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A SYSTEMATIC REVIEW AND ANALYSIS OF RISK ASSESSMENT IN HIGHWAY CONSTRUCTION PROJECTS

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Review paper

Abstract: *Before planning and managing risks to reduce the causes of severe risks associated with road construction, it is very important to conduct an evaluation first. Aspects related to risk are convoluted in several steps from design to planning to project fulfillment. This research aims to implement a complete risk management process for highway construction projects. Through this process, there will be a list of risks in the highway construction project (risk identification) and the definition of the most significant risk through the application of the evaluation process (applying risk analysis and valuation). To successfully improve the performance of road projects, it is necessary to identify and assess various risk factors in a project for efficient project fulfillment. The research method begins by reviewing at least 50 articles to find a list of the main risk factors that might be encountered during highway construction. This analysis involves the identification, classification, and assessment of various risks involved in the construction of a highway project.*

Keywords: Risk, Highway Project, Road, Construction, Pavement.

1. INTRODUCTION

Progress in development in various fields continues to develop at any time, especially infrastructure development. In general, various types of construction are carried out by a contract involving various service providers in the construction sector. With a contract system, the implementation of development projects can be carried out effectively and can be accounted for, both in terms of quality and administration. In the implementation of construction, projects will not be separated from big risks and small risks. Project accuracy in implementing risk management is

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needed for the smoothness and success of a project. A smaller potential risk will benefit the project in terms of time, cost, and quality of construction. The larger the scale of the project, the greater the risk that will be faced and will affect the performance of project implementation if not handled properly. Like other construction projects, this highway construction project is an infrastructure project that is not free from various risks that may occur. Therefore, to reduce the risk of impacts that occur, we need a risk management system that includes identification, analysis, response, and monitoring of various risks that may occur during the development period. From the risk analysis, it can predict what risks will occur in the future based on the probability of the risk that has occurred and also other factors that will be very helpful for future projects. Research related to project risks in road construction is necessary and important to do, especially those related to road structure work. This article aims to determine and analyze important factors that pose risks in the implementation of construction projects and to find out how they affect the implementation of project risks. With risk assessments, these tasks can be prioritized for the smooth completion of road construction projects.

In completing research, there are various data and source collection methods commonly used. On this occasion, the research will be discussed further about data collection strategies through the literature review. This paper is based on a literature review from a trusted source that discusses the identification of risks and risk management in road construction, then obtained 50 articles selected and reviewed. Risks are identified through a literature review, identified risks are then assessed in terms of the impact and priority risks that are dominant so that a rating is obtained based on risk factors.

2. Research method

The writing of this article is based on a literature review conducted online including various scientific articles relating to risk analysis on road construction projects, which are then reviewed and synthesized to provide comprehensive information. The research framework of this research of articles is shown in Figure 1 bellow:

Figure 1. Research Framework

The list of articles selected and analyzed from the aspect of risk assessment in the highway construction project is shown in Table 1.

A systematic review and analysis of risk assessment in highway construction project

Table 1. Summary literature review of risk assessment in highway construction projects

No	Article	Risk Category						Result
		Internal		Project		External		
		Tech	Non-Tech	Tech	Non-Tech	Tech	Non-Tech	
1	(Nasir et al., 2003)	x	x	x	✔	x	x	Evaluating Risks in the Construction Model is carried out to develop a schedule risk model that discusses pessimistic and optimistic estimates of the duration of activities based on project characteristics.
2	(Wang & Chou, 2003)	x	✔	x	x	x	x	When deciding on risk management strategies, a contractor must consider many aspects, including risk responsibilities, risk patterns, risk management capabilities, etc.
3	(Molenaar, 2005)	x	x	x	✔	x	x	Provide estimates for road project cost estimates, which provide more transparent estimation, estimates and the significant and direct benefits of this process are the ability to increase high-risk items and potential mitigation measures that can be taken to improve safety.
4	(Shiraki et al., 2007)	x	x	✔	x	x	x	Combines earthquake and transportation engineering techniques to better characterize the system risk curve for the highway system.
5	(Damnjanovic & Zhang, 2008)	x	x	x	✔	x	x	A general and flexible framework for measuring risk-based performance with numerical examples where premium costs are estimated for various preventive maintenance and rehabilitation strategies and contract specifications.
6	(Gharaibeh & Shirazi, 2009)	x	x	x	✔	x	x	The risk-based model presented here to fill the price gap of warranty offers is often estimated subjectively due to the lack of a systematic methodology for measuring warranty service costs for road infrastructure assets with WCEM, estimated warranty costs, taking into account the PF of guaranteed goods as defined in the warranty clauses and costs which is projected to correct the failure.
7	(Li & Bai, 2009)	x	x	✔	x	x	x	The facts show that there is room to increase the effectiveness of traffic control currently used in high-risk work zones and help engineers to understand these risk factors and how they can increase the likelihood of death when severe accidents occur in work zones.
8	(Li & Madanu, 2009)	x	x	x	✔	x	x	Using the project-level life cycle benefits estimated by the uncertainty-based analysis approach results in a higher percentage of the level of conformity with actual programming practices compared to the level of conformity using the project benefits calculated by the risk-based analysis approach.

