

University of Wales Trinity Saint David

Wales Institute of Art and Science



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Root Cause Analysis – Technical Report

Engineering Application & Study Skills (ACMA 4039)

Laith Hazell

2511919

November 2025

Table of Contents

1	INTRODUCTION	2
2	LITERATURE REVIEW.....	3
2.1	RISK MANAGEMENT IN ENGINEERING	3
2.2	LEGAL COMPLIANCE AND LEGISLATION ALIGNMENT.....	4
2.3	PROFESSIONAL CODES AND STANDARDS	4
2.4	THE ROLE OF RCAs IN MANUFACTURING RISK MANAGEMENT	5
3	METHODOLOGY	7
4	RESULTS AND JUSTIFICATION OF RCA FINDINGS	8
4.1	RCA RESULTS SUMMARY.....	8
		9
4.2	RISK PRIORITY NUMBER SCORE AND METRICS COMPARISON	10
5	CONCLUSION	12
6	BIBLIOGRAPHY.....	13
7	APPENDICES	14

1 Introduction

Effective risk management is the cornerstone of every engineering sector, especially manufacturing. Organisations are legally and morally obliged to carry out risk management assessments to ensure personnel safety. Failure to act increases incidents, compromising welfare, workflow, and finances.

Engineers employ effective, problem-solving methods, such as Root Cause Analysis (RCA), to proactively identify and eliminate underlying causes rather than reacting to consequences. An apperceptive approach allows employers to navigate problems more effectively.

This report aims to explore root cause analysis in managing safety risks in the manufacturing sector. The objectives are to:

- Analyse legislation, standards, and professional codes relevant to engineering safety.
- Apply RCA to a personal case study and justify corrective actions
- Evaluate the effectiveness of RCA using measurable outcomes

2 Literature Review

2.1 Risk Management in Engineering

Manufacturing and associated fields require effective risk management strategies due to the potential hazards in the industry. Policies vary between sectors but share common criteria for accidents.

According to (Innova Search, 2025), there are approximately 2.5 million workers in this field. In the past 5 years alone, there have been an average of 22 fatalities per year, alongside 3,100 major injuries and 4,100 reports of injuries that led to workers requiring more than 7 days from work. These figures highlight that accidents occur despite updated legislation.

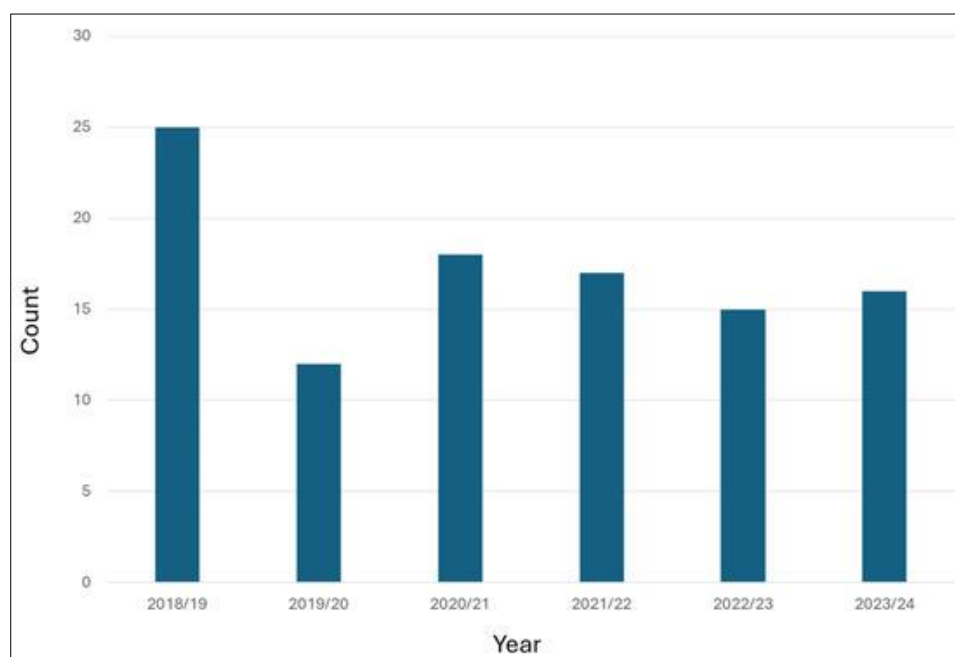


Figure 1 - Fatal Accidents in the UK Manufacturing Sector (Health and Safety Executive, 2025)

Risk assessments prevent major incidents and address underlying causes early. Many health conditions can be “caused or made worse by work and working environments”, as emphasised by (Health and Safety Executive, 2025), demonstrating that mandatory procedures, like RCAs, are necessary to mitigate new problems and eliminate advancing issues.

