Lecture 15 – Risk Assessment Methodologies

Student Notes

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Introduction to Risk Assessment Methodologies

Risk assessment is a fundamental practice in occupational health and safety (OHS), forming the backbone of proactive risk management in workplaces. It is a systematic process used to identify hazards, evaluate risks, and determine appropriate control measures to eliminate or reduce the likelihood of harm. By conducting risk assessments, organisations can enhance workplace safety, comply with legal requirements, and prevent incidents that may lead to injuries, illnesses, or financial losses.

Risk assessment methodologies vary in complexity and application, ranging from simple qualitative methods based on expert judgement to sophisticated quantitative models that utilise statistical analysis. The choice of methodology depends on several factors, including:

- The nature of workplace hazards (e.g., chemical, physical, ergonomic, psychosocial risks).

- The level of detail required (e.g., basic hazard identification vs. in-depth probabilistic modelling).

- Regulatory and legal obligations (e.g., specific industry standards that mandate certain risk assessment techniques).

- Operational and business needs (e.g., time, resources, and expertise available).

As briefly discussed in Lecture 8 Student Notes (Sections 1.2.2 and 1.6), risk assessments play a crucial role in developing a structured approach to hazard identification and control. Section 1.2.2 introduced the general concept of risk assessments, while Section 1.6 focused on Risk Profiling and Identification, which is an essential step in understanding and categorising workplace risks. This lecture builds on those foundations by examining specific risk assessment methodologies in greater detail.

A thorough understanding of various methodologies allows organisations to select the most suitable approach for their industry and operational context, ensuring that risks are systematically assessed and effectively managed. This contributes to a safer and healthier working environment while supporting regulatory compliance and continuous improvement.

Legal Frameworks for Risk Assessment

Risk assessment is not only a best practice in occupational health and safety (OHS) but also a legal obligation under both UK and EU health and safety legislation. Employers have a duty to systematically evaluate workplace hazards and implement measures to control risks, ensuring the health, safety, and welfare of workers and other affected parties.

The legal frameworks governing risk assessment establish clear responsibilities for employers, managers, and workers, emphasising the importance of proactive risk management. These regulations require risk assessments to be suitable and sufficient, meaning they must:

- Identify all foreseeable hazards.

- Assess who may be harmed and how.

- Evaluate the likelihood and severity of harm occurring.

- Implement appropriate control measures to reduce risks.

- Be reviewed and updated regularly, especially when changes occur.

📜 EU & Maltese Legislation

In the European Union (EU) and Malta, risk assessment requirements are embedded within key legal instruments:

✅ Framework Directive 89/391/EEC – This is the cornerstone of EU occupational health and safety law. It places a general duty on employers to:

- Conduct risk assessments to identify workplace hazards.

- Take preventive measures based on the hierarchy of controls.

- Consult and inform workers about risks and safety procedures.

- Ensure continuous monitoring and review of risk assessments.

✅ Maltese Occupational Health and Safety Authority Act (CAP. 646) – This legislation transposes EU directives into Maltese national law, requiring employers to:

- Assess workplace risks in accordance with EU safety principles.

- Implement control measures to mitigate identified hazards.

- Maintain documentation of risk assessments.

- Provide training and information to workers on occupational risks.

Failure to comply with these obligations may result in legal penalties, enforcement actions, and reputational damage.

📜 UK Legislation

In the United Kingdom, risk assessment is a statutory requirement under primary and secondary legislation:

✅ Health and Safety at Work etc. Act 1974 (HSWA) – This is the primary piece of health and safety legislation in the UK. It imposes a general duty on employers to:

- Ensure the health, safety, and welfare of employees and others.
- Identify and assess workplace risks as part of their duty of care.
- Implement reasonably practicable measures to control risks.

✅ Management of Health and Safety at Work Regulations 1999 (MHSWR) – These regulations expand on the HSWA by providing a structured framework for risk assessments. Employers must:

- Conduct a systematic risk assessment for all work activities.
- Record significant findings, particularly for businesses with five or more employees.
- Appoint competent persons to oversee health and safety.
- Implement control measures following the hierarchy of risk control.
- Review and update risk assessments to ensure their effectiveness.

Non-compliance with these laws can lead to prosecution, fines, and even imprisonment under the Health and Safety Executive (HSE) enforcement powers.

