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.
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.

![Study Framework](image)

**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.
| 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, Zhang 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. |
|   | Author(s)                                      | Year | Mark | Mark | Mark | Mark | Description                                                                                                                                                                                                 |
|---|------------------------------------------------|------|------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9 | Serdar Dindar, Sakdirat Kaewunruen, & Min An  | 2017 | 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    | v    | v    | x    | Risk assessment of passengers                                                                                                                                                                               |
| 11| Yang Xuebin, Du Wen, & Li Zongping             | 2009 | v    | 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    | Use of multi-sensor geophysical technology                                                                                                                                                                  |
| 13| Zeng                                           | 2015 | x    | x    | v    | v    | Through risk-based safety management, can find and solve security problems in the railway system more effectively and comprehensively.                                                                         |
| 14| Zhang                                          | 2009 | x    | v    | x    | x    | Funding and market risks must be taken by the private sector                                                                                                                                                 |
| 15| Asa Bohholm                                    | 2010 | v    | x    | x    | x    | Incorporate risk analysis in expert practical knowledge.                                                                                                                                                     |
| 16| Johan M. Sanne                                 | 2008 | x    | v    | 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    | Risk on railway construction in internal and external                                                                                                                                                        |
| 18| Flammini, Andrea Gaglione, et al               | 2009 | x    | v    | x    | v    | Analyze critical infrastructure methods                                                                                                                                                                      |
| 19| C. van Gulijk, Peter Hughes & M. Figueres-Esteban | 2015 | x    | v    | 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    | 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    | Using a computing system.                                                                                                                                                                                   |
| 22| Xianbo Zhao, Xianbo Zhao                      | 2012 | v    | 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    | 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. |
Risk Management on Railway Projects: A Literature View

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 al., 2013) v x x x x The use of the AHP method depends on experience, knowledge and expert judgment.

27. (Pastarus, et al., 2007) v v x x x Using risk analysis / assessment methods

28. (T.H. Nguyen, Bhagavatulya, F. Jacobs) 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 Wu, 2006) v v 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. |

Table 2 Result Risk Identification
| 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. |
| 6. | (J.-R. Pastarus, S. Sabanov, & T. Tohver, 2007) | Technical Internal, External & Non-Technical Internal, External, Legal | 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) | 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, ZhangJun, & 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. |
| 9. | (Serdar Dindar, Sakdirat Kaewunruen, & Min An, 2017) | Technical Internal | 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) | Non-Technical Internal, External | Risk assessment of passengers. |
| 11. | (Yang Xuebin, Du Wen, & Li Zongping, 2009) | Technical Internal | Establishing supply logistics optimization model selection modes, and obtaining algorithms. |
| 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. |
| 16. | (Johan M. Sanne, 2008) | Technical External | Reducing the need to take risks through corporate actions will reduce the risk of job loss. |
| 17. | (Sunduck, 2000) | Technical Internal, External & Non-Technical Internal, External | Risk on railway construction in internal and external. |
|   | Authors and Year                        | Type of Risk Management | Description                                                                                                                                                                                                                                                                                                                                 |
|---|----------------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18. | Flammini, Andrea Gaglione, et al, 2009 | Technical External & Non-technical External | Analyze critical infrastructure methods                                                                                                                                                                                                                                                                                                       |
| 19. | C. van Gulijk, Peter Hughes & M. Figueres-Esteban, 2015 | Technical External | Computerized in supporting safety and risk management in the GB railway and in other risk domains                                                                                                                                                                                                                                    |
| 20. | Qiyu Shen, 2016                         | Technical Internal & External | 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       | 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.                                                                                                 |
| 23. | Terry Morgan, 2011                     | Technical External & Non-technical External | 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  | Technical Internal, External & Non- Technical Internal, External, Legal | Risk reduction (44.19 percent), risk-retention (53.49 percent), and risk transfer (25.58 percent)                                                                                                                                                                                                                                   |
| 25. | Vishwas, Gidwani, 2017                 | Technical External & Non-technical Legal | Using risk management in the context of construction project management.                                                                                                                                                                                                                                                                   |
| 26. | Zhao Teng, et all, 2013                | Technical Internal | The use of the AHP method depends on experience, knowledge and expert judgment.                                                                                                                                                                                                                                                                            |
| 27. | Pastarus, et all, 2007                 | Technical Internal | Using risk analysis / assessment methods                                                                                                                                                                                                                                                                                                          |
| 28. | T.H. Nguyen, Bhagavatulya, F. Jacobs3 | Technical Internal, External & Non-technical Legal | 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,                             | 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:

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.

