Journal of Ecological Engineering

Journal of Ecological Engineering 2024, 25(2),
ISSN 2299–8993, License CC-BY 4.0

Received: 2023.02.14
Accepted: 2023.03.12
Published:2024.01.01

A Prediction Model for Geotechnical Construction Project Factors Effect Using K-NEAREST Neighbor Method

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ABSTRACT

Predicting project workflow performance are the continuous routine in the tracking of key elements of project implementation performance that is: inputs (resources, equipment) activities and outputs, through recordkeeping and regular reporting through assessment of an on-going or completed project to determine its actual impact against the planned impact in relation to its design and implementation processes. One of the major effective factors on project performance is the geotechnical factors. for that, the present research developed an approach to identify the geotechnical project factors effect on building construction in Iraq. the paper specifies the Iraq as a case study due to the big verities in the geotechnical factors were specified and evaluated through previous studies, questionnaires, and interviews with experts to build a geotechnical factors database for construction projects. The geotechnical factors were established from relevant research and expert views, in the first stage of this paper, which was to designate the study regions based the Latitude and longitude coordinates of different towns in Iraq. In the second step, the researcher ranking the factors within the weighted aggregated sum product assessment (WASPAS) method using the regions characteristics. In the third phase, the K-Nearest Neighbor Method was created which evaluates the collected data to discover and assess factors. The system performance was tested and the results were significant, and the factor prognosis was excellent, according to expert opinion.

Keywords: geotechnical factor, K-Nearest Neighbor Method, WASPAS, construction projects.

Introduction

Early design phases provide designers with a fundamental understanding of physical phenomena, enabling them to foresee and analyze. Factor monitoring is an ongoing factor management activity that comprises tracking the execution of factor management and detecting and managing new variables. If a factor's probability, severity, or prospective impact exceeds acceptable criteria, monitoring permits rapid response. It may have an effect on the safety and health of workers. These incidents can have negative effects on a construction project, including revenue loss, timetable delays, and increased operational and maintenance costs [1]. Numerous researchers have established a factor-focused project management statistic for geotechnical engineering projects since geotechnical factors exist. Based on the nature of the influence, Patil et al2015 .'s study classifies construction project components into eight categories: legal, physical, financial, political, construction, environmental, design, and contractual factors. [2]. In 2020, Kerim Koc and colleagues performed a study with the involvement of 47 professionals from the Turkish civil construction business. Using correlation analysis based on index theory, they estimated the cost and time ranking of each factor. They discovered that "organic silts, soft clays, or peat" were the most important element [3]. The majority of professionals in ground engineering concur that handling geotechnical factors and the benefits that a thorough factor management framework may provide for a project are indisputable (geologists, engineering geologists and geotechnical engineers). In the construction industry, the use of geotechnical factor registers throughout a Civil or Building Engineering project and the incorporation of geotechnical factor management frameworks into the overall project factor management strategy are seen as positive developments. This is advantageous for the building team in terms of decreased design and construction factor, as well as for the client in terms of decreased total financial factor.[4]. Understanding the characteristics of geotechnical engineering projects is essential for controlling geotechnical factors. Numerous geotechnical engineering projects and situations are characterized by variable and difficult conditions, extended project timelines, significant uncertainties, changing and dispersed needs, vast and complex organizations, high technical levels, and a political, public, and environmental focus. Numerous diverse parties are involved in the construction process, many of whom have competing interests and no prior experience cooperating. Numerous geotechnical engineering tasks, including foundation construction, excavations, and tunneling, can be categorized as series systems. The completion sequence of work activities is controlled by preceding work processes and influences subsequent work activities[5]. KOC et al., in 2020, explored the several geotechnical benefits of deterministic factor evaluation systems. In addition, the geotechnical design codes for the entire structure satisfy the requirements for load capacity, durability, geometrical qualities, and stability, as well as environmental impact and working conditions. In geotechnical engineering projects, the construction process, the contract, the organization, and the economic arrangements are all crucial considerations. In this process, the terms hazard, factor item, warning bells, starting event, damage event, and damage are crucial. [3].

