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Assessment of Risk Associated with Road Infrastructure Development in the Developing Countries

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Abstract

Developing countries are striving to build their infrastructure to foster their economic growth. Authors discovered that continuous rising in the access to locations along with spending on infrastructure enhances the economic development and growth of developing countries. However, this development process comes with various challenges such as the right of way, traffic management, diversions, noise, vibration, dust etc. In addition to that, the weak performance of road construction projects in these countries can be attributed to the inefficient understanding and deployment of risk management. As a result of these challenges, residents, businesses, travellers etc. are subject to risks at different levels and magnitudes. This study aims to identify and measure the risks associated with infrastructure development within cities in the developing nations. A questionnaire is used as a tool for data collection; the collected data is then analysed using percentages and Risk Assessment Matrix (RAM). The study identifies the significant risks associated with road infrastructure development (i.e. Heavy, traffic, Dust and Accident and Destruction) in the cities and their severity. This study contributes to identifying rating and likelihood of the associated risks while evaluating the critical risks that needed attention.

Keywords: Developing Countries, Infrastructure, Risk Assessment, Road Construction

1. Introduction

Trillions of dollars at present are being expended on the road and other infrastructure projects in developing countries (Okate and Kakade, 2019). About 90% of 25 million kilometre new roads will be constructed in the developing countries (Alamgir et al., 2019), and so much is expected within their cities. Alamgir et al. (Alamgir et al., 2019) identified the risk that can hamper road construction projects from developing countries in dry and wet tropical environments. The risks identified in this category are time and again considered evaluators, projects sponsors and the public in general, generating a logical tendency to overrate the benefits of the project while underestimating the risks in the projects. The understanding and awareness of the risk that do exist in practice, the imperative aspect of risk management and analysis is not fully utilised (Rihar et al., 2019). Analytical Hierarchy Process (AHP) is commonly used for risk assessment in the construction industry. For instance, Taylan et al. (2014) used fuzzy AHP and fuzzy TOPSIS methodologies in construction projects risk assessment and one more additional method by Zavadskas et al., (2010). On the other hand, the current trend of public nuisance, disruptions and hardship pose during road development in the cities received little or no attention (Altshuler, 2019). Thus, these challenges require attention to a different approach or strategy to mitigate such happenings. This study intends to investigate the common risks inflicted on the populace and consequently on the economic activities during road infrastructure development in cities. The study is to be achieved through common risks identification, rating and evaluations.

2. Literature Review

Twenty-five million kilometres of newly paved road is predicted to be developed globally by 2050 sufficient to encompass the globe more than 600 times. It is estimated that about 90% of new roads will be constructed in developing countries (Alamgir et al., 2019). Infrastructure is vulnerable to high regulatory, political and completion risk. Modern roads are important in contexts; they can stimulate social and economic benefits. If implemented or managed poorly, nonetheless, they can aggravate serious environmental impacts, cost overruns and corruption, while generating intense political and social conflict along with scarce economic benefit (Alamgir et al., 2019). For instance, road construction in remote areas can lead to an increase in illicit mining, smuggling, logging, poaching and drug production. Such attempts can aggravate social and environmental problems, defrauding the government or royalty and tax revenues and necessitate expenditure increment for law enforcement and monitoring.

Risk is considered iterative as it may arise at any stage during the project progress and also throughout the life cycle (Khodeir and Nabawy, 2019). Trillions of dollars at present have been expended on the road and other infrastructure projects in developing countries (Okate and Kakade, 2019). Nonetheless, the economic risk in the long term to which the international lenders and projects investors are exposed to, are rarely obvious transparently presented or understood (Drabek and Payne, 2002) . Road project conveys a substantial amount of risk owing to underground condition threat and its expanse over an extensive geographical region (Okate and Kakade, 2019). The level of projects uncertainty is on the increase owing to the intricacy in construction risks management (Khodeir and Nabawy, 2019). Taylor and Carn (2010) defined risk to be the "economic process of allocating business firms' the financial resources in the optimum combination of loss control and loss financing." While, Khodeir and Nabawy (2019) defined risk management as a scientific approach of identifying, anticipating and minimising the possible adverse effects on the projects. The infrastructure risk that is mostly agreed upon are regards as project management associated risk and secondly, financially associated risk.