Conclusion

The legal frameworks for risk assessment in both EU/Maltese and UK law are designed to ensure a consistent, proactive approach to workplace safety. Employers must conduct thorough and ongoing risk assessments, integrating them into day-to-day operations to maintain compliance and protect workers from harm.

These regulations not only mandate legal compliance but also promote a culture of risk awareness and prevention, ultimately fostering a safer working environment for all.

Types of Risk Assessment Methodologies

Different industries employ various risk assessment methodologies, depending on the nature of hazards, the level of detail required, and the complexity of the work environment. These methodologies range from simple qualitative assessments to sophisticated quantitative models that use statistical analysis. The choice of methodology is influenced by:

- The type of hazards present (e.g., physical, chemical, ergonomic).

- The precision required (e.g., broad risk categorisation vs. detailed probability calculations).

- Regulatory and industry-specific requirements.

- Available resources and expertise.

The table below outlines common risk assessment methodologies, their descriptions, and the industries or scenarios where they are best applied.

Common Risk Assessment Methodologies

Methodology	Description	Best For
Qualitative Risk Assessment	A subjective and descriptive evaluation of risks, often using simple categories such as Low/Medium/High. It relies on expert judgement and past experience rather than numerical data.	Office environments, administrative settings, and low-risk workplaces where a general risk overview is sufficient.
Semi-Quantitative Risk Assessment	Uses numerical scales to assign likelihood and severity scores (e.g., a 5x5 risk matrix). This approach provides more structure than qualitative methods while remaining accessible to organisations without advanced analytical tools.	Warehousing, construction, manufacturing, and general industry, where a more structured yet straightforward risk ranking is beneficial.
Quantitative Risk Assessment (QRA)	Employs statistical models, real-world data, and probability calculations to numerically measure risks. This approach is data-driven	High-risk industries such as oil & gas, chemical processing, nuclear energy, and aviation, where exact risk measurements are required

Methodology	Description	Best For
	and allows for precise risk evaluation.	for compliance and operational safety.
Job Safety Analysis (JSA) / Task-Based Risk Assessment	Breaks individual tasks into specific steps, identifying hazards at each stage and specifying control measures. It focuses on human factors, procedural errors, and task-specific risks.	Workshops, manufacturing, maintenance activities, and fieldwork, where detailed task-based risk control is necessary.
Hazard and Operability Study (HAZOP)	A systematic review of potential process deviations using structured guidewords (e.g., "More," "Less," "Reverse") to identify risks in complex systems.	Chemical plants, oil & gas, pharmaceuticals, and other process-intensive industries, where deviations from normal operations can have serious safety implications.
Failure Modes and Effects Analysis (FMEA)	Assesses failure risks in systems, components, or processes, assigning severity, likelihood, and detection scores to prioritise mitigation actions.	Manufacturing, engineering, automotive, aerospace, and medical device industries, where reliability and failure prevention are critical.

Conclusion

The selection of a risk assessment methodology should align with the organisation's risk profile, operational complexity, and regulatory requirements. While qualitative and semi-quantitative methods provide quick and accessible insights, quantitative techniques offer detailed risk probability data for high-risk environments. Additionally, task-based and system-oriented methodologies, such as JSA, HAZOP, and FMEA, enable industries to pinpoint and mitigate risks at a granular level.

A well-chosen risk assessment methodology ensures that workplace hazards are effectively identified, evaluated, and controlled, contributing to a safer and more resilient working environment.

The Five Steps to Risk Assessment

A structured and systematic approach to risk assessment is essential for ensuring workplace safety. According to the UK Health and Safety Executive (HSE), risk assessments should follow five key steps to effectively identify, evaluate, and control risks in the workplace. These steps help organisations comply with legal obligations and maintain a proactive safety culture.

Step 1: Identify Hazards

The first step in any risk assessment is to recognise and document workplace hazards. A hazard is anything with the potential to cause harm, and these can be classified into various categories:

- **Physical hazards** – Machinery, noise, vibration, working at height, slips and trips.

- **Chemical hazards** – Exposure to toxic, flammable, or corrosive substances.

- **Biological hazards** – Viruses, bacteria, fungi, and other pathogens.

- **Ergonomic hazards** – Poor workstation design, repetitive movements, manual handling risks.

- Psychosocial hazards – Work-related stress, bullying, and violence.

To ensure a comprehensive hazard identification process, organisations should use a combination of workplace inspections, employee feedback, incident reports, and historical data.