Sandip Deb and his coworkers provide Most ground engineering practitioners understand the effect of geotechnical factors, but other construction professionals typically misunderstand or undervalue the problem and mitigating measures[6].

A.G. Polyankin et al. explored geotechnical concerns with an exclusive focus on economic repercussions. In addition, there is no complete technique for factor control in the building of complex multifunctional facilities. The surrounding structures, topography, engineering-geology, and hydrogeology of the building site region as potential geotechnical elements that influence the development of emergencies during the construction of subterranean structures [7].

Although Evert Hoek et al. addressed the scenarios of factors by incorporating various words within contract documents, the problems persist. To minimize surprises, it is preferable to precisely identify geological conditions as early as possible[8].

Kevin McLain et al. Before granting a contract, a comprehensive geotechnical examination is the most effective method for mitigating pre-award risk. However, the federal government's goal to hasten project delivery, along with financial incentives to engage DB, increases the likelihood that state DOTs will use DB to accomplish large-scale projects with severe geological impediments [9].

According to Nick Koor, the continuing growth of the conceptual ground model across all phases of the project was the most important factor management tool. High pore pressures, low strength relict shear areas, and collapse characteristics were all geological issues that threatened the development and long-term performance of the project [10].

Amadi Alolote examines cost overruns and geotechnical variables. According to the study, the identified gaps in practice might be utilized as a reasonable theoretical perspective for examining the financial element of ground conditions in highway construction projects. The research provides a colorful depiction of the different approaches to regulating elements connected to the ground throughout the preconstruction phases of highway projects, and how the absence of such techniques may result in a pattern of large cost overruns[11].

Mike Black describes the scheme's geological history as well as the geotechnical factors that were initially found. In order to eliminate or reduce these factors to acceptable levels, adequate mitigation was developed throughout both design and implementation.[12].

Crossrail [13]provides a wonderful opportunity to collaborate with academic and industry professionals to advance knowledge and understanding, hence reducing factor on the ground for future projects.

Regionally, Raffaele De Risi et al. present a method for evaluating the construction factor of a gas pipeline following a seismic event. Using a simulation-based technique, seismic intensity measurements (IMs) such as peak ground acceleration (PGA) and peak ground velocity (PGV) are computed at the location of each pipe when earthquake data such as magnitude and epicenter are known. Damage maps facilitate the prioritization of post-event inspections, whilst losses provide a rough estimate of repair costs.[14]. Plans and construction have mistaken. Insufficient quality control and unskilled personnel caused the problems. Concrete shows corrosion and fracture of the reinforcement bars and settles unevenly. Rebuilding and restoring the structure will cost more [15]. Reviewing relevant literature helped find elements that affect construction cost estimates during early planning. To efficiently manage a major project with a budget in the hundreds of crores or thousands of dollars, employ cutting-edge technology and a flexible strategy [16]. Construction management demands many resources, making good resource management difficult. Price, availability, quality, and volume of imported commodities are factors. Particle shape and size, which are connected to gradation, have not received much attention in study, and there is little information connecting these parameters to mechanical performance. All of these causes affect the economy[17].

