Journal of Critical Reviews

ISSN- 2394-5125 Vol 7, Issue 8, 2020

COST RISK OF RAILWAY PROJECT AND ITS EFFECTIVE MITIGATION STRATEGIES

NazirulFariq*1, Syuhaida Ismail2,Nur IzzatiAb Rani2

1Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia
2Faculty of Civil Engineering, Universiti Teknologi MARA, Shah Alam, Malaysia
Email: *1nazirulfariq@gmail.com.com

Received: 20.05.2020 Revised: 17.06.2020 Accepted: 06.07.2020

Abstract
Mega infrastructure project like the railway is very complex, unique, and impactful in nature. Many studies were carried out and shown how critical the subject needs to be given attention and focus. The railway projects are known for various risks. The presence of technical risks in the railway construction projects is needed to be understood in detail so that it will be managed effectively especially ones that involving cost impact. Hence, this paper is determined to assess the technical risk factors that contribute to cost impact on railway construction projects and identify its response strategies. There are 9 technical risks that are found to be critical based on the results that had been analysed with the frequency analysis and Relative Importance Index (RII) method. Furthermore, the risks are filtered and found to avoid, mitigate, and escalate as effective response strategies. The study is also confident that this can give guidelines to professionals that involve in the railway construction project.

Keywords--Cost Risk, Project Management, Railway Project, Quantity Surveying

DOI: http://dx.doi.org/10.31838/jcr.07.08.262

INTRODUCTION

The world economy is steadily growing every year especially in the United States (U.S.), European countries, and China. Sindreu*et al.* (2018) in their report found that The International Monetary Fund released a statement that the world's seven largest economies, which includes U.S., China, Japan, Germany, India, France, and the United Kingdom grew more than 1.5 percent in 2017, and the trend is predicted to have more solid growth in the following year. Meanwhile, China and the U.S. make up almost 40 percent of the world economy (Scott and Sam, 2016). The growth leads the global economic players to be aggressively looking for a new marketplace to expand.

Fortunately, Malaysia is a strategic location and competitive in Southeast Asia for foreign investment. The improvement in infrastructure that is actively in progress can provide significant economic benefits (Fay*et al.*, 2010). Thus, it is necessary to promote sustainable advantage in this kind of project which the project management being one of the factors in achieving that goal (Amiril*et al.,* 2014). Such investments are consistent throughout the country which can be seen recently through phase 1 of the Penang Transport Master Plan project which costs RM 16 billion comprising of Bayan Lepas Light Rail Transit (LRT) and Pan Island Link 1 (PIL1) (Idris, 2020).

Consequently, based on these huge investments on the mega infrastructure project like the railway, it is important to understand and broaden the knowledge in this area. Various factors can contribute to the success of a railway project although it entails several risks. There are substantially high risks in railway projects(Patil *et al*., 2017). Thus, the ability to manage it is so important so that these railway projects would benefit and bring value to the public and economic growth in the long term.

Nevertheless, only the technical risks were investigated in this paper which is found to be a significant factor to influence the project cost. Construction projects are often vulnerable and expose to greater exposures to technical risks (Jayasudha and Vidivelli, 2016). The study was observed from the client's perspective. This paper aims to assess technical risk factors that contribute to cost impact on railway construction projects and identify its response strategies. This paper also intended to increase the awareness in managing a project, so that each of the risks will be given specific attention managing it proactively and effectively.

LITERATURE REVIEW

Risks in Railway Construction Project

Risk is commonly known as the outcome of the probability of the occurrence of an adverse event and weight of the consequences of such an event (Sotic and Rajic, 2015). Iqbal *et al.* (2015) defined risk as exposure to loss or gain or the probability of occurrence of loss or gain multiplied by its corresponding magnitude. In a construction project perspective, the risk is defined as any action or occurrence, which will affect the achievement of project objectives (Krantikumar and Amarsinh, 2016). International Organization for Standardization (ISO) (2018)defined risk as the effect of uncertainty on objectives.