Step 2: Determine Who Might Be Harmed and How

Once hazards are identified, the next step is to assess who may be at risk and in what way. This includes considering:

- Employees – Full-time, part-time, temporary, and agency workers.

- Visitors and contractors – External personnel working on-site.

- Vulnerable groups – Pregnant workers, young workers, those with disabilities or pre-existing conditions.

- Public and customers – If hazards extend beyond the workplace.

For each hazard, it is important to identify the possible consequences, such as injuries, illnesses, or long-term health effects.

Step 3: Evaluate Risks and Decide on Controls

After identifying who may be harmed, the next step is to assess the level of risk and decide on appropriate control measures. Risk evaluation typically involves:

- Determining the likelihood of harm occurring.

- Assessing the severity of potential harm.

- Prioritising risks based on urgency and impact.

Control measures should follow the hierarchy of risk control:

1. Elimination – Remove the hazard entirely (e.g., replacing a dangerous chemical with a safer alternative).

2. Substitution – Use a less hazardous process or material.

3. Engineering controls – Implement physical changes such as machine guards or ventilation.

4. Administrative controls – Introduce training, safe work procedures, and job rotation.

5. Personal Protective Equipment (PPE) – Use as a last resort when other controls are insufficient.

Step 4: Record Findings and Implement Controls

A written record of the risk assessment must be kept, especially if the organisation has five or more employees (as required by UK law). Documentation should include:

- The hazards identified.

- Who is at risk.

- The control measures in place.

- Any further actions required.

- The person responsible for implementation.

Once documented, control measures must be effectively implemented, ensuring that workers are informed, trained, and equipped to follow safe practices.

Step 5: Review and Update as Necessary

Risk assessments should not be a one-time process but must be reviewed and updated regularly to reflect:

- Changes in the workplace (e.g., new equipment, processes, or layouts).

- New hazards identified through incidents, near-misses, or worker feedback.

- Regulatory updates or changes in legal requirements.

- Effectiveness of control measures based on monitoring and evaluation.

Employers should set a review schedule and encourage a culture of continuous improvement in risk management.

Qualitative Risk Assessment

Overview

A **Qualitative Risk Assessment** is a **descriptive approach** to evaluating workplace risks. It relies on **expert judgment, experience, and observations** rather than numerical data to assess the likelihood and severity of potential hazards. This method is widely used in **low- to medium-risk environments** where precise quantification is unnecessary or impractical.

A qualitative assessment provides a **general ranking of risks**, often using **simple categories** such as:

- **Low, Medium, or High** risk.
- **Minor, Moderate, or Severe** consequences.
- **Unlikely, Possible, or Likely** likelihood levels.

The primary objective of qualitative risk assessment is to **prioritise risks** and implement **effective control measures** without requiring extensive data collection or statistical analysis.

When to Use Qualitative Risk Assessment

A **qualitative approach** is best suited for:

✅ **Low-risk environments** – Office spaces, administrative workplaces, and small retail businesses.

✅ **Preliminary assessments** – When an initial, broad risk evaluation is required before applying more detailed methods.

✅ **Limited data availability** – When historical data, failure rates, or statistical information are unavailable or impractical to obtain.

✅ **Regulatory compliance** – Meeting legal requirements for risk assessments without needing in-depth numerical analysis.

Key Features of Qualitative Risk Assessment

1. **Subjective Evaluation** – Based on expert judgment, worker experience, and workplace observations rather than empirical data.
2. **Descriptive Risk Ratings** – Risks are categorised using descriptive scales, such as "Low, Medium, High," or colour-coded matrices (e.g., green, amber, red).

3. **Simple Risk Matrix Application** – A **risk matrix** (often **3x3** or **5x5**) is commonly used to rank risks based on:

   a. **Likelihood** of occurrence (e.g., Rare, Unlikely, Possible, Likely, Certain).

   b. **Severity** of consequences (e.g., Insignificant, Minor, Moderate, Major, Catastrophic).

4. **Quick and Cost-Effective** – Does not require advanced tools or statistical expertise, making it accessible for small to medium-sized businesses.

5. **Decision-Making Support** – Helps organisations prioritise risks and implement appropriate control measures.

How to Conduct a Qualitative Risk Assessment

A qualitative risk assessment typically follows these **steps**:

Step 1: Identify Hazards

- Conduct **workplace inspections** and review past incidents.

- Engage workers in **hazard identification discussions**.