2. Geological Factors in Iraq

There have been many different types of geological factors discovered in Iraq. Because the topography, morphology, and rock cover of Iraqi soil are so variable, fifteen distinct geological factors have evolved throughout the country. On the entire continent, seven physiographic provinces can be distinguished. In the middle, the Mesopotamia Plain is formed, spanning around 730 kilometers from the Arabian Gulf in the south to Baiji, where it reaches a maximum elevation of approximately 150 meters. It is mostly composed of alluvial deposits from the Tigris and Euphrates Rivers, as well as their distributaries and the Shat Al-Arab, which are susceptible to flooding, pipelines, sabkhas, seawater intrusion, and depressions, among other geological phenomena. To the west of this huge plain are the Iraqi Southern and Western Deserts, which cover approximately one-third of the country and are composed of sedimentary rocks with a somewhat difficult topography in places like the Ga'ara Depression. Near Jabal Anaza, the topography rises to around 1,000 meters in the west, showing various geological features such as floods, mass movements, swelling clays, and depressions. A network of prone-to-flooding valleys separates the two deserts. The highly developed karst phenomena in the Southern Desert is an additional sort of geological danger. Due to the diversity of rocks and geography, numerous geological factors, such as mass movements, floods, pollution, earthquakes, mining catastrophes, and gypsum-induced events, may occur[18].

This study used the findings of Douglas et al[19] .'s study since it covered a significant body of literature on the subject and gave a holistic view of geotechnical difficulties as opposed to focusing on individual issues. The 27 factors found by Kerim Koc et al. in [3] have been described and tested by specialists. The following phase in this inquiry will be to recruit the assistance of specialists in order to determine the factors associated with transportation projects. On the basis of a review of the relevant literature, a thorough list of 27 factor indicators was compiled, and a questionnaire was constructed to solicit feedback from Iraqi construction project managers. The factors are outlined in Table 1.

Table 1. Selected Geotechnical effective factors (from Kerim Koc et al.[3] and Sissakian et al, [18])

F1	Highly compressive soils
F2	Settlement of adjacent structure
F3	Mass movements

F4	Depressions
F5	Existing Contaminated material
F6	Swelling clays
F7	Pollution
F8	Tectonic active areas
F9	Gypsum induced hazards
F10	Sabkhas
F11	Marshes (Organic soils)
F12	Mining disasters
F13	Sand dunes
F14	Gypcrete
F15	Groundwater infiltration
F16	Soft compressible soil
F17	Groundwater/water table
F18	Soft clays, organic silts, or peat
F19	Floods
F20	Landfill and construction wastes

The factors indicate a connection between the environment of Iraq and the environment of Iraq. The type of soil surrounding the foundation has a substantial impact. It is possible that the building of the researcher's residence was not intended for the sort of soil beneath it. The soil's moisture content also has an effect. Near the perimeter of the foundation, the soil is drier. In contrast, excessive moisture softens and weakens soil. The water leak will erode the soil surrounding the foundation's footing, causing it to droop. Depending on the soil's composition, hydrostatic pressure develops either when it is too dry or too wet[20][21]. Plants and trees in close proximity to the construction site have the potential to induce settlement. Particularly tree roots will absorb water from the soil. This is common during droughts and extended periods of dry weather. The soil contracts when conditions are dry. The most common reason is tree roots, which are always searching for water and will develop around and beneath the foundation. Soil dehydration is more likely in shallow, surface-level foundations. Since they extend so far into the ground, basement-level foundations are particularly vulnerable to earth movement. [22].

