



# BRIDGE PROJECT DEVELOPMENT RISK MANAGEMENT : A LITERATURE REVIEW

**Dwi Tri Nugroho**<sup>1</sup>

Master of Civil Engineering,  
Mercu Buana University  
Jl. Raya Meruya Selatan No.1, Meruya Selatan,  
Kembangan, West Jakarta, Daerah Khusus  
Ibukota Jakarta 11650, Indonesia

**Muhammad Nur**<sup>2</sup>

Master of Civil Engineering,  
Mercu Buana University  
Jl. Raya Meruya Selatan No.1, Meruya Selatan,  
Kembangan, West Jakarta, Daerah Khusus  
Ibukota Jakarta 11650, Indonesia

**Humiras Hardi Purba**<sup>3</sup>

Master of Industrial Engineering,  
Jl. Raya Meruya Selatan No.1,  
Meruya Selatan, Kembangan, West Jakarta,  
Daerah Khusus Ibukota Jakarta 11650,  
Indonesia

Article DOI: <https://doi.org/10.36713/epra3952>

## ABSTRACT

*The development of the development sector, especially the infrastructure sector, namely the construction of bridges with the aim of equitable distribution of the community's economy, politics, social, culture, and environment. For this reason, there are reasons to analyze the factors that influence the risks inherent in bridge construction, including internal and external factors, so that they can be used as a basis for future bridge planning. The method used is to conduct a literature review relating to the risk of bridge construction to address the risks that occur in the construction of the bridge. Risk analysis studies include risk identification factors consisting of internal and external factors, where these factors are very influential on the sustainability of the project so that it can be reduced or eliminated altogether with risk management. Internal factors consist of the environment in the project and external factors consist of risks that have an impact on the environment outside the project*

**KEYWORDS :** *Risk analysis internal and external*

## 1. INTRODUCTION

Bridges have a very important role for everyone, with different levels of importance each person (Supriyadi, 2000). The bridge is a construction that is used to continue the road through a lower obstacle, where the obstacle is usually in the form of another road that is waterway or ordinary traffic (Struyk, 1995). The construction of a bridge is not free from risks that are uncertain. To approach the uncertainty, it can be anticipated through risk management.

The stages of risk management consist of risk management planning, risk identification, risk analysis, risk management, and monitoring of risk. Risk

identification is the first step in implementing risk management and is an important step in the implementation of activities. With the identification of risks in the process of carrying out construction activities, it will be known what risks occur during the implementation of activities from the time they are worked through to completion. Furthermore, it will be known how potential those risks are in influencing the achievement of the activity's objectives. Based on the foregoing, then I try to identify the risk factors for bridge construction which will be analyzed for internal and external risk factor.

## 2. RESEARCH METHODOLOGY

In the writing of this journal obtained from a trusted source and online and from a literature review that

discusses risk management and risk identification that can provide the latest information in the risk analysis of bridge construction projects.

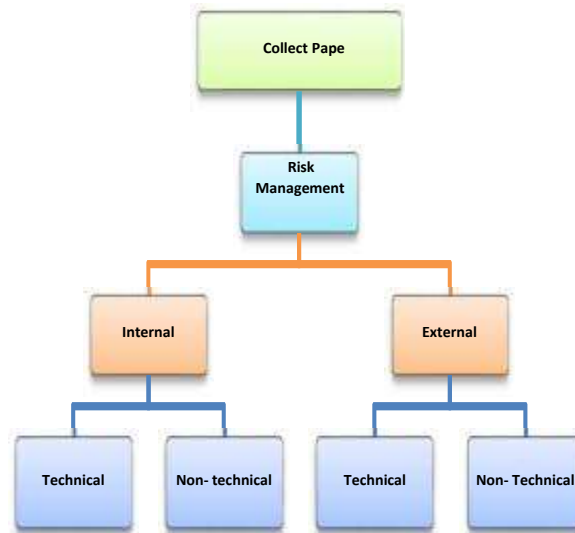


Figure 1.  
Study framework

## 3. RESULT AND DISCUSSION

In the writing of this journal obtained from a trusted source and online and from a literature review that

discusses risk management and risk identification that can provide the latest information in the risk analysis of bridge construction projects.

No	Identitas Paper	Risk Identification				Result
		Internal		Eksternal		
		Tech nical	Non- technical	Tech nical	Non - Technical	
[1]	Mohammadreza Yadollahi, et al.(2014).	X	X	√	√	According to the pairwise comparison of the relative weights and RSs, the SF of Traffic Efficiency & Alternative Transportation serves as the most important mechanism in integrating the Second Penang Bridge to address the impacts on surrounding environment, economy and society. The SFs of Equity & Social Issues, Payment Technologies and Custom Credits were categorised as the least important factors among the 12 SFs. Most of the attributes of these factors can be grouped under the construction phase. More effort and attention are required on the site management and safety precautions so as to address the recent reported incident of the collapse of a ramp that was constructed by the local contractors. It is necessary to develop a comprehensive or collaborative policy that caters to effective safety and site management.



