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RISK MANAGEMENT ON RAILWAY PROJECTS: A LITERATURE VIEW

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Abstract. *Railway construction either underground or in an open area or under a bridge carries work risks. The same in the process of design, implementation or maintenance. We chose this article because it is interesting for everyone to know all the risks that occur. These risks can hinder the activities of both planning, implementation or maintenance. The purpose of this paper is to identify all the risks of railway work and to minimize the risks that occur in subsequent work. Risk identification is carried out through the study of international journal literature by taking data from 30 journals from 100 related journals. Risk analysis based on literature view is divided into Internal and External Factors. Internal Factors: (1). Technical and (2) Non-technical, External Factors (1). Technical, (2) Non-technical and (3) Legality. From the results of the pareto chart and pie diagram analysis it can be concluded that Internal Technical Factors are the most involved in the identification of this risk.*

Key words: *Railway, risk management, construction, technical, non technical, risk*

1. INTRODUCTION

The train is a mass transportation vehicle that is quite effective to carry out the transfer activities, of goods, services and other commodities. Therefore, there is the need for special attention in supporting this mass transportation. In recent years many countries have turned into developing countries and therefore the need for mass transportation that is integrated into all aspects of social, cultural, economic and others. For this reason, it is necessary to identify the risks that occur in planning, implementation and maintenance.

This paper hopes to help minimize any risks that arise later. For example the train Slipping during operation is due to a lack of maintenance (1). These events can have fatal consequences such as deaths and other impacts and the difficulty of land acquisition for the commencement of the railway project (2). This could hamper the work schedule which will later affect all aspects of life.

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2. INTRODUCTION

The writing of this article is based on a literature review study obtained online including various scientific articles relating to risks in the construction of railway construction projects which are then reviewed and synthesized to provide comprehensive information. In this research, there are 2 risks (1) Internal & (2) External.

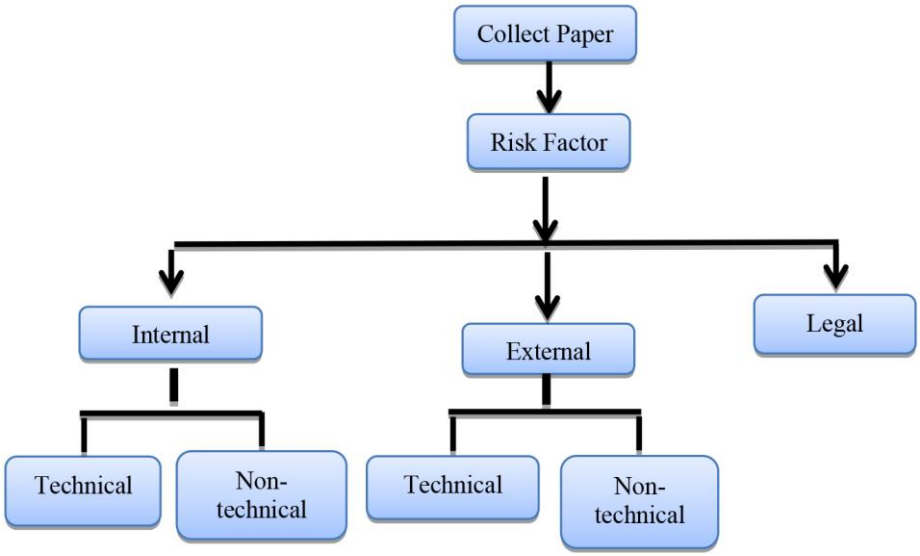

Fig. 1 Study Framework

In Figure 1, this function study framework explains how to obtain journals related to risk management on railway. The key word for the search is using the keyword railway, identify railway or risk railway.

3. RESULT & DISCUSSION

The review of scientific article publications was carried out from several sources, namely: Google Scholar, Sciendo, Arce Library etc. The list of selected articles analyzed from the aspect of risk identification in railway are as shown in Table 1.

