The Cost of Late Payments in Residential buildings in Arabian Countries

Mohamed Badawy, Omar ELNawawy, Essam Mohamed

Abstract— The phenomenon of delaying of residential projects has become a common phenomenon, especially in developing countries. The delaying payment considers one of the main reasons for the delay, which leads to disruption and interruption in the cash flow of the project, which may lead to termination of the project. This research aims to develop a model to estimate the cost of late payments at an early stage. Real data from Egypt, Saudi Arabia, UAE, and Qatar were collected to obtain this aim. An artificial neural network with a multilayer perceptron was used for analyzing the data. The inputs for the proposed model were the contract value, the delayed payment duration, the type of client, the location, and the total project duration whereas the output was the cost of late payments. The proposed model was contained one hidden layer with four neurons. The sensitivity analysis of the input variables was performed to estimate the importance value of each variable. Regression analysis was used to predict a simple equation for estimating the cost of late payment. the results show that the artificial neural network model is more accurate than the regression analysis. This research can help the contract managers and the arbitrators in determining the appropriate compensation value for the contractor due to late payments.

Index Terms— late payment; consequent compensation, artificial neural networks, regression analysis; construction issue, contract conditions.

1 Introduction

Payment is the main source of construction work where the completion of any activity depends on the continuity of the flow of funds without interruption. Unfortunately, there is often an interruption of fund flow. In recent years, most disputes in construction projects have been concentrated on a single issue which is the delay in paying contractors' invoices, especially in developing countries. Approximately 26% of total disputes are related to payment issues in Australia, whereas, in New Zealand, the disputes relating to payment between the contracting parties were 80% of all cases, and the contractors rarely recover their full payment [1].

The conditions of payment, according to the national law, consider that the contractors are the weak party and do not take into consideration the profitable situation of the contractor to reduce disputes in the future. Ignoring repayment terms in different contracts harms projects, starting from delays in project delivery to complete termination of the project. Subcontractors in the construction industry make between 80 and 90% of direct work in the project. Where the flow of payments from the owner to the main contractor and then to the various subcontractors, so any delay in payments to the main contractor will delay payments to the subcontractors which leads to a delay in the project [2]. Despite contractual obligations to pay in an efficient and timely manner, there are still many payment problems plaguing the construction sector [3]. In the UK, the late payments doubled from $ 26 billion in 2008 to $ 50.6 billion in 2012 [4], which indicates a significant change in the amounts due to contractors and the need to estimate the contractual compensation for late payment problems.

Usually, a clause is written into contracts stating that if the contractor delays the contractor's payments, the project's duration extends by the same amount of delaying payments, but the contractor's compensation cost has not been identified in the prior studies. This study aims to develop a model using artificial neural networks (ANNs) to estimate the cost of late payment based on the analytical data of real cases.

2 Literature Review

There is a consensus among researchers over the world that, delaying payments leads to delay of the project and

- *Mohamed Badawy Lecturer, Department of Structural Engineering, Faculty of Engineering, Ain-Shams University, Cairo, Egypt.E-mail: Mohamed_Badawy@eng.asu.edu.eg*
- *Omar El-Nawawyis a Professor, Department of Structural Engineering, Faculty of Engineering, Ain-Shams University, Cairo, Egypt.*
- *Essam Mohamed is currently pursuing a master's degree program in structural engineering atAin Shams University, Egypt.*

cost overrun. For example, Mansfield et al. (1994) in Nigeria [5], Frimpong et al. (2003) in Ghana [6], Kaliba et al. (2009) in Zambia [7], Odeh and Battaineh (2002) in Jordan [8], Kikwasi (2012) in Tanzania [9], Fallahnejad in Iran (2013) [10], Shehu et al. (2014) in Malaysia [11], Abd El-Razek et al. (2008) [12] and Taha et al. (2016) in Egypt [13], and Seddeeq et al. (2019) in Saudi Arab [14].

Assaf and Al-Hejji (2006) found that 59% of all construction projects in Saudi Arabia suffered from delay [15]. Delay in construction projects is one of the most common issues that could affect the competitiveness of construction companies [16]. Delay has a great effect on the interests of all stakeholders; owners, designers, general contractors, subcontractors, users, and others [17].

Claims related to payment constitute the basis for a significant number of disputes [18]. The late payments have negative consequences not only for the construction industry but also for the wider economy, where contractors should provide more funding for their offers. Moreover, late payments lead to higher construction costs and lower employment opportunities, reduction in productivity, and erosion of competition standards in the construction industry. The cash flow of the contractor is negatively affected by delays in the approval of invoices, settlement of payments, settlement of cost claims and the release of the values of retention [19].