[2]	Maria Rashidi, et al.(2015).	X	X	X	√	In this study, a methodology for priority ranking of bridges is proposed. Following a multi-criteria type of analysis, a PI is computed for each bridge. PI is expressed as a number which enables the decision-makers to simply understand and compare the condition of a variety of bridges in the network. Because of the multi objective nature of the work, various factors are involved that required to be identified and weighted properly. The proposed system provides flexibility for the decision-makers in stating their degree of satisfaction with each criterion and alerts the decision-makers towards the expected risks.
[3]	Saenthan Sathanantha, et al.(2008).	√	√	√	√	Main groups of bridges are proposed, based on the type and age variations, and these are ranked according to their risk levels considering the environment, inspectability and consequences. Each of these three attributes used in the ranking process are classified into two categories based on their severity. Criteria were developed and proposed for assessing the severity of these attributes.
[4]	K. D. Flaig PhD, et al.(2005).	√	√	X	X	This paper addresses two key issues in the bridge mangement procee, the assessment of structural adequacy and the prioritisation of competing MR& R project.
[5]	Qingfu Li, et al.(2011).	√	√	√	√	the purpose of the risk factors analysis is to simplify and integrate the complex and fussy data, and find the relationship between two various factors and their connection with the bridge construction process on the basis of the analysis of the data, thus provide the basis for estimation of risk consequence and risk prevention.
[6]	Duygu Saydam, et al. (2013)	X	√	X	X	This paper presents a methodology for quantifying the lifetime risk of bridge superstructures. The risk is quantified in terms of the expected direct and indirect losses. Assessing failure probabilities and risk based on a single time-variant corrosion penetration curve for components has been a common approach in previous studies.
[7]	Rafiq M. Choudhry, et al.(2014).	√	√	√	√	The key findings of this research are the exploration of critical risk factors affecting project schedule and costs. The relative importance index categorized seven risk categories in descending order, including financial risks, external risks, design risks, management risks, construction risks, contractual risks, and health and safety risks. The research determined that financial risks were the major factor in affecting the costs and schedule of projects. Among the 37 factors, the top five highest-ranked risk factors were unavailability of funds, financial failure of contractor, poor site management and supervision, inadequate site investigation, and inadequate project planning.
[8]	Chau Ngoc Dang, et al. (2017)	√	√	√	√	This study attempted to identify the risk patterns in Vietnamese road and bridge construction. Questionnaire-based interviews were employed to extract the actual context and content of risks from road and bridge projects in Vietnam. To collect risk-related data, 48 practitioners working for 33 different contractors were interviewed using a questionnaire which consisted of 51 risk factors. Then, the specific probability and impact of 51 risk factors, which were grouped into contractor-related, project-related, owner-related, and external risks, were determined.
[9]	Alysson Mondoro, et al. (2016)	X	X	√	√	Optimal bridge management strategies in coastal areas dealing with associated risks with dominant natural hazards, hurricanes, intrinsic traffic danger and aggressive environment.