METHODOLOGY OF PRESENT WORK

The primary objective of the study is to identify the most significant parameters for construction projects. A professional team must conduct the rating. The Delphi technique offers the researcher with a versatile and adaptive instrument for data collection and interpretation. The Delphi approach is used because of the following [23] [24]. Understanding each of the highlighted factors is referred to as the evaluation approach. It requires input to determine the most cost-effective factor management approaches and to evaluate the factors that must be handled. It includes both the factor sources and the effects of those factors. Frequently, outcomes and probabilities are combined to examine and analyze causes. Factor assessments can be qualitative, quantitative, or semi-quantitative[25][1]. If there are differences in data quality or data sources, quantitative analysis is not always the best solution. Under these conditions, a detailed qualitative analysis with the same level of specificity can be used. Regardless of the methodology employed, the documentation should include a description of the data quality and data sources used in the study. Also included should be a description and explanation of the system and problem definition, recognized factor sources and factors, initiating events, etc. This study provides a realistic and efficient way for evaluating the importance of geotechnical issues. [26] [27]. In state of the art studies, Using the Firefly algorithm and developing it through a scanning technique, elewe et al. [28] introduced a new set of techniques for handling such difficult issues. The MC-GPSO technique was utilized by talib et al., in [30] and bin Hasnan et al., in [31] to create a strategy for tackling massive challenges. In [32], Majeed et al. created an assimilated ANN for fault pattern recognition [33]. According to a general rule in factor management, factors are most effectively managed by the party with the most relevant skills and qualifications. Consequently, some elements can be assigned to a single party, guaranteeing that the project is safeguarded or that the factors' effects are avoided. In the first stage of this work, which consisted of identifying the study area, the geotechnical criteria were determined using the Delphi method, based on pertinent literature and expert opinion. In the second stage, the researcher determined the WASPAS of factors for each region. In the third step, the K-Nearest Neighbor Method was developed utilizing MATLAB software, which examines the given data to identify and evaluate factors and to establish the factor rating. On the basis of the WASPAS and K-Nearest Neighbor Method findings, the influencing variables of building projects were identified and tested.

RESULTS AND DISCUSSION

To establish the importance of the parameters, the percentage scoring method described earlier in this study was utilized. A comprehensive technique is necessary to identify all aspects influencing building project operations. The results for the top twenty most important criteria are presented in Table 2. Due to the varying geotechnical qualities of these places, the researcher divided the geotechnical variables factor influence into three regions for this study. On the island, there are few urban and archaeological sites. As depicted in Figure 1, the city of Kirkuk is renowned for its expansive muddy grounds, port with views of the Arabian Gulf, and plenty of urban constructions. A result of zoning, we are better able to identify dangers. The geological structure and nature of the land have an effect on geotechnical considerations.

Table 2. the selected regions in Iraq

	Latitude coordinate	longitude coordinate
Baghdad	33.312805	44.36149
Basrah	30.508102	47.78349
Al Anbar	33.66946	39.96779
Mosul	36.34	43.13
Sulaymaniyah	35.566864	45.41611

Based on the expert's opinions, the working factors have been specified and the evaluation of each factor specified in the tables below.

WASPAS RESULTS

WASPAS analysis is a technique for prioritizing indicators evaluated on Likert-type scales that identifies the majority of significant criteria based on participant responses. To determine the relative significance of the criteria, a relative index analysis was employed. The ranking results of the relative index study for each region are presented in the tables that follow. As a result of these rankings, twenty risks were identified as having high priority levels in the factor assessment of geotechnical implications on construction projects.

For each challenge, the WASPAS was developed to identify factor factors in geotechnical construction projects. Using the derived WASPAS values, these factors were ranked.

Table 2: WASPAS of Factor factors respond scoring

	geotechnical factor	Sulaymania	Mosul	Baghdad	Basrah	Anbar
F1	Highly compressive soils	58.81 %	57.14 %	60.07 %	62.14 %	60.29 %
F2	Settlement of adjacent structure	67.74 %	66.55 %	67.50 %	58.93 %	59.29 %
F3	Mass movements	64.76 %	66.43 %	62.71 %	55.60 %	58.59 %
F4	Depressions	64.29 %	63.45 %	61.21 %	57.26 %	57.73 %
F5	Existing Contaminated material	62.62 %	62.62 %	65.21 %	58.21 %	60.25 %
F6	Swelling clays	62.50 %	62.50 %	63.43 %	56.90 %	61.72 %
F7	Pollution	64.76 %	61.79 %	64.86 %	57.86 %	61.64 %
F8	Tectonic active areas	61.31 %	59.64 %	57.57 %	55.24 %	58.98 %
F9	Gypsum induced hazards	65.36 %	68.57 %	68.50 %	59.17 %	55.71 %
F10	Sabkhas	63.45 %	62.62 %	64.86 %	57.38 %	58.98 %
F11	Marshes (Organic soils)	61.31 %	62.14 %	64.57 %	57.26 %	57.73 %
F12	Mining disasters	65.95 %	66.79 %	62.71 %	57.74 %	60.25 %
F1	Sand dunes	63.33	63.33	65.21	58.57	61.72

