



## ANALYSIS OF TRADITIONAL METHODS FOR RISK ASSESSMENT

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**Abstract:** The article discusses the issues of risk assessment and management. The article examines in detail the methods of identifying potential threats, analyzing their impact and effectively managing risks. In particular, quantitative and qualitative risk assessment methods were studied, their features, advantages and disadvantages were identified. Although both approaches are aimed at assessing and analyzing risks, they differ in methodologies, data collection and analysis methods.

Risk assessment helps to identify and assess potential risks that may affect the activities of transport enterprises.

Transport enterprises must assess their risks and make appropriate decisions. It was recommended to take appropriate measures to effectively mitigate or manage these risks.

**Keywords:** *risk analysis, risk assessment, risk matrix*

**Introduction.** Risk assessment is the most important step at the strategic level for their management. Quantitative and qualitative methods are applied for the purpose of risk assessment, which give different results.

Qualitative risk assessment is a subjective approach that focuses on the probability and impact of identified risks. This method involves gathering information through expert opinions, historical data, brainstorming sessions and risk matrices.

The identified risks are then assessed based on predefined criteria such as low, medium or high probability and impact. Qualitative risk assessment provides a qualitative understanding of risks, allowing organizations to assess and manage risks based on their potential consequences.

In contrast, quantitative risk assessment is a more objective and data-driven approach. Risk mitigation measures can be operational, technical or organizational [1, p.28]. Accurate measurement of risks involves the use of statistical analysis, probability models, historical data, simulations and other mathematical techniques. This method allows organizations to make more informed decisions based on quantitative data, by providing numerical values to represent the probability and impact of risks. Methodology

First, a mathematical model for calculating the time losses of buses and vehicles on the road is proposed. A methodology for calculating the time savings of road users as a result of switching from private cars to public transport is given. Based on the initial data obtained from the city streets, a simulation model was built using the PTV VISSIM program to estimate the time (speed) of traffic flows along the considered section of the street. A survey was conducted in Baku among private vehicle owners in order to assess the conditions under which they would switch from private to public transport. Using the simulation model, a comparative analysis of time losses was carried out during the implementation of a dedicated bus lane, taking into account the existing number of bus and private vehicle users, as well as the transition of private vehicle owners to

public transport.

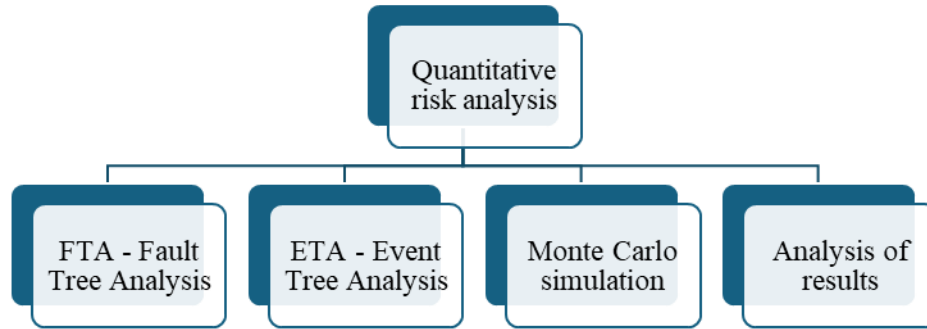


Figure 1. Quantitative risk analysis methods

*Monte Carlo Simulation:* Monte Carlo simulation is a technique that uses random sampling to model and analyze uncertainty and variability in a system[2,p249]. It is often used in conjunction with qualitative risk analysis to assess the impact of multiple variables and uncertainties on the overall risk.

*Fault Tree Analysis (FTA):* FTA is used in both qualitative and quantitative risk assessment to identify and assess the causes of a particular event in a transportation system. In quantitative risk assessment, fault tree analysis can be used to calculate the probability of a major event (undesirable event) based on the probabilities of the root causes. This method involves dividing an event into causes and analyzing the causes to determine their probability and impact on the transportation system[3,372]. The method is useful for identifying the causes of accidents or safety threats in a transportation system.