9	(Le et al., 2009)	x	x	✔	x	x	x	The development and testing of the APRA method is an innovative tool that can help the project team to improve the road development process through the definition of proactive scope and risk management.
10	(Zhao et al., 2009)	x	x	✔	x	x	x	The results show that the risk of fatigue cracking is not possible at the surface layer for properly designed asphalt pavement with a semi-rigid base if all layer interfaces are fully bound.
11	(Creedy et al., 2010)	x	x	x	✔	x	x	That the arbitrary application of a base contingency percentage figure, such as 10%, to accommodate project risk can lead to those projects reporting a substantial budget overrun.
12	(Sarkar & Dutta, 2010)	x	x	✔	x	x	x	Efforts have been made to design and implement new cumulative addition procedures for the ready-mix concrete industry, which address the risks involved and related to concrete production.
13	(Hall et al., 2011)	x	x	✔	x	x	x	Can be drawn: (1) Risk analysis is illustrated to help pavement engineers; (2) The AHP method makes it possible to compare the importance of parameters not only in each category, but also between categories.
14	(Honjo et al., 2011)	x	x	✔	x	x	x	The results are (1) The probability of the relative failure risk of each slope successfully estimated; (2) The absolute failure probability of each slope is estimated by calibrating the relative failure probability.
15	(Hu & Huang, 2011)	x	x	x	✔	x	x	Some conclusions: (1) Risks may be serious when the shielding machine advances under the cement concrete pavement; (2) Loss of risk and pavement condition index associated with maximum settlement due to tunneling; (3) There are about 10 accidents that will occur in the construction of several subways.
16	(Pantelidis., 2011)	x	x	✔	x	x	x	The risk value for each embankment examined derives from the failure hazard and consequence value following the well-known definition of risk.
17	(Heravi & Hajihosseini, 2012)	x	x	x	✔	x	x	The identification of the most important risks and their allocation and funding can be used by other parties who seek to attract private investment for large infrastructure projects in developing countries.
18	(Mukhopadhyay et al., 2012)	x	x	✔	x	x	x	Reducing the risk of injury, death, and property damage in the highway work zone for employees who carry out operations/maintenance and the community of road users.
19	(Tran & Molenaar, 2012)	x	x	x	✔	x	x	Conduct a risk analysis at the beginning of the project development process, but also serves as an input to the risk-based framework for selecting the appropriate project delivery method.
20	(Yasamis-Speroni et al., 2012)	✔	x	x	x	x	x	An evaluation of the contractor's quality performance, combined with an evaluation of the technical and financial performance of the contractor, can result in a better understanding of the contractor's overall capabilities.

21	(Cruz & Marques, 2013)	x	x	x	x	x	✔	This investigation revealed evidence that showed that although contracts became increasingly complex over time, the public sector assumed more production and commercial risks in the road development process.
22	(Lu et al., 2013)	x	x	✔	x	x	x	Theory and method support in terms of sensible traffic organization to improve traffic safety as well as prevent traffic jams on-road working zones on urban freeways.
23	(Azambuja & Chen, 2014)	x	x	✔	x	x	x	Mode failure methodology and criticality analysis (FMECA) is an alternative scenario recommended for ready-mix concrete plants to achieve the desired balance between having more than enough resources and avoiding risks and disruptions in the supply chain on time.
24	(Ghorbani et al., 2014)	x	x	x	x	x	✔	Time and costs are subject to adverse deviations that lead to the highest priority risk from time delays and cost overruns.
25	(Kaleem et al., 2014)	x	x	x	✔	x	x	The risk of overtime resulting from various factors is the most cardinal problem which ultimately leads to cost overruns and hence triggers turbulence in the estimated cost and initial time.
26	(Pineda & Arboleda, 2014)	x	✔	x	x	x	x	The aggregate effect of increasing cost of emergency response, uninsured calamities, third party, and user influence on indicator results, shows a particular risk arising from the indicator-based model and the interaction with road safety policies.
27	(Tran & Molenaar, 2014)	x	x	x	✔	x	x	The results indicate that seven delivery selection risk factors have the most influence on DB delivery selection: (1) scope risk; (2) third-party and complexity risk; (3) construction risk; (4) utility and right-of-way (ROW) risk; (5) level of design and contract risk; (6) management risk; and (7) regulation and railroad risk.
28	(Wang et al., 2014)	x	x	✔	x	x	x	Pavement engineers need to establish corrective measures such as building superior grooving textures, installing traffic signs at the right speed, etc. to avoid traffic accidents due to hydroplaning.
29	(Yan et al., 2014)	x	x	✔	x	x	x	The lowest evaluative criteria of the road operating environment are given to improve the design of road facilities and intensify the environmental safety risks of the operation of basic road facilities.
30	(El-Sayegh & Mansour, 2015)	x	x	x	✔	x	x	Inefficient planning is the most significant risk in the highway construction with a probability of moderate to high, inefficient planning weighed the highest among other risks, highway projects require efficient and accurate planning.
31	(Hanna et al., 2015)	x	x	x	✔	x	x	Designed to identify the top misallocated risks in the highway construction industry and to provide recommendations to more appropriately allocate these risks on highway construction projects.