Categorised as megaproject typically, railway construction projects undeniably engage with a lot of risks due to its size. Patil *et al.* (2017) described that the incidence of risks in railway construction projects is high. The complexity of railway construction is the reason why it is synonymised with risk. Kaczorek, Krzeminski, and Ibadov (2017) claimed the specificity of execution involves high risk throughout the construction process of railway construction projects.

There are several risks in a construction project that have an impact on the project which can be divided into 6 types which are environmental, financial, logistical, management, socio-political, and technical (Ehsan *et al.,* 2010). In addition to that, Wolters Kluwer (2016) found that legal risk is also a common risk that could influence any businesses, including the construction industry. As mentioned earlier, this paper only focuses on the technical risks.

Technical risk is defined as the inability to build a product that satisfies the requirements (Jayasudha and Vidivelli, 2016) and it usually transpires from the consultant or project team. Reddy (2015) explained technical risk as risks that are associated with the construction process, design, and technology. The risk includes the complexity and system integration of design and construction which is synonymous with the nature of railway and infrastructure construction projects. Hwang, Zhao and Yu (2013) stated that interfacing with existing built structures and utilities is a risk, which can cause excessive deformations and damage.

Observing from the design viewpoint, the technical risk could appear from the standard and code of design. Delay in providing design drawing is also found to be a risk. Patil *et al.* (2017) listed design technical risk comprises defective design, change of design, and inexperience engineer that responsible to do the design. Some inexperienced engineers sometimes being assigned to the design work without being properly coached and supervised. Additionally, Sousa and Einstein (2012) and Hussain et al., (2013) stated that deficient supervision of the work and lack of communication between project teams are technical risks that are found in many construction projects including railway.

Last but not least, the safety standard and quality control is a common risk from a technical aspect. The type of contract and procurement route is also another risk involved. Moreover, inadequate investigation on-site condition, lack of prompt analysis, material not conforming to the specification, construction defects, misunderstanding of drawings and specifications, and actual quantities differ from the contract quantities are also among other technical risks found in the railway construction project. Table 1 displays the technical risks in railway construction projects.

Table 1. Technical Risks in Railway Construction Project

Technical Risks	Sunduck (2000)	Ehsan et al. (2010)	Wang, Li, and Wang (2011)	Institute of Transport India (2012)	Sousa and Einstein (2012)	Patil et al. (2017)	Hwang, Zhao, and Yu (2013)
Complexity and system integration of design and construction	●						●
Design risk	●	●		●		●	
Delay in providing design drawing		●	●			●	
Lack of supervision					●	●	
Lack of communication					●		
Standard of safety and quality control	●					●	
Contract and procurement route	●						
Inadequate investigation on-site condition		●					
Lack of project analysis					●		
Material not conforming to the specification	●					●	
Misunderstanding of drawings and specifications						●	
Construction defects	●					●	
The variance between contract and actual quantities						●	

Influence of Risk on Project Cost

According to Andric, Mahamadu, and *et al.* (2019), almost 57 per cent of projects in Asia had experienced cost overrun by 26 per cent that was due to risks such as the acquisition of land and resettlement, change in design specifications and safety issues, environmental issues, project resources, and fluctuation. Respectively, these are fall under legal risk, technical risk, environmental risk, management risk, and financial risk.

This paper is intended to understand the risk factors that contribute to cost overrun. Vu, Wang *et al.* (2011) found that the key to mitigating the issue of cost overrun is by identifying the risk factors of cost overrun. The correlation between risk and cost overrun seems in the vicinity. Cunningham (2017) also suggested that when the risk occurs in the construction, it is not just the delaythat is likely to happen, but cost overrun can also take place.

It is observed in London where Tottenham Hotspur Stadium's original cost was £850 million (Zak, 2018) furthered up to the final amount of around £1 billion (Herman, 2019). It is found that risks like economic uncertainties gave quite an impact on the development of the stadium (Gerrard, 2018). Furthermore, the research also found that an unreasonable project programme has led to the surge of the labour cost when workers were required to work overtime. On top of that, political risk during Brexit which means the departure of Britain from the European Union has increased easily 20 per cent through the price of foreign goods (Watson, 2018).