*Event Tree Analysis (ETA):* Event tree analysis is a graphical method used with fault tree analysis to model the sequence of events following an initiating event to assess the potential consequences of specific hazard scenarios and to estimate the probability and consequences of different outcomes. Event Tree Analysis is an important risk assessment tool used in transportation systems to analyze potential events and their consequences. It provides a systematic approach to understanding and evaluating the sequence of events that can occur in a given transportation scenario[4, p196]. Event tree analysis helps to identify hazards, assess their likelihood and impact, and develop effective mitigation strategies.

The primary purpose of event tree analysis in transportation is to identify and evaluate potential accident scenarios and their consequences. By constructing a detailed event tree, analysts can model the sequence of events that could occur during a transportation accident. These events may include vehicle malfunctions, human errors, environmental factors, or external hazards. Each event is then associated with probabilities and predicted consequences, which allows for a quantitative assessment of risk[5, p38].

*Consequences Analysis:* Consequences analysis involves assessing the potential consequences of a hazardous event, such as a fire, explosion, or release of toxic substances. This may include assessing the impact on personnel, equipment, infrastructure, and the environment.

The table below compares traditional methods for assessing risks in the transport system (table 1)

Table 1. Comparison of traditional methods for risk assessment in the transport system

Method	Objective	Strengths	Weaknesses
<b>Hazard identification</b>	To identify potential hazards that may occur in the transportation system	Qəzalar və təhlükəli təhdidlərə səbəb olan təhlükələri müəyyən etmək üçün faydalıdır.	It is limited in determining the likelihood and impact of hazards.

<b>Fault tree analysis</b>	To identify and evaluate the causes of a specific incident in the transportation system	It is useful for identifying the causes of accidents and dangerous threats in the transportation system.	It is limited in determining the probability and effect of causes.
<b>Event tree analysis</b>	To analyze to determine the consequences of a specific event in the transportation system	It is useful for assessing the consequences of accidents and dangerous threats in the transportation system.	Limited in determining the probability and impact of events.

### Qualitative Risk Analysis

Transportation is an integral part of our daily lives. Whether it is to get to work, go on holiday or transport goods, we rely on transport systems to move ourselves and our belongings from one place to another. However, transport also carries risks that can affect the safety of individuals and the environment. Therefore, it is important to understand qualitative risk analysis in transport in order to minimise negative impacts and promote sustainable transport systems.



Figure 2: Qualitative risk analysis methods

1. HAZID (Hazard Identification) : This method involves identifying potential hazards associated with a specific process or project and rating them based on their risk level. It is usually done during the initial planning phase.

2. HAZOP (Hazard and Operability Study) : HAZOP is a structured and systematic method for identifying potential hazards and operability issues in the design of a process. This process involves brainstorming sessions and recommendations are made to improve safety and operability.

3. FTA (Fault Tree Analysis): FTA is a graphical method used to analyze and understand the relationship between an undesirable event and the root causes of that event.

4. Risk Matrix : This method involves assigning probability and severity scores to various hazards or scenarios and plotting them in a matrix to assess the most critical risks. Once the risks have been mapped, risk mitigation strategies can be developed.

5. Bow Tie Analysis: Bow Tie analysis is a graphical method used to visualize potential hazards and the measures taken to control them. It is used to identify the critical control measures that can be implemented to prevent a hazardous event from occurring and the possible consequences if the control measures fail.

Risk management is essential for the well-being of individuals, organizations, and society as a whole. It is important to assess risk in order to minimize the likelihood and impact of adverse events. Risk analysis is a systematic approach that involves identifying and evaluating risks in order to minimize their impact. Qualitative risk analysis is one of the most commonly used approaches to risk analysis, especially when quantitative data are not

available or when the likelihood and consequences of risks are difficult to measure[6.p41].