32	(Tran & Molenaar, 2015)	x	✔	x	x	x	x	Based on the probabilistic risk analysis process, a risk-based project delivery model selection workshop utilizes probabilistic risk-cost estimation concurrently with the project delivery decision process.
33	(Xiao et al., 2015)	x	x	✔	x	x	x	The traffic risk on the rural highway in general, all of the risk factors can be classified as the four factors and natural environmental factors.
34	(Chu & Fwa, 2016)	x	x	✔	x	x	x	The risk analysis procedure aims to overcome the inadequacy of the current asphalt pavement design methods, specifically the asphalt mix design, concerning the functional safety requirements of road operations.
35	(Fontán-Pagán et al., 2016)	x	x	x	✔	x	x	The use of a hybrid contract method produces a significant reduction in costs when compared with the unit price contracting method for this particular construction project.
36	(Louhghalam & Ulm, 2016)	x	x	✔	x	x	x	The model presented here is only a first-order approach towards a paradigm shift from current strength-based designs to fracture-based designs that are consistent to increase pavement resistance to various risks of distress mechanism, which ultimately aims to reduce maintenance costs and to improve environmental footprint from the aging infrastructure.
37	(Tran & Bypaneni, 2016)	x	x	x	✔	x	x	The findings from this paper provide some guidelines for highway agencies to better perform a more accurate risk cost estimate.
38	(Diab et al., 2017)	x	x	x	✔	x	x	Inadequate constructional reviews have a significant influence in determining owner contingencies, while changes in owner demand affect the number of owner and contractor contingencies, and also have a significant impact on project schedules.
39	(Liu et al., 2017)	x	x	✔	x	x	x	A comprehensive evaluation model of construction site risk based on the fuzzy mathematical method by establishing a construction risk index rating system derived from AHP, using risk management methodologies, and considering the risk probability and the severity of the consequences.
40	(Tokiwa & Queiroz, 2017)	x	x	x	✔	x	x	In PPP projects on the road, it is important to identify risks and allocate responsibilities for risks identified between the public and private sectors specifically, allocating risks related to income is very important because it involves uncertainty for future demand.
41	(Nguyen et al., 2018)	x	x	x	✔	x	x	Provide practitioners implementing or considering the implementation of public-private partnerships with a comprehensive overview of risk allocation practices and contractual language across a variety of public-private partnership project characteristics.
42	(Nguyen et al., 2018)	x	x	x	✔	x	x	Inadequate constructional reviews have a significant influence in determining owner contingencies, while changes in owner demand affect the number of

								owner and contractor contingencies, and also have a significant impact on project schedules.
43	(Yuan & Li, 2018)	x	✔	x	x	x	x	Empirical evidence and simulation results have shown that P3 pavement assets significantly outperform PSC pavement assets in terms of service life, probability and duration of maintenance delays, and remaining life after the concession period.
44	(Bypaneni & Tran, 2018)	✔	x	x	x	x	x	Decision-makers must have a clear understanding of how risks impact each delivery method to select the most suitable delivery method for their projects.
45	(Castro-Nova et al., 2018)	x	x	✔	x	x	x	Statistically significant differences in perception of the importance of geotechnical risk factors between public institutions and the Design Built industry.
46	(Andrić et al., 2019)	x	x	x	✔	x	x	Risk considerations for BRI projects are complex tasks requiring efficient tools that provide complex information about financial issues, to bridge this coverage, new methods developed and applied to complex, scattered and large-scale infrastructure project financial reports.
47	(Firouzi & Vahdatmanesh, 2019)	x	✔	x	x	x	x	By using the Bermudan collar option, the company will be able to make a more accurate estimate of the total operational costs at the pre-construction stage of the project thereby reducing the risk of failure.
48	(Guo et al., 2019)	x	x	✔	x	x	x	Use risk assessments to provide risk specifications for operating rural mountain roads and decide on priority safety precautions.
49	(Zheng et al., 2019)	x	x	x	x	✔	x	The relationship between the risk of the likelihood of a collision and related factors is nonlinear and indicates that the independent variables are not completely independent of each other.
50	(Nicholson, 2020)	x	x	x	✔	x	x	Risk communication and consultation will need to take account of variations between risk management specialists and the public, as well as variations between members of the public, in the understanding and interpretation of qualitative and quantitative probability terms.

Remarks: ✔=discussed   x=not discussed

Based on the analysis of 50 articles in the above table, that in Figure 2 shows the distribution of literature reviews from the aspect of risk assessment in highway construction projects.
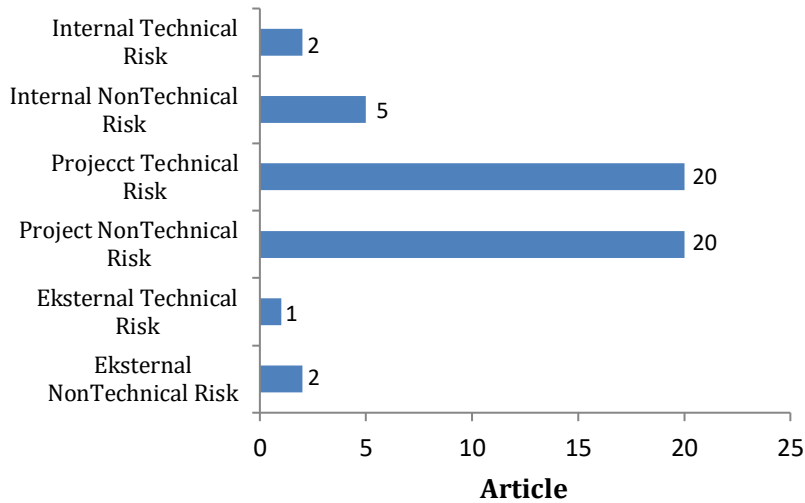

Figure 2. Distribution of literature reviews

3. Risk Identification

3.1. Internal Technical Risk

This article introduces a contractor quality performance evaluation model (CQP) which measures the quality performance of a pavement contractor that the DOT that is in the process of selecting a pavement contractor for a project will benefit from the CQP evaluation model because this system allows clients to quickly assess the quality performance of potential pavement contractors in the list of their offers (Yasamis-Speroni et al., 2012). Cronbach's alpha test and correlation analysis were carried out to verify internal consistency, interdependence, and the reliability of delivery risk factors. The ranking of risk factors and their impact on each method of project delivery can help the road agency to increase appropriate risk allocation and risk-taking wisely, which can result in more efficient project delivery (Bypaneni & Tran, 2018).

3.2. Internal Non-Technical Risk

The contractor's ability in risk management is a key factor for project performance when deciding on a risk management strategy, the contractor must consider many aspects, including risk responsibilities, risk patterns, risk management capabilities, etc. (Wang & Chou, 2003). Performance analysis finds risks in the relationship between the owner and the concessionaire, revealing weaknesses in the indicator mechanism and dispute resolution. This analysis also reports that force majeure events are not easily distinguishable between insured and non-insured events. This shows a failure in guarantee management with separate incentives in premium costs,

risk coverage, and the effect of moral hazard (Pineda & Arboleda, 2014). This article shows that this same team member can assist in the selection of project submissions. Based on the probabilistic risk analysis process, a risk-based project delivery model selection workshop utilizes probabilistic risk-cost estimation concurrent with the project delivery decision process (Tran & Molenaar, 2015). Empirical evidence and simulation results have shown that P3 pavement assets significantly outperform PSC pavement assets in terms of service life, probability and duration of maintenance delays, and remaining life after the concession period. While the average lifetime of a PSC residual is only 6.3 years, the average residual life of a P3 partner is 13.5 years (Yuan & Li, 2018). From numerical results, this article found that, by using the Bermudan collar option traded in OTC, the company would be able to make a more accurate estimate of the total operational costs at the pre-construction stage. It was also found that limiting future purchase prices could reduce the likelihood of unexpected cost overruns during the project construction phase. It can be concluded that using the Bermudan OTC collar option can reduce the risk of construction material prices (Firouzi & Vahdatmanesh, 2019).

3.3. Project Technical Risk

This article combines earthquake and transportation engineering techniques to better characterize the risk curve system for the Los Angeles and Orange County, California highway systems. Knowledge of seismic hazards must be combined with a means to adequately model system performance (Shiraki et al., 2007). Comprehensive knowledge about risk factors found from damage data, therefore, becomes important to reduce the level of risk and prevent severe accidents in the work zone (Li & Bai, 2009). It presents the development and testing of the APRA method, which is an innovative tool that can help the project team to improve the highway development process through proactive scope definition and risk management (Le et al., 2009). Asphalt pavement fatigue behavior with semi-rigid bases: crack Fatigue cracking is not possible in the AC layer for well-designed asphalt pavement with semi-rigid bases if the semi-base is rigid in good condition and all interface layers are fully bound (Zhao et al., 2009). RACUSUM and CUSUM can detect that a change has occurred in the process, but cannot predict the cause of the change. This research can be extended by applying the RACUSUM technique to monitor quality in other sectors of the construction industry such as precast and modular manufacturing units including modular formwork and scaffolding, the highway industry including hot mix asphalt plants, units for manufacturing fly ash bricks, block pavers, and other related products (Sarkar & Dutta, 2010).

The risk analysis method is applied to analyze the flexible pavement design using a mechanistic-empirical method. Based on this research, the following conclusions can be drawn: (1) Risk analysis is illustrated to help pavement engineers. The steps of risk analysis include risk identification using Holographic Hierarchical Modeling (HHM), risk ranking using Analytical Hierarchy Process (AHP), risk assessment, and risk management. (2) The AHP method makes it possible to compare the importance of parameters not only in each category, but also between categories (Hall et al., 2011). The conclusions that can be drawn from the analysis are as follows: (1) The probability of the relative failure of each slope is successfully estimated based on the SAT data; (2) The absolute failure probability of each slope is estimated by calibrating the relative failure probability based on RFAR data (Honjo et al., 2011). Some conclusions are

drawn from the analysis and case studies in this paper as follows: (1) Risks may be serious when the shielding machine advances under a cement concrete pavement. This results in a lot of damage such as cracks, breakages, crashing, potholes and explosions, etc., which affect the pavement operation performance and traffic capacity; (2) Loss of risk and pavement condition index associated with maximum settlement due to tunneling; (3) There are around 10 accidents that will occur in the construction of several subways in China. Also, the risk of tunneling has received high attention in recent years (Hu & Huang, 2011). This system consists of three main stages, (1) quantification of the danger of failure of the road embankment, (2) calculation of the geometric characteristics of the possibility of failure, and (3) quantification of the consequences. The risk value for each embankment inspected originates from the hazards and the consequence values follow a known risk definition (Risk = Hazard x Consequences) (Pantelidis., 2011).

Intuitively, any process that reduces risk must improve worker safety, reduce agency costs, improve services to the public who are traveling, and lead to more efficient procedures in the long run (Mukhopadhyay et al., 2012). With the application of REMRUE into the risk evaluation of sample road work zones on the Beijing toll road, the difference in operating speed between neighboring parts of the road work zone is analyzed to check whether there is a risk of traffic safety and the value of the Traffic performance Subdivision in the road work zone related to the average operating speed calculated to evaluate the operational risk of traffic (Lu et al., 2013). Presenting an effective failure mode methodology and criticality analysis (FMECA) combined with a simulation modeling approach for Just-in-Time supply chain risk management. FMECA and discrete event simulation can be used to model the dynamic nature of Just-in-Time supply chain networks. Several alternative scenarios are recommended for ready-made concrete plants to achieve the desired balance between having more than enough resources and avoiding risks and disruptions in their timely supply chain (Azambuja & Chen, 2014). MTD, transverse, longitudinal slope, tire pattern, and rainfall intensity are important factors for hydroplaning prediction. This paper uses a volumetric measurement method based on 3D laser imaging technology to estimate MTD and to measure the texture depth of all paths. Besides, directly using the IMU to measure cross slope cannot guarantee good accuracy due to the dynamic movement of the data collection vehicle (Wang et al., 2014). By assessing four aspects of the road operating environment including climate, roads, transportation, and administration, it provides road facilities with functions such as early warning before an accident, feedback in emergencies and quick repairs after a disaster, so that the safety of road operations is greatly enhanced (Yan et al., 2014). ISM is an effective method used to analyze and uncover complex structures, which transform complex and scattered relationships between various elements into a clear multilevel hierarchical structure model (Xiao et al., 2015).

Frameworks and procedures have been presented to include consideration of road slip resistance and hydroplaning in the asphalt mixture design. The proposed framework and analysis procedures aim to address the inadequacy of the current asphalt pavement design methods, specifically asphalt mix designs, concerning the functional safety requirements of road operations (Chu & Fwa, 2016). The proposed mechanics-based model links the risk of concrete pavement fractures that experience different pressure mechanisms on the material and its structural properties. In addition to classic design recipes such as increasing pavement thickness and reducing

joint spacing, both of which reduce the rate of release of energy, the results allow the following conclusions: (1) For fixed pavement structures, increasing fracture toughness and reducing material stiffness reduce the risk of fractures; (2) Increasing the horizontal stiffness of the subgrade will improve the performance of concrete pavement that experiences autogenous shrinkage at an early age by reducing the rate of structural energy release; (3) For cases of pavement undergoing a thermal cycle, special attention must be paid to the ratio of the rate of release of dimensionless energy due to bending and axial contributions to ensure that fractures will not occur during transient conditions immediately after the application of sudden temperature changes (Louhghalam & Ulm, 2016). This paper proposes a comprehensive evaluation model of construction site risk based on the fuzzy mathematical method by building a construction risk rating system derived from AHP, using risk management methodologies, and considering risk probabilities and severity of consequences. The accuracy of the evaluation model is validated through calculation examples, so that it can provide theoretical and practical guidance to reduce the risk of road project construction (Liu et al., 2017). The results prove that there is an optimism bias in the DB highway project and that there are statistically significant differences in geotechnical risk perception (Castro-Nova et al., 2018). Introducing the application procedure and GHSLPE risk assessment model, then, with data on traffic accidents, road conditions, and traffic volume from typical rural mountain roads, the risk of traffic accidents (TAR), and the risk of traffic operations (TOA) are calculated; the difference between TOA and post-TAR predictions is compared based on actual conditions (Guo et al., 2019).

3.4. Project Non-Technical Risk

The resulting model is referred to as ERIC-S. This is the first risk-schedule construction model known by the author to measure the relationship between variables. This model is tested on large projects where target completion dates are monitored. The results are almost identical to those of project participants except that the data from experts took 6 weeks while incorporating project characteristics into the ERIC-S model only took 2 hours, indicating that the model was effective and efficient (Nasir et al., 2003). The model described in this paper is a first-order model in which uncertainty is represented by using averages of each uncertain variable, and risk events are modeled as independent events - uncorrelated events because they are actually possible. One possible improvement for the risk modeling process is to build a second-order model in which uncertainty is modeled by the mean and standard deviation of the uncertain variable, including the delay variable. Such a model will produce more accurate results in the outermost range of the distribution of costs and time (Molenaar, 2005). The premium pricing model developed can be used to assist transport agents and contractors in estimating the "fair" value for PSMC. This paper presents a conditional reliability function which can be developed by entering information about in-service pavement conditions using indirect methods. Besides, the formulation of boundary-state functions and the application of the moment method allow for direct consideration of different design approaches, as well as the different effects of preventive maintenance and rehabilitation measures. Finally, this paper illustrates a framework with numerical examples in which premium costs are estimated for various PM&R strategies and contract specifications (Damnjanovic & Zhang, 2008).

The case article results revealed that using project-level life cycle benefits estimated by the uncertainty-based analysis approach resulted in a higher percentage of conformity with actual Indiana DOT programming practices compared to the level of compliance using project benefits calculated by risk-based analysis approaches (Li & Madanu, 2009). The risk-based model presented here to fill the price gap of warranty offers is often estimated subjectively because of the lack of a systematic methodology for measuring warranty service costs for road infrastructure assets. Under WCEM, the cost of guarantee is estimated, taking into account the PF of the guaranteed item as defined in the warranty clause and the projected costs to correct the failure (Gharaibeh & Shirazi, 2009). Regression analysis shows a weak correlation between the size of the highway project, as measured in indexed programmed costs and measures of excess costs. Correlations develop after data transformation is carried out to improve the model. It can also be concluded from research that the arbitrary application of a basic contingency percentage rate, such as 10%, to accommodate project risks can cause projects that report substantial budget overruns (Creedy et al., 2010). Some conclusions: (1) Risks may be serious when the shielding machine advances under the cement concrete pavement; (2) Loss of risk and pavement condition index associated with maximum settlement due to tunneling; (3) There are about 10 accidents that will occur in the construction of several subways (Hu & Huang, 2011). Lessons from two PPP case studies are used to improve the contract organization of the Tehran-Chalus Toll Road project. The findings from this case article on the identification of the most important risks and their allocation and funding can be used by others who are trying to attract private investment for large infrastructure projects in developing countries (Heravi & Hajihosseini, 2012).

The findings from this article not only encourage decision-makers to carry out risk analysis at the beginning of the project development process, but also function as an input for a risk-based framework for selecting appropriate project delivery methods in high industries (Tran & Molenaar, 2012). The mathematical relationship between the duration of the highway project, the planned costs, and the type of project are shown in this paper by using various time correlation models flooded with potential risk factors investigated including attributes such as project type, costs, and geographic location. This paper identifies several significant risk variables and their severity that contribute to extensive delays and the consequences exceeding the planned time estimate (Kaleem et al., 2014). The results of this test indicate that the risk preferences between public owners and designers and contractors towards the choice of DB delivery method do not differ significantly in the scope of risk, third party risk, and complexity risk, utility risk and, ROW, level of design risk and contract risk, management risk, or regulatory and railroad risk, but statistically different in construction risk (Tran & Molenaar, 2014).

External risks have little effect on the UAE highway construction industry. Research shows clearly that internal risks threaten projects more than external risks (El-Sayegh & Mansour, 2015). This flowchart acts as a guideline to assist contractors and owners in designing contracts that are transparent and that efficiently allocate risk to the parties best suited to bear it. By designing contracts with appropriate risk allocation strategies, the project will perform better from a cost and schedule perspective by eliminating activities that do not add value. Contract disputes and litigation are examples of activities that did not add value to the project participants who were forced to do when the risk of misallocation. This research has revealed the

pitfalls of improper risk allocation in the highway construction industry and offers practical considerations that, if combined from the beginning of the project, will result in higher performance projects (Hanna et al., 2015). The use of the hybrid contract method results in a significant cost reduction when compared to the unit price contract method for this particular construction project. This article concludes the effectiveness of assigning contractors to risks associated with variations in the amount. Implementation of items for unexpected possibilities shows benefits for both parties, the owner, and the contractor. Contracting contingency estimates can be reduced by showing a higher chance of becoming the lowest bidder (Fontán-Pagán et al., 2016). Simulation results show the importance of viewing data from a practical point of view. However, in this case, the difference is small and will not affect funding decisions. Users are warned not to neglect the correlation between related inputs because that would result in underestimation of the total cost variance with the effect of cancellation during the simulation between uncorrelated variables (Tran & Bypaneni, 2016).

The models developed and discussed in this paper can help deal with risks in road construction projects by looking at RI, CI, and SI ratings of risk drivers and allocating appropriate contingency percentages for use (Diab et al., 2017). Potential PPP road projects in developing countries may want to take advantage of one or more financial instruments, such as the World Bank Partial Risk Guarantee and Political Risk Insurance, even more, developed countries, such as France and Spain, have subsidized projects, changing them into successful PPP projects, such as the Perpignan-Figueras Rail Concession (Tokiwa & Queiroz, 2017). This article has introduced practical guidelines for conducting detailed assessments of the impact of risks on the financial viability of PPP projects in developing countries. Finally, this paper focuses on risk and the preferred allocation mechanism for PPP toll road projects in Vietnam, recognizing that the risk allocation mechanism in PPP projects is dynamic and depends on several contextual variables at the country level (Nguyen et al., 2018). The allocation results show that some risks are managed by the public sector such as changes by public authorities, but most of the 31 risks are transferred to the private sector or shared, practitioners who apply or consider implementing PPP, a comprehensive review of risk allocation practices and contract language in various project characteristics PPP in the US (Nguyen et al., 2018). BRI's project risk assessment demonstrates the application of the fuzzy logic method proposed for large-scale, complex, and geographic infrastructure projects. Fuzzy logic-based methods are proven to be a systematic, efficient, and practical tool for infrastructure project risk assessment (Andrić et al., 2019). Transportation risk management will be improved if greater attention is given to so-called human factors, including risk perception, risk acceptance (including the factors that influence it and the relative importance of those factors), and the nature of the changes in driver behavior with perceived risk changes. (Nicholson, 2020).

3.5. External Technical Risk

The results prove that the NN model is a powerful tool for predicting and explaining HRGC crashes with the ability to reveal a continuous function relationship between the likelihood of an accident and contributors. The results showed that the relationship between the likelihood of a collision and related factors was nonlinear,

and showed that the independent variables were not completely independent of each other (Zheng et al., 2019).

3.6. External Non-Technical Risk

Concessions were developed using completely different contract models, although certain features are common among these models, especially the duration of the contract and the conditions that must be met to trigger a mechanism to restore financial balance through renegotiation, the uncertainties and negative results of renegotiation lead to changes in risk allocation which have generally transferred commercial risk from the concession from the concessionaire to the grantor. Re-negotiated contract clauses generally guarantee that their returns will not change, even though their risks are significantly reduced (Cruz & Marques, 2013). The PPP Toll Road Project in Iran observes that the basic performance indicators of these projects due to time and cost may be subject to adverse deviations that lead to the highest priority risk of time delays and excessive costs, the risk of high inflation also results in excessive cost overruns (Ghorbani et al., 2014).

4. Result

The results of the research article analysis based on risk factors are shown in Table 2.

Table 2. Mapping research articles analysis based on risk factor

Factor	Research Article
Internal Risk	
Finance	(32) (47)
Contractor Experience	(2) (20)
Client Service	(26) (43) (44)
Project Risk	
Material	(12) (23)
Duration	(1) (25)
Finance	(3) (6) (8) (9) (11) (37) (38) (40) (42)
Construction Method	(13) (22) (33) (34) (39) (45)
Structure Construction	(4) (10) (14) (15) (16) (28) (36)
Project Management	(17) (29) (30) (31) (35) (46)
Contract	(5) (19) (27) (41)
Field Condition	(7)
K3	(18) (48) (50)
External Risk	
Socio-Economic Conditions	(49)
Government	(21) (24)

Based on the analysis of risk sources above, it is found that the risk aspect in the construction of highways that has the highest percentage is financial factors, as shown in Figure 3 below:
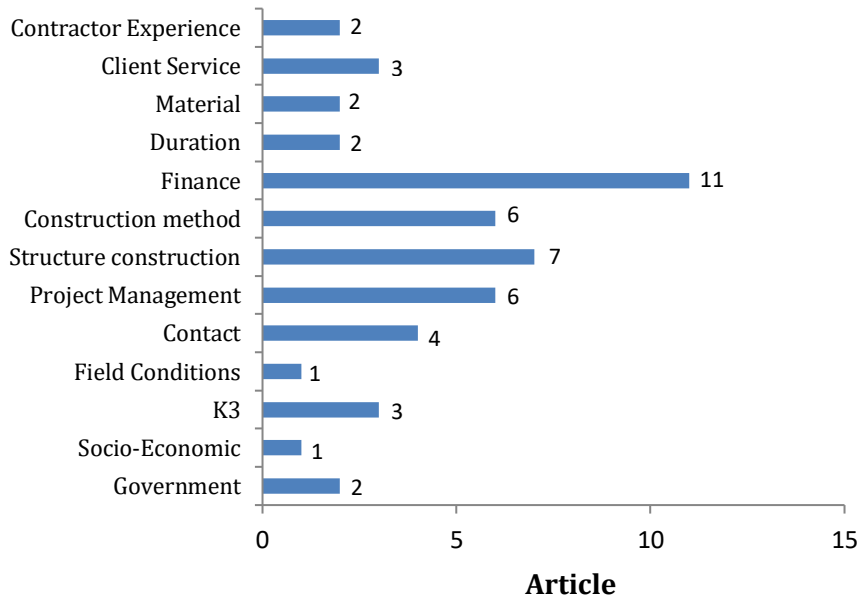
Figure 3. Barchart analysis of research articles based on risk factors

5. Conclusion

This article concludes that there is one source of risk that is very influential, namely the risks originating from the project itself, both technically and non-technically. The potential risk weights of a project are based on the frequency parameters of the occurrence of risks and negative consequences due to the occurrence of these risks for project objectives. The results obtained show that from 50 identified risks, there are 11 risks originating from financial factors consisting of 2 internal risks and 9 project risks. Finance is the highest risk percentage of the article analyzed. This shows that finance is an important factor in the implementation of construction projects, project financing must be managed properly to avoid problems during project implementation. Contractors who do not have adequate finance and poor financial planning will have an impact on project implementation starting from delays in the realization of work, and poor quality of work. By knowing the main risks in a road project, this article is expected to assist the contractor in recognizing and investigating the effect of risk allocation on contractors' risk management decisions, so that prevention can be carried out earlier. This research is expected to assist future research in investigating rigorous analytical methods to verify project financial estimates and also must examine how to consider the effects of correlations on other risk analysis frameworks in the construction industry.

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