Table 1 Risk Management Identification

No.	Paper Identity	Risk Identification					Result
		Internal		External			
		Technical	Non-technical	Technical	Non-technical	Legal	
1.	(Allan M. Zarembski, 2006)	v	x	v	x	x	Reduction in rail damage by 30% or more.
2.	(Abdelaziz Berrado, El-Miloudi El-Koursi, Abdelghani Cherkaoui & Moha Khaddour, 2011)	v	x	x	x	x	The use of functional diagrams for modeling operations in LC from the perspective of LC actors.
3.	(Ratnaningsih, Dhokhikah, & Fitria, 2018)	v	v	v	x	x	Future work should focus on (1) a more thorough investigation of the differences between the three models, (2) expanding the model to the railway network, (3) expanding the model to better consider station considerations; (4) broadening the model to be taken into account traffic schedules to more realistically determine channel closing costs and speed reductions instead of using fixed costs values; and (5) expanding the model to determine optimal program interventions over several years..
4.	(Guanghong Ma, Huimei Luo, & Jianjun Zheng, 2017)	v	v	v	v	v	The use of BIM is proposed to reduce risk losses.
5.	(MOU Ruifang, WU Yan, 2011)	v	x	x	x	x	Construction methods and geological conditions are the main risk factors for tunnel and underground projects
6.	(J.-R. Pastarus, S. Sabanov, & T. Tohver, 2007)	v	v	v	v	v	Transportation of oil shale from mines and casts to consumers by train causes many technical, economic, ecological and juridical problems.
7.	(Piotr Smoczyński, & Adam Kadziński, 2016)	x	x	v	v	v	Certain hazards associated with railway maintenance, - determine the interface between risk management carried out under the railway maintenance system and risk management related to infrastructure manager
8.	(Li Qing, Liu Rengkui, Zhangm Jun, & Sun Quanxin, 2014)	v	x	x	x	x	Developing RCPQRMIS in detail by first analyzing standard data and then forming a dynamic quality risk tracking model, a quality risk pre-warning model, and an automatically generated quality risk publicity model.

9.	(Serdar Dindar, Sakdirat Kaewunruen, & Min An, 2017)	v	x	x	x	x	An accurate estimate of the high level of risk posed by the rail participation system is very important for companies and organizations to operate the entire railway system without safety concerns.
10.	(Jana Sekulová, Eva Nedeliaková, 2015)	x	x	v	v	x	Risk assessment of passengers
11.	(Yang Xuebin, Du Wen, & Li Zongping, 2009)	v	x	x	x	x	Establishing supply logistics optimization model selection modes, and obtaining algorithms.
12.	(G. N. Young, S. P. DiBenedetto, & V. Hutchison, 2016)	v	x	x	x	x	Use of multi-sensor geophysical technology
13.	(Zeng, 2015)	x	x	x	v	v	Funding and market risks must be taken by the private sector
14.	(Zhang, 2009)	x	v	x	x	x	Through risk-based safety management, can find and solve security problems in the railway system more effectively and comprehensively.
15.	(Asa Boholm, 2010)	v	x	x	x	x	Incorporate risk analysis in expert practical knowledge.
16.	(Johan M. Sanne, 2008)	x	v	x	x	x	Reducing the need to take risks through corporate actions will reduce the risk of job loss
17.	(Sunduck, 2000)	v	v	v	v	x	Risk on railway construction in internal and external
18.	(Flammini, Andrea Gaglione, et al, 2009)	x	v	x	v	x	Analyze critical infrastructure methods
19.	(C. van Gulijk, Peter Hughes & M. Figueres-Esteban, 2015)	x	v	x	x	x	Computerized in supporting safety and risk management in the GB railway and in other risk domains
20.	(Qiyu Shen, 2016)	v	v	x	x	v	Risk assessment method in this paper is reasonable and reliable. The analysis process is simple and easy to understand and operate, and the evaluation result is in accordance with the actual situation.
21.	(Yung-Cheng, Kuan-Ting Chen, 2017)	x	x	v	x	x	Using a computing system.
22.	(Xianbo Zhao, Xianbo Zhao, 2012)	v	x	x	x	v	Identification of the most critical risks associated with implementing ICJV underground rails in Singapore and checking the differences in RC values and risk factor ratings according to contractor characteristics.
23.	(Terry Morgan, 2011)	x	v	x	v	x	There is a range of risks which contractors are best placed to Manage: (a) labour shortages arising from new immigration quotas (b) constructability of new stations on constrained central London sites (c) the impact of Crossrail works on its neighbours and on London and the south east as a whole.