2.2 Legal Compliance and Legislation Alignment

Injury and fatality reports demonstrate the need for essential guidelines. Primary legislation, the Health and Safety at Work etc. Act 1974 touches upon fundamentals “designed to maintain or improve the standards of health, safety and welfare established by or under those enactments” as dissected by (The National Archives, 2015).

Enforcing regulations ensures legal compliance. Key legislation, such as Provision and Use of Work Equipment Regulations (PUWER), Reporting of Injury, Disease and Dangerous Occurrences Regulations (RIDDOR), Control of Substances Hazardous to Health (COSHH) and Lifting Operations and Lift Equipment Regulations (LOLER), etc., should be effectively administered. Any breach requires an RCA. The (Tandridge District Council, 2025) reinforces that it is the duty of the employer to administer reviews regarding equipment, premises and system of work to identify hazards and curtail associated risks.

(Health and Safety Executive, 2025), state that it is the duty of the employer to protect their employees. Government published guidelines (Secretary of State for Work and Pensions, 2015), outline the duties of the employer and employee. Employers' priorities include risk assessments, appointing competent safety personnel and providing adequate safety information and training. Individuals must undertake personal training, undertake the RCA or report issues. Mitigation techniques identify risks, prevent escalation and support practices compliance.

2.3 Professional Codes and Standards

Internationally recognised, the IMechE is vital in supporting engineers through training and networking to promote innovation and growth. The institute also reinforces the importance of professional standards in protecting all involved. “Safety and risk concerns are paramount... in complex engineering activities,” (Institute of Mechanical Engineers, 2025). Health and safety is a core pillar of the profession. RCA provides a structured method of identifying and raising safety concerns, reinforcing a culture of “safety consciousness” and helping professionals meet expected standards by focusing on understanding and prevention.

Standards are essential to the continuous improvement of health and safety management systems in manufacturing. ISO 45001:2018 (replacing OHSAS 18001) sets a sector-wide framework for occupational health and safety standards (International Organisation of

Standardisation, 2018). This establishes safety standards tailored to businesses for proactive approaches.

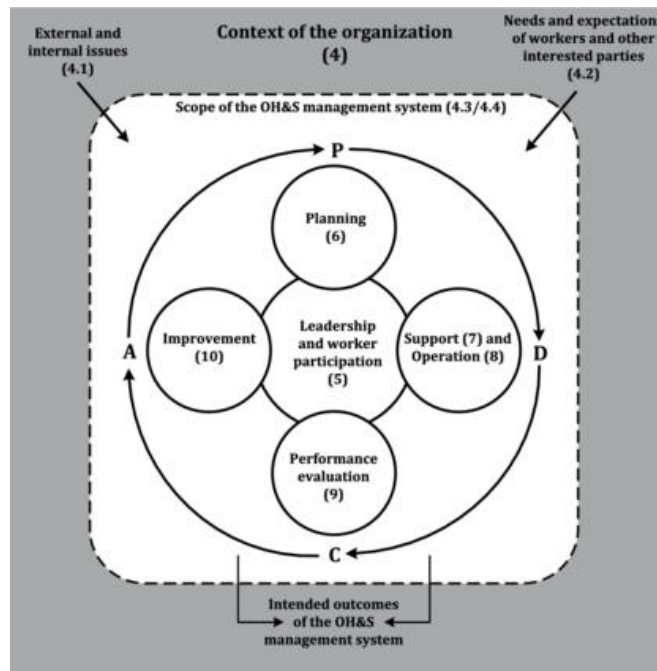


Figure 2 - Relationship between PDCA and the framework in this document (International Organisation of Standardisation, 2018)

Figure 2 represents the ISO structure for health and safety management systems around the PDCA cycle. Within this, RCA is crucial in the “Performance evaluation” and “Improvement” phases. Organisations should monitor and measure processes and results, implementing corrective actions to improve performance.

Statements throughout the report justify RCA measures, highlighting how it is “critically important for the organization to eliminate hazards and minimize OH&S risks by taking effective preventive and protective measures.”. Success is not about completing the steps, but about prevailing and surpassing the minimum criteria. “0.3 Success Factors” emphasises that management systems must “tak[e] advantage of OH&S opportunities” and undertake “continual performance evaluation and monitoring of the OH&S management system to improve OH&S performance”. In practice, this understanding and applying RCAs is not enough; continuous review and evaluation in relation of policies and amending when required is needed.

2.4 The Role of RCAs in Manufacturing Risk Management

Health and safety management systems apply to all aspects of engineering, particularly manufacturing. RCAs are not only useful but also mandatory in engineering and manufacturing processes. Applying and improving RCA policies is essential for compliance and risk reduction.

Workplace health and safety, especially seemingly insignificant incidents/issues, are often overlooked. RCA processes and associated legislation and standards emphasise managing all issues, acknowledging that minor problems could snowball and develop into something more consequential. By abiding by the recommended procedures, like RCA, organisations are more likely to fall within legal health and safety laws.

In addition, practising RCAs aligns with legal guidelines, maintaining positive relationships with local authorities, government and professional institutions. Effectively and consistently implementing current health and safety management systems strengthens the company's reputation. Financially, companies are less likely to face prosecution or legal fees, or the cost of replacing damaged machinery, tools, materials or even human resources.

Underlining safety concerns to the workforce creates a tone of respect and a safety-oriented mindset, placing personnel at the forefront of the company cultivates a positive work ethic. In turn, employee morale increases, making the company more attractive to potential employees and leading to collaborations with partners due to the company's favourable reputation.

3 Methodology

This investigation applies RCA in manufacturing processes to reduce failures, improve safety and lower operational costs. Frequent rework on sub-assemblies was used to identify and analyse ongoing or developing issues, creating a solution to mitigate them.

A structured table identifies the main problem and failures. Feedback and observation revealed issues with incorrect torque, poor SOP adherence and insufficient training

The 'Risk Priority Number (RPN)' allows a clear and distinct ranking of each incident by scoring the individual 'Severity', 'Occurrence', and 'Detection' of the 'Identified Issue'. This clearly indicates which issue to address first and allows for appropriate prioritisation.

Furthermore, corrective actions are proposed using various techniques, with the most effective selected. After implementation of controls, risks are re-evaluated to assess reduction. Success is measured by comparing risk levels before and after improvements.

All feedback is recorded in the table. Controls already administered – such as quality checks and training - are documented alongside the newly applied actions. The goal was to develop repeatable processes for future use.

The RPN score is determined using occurrence data, industry standards and personnel feedback. Severity is static because it reflects the consequences if a failure occurs. Occurrence is revised to account for changes in failure frequency before and after corrective action was taken. Detection is altered depending on the reliability of new control measures at identifying potential failures.

4 Results and Justification of RCA Findings

4.1 RCA Results Summary

Table 1 - Root Cause Analysis of Rework in Sub-Assemblies

Process /Function	Identified Issue	Potential Effect(s) of Failure	S e v e r i t y	C a u s e	Potential Cause(s) /Mechanism(s) of Failure	O c c u r r e n c e	Current Controls	D e t e c t i o n	R e p a r e d	Recommended Action(s)	Responsibility and Target Completion Date
Process / Function	Describe the issue	Rate the severity from 1-10	Ex: Operational Failure		List potential causes of the issue	Rate the occurrence or likelihood from 1-10	List current controls in place to detect/prevent the issue	Rate the detection capability from 1-10	Multiply severity, occurrence, and detection	Actions recommended to mitigate the issue	Person responsible and target date for action completion
Frequent Rework on Assemblies	Incorrect Torque Application	Leading to loose fasteners. Increases risk during operation (leaks, disassembly etc.)	10	Human Error	- Misreading torque specification - Lack of calibration on tools - Inadequate supervision	8	Torque Gauge available for every station	5	400	Implement regular audits	Production Manager - 15/11/25
	Incompatible/Worn Tools	Reduced accuracy or damage to fittings. Can strip threads or misalign parts	10	Equipment Failure	- Lack of preventative maintenance - Wrong tool selected for task - Tools not checked for wear before use	5	- Replacement parts available on site - Experienced workers available to ensure the right tool is used	6	300	Understand tool life, implement replacement schedule	Maintenance - 20/11/25
*	Poor SOP Adherence	Skipped steps. Rushed work.	9	Human Error	- SOP not enforced or reviewed - Operators rushing or skipping steps - Lack of ownership	6	- SOP reminders in each workday - Supervisors overlooking the process	6	324	Daily SOP briefings and operator sign-offs	Production Lead - 03/11/25
	Lack of Training	Operators are unfamiliar with torque settings, part tolerances or tooling. Causes of the expectations of each role they play.	9	Human Error	- No formal induction or refreshers - Inexperienced staff handling tasks - Training not tailored to task complexity	5	- Refreshers sessions available before job commences, and refreshers if needed. - Experienced workers available to explain on-hand work	7	315	Refresher training. Introduce buddy training for new staff.	HR & Team Leaders - 12/11/25
*	Inconsistent Workmanship Between Shifts	Different staff apply procedures differently. Mixed information due to weak handovers.	6	Human Error	- No standardised handover process - Different skill level across shifts - Poor communication or unclear responsibilities	7	- Guides to be completed after every shift - Common area for senior staff to meet and discuss job	8	336	Create shift handover checklist. Lead operators to meet after/before shift starts.	Quality Control/Production Lead - 03/11/25
	Inadequate Quality Control	Errors go undetected until late-stage testing or customer use.	9	Process Issue	- Insufficient inspection points - QC relies on manual checks only - Late-stage detection rather than in-line	7	- Spec guide at the end of every station - Process Lead to sticker every non-conject with personal employee code - Job starts slow to order to master before increasing work pace	10	630	Inspections mandatory at key stages. Proper measurement and gauges to be compared to specification sheet.	Quality Control - 25/11/25
*	Rushed Production	Leading to error prone assembly or missed inspections.	8	Process Issue	- Unrealistic deadlines from planning - Pressure from management to meet targets - Undermanning in production cells	8	- Process lead to ensure correct achievable tempo, and correct process - If behind schedule, increase labour force - Reasonable targets to hit per shift	8	512	Review deadlines. Adjust schedules to allow buffer times.	Production Manager - 21/11/25
	Contaminates Leaking from Improper Assembly	If improperly torqued, gaskets and seals fail. Could lead to fluid leaks, exposure, fire hazard	10	Environmental Concern	Seals not installed/torqued properly	7	- Reinforced safety protocols if incident arises - Specification reminder after every station - Thorough checking throughout process	10	400	Add mandatory checklist for gaskets/seal torque. Provide clear instructions.	Quality Control - 25/11/25
*	Misaligned Parts	Introduces unnecessary risk for assembly or inspection staff	9	Equipment Failure	- Faulty fixtures - Inaccurate part positioning tools	3	- Specification reminder after every station - Calibrated tooling to be used - Ensure parts are not damaged or obstructed when assembled.	8	216	Introduce laser alignment guides and visual aids	Maintenance - 20/11/25
	Repeated Labour	Increases cost of labour hours for job. Delays following processes downstream.	4	Process Issue	- Poor documentation of fixes - Lack of root cause follow-up - No feedback loop from QC to operators	5	- Process lead to ensure job done correctly the first time - Staff to hit expected objectives within shift - If issue occurs staff are to report it for the job to run smoothly after corrected	10	200	Use tracking sheet linked to job number.	Quality Control - 17/11/25
*	Material Waste	Scrapped parts increase cost and environmental burden.	5	Cost Impact	- Poorly built first time - No waste tracking system	6	- Record damaged, wasted or other circumstance of scrapped material - Proper disposal of item allocated to process lead	10	300	Implement a digital waste tracking system, so all items are saved and not lost. Add coding for reason of reject.	Environmental Officer - 24/11/25
	Failure to Meet Customer Specifications	Returns, warranty claims, reputational damage. Legal action and financial repercussions.	10	Compliance Risk	- No verification against customer drawings/specs - Poor customer communication - Outdated document so clarified before production	2	- Keep customer updated - Retrieve customer expectations - Ensure contract is not breached on any grounds	7	140	Link customer spec to job ticket. Include drawing verification step.	Project Engineer - 16/11/25

Table 1 - Root Cause Analysis of Rework in Sub-Assemblies represents all recorded information prior to corrective action being taken. All data recorded refers to the identified failures, their severity, occurrence and detection and resulting RPN scoring.

Table 2 - Scoring of RCA after Corrective Action

Action Results				
Actions Taken	S e v	O c c	D e t	R P N
Results after implementing actions				0
Weekly audits introduced; no compliance flagged.	10	2	2	40
Tools repaired and monitored based on usage hours.	10	2	2	40
Morning SOP checks implemented	9	2	2	36
New starters assigned mentors.	9	2	2	36
Handover sheets now standard; reviewed daily.	6	2	2	24
In-process inspection sections added.	9	2	2	36
Adjusted job cards with realistic goals and time restraint.	8	2	2	32
Mandatory check step added to final sign-off.	10	2	2	40
Measuring aid installed at all work stations	9	2	2	36
Root causes logged in weekly tracker.	4	2	2	16
Waste bin labelled with waste type (colour co-ordinated)	5	2	2	20
Final sign-off includes drawing match review	10	1	1	10

Table 2 uncovers how RNP changed due to corrective action by the reassessment of occurrence and detectability. Severity remains consistent since actions don't change seriousness.

4.2 RPN Comparison and Justification

Figure 3 - Reduced RPN Score of All Incidents Before and After Mitigation Methods

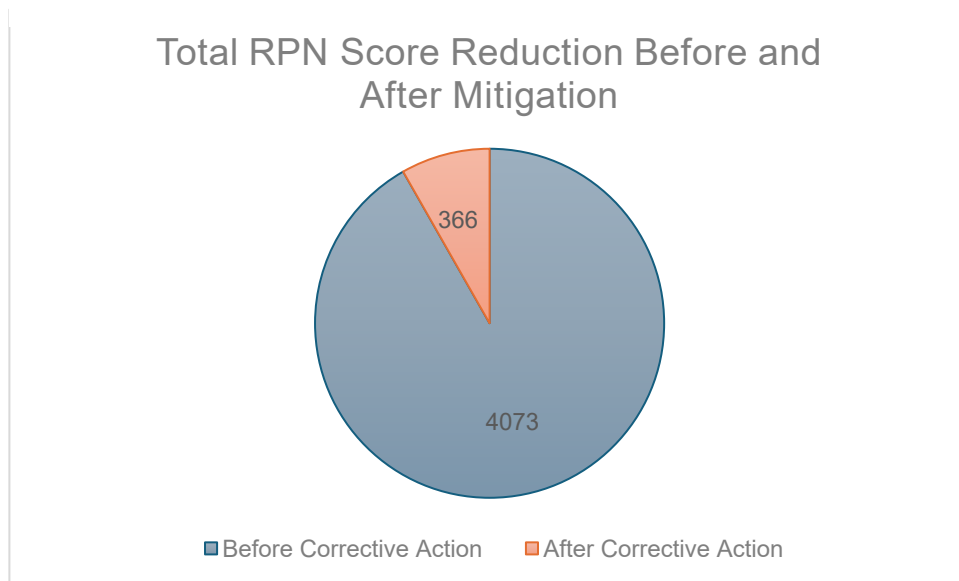


Figure 4 -The Sum of All RCA Metrics of All Incidents Before and After Control Measures Were Applied

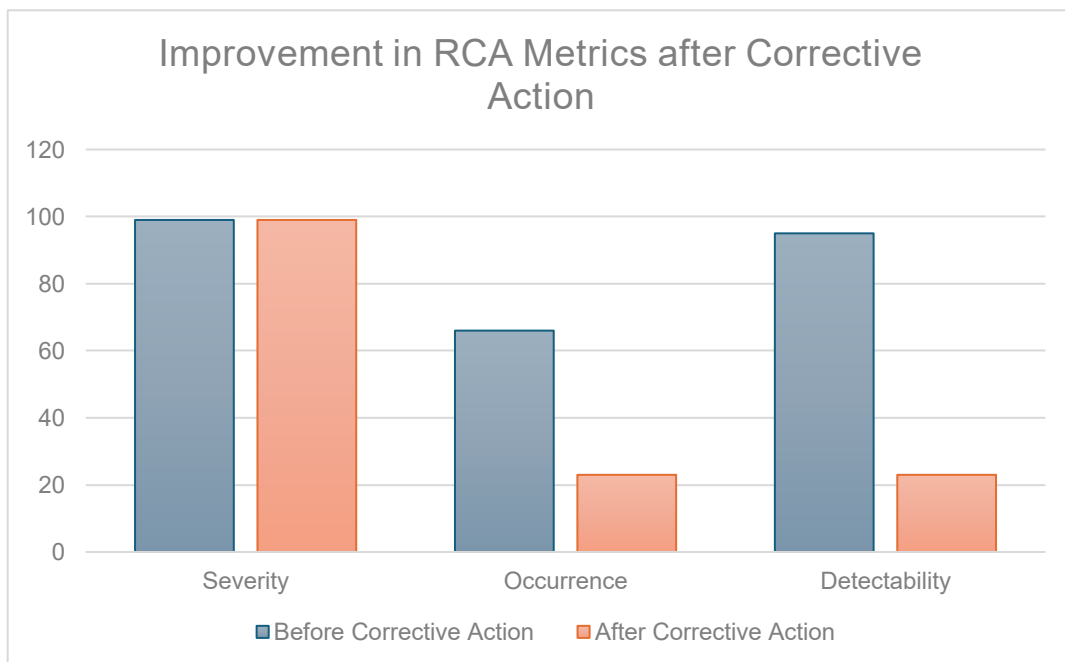


Figure 3 - Reduced RPN Score of All Incidents Before and After Mitigation Methods and Figure 4 -The Sum of All RCA Metrics of All Incidents Before and After Control Measures Were Applied represent the impact of reliable control methods. The difference is clear when comparing 'Occurrence' and 'Detectability' scores before and after corrective action. Figure 4 illustrates how mitigation can dramatically reduce risk. Similarly, Figure 3 shows this decline and demonstrates how implementing controls improves safety and well-being.

Before imposing these techniques, the RPN across all issues was 4073. After corrections, it dropped by 91% to 366, confirming that RCA methods can have measurable impacts on risk reduction.

The most notable drop was in 'Inadequate Quality Control', with its RPN dropping from 594 to 36; due to the introduction of frequent process checks and late-stage quality insurance. A severity rating of 9 reflected the critical nature of undetected faults, and the detection score was low as it relied solely on final inspections. Implementing mandatory inspections at key stages improved detectability. These steps reduced risk and strengthened reliability, assuring staff that faults and their well-being were a priority.

Initially, "Incorrect Torque Application" scored high due to the severity of failures caused by over- or under-tightening. A seriousness of 10 was given because incorrect torque can lead to part failures or safety hazards. Detection scored 6 because no tool was used to measure torque. Regular monitoring and ensuring the use of torque gauges resulted in improved detection and reduced risk – RPN fell from 600 to 40. Allowing mistakes to be easily detected before impacting assembly or performance.

"Insufficient Workmanship Between Shifts" was rated highly due to the inconsistency caused by poor handovers. A severity of 6 was used, as missed steps didn't always lead to failure but often caused delays or extra checks. Detection scored 6 because there was no standard way to confirm what had been completed. After introducing a structured handover checklist and making lead operators responsible for review, both occurrence and detection scores improved. The RPN dropped from 216 to 24, showing that small changes in communication between shifts can have a big impact on reducing repeat errors.

These examples show how RCA scoring helped prioritise the most pressing issues and guide the right actions. Not every fix needed big changes — some just needed clearer processes or better tools. But across all cases, targeted interventions based on RCA made the risk more manageable and the process more reliable.

5 Conclusion

The objective was to highlight the relevance of risk management in manufacturing, focusing on RCA to reduce safety risks.

The sub-assembly case exposed multiple issues, prioritised by RCA scores. High scores were dealt with urgently. Some had simple fixes, like a handover checklist. Others needed investment, like laser alignment guides. Altogether, the improvements reduced risk by 91%, proving the method's value.

RCA didn't eliminate all risk. Human error, weak reporting, