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Prediction model for pile construction productivity rate utilizing the multiple linear regression technique

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Abstract

Productivity is a prevalent requirement in the bridge construction industry. The precision of productivity rate measurement is significantly influenced by the ability to recognize and implement the critical factors that impact the productivity rate. However, the significance of productivity in cost reduction and profit generation is fundamental to every construction industry. Bored piles are critical components in the foundation of transportation bridges. The productivity estimation processes for piles are influenced by a multitude of factors, leading to several challenges for estimators in terms of time and cost. Hence, the present study aims to diagnose these issues and evaluate the rate of productivity in pile construction through the utilization of the multiple linear regression (MLR) Technique. The data for this study was gathered via designated questionnaires, on-site interviews, and telephone inquiries to professionals affiliated with various construction firms. A selection of nine factors that have the greatest influence on the productivity of construction have been identified. These factors are considered autonomous variables that have an impact on the rate of pile productivity. The construction productivity rate, which is impacted by the influencing factors, is the dependent variable. An equal number of 84 questionnaire samples were utilized to construct each of the influencing factors incorporated in this model. The work measurement form was designed to collect real-time primary data from the construction site, six data samples for each factor were obtained from different bridge and overpass projects to verify the effectiveness and performance of the model. The study revealed that the multi-linear regression model has a high level of prediction for productivity, with an accuracy rate of 92.93%. Additionally, the correlation coefficient was determined to be 99%. The results indicated a robust correlation among the independent variables in the constructed model, and the predictions generated by the model matched what was observed.

Keywords: Multiple linear regression technique, Bored pile, Productivity rate, Resource efficiency

1. Introduction

Drilled shafts (bored piles) are extensively employed in the construction of bridges in contemporary times. Various issues can impede the construction of bored pile foundations, including subsurface obstructions, insufficient contractor expertise, and challenges in site design. The impact of the aforementioned issues on productivity may be succinctly summarized as follows. The preliminary assessment of the site typically involves inadequate statistical samples taken in the vicinity of the foundation, which fail to encompass the entire region. The variation in soil types across sites or within a site can be attributed to factors such as cohesion or stiffness, natural barriers, and impediments related to the installation of subterranean infrastructure. Inexperience in regulating the pile axis, length, and size adds another layer of complexity. It is important to take into account the mechanical and drilling issues related to piling machines. The productivity is significantly impacted by the problems arising from site limits and the disposal of excavated debris. The efficiency of steel installation and concrete pouring is influenced by the expertise of the rebar team and the technique used for pouring. Undoubtedly, these issues significantly impact the on-site manufacture of concrete piles. Furthermore, there is a dearth of research in this particular domain. Due to the aforementioned issues and additional factors, the estimator has challenges in assessing the efficiency of the piling process. Insufficient research has been conducted on the topic of pile foundation building. Hence, it is important to employ advanced methodologies to scrutinize the issue and ascertain the most proximate best resolution. The current research aims to investigate the elements that influence the productivity of the piling process. Additionally, it seeks to evaluate productivity by employing the regression analysis approach, which takes into account most of the aforementioned aspects [1, 2]. enhancing the efficiency of bridge construction in order to facilitate more effective utilization of labor, materials, and equipment. By conducting precise productivity rate measurements and discerning determinants of efficiency, construction endeavors have the ability to reduce resource wastage and optimize the allocation of resources, thereby making a positive contribution to sustainable construction practices. Profitability and cost savings can result from increased productivity on construction initiatives. The implementation of economical construction methods and practices is critical for the construction industry to attain long-term economic viability. Construction initiatives can have a smaller environmental impact through the use of efficient building methods. Construction activities can mitigate disruption to adjacent ecosystems, curtail energy usage, and diminish greenhouse gas emissions through the expeditious completion of projects and the allocation of fewer resources. Social benefits may result from increasing construction productivity and efficiency, including the creation of employment opportunities, the enhancement of worker safety, and the reduction of disruptions to local communities. The prioritization of laborer and community well-being is a defining characteristic of sustainable construction practices. In construction initiatives, the application of statistical analysis and data acquisition methods, including multiple linear regression, facilitates the adoption of evidence-based decision-making. By utilizing data to recognize and resolve obstacles to productivity, construction companies can make well-informed decisions that promote sustainable results. The study's findings may provide valuable insights for construction industry professionals in Iraq seeking to optimize project performance and productivity via productivity forecasting. Additionally, they may aid in enhancing resource efficiency, cost reduction, profit generation, environmental impact mitigation, decision making, and social impact. Additionally, the study aids in determining the necessary timeframe to finish the specified task, therefore avoiding the current practice of un specifying precise and unplanned periods that are prevalent in the majority of projects in Iraq.