Yang and Wei (2010) analyzed 18 studies and determined that there are 31 causes for the delay. The financial problem of the owner is one of the most important reasons [20]. Khoshgoftar et al. (2010) indicated that the key reasons for the delay in construction projects are the delay in payments of completed work, contract management, lack of communication between the parties, improper planning, and the site management [21].

Abdul Rahman et al. (2014) found after conducting 1,000 surveys with a group of registered third- to seventh-degree contractors in Malaysia that the owner's cash flow problems factor was the main cause of the delay in payment [22]. Marzouk & El-Rasas (2014) indicated that the finance and payments of completed work by the owner factor is the most important factor that causes a delay in the construction project in Egypt [23].

The lack of agreement on the evaluation of the work performed, which leads to delayed issuance of performance certificates, poor financial management of the owner, and non-compliance with contractual provisions in the payment are the most important factors causing late payment [24]. The main causes of delay in Indian projects are the delay in settlement of contractor claims by the owner, contractor's financial difficulties, delay in payment for variation orders, and late payment [25].

Many disputes were occurred due to late payment / non-payment, especially when the main contractor contracts by the way of conditional payment with suppliers or subcontractors where the risk of payment is transferred from the main contractor to subcontractors or suppliers. Since there is no contractual relationship between suppliers/ subcontractors and the employers, the delay in payment / non-payment threatens both cash flow and work performance [26]. The performance of the contractor and the progress rate are largely affected by delays in settlement of claims and payments, approval of invoices and release of retained values. Although payment terms have been specified in the contracts, payment problems remain due to poor contract management [25].

Kadry et al. (2016) suggested a hybrid model using quantitative data from analysis of the delay in six projects and qualitative data based on interviews with several experts. The hybrid model can be used to predict the main causes of delays in a highly politically risky country[27].

Aziz (2013) identified 99 factors that affecting the delay in construction projects, using a questionnaire survey and found that the most important factor is the delay in progress payments. An approximation equation for real-time construction prediction was suggested by knowing the total planned project duration, the project delay factor, the relative importance index for each category, and the percentage of the impact of each category [28].

3 Research Methodology

This study aims to estimate the cost of delaying payment in residential buildings in developing countries. The methodology of this research consists of three parts. The first part relates to determining the critical factors that influence the estimation of the cost of compensation due to

late payment in the early stage, a comprehensive literature review was conducted to define a preliminary list of the critical factors that influence the estimation of the cost of late payments. Using the Delphi technique, a consensus was reached among experts on the final list of factors that influence the cost of compensation for late payments. Data on these factors, as well as the cost of late payment, were collected by reviewing actual cases. ANOVA test was applied to discuss the difference in average individual data according to the type of client or project location. The second part of the study concerns the development of a model using the artificial neural network to estimate the cost of late payment based on the data collected by changing the number of hidden layers and the activation function. Sensitivity analysis was used to determine the normalized importance of each factor. The third part relates to developing a simplified model using regression analysis to predict the cost of delaying payments using regression analysis.

4 Factors Affecting the Cost of Delay

Five experts with a minimum of 15 years of experience in cost compensation claims were selected from 5 construction companies operating in Egypt. Delphi technique was chosen to reach consensus among the experts on the most important factors affecting the cost of compensation due to late payment at an early stage.

The first round relates to an open questionnaire on the most important factors affecting the estimated cost of late payments. The authors summarized the response and resubmitted it to the same experts as the second round to verify whether these factors could be identified in the early stage or not. The third round was concerned with one question whether these factors could determine the cost of late payment without any other factors or not. Expert consensus was reached after three rounds.

This research is concerned with the cost of late payments on residential projects, so the type of project is the same in all cases, and therefore the type of project is not considered one of the factors affecting the cost of late payments. The interest rate during the late payment period and the timing of late payment at the beginning, middle, or end of the project cannot be determined at the early stage. Hence, the types of projects, the interest rate during the late payment period, and the timing of late payment at the beginning, middle, or end of the project were excluded from the final list of factors. The final factors were the type of client, location, the contract value, delayed payment duration, and the total project duration.

5 The Proposed Model Using ANN

The inputs of the proposed model were the type of client, location, the contract value, delayed payment duration, and the total project duration. The factor of the type of client was classified into two categories; the public sector and the private sector, whereas the location factor was classified into two categories; Egypt and others. The frequencies of each category were shown in Table (1).