[10]	Eric B. Williamson, et al. (2005).	X	X	√	X	The concept of planning a bridge against the risk of terrorist threats.
[11]	Lu Mingqi, et al.(2005).	√	X	X	√	In the paper, the theoretic framework of seismic risk management of bridge engineering was proposed and primary analysis was made. From the theoretic framework, it can be seen that seismic risk management of bridge engineering is feasible. Based on the theoretic framework, further research work should be carried out.
[12]	Swagata Banerjee, et al (2013)	√	X	√	X	For a highway transportation network that consists of bridges with statistically identical structural attributes and configurations as of the example bridges and spans over a similar site as of the study region, developed fragility curves and risk curves can be used to describe the damageability and associated risk of these highway bridges under regional multihazard. Furthermore, the analysis framework discussed herein can be used to investigate the effectiveness of currently available seismic retrofit techniques for bridges under the combined seismic and flood hazards.
[13]	Caitlyn Davis-McDaniel, S.M, et al (2013)	√	√	√	X	The case study suggested that the top five critical factors leading to segmental concrete box girder bridge failure, from most to least critical, are as follows: flood, scour, overloading, corrosion of posttensioning tendons, and earthquake. The overall failure risk identified through FTAs was consistent with past bridge failure trends. The analysis showed the bridge approaching an unsafe structural state at 50 years, with a $1.21 \times 10^{-3}$ probability of failure. Although the causal analysis of failure through fault tree can help identify countermeasures to minimize failure risks, it is best used in combination with current methodologies, such as visual inspections and SHM sensors. One limitation identified through this case study was sofin-depth basic events, such as those related to corrosion. More research on occurrence probabilities for initiating basic events would be beneficial to the success of bridge risk analysis through FTA.
[14]	Dena Khatami, et al (2016)	X	√	X	√	The outcome demonstrated that the incorporation of the natural hazards into the bridge management systems plays an important role to determine the required maintenance budget, provide the best maintenance strategies, and plan for emergency response actions. This outcome is completely in line with the objectives of MAP-21 and is expected to help the transportation agencies to minimize both direct and indirect costs.
[15]	B. Adey, et al (2003)	X	√	X	X	An incorporation of a risk-based approach into bridge management systems will provide decision makers with a more complete tool to help them development optimal management strategies for their bridges that are subject to multiple hazards.
[16]	Prama Widayat (2018)	X	X	X	√	The development of an urban infrastructure should be well planned both from the financial and non-financial side so as not to cause problems in the future which may interfere with the work, but not with the construction of siak bridge 4 Pekanbaru City which started in 2009 and stopped working in 2012, end of year 2017 just started again construction work and that too new work to build block pavling under the bridge instead of continuing the main work of connecting the two sides of the bridge. By conducting SWOT analysis, it is found that the dominant environmental risk is the policy of Riau provincial government using siak bridge construction budget 4 for PON activities in 2012, so that the construction of the bridge becomes dormant for 5 years (2012-2017), then the access of citizens to the city center becomes blocked by a bridge that is not finished.



[17]	Jemmy E. E. Tumimomo, et al (2014)	√	√	√	√	Risk analysis that occurs in the implementation of bridge construction in North Sulawesi based on events using the Analysis of Main Components produces aspects, namely: aspects of strategy, coordination and location, aspects equipment, material and finance, planning aspects and control and technology aspects. Risk analysis based on consequences by using principal component analysis produces aspects namely: management, social and financial aspects, equipment, transportation and time aspects as well as planning, cultural and weather aspects.
[18]	Rusdi Rusman Latief, et al (2014)	√	√	√	√	In this research, there are risks that affect the tello bridge construction project, namely the emergence of congestion around the project site, Land Acquisition, low labor productivity, The existence of internal conflicts in the ranks of project management using the fuzzy inference risk map method has a better level of validation compared to the TFN (Triangular Fuzzy Number) approach.
[19]	Ajeng Listianti, et al (2014)	√	√	√	√	The study results show as many as 27 (twenty seven) risks identified have a direct impact on road and bridge planning consultants in North Morowali Regency. Of the risks identified there are 3 (three) risks of political / regulatory factors, 6 (six) managerial factors, 3 (three) design error factors, 3 (three) planners quality factors, 3 (three) personnel factors, 3 (three) ) factors of project delay are completed, 3 (three) factors of field conditions and 2 (two) Force Majeure factors. Risks that are included as dominant (major risk) consist of 5 (five) risks that are unacceptable, ie delays in project commencement, delay in preparation of work administration, inability to analyze data and problems, replacement of personnel at the direction of PPK, replacement planning personnel at the request of the planning consultant.
[20]	Habir, et al	√	√	√	√	From the indicator of risk variable factors that most influence on the construction project of the Mahakam IV Samarinda bridge construction are the factors of the late delivery of equipment, the delay of delivery of goods, and the rainfall.
[21]	Syafran Noferi (2015)	√	√	√	√	Baturusa II bridge in Pangkalpinang City has 7 (seven) high risk sources that greatly affect cost performance and 4 (four) high risk sources that greatly affect time performance. From the source of high risk that the source of the risk of collapsed construction by a ship hit and the addition of work items is a risk that greatly affects the addition of project costs and changes in regulations are a source of risk that affects the additional time of project work implementation.
[22]	Aceng Maulana Karim (2014)	X	X	√	√	Resources in terms of planning, supervising work in the field, and monitoring for long span bridges in the field are still limited. External risks such as adverse weather conditions and earthquakes may occur during the bridge implementation project. Until now the parties involved in the construction of the Sunda Strait Bridge are still in the stage of assessing the possibility of impacts due to external risks
[23]	Subandiyah Azis (2015)	√	√	√	√	In this study, the factors that significantly affect the achievement of the target time are Financial Factors, HR Factors and Work Environment Factors. While the factors that significantly affect the achievement of the quality target are not the Time Target Factor, Financial Factor, Human Resources and work environment.



From the table above it can be explained, namely: The first journal is to discuss risk management in the bridge of the impact on the environment, economy, and surrounding communities and issues of equity, social, payment technology, and credit. The second journal is about risk management in bridge projects about decision makers in stating their level of satisfaction with each criterion and reminding decision makers of the expected risks. The third journal is to discuss the level of risk in bridge projects by considering the types and variations in age, environment, inspection capabilities and their consequences. Journal four, discusses the bridge management process and assessment of structural adequacy and competing project priorities. Journal five, which discusses the internal and external risks in bridge construction. Journal six, which discusses measuring the lifetime risk of bridge structures against direct and indirect losses. Journal seven, which discusses identifying and measuring the level of risk in bridge projects that are influenced by internal and external factors. Journal eight, which discusses bridge projects in Vietnam by identifying risk patterns for internal and external factors. Journal Nine, which discusses the risk of optimal bridge management in coastal areas related to natural hazards, storms, traffic hazards, and the environment. Journal ten, which discusses the concept of bridge planning to the risk of terrorist threats (political factors). Eleventh Journal, which discusses risk management in bridge structures and seismic risk. Journal Twelve is the risk of road bridges and seismic risks and flooding. Thirteen Journal, which discusses the risk of bridge failure from critical to the most critical are flooding, scouring, overload, post-stress tendon corrosion and flooding. The fourteenth journal is about natural hazards in a bridge management system to determine the required maintenance budget. The fifteen journal that discusses risk into bridge management will give a complete decision in developing an optimal management strategy for hazardous bridge construction. The sixteenth journal is about environmental risk factors that influence the construction of the Siak 4 bridge in Pekanbaru City. The seventeen journal that discusses the implementation of bridges in Sulawesi by taking into account internal factors including: aspects of strategy, coordination and location, material, financial, planning aspects, control aspects, technology and external factors include: management, social, cultural, and weather aspects. An eighteen journal that discusses the risks of building a Tello bridge project, namely: congestion, land acquisition, low labor productivity, as well as internal conflicts in the project management ranks. The Nineteen Journal, which discusses the risks identified as having an impact on bridge projects in North Morowali district, among others: political, managerial, design errors, quality of planners, personnel, project delays, field conditions, and force majeure. Journal Twenty, which discusses the risk factors that influence the construction of the Mahakam IV Samarinda bridge, among others:

factors in the late delivery of equipment, late delivery of goods and rainfall. Twenty-first journal, which discusses the risk of building a Baturusa II bridge project, namely the existence of a source of high risk to the risk of collapse in construction by ships that affect the cost and time. Twenty-two journal that discusses the external risks of the Sunda Strait bridge project namely weather and earthquakes. Twenty-three journals are about the risks on bridge projects, among others: financial factors, Human Resources factors, work environment, time factors. From the research above, it is found that the order of influential factors is external non-technical, external technical, internal non-technical, and internal technical.

#### 4. CONCLUSIONS

In this research it can be found that in the construction of bridges there are many risk factors. These risk factors include internal and external factors. Therefore, to be able to minimize all risks arising from the construction of the bridge must pay attention to internal and external risk factors so that it does not result in swollen costs in the construction of the bridge and the risk response and risk allocation needs to be done so that risk management can be implemented into a bridge construction project.

#### 5. REFERENCES

1. Mohammadreza Yadollahia, Reza Ansaria, Muhd Zaimi Abd Majidb & Chong Heap Yih. "A multi-criteria analysis for bridge sustainability assessment: a case study of Penang Second Bridge, Malaysia." *Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance*(2014), 11:5, 638-654.
2. Maria Rashidi, Bijan Samali & Pezhman Sharafi. "A new model for bridge management: Part A: condition assessment and priority ranking of bridges, *Australian Journal of Civil Engineering* (2015).
3. Saenthan Sathananthan , Toulou Onoufriou & M. Imran Rafiq. "A risk ranking strategy for network level bridge management, *Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance* (2008), 6:6, 767-776.
4. K.D.Flaig Phd,Dipl.-Ing and R.J.Lark BSc (Eng), Phd,CEng,MICE. "A risk – based decision – support system for bridge management.Proceeding Of the Instituion Of Civil Engineering Bridge Engineering 158 (2005), issue BE3, 101-106.
5. Qingfu Li1, Zhenxin Li1,Jie Niu1. "Application of factor analysis to risk evaluation of bridge construction, *Advanced Materials Research Vols* 243-249 (2011) pp 1848-1853.
6. Duygu Saydam, S.M.ASCE; Dan M. Frangopol, Dist.M.ASCE; and You Dong, S.M.ASCE. "Assessment of Risk Using Bridge Element Condition Ratings, *American Society of Civil Engineer* (2013).
7. Rafiq M. Choudhry, Ph.D., P.E., M.ASCE; Mohammad A. Aslam; Jimmie W. Hinze, Ph.D., M.ASCE; and Faisal M. Arain, Ph.D. "Costand



- Schedule Risk Analysis of Bridge Construction in Pakistan: Establishing Risk Guidelines*, American Society of Civil Engineer (2014).
8. Chau Ngoc Dang Long Le-Hoai Soo-Yong Kim Chau Van Nguyen Young-Dai Lee Sun-Ho Lee. "Identification of risk patterns in Vietnamese road and bridge construction Contractor's perspective", *Built Environment Project and Asset Management* (2017), Vol. 7 Iss 1 pp. 59 – 72.
  9. Alysson Mondoro, S.M.ASCE; Dan M. Frangopol, Dist.M.ASCE; and Mohamed Soliman, A.M.ASCE. "Optimal Risk-Based Management of Coastal Bridges Vulnerable to Hurricanes", *American Society of Civil Engineer* (2016).
  10. Eric B. Williamson, M.ASCE, and David G. Winget, P.E., M.ASCE. "Risk Management and Design Of Critical Bridge For Terrorist Attacks", *American Society of Civil Engineer* (2005).
  11. Lu Mingqi, and Qu Weibo. "Seismic. " Risk Management Framework of Bridge Engineering", *School of Civil Engineering Beijing Jiaotong University and China Textile Industrial Engineering Institute* (2009).
  12. Swagata Banerjee & Gautham Ganesh Prasad. " Seismic risk assessment of reinforced concrete bridges in flood-prone regions", *Department of Civil and Environmental Engineering , The Pennsylvania State University , University Park , PA , 16802 , USA* (2012).
  13. Hassan Hashemi, S. Meysam Mousavi, and S. Mohammad H. Mojtahedi. " Bootstrap Technique for Risk Analysis with Interval Numbers in Bridge Construction Projects", *American Society of Civil Engineer* (2011).
  14. Dena Khatami, Behrouz Shafei, and Omar Smadi. " Transportation Research Record: Journal of the Transportation Research Board, No. 2550, Transportation Research Board, Washington, D.C., 2016, pp. 89–95.
  15. B. Adey, R. Hajdin , E. Bru "hwiler . " Risk-based approach to the determination of optimal interventions for bridges affected by multiple hazards", *Engineering Structures* 25 (2003) 903–912.
  16. Prama Widayat. " Manajemen Risiko : Risiko Lingkungan Akibat Terbengkalainya Pekerjaan Proyek Jembatan Siak 4 Kota Pekanbaru", *Ganaya : Jurnal Ilmu Sosial dan Humaniora* (2018), vol 1.
  17. Jemmy E. E. Tumimomor, H. Manalip & R.J.M Mandagi. " Analisis Resiko Pada Konstruksi Jembatan Di Sulawesi Utara", *Sabua* (2014) Vol.6, No.2: 235 – 241.
  18. Rusdi Usman Latief, Muh.Asad Abdurrahman, Reza Setiawan. " Penilaian Resiko dengan Metode Fuzzy Pada Proyek Pembangunan Jembatan Tello", *Jurusan Teknik Sipil Universitas Hasanudin*.
  19. Ajeng Listianti , Jane Sekarsari. " Identifikasi Risiko Konsultan Perencana Jalan dan Jembatan", *Seminar Nasional Cendekiawan ke 3 tahun 2017*.
  20. Habir, Frengky Fajar Mukti. " Analisa Risiko Pelaksanaan Konstruksi Pembangunan Jembatan Mahakam IV Samarinda ", *Jurnal Teknologi Sipil*.
  21. Syafran Noferi. " Analisa Faktor Risiko Pembangunan Jembatan Batu Rusa II Di Kota Pangkal Pinang", *Seminar Nasional Teknik Sipil V Tahun 2015 – UMS*.
  22. Aceng Maulana Karim. "Identifikasi Risiko Dalam Pembangunan Jembatan Bentang Panjang ", *Jurnal Infrastruktur* Vol. 3 No. 01 Juni 2017.
  23. Subandiyah Azis , Edi Hargono D Putranto, Novie Surachmad. "Faktor-Faktor Risiko Kegagalan Pencapaian Sasaran Proyek Tepat Waktu Dan Mutu Pada Pembangunan Proyek Jembatan di Kabupaten Probolinggo", *Jurnal Info Manajemen Proyek*