1.1. Research objective

The objective of this study is to emphasize the significance of employing contemporary technologies, with the primary method being Multiple Linear Regression (MLR), in forecasting the productivity rate of bored pile construction. This involves developing a model that can predict or estimate the productivity rate of pile construction work using MLR.

1.2. Motivations of the research

The motivation for undertaking this study is from the lack of prior research on accurately assessing the productivity of piles foundations in Iraq. The researcher aims to calculate the actual productivity rate of piles and identify the elements that influence it. To effectively anticipate productivity rates, the forecasting equations use both quantitative and qualitative criteria to describe the rate of productivity. Construction projects in Iraq require the use of innovative strategies to accurately forecast the performance of construction projects throughout the planning, estimating, and scheduling stages. This may be achieved via the utilization of advanced methodologies such as Multiple Linear Regression (MLR), Artificial Neural Networks (ANN), Support Vector Machines (SVM), and others.

1.3. Hypotheses of research

The hypothesis states that: Multiple Linear Regression (MLR) is a powerful modelling tool with an optimum mechanism and have adequate recognition skills for estimating production rates in every given scenario.

1.4. Data collection

This study employed two data gathering techniques: 1. Direct data collection, which involved doing site interviews, making site visits to complete data forms, and conducting telephone calls. 2. The use of a questionnaire. A survey was conducted to gather data from various professionals in the fields of academia, consulting, expertise, engineering, and contracting, both in the public and private sectors. This included individuals working on construction projects involving bored pile (also known as drilled shaft) construction, as well as those involved in bridge design and construction projects in Iraq. This questionnaire consisted of many sections that gathered factors related to the productivity of the piling process. Out of the 90 forms sent, only 84 forms were submitted, resulting in a response rate of 93%.

2. Study methodology

A two-phase framework, as illustrated in Figure 1, is designed to identify regression models for assessing pile construction productivity rate.

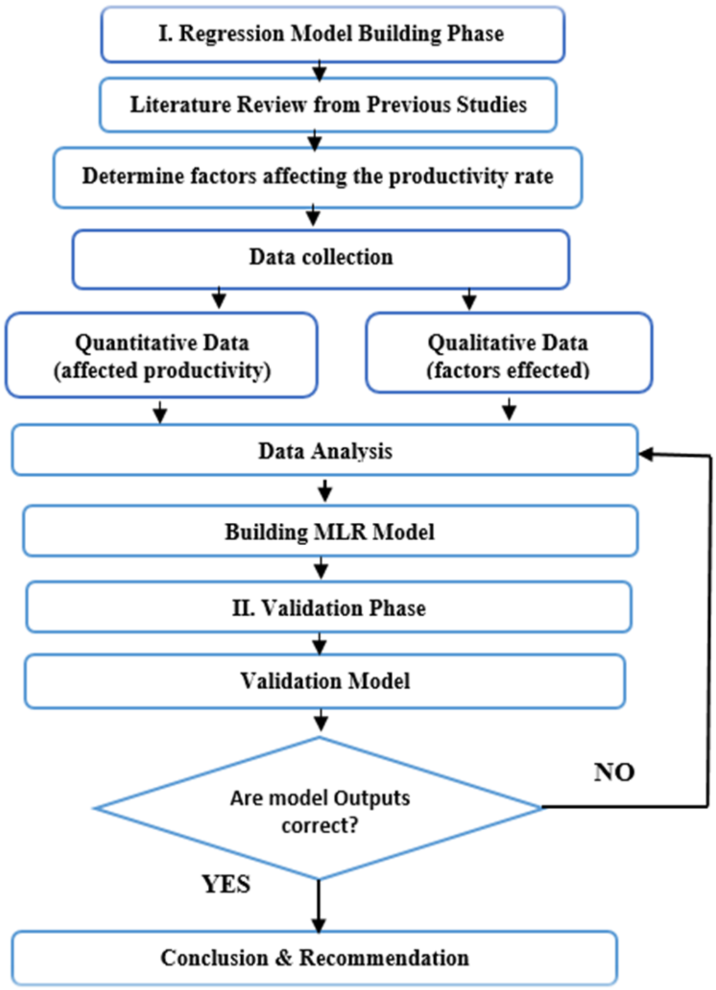

Figure 1. regression model Structure for concrete pile construction

2.1. Previous studies

There is a scarcity of studies and research pertaining to pile productivity within the construction industry of Iraq. Nevertheless, the researcher was able to examine a multitude of pertinent studies, particularly those that employ various techniques based on support vector machines, artificial neural network technology, and multiple linear regression as described in [1-7]to calculate and assess productivity. The researcher asserts that a significant portion of this literature exhibited variability in both productivity calculations and estimations. In fact, the engineer's estimation is contingent upon personal experience or insights gained from prior projects, given that productivity calculations do not rely on the estimation of a highly precise mathematical equation.