TABLE 1
The frequencies of each category

	Location		Type of client	
	Egypt	Others	Public	Private
No.	26	5	22	9
%	84	16	71	29

Hence, the factors of the type of client and the location were considered input factors, whereas the contract value, delayed payment duration, and the total project duration were considered input covariates. The cost of late payment was considered the output variable. An artificial neural network with a multilayer perceptron was used for developing the model. The authors conditioned that the accepted model should have a relative error in both training and testing phases of less than 0.2. By using the trial and error method, with different activation functions and different hidden layers, twenty models were developed. The

selected ANN model is the model that has a minimum relative error in both training and testing phases. 26 cases were used for training the network and 5 cases were separated for testing the network. The proposed model contained one hidden layer with four neurons and the hyperbolic tangent was selected as the activation function for the hidden layer. Figure (1) shows the structure of the proposed ANN model.

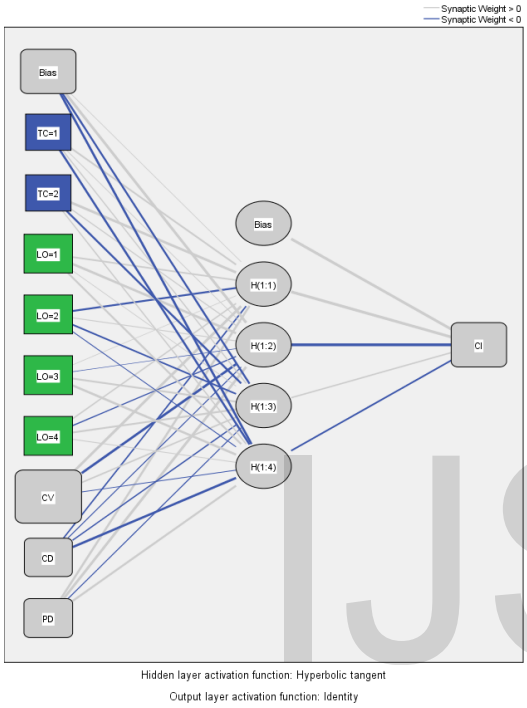


Fig. 1. The structure of the proposed model

In the proposed ANN model, the sum of square error in the training phase was 0.717 and the relative error was 5.7%, while in the testing phase, the sum of square error was 0.085 and the relative error was 19.7%. Figure (2) shows the relationship between the observed cost of delaying payment and the predicted value. The value of R squared equals 94% which indicated that the model can fit 94% from all cases.

The most impact factor was the contract value which has an importance value of 0.626 following by the duration of late payment factor with an importance value of 0.124. Table (2) shows the independence variable important and the normalized importance for all input factors.

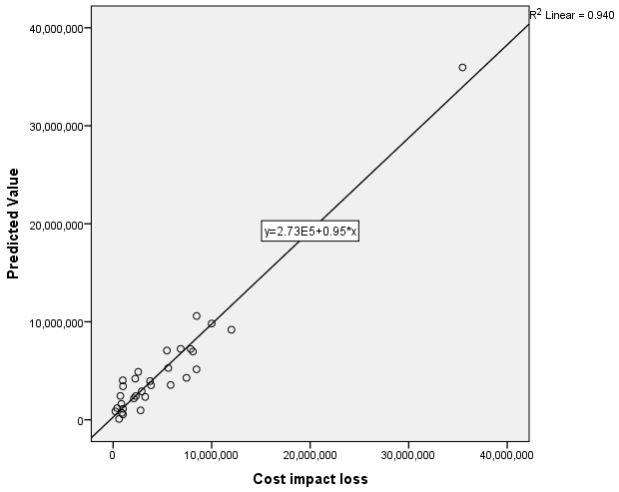


Fig. 2. The predicted by the observed chart

TABLE 2
The Independent Variable Importance

Factor	Importance	Normalized importance
Type of client	0.029	4.6%
Location	0.118	18.9%
Contract value	0.626	100%
Contract duration	0.103	16.5%
Duration of delay payment	0.124	19.8%

6 The Cost of Delaying Payments Using Regression Analysis

Based on the results of the sensitivity analysis, the cost of late payment can be estimated depending on the delay of the payment duration, the total project duration, and the total contract value. The delay ratio (DR) can be calculated using equation (1) and the cost ratio (CR) can be calculated using equation (2).

