

Application of Risk Matrices in Risk Assessment Methods and Case Studies

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Abstract. Constructing risk matrices is a way to analyze potential risks in order to avoid negative results. First, the paper introduces the advantages of the risk matrix, such as objectiveness and explicitness. Next, the paper suggests how to construct a risk matrix by combining the evaluation of risk probability and risk severity step by step. After that, the paper delves into three cases that apply risk matrices from different fields and analyzes the pros and cons of the application in each case, respectively. It is found that applying risk matrices leads to rational decisions that avoid future loss and ensure safety significantly. However, the limited perspective of the matrix could lead to one-sided results. In the future, one can develop risk prediction algorithms and multi-agent collaborative management, promote communication between people from different departments, establish a risk project database on the big data platform, and include more risk factors to make application of the risk matrix more intelligent and precise.

Keywords: Risk Matrix, Evaluation, Severity, Possibility

1. Introduction

Nowadays, risks are common in many fields, which may lead to various negative results. Therefore, risks need to be properly analyzed to reduce possible loss and ensure safety. Traditionally, people analyze the risks in person. However, the results of the traditional method are often subjective and one-sided. Nowadays, constructing risk matrices is a popular way to quantify and visualize the potential effects of different risk sources objectively, which translates into more rational decisions.

This paper dives into three cases of application of the risk matrix in the field of chemical engineering, home care, and commerce. Then, the paper analyzes the pros and cons of applying the risk matrix in each case so that readers can gain a better understanding of how risk matrices can be effectively used in different fields.

2. Principles and advantages of risk matrix

Applying a risk matrix is an effective way to analyze risks. Through analyzing the risk sources, severity of risks, the possibility that a risk happens, and the degree of risks, one can convert abstract risk information (in commerce, home care, etc.) into the vivid graph of risk matrices [1-3]. The risk

matrix objectively visualizes a required criterion of evaluation, which helps one get rid of misleading intuitions and evaluate risks rationally. Therefore, the risk matrix is widely used in fields that are full of risk analysis, such as finance and medical care [4,5]. To create a risk matrix, one should first decide the goal of the risk matrix and the range of risk to be considered, narrowing down one's focus to avoid confusion caused by introducing irrelevant risk sources and getting valid results [3,6,7]. Second, one must collect risk information comprehensively through methods such as field study, collecting past data, and making questionnaires [3,6,7]. In this process, one should be mindful that each risk has clear definitions and similar risks should be combined in larger risk groups [3,6,7]. Third, it is crucial that one establish a clear, uniform criterion of evaluation, including risk factors like the possibility of a risk happening and risk severity [1-3]. For risk possibility, for instance, one may define a risk happening five times a year as 'almost certain to happen' while defining a risk happening only once in the past twenty years as 'not likely to happen' [7,8]. For risk severity, the severity of risk should be evaluated according to the requirements of the relevant field [1,3]. For example, in the field of medical care, the health of patients is valued most, while in finance, the worst result may be massively losing money [5,9,10]. Fourth, one should score the risk factors in numbers (ranging from one to five, for example) [3,6,7]. To make the evaluation objective, this phase may involve setting up a team consisting of experts and those in charge [3,6,7]. The ultimate score is determined by the voting result of the team [3,6,7]. After all the preparations above, one can now begin to construct a two-dimensional matrix, with the x-axis of the matrix quantifying the risk probability and the y-axis quantifying the risk severity [3,6-8]. Three regions colored red (high risk), yellow (medium risk), and green (low risk) are divided in the matrix according to the comprehensive evaluation of both probability and severity [3,6-8]. These colored regions vividly illustrate the distribution of risks [2,3]. Eventually, one can draw conclusions based on the matrix and make decisions [2,3]. To be specific, three examples are listed below about how the matrix works.

3. The application of risk matrix in chemical engineering

Based on the problem in practice that two leakage accidents happened in a factory in 2024, the case analyzed the risks of the manufacturing of epoxypropane in a chemical engineering company [9]. The case used the risk matrix as a tool to regulate the manufactory process and avoid potential accidents [9]. The case categorized the possible risks into four groups: technique, facility, personnel, and emergency management, which is clear and readable [9]. To quantify the risk, the case divided the risk index into five levels from 1 point to 5 points [9]. The larger the point is, the higher the risk is [9]. Most risk factors were evaluated according to the industrial standard and experience from experts in chemical engineering [9]. For those factors that were hard to quantify, the case analyzed the independent scoring results from several experts (taking the mean score) [9]. This ensures the result is objective and accurate [9]. For the risk severity, the case analyzed casualty, financial loss, and environmental impact [9]. After the construction of a risk matrix, the company made some changes in manufacturing technique, personnel management, and the capability of personnel to tackle the risk factors marked red (high risk) [9]. After further analysis of the result of the risk matrix, the company made corresponding improvements in various aspects, including techniques, management, and personnel [9]. As a result, the serviceability rate of the critical instrument is projected to be raised from 87% to 95%, the risk value of the chlorine storage tank area is lowered from 12.6 to under 10.0, and the implementation rate of operation norms is kept above 98% as opposed to the previous 93% [9]. To sum up, the case constructed a dynamic risk matrix model to accurately evaluate the safety risks in the chemical production process, and proposed practical and

feasible optimization solutions, effectively enhancing the essential safety level of chemical enterprises [9].