Meanwhile, Berlin Brandenburg International Airport shows another close correlation between the risk and cost overrun when the cost of the original contract €2 billion has an anticipated final cost of €7.3 billion (Schultheis, 2018). The difference in cost was due to the additional scope of works through maintenance works every month. This project has also political influence and interference by firing the consortium of private companies (Organisation for Economic Cooperation and Development, 2016). The article also recognised that the budget prepared was unrealistic and a lot of changes and variations happened to the project.

Moving forward to railway projects such as Crossrail UK.Plimmer (2019) stated the original cost of the project was £14.8 billion and now has risen to around £17.6 billion. It is believed that rising costs will be furthered up in the future. Waite (2019) found that risks such as lack of design coordination of the project were neglected earlier. Then, the complexity of the design which increases the likelihood of having risks to a budget was also being neglected.

Apart from that, unreasonable budgets and schedules were also part of the risks (Plimmer, 2019). He added that lack of detail design and pressure to contractors have led to this disastrous event. The pressure in this context means effective communication and proactive measures by the project control team. Poor coordination between contractors was also one of the risk factors that led to cost overrun (Price, 2019). Price (2019) also mentioned that the seven stations on the central part of the line have increased by an average of 240 per cent from their target costs when the contracts were awarded in 2011.

In Germany, the railway project of Stuttgart 21 was also experienced the overrun cost due to risk. The cost of the project was influenced negatively from the original contract of €4.088 billion (Novy and Peters, 2012) to the latest forecast of €8.2 billion (Traufetter, 2018). It was increased from €7.7 billion due to the risk reserve of €495 million (Wupper, 2019). Somehow, Wupper (2019) reported that the amount will increase to more than €3 billion for future work orders. It is understood that geological risks and additional scope of works have led to this cost overrun (Deutsche Bahn, 2018).

Among other reasons were inflation (Briginshaw, 2017) which was due to the long period of construction as it was started in 2010 and target to be completed in 2024 (Traufetter, 2018). Unrealistic budget and errors in planning and management also found to be the main risk factors of the increase in cost (Spiegel, 2013). Bracholdt (2013) further added that change of design as one of the factors as well.

The identical scenario happened in the United States through California's High-Speed Rail where the original cost of the contract worth $77 billion (Daniels, 2018) experiencing cost overrun to anticipated final cost which could be as high as $98.1 billion (Shepardson, 2019). The future projections suggest that it is a very high risk of the cost to get an increase. (Ashton, 2018). Despite the awareness of risks, the project team did not factor them into their cost forecasts which considered as a technical risk (The Business Journal of Fresno and The Madera Tribune, 2018). Among risk factors were due to weak decision making and poor contract management (Shepardson, 2019) which unclear contract amendments (Ashton, 2018) were not being managed properly.

Furthermore, Varghese (2019) cited that additional scope of works and changes in planning which includes the $20.4 billion extensions to Bakersfield and Merced were also led to a deleterious impact on the project cost. Poor planning and appalling cost estimation are also risks that impacted the project (Cowin, 2018). Cowin (2018) found that matters related to land acquisition and relocation of the utilities system have directed to $2.2 billion cost overrun. Finally, Ashton (2018) reported that weak supervision on contractors was also contributed to the cost overrun in California's High-Speed Rail.

Last but not least, Sha Tin-Central Link MTR in Hong Kong also demonstrated the correlation between risk and cost. In the beginning, the original cost of the project was HK$70.82 billion (Tsang, Yau, and Yeung, 2017) and there is an estimated cost overrun of HK$16.5 billion. However, Tsang, Yau, and Yeung (2017) claimed that would not be the last cost overrun given to its complexity in nature. Currently, the cost is recorded at HK$97.1 billion (Siu, 2019).