Qualitative risk analysis is the process of assessing risks based on subjective judgment and experience rather than quantitative data. It involves identifying and evaluating the characteristics and attributes of risks, such as probability, consequences, severity, and frequency, to develop a qualitative understanding of risks. Qualitative risk analysis is often used in situations where risks are difficult to measure or where there is a lack of data to support quantitative analysis.

Qualitative risk analysis involves several key steps that are important to understand. These steps include:

**Step One: Risk Identification** - The process of identifying potential risks that could affect an organization or society related to transportation systems. This process involves gathering information about the participants in the transportation system and other factors that could affect the environment.

**Step Two: Risk Assessment** - The assessment of the likelihood and impact of each identified risk. This is the process of assessing the likelihood and consequences of the identified risks. This process involves analyzing the potential impact of risks on a project, organization, or society and determining strategies to manage the risks [7, p.188]. Risk analysis is a critical tool that can be used to assess potential risks associated with transportation systems. The purpose of risk analysis is to identify potential hazards and assess the likelihood and severity of their occurrence. Risk analysis helps transportation planners and policymakers make informed decisions by identifying and assessing risks associated with different transportation modes, routes, and infrastructure.

**Step Three: Risk Mitigation and Risk Management** - Risk mitigation is the process of implementing strategies to reduce the likelihood and consequences of risks. This process involves developing and implementing risk management plans that address identified risks. The process of risk management is the development and implementation of risk management strategies to reduce or eliminate identified risks.

**Step Four: Risk Monitoring** - The process of monitoring risks to identify new risks, track the progress of risk mitigation activities, and evaluate the effectiveness of risk management strategies.

Qualitative risk analysis is one of the methods used to assess risks associated with transportation systems. Qualitative analysis involves identifying potential risks and their impact on the transportation system, the environment, and individuals. Qualitative risk analysis does not provide numerical estimates of risks, but rather identifies the possible consequences of an incident or accident.

Although qualitative risk analysis does not involve mathematical or numerical calculations, formulas can be used to assist in the analysis process. Formulas can provide a structured and consistent approach to identifying, assessing, and managing risks. Some formulas used in qualitative risk analysis include:

$$\text{Risk} = \text{Probability} \times \text{Severity}$$

This formula is used to estimate the overall risk associated with a given event. Probability is the likelihood that an event will occur, and severity is the magnitude of the impact if the event does occur. By determining the probability and severity, the overall risk associated with an event can be determined.