24.	(Ploywarin Sangsomboon, Song Yan, 2014)	v	v	v	v	v	Risk reduction (44.19 percent), risk-retention (53.49 percent), and risk transfer (25.58 percent)
25.	(Vishwas, Gidwani, 2017)	v	x	v	x	x	Using risk management in the context of construction project management.
26	(Zhao Teng, et all, 2013)	v	x	x	x	x	The use of the AHP method depends on experience, knowledge and expert judgment.
27	(Pastarus, et all, 2007)	v	x	x	x	x	Using risk analysis / assessment methods
28	(T.H. Nguyen, Bhagavatulya, F. Jacobs3)	v	v	x	x	v	Momentification of the contract is based on the following factors: 1. Design issues 2. Problems related to material availability 3. Clearly defines the role of project team members 4. Delay damage 5. Contingency plans in terms of personnel leaving the project or uncertainty in terms of material availability 6. Establishing standard for communication policy
29	(David Bray,	v	x	x	x	x	Using the ALARP Framework
30	(Joseph Berechman, Qing Wu2, 2006)	v	x	x	x	x	Developing the method of mounting probability distributions, regression analysis and simulation models

Table 1 is a continuation of figure 1. From what has been obtained from figure 1 is broken down again into the category of internal risk (technical or non technical) or external (technical or non technical or legality) and what results are obtained. From grouping table 1, it will aim to group which factors contribute most to the railway work process with the following result.

Table 2 Result Risk Identification

No	Paper Identity	Risk Identification	Result
1.	(Allan M. Zarembski, 2006)	Technical Internal & External	Reduction in rail damage by 30% or more.
2.	(Abdelaziz Berrado, El-Miloudi El-Koursi, Abdelghani Cherkaoui & Moha Khaddour, 2011)	Technical Internal	The use of functional diagrams for modeling operations in LC from the perspective of LC actors.
3.	(Ratnaningsih, Dhokhikah, & Fitria, 2018)	Technical Internal, External & Non- Technical Internal, Legal	Future work should focus on (1) a more thorough investigation of the differences between the three models, (2) expanding the model to the railway network, (3) expanding the model to better consider station considerations; (4) broadening the model to be taken into account traffic schedules to more realistically determine channel closing costs and speed reductions instead of using fixed costs values; and (5) expanding the model to determine optimal program interventions over several years.

4.	(Guanghong Ma, Huimei Luo, & Jianjun Zheng, 2017)	Technical Internal, External & Non- Technical Internal, External,Legal	The use of BIM is proposed to reduce risk losses.
5.	(MOU Ruifang, WU Yan, 2011)	Technical Internal	Construction methods and geological conditions are the main risk factors for tunnel and underground projects
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7.	(Piotr Smoczyński, & Adam Kadziński, 2016)	Non- Technical Internal, External & Legal	Certain hazards associated with railway maintenance, - determine the interface between risk management carried out under the railway maintenance system and risk management related to infrastructure manager
8.	(Li Qing, Liu Rengkui, Zhangm Jun, & Sun Quanxin, 2014)	Technical Internal & Non-Technical Internal, External,Legal	Developing RCPQRMIS in detail by first analyzing standard data and then forming a dynamic quality risk tracking model, a quality risk pre-warning model, and an automatically generated quality risk publicity model.
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10.	(Jana Sekulová, Eva Nedeliaková, 2015)	Non- Technical Internal, External,	Risk assessment of passengers
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12.	(G. N. Young, S. P. DiBenedetto, & V. Hutchison, 2016)	Technical Internal	Use of multi-sensor geophysical technology
13.	(Zeng, 2015)	Non-technical External & Legal	Funding and market risks must be taken by the private sector
14.	(Zhang, 2009)	Technical External	Through risk-based safety management, one can find and solve security problems in the railway system more effectively and comprehensively.
15.	(Asa Boholm, 2010)	Technical Internal	Incorporate risk analysis in expert practical knowledge.
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17.	(Sunduck, 2000)	Technical Internal, External & Non- Technical Internal, External	Risk on railway construction in internal and external

18.	(Flammini, Andrea Gaglione, et al, 2009)	Technical External & Non-technical External	Analyze critical infrastructure methods
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21.	(Yung-Cheng, Kuan-Ting Chen, 2017)	Non- Technical Internal	Using a computing system.
22.	(Xianbo Zhao, Xianbo Zhao, 2012)	Technical Internal & Non-technical Legal	Identification of the most critical risks associated with implementing ICJV underground rails in Singapore and checking the differences in RC values and risk factor ratings according to contractor characteristics.
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24.	(Ploywarin Sangsomboon, Song Yan, 2014)	Technical Internal, External & Non- Technical Internal, External, Legal	Risk reduction (44.19 percent), risk-retention (53.49 percent), and risk transfer (25.58 percent)
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29	(David Bray,	Technical Internal	Using the ALARP Framework
30	(Joseph Berechman, Qing Wu2, 2006)	Technical Internal	Developing the method of mounting probability distributions, regression analysis and simulation models

Table 3 Scoring - technique of risk management.

