

PAPER • OPEN ACCESS

## External time-influencing risk factors in infrastructure soft soils projects

To cite this article: W W Low *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **943** 012028

View the [article online](#) for updates and enhancements.

You may also like

- [Spatially coordinated changes in intracellular rheology and extracellular force exertion during mesenchymal stem cell differentiation](#)  
Kathleen M McAndrews, Daniel J McGrail, Nhat D Quach et al.
- [Use of Lightweight Cellular Mats to Reduce the Settlement of Structure on Soft Soil](#)  
R Ganasan, A J M S Lim and D C Wijeyesekera
- [Risk assessment framework on time impact: Infrastructure projects in soft soil during construction stage](#)  
W W Low, K S Wong and J L Lee



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# External time-influencing risk factors in infrastructure soft soils projects

W W Low<sup>1</sup>, K S Wong<sup>1</sup> and J L Lee<sup>1</sup>

<sup>1</sup> Department of Civil and Construction Engineering, Faculty of Engineering and Science, Curtin University Malaysia, CDT 250, Miri, Sarawak, Malaysia

E-mail: low.wai.wah@curtin.edu.my

**Abstract.** Malaysian government has putting a lot of budget and resources in developing and upgrading infrastructure of the country. The covered area of an infrastructure project especially in a transportation project is quite significant compared to residential and commercial projects. As such, construction on soft soils is unavoidable and it increases uncertainties and risks in an infrastructure project. The current literature review showed that existing knowledge on risk assessment of infrastructure projects on soft soils is scarce. Hence, this research was focused on determining the critical time-influencing external risk factors during the construction phase. Analytical Hierarchy Process (AHP) was used to determine the most critical external risks in infrastructure projects on soft soils. Research method was questionnaire survey. It is found that the five most critical risk factors were thick soft soil layer, high water content, high organic content, price changes (material & energy) and karstic cavity formation. While the five least critical risk factors were archaeological/habitant issue, lack of political support, protectionism, corruption and change in government/legislative/regulatory. In conclusion, soil condition and economic are critical determining the time performance in infrastructure projects on soft soils, while political risk contributes little impact on this aspect.

## 1. Introduction

Malaysian government has putting a lot of resources and investment in respect of the infrastructure development. In the 11<sup>th</sup> Malaysian Plan (11MP) (2016-2020), one of the strategic thrusts is to strengthen infrastructure for economic expansion [1]. The examples strategies involved in 11MP are “transforming rural areas to uplift wellbeing of rural communities” (p. 16), “improving coverage, quality, and affordability of digital infrastructure”, “continuing the transition to a new water services industry framework”, “building an integrated need-based transport system” (p. 32) and “transforming construction” (p. 35) [1]. Some of the major investment in infrastructure projects include high-speed railway, LRT3 and Pan Borneo Highway [1]. In the Twelfth Malaysia Plan (12MP) (2021-2025), Malaysian government is planning to maintain their priority on the infrastructure development in which one of the main focuses is integrated regional development which include infrastructure connectivity [2]. According to the Economic Planning Unit, construction sector has contributed 11.1% of Gross Domestic Product (GDP) in the 10<sup>th</sup> Malaysian Plan (2011-2015) and the targeted contribution of this sector in the 11MP is 10.3% (Economic Planning Unit, n. d., p.11).

As the area that covered in infrastructure projects is large, it is unavoidable that part of the structure or the entire structure to be constructed on soft soils. Soft soils are problematic [3] in the fields of construction and geotechnical engineering. Examples of soft soils are organic soil and peat soil [4]. One



of the significant issue caused by soft soils is low bearing capacity and this is because of its natural characteristics of “rich-water content, high natural void level, low shear strength, high compressibility” [5]. The low bearing capacity can affect project performance especially in terms of time, cost and quality. The traditional way of replacing soft soils is merely incurred high project cost [4], due to the complication in the process, it requires additional time. Any wrong or inaccurate decision will further increase project time and thus provide pressure on project time performance. Besides that, poor risk management in respect of risk identification and assessment could further aggravate project time performance. Risks and uncertainties are unique in every construction project. In view of the higher and unique risks and uncertainties of construction projects on soft soils, risk management plays a critical role in project management. In addition, the current literature review showed that existing knowledge on risk assessment of infrastructure projects on soft soils is scarce.

In view of the significance of infrastructure projects in developing countries as well as the issues and risks of construction projects on soft soils, this study intends to determine critical time-influencing external risk factors of infrastructure projects on soft soils. The focus of this study was on the project time performance as it is one of the key elements in determining the success of project management. As the types, probability and likelihood of risks are different at each project life cycle, this research focused on the construction phase. According to Edwards and Bowen [6], external risks such as political, economic and financial risks are critical and should be given priority in the construction research.

## **2. Literature Review**

Review of the past studies showed that studies on risk assessment of infrastructure projects has been gaining considerable attention by researchers in the past. Some focused on general infrastructure projects [7], others on specific types of infrastructure projects such as bridge, roads, highway [8, 9], seaport [10] and railway [11]. As indicated by Low, Wong and Lee [7], managerial (soft) aspect is paying very little attention by past literature compared to the technical (hard) aspect of infrastructure projects on soft soils. Soft knowledge is essential in assuring the success of a construction project especially if the ground condition is problematic like soft soils. With reference to the work by Low, Wong and Lee [7], 4 types of external risks at level 1 (criteria) were used in this study. A total of 21 risk factors at level 2 (subcriteria) were extracted and used in studying the risk assessment of infrastructure projects on soft soils.

## **3. Research Methodology**

The risk assessment of this study was conducted based on the Analytic Hierarchy Process (AHP) method. According to Saaty [12], AHP was introduced by Thomas Saaty and it is a multicriteria decision making approach that determining critical factors in a decision [12] based on pairwise comparison method. The main advantages of this approach is the input of experts' knowledge [13] and thus the reliability of findings is quite high in a small sample size [14]. This study adopted the relative importance scale of 1 (equal) to 9 (extreme importance) introduced by Saaty [12]. The research method of this study was questionnaire and the questionnaires were sent to the respondents by few techniques, namely, by post, email and face-face. This study was conducted based on cross-sectional approach. The experts of this study were professionals from the contractor organizations with civil engineering or other construction-related background, at least 15 years and above working experience in the construction sector and have been involved in at least one infrastructure project on soft soils.

## **4. Results and discussions**

A total of 13 valid responses were used in this study. Five (5) industry experts have 16-20 years working experience in the construction and the remaining eight respondents have more than 20 years working experience in the construction. Three respondents have involved in one infrastructure project on soft soils and ten respondents have involved in at least 2 or more infrastructure project on soft soils. The consistency ratios at level 1 & 2 were less than 0.10 which is within the acceptable threshold. Table 1 indicates the results of the local and global weightage of the external risk factors. The significance level

of external risks in descending order was as follows: “Soil condition” risk (0.47), “Economic” and “Political” risks (0.19) and “Environmental” risk (0.15). In respect of the global weightage, the five most critical external risk factors on infrastructure project time performance on soft soils were “Thick soft soil layer” (0.14), “High water content” (0.11), “High organic content” (0.08), “Price changes (material & energy)” (0.07) and “Karstic cavity formation” (0.06). Results of this study were consistent with past studies in which “Thick soft soil layer”, “High organic content” and “Price changes (material & energy)” are not merely play a critical role on project cost performance as indicated by Low, Wong and Lee [7] but they play an equal important role in determining time performance of infrastructure projects on soft soils. Although the annual inflation rate in Malaysia marked an average +1.5% in August 2019, “Price changes (material & energy)” is still considered as an important risk factor in infrastructure projects on soft soils.

While the five least critical external risk factors on project time performance were “Archaeological/habitant issue” (0.02), “Lack of political support” (0.02), “Protectionism” (0.02), “Corruption” (0.02) and “Change in government/legislative/regulatory” (0.03). The results implied that Malaysian government provides support in infrastructure development which is in line with the 11<sup>th</sup> Malaysian plan and the change in government provides least significant impact on project time performance. In other words, it can be suggested that political risk plays a little role in determining the success of project time performance.

