The decision-making process concludes with a foundation or set of suggestions that will assist the decision-maker in making the best possible conclusion. Depending on the quantity of research and formal requirements, qualitative or quantitative factor impact categorization may be utilized. In qualitative factor effect categorizations, the use of a factor effect matrix is typical. In a factor effect matrix, categories of probability and severity are evaluated to determine how severe a prospective consequence may be. This strategy provides basic factor effect visualization and decision-making aid. For each project, it is essential to develop a factor impact matrix that considers the acceptable level of factor effect as well as the project's scope and scale. Factor effect classes, such as likelihood and consequence, should be expressed in straightforward language in the factor effect matrix. When assessing the factor effect, it is essential to evaluate the total exposure to the factor effect.

The MATLAB code for this step shown below

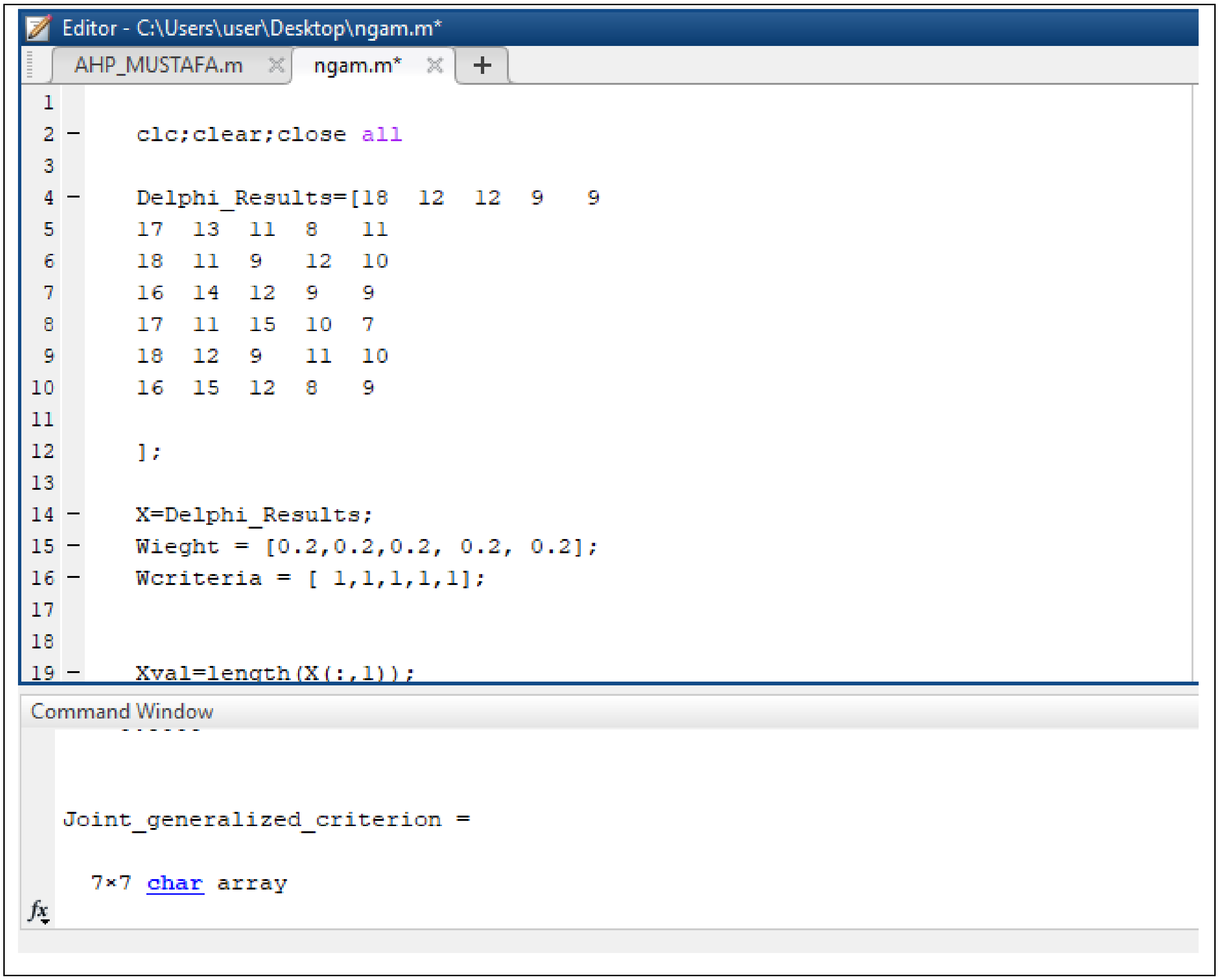


Figure 3.15: MATLAB Code

4. RESULTS AND DISCUSSION

Road construction projects are predicted to be completed on schedule and under budget. Schedules and budgets for transportation projects are subject to last-minute changes. Civil infrastructure development projects may result in claims, cost increases, and schedule delays due to a variety of circumstances. In transportation projects, it is normal for a change order to result in an increase in costs. Even slight modifications to construction projects might result in lawsuits and arguments. The purpose of this study is to understand more about the risks that result in claims, rework, and budget overruns. Several publications examine cost overruns and claims in civil construction projects, such as buildings, roads, tunnels, and hydropower or water infrastructure. There are a few studies on claims, modification orders, and cost overruns in Iraq as a result of risk. This research examines the successful aspects in road pavement construction projects and evaluates the firms based on those findings.