The main factors of the cost overrun were due to the additional scope of works through heritage preservation works near Sung Wong Toi Station and additional foundation works at Exhibition Centre station (Tsang, Yau, and Yeung, 2017). Tsang *et al.* (2017) found that the project also has experienced a shortage of manpower which offers higher wages was a strategy to lure workers for the project. Among other factors were due to unfavourable ground conditions and the rise in the cost of raw materials (Lok-kei and Hui, 2017). Political risk has also added as a factor to the cost overrun through the change of government's requirements (Chiu, 2017).

Based on the case studies above, ithas shown the close relationship between the risk and the cost. The amount that this paper has seen involved in these cases were catastrophic to the project's shareholders. It is hard to recoup with these oversight matters especially when there are no alternate strategies to this financial disaster. It is hoped that this section can help to understand furtherhow the project cost can be influenced by the risks so that necessary mitigation strategies can be developed. Table 2 summarises the cost differences of the projects due to risks.

Table 2. Summary of Cost Differences of the Projects Due to Risks

Projects	Initial Cost (billion)	Final / Anticipated Final / Current Cost (billion)	Differences
Tottenham Hotspur Stadium	£0.85	£1.00	18%
Berlin Brandenburg International Airport	€ 2.00	€ 7.30	265%
Crossrail UK	£14.00	£17.60	26%
Stuttgart 21	€ 4.09	€ 8.20	101%
California's High-Speed Rail	$77.00	$98.10	27%
Sha Tin-Central Link MTR	$70.82	$97.10	37%

LIMITATION

The distributed questionnaire is confined to investigate the responses of construction players in the Klang Valley area and is limited to the scope of cost risk management. This paper also limited from risk identification to the mitigation act of railway construction projects. In this paper, previous studies from researchers that investigated risk in railway construction projects are used as a reference in identifying risk factors and further developing the research instruments for data collection purposes.This paper focuses on the effective strategies in mitigating cost risk in railway construction projects by looking into the detailed relationship of the risks encountered that influence the cost.

METHODOLOGY

This paper was prepared through a thorough literature review and questionnaire survey followed by data collection, data analysis, and lastly, the conclusion of data. In this paper, the population consists of all consultancy firms, contractors, and organisation involved in the construction of a railway in Malaysia.Total of 200 respondents that involved in railway construction projects in Klang Valley areas are targeted sample in this paper which come from quantity surveying and project management consulting firms, contractors and also the client who also the operator of the railway.

This paper aims to target sample with at least Diploma in academic qualifications, and job experiences in quantity surveying, project management, or any related disciplines that involve in the project cost management. The data were analysed using IBM SPSS Statistics 26.0 and Microsoft Excel with a frequency analysis and Relative Importance Index (RII) method.

RESULTS AND DISCUSSION

This paper suggested that there are 17 technical risks in the railway construction project. The risk ranking can guide to priorities and increase the awareness of the risks for effective measures. Otherwise, the significant ones could end up being neglected (Fischhoff and Morgan, 2009).

Relative Importance Index for Technical Risks

The technical risks are ranked based on RII in Table 3. When the RII is greater than 0.800, it is considered as the most important factor (Muneeswaran*et al*., 2018). Therefore, it is relatively important to discuss further only on these risks. This paper found 9 technical risks that are regarded as crucial in the railway construction project.

Table 3. Relative Importance Index for Technical Risks in Railway Construction Project

Item	TechnicalRiskFactors	RII	Rank
TR1	Complexity and system integration of design and construction	0.900	1
TR2	Design risk (i.e. defective design, design change, design error)	0.892	2
TR17	Unrealistic project plan and schedule	0.873	3
TR12	Additional scope of works	0.860	4
TR8	Inadequate investigation on site and soil condition	0.837	5
TR16	Delay in the relocation of existing utilities	0.833	6
TR3	Delay in providing design drawing and specification	0.831	7
TR5	Poor communication	0.806	8
TR4	Poor supervision and design coordination	0.800	9
TR10	Misunderstanding of drawings, specifications, and requirements	0.798	10
TR15	Excessive deformation and damage when interfacing existing built structures.	0.794	11
TR7	Mismanagement of contract and procurement	0.792	12
TR11	Construction defects	0.762	13
TR9	Material not conforming to the specification	0.756	14
TR14	Delay of supply of materials	0.756	15
TR6	Poor standard of safety and quality control	0.753	16
TR13	Failure of equipment	0.719	17