2.2. Factors effecting productivity rate

There is large number of variables that affect the estimation process of pile construction productivity. It is impossible to consider all of them in one research [2]. Predicting the rate of productivity is possible if all factors influencing productivity are identified [8]. Current study concentrates only on some of the major variables, such as pile size, soil type, pile depth, pouring system, poor contractor’s experience, Poor availability of Equipment, poor availability of sufficient spaces, visible and invisible obstacles, working conditions and management and quality assurance and control. The investigation of factors that impact productivity rate was the focus of an extensive inquiry by numerous researchers. To increase and improve productivity, it is critical to explore the positive and negative factors that influence productivity rate. This enables one to capitalize on those factors that positively affect productivity rate, while minimizing or eliminating those that have a negative impact on productivity rate.

3. Results and discussion

3.1. Influencing factors (independent variables)" quality data"

Table 1 Describe the details of the influencing factors (independent variables) as qualitative variables, and each variable is coded.

Table 1. Influencing factors - "quality data”

Variable Kinds			Variables	Units
	No.	Code		
Independent Variables	1	PL1	poor contractor’s experience	No effect = 1 Little effect = 2 Moderate effect = 3 Significant effect = 4 Very significant effect = 5
	2	PL2	Poor availability and number of specialized and non-specialized Equipment	
	3	PL3	Soil type	
	4	PL4	Implementation method and equipment required for implementation	
	5	PL5	Poor availability of sufficient spaces for the movement of machinery and carrying out pile implementation work	
	6	PL6	presence of visible and invisible obstacles	
	7	PL7	Lack of working conditions and management	
	8	PL8	Type of piles	
	9	PL9	Quality assurance and control	

3.2. Affected productivity (dependent variables) "quantity data”

In order to determine the productivity affected of a given activity, it is initial presumed that one possesses knowledge of the activity's standard or measured productivity. Subsequently, the productivity affected by the factors that influence the standard productivity is delineated. The standard productivity rate utilized in this investigation was (50 M.L/day. The questionnaire received a total of 84 responses. The probability ratio and impact rate for each influential factor were computed, and the productivity affected by these factors was determined using the equation presented below. The most information is presented in Appendix (1); The dependent variable in the linear regression equation is represented by the affected productivity rate.

$$Pa = Ps \times (1- P.R) \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where,

Pa: Affected Construction Productivity Rate.

Ps: Standard Construction Productivity Rate. (Ps = 50 M.L/day)

P.R: Probability Rate.

3.3. Multiple variable linear regression (MLR)

"Multi-linear regression" is an advanced statistical technique that employs heuristics to enhance search results by optimizing data utilization and identifying associations between research subjects [9]. Regression analysis is a fundamental method in scientific research that allows for the discovery of the functional connection between independent and dependent variables [10]. Regression analysis offers a numerical method for evaluating the connection between many variables, where one variable is designated the dependent or response variable, and the others are termed the independent or explanatory variables (sometimes known as "covariates"). The analysis may serve the objective of either estimating the impact of a covariate or predicting the value of the answer based on the values of the covariates. For all scenarios, a regression model is created to forecast the value of the response variable [11]. Linear models of statistical analysis have been utilized for several purposes: management and Construction site engineers may readily utilize them; Visual data examination reveals linear trends in the data through the use of scatter plots. Furthermore, a statistical assessment for quadratic and cubic models does not yield superior results compared to linear models. However, these models are more intricate, especially for users [2].

3.4. Model design for productivity rate

The following model's multiple regression analysis was performed to predict productivity [7].

$$Productivity = \beta 0 + \beta 1\ x1 + \beta 2\ x2 + \beta 3\ x3 + \cdots \ldots + \beta n\ xn \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$Productivity = \beta 0 + \sum_{n=1}^{\infty} (\ \beta n\ xn\ ) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

β = Coefficient of the particular factor affecting piling productivity.

Xn= Pile performance factor.