**Table 1.** Local and global weightage of external risks.

Risks		Risk Factors		Local	Global
Level 1		Level 2		weightage	weightage
Economic	0.19	Wages inflation		0.19	0.036
		Local inflation change		0.26	0.049
		Price changes (material & energy)		0.35	<b>0.065</b>
		Economic recession		0.20	0.038
Environment	0.15	Unfavourable weather condition		0.40	0.059
		Adverse environmental impact due to construction works		0.25	0.037
		Hard to access site and mobilize resources		0.26	0.038
		Archaeological/habitant issue		0.10	0.015
Soil condition	0.47	Thick soft soil layer		0.30	<b>0.144</b>
		High water content		0.23	<b>0.110</b>
		High organic content		0.17	<b>0.083</b>
		Karstic cavity formation		0.13	<b>0.064</b>
		Sand lenses/laminations/different soils mixture (complex soil layers)		0.08	0.036
		Mineralogy of soil (high activity/sensitivity of soils etc.)		0.08	0.040
		Change in government/legislative/regulatory		0.15	0.029
Political	0.19	Corruption		0.11	0.021
		Political opposition/interferences		0.16	0.031
		Lack of political support		0.08	0.015
		Protectionism		0.08	0.015
		Land acquisition issue		0.24	0.045
		Delay in obtaining consent/approval (access right etc.)		0.18	0.033

## 5. Conclusions

It can be concluded that soil condition risk and economic risk play a vital role in assuring the success of an infrastructure project on soft soils. While, political risk has little contribution in determining the success of an infrastructure project on software. As such, a further study is proposed to delve into the impact level of different soil condition on project time performance of infrastructure project on soft soils.

## References

- [1] Economic Planning Unit n.d Eleventh Malaysia Plan 2016-202: Anchoring growth on people.
- [2] Ministry of Economic Affairs 2019 Twelfth Malaysia Plan.
- [3] Jafer H M, Atherton W, Sadique M, Ruddock F and Loffill E 2018 Development of a new ternary blended cementitious binder produced from waste materials for use in soft soil stabilization *Journal of Cleaner Production* **172** 516-28
- [4] Mujah D, Rahman M E and Zain N H M 2015 Performance evaluation of the soft soil reinforced ground palm oil fuel ash layer composite *Journal of Cleaner Production* **95** 89-100
- [5] Yang G, Xue R and Li H 2011 *Rock mechanics: Achievements and ambitions*, pp 683-6
- [6] Edwards P J and Bowen P A 1998 Risk and risk management in construction: A review and future directions for research. *Engineering Construction and Architectural Management* **5** 339-49
- [7] Low W W, Wong K S and Lee J L 2019 Cost-influencing risk factors in infrastructure projects on soft soils *International Journal of Construction Management* 1-13
- [8] Kumar L, Jindal A and Velaga N R 2018 Financial risk assessment and modelling of PPP based Indian highway infrastructure projects *Transport Policy* **62** 2-11
- [9] Mousavi S M, Tavakkoli-Moghaddam R, Azaron A, Mojtahedi S M H and Hashemi H 2011 Risk assessment for highway projects using jackknife technique *Expert Systems with Applications* **38** 5514-24
- [10] John A, Paraskevadakis D, Bury A, Yang Z, Riahi R and Wang J 2014 An integrated fuzzy risk assessment for seaport operations *Safety Science* **68** 180-94
- [11] Hwang B-G, Zhao X and Yu G S 2016 Risk identification and allocation in underground rail construction joint ventures: contractors' perspective *Journal of Civil Engineering and Management* **22** 758-67
- [12] Saaty T L 1990 How to make a decision: the analytic hierarchy process *European journal of operational research* **48** 9-26
- [13] Saaty T L 2008 Decision making with the analytic hierarchy process *International Journal of Services Sciences* **1** 83-98
- [14] Darko A, Chan A P C, Ameyaw E E, Owusu E K, Pärn E and Edwards D J 2018 Review of application of analytic hierarchy process (AHP) in construction *International Journal of Construction Management* 1-17