Results in Table 3 above show that the complexity and system integration of design and construction is the highest in ranking for risk that impacts the cost in a railway construction project with RII of 0.900. Next, TR2-Design risks such as defective design, design change, design error, etc. with RII of 0.892. Then TR17-Unrealistic project plan and schedule at third place with RII of 0.873.

After that, TR12-Additional scope of works at fourth place with 0.860. A fifth and sixth place with 0.837 and 0.833 are TR8-Inadequate investigation on site and soil condition and TR16-Delay in the relocation of existing utilities. Last but not least, among the most important factors are TR3-Delay in providing design drawing and specification, TR5-Poor communication and TR4-Poor supervision, and design coordination with RII of 0.831, 0.806 and 0.800 respectively.

Other than that, TR10-Misunderstanding of drawings, specifications, and requirements at tenth place with 0.798. Then, TR15-Excessive deformation and damage when interfacing existing built structures and TR7-Mismanagement of contract and procurement with 0.794 and 0.792. Next in the ranking is TR11-Construction defects with 0.762. Subsequently, bothTR9-Material not conforming to the specification and TR14-Delay of supply materials with RII of 0.756. Finally, TR6-Poor standard of safety and quality control and TR13-Failure of equipment with RII of 0.753 and 0.719 correspondingly.

Risk Filtering and Response Strategies

The investigation continued to find out the effective mitigation plan for the risks by using the established response strategies in dealing with risks which are: avoid, transfer, mitigate, accept, and escalate (Project Management Institute, 2017). Figure 1 below illustrated the response strategies for the crucial technical risks in the railway construction project.

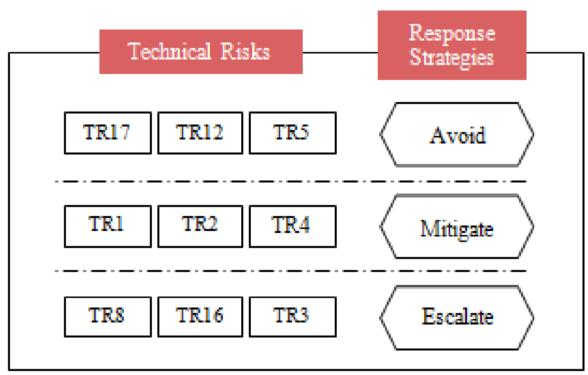

Figure 1. Response Strategies for Technical Risks in Railway Construction Project

This paper found that TR17, TR12, and TR5 can use response strategy like risk avoidance, which defined as to eliminate the threat from its impact (Project Management Institute, 2017). Then, mitigate which described as to reduce the probability of occurrence or impact (Project Management Institute, 2017) can be used as a response strategy for TR1, TR2, and TR4. Lastly, TR8, TR16, and TR3 can use escalate which to escalate the risk to a party that is outside or higher of the project level (Project Management Institute, 2017). It is also identified that response strategies of transfer and accept are not applicable to any of these 17 technical risks.

CONCLUSION

This paper has accomplished its aim which is to assess the technical risk factors that contribute to cost impact in railway construction projects and identify its response strategies. Other than that, the filtered risks are intended to increase the awareness of industry professionals in managing a project proactively and more cost-effective. In conclusion, this paper is hoped to give guidelines to professionals that involve in construction, particularly in railway projects.

It is recommended for future studies to see how the technical risks can be intervened with digitalisation and advanced technology in construction. This also aligns with the Construction Industry Transformation Programme (CITP) and Building Information Modeling (BIM) Roadmap in promoting the BIM technology, and Malaysia's agenda in the need to embrace Industry 4.0 as a critical cornerstone of sustainable competitiveness.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation for the support of Razak Faculty of Technology and Informatics of Universiti Teknologi Malaysia, Faculty of Civil Engineering of Universiti Teknologi MARA, and construction industry practitioners in Malaysia.

REFERENCES

1. Amiril, A., Nawawi, A. H., Takim, R. and Latif, S. N. F. (2014). The Importance and Implementation of Sustainability Factors in Malaysia Railway Projects. Proceedings 30th Annual Association of Researchers in Construction Management Conference, ARCOM. Page 73-82.
2. Andric, J. M., Mahamadu A., Wang, J., Zou, P. X. W., and Zhong, R. (2019). The Cost Performance and Causes of Overruns in Infrastructure Development Projects in Asia. Journal of Civil Engineering and Management. Volume 25 (Issue 3). Page 203-214.
3. Ashton, A. (2018). Rushed Construction Cost High-Speed Rail $600 Million and Delays Mount, Audit Finds. Retrieved from https://www.sacbee.com/news/politics-government/the-state-worker/article221711560.html
4. Bracholdt, C. (2013). These Three Projects Have Wasted Billions of Taxpayer Euros and Debunked Germany's Famous Efficiency. Retrieved from https://qz.com/50149/these-three-projects-have-wasted-billions-of-taxpayer-euros-and-debunked-germanys-famous-efficiency/
5. Briginshaw, D. (2017). Stuttgart 21 Facing Three-Year Delay and €1 Billion Cost Overrun. Retrieved from https://www.railjournal.com/regions/europe/stuttgart-21-facing-three-year-delay-and-e1bn-cost-overrun/
6. Chiu, P. (2017). Cost Overrun for Hong Kong's Sha Tin-Central MTR Link Could Be HK$16 Billion. Retrieved from https://www.scmp.com/news/hong-kong/economy/article/2122748/cost-overrun-hong-kongs-sha-tin-central-mtr-link-could-be
7. Cowin, L. (2018). Audit: California High Speed Rail's $600 Million in Cost Overruns Caused by Poor Planning, Contract Mismanagement. Retrieved from https://www.constructiondive.com/news/audit-california-high-speed-rails-600m-in-cost-overruns-caused-by-poor-p/542635/
8. Cunningham, T. (2017). What Causes Cost Overruns on Building Projects? – An Overview. School of Surveying and Construction Management, Dublin Institute of Technology, Bolton Street, Dublin.
9. Daniels, J. (2018). California's $77 Billion 'Bullet Train to Nowhere' Faces a Murky Future as Political Opposition Ramps Up. Retrieved from https://www.cnbc.com/2018/03/12/californias-77-billion-high-speed-rail-project-is-in-trouble.html
10. Deutsche Bahn. (2017). Cost and Schedule Development for Stuttgart 21 and TheWendlingen-Ulm New Construction Line. Retrieved from https://zb.deutschebahn.com/
11. Ehsan, N., Mirza E., Alam M., and Ishaque A. (2010). Risk Management in Construction Industry. Engineering Management Department, Center for Advanced Studies in Engineering, Islamabad.
12. Fay, M., Toman M., Benitez D., and Csordas S (2010). Infrastructure and Sustainable Development. Available from http://siteresources.worldbank.org/DEC/Resources/PCGD_329-382.pdf
13. Fischhoff, B. and Morgan, M. G. (2009). The Science and Practice of Risk Ranking. Horizons. Volume 10 (Issue 3). Page 40-47.
14. Gerrard, N. (2018). Will Spurs' Stadium Delay Hit Construction Management's Reputation? Retrieved from https://www.constructionmanagermagazine.com//insight/will-spurs-stadium-delay-hit-construction-manageme/
15. Herman, M. (2019). New Chapter for Tottenham as Stadium Hosts First Game. Retrieved from https://www.thestar.com.my/sport/football/2019/03/25/new-chapter-for-tottenham-as-stadium-hosts-first-game/
16. Hussain, A., Hashim, N.L., Nordin, N., Tahir, H.M. (2013). A metric-based evaluation model for applications on mobile phones. Journal of Information and Communication Technology, 12 (1), pp. 55-71.
17. Hwang, B., Zhao, X., and Yu, G. S. (2013). Risk Identification and Allocation in Underground Rail Construction Joint Ventures: Contractors' Perspective. Journal of Civil Engineering and Management. Volume 22 (Issue 6). Page 758-767.
18. Idris, A. N. (2020). All Eyes on Upcoming Mega Infrastructure Job Awards in 2020. Available from https://www.theedgemarkets.com/article/all-eyes-upcoming-mega-infrastructure-job-awards-2020
19. Iqbal, S., Choudhry, R. M., Holschemacher, K., Ali, A., and Tamošaitienė, J. (2015). Risk Management in Construction Projects. Technological and Economic Development of Economy, 21(1). Page 65-78.
20. Jayasudha, K. and Vidivelli, B. (2016). Analysis of Major Risks in Construction Projects. ARPN Journal of Engineering and Applied Sciences. Volume 11 (Issue 11). Page 6493-6950.
21. Krantikumar, M., Konnur, B. A., and Amarsinh, B. L. (2016). Risk Management in Construction Industry. International Journal of Engineering Research. Volume 5 (Issue Special 1). Page 153-155.
22. Lok-kei, S. and Hui, S. (2017). Off The Rails: Sha Tin-Central Link Cost Soars to $97.2 Billion. Retrieved from www.thestandard.com.hk/section-news.php?id=190403&sid=11
23. Muneeswaran, G., Manoharan, P., Awoyera, P. O., and Adesina, A. (2018). A Statistical Approach to Assess the Schedule Delays and Risks in Indian Construction Industry. International Journal of Construction Management.
24. Novy, Johannes, and Peters, D. (2012). Railway Station Mega-Projects as Public Controversies: The Case of Stuttgart 21. Alexandrine Press (Built Environment). Volume 38 (Issue 1). Page 128-145.
25. Organisation for Economic Cooperation and Development (2016). Country Case: Governance Failures in the Management of the Berlin-Brandenburg International Airport. OECD Publishing. Retrieved from:

https://www.oecd.org/governance/procurement/toolbox/search/governance-failures-management-berlin-brandenburg-international-airport.pdf

26. Patil, M., Shinde R. D., and Hailkar S. S. (2017). Ranking of Risk in Railway Projects. International Journal of Engineering Sciences and Research Technology. Volume 6 (Issue 6).
27. Plimmer, G. (2019). Contractor Renegotiations Added £2.5 Billion to Crossrail Bill. Retrieved from https://www.ft.com/content/ca290d60-6cba-11e9-80c7-60ee53e6681d
28. Price, D. (2019). Crossrail: Contractor Compensation Added £900m to Costs. Retrieved from: https://www.constructionnews.co.uk/civils/crossrail-contractors-compensation-added-900m-costs-03-05-2019/
29. Project Management Institute (2017). A Guide to the Project Management Body of Knowledge (PMBOK Guide). 6th ed. Newton Square, Pa: Project Management Institute.
30. Reddy, A. S. (2010). Risk Management in Construction Industry – A Case Study. India; International Journal of Innovative Research in Science, Engineering and Technology.
31. Schultheis, E. (2018). Whatever Happened to Berlin's Deserted 'Ghost' Airport? Retrieved from www.bbc.com/capital/story/20181030-what-happened-to-berlins-ghost-airport
32. Scott, M. and Sam, C. (2016). Here's How Fast China's Economy is Catching Up to The U.S. Retrieved from https://www.bloomberg.com/graphics/2016-us-vs-china-economy/
33. Shepardson, D. (2019). California to Scale Back $77 Billion High-Speed Rail Project: Governor. Retrieved from https://www.reuters.com/article/us-california-governor-rail/california-to-scale-back-77-billion-high-speed-rail-project-governor-idUSKCN1Q12II
34. Sindreu, J., Gold, R., and Mitchell, J. (2018). Economic Growth in U.S. Leaves World Behind. Retrieved from https://www.wsj.com/articles/strong-spending-data-shows-u-s-economy-chugging-ahead-of-europe-and-asia-1528994914
35. Siu, P. (2019). Central-Wan Chai Bypass to Open as Scheduled Despite Cracks in Tunnel Ceiling, Hong Kong Transport Chief Frank Chan Says. Retrieved from https://www.scmp.com/news/hong-kong/transport/article/2180943/central-wan-chai-bypass-open-scheduled-despite-cracks
36. Sotic, A. and Rajic, R. (2015). The Review of The Definition of Risk. Special Issue 2015 - Paper selected from International Conference in Applied Protection and Its Trends, Volume 3, Issue 3: Online Journal of Applied Knowledge Management
37. Sousa, R. L. and Einstein, H. H. (2012). Risk Analysis During Tunnel Construction Using Bayesian Networks: Porto Metro Case Study. Tunnel and Underground Space Technology. Volume 27 (Issue 1). Page 86-100.
38. Spiegel. (2013). Berlin Alarmed at Surging Cost of Rail Project. Retrieved from https://www.spiegel.de/international/business/berlin-alarmed-at-cost-overruns-of-stuttgart-21-station-project-a-880112.html
39. The Business Journal of Fresno and The Madera Tribune. (2018). High Speed Rail Slammed in Audit. Retrieved from www.maderatribune.com/single-post/2018/11/20/High-speed-rail-slammed-in-audit
40. Traufetter, G. (2018). Stuttgart 21 Threatens Still More Expensive and Later to be Finished. Retrieved from https://www.spiegel.de/wirtschaft/soziales/stuttgart-21-deutsche-bahn-rechnet-mit-mehr-als-acht-milliarden-euro-a-1189732.html
41. Tsang, D., Yau, C., and Yeung, R. (2017). Cost of Sha Tin-Central Rail Link Balloons to HK$87 Billion. Retrieved from https://www.scmp.com/news/hong-kong/economy/article/2123003/cost-sha-tin-central-rail-link-balloons-hk87-billion-most
42. Varghese, R. (2019). California's High-Speed Rail Cost Grows by About $2 Billion. Retrieved from https://www.bloomberg.com/news/articles/2019-05-01/california-s-high-speed-rail-line-cost-grows-by-about-2-billion
43. Vu, H. A., Wang, J., Min, L., Mai, S. H., and Nguyen, H. P. (2016). Research on Cost Overrun Risk of Construction Phase of Vietnam Highway International Contracting Project. Scientific Research Publishing, Engineering, Volume 8 (Issue 3). Page 86-98. Retrieved from http://dx.doi.org/10.4236/eng.2016.83011
44. Waite, R. (2019). Crossrail's Designs Too Complex and Bosses Ignored Risks. Retrieved from https://www.architectsjournal.co.uk/news/crossrails-designs-too-complex-and-bosses-ignored-risks-says-city-hall-watchdog/10042119.article
45. Watson, J. (2018). Tottenham Boss Mauricio Pochettino Likens Brexit to 'Car Crash' and Calls on Government to Halt EU Departure. Retrieved from https://www.independent.co.uk/sport/football/premier-league/brexit-mauricio-pochettino-european-union-britain-tottenham-hotspur-referendum-a8591976.html
46. Wupper, T. (2019). Costs for Stuttgart 21 Rise Again. Retrieved from https://www.stuttgarter-zeitung.de/inhalt.stuttgart-21-kosten-fuer-stuttgart-21-steigen-erneut.8b5d92ea-1196-45f0-a263-9e00d3ea5e9b.html
47. Zak, G. (2018). Spurs Stadium Delayed Until 2019. Retrieved from https://www.constructionnews.co.uk/buildings/project-reports/spurs-stadium-delayed-until-2019-26-10-2018/