No	Technique of risk management	Frequency	Accumulative Freq.	%	acc. %
1	Technical Internal	22	22	36%	36%
2	Non-Technical Internal	12	34	20%	56%
3	Technical External	10	44	16%	72%
4	Non-Technical External	9	53	15%	87%
5	Legal	8	61	13%	100%
	Total	61		100%	

All data in Table 3 has to recap into the form of a table, then we scoring based on the table and pie diagram at figure 2, then resulting in data like table 3, the conclusion drawn from this discussion is based on pareto analysis & diagram pie, as shown Figure 2 & 3, below:

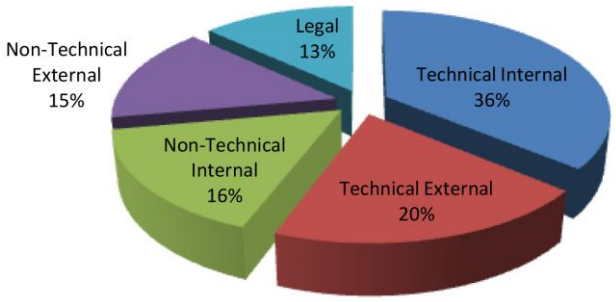

Fig. 2 Percentage results of risk identification

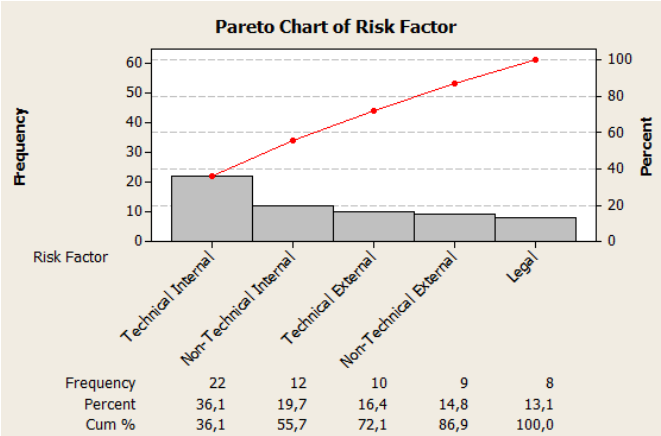

Fig. 3 Pareto Chart

From the pie chart above, the most significant influence is risk identification at (1) 36% Technical Internal, (2) Technical External 20%, (3) Non Technical Internal 16%, (4) Non Technical 16%, (5) Non Technical External 15% & (6) Legal 13% and from the pareto chart internal technical is the most significant.

4. CONCLUSION

The railway project is a mass project that greatly impacts the national economy of a country. This is because it can support all aspects of the economy. But the railway project is a project that has a very large investment value from planning to the maintenance stage. Moreover, there are still many accidents that occur. Therefore it is necessary to identify risks to reduce the risk itself. From the literature view, the results show that internal engineering factors are very influential 36%. So our suggestion in the process of railway projects should be emphasized more on these factors but without ignoring other factors in the hope of reducing the risk of railway project. However, judging from the Pareto analysis it shows the most significant internal technical results, so this section needs to be considered because the basic principle of Pareto states that for many events, about 80% of the effect is caused by 20% of the causes.

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UPRAVLJANJE RIZICIMA ŽELEZNIČKIH PROJEKATA: PREGLED LITERATURE

Izgradnja železnica kako pod zemljom tako i na otvorenom ili ispod mostova nosi radne rizik. Rizici su prisutni i procesu dizajniranja, implementacije ili održavanja. Odabrali smo ovaj članak jer je svima zanimljivo da znaju sve rizike koji se javljaju. Ovi rizici mogu ometati aktivnosti planiranja, implementacije ili održavanja. Svrha ovog rada je da identifikuje sve rizike železničkog rada i da minimizira rizike koji se javljaju u budućem radu. Identifikacija rizika vrši se proučavanjem međunarodne literature u časopisima uzimanjem podataka iz 30 časopisa iz 100 povezanih časopisa. Analiza rizika zasnovana na literaturi podeljena je na unutrašnje i spoljne faktore. Unutrašnji faktori: (1). Tehnički i (2) netehnički, spoljni faktori (1). Tehnička, (2) netehnička i (3) zakonitost. Iz rezultata analize pareto grafikona i dijagrama sa isečcima može se zaključiti da su unutrašnji tehnički faktori najviše uključeni u identifikaciju ovog rizika.

Ključne reči: *železnica, upravljanje rizikom, građevinarstvo, tehnički, netehnički, rizik*