3.5. "MLR" technique results

The research utilized the Statistical Package for Social Sciences (SPSS) program, specifically version 26. It was employed in the analysis of the data and construction of a prediction model for the productivity rate. The objective of this programmer is to determine the coefficients of linear regression for Equation (2). Table 2 presents a concise overview of the model, showcasing significant statistical results. The statistical analysis was performed using the MLR model (PLPR) to examine the relationship between the input variables (PL1, PL2, PL3...PL9) and the affected productivity. In addition, the "correlation coefficient" R value for the "PLPR" model is 99%, indicating a strong connection. The coefficient of determination (R2) value of 98.1% the percentage of the variance in input variables that can be accurately predicted from the output variables.

Table 2. A summary of the "PLPR" model in regression analysis

Model	R (%)	(R2)%	Adj. (R2)%	Std. Error
PLPR*	99	98.1	97.8	1.295

PLPR* = Piles Productivity Rate

Table 3 presents the analysis of variance (ANOVA) values, which defines the explanatory model's overall strength through the statistical F test. through The analysis of variance table shows a high contrast and a highly significant effect (P=Sig <0.0001), confirming the model MLR's high explanatory power. This model provides a reliable approximation.

Table 3. Summary statistical analysis of variance "PLPR" model

Model		Sum. Of Squares	df	Mean Square	F	Sig.
PLPR	Regression	6309.928	9	701.103	417.981	.000
	Residual	124.124	74	1.677		
	Total	6434.052	83			

PLPR is the predicted productivity rate for the model, measured in M.L/day.

The values of constants, regression coefficients, and the statistical significance of independent variables with respect to the dependent variable are presented in Table 4. A concise summary of this table is as follows:

Table 4. Result of MLR analysis "PLPR" model

Model		Coefficients		Standard Coeff.	t	Sig.
		b	St. Error	β		
PLPR	Constant	86.45	1.114	----	77.603	.000
	PL1	-2.228	0.209	-0.204	-10.666	.000
	PL2	-2.449	0.242	-0.209	-10.120	.000
	PL3	-1.331	0.208	-0.146	-6.394	.000
	PL4	-1.655	0.255	-0.141	-6.489	.000
	PL5	-1.856	0.200	-0.180	-9.300	.000
	PL6	-1.766	0.212	-0.207	-8.347	.000
	PL7	-1.295	0.187	-0.129	-6.916	.000
	PL8	-1.616	0.177	-0.183	-9.105	.000
	PL9	-1.852	0.161	-0.210	-11.509	.000
Dependent Variable:		Pile works Affected Productivity Rate (M.L/Day)				

Table 4 presents the coefficient parameters β and independent variables, based on the t-test and Sig. It aids in determining the regression equation and standard error of the unstandardized coefficient. Based on the results of the t-test (with a significance level of less than 0.05), it can be concluded that all of the independent variables had a significant impact on the regression models. The ultimate equation for quantifying the affected productivity, as derived from the Model Summary, Anova, and Coefficients tables, has been established:

$$PLPR = 86.45 – 2.228(PL1) – 2.449(PL2) – 1.331(PL3)1.655(PL4) – 1.856(PL5)– 1.766(PL6) – 1.295(PL7) – 1.616(PL8) – 1.852(PL9) \quad \ldots\ldots\ldots\ldots\ldots(4)$$

Where: PLPR is the predicted affected productivity rate for Pile works model (M.L/day).

Regarding the factors (PL1, PL2, PL3, ……., PL9) in relation to the variables included in the regression equation, the researcher devised a five-point scale for their determination. This scale is predicated on the likelihood of an event occurring or the likelihood that the activity will be exposed to a particular factor, as well as the degree of influence substantiated by The factor described previously. Further information regarding these variables can be found in Table 5. These values depend on many factors that show differences between sites and individuals, and they can be arrived at accurately through project data and documents, including daily and weekly reports, and studying the percentages of deviation between the planned completion and the reality of the implementation situation, and these depend on personal experience and the circumstances of the project. These variables must be duly considered when ascertaining the probability rate at the outset or when forecasting these values.