REFERENCES

1. Berrado, A. (2011). A Framework for Risk Management in Railway Sector: Application to Road-Rail Level Crossings, The Open Transportation Journal, 5(1), 34–44. https://doi.org/10.2174/1874447801005010034
2. Boholm, A. (2010). On the organizational practice of expert-based risk management: A case of railway planning, Risk Management, 2(4), 235–255. https://doi.org/10.1057/rm.2010.4
3. Bray, D. (2005). Risk tolerability and rail safety regulation. 28th Australian Transport Research Forum, ATRF 05, 1–15.
4. Burkhalter, M., Martani, C., & Adey, B. T. (2018). Determination of risk-reducing intervention programs for railway lines and the significance of simplifications. Journal of Infrastructure Systems, 24(1). https://doi.org/10.1061/(ASCE)IS.1943-555X.0000401
5. Dindar, S., Kaewunruen, S., & An, M. (2018). Identification of appropriate risk analysis techniques for railway turnout systems. Journal of Risk Research, 21(8), 974–995. https://doi.org/10.1080/13669877.2016.1264452
6. Flammini, F., Giglione, A., Mazzocca, N., & Pragliola, C. (2009). Quantitative security risk assessment and management for railway transportation infrastructures. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 5508 LNCS, 180–189. https://doi.org/10.1007/978-3-642-03552-4_16
7. Huo yamin, xu qin. (2011). Icte 2011 © asce 2011 991. Asce, (1), 991–996. Retrieved from http://ascelibrary.org/doi/abs/10.1061/41184(419)93
8. Iccrem 2016 518. (2016), (November 2014), 518–526.
9. Icte 2015 493. (2015), (2), 493–497.
10. Lai, Y. C. (Rex), & Chen, K. T. (2017). Evaluating service risk in railway capacity utilization using expected recovery time. Journal of Transportation Engineering, 143(6), 1–10. https://doi.org/10.1061/JITEPBS.0000038
11. Li, M. G., Chen, J. J., Xu, A. J., Xia, X. H., & Wang, J. H. (2014). Case study of innovative top-down construction method with channel-type excavation. Journal of Construction Engineering and Management, 140(5), 1–10. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000828
12. Li, Q., Liu, R., Zhang, J., & Sun, Q. (2014). Quality risk management model for railway construction projects. Procedia Engineering, https://doi.org/10.1016/j.proeng.2014.10.426
13. Allan M. Zarembski, Ph.D., P.E., FASME 1, Joseph W. Palese, PE, MSCE, MBA 1. (n.d.). 1–18. Managing Risk on the Railway Infrastructure
14. Morgan, T. (2011). Briefing: Risk management critical to cross rail’s success. Proceedings of Institution of Civil Engineers: Management, Procurement and Law, 164(2), 57–58. https://doi.org/10.1680/mpal.2011.164.2.57
15. Nguyen, T. H., Bhagavatula, G., & Jacobs, F. (2014). Risk Assessment: A Case Study for Transportation Projects in India. 3(9), 1–14.
16. Pastarus, J. R., Sabanov, S., & Tolhver, T. (2007). Application of the risk assessment methods of railway transport in estonian oil shale industry. Oil Shale, 24(1), 35–44.
17. Ratanaringsah, A., Dhotikikah, Y., & Fitria, A. (2018). Hazard identification, risk analysis and risk assessment on high-rise building construction project. AIP Conference Proceedings. https://doi.org/10.1063/1.5042870
18. Sangsomboon, P., & Yan, S. (2014). Analysis of Risk- Response based on Railway Construction Project Author s Details: Risk Identification Risk Analysis Risk Response Risk Monitoring & Evaluation Risk Retention Risk
Avoidance Risk Transfer Insurance Risk Reduction. International Journal of Management Sciences and Business Research, 3(12), 81–91.

19. Smočynski, P., & Kadźżiński, A. (2016). Introduction to the risk management in the maintenance of railway tracks. Journal of Mechanical and Transport Engineering, 68(4), 65–80. https://doi.org/10.21008/j.2449-920x.2016.68.4.06

20. Sukalová, J., & Nedelkalová, E. (2015). RISKS ASSESSMENT IN RAILWAY PASSENGER TRANSPORT IN RELATION TO CUSTOMERS. 79–89.

21. Zhao, T., Liu, X., & Yang, W. (2013). Identifying the critical risks in underground rail international railway line of high-speed railway for PDL. IATSS Research, 24(2), 53–63. https://doi.org/10.1016/s0386-1112(14)60029-7

22. Sun, Y., Fang, D., Wang, S., Dai, M., & Lv, X. (2008). Safety risk identification and assessment for Beijing Olympic Venues construction. Journal of Management in Engineering. https://doi.org/10.1061/(ASCE)0742-597X(2008)24:1(40)

23. Van Gulijk, C., Hughes, P., Figueres, Esteban, M., Dacre, M., & Harrison, C. (2015). Big Data Risk Analysis for rail safety? Safety and Reliability of Complex Engineered Systems - Proceedings of the 25th European Safety and Reliability Conference, ESREL 2015, 643–650. https://doi.org/10.1201/b19094-88

24. Smoczyński, P., & Kadziński, A. (2016). Introduction to the risk management in the maintenance of railway tracks. Journal of Mechanical and Transport Engineering, 68(4), 65–80. https://doi.org/10.21008/j.2449-920x.2016.68.4.06

25. Zhao, X., Hwang, B. G., & Yu, G. S. (2013). Identifying the critical risks in underground rail international railway line of high-speed railway for PDL. IATSS Research, 24(2), 53–63. https://doi.org/10.1016/s0386-1112(14)60029-7

26. Vishwas H S, & Dr. G D Gidwani. (2017). Hazards Identification and Risk Assessment in Metro Railway Line Construction Project at Hyderabad. International Journal of Engineering Research And, V6(08), 243–249. https://doi.org/10.17577/hijertv6is080126

27. Yang, X., Du, W., & Li, Z. (2009). Analysis and optimization of supply logistics mode in new lines railway construction project. Proceedings of the 2nd International Conference on Transportation Engineering, ICYTE 2009, 2009(Ice), 4293–4298. https://doi.org/10.1061/(ASCE)0742-597X(2009)14:1(4293)

28. Young, G. N., Dibenedetto, S. P., & Hutchison, V. (2016). Utility Risk Management in Transmission Line Construction. Pipelines 2016: Out of Sight, Out of Mind. Not Out Of Risk - Proceedings of the Pipelines 2016 Conference, 219–227. https://doi.org/10.1061/9780784479957.021

29. Zhao, T., Liu, X., & Yang, W. (2013). Risk Analysis And Management Of Track Construction On Running Railway Line Of High Speed Railway For PDL. (Icssr), 245–249. https://doi.org/10.2991/icssr-13.2013.54

30. Zhao, X., Hwang, B. G., & Yu, G. S. (2013). Identifying the critical risks in underground rail international construction joint ventures: Case study of Singapore. International Journal of Project Management, 31(4), 554–566. https://doi.org/10.1016/j.iproman.2012.10.014

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. Odabrani smo ovaj članak jer je svima zanimljivo da znaju sve rizike koji se javljaju. Ovi rizici mogu ometati aktivnosti planiranja, implementacije ili održavanja. Svraha 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 isećima može se zaključiti da su unutrašnji tehnički faktori najviše uključeni u identifikaciju ovog rizika.

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