$$DR = DP/TD \quad (1)$$

$$CR = CD/CV \quad (2)$$

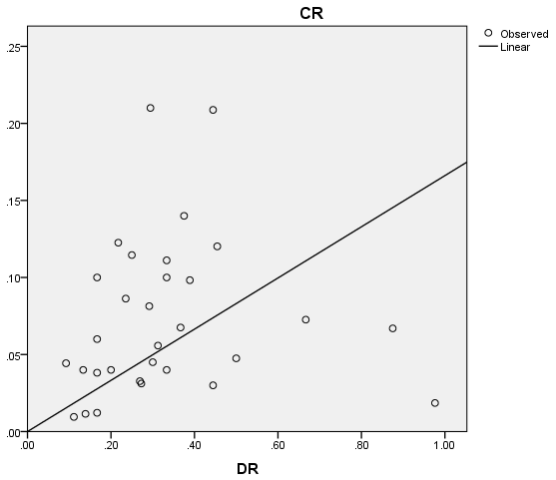
Where "CD" represents the cost of late payment, "DP" represents the duration of the late payments, "TD" represents the total project duration, "CV" represents the contract value.

A mathematical linear equation derived from the real data was extracted to deduce the cost of delaying the payment based on the ratio of the delay of the payment duration for the total project duration and the total contract

value as shown from the equation (3). The relationship between the delay ratio (DR) and the cost ratio was illustrated in Figure (3).

$$CR = 0.166 * DR \quad (3)$$

Fig. 3: The delay ratio & the cost ratio



7 Discussion

The analysis of variance (ANOVA) test was performed to discuss the difference in the average data of individuals according to the type of client. There is two Hypothesis. The null Hypothesis, which indicates that there were no differences between the average data according to the type of client. The alternative Hypothesis, which indicates that there are differences between the average data according to the type of client. By comparing the means by ANOVA test on the contract value, contract duration, delay in time, and delayed cost impact, the significant values were 0.948, 0.635, 0.449 and 0.763 which were more than 0.05. Hence the null hypothesis was accepted, which means there are no differences between the mean data based on the type of client. Whereas, the difference in the average data of individuals according to the location of the project, the significant values were 0.931, 0.725, 0.887 and 0.955 which were more than 0.05. Hence the null hypothesis was accepted, which means there are no differences between the mean data based on the location of the project. Hence, the sample represents any of the Arabian countries.

The sensitivity analysis of the input variables indicated that the most significant factors were the contract value and the delayed payment period, while the location, the type of customer and the total duration of the project were the least important factors. These results are logical since the cost of delayed payment is a percentage of the contract value and affected by the duration of delaying payments.

R squared of the regression model is 0.513, which means that half of the observed variance can be explained by the inputs of the model while the R squared for the model derived from artificial neural networks is 0.94. Hence, the proposed ANN model is more accurate than the approximate equation extracted from the regression model.

8 Conclusion

Almost all residential projects suffer from delays in the completion of the project. One of the most important reasons for delays is delaying the payment of the contractor's invoices, which may lead to the weak performance of the project or termination of the project. Although numerous researches studied the causes and effects of delays, there is a lack of research that determines the amount of the contractor's compensation due to the owner's delaying payment. Therefore, this study aims to develop a model for estimating the cost of delaying the payment.

By using a Delphi technique to reach consensus among experts, five factors affecting the cost of late payment were identified. These factors were the total contract value, the period of delaying payment, total project duration, location, and client type. Data were collected from 31 residential projects from Egypt, UAE, Qatar, and Saudi Arab. ANOVA analysis results show no discrepancy in the data depending on the location or the client type. Consequently, such data could be considered as representative of any Arab country.

After one hundred trails, 0nly 20 models were accepted. The ANN proposed model is the model that has the minimum relative error in both training and testing phases. The proposed model for predicting the cost of delaying payments using ANN which consists of five units of the inputs, one hidden layer containing four neurons and one output. The relative error was 5.7% in the training phase, while in the testing phase the relative error was 19.7%. The contract value was the most impact factor in the cost of late payment and the duration of the delayed payment factor

was ranked second. To calculate the cost of delaying payment in an easier method, the regression was used to derive an approximate equation to estimate the cost of delaying payments by knowing the duration of delaying payment duration, the total duration of the project and the total value of the contract.

9 LIMITATION OF RESEARCH

The proposed model is suitable for residential buildings that were built between 2105 and 2019 in Arabian countries such as Egypt, UAE, Qatar, and Saudi Arab on condition that the duration of the late payment is less than the original total project duration.

The author collected data from 31 residential projects. The type of client, location, the contract value, delayed payment duration, the total project duration and the cost of delayed payment were recorded for each case. The sample size of the unlimited population can be determined using equation (4).

$$C = \sqrt{\left(\frac{Z^2 * p * (1-p)}{SS}\right.} \qquad (4)$$

Where; C is the confidence interval expressed as a decimal, Z is 1.96 according to the 95% confidence level, p is percentage picking a choice expressed as a decimal which is chosen 0.5, and SS is the sample size, which was 31 in this research. From equation (4) the confidence interval was 0.176.

REFERENCES

[1] T. Ramachandra and J. O. B. Rotimi, "Mitigating Payment Problems in the Construction Industry through Analysis of Construction Payment Disputes," J. Leg. Aff. Disput. Resolut. Eng. Constr., vol. 7, no. 1, Feb. 2015, DOI: 10.1061/(ASCE)la.1943-4170.0000156.

[2] J. Hinze and A. Tracey, "The Contractor-Subcontractor Relationship: The Subcontractor's View," J. Constr. Eng. Manag., vol. 120, no. 2, pp. 274–287, Jun. 1994, DOI: 10.1061/(ASCE)0733-9364(1994)120:2(274).

[3] M. F. Hasmori, I. Ismail, and I. Said, "Issues of late and non-payment among contractors in Malaysia," in In Proc., 3rd Int. Conf. on Business and Economic Research, 2012, pp. 2–13.

[4] DBIS (Department for Business Innovation and Skills), "Late Payment: challenging grossly unfair terms and practices," 2015.

[5] N. Mansfield, O. Ugwu, and T. Doran, "Causes of delay and cost overruns in Nigerian construction projects," Int. J. Proj. Manag., vol. 12, no. 4, pp. 254–260, Nov. 1994, DOI: 10.1016/0263-7863(94)90050-7.

[6] Y. Frimpong, J. Oluwoye, and L. Crawford, "Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study," Int. J. Proj. Manag., vol. 21, no. 5, pp. 321–326, Jul. 2003, DOI: 10.1016/S0263-7863(02)00055-8.

[7] C. Kaliba, M. Muya, and K. Mumba, "Cost escalation and schedule delays in road construction projects in Zambia," Int. J. Proj. Manag., vol. 27, no. 5, pp. 522–531, Jul. 2009,DOI: 10.1016/j.ijproman.2008.07.003.

[8] A. M. Odeh and H. T. Battaineh, "Causes of construction delay: Traditional contracts," Int. J. Proj. Manag., vol. 20, no. 1, pp. 67–73, Jan. 2002, DOI: 10.1016/S0263-7863(00)00037-5.

[9] G. Kikwasi, "Causes and Effects of Delays and Disruptions in Construction Projects in Tanzania," Australas. J. Constr. Econ. Build. - Conf. Ser., vol. 1, no. 2, p. 52, Feb. 2013, DOI: 10.5130/ajceb-cs.v1i2.3166.

[10] M. H. Fallahnejad, "Delay causes in Iran gas pipeline projects," Int. J. Proj. Manag., vol. 31, no. 1, pp. 136–146, Jan. 2013, DOI: 10.1016/j.ijproman.2012.06.003.

[11] Z. Shehu, I. R. Endut, and A. Akintoye, "Factors contributing to project time and hence cost overrun in the Malaysian construction industry," J. Financ. Manag. Prop. Constr., vol. 19, no. 1, pp. 55–75, 2014, DOI: 10.1108/JFMPC-04-2013-0009.

[12] M. E. Abd El-Razek, H. A. Bassioni, and A. M. Mobarak, "Causes of delay in building construction projects in Egypt," J. Constr. Eng. Manag., vol. 134, no. 11, pp. 831–841, Nov. 2008, DOI: 10.1061/(ASCE)0733-9364(2008)134:11(831).

[13] O. E.-N. Mohamed Badawy, Ghada Taha, "A Model for Evaluation of Delays in Construction Projects," Int. J. Innov. Res. Sci. Eng. Technol., vol. 5, no. 3, pp. 3021–3028, Mar. 2016, DOI: 10.15680/IJIRSET.2016.0503048.

[14] A. Bin Seddeeq, S. Assaf, A. Abdallah, and M. A. Hassanain, "Time and Cost Overrun in the Saudi Arabian Oil and Gas Construction Industry," Buildings, vol. 9, no. 2, p. 41, Feb. 2019, DOI: 10.3390/buildings9020041.