Alamgir et al. (2019) identified the risk that can hamper road construction projects from developing countries in dry and wet tropical environments. The risks identified in this category are time and again considered evaluators, projects sponsors and the public in general, generating a logical tendency to overrate the project's benefits while underestimating the risks in the projects. A more preventive approach is required to mitigate the risk while the benefits of new roads construction projects in the tropical environment are maximised. The positive impacts of the construction of new roads are over and over again proclaimed enthusiastically by the road stakeholders and promoters.

There is also an increase in the risk of the landslides in the road construction around the mountainous region. Damages in the road surfaces reduce the speeds of the vehicles while accident risk and traffic bottlenecks increase. Moreso, social risk does not finish at the completion of road construction. The cost-benefit of the analysis of road construction must not only consider their immediate potential benefit but must also consider the longer-term environmental and socio-economic benefit.

The current financial predicament identified by Craciun (2011) has generated a different discussion around the risk that infrastructure projects are subjected to. Investment projects infrastructure risk are common to those that have an impact on Foreign Direct Investments (FDI). Risk can be categorised into process risks (relating to the realisation of the company's objective and goals nevertheless, manageable by the same) environmental (which cannot be affected by the prompted by the company) and informational risks (which relates to insufficient information management).

The understanding and awareness that risk may or do exist are in practice, the imperative aspect of risk management and analysis (Rihar et al., 2019). Risks in infrastructure project are treated differently most, especially based on the evaluation of the probability of the occurrence of the risk event and its impact based on activity in the individual projects.

		Consequence				
		Negligible 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	5 Almost certain	Moderate 5	High 10	Extreme 15	Extreme 20	Extreme 25
	4 Likely	Moderate 4	High 8	High 12	Extreme 16	Extreme 20
	3 Possible	Low 3	Moderate 6	High 9	High 12	Extreme 15
	2 Unlikely	Low 2	Moderate 4	Moderate 6	High 8	High 10
	1 Rare	Low 1	Low 2	Low 3	Moderate 4	Moderate 5

Figure 1: Standard Risk Assessment Matrix (Kaya, 2018).

The common risk assessment method uses in several engineering activities, and tasks evaluation is Risk Assessment Matrix (RAM), but, seldom use on the road construction projects. As described by Gul and Guneric (2016), RAM is based on an equal criteria weight for probability and severity. Distinctive assessments on the criteria may lead to diverse implications (Grassi et al., 2009). For illustration, dangers with high likelihood and low severity can be classified at the same level as ones with low likelihood and high seriousness. Figure 1 presents the Standard Risk Assessment Matrix.

3. Method

The paper investigates the likelihood and impact of risks associated with road infrastructure development in the cities. The investigation adopted the use of the Risk Assessment Matrix (RAM) as used in other industries (Malone and Moses, 2004). The development and use of RAM are growing in many more industries, and its usage is quite impactful (Gul and Guneric, 2016; Kaya, 2018). A questionnaire survey form is deployed online using Google form. Random distribution is used across targeted industry professionals. Seventy-two valid responses were received, and the generated response values were arithmetically compiled and used on the RAM table. The respondents are diverse within the construction industry professionals. Table 1 presents the respondents' demography.

Table 1: Respondents Demography

Variable	Characteristics	Freq.	Percentage (%)	Total
Academic Qualification	Higher National Diploma	0	0.0	
	First Degree	27	37.5	
	MSc	36	50.0	
	PhD	9	12.5	72
Years of practice	< 5 years	0	0.0	
	5 - 10 years	18	25.0	
	11 - 15 years	45	62.5	
	> 15 years	9	12.5	72
Number of employees	< 10 personnel (Micro)	36	50.0	
	10 - 50 personnel (Small)	18	25.0	
	50 - 200 personnel (Medium)	9	12.5	
	> 200 personnel (Large)	9	12.5	72
Profession	Civil Engineering	54	75.0	
	Construction/Project Management	9	12.5	
	Quantity Surveying	9	12.5	72
Specialisation	Contractor/Construction	27	37.5	
	Designer or Consultant	36	50.0	
	Development Authority	9	12.5	72

The respondents of this questionnaire are highly skilled in their professions and trained from the first degree and above. More so, they are dominantly experienced in practice for over ten years. Having infrastructure developed by Civil Engineers, the participants are predominantly Civil Engineers.

