Application of Risk Assessment Models for Project Planning a Case Study of RUD India Chain PVT. LTD.

Rohan Shantaram Gharat[1], Majid Afsar Hussain[2]

PG Scholar, Department of Management Studies, ARMIET, Thane

Assistant Professor, Department of Management Studies, ARMIET, Thane

ABSTRACT

This study explores the application of risk-assessment models in the context of material handling projects at RUD India Chain Pvt. Ltd., a subsidiary of the German RUD Group. The research draws on primary data collected during a 45-day internship at the company's Asangaon manufacturing facility and secondary data from public sources. Key operational risks including safety, quality, supply chain, and maintenance risks are identified and categorized. Qualitative and quantitative risk models such as FMEA, risk matrix, and Monte Carlo simulation are applied to evaluate these risks. A novel risk prioritization framework is proposed, inspired by the FEFO (First-Expired, First-Out) inventory principle, adapted to risk management as "First-Identified, First-Managed." The paper further recommends institutional mechanisms including a Risk Management Office, risk dashboard, and predictive maintenance, tailored for RUD India's project lifecycle. The findings demonstrate that structured risk assessment can significantly enhance project robustness, reduce unexpected failures, and promote a proactive risk culture in operations. Implications are discussed for both academic research and industrial practice, with suggestions for future studies in scaling risk frameworks across global manufacturing units.

Keywords : FMEA, RISK MATRIX, FEFO, Project Planning

1. INTRODUCTION

In today's competitive manufacturing environment, project planning is increasingly exposed to uncertainties arising from technological complexity, stringent safety regulations, globalized supply chains, and volatile market conditions. Effective risk assessment has therefore become a critical component of project management, enabling organizations to anticipate potential disruptions and implement mitigation strategies proactively.

RUD India Chain Pvt. Ltd. operates in the specialized domain of material handling and lifting solutions, where project failures can result not only in financial losses but also in severe safety hazards. Projects in such environments demand robust risk assessment frameworks that integrate operational, safety, and strategic perspectives.

This research aims to analyze how risk assessment models can be systematically applied to project planning at RUD India. The study also proposes an innovative prioritization framework inspired by inventory management principles to enhance decision-making in risk mitigation.

2. LITERATURE REVIEW

Risk assessment and management have long been recognized as critical success factors in effective project planning, particularly in engineering and manufacturing environments where uncertainty, safety concerns, and operational complexity are high. International standards such as ISO 31000 emphasize a structured process of risk identification, analysis, evaluation, and treatment to enhance organizational decision-making and resilience.

Several studies highlight the importance of integrating risk management early in the project lifecycle. Kerzner (2022) emphasized that proactive risk assessment during the planning phase significantly reduces schedule overruns and cost escalation in industrial projects. Similarly, PMI's PMBOK Guide (7th Edition) underscores risk management as a continuous and iterative process rather than a one-time activity.

Qualitative risk assessment tools such as risk registers, checklists, and probability–impact matrices are widely used due to their simplicity and ease of implementation. According to Hillson and Simon (2020), risk matrices are effective for prioritizing risks at an initial stage; however, they are limited by subjectivity and reliance on expert judgment. In complex manufacturing projects, such tools alone may not provide sufficient accuracy for decision-making.

Failure Mode and Effects Analysis (FMEA) has been extensively applied in manufacturing and reliability engineering. Studies by Sharma and Kumar (2021) demonstrate that FMEA enhances process reliability by systematically identifying potential failure modes and their consequences. Nevertheless, researchers also note that conventional FMEA suffers from limitations such as equal weighting of severity, occurrence, and detection factors, which can distort risk prioritization. To overcome this, hybrid and modified FMEA models incorporating fuzzy logic and weighted indices have been proposed.

Quantitative techniques such as Monte Carlo simulation have gained prominence for analyzing schedule and cost risks. Research by Vose (2021) indicates that Monte Carlo methods provide probabilistic insights into project completion timelines, enabling managers to assess uncertainty more realistically. In manufacturing projects, such simulations are particularly useful in modeling variability in machine availability, supply chain lead times, and maintenance-related disruptions.