Table 5. Scales of probability-factors

Degree of influence	Probability of occurrence	(PL1,PL2,PL3,….,PL9)
No affect	0%-----20%	1
Little affect	20%-----40%	2
Moderately affect	40%-----60%	3
Significant affect	60%-----80%	4
Very significant affect	80%-----100%	5

3.6. Multiple linear regression verification for model

Models are used to forecast or contrast how a new system, a system that has been changed, or a current system will work in different situations. The goal of validation and verification is to get a model that is correct. If the model is accurate enough, it can be used instead of the real system for testing and research, when utilized to forecast the performance of the actual system it represents, or to anticipate the disparity in performance between two scenarios or two model configurations [12]. Therefore, by conducting statistical analysis and by employing data collected from multiple projects in Iraq for pile works activity the correlation (R) between the actual and predicted productivity was determined in order to assess the accuracy of the model. The model (PLPR) verification exhibits a strong performance, as evidenced by the high correlation (R) of 92.0 percent between the predicted and actual productivity rates in Table 6. The capability multiple linear regression model (PLPR) is depicted in Figure 2, where the value of the coefficient of determination is 84.6%. Therefore, it can be concluded that this model strongly matches the actual measurements.

Table 6. Verification of "PLPR" model

Proj. NO.	PL1	PL2	PL3	PL4	PL5	PL6	PL7	PL8	PL9	E.P*	A.P*	Error
1	5	4	2	3	4	3	4	3	4	27.729	30.5	2.771
2	4	5	4	3	2	2	3	4	3	31.855	30.25	-1.605
3	4	4	5	4	3	2	3	3	3	31.078	33.75	2.672
4	3	4	3	3	3	3	2	4	2	37.388	35.75	-1.638
5	3	3	3	2	2	4	3	3	2	41.903	45.25	3.347
6	2	5	2	3	3	3	3	2	3	38.583	42	3.417
Correlation (R): between Actual and predicted productivity											92.0%	

E.P*= estimate Productivity, A.P*= Actual Productivity

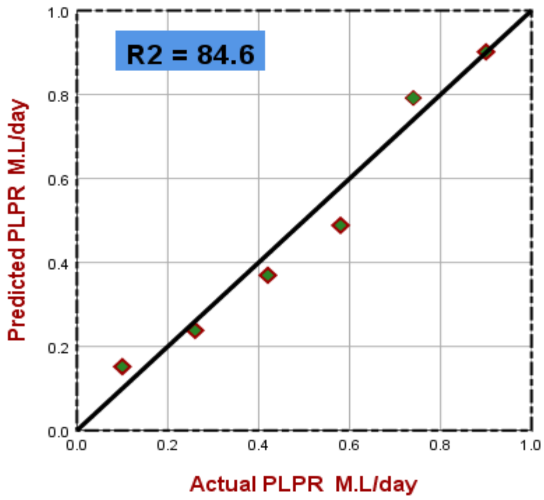

Figure 2. Validation data comparison of predicted and actual PLPR

The linear relation between the predicted and actual productivity rates, can be shown in Figure 3.

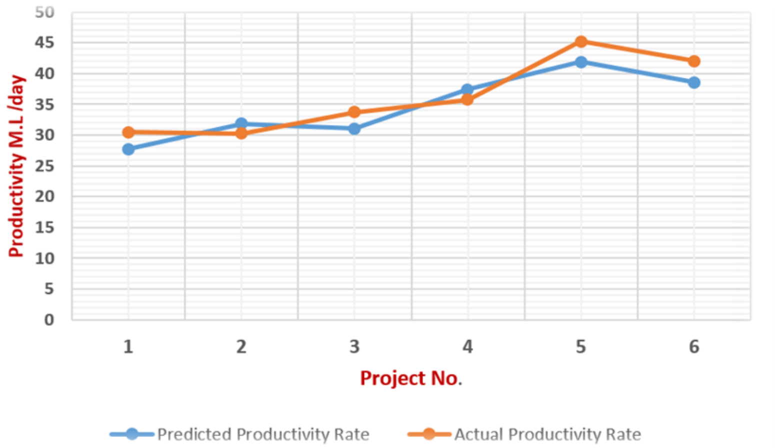

Figure 3. The linear relationship between actual and predicted productivity

The actual and expected production for the first four projects are clearly quite close. It is clear that there is a little difference between the model's output and the actual production for the last two Projects.

3.7. Evaluation. "MLR" model

Verification is conducted to ascertain the efficacy and precision of models that represent actual systems. By applying two statistical equations in addition to determination and correlation coefficients (R^2, R), the validity of MLR for PLPR model will be evaluated.