[15] S. A. Assaf and S. Al-Hejji, "Causes of delay in large construction projects," Int. J. Proj. Manag., vol. 24, no. 4, pp. 349–357, May 2006, DOI: 10.1016/j.ijproman.2005.11.010.

[16] F. A. Orozco, A. F. Serpell, M. A. Keith R. Molenaar, and E. Forcael, "Modeling Competitiveness Factors and Indexes for Construction Companies: Findings of Chile | Journal of Construction Engineering and Management | Vol 140, No 4," J. Constr. Eng. Manag., vol. 140, no. 4, 2014,DOI: https://doi.org/10.1061/(ASCE)CO.1943-7862.0000462.

[17] A. S. Faridi and S. M. El-Sayegh, "Significant factors causing delay in the UAE construction industry," Constr. Manag. Econ., vol. 24, no. 11, pp. 1167–1176, Nov. 2006, DOI: 10.1080/01446190600827033.

[18] V. M. Watts and J. C. Scrivener, "Review of Australian building disputes settled by litigation: Fifty-nine different categories of dispute recognized within a total of 117 sources of dispute from building dispute judgments in supreme courts of new south wales and victoria from 1989–1990," Building Research & Information, vol. 21, no. 1. Taylor & Francis Group, pp. 59–63, 01-Jan-1993, DOI: 10.1080/09613219308727257.

[19] J. Wu, M. M. Kumaraswamy, and G. Soo, "Regulative measures addressing payment problems in the construction industry: A calculative understanding of their potential outcomes based on gametric models," J. Constr. Eng. Manag., vol. 137, no. 8, pp. 566–573, Aug. 2011, DOI: 10.1061/(ASCE)CO.1943-7862.0000336.

[20] J.-B. Yang and P.-R. Wei, "Causes of Delay in the Planning and Design Phases for Construction Projects," J. Archit. Eng., vol. 16, no. 2, pp. 80–83, Jun. 2010, DOI: 10.1061/(ASCE)1076-0431(2010)16:2(80).

[21] M. Khoshgoftar, A. H. A. Bakar, and O. Osman, "Causes of delays in Iranian construction projects," Int. J. Constr. Manag., vol. 10, no. 2, pp. 53–69, 2010, DOI: 10.1080/15623599.2010.10773144.

[22] H. Abdul-Rahman, M. Kho, and C. Wang, "Late payment and nonpayment encountered by contracting firms in a fast-developing economy," J. Prof. Issues Eng. Educ. Pract., vol. 140, no. 2, Apr. 2014, DOI: 10.1061/(ASCE)EI.1943-5541.0000189.

[23] M. M. Marzouk and T. I. El-Rasas, "Analyzing delay causes in Egyptian construction projects," J. Adv. Res., vol. 5, no. 1, pp. 49–55, Jan. 2014, doi: 10.1016/j.jare.2012.11.005.

[24] I. El-adaway, S. Fawzy, H. Burrell, and N. Akroush, "Studying Payment Provisions under National and International Standard Forms of Contracts," J. Leg. Aff. Disput. Resolut. Eng. Constr., vol. 9, no. 2, p. 04516011, May 2017, doi: 10.1061/(asce)la.1943-4170.0000200.

[25] I. S. Abotaleb and I. H. El-adaway, "Administering Employers' Payment Obligations under National and International Design–Build Standard Forms of Contract," J. Leg. Aff. Disput. Resolut. Eng. Constr., vol. 9, no. 2, p. 04517003, May 2017, doi: 10.1061/(asce)la.1943-4170.0000213.

[26] S. Hansen, S. F. Rostiyanti, and Purnomo, "Conditional Payments in the Indonesian Construction Industry," J. Leg. Aff. Disput. Resolut. Eng. Constr., vol. 9, no. 3, p. 06517001, Aug. 2017, doi: 10.1061/(asce)la.1943-4170.0000226.

[27] M. Kadry, H. Osman, and M. Georgy, "Causes of Construction Delays in Countries with High Geopolitical Risks," J. Constr. Eng. Manag., vol. 143, no. 2, Feb. 2017, doi: 10.1061/(ASCE)CO.1943-7862.0001222.

[28] R. F. Aziz, "Ranking of delay factors in construction projects after Egyptian revolution," Alexandria Eng. J., vol. 52, no. 3, pp. 387–406, Sep. 2013, doi: 10.1016/j.aej.2013.03.002.