3		%	%	%	%	%
F14	Gypcrete	65.24%	66.79%	63.43%	58.57%	58.38%
F15	Groundwater infiltration	63.93%	66.07%	65.21%	58.69%	59.42%

F16	Soft compressible soil	61.67%	62.50%	65.57%	58.57%	57.29%
F17	Groundwater/water table	60.00%	59.17%	64.86%	59.05%	59.57%
F18	Soft clays, organic silts, or peat	59.76%	58.10%	64.57%	56.90%	60.29%
F19	Floods	65.12%	67.62%	62.71%	59.88%	59.29%
F20	Landfill and construction wastes	62.26%	61.79%	62.36%	57.02%	58.59%

As evidenced, the position came in first. The most significant contributor to factor difficulties was gypsum-induced geotechnical complications. It is extremely simple for gypsum to develop induced factors when subjected to a mechanical load. Gypsum is a source of inorganic pollutants and geological formations that thrive in karstic conditions in particular. Moreover, gypsum regions are dangerous geological environments where natural elements may emerge if settlement areas or human-made structures (such as houses, roads, and substructure systems) are present. In light of natural calamities, environmental concerns, and urbanization, gypsum is a crucial evaporation unit.

K-Nearest Neighbor Method results

In the sections that follow, the results of the K-Nearest Neighbor Method analysis are presented. The K-Nearest Neighbor Method analysis results for each region are displayed in the tables in the subsequent sections. On the basis of these ranking results, it was determined that the selected 20 variables had significant degrees of importance in the factor assessment of construction projects based on geotechnical effects. For each component in geotechnical construction projects, the K-Nearest Neighbor Method was computed in order to discover factor factors. The results obtained using the K-Nearest Neighbor Method were used to rank these criteria.

It offers a substantial geotechnical risk. Moreover, the parent construction waste dump is a significant source of geotechnical issues.

Table 3: results of factors respond scoring

place (input)		K-Nearest Neighbor (output)	
Latitude	34.13333	Latitude	33.3128
Longitude	42.38333	Longitude	44.3615
factor	rank effect	factor	rank effect
F1	0.60	F11	0.65
F2	0.68	F12	0.63
F3	0.63	F13	0.65
F4	0.61	F14	0.63
F5	0.65	F15	0.65
F6	0.63	F16	0.66
F7	0.65	F17	0.65
F8	0.58	F18	0.65
F9	0.69	F19	0.63
F10	0.65	F20	0.62

According to the research, these components were identified as an intriguing geotechnical contributing factor. Comparing the results of WASPAS and the K-Nearest Neighbor Method reveals that the top higher ranks, as shown in table 3, are much higher. The results indicate, according to the experts, that the K-Nearest Neighbor Method has a high degree of reliability.

CONCLUSION

This study aims to establish a unique way for forecasting project elements stemming from geotechnical concerns in northern Iraq by creating a model that can aid parties involved in construction projects in recognizing obstacles and factors in advance. These strategies and procedures were employed to achieve this objective:

In addition to interviews with experts and exploratory research from earlier studies, surveys and the opinions of construction project specialists were used to evaluate effective factor elements and the extent of their influence. Twenty distinct categories of characteristics affecting construction projects were selected.

2-Creating a K-Nearest Neighbor Method model took numerous steps, the first of which was selecting the application that would be used to produce the model. Because of its usability and capacity to draw conclusions, the MATLAB tool for basic factor evaluation is selected for determining the degree of influence of each factor category.

3- The notion was tested by dividing northern Iraq according on geology, history, and urbanization level. Other parameters such as project size and drilling depth were utilized to evaluate the flexibility of the system.

According to professionals, the results were favorable and the prognosis for the factor was optimistic.

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