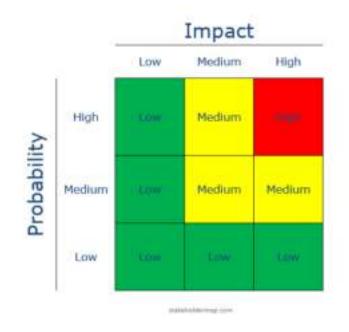- Consider **physical, chemical, biological, ergonomic, and psychosocial hazards**.

Step 2: Assess Who Might Be Harmed and How

- Identify **employees, contractors, visitors, and vulnerable groups** who may be exposed to risks.

- Consider **potential injury types**, such as slips, falls, repetitive strain injuries, or stress-related issues.

Step 3: Evaluate Risks Using a Risk Matrix

- Assign a **likelihood rating** (e.g., Rare, Unlikely, Likely, Almost Certain).

- Assign a **severity rating** (e.g., Minor, Moderate, Major, Catastrophic).

- Cross-reference these values in a **risk matrix** to determine **risk levels** (e.g., Low, Medium, High).

Example of a 3x3 Risk Matrix:

Step 4: Determine and Implement Control Measures

- Apply the **Hierarchy of Control**:
  - ✅ **Eliminate the hazard** (preferred approach).
  - ✅ **Substitute safer alternatives**.
  - ✅ **Use engineering controls** (e.g., machine guards).
  - ✅ **Implement administrative controls** (e.g., training, safe work procedures).
  - ✅ **Provide PPE as a last resort**.

Step 5: Record and Review Findings

- **Document significant risks and control measures**.

- **Monitor** the effectiveness of control measures.

- **Review and update** assessments as workplace conditions change.

Advantages of Qualitative Risk Assessment

✓ **Simple and Quick** – Easy to apply without complex calculations.

✓ **Cost-Effective** – Does not require specialised risk modelling tools.

✓ **Supports Decision-Making** – Helps prioritise risk control actions.

✓ **Applicable to a Broad Range of Workplaces** – Suitable for general industry settings.

Limitations of Qualitative Risk Assessment

❌ **Subjectivity** – Relies on experience and judgement, which may lead to inconsistencies.

❌ **Limited Precision** – Lacks numerical accuracy for complex, high-risk industries.

❌ **Difficult to Compare Across Sites** – Descriptive categories may vary between organisations.

Conclusion

A Qualitative Risk Assessment is a practical and widely used method for evaluating workplace risks in low- to medium-risk settings. By using expert judgment and a structured risk matrix, organisations can effectively identify hazards, prioritise risks, and implement necessary controls. While simple and cost-effective, qualitative assessments may lack the precision needed for high-risk environments, where semi-quantitative or quantitative methods are preferred.

For many workplaces, qualitative risk assessment serves as an essential first step in ensuring a safe and compliant working environment.

Key Features of Semi-Quantitative Risk Assessment

1. **Numerical Risk Scoring** – Assigns numbers to different risk factors (e.g., **likelihood 1-5, severity 1-5**).
2. **Structured Risk Ranking** – More **objective and repeatable** than qualitative methods.
3. **5x5 Risk Matrix Application** – A common tool used to **systematically score risks**.
4. **Balances Simplicity and Detail** – Less complex than **quantitative risk assessments** but **more precise than qualitative**.
5. **Prioritisation of Risks** – Helps in decision-making for risk control implementation.

How to Conduct a Semi-Quantitative Risk Assessment

A **semi-quantitative assessment** follows the same **five-step process** as a general risk assessment but introduces **numerical scoring** for better accuracy.

Step 1: Identify Hazards

- **Physical hazards** – Equipment, machinery, falls, noise.

- **Chemical hazards** – Hazardous substances, toxic fumes.

- **Ergonomic hazards** – Manual handling, repetitive movements.

- **Psychosocial hazards** – Workload stress, harassment.

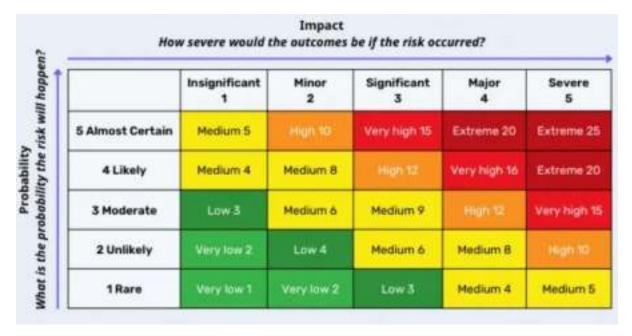**Step 2: Determine Who Might Be Harmed and How**

- Identify affected **employees, contractors, visitors, and vulnerable individuals**.