3.1 Data in Brief

The generated data from the questionnaire survey is presented in the form of data in brief in Table 2. The questions and summary of responses received are presented as follows.

Table 2: Summary of the generated information

Question(s)	Potential Risks	Average responses (likelihood/probability)	Percentage (%)	Total
Likelihood/probability of the risks associated with road infrastructure development in cities	Noise	3.25	65.0	
	Dust	3.25	65.0	
	Poor alternative access	2.88	57.6	
	Heavy traffic	3.50	70.0	
	Accident and destruction	3.38	67.6	
	Vibration	2.63	52.6	
	Increase in criminal activities	2.38	47.6	72
Question(s)	**Potential Risks**	**Average responses (severity/consequences)**	**Percentage (%)**	**Total**
Severity/consequences of	Noise	2.50	50.0	

the risks associated with road infrastructure development in cities	Dust Poor alternative access Heavy traffic Accident and destruction Vibration Increase in criminal activities	3.25 3.00 3.50 3.00 2.63 2.38	65.0 60.0 70.0 60.0 52.6 47.6	72
Question(s)	**Additional Risks**			**Total**
The additional risk associated with road infrastructure development in cities□	Delays in a timely project execution posing risks to economic activities Breakages/destructions of existing services or water pipes that could lead to scarcity of water, tampering with electrical wires, signpost, and material handling			54
The greatest risk encountered during infrastructure development in cities	Improper planning Traffic movements Existing services issues Poor construction standards Accident and destruction at the site			27
Question(s)	**Response options**	**Average responses**	**Percentage (%)**	**Total**
Do you carry out any risk assessment ahead of your project in relation to this subject	Yes No	27 45	37.5 62.5	72
Would you consider a different method of risk assessment?	Yes No	45 27	62.5 37.5	72
Is it a requirement to carry out risk assessment ahead of project execution in your organisation?	Yes No	45 27	62.5 37.5	72

4. Analysis and Result

The analysis of data was done using the Risk Assessment Matrix (RAM) as presented in the method section. Table 3 presents that calculation and the outcome of the potential risks associated with the road infrastructure development in the cities. Heavy traffic is found to pose a high risk during road development in the cities, followed by dust and accident/destruction. This class of risk is referred to as intermediate risk (Gul and Guneri, 2016). On the other hand, vibration and increase in criminal activities are found to pose a moderate level of risk as such required less mitigation than those with a high-risk level.

Table 3: Evaluation using RAM

S/No	Potential Risks	Likelihood/ probability	Severity/ consequences	Outcome	Remark
1	Heavy traffic	3.50	3.50	12	**High**
2	Dust	3.25	3.25	11	**High**
3	Accident and destruction	3.38	3.00	10	**High**
4	Poor alternative access	2.88	3.00	9	**High**
5	Noise	3.25	2.50	8	**High**
6	Vibration	2.63	2.63	7	**Moderate**
7	Increase in criminal activities	2.38	2.38	6	**Moderate**

There are also additional risks associated with road development in the cities as described repeatedly by the experienced construction professionals. These include delays in a timely project execution posing risks to economic activities, breakages/destructions of existing services or water pipes that could lead to scarcity of water, tampering with electrical wires, signpost, and material handling. Furthermore, the respondents experienced significant risks in the areas of improper planning, traffic movements, existing services issues, poor construction standards, accident and destruction at the site.

4.1 Conclusion

It can be concluded that regulation should be put in place to ensure proper risk assessment ahead of road construction in the cities. Template for risks assessment should be provided (i.e. Table 3) with addition potential risks which may be further developed based on experiences from the previously executed projects (e.g. second segment of Table 2). Heavy traffic, Dust, Accident and destruction, Poor alternative access and Noise were the components of the high risk identified in descending order. Furthermore, Improper planning, Traffic movement issues, Existing services issues, Poor construction standards as well as accident and destruction were the most significant risks suffered by the professionals as such required hearty consideration while planning road construction.

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