4.1 DELPHI RESULTS

When it comes to identifying and ranking challenges for management decision-making, the Delphi method in information systems research has shown to be an effective and extensively utilized approach. Nevertheless, the great majority of prior Delphi research did not employ a systematic approach. When the material given to researchers is either insufficient or susceptible to some degree of uncertainty, and when they are unable to utilize alternative techniques that provide higher levels of proof, they typically employ the Delphi method. The objective of this activity is to collect the professional opinions of a diverse group of individuals in order to discover areas of agreement. The Delphi method is a tried-and-true technique for answering research questions. This is achieved by identifying a position supported by the great majority of subject-matter specialists. It affords the possibility for reflection among the participants, who are able to change and analyze their perspective in light of the anonymised perspectives of others expressed throughout the session. The Delphi method necessitates the participation of specialists with knowledge of construction expenses in order to precisely predict the outcomes of probable future scenarios, calculate the possibility of an event occurring, or reach a judgment on a specific topic. Consequently, the involvement of the specialists in the survey is made feasible. The implementation of the percentage scoring method outlined before in this thesis was utilized to assess how much money should be spent on building construction. The identification procedure necessitates a rigorous strategy that can identify all of the components that are essential to the operation of the building project.

4.1.1 Round One

The first round of Delphi method presents the effective main group of factors as in below (FOR ALL FACTORS SEE APPENDIX I):

Table 4.1: Success Factors Group

	Success factors group
F1	Project Management Factors
F2	Contractor-Related Factors
F3	Project Manager Related Factors
F4	Project related factors

Table 4.2: Statistical Analysis of Failure Factors

	Statistical analysis of failure factors.
FL1	Ineffective project planning and control
FL2	Lack of available skilled personnel and technical experts
FL3	Financial and administrative corruption
FL4	Mode of financing and payment for completed work
FL5	Financial difficulties of contractor.
FL6	Financial difficulties of owner (Delays in progress payments by owner).
FL7	Frequent equipment breakdown.
FL8	Insufficient data collection and Survey before design.
FL9	Obsolete or unsuitable construction methods.
FL10	Poor site management and supervision.
FL11	Incompetence of project team.
FL12	Shortage of manpower (skilled, semi-skilled, unskilled labor).
FL13	Slow payment of completed works.
FL14	Bureaucratic administrative system.

4.1.2 Round Two

The first-round factors presented to the other Delphi's team to specify the effective factors on road paving projects> the results observed in the tables below:

Table 4.3: Statistical analysis of success factors group 1

frequent design change	strongly agree	agree	neutral	Disagree	strongly Disagree
	5	4	3	2	1
SF1	15	16	15	9	5
SF2	11	11	15	12	11
SF3	12	9	12	12	15
SF4	15	14	11	10	10
SF5	17	12	15	9	7
SF6	9	12	7	16	16
SF7	9	11	18	12	10
SF8	7	10	15	14	14

Table 4.4: Statistical analysis of success factors group 2

frequent design change	strongly agree	agree	neutral	Disagree	strongly Disagree
	5	4	3	2	1
SF19	18	13	12	7	10
SF20	10	9	15	12	14
SF21	17	10	12	14	7
SF22	10	6	14	15	15
SF23	10	12	11	12	15
SF24	8	11	12	15	14

Table 4.5: Statistical analysis of success factors group 3

frequent design change	strongly agree	agree	neutral	Disagree	strongly Disagree
	5	4	3	2	1
SF27	18	12	12	9	9
SF29	17	13	11	8	11
SF32	18	11	9	12	10
SF33	16	14	12	9	9
SF34	17	11	15	10	7
SF35	18	12	9	11	10
SF36	16	15	12	8	9

Table 4.6: Statistical Analysis of Success Factors group 4

frequent design change	strongly agree	agree	neutral	Disagree	strongly Disagree
	5	4	3	2	1
SF37	18	15	12	8	7
SF38	10	12	15	12	11
SF39	15	17	12	8	8
SF40	8	12	18	12	10
SF41	10	9	15	12	14
SF42	8	12	18	12	10
SF43	7	7	18	15	13

Table 4.7: Statistical Analysis of Success Factors Group 5

frequent design change	strongly agree	agree	neutral	Disagree	strongly Disagree
	5	4	3	2	1
SF1	8	10	12	18	12
SF2	7	8	15	15	15
SF3	18	15	8	12	7
SF4	6	15	18	9	12
SF5	16	17	15	8	4
SF6	8	12	18	12	10
SF7	8	12	9	12	19
SF8	10	9	12	12	17
SF9	9	10	12	11	18
SF10	6	9	12	15	18
SF11	9	9	12	15	15
SF12	7	6	12	17	18
SF13	14	17	11	10	8
SF14	8	10	12	16	14