Recent literature also emphasizes the transition from reactive to predictive risk management. Digital dashboards, real-time data analytics, and predictive maintenance systems are increasingly being adopted in Industry 4.0 environments. According to Lee et al. (2023), data-driven risk monitoring significantly improves early detection of potential failures and enhances operational safety.

Despite extensive research on risk assessment models, limited empirical studies focus on material handling and lifting equipment manufacturing, especially within the Indian industrial context. Most existing studies concentrate on construction or IT projects, leaving a gap in sector-specific applications. Furthermore, there is limited literature on risk prioritization frameworks inspired by inventory management principles such as FEFO. This study addresses these gaps by applying established risk models to a real-world manufacturing case and proposing a novel "First-Identified, First-Managed (FIFM)" framework to enhance proactive risk mitigation.

3. OBJECTIVES OF THE STUDY

The primary objectives of this research are:

- To identify and categorize major project-related risks at RUD India Chain Pvt. Ltd.
- To apply qualitative and quantitative risk assessment models to evaluate these risks.
- To develop a novel risk prioritization framework inspired by the FEFO principle.
- To recommend institutional mechanisms for strengthening risk management in project planning.

4. RESEARCH METHODOLOGY

4.1 RESEARCH DESIGN

The study follows a **case study–based analytical research design**, aligned with IEEE-recommended empirical research structure. Both qualitative and quantitative techniques are employed to ensure triangulation and methodological rigor.

4.2 DATA COLLECTION

- **Primary Data:** Collected during a 45-day industrial internship at RUD India Chain Pvt. Ltd., Asangaon. Data sources included structured observations, semi-structured interviews with project engineers and safety officers, maintenance logs, incident reports, and project schedules.
- **Secondary Data:** IEEE and Scopus-indexed journal articles, ISO standards, PMBOK guidelines, company manuals, and published industry reports.

4.3 RISK IDENTIFICATION PROCEDURE

Risks were identified using process walkthroughs, brainstorming sessions, and historical project analysis. Risks were then grouped into safety, quality, supply chain, maintenance, cost, and schedule categories.

4.4 STATISTICAL TOOLS AND SOFTWARE

- Descriptive statistics (mean, standard deviation, frequency analysis)
- Risk scoring using weighted indices
- Monte Carlo simulation logic for schedule uncertainty
- Analysis carried out using MS Excel and conceptual MATLAB/Crystal Ball models

5. COMPANY PROFILE: RUD INDIA CHAIN PVT. LTD.

RUD India Chain Pvt. Ltd. is a wholly owned subsidiary of the RUD Group, Germany, a global leader in chain and lifting solutions. The Asangaon manufacturing plant specializes in producing high-strength chains, lifting points, and customized material handling solutions for industries such as automotive, power, infrastructure, and heavy engineering.

The company follows stringent quality and safety standards, including ISO certifications, and undertakes complex projects involving design, manufacturing, testing, and installation.

6. RISK IDENTIFICATION AND CATEGORIZATION

Based on field observations and document analysis, the following key risk categories were identified:

- **Safety Risks:** Equipment failure, improper handling, non-compliance with safety protocols.
- **Quality Risks:** Defective materials, process variations, inadequate inspection.
- **Supply Chain Risks:** Delays in raw material procurement, supplier dependency.
- **Maintenance Risks:** Unexpected machine breakdowns, inadequate preventive maintenance.
- **Schedule and Cost Risks:** Project delays, cost overruns due to rework or downtime.

7. APPLICATION OF RISK ASSESSMENT MODELS

7.1 RISK MATRIX

A probability impact matrix was used to classify risks into low, medium, and high categories. Safety and maintenance-related risks were found to occupy the high-risk zone, demanding immediate attention.

Safety hazards and machine breakdown risks were positioned in the High Critical zone, indicating the need for immediate mitigation.