4. The application of risk matrix in home care

Based on practical problems that the risks faced by both the nurses and the patients have significantly increased during the process of home care services due to multiple factors [10]. Just as in the previous case, this case categorized the risks into several general groups: risks from caregivers, risks from patients, risks from management, risks from communication, and risks from the house environment [10]. The risk degree is divided into four ranks: E (extremely high risk), H (high risk), M (medium risk), and L (low risk), so that ordered pairs of quantified numbers of risk severity and risk possibility (S, P) of a risk source can be categorized [10]. The case randomly selects several caregivers in a certain hospital [10]. Some information about caregivers, like sex, division, position, age, and level of education, is also gathered to prevent underrepresentation, making the result more precise [10]. The case used an interviewing method and questionnaire survey as well as consulting experts to acquire risk information [10]. The qualification of experts was also considered [10]. The goal of the case was to analyze risk categories rather than specific risk factors, so the case adopted a Borda ranking method to quantify the general risk scores of categories statistically [10]. Through constructing a risk matrix, the case found that there are five extremely high-risk projects, eleven high-risk projects, and five medium-risk projects [10]. The risk sources are diverse and complex [10]. The risks of nurses are dominant sources, followed by factors related to patients, management, home environment, and communication collaboration [10]. The result promoted home care of the elderly to be more standardized [10].

5. The application of risk matrix in commerce

Based on real-life problems, the case studied possible risks during the operation of companies to predict and manage risks [11]. This case introduced the risk matrix as a tool to evaluate risks in four dimensions, including credit status, credit period, large sums of funds, and contract performance [11]. This case set up a detailed evaluation standard for the severity of risks [11]. Ignored: losing a small amount of money and having no serious impact on the company's business [11]. Minor: having a controllable impact on business, having a minor impact on routine operation and strategic goals, and losing only a small amount of money [11]. Medium: affecting production and management, having a medium impact on routine operation and strategic goals, failing to achieve some strategic goals and meet some crucial performance indicators, and losing a decent amount of money [11]. Serious: seriously affecting production and management, failing to achieve some strategic goals and meet some crucial performance indicators, the company is starting to lose money, losing a large amount of money [11]. Catastrophic: huge loss of money accompanied by fines and judicial losses, failing to achieve all strategic goals and meet crucial performance indicators, the company suffers from a serious loss, and the amount of money lost is too massive to be retrieved [11]. The evaluation process referred to relevant laws in the country [11]. Moreover, the case recruited people from all relevant positions (general manager, division leader, etc) to engage in scoring risk factors [11]. The weight of scoring from people from different positions is balanced in some ways due to the difference in the risk information they get and their vision [11]. The risk matrix shows that the risk level of contract fulfillment is the highest (scoring 9), followed by large-scale capital risk [11]. Accordingly, the company placed more emphasis on the fulfillment of contract terms. The relevant business department of the company monitored the project progress,

defined the collection deadlines clearly, communicated with the client about payment matters on time, and anticipated potential risks in addition to routine inspection and precaution [11]. It turns out that the accounts receivable with a duration of more than two years decreased significantly from 21.1% to 9% from 2020 to 2023 [11]. The accounts receivable turnover rate also steadily improved, rising from 1.66 times per year to 2.1 times per year [11]. The method used in the case effectively reduced the business operation risks and losses from bad debt [11].

6. Analysis

However, the application of the risk matrix can be improved in many ways to work better.

For case 1, future research can delve deeper into areas such as risk prediction algorithms and multi-agent collaborative management to further enhance the scientific nature and effectiveness of safety management in the chemical industry [9].

The result of case 2 may be biased to some extent because it evaluated the risks of the home care service program only from the perspective of nurses [10]. Therefore, to make the result more objective and scientific, the risks of the service project may be measured comprehensively from the perspectives of both nurses and patients in the future [10]. By focusing on the needs and concerns of both service parties, a more comprehensive evaluation of the risks during the service process can be conducted, which promotes the "Internet + home care" services for the elderly to be more standardized [10].

In case 3, the integration of the application of the risk matrix in the fund risk management system and the gradual establishment of the digital and intelligent platform system by the group requires communication between financial management personnel and the platform builders [11]. In terms of the design of the risk management module, factors such as the roles of risk assessment personnel, the risk framework, quantitative standards, etc., can be introduced into the system in the future to draw risk matrices and get scoring results intelligently [11]. In terms of historical data accumulation, a risk project database can be established on the big data platform to achieve full-process management of the contract project execution process [11].

7. Conclusion

This paper analyzes the application of risk matrix in the fields of chemical engineering, home care, and commerce in detail, including classification of the risk factors, the principle and method of evaluation, and the methods used to acquire risk information. It turns out that the risk matrix contributes to more rational decisions and significantly avoids risks and ensures safety. However, the limited perspective of the matrix may make the results biased. In the future, in terms of chemical engineering, one can develop risk prediction algorithms and multi-agent collaborative management to enhance the scientific nature and effectiveness of safety management. In terms of home care, focusing on the needs and concerns of both service parties makes the result more comprehensive. In terms of commerce, one can promote communication between people from different departments, establish a risk project database on the big data platform, and include more risk factors to make application of the risk matrix more intelligent and precise. This paper specifically illustrates the function and construction process of risk matrices and concludes the advantages and disadvantages of the application of the risk matrix in analyzing risks in different fields, serving the purpose of introducing the application of the risk matrix to readers.

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