4.2 RII RESULTS

The relative importance index (RII) is proposed as a method for determining each component's significance (RII). In this research, the relative importance index (RII) was used to establish the relative ranking of effective factors on steel building projects for sustainable project management. The Industrialized Building System use the RII to evaluate all of the aspects that impact the quality of the final product throughout a building project. On the basis of the ranking criteria, it was determined that the cost should be accorded a high level of importance. The criteria were ranked according to their relative importance using relative index analysis. These ranks were determined by applying the relative index analysis to each category, as shown in the subsequent tables. Relative relevance index analysis is a good method for evaluating indicators based on the replies of participants, and it may be utilized to determine the majority of the most essential criteria. On the basis of the results of the relative importance index, the aspects of construction that might cause a delay or cost overrun were rated in descending order (RII). The element with the highest RII value has the most influence, whereas the one with the lowest RII value has the least. The questionnaire analysis results were displayed in ten graphs as shown below:

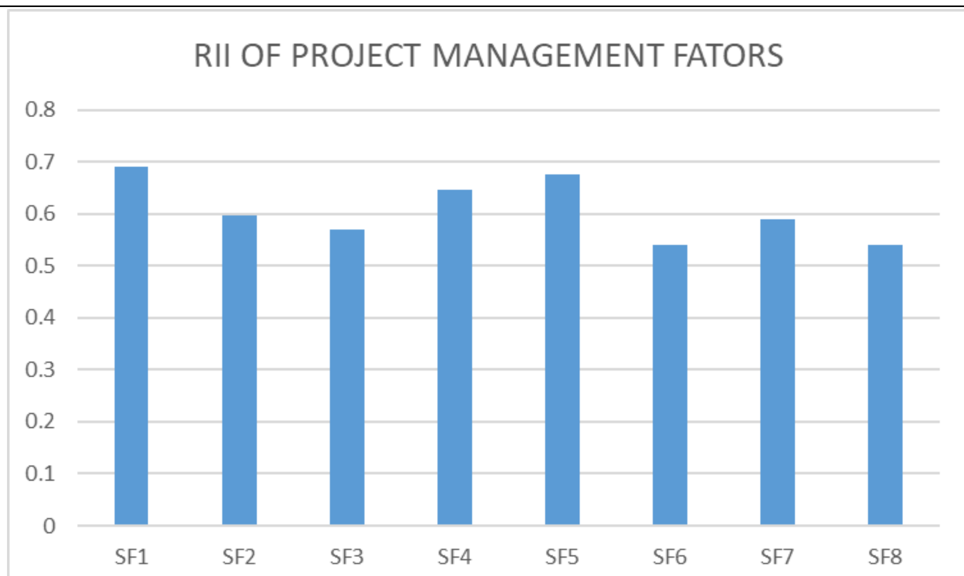


Figure 4.1: RII Results of Group 1

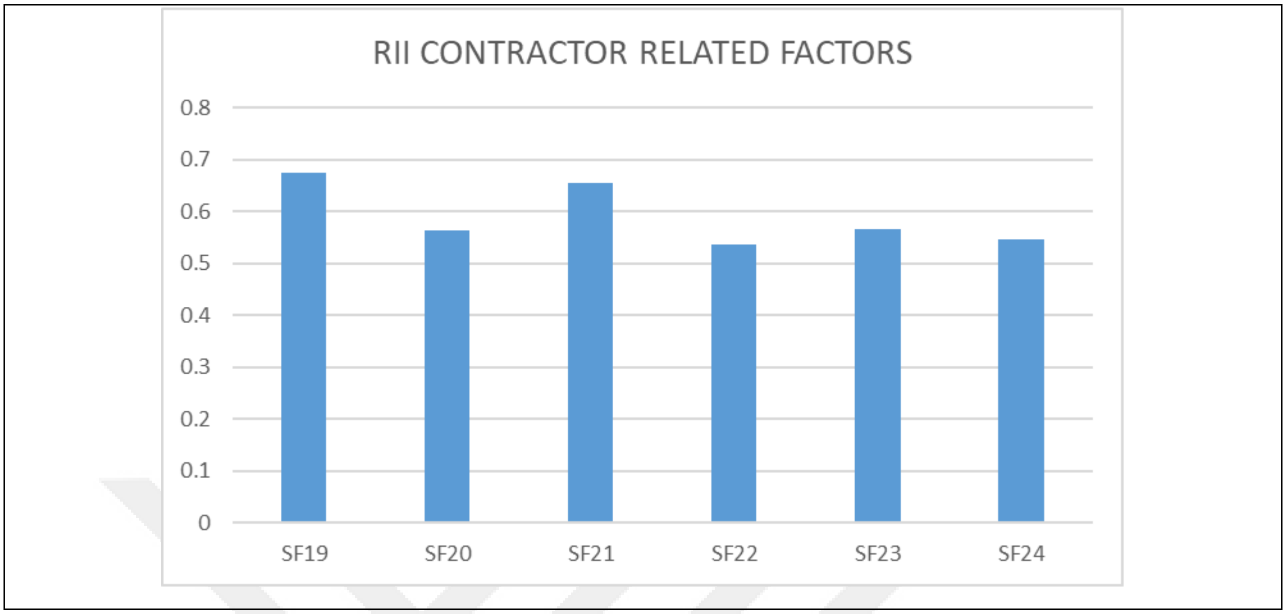


Figure 4.2: RII Results of Group 2

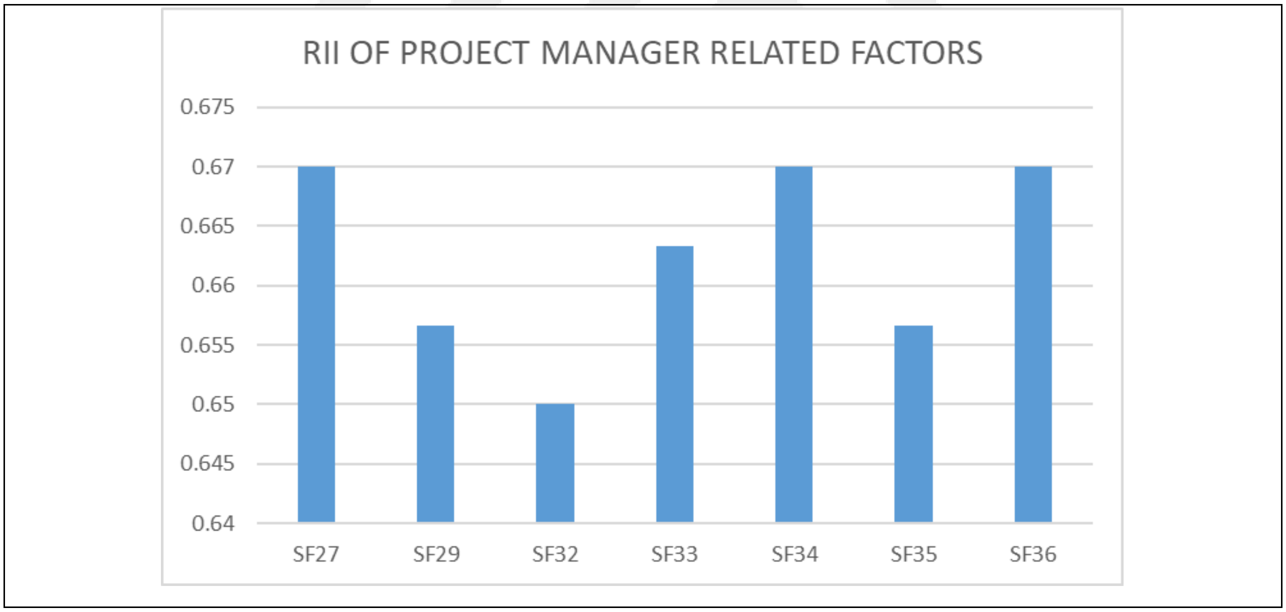


Figure 4.3: RII Results of Group 3

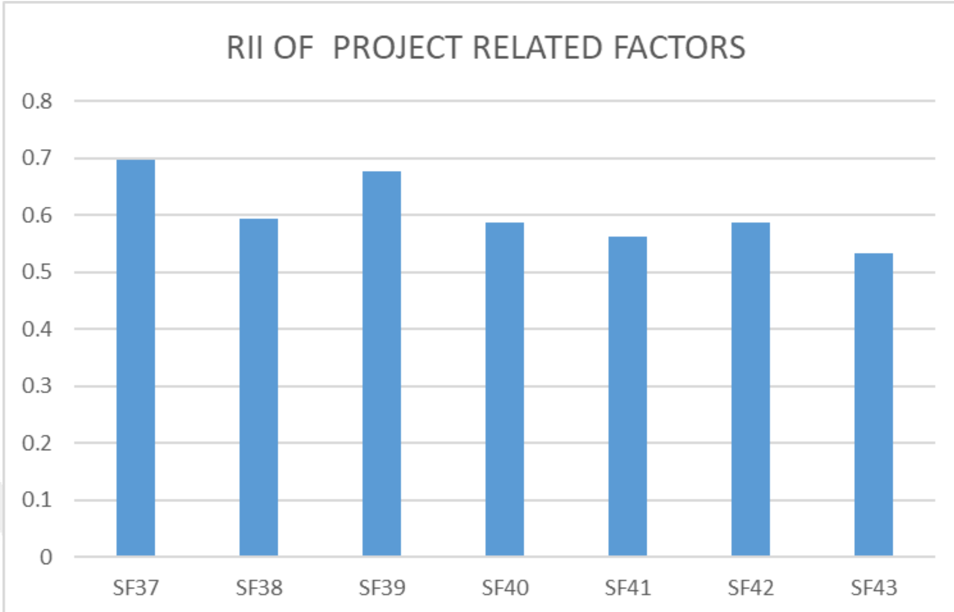


Figure 4.4: RII Results of Group 4

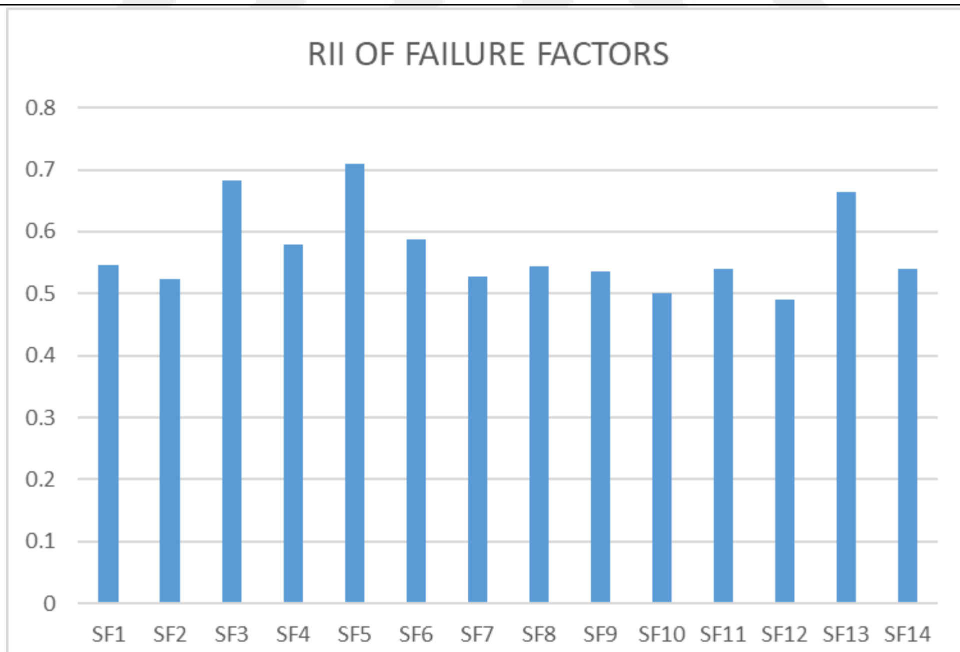


Figure 4.5: RII Results of Failure Group

4.3 WASPAS RESULTS

The following sections will provide an overview of the findings obtained from the WASPAS investigation. The results of the WASPAS study for each of these potential reasons are presented in the figures that may be seen below. The consequences of development led to the conclusion that the identified elements should be given a great deal of consideration in the road construction projects. When placed side by side with the findings of the RII, the findings of the first WASPAS group do not differ at all. The similarities between the two approaches suggest that they are interacting in some significant way.

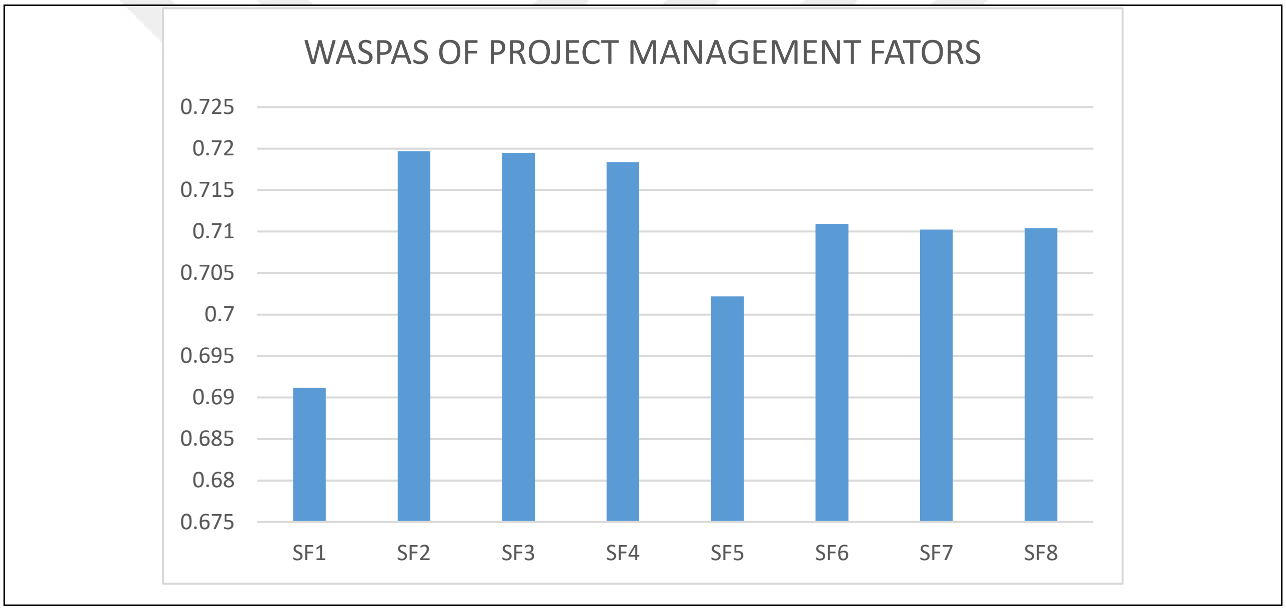


Figure 4.10: WASPAS Results of group 1

It is clear that there are a variety of elements that determine a person's height rank; nonetheless, the SF2 is the most important component in this group.

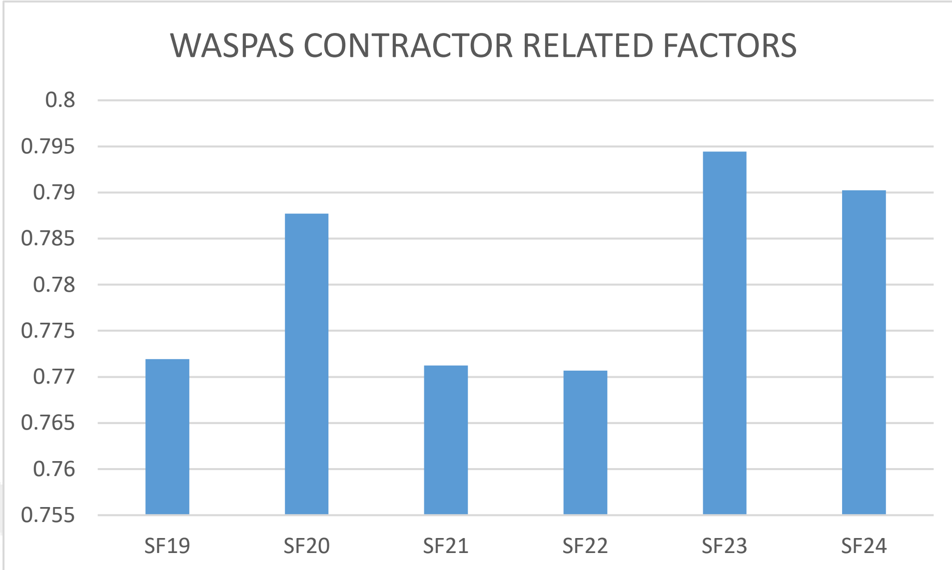


Figure 4.11: WASPAS Results of group 2

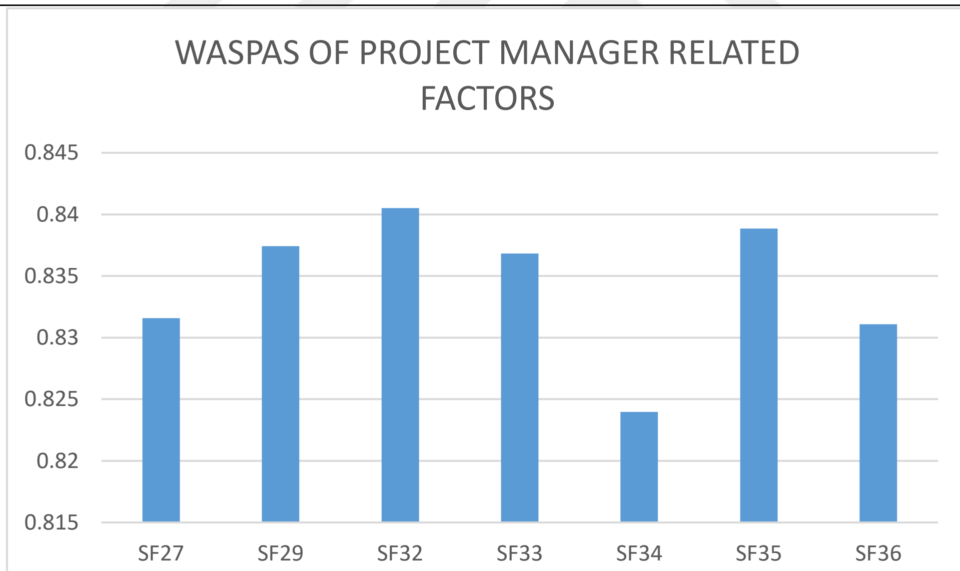


Figure 4.12: WASPAS Results of group 3

It can be seen that the supervision effect is considered the main factor. Time, salaries, and supplies are all slashed in order to keep project expenses in check.

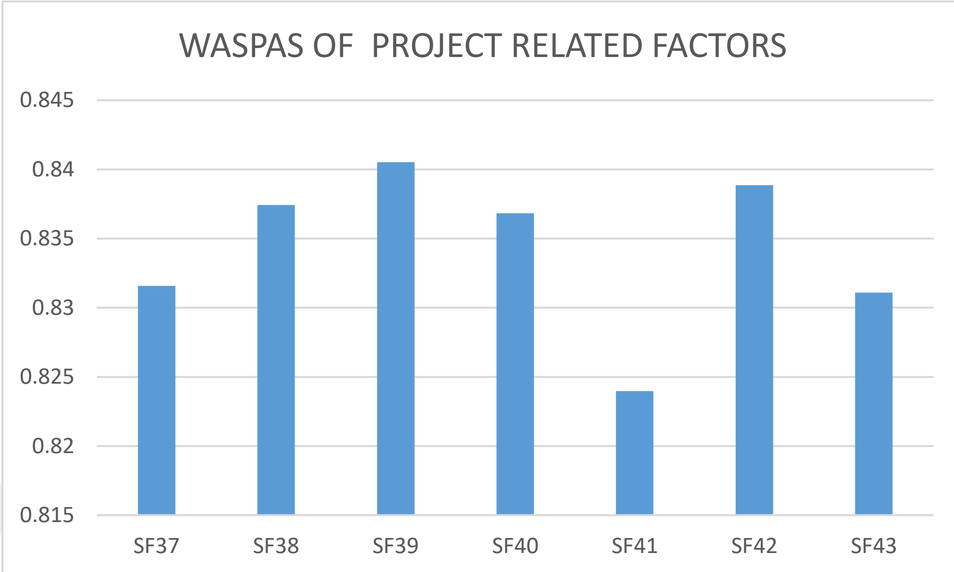


Figure 4.13: RII Results of Group 4

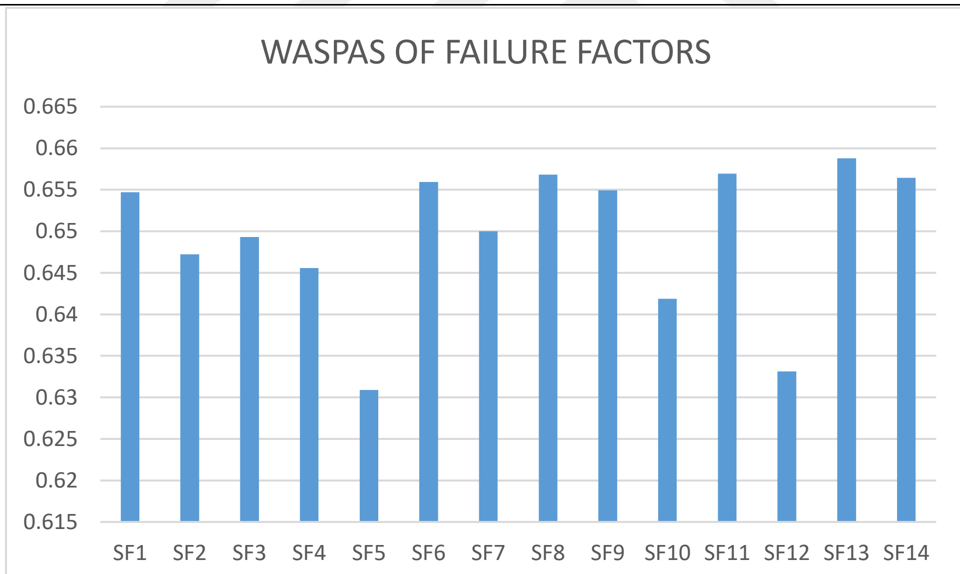


Figure 4.14: WASPAS Results of group 5

In a market economy, which refers to an economy in which the government does not play a significant role, the availability of certain technologies and the scale of the project both play an essential part in determining whether or not prices go up.

4.4 APPLYING WASPAS ON GIS INFORMATION

In order to combine the GIS results with the present methods to evaluate the company's performance and predict the main obstacles and success factors in this type of projects, the procedure will be as in below:

a) the first step is to summarize the effective factors

Table 4.8: Summary of Effective Factors

SF2	Control of sub-contractors" work.	0.719663
SF23	Extent (Involvement) of Subcontracting. Supervision.	0.794422
SF32	Technical capability of project manager.	0.840519
SF39	Project size.	0.840519
FL13	Slow payment of completed works.	0.658789

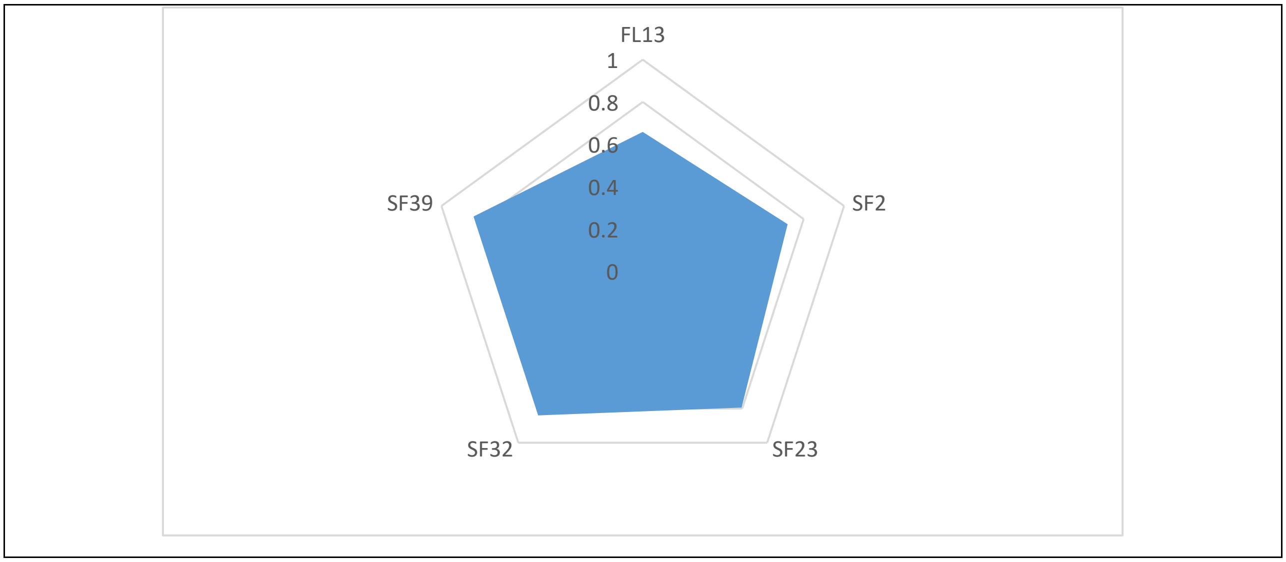


Figure 4.15: Plot of Effective Factors

b) the next step is to specify the companies works from GIS files

Table 4.9: Statistical Analysis of Failure Factors

company work	مجموع من OBJECTID
Aabir alkhalij + Zahw aleula	1797
Albahjat alealamia	5163
Albina' alsaeid	7614
Albina' alsaeid+ Mabani alnaasiria	12535
Al-Bunyan Company	4727
Al-Bunyan Company + Rawnaq aljanub	1526
aldalil alealamiatu+alghasaq aldawlia	10227
ALfurat alawst	2524
alfurat alealamiatu	1553
ALghasaq aldawlia	190
Al-Jawad Company	50536
ALlsaadiq alamin	785
ALrawabi alshaamikha	2451
ALrawaq alakhdar	3088
ALtaemir alhandisih	38482
ALtafawul Company	16463
Dhi Qar Shameat	3015
Difaf asia	586
majmueat nur alttyf	29608
municipal work	28068
Runaq aljanub	435
Sarah alajawid	3694
Sewer work	885
Yanabie akad	10996

The results are the rank effect of each factor as in the table below:

Table 4.10: Statistical Analysis of Failure Factors

	GIS RESULTS	RANK EFFECT				
COMPANY NAME		FL13	SF2	SF23	SF32	SF39
Al-Jawad Company	50536	0.30	3.64	0.25	0.24	0.24
ALtaemir alhandisih	38482	0.39	2.77	3.06	3.23	3.23
ALtafawul Company	16463	0.92	1.18	1.31	1.38	1.38
majmueat nur alttyf	29608	0.51	2.13	2.35	2.49	2.49
municipal work	28068	0.54	2.02	2.23	2.36	2.36
Albina' alsaeid+ Mabani alnaasiria	12535	1.21	0.90	1.00	1.05	1.05
aldalil alealamiatu+ alghasaq aldawlia	10227	1.48	0.74	0.81	0.86	0.86
Yanabie akad	10996	1.38	0.79	0.87	0.92	0.92
ALghasaq aldawlia	190	79.89	0.01	0.02	0.02	0.02
Runaq aljanub	435	34.90	0.03	0.03	0.04	0.04
Sewer work	885	17.15	0.06	0.07	0.07	0.07

5. CONCLUSIONS

In road construction projects, doing research and analysis on the aspects that lead to successful outcomes is an imperative requirement. It is possible to reduce the amount of time spent waiting by taking the appropriate precautions. This article examines successful factor management from the standpoint of providing a thorough basis for delay control, and it does so from the perspective of the reader. Using this framework, you will be able to discover and prioritize effective variables, investigate vital criteria, provide information to reduce and improve the general processes of the project, and so on. In order to create a framework for identifying and prioritizing concerns in relation to road developments, the WASPS methodology was utilized. The WASPAS methodology is used within the context of a system management framework in order to investigate and lessen the rate of discrepancies that specialists have uncovered. Both the RII method and the WASPAS technique have shown themselves to be effective in identifying and ranking qualitative and quantitative risks, respectively. Consider the structure as an illustration of how a framework for the management of influencing elements could be of assistance to decision-makers in a road building project that is currently being carried out. These methods and approaches were utilized so that we could accomplish our goal, which is as follows:

a) In order to evaluate effective variables, component parts, and the consequences of those aspects, two surveys, the opinions of professionals working on infrastructure ROAD projects, interviews with experts, and exploratory research from past studies were used.

b) The process of developing models for RII and WASPAS got off to a running start when the program that would be utilized to develop the models was chosen. 2- The MATLAB WASPAS effective factors rating program and the Microsoft Excel software were utilized in order to estimate effective factors because of the ease with which they could be employed and the ability to make conclusions.

c) When road construction sites and experienced foremen were taken into account, the findings of the study indicated a statistically significant difference in output with and without supervisors on the site, and the difference was larger when supervisors were present on the site.

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