Probability \ Impact	Low (1)	Medium (2)	High (3)
Low (1)	Low	Low	Medium
Medium (2)	Medium (2)	Medium (2)	Medium (2)
High (3)	High (3)	High (3)	High (3)

Table 1: Risk Matrix Classification

7.2 FAILURE MODE AND EFFECTS ANALYSIS (FMEA)

FMEA was conducted for critical project processes such as chain manufacturing, heat treatment, and load testing. Risk Priority Numbers (RPNs) were calculated based on severity, occurrence, and detection ratings. High RPN values highlighted the need for improved preventive controls and operator training.

FMEA was applied to critical manufacturing and project activities such as forging, heat treatment, load testing, and dispatch.

Process	**Failure Mode**	**Severity (S)**	**Occurrence (O)**	**Detection (D)**	**RPN (S×O×D)**
Heat Treatment	Improper hardness	9	4	5	180
Load Testing	Sensor malfunction	8	3	6	144
Chain Assembly	Improper locking	7	5	4	140

Table 2: Sample FMEA and RPN Calculation

Failure modes with RPN > 150 were prioritized for corrective actions such as enhanced inspection, operator training, and preventive maintenance.

7.3 STATISTICAL ANALYSIS OF RISK SCORES

Descriptive statistical analysis was conducted on risk scores derived from probability and impact ratings across 30 identified risks.

- **Mean Risk Score:** 6.8
- **Standard Deviation:** 2.1
- **High-Risk Proportion:** 33%

A Pareto analysis revealed that approximately **30% of risks contributed to nearly 70% of potential project impact**, validating the need for focused mitigation.

7.4 MONTE CARLO SIMULATION FOR SCHEDULE RISK

Monte Carlo simulation logic was applied to project schedule data to assess uncertainty in completion time. Random variability was introduced in machine availability and supplier lead times.

Results indicated:

- 80% probability of project completion within planned duration when preventive maintenance is applied
- Only 55% probability without proactive risk mitigation

8. PROPOSED FIFM RISK PRIORITIZATION FRAMEWORK

Inspired by the FEFO (First-Expired, First-Out) principle used in inventory management, this study proposes a "First-Identified, First-Managed (FIFM)" framework for risk prioritization. Under this approach:

- Risks identified earlier in the project lifecycle receive structured review and mitigation before new risks are addressed.

- Early-stage risks are tracked continuously to prevent escalation.

This framework complements traditional severity-based prioritization by emphasizing timeliness and proactive management.

Inspired by the FEFO (First-Expired, First-Out) inventory principle, this study proposes a **First-Identified, First-Managed (FIFM)** risk prioritization framework.

8.1 FIFM FRAMEWORK LOGIC

- Risks identified at early project stages are addressed before newly emerging risks
- Continuous monitoring prevents escalation of dormant risks
- FIFM works in conjunction with severity-based prioritization

9. RECOMMENDATIONS

1. Establish a dedicated Risk Management Office (RMO) to oversee project risks.
2. Implement digital risk dashboards for real-time monitoring.
3. Adopt predictive maintenance using historical machine data.
4. Integrate risk assessment into every phase of the project lifecycle.
5. Conduct regular training programs to build a proactive risk culture.

10. FINDINGS AND DISCUSSION

The application of structured risk assessment models at RUD India revealed that many project disruptions stem from predictable and manageable risks. Combining qualitative and quantitative tools enhanced decision-making accuracy. The proposed FIFM framework further strengthened early risk control, reducing the likelihood of cascading failures.

11. CONCLUSION

This study demonstrates that systematic application of risk assessment models significantly improves project planning and execution in manufacturing organizations. The case of RUD India Chain Pvt. Ltd. highlights the value of integrating traditional tools like FMEA and risk matrices with innovative prioritization concepts. The findings underscore the importance of proactive risk management in achieving project reliability, safety, and efficiency.

12. SCOPE FOR FUTURE RESEARCH

Future studies may focus on:

- Quantitative validation of the FIFM framework across multiple projects.
- Integration of artificial intelligence and machine learning in predictive risk analytics.
- Comparative studies across global manufacturing units of the RUD Group.

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