- Consider the **potential consequences** for each group.

Step 3: Evaluate Risks for Example Using a 5x5 Risk Matrix

A **5x5 risk matrix** is commonly used, assigning scores to:

- **Likelihood** (How often the hazard may result in harm).

- **Severity** (The impact if harm occurs).

- **Risk Level** (The overall risk score).

5×5 Risk Matrix Example

Color-coding is crucial for a 5×5 risk assessment matrix template to represent the combination level of probability and impact of the identified risks. That said, high risks must be in red, moderate risks in yellow (amber), and low risks in green. Organizations, EHS professionals, and project managers can then use other closely-related colors, such as orange, light red, and light green, to differentiate the specific risk ratings.

A 5×5 risk matrix also aims to answer the question "What are the 5 risk rating levels in the risk assessment matrix?" A 5×5 risk matrix has two axes, or components to put it simply, that make up the whole table or grid: the Probability and the Impact. Under the two are 5 risk rating levels used to calculate risks.

Probability

Also called likelihood, the Probability (x-axis) pertains to the extent of how likely it is for the risk to occur. The 5 risk rating levels under this component are as follows:

1. **Rare** – unlikely to happen and/or have minor or negligible consequences

2. **Unlikely** – possible to happen and/or to have moderate consequences

3. **Moderate** – likely to happen and/or to have serious consequences

4. **Likely** – almost sure to happen and/or to have major consequences

5. **Almost certain** – sure to happen and/or have major consequences

Impact

Also called severity or consequences, the Impact (y-axis) aims to determine the level of effects that the hazard can cause to workplace health and safety.

While a 5×5 risk matrix can be tailored to the needs of an organization, the following represent the general terms used to describe the 5 levels to determine the risk's impact:

1. **Insignificant** – won't cause serious injuries or illnesses

2. **Minor** – can cause injuries or illnesses, only to a mild extent

3. **Significant** – can cause injuries or illnesses that may require medical attention but limited treatment

4. **Major** – can cause irreversible injuries or illnesses that require constant medical attention

5. **Severe** – can result in fatality

Each risk box represents the rating of a risk that is calculated based on its particular levels of probability and impact. In most cases, the 5×5 risk matrix uses numeric values to better represent the risk ratings.

Calculating Risks Using the 5×5 Risk Matrix

Probability x Impact = Risk Level

The first step is to assign a numeric value from 1 to 5, 1 being the lowest, for each of the categories under Probability and Impact. Then, use the formula of multiplying the value of the Probability to the value of Impact to determine the Risk Level.

To better understand how the various levels indicate the Probability and Impact, here's a guide on the numeric values and their representation as a result of the analysis:

- **1-4: Acceptable** – no further action may be needed and maintaining control measures is encouraged

- **5-9: Adequate** – may be considered for further analysis

- **10-16: Tolerable** – must be reviewed in a timely manner to carry out improvement strategies

- **17-25: Unacceptable** – must implement cease in activities and endorse for immediate action

Step 4: Implement Control Measures

- Apply the **Hierarchy of Control** to reduce risk.

- Document controls in **risk assessment records**.

Hierarchy of Controls

Most Effective	Elimination	Physically remove the hazard
	Substitution	Replace the hazard
	Isolation	Isolate people from the hazard
	Engineering Controls	Engineer out the hazard
Least Effective	PPE	Protect the worker with personal protective equipment

Step 5: Review and Update

- **Monitor effectiveness** of controls.

- **Review assessments regularly** or when workplace conditions change.

Advantages of Semi-Quantitative Risk Assessment

✓ **More structured than qualitative methods** – Provides numerical justification.

✓ **Quick and practical** – Easier to apply than full quantitative models.

✓ **Supports prioritisation** – Helps focus on high-risk areas.

✓ **Easier to communicate** – Risk matrices and numerical scores make results clear.

Limitations of Semi-Quantitative Risk Assessment

✖ **Still involves subjectivity** – Risk scoring depends on expert judgment.

✖ **Not precise enough for highly complex hazards** – Lacks full probability analysis.

✖ **May oversimplify complex risks** – Some hazards require more detailed examination.

Conclusion

A Semi-Quantitative Risk Assessment provides a balanced approach to evaluating workplace risks. It is more structured and precise than qualitative methods, yet simpler and more practical than full quantitative analysis. Using numerical scores and risk matrices, this method allows organisations to prioritise hazards, apply effective controls, and maintain compliance with safety regulations.

This approach is widely used across industries for moderate- to high-risk environments, helping businesses maintain a safe and well-controlled workplace.

Quantitative Risk Assessment (QRA)

Overview

A **Quantitative Risk Assessment (QRA)** is a data-driven method used to evaluate risks using numerical values, statistical models, and probability analysis. Unlike qualitative or semi-quantitative methods, which rely on broad categorisations or scoring systems, QRA provides precise numerical estimates of risk, making it essential for high-risk industries and complex hazard assessments.

This method is widely used for hazards that require accurate measurement and detailed modelling, such as:

- **Noise exposure** – Measured in **decibels (dB)** to assess hearing damage risks.

- **Chemical exposure** – Analysed using **concentration limits and toxicological data**.

- **Airborne particles** – Evaluated through **particulate concentration (e.g., PM2.5, PM10)** and respiratory exposure models.

- **Heat stress** – Measured using **Wet Bulb Globe Temperature (WBGT)** or physiological strain indices.

When to Use Quantitative Risk Assessment

✅ **High-risk industries** – Oil & gas, chemical plants, aviation, nuclear energy.
✅ **Exposure monitoring** – Noise, hazardous substances, radiation, heat stress.
✅ **Regulatory compliance** – Industries requiring precise documentation (e.g., COSHH, COMAH, OSHA).
✅ **Complex scenarios** – When a detailed probabilistic model is needed.

Key Features of QRA

1. **Probability-Based Approach** – Uses historical failure rates and statistical models to calculate risk.
2. **Numerical Risk Metrics** – Includes:

    a. **Fatal Accident Rate (FAR)** – Expected deaths per 100 million hours worked.

    b. **Potential Loss of Life (PLL)** – Estimated fatalities over a given period.

    c. **Dose-Response Relationships** – Predicts health impacts from chemical or noise exposure.

3. **Monte Carlo Simulations** – Used to **model uncertainty and variability** by running thousands of potential scenarios to estimate probable outcomes.
4. **Consequence Modelling** – Predicts outcomes of hazardous events using:

    a. **Explosion radius calculations**.

    b. **Toxic gas dispersion modelling**.

    c. **Heat stress and physiological response analysis**.

5. **Objective & Reliable** – Data-driven results that are repeatable and precise.

QRA Process (Simplified)

Step 1: Hazard Identification

- Identify potential failures (e.g., equipment breakdown, toxic exposure).

Step 2: Frequency Analysis

- Use **historical data and failure rates** to estimate likelihood.

Step 3: Consequence Analysis

- Model potential harm using **dose-response data, explosion modelling, or heat stress indices**.

Step 4: Risk Calculation

- **Risk = Likelihood × Consequence Severity**
- Compare to **acceptable risk criteria** (e.g., ALARP principle).

Step 5: Implement Risk Reduction Measures

- Apply engineering controls, process changes, and safety measures.

Step 6: Review and Update

- Monitor data and update models as conditions change.

Advantages of QRA

✓ **Precise and data-driven** – Reduces uncertainty.

✓ **Ideal for complex hazard assessment** – Used for noise, chemicals, heat stress, and airborne particles.

✓ **Regulatory compliance** – Meets high-level safety requirements.

✓ **Decision-making support** – Helps allocate safety resources effectively.

Limitations of QRA

❌ **Complex and resource-intensive** – Requires expertise and computational models.

❌ **Dependent on data quality** – Inaccurate data can affect results.

❌ **Not practical for low-risk workplaces** – Overly detailed for simple risk assessments.

Conclusion

Quantitative Risk Assessment (QRA) is essential for high-risk industries and hazards that require precise exposure measurement, such as noise, chemicals, airborne particles, and heat stress. It uses statistical modelling, Monte Carlo simulations, and consequence analysis to provide accurate risk predictions, ensuring better decision-making and compliance with stringent safety regulations. While resource-intensive, it remains the gold standard for assessing complex risks in hazardous environments.

Specialised Risk Assessment Techniques

In addition to general risk assessment methodologies, certain industries and workplaces require **specialised risk assessment techniques** to address complex and specific hazards. These methods are used in high-risk environments where a structured, in-depth analysis is necessary to prevent failures, improve safety, and enhance operational efficiency.