1. *"Mean absolute percentage error" (MAPE):*

This equation is utilized to calculate the average error [13].

$$MAPE = \frac{1}{n}\left(\sum_{1}^{n}\frac{|Actual - Predicted|}{Actual} * 100 \quad \ldots\ldots\ldots\ldots (5)\right.$$

2. *"Average accuracy percentage" (AA%):*

To determine the degree of accuracy, AA is utilized [14].

$$AA\% = 100 - MAPE \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The coefficient of determination indicates the degree to which the model's output corresponds to the objective value. The findings of the study are presented in Table 7. The (MAPE) and (AA%) obtained from the MLR models They had been determined as (7.07%) and (92.93%) respectively for the PLPR model. As a result, it is possible to deduce that the MLR with the actual measurements are in excellent agreement.

Table 7. findings of statistical techniques of" PLPR" Model

Description	Result
MAPE	7.07%
AA%	92.93
R	92%
R2	84.6%

In order to attain these resolutions, an extensive series of experiments were conducted. A conceptual estimate error category was established throughout these trials. AS suggested by [15], the fallacy of productivity the range of approximations is ±25%. In this investigation, errors were classified using the MAPE Table 8. The table indicates that the MAPE of the models is satisfactory.

Table 8. Classification of Errors (%) [15]

MAPE		
Good	Fair	Poor
Less than 25	25-50	More than 50

4. Conclusions and recommendations

The current search Seeking to create a model for predicting productivity rates. MLR is employed to construct a model for pile works. The model was constructed using 84 data samples obtained through a questionnaire, personal interviews, and phone calls with engineers, consultants, and contractors involved in projects in Iraq, both in the public and private sectors.

4.1. Conclusions

Based on the findings of this study, the following conclusions may be reached:

- The application of MLR allows for the simultaneous investigation of several variables and their interrelationships. The MLR model has a remarkable accuracy of 92.93% and a correlation coefficient (R) of 92%.
- The present study identifies nine key determinants that significantly influence the development of the productivity rate prediction model, and each of these determinants has a substantial effect on the rate of productivity in stacking operations. A selection of factors was identified, and The findings derived from the survey indicate that there are nine factors that have the greatest impact on construction productivity and negatively affect productivity These factors were ranked from most influential to least influential based on the relative importance index (RII), primary determinant of influence is the contractor’s experience, accounting for 84.29% of the total, while quality assurance and control have the least impact, representing 69.76% .
- This research is pertinent to both the building construction sector and Investigators.
- This tool is utilized to schedule and forecast the timeframes required for the pile works activity execution of bridge-building projects.
- it is designed to be simple for engineers involved in implementation and project management.
- it offers researchers a systematic approach to designing methodologies and Regression models for the pile works and their bounds, as well as future recommendations.

- The statistical evaluation for other functions such as quadratic and cubic models does not provide better results than linear models. However, they are more complex, especially for practitioners.

4.2. Recommendations

- It is advisable to utilize the MLR equations created in this study for estimating the productivity rate of building projects across every department of engineering of state departments in Iraq, through which an accurate determination duration period for project completion can be reached.
- Thorough investigations, inspections, and early site inspections are crucial throughout the phase of project design to prevent design modifications during implementation. It is essential to choose contractors with specialized skills and experience to do the necessary tasks.
- Pushing government initiatives and contracting firms to systematically document and safeguard historical data on factors impacting productivity, with the intention of facilitating future private research endeavours.

Declaration of competing interest
The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution
The contribution to the paper is as follows: Waseem M. Jasoor, Tareq A. Khaleel: methodology, resources, data curation, formal analysis, investigation, validation, supervision, writing-original draft, writing-review and editing.

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Appendix A

No.	Prob. PL l	Prob. PL 2	Prob. PL 3	Prob. PL 4	Prob. PL 5	Prob. PL6	Prob. PL7	Prob. PL 8	Prob. PL 9	Average Probability.	Productivity Affected
1	0.631	0.519	0.848	0.881	0.880	0.638	0.696	0.917	0.835	0.760	11.987
2	0.631	0.100	0.848	0.881	0.880	0.638	0.696	0.583	0.003	0.584	20.790
3	0.631	0.519	0.147	0.582	0.437	0.216	0.068	0.583	0.066	0.361	31.948
4	0.047	0.100	0.018	0.042	0.002	0.216	0.696	0.168	0.066	0.151	42.473
5	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.583	0.395	0.553	22.355
6	0.631	0.519	0.495	0.223	0.437	0.638	0.696	0.583	0.395	0.513	24.352
7	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.168	0.395	0.507	24.663
8	0.909	0.916	0.848	0.881	0.880	0.638	0.935	0.917	0.835	0.862	6.907
9	0.631	0.519	0.848	0.881	0.880	0.638	0.696	0.168	0.395	0.628	18.588
10	0.909	0.916	0.848	0.881	0.880	0.001	0.313	0.000	0.835	0.620	18.989
11	0.631	0.100	0.495	0.582	0.437	0.216	0.313	0.583	0.835	0.466	26.716
12	0.252	0.519	0.495	0.042	0.068	0.638	0.313	0.016	0.066	0.268	36.617
13	0.631	0.916	0.495	0.223	0.880	0.216	0.068	0.583	0.395	0.490	25.518
14	0.047	0.519	0.848	0.582	0.068	0.638	0.068	0.168	0.395	0.370	31.480
15	0.047	0.004	0.147	0.042	0.437	0.638	0.696	0.583	0.835	0.381	30.954
16	0.631	0.519	0.147	0.582	0.068	0.027	0.313	0.583	0.395	0.363	31.861
17	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.583	0.395	0.553	22.355
18	0.631	0.519	0.495	0.223	0.068	0.638	0.313	0.583	0.835	0.478	26.089
19	0.909	0.519	0.848	0.223	0.068	0.932	0.696	0.917	0.395	0.612	19.409
20	0.909	0.519	0.848	0.582	0.437	0.216	0.313	0.583	0.835	0.582	20.882
21	0.631	0.100	0.495	0.582	0.880	0.638	0.696	0.917	0.395	0.593	20.372
22	0.909	0.916	0.848	0.582	0.068	0.216	0.313	0.168	0.395	0.491	25.474
23	0.252	0.519	0.848	0.582	0.437	0.638	0.696	0.917	0.835	0.636	18.207
24	0.252	0.519	0.018	0.003	0.437	0.638	0.313	0.583	0.395	0.351	32.452
25	0.252	0.519	0.495	0.582	0.437	0.638	0.313	0.583	0.395	0.468	26.587
26	0.909	0.519	0.495	0.881	0.437	0.638	0.696	0.917	0.066	0.617	19.126
27	0.252	0.100	0.147	0.223	0.437	0.027	0.068	0.016	0.066	0.149	42.575
28	0.004	0.004	0.147	0.042	0.068	0.216	0.068	0.168	0.066	0.087	45.652
29	0.631	0.916	0.495	0.881	0.880	0.932	0.935	0.168	0.395	0.692	15.378
30	0.252	0.519	0.495	0.582	0.437	0.638	0.313	0.583	0.066	0.432	28.415
31	0.631	0.916	0.147	0.881	0.880	0.932	0.935	0.583	0.835	0.749	12.566
32	0.252	0.519	0.147	0.223	0.437	0.216	0.696	0.168	0.395	0.339	33.044
33	0.631	0.100	0.848	0.881	0.437	0.216	0.696	0.016	0.395	0.469	26.562
34	0.909	0.916	0.495	0.582	0.437	0.638	0.313	0.917	0.835	0.671	16.437
35	0.631	0.519	0.495	0.881	0.437	0.932	0.006	0.917	0.835	0.628	18.598
36	0.252	0.100	0.495	0.223	0.437	0.638	0.313	0.917	0.395	0.419	29.059
37	0.631	0.519	0.147	0.582	0.068	0.216	0.068	0.583	0.395	0.357	32.170
38	0.047	0.916	0.147	0.223	0.880	0.027	0.935	0.917	0.835	0.547	22.635

No.	Prob. PL l	Prob. PL 2	Prob. PL 3	Prob. PL 4	Prob. PL 5	Prob. PL6	Prob. PL7	Prob. PL 8	Prob. PL 9	Average Probability.	Productivity Affected
39	0.631	0.519	0.848	0.223	0.437	0.638	0.313	0.168	0.835	0.512	24.388
40	0.909	0.100	0.001	0.003	0.880	0.216	0.068	0.917	0.835	0.436	28.176
41	0.909	0.916	0.848	0.881	0.437	0.638	0.696	0.583	0.835	0.749	12.547
42	0.047	0.004	0.018	0.042	0.002	0.027	0.068	0.016	0.003	0.025	48.728
43	0.252	0.519	0.495	0.582	0.437	0.638	0.313	0.583	0.395	0.468	26.587
44	0.631	0.519	0.147	0.223	0.880	0.932	0.696	0.168	0.395	0.510	24.501
45	0.909	0.916	0.848	0.881	0.880	0.638	0.696	0.917	0.835	0.835	8.235
46	0.631	0.519	0.848	0.582	0.437	0.216	0.313	0.168	0.066	0.420	29.005
47	0.047	0.519	0.848	0.881	0.880	0.932	0.696	0.583	0.835	0.691	15.446
48	0.252	0.916	0.848	0.881	0.880	0.638	0.935	0.583	0.835	0.752	12.411
49	0.631	0.519	0.495	0.223	0.437	0.216	0.313	0.583	0.003	0.380	31.004
50	0.047	0.519	0.495	0.582	0.437	0.932	0.313	0.583	0.835	0.527	23.648
51	0.909	0.916	0.495	0.582	0.880	0.932	0.313	0.583	0.835	0.716	14.196
52	0.252	0.519	0.495	0.881	0.437	0.638	0.696	0.583	0.835	0.593	20.362
53	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.168	0.395	0.507	24.663
54	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.583	0.835	0.602	19.915
55	0.047	0.519	0.495	0.582	0.437	0.638	0.313	0.583	0.395	0.446	27.724
56	0.631	0.519	0.147	0.223	0.437	0.638	0.313	0.583	0.395	0.432	28.415
57	0.631	0.100	0.495	0.582	0.437	0.216	0.068	0.168	0.395	0.344	32.821
58	0.909	0.916	0.848	0.881	0.880	0.638	0.935	0.583	0.835	0.825	8.760
59	0.252	0.100	0.495	0.582	0.437	0.638	0.313	0.168	0.395	0.376	31.223
60	0.631	0.519	0.848	0.582	0.880	0.638	0.313	0.583	0.395	0.599	20.066
61	0.252	0.519	0.848	0.881	0.437	0.638	0.935	0.583	0.835	0.658	17.075
62	0.631	0.519	0.495	0.582	0.880	0.638	0.696	0.583	0.395	0.602	19.897
63	0.631	0.519	0.848	0.582	0.880	0.001	0.696	0.583	0.835	0.619	19.035
64	0.909	0.916	0.848	0.582	0.880	0.216	0.696	0.917	0.835	0.755	12.237
65	0.252	0.519	0.848	0.223	0.068	0.027	0.935	0.016	0.395	0.365	31.761
66	0.909	0.916	0.848	0.881	0.437	0.932	0.935	0.917	0.395	0.797	10.171
67	0.004	0.004	0.147	0.582	0.437	0.638	0.696	0.917	0.835	0.473	26.338
68	0.631	0.519	0.147	0.223	0.068	0.638	0.313	0.583	0.835	0.440	28.024
69	0.252	0.519	0.495	0.881	0.880	0.638	0.068	0.583	0.835	0.572	21.388
70	0.252	0.519	0.018	0.042	0.068	0.216	0.313	0.583	0.395	0.267	36.634
71	0.631	0.519	0.848	0.881	0.880	0.932	0.935	0.583	0.395	0.734	13.318
72	0.909	0.100	0.495	0.042	0.437	0.216	0.313	0.168	0.395	0.342	32.921
73	0.909	0.916	0.495	0.582	0.880	0.638	0.696	0.917	0.835	0.763	11.851
74	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.583	0.395	0.553	22.355
75	0.909	0.916	0.848	0.881	0.880	0.932	0.935	0.583	0.395	0.809	9.566
76	0.631	0.519	0.495	0.582	0.437	0.638	0.696	0.583	0.395	0.553	22.355
77	0.047	0.100	0.495	0.223	0.437	0.638	0.006	0.168	0.835	0.328	33.618

No.	Prob. PL l	Prob. PL 2	Prob. PL 3	Prob. PL 4	Prob. PL 5	Prob. PL6	Prob. PL7	Prob. PL 8	Prob. PL 9	Average Probability.	Productivity Affected
78	0.252	0.519	0.848	0.582	0.437	0.638	0.696	0.583	0.395	0.550	22.501
79	0.252	0.519	0.848	0.881	0.437	0.638	0.696	0.168	0.395	0.537	23.151
80	0.631	0.916	0.001	0.042	0.437	0.027	0.935	0.583	0.835	0.490	25.524
81	0.252	0.100	0.147	0.223	0.068	0.216	0.313	0.168	0.003	0.165	41.729
82	0.631	0.519	0.848	0.582	0.880	0.638	0.935	0.583	0.835	0.717	14.170
83	0.252	0.519	0.495	0.582	0.880	0.638	0.068	0.583	0.835	0.539	23.045
84	0.252	0.519	0.495	0.042	0.068	0.216	0.068	0.583	0.395	0.293	35.343