### **Comparative Analysis of Qualitative and Quantitative Assessments**

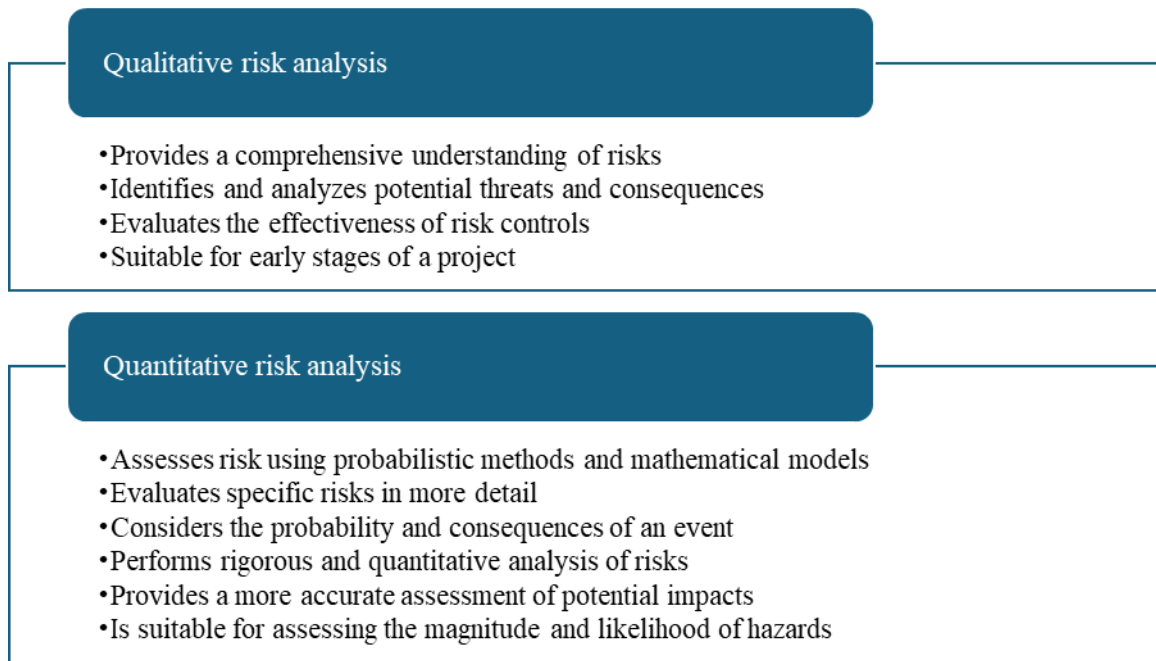


Figure 3 : Components of effective risk management

Qualitative and quantitative risk assessment methods are not mutually exclusive, but can complement each other in the overall risk management process.

Qualitative analysis methods are often used in the initial stages of risk assessment to quickly identify and assess key risks. Quantitative methods are then used to provide a more detailed and accurate analysis of risks for decision-making.

Here is a list of the main advantages and limitations of both methods.

Table 2: Advantages and disadvantages of quantitative and qualitative assessment

	Qualitative risk assessment	Quantitative risk assessment
Advantages	Simplicity and ease of use	Provides a more accurate and detailed understanding of risks
	Quickly identifies key risks	Enables informed decision-making based on numerical results
	Useful for initial screening and decision-making	Incorporates complex mathematical models and statistical analysis
	Can be applied when detailed information is not available	Can consider multiple variables and uncertainty
Disadvantages	Subjective and based on expert judgment	Requires extensive data collection and analysis
	Lacks numerical data and precision	Can be time-consuming and resource-intensive
	Insufficient in assessing probabilities and consequences	Complex models can be difficult to understand
	Insufficient in distinguishing risks of similar severity	Assumptions and uncertainties can affect the accuracy of results

## Conclusion

This study examined the traditional methods used for risk assessment in transportation systems and compared their strengths and weaknesses. The importance of both qualitative and quantitative analyses in the risk management process was emphasized and it was determined that they are complementary approaches.

Based on the research results, the following key points were identified:

Differences in risk assessment methods – Each of the qualitative and quantitative approaches serves different purposes. Qualitative analyses are more useful for identifying initial risks and assessing their impact. In contrast, quantitative analyses are used to accurately calculate risk probabilities and measure their impact.

Effectiveness of traditional methods – Traditional methods such as fault tree analysis (FTA), event tree analysis (ETA), Monte Carlo simulation and risk matrix are widely used for risk management in the transportation sector. These methods allow for a structured analysis of risks and the development of safety measures.

Limitations of methods – Traditional risk assessment methods sometimes pose certain difficulties as they require insufficient data, subjective judgment and complex calculations. In particular, qualitative methods can cause variable results since they are based on subjective assessments. Quantitative methods require a large amount of statistical data and complex mathematical models.

Combined approach to risk management – For effective risk management, it is recommended to apply both qualitative and quantitative methods together. Identifying risks with qualitative methods at the initial stage, and then measuring and assessing them with quantitative methods, allows for more accurate risk management.

Future research directions – The use of modern technologies such as intelligent transportation systems (ITS), big data analysis (Big Data), artificial intelligence and machine learning is considered promising for more accurate and reliable risk assessment in transport systems. These approaches will allow for more accurate and faster analyses compared to traditional methods.

Overall, the research conducted shows that a comprehensive approach should be applied for effective risk management in transport systems. The appropriate combination of qualitative and quantitative methods, the application of new technologies, and dynamic monitoring of risks can contribute to building safer and more sustainable transportation systems in the future.

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