Below are examples of three specialised risk assessment techniques, applied in different industrial settings.

Job Safety Analysis (JSA)

Job Safety Analysis (JSA) is a task-based risk assessment method that breaks down work activities into specific steps to systematically identify hazards and implement controls.

- ◆ **Application Example: Steel Fabrication Workshop**

📌 **Task Steps:**

1. Preparation of steel materials.

2. Cutting steel beams.

3. Welding components.

4. Inspecting the finished structure.

📌 **Hazards Identified:**

- **Flying sparks** – Risk of burns and fire.

- **Fume inhalation** – Exposure to metal fumes from welding.

- **UV radiation from welding** – Risk of eye damage (arc eye).

📌 **Control Measures:**

✓ **Personal Protective Equipment (PPE):** Welding helmets, gloves, flame-resistant clothing.

✓ **Ventilation and Fume Extraction:** Local exhaust ventilation (LEV) to remove hazardous fumes.

✓ **Fire-Resistant Barriers:** Fire blankets and screens to prevent fire hazards.

✓ **Safe Work Procedures:** Proper training on welding safety and emergency response.

◆ **Why JSA?**

JSA is particularly effective in **manufacturing and workshop environments**, where **task-specific risks** must be carefully analysed to ensure safe work practices.

Hazard and Operability Study (HAZOP) – Chemical Mixing Tank

A HAZOP (Hazard and Operability Study) is a structured and systematic approach for identifying process deviations and potential hazards in chemical and industrial systems. It uses guidewords (e.g., "No," "More," "Less") to examine what could go wrong in a process.

◆ **Application Example: Chemical Mixing Tank**

📌 **Guideword Analysis Example:**

🔍 **"No Flow"** → Water pump failure → Overheating → Explosion risk.

📌 **Control Measures:**

✓ **Redundant Pumps:** Backup systems in case of failure.
✓ **Automatic Shutoff Systems:** To prevent overheating and pressure build-up.
✓ **Temperature & Pressure Sensors:** Early warning mechanisms to detect deviations.
✓ **Regular Maintenance & Testing:** Preventative checks to ensure system integrity.

◆ **Why HAZOP?**

This method is widely used in **chemical plants, refineries, and industrial processing facilities**, where **small process failures can lead to catastrophic consequences**.

Failure Modes and Effects Analysis (FMEA) – Hydraulic Press Machine

Failure Modes and Effects Analysis (FMEA) is a systematic approach to identify potential failure modes, evaluate their impact, and determine preventive actions. It is widely used in engineering, manufacturing, and quality control to improve equipment reliability.
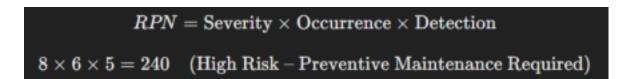
◆ **Application Example: Hydraulic Press Machine**

📌 **Failure Mode Identified:**

- **Loss of hydraulic pressure.**

📌 **Effects of Failure:**

- Machine stoppage.

- Potential worker injuries (due to uncontrolled movement or falling loads).

📌 **Risk Assessment Scoring:**

- **Severity Score:** 8 (Serious injury potential).

- **Occurrence Score:** 6 (Moderate likelihood of failure).

- **Detection Score:** 5 (Failure might not be detected immediately).

- **Risk Priority Number (RPN):**

$$RPN = Severity \times Occurrence \times Detection$$

$$8 \times 6 \times 5 = 240 \quad (High\ Risk - Preventive\ Maintenance\ Required)$$

📌 **Control Measures:**

✓ **Preventive Maintenance Program:** Regular hydraulic fluid checks and pressure testing.

✓ **Pressure Sensors & Alarms:** Early warning system for pressure loss.

✓ **Emergency Stop Mechanism:** Immediate shutdown to prevent injury.

◆ **Why FMEA?**

FMEA is **highly effective in industrial machinery and automotive sectors**, where **identifying and mitigating failure modes can prevent costly breakdowns and serious injuries**.

Conclusion

Each of these specialised risk assessment techniques serves a unique purpose:

- **JSA** is effective for **task-based hazards** in **workshops and manual operations**.

- **HAZOP** is ideal for **complex industrial processes** where **small deviations can lead to serious consequences**.

- **FMEA** is widely used in **engineering, manufacturing, and maintenance** to **prevent equipment failures and improve system reliability**.

By selecting the appropriate risk assessment technique, organisations can enhance safety, improve operational efficiency, and prevent costly incidents in their respective industries.

Reviewing & Updating Risk Assessments

Risk assessments are not static documents—they must be regularly reviewed and updated to ensure they remain effective, relevant, and compliant with legal and industry standards. ISO 45001:2018, the international standard for Occupational Health & Safety Management Systems (OHSMS), emphasises the need for continuous improvement in risk assessment processes.

ISO 45001 specifically requires organisations to:

✓ **Monitor and review** hazards and risks regularly.

✓ **Ensure that risk controls remain effective** over time.

✓ **Take proactive steps** to prevent incidents through a systematic approach.

✓ **Engage workers** in the risk assessment review process.

Failure to keep risk assessments updated can lead to **uncontrolled hazards, non-compliance with safety regulations, and increased accident risks**.

When to Review a Risk Assessment?

A risk assessment should be reviewed under the following conditions:

1. **After an Incident or Near Miss**

    1. Any accident, injury, or near miss suggests that existing controls may be inadequate.

    2. A full root cause analysis should be conducted, and the risk assessment updated accordingly.

2. **When Work Conditions Change**

    1. Introduction of new machinery, chemicals, or work processes.

    2. Changes in workforce, shift patterns, or job roles.

    3. Modifications to work environments (e.g., new workstations, site expansions).

3. **If New Hazards Emerge**

    1. Introduction of new technologies, substances, or ergonomic risks.

    2. Psychological hazards, such as increased stress or workplace violence.

    3. Environmental changes (e.g., exposure to extreme temperatures, noise, or airborne contaminants).

4. **Following Regulatory, Industry Standard, or ISO 45001 Updates**

   1. Changes in UK and EU health & safety laws (e.g., HSE, COMAH, COSHH).

   2. Updates to ISO 45001:2018 requirements, which emphasise proactive hazard identification and risk control.

5. **At Predefined Intervals (Routine Review)**

   1. Even without workplace changes, ISO 45001 and best practices recommend reviewing risk assessments at least annually.

   2. High-risk environments (e.g., construction, chemical plants) may require more frequent reviews.

🛠 **How to Review and Update a Risk Assessment?**

✅ **Re-examine Identified Hazards** – Are all hazards still relevant? Have new ones emerged?

✅ **Assess the Effectiveness of Current Control Measures** – Are they reducing risk as expected?

✅ **Engage Workers & Supervisors** – Involve employees in discussions about safety concerns.

✅ **Update Risk Scores & Documentation** – Adjust likelihood/severity ratings if conditions have changed.

✅ **Implement Additional Controls if Necessary** – Strengthen safety measures where risks remain high.

✅ **Communicate Changes** – Ensure workers are trained and informed about **updated risk assessments**.

Further Reading & Resources

For a deeper understanding of **risk assessment methodologies, legal frameworks, and best practices**, the following resources provide valuable insights:

📌 **EU-OSHA Guide on Risk Assessments** – A comprehensive guide from the European Agency for Safety and Health at Work (EU-OSHA) on conducting effective workplace risk assessments. https://oira.osha.europa.eu/en/what-is-risk-assessment

📌 **HSE UK: Five Steps to Risk Assessment** – The UK Health and Safety Executive's (HSE) official guide outlining the **step-by-step approach** to risk assessment and control measures. https://www.hse.gov.uk/simple-health-safety/risk/

📌 **ISO 31010:2019 – Risk Assessment Techniques** – This international standard provides an in-depth review of various risk assessment methodologies, including qualitative, semi-quantitative, and quantitative techniques. It serves as a guideline for risk evaluation across industries.

📌 **HAZOP: Guide to Best Practice, 3rd Edition** – By Frank Crawley & Brian Tyler, this book provides expert guidance on implementing Hazard and Operability Studies (HAZOP). It includes real-world examples, best practices, and updated methodologies for conducting effective risk assessments in process industries.

📌 **Failure Mode and Effect Analysis: FMEA From Theory to Execution** – By D.H. Stamatis, this book offers an in-depth theoretical and practical guide on implementing Failure Mode and Effect Analysis (FMEA) across industries. It covers system, design, process, service, and machine FMEAs, with tools such as FMEA forms, sample guidelines, and design review checklists. This is an essential resource for professionals in quality assurance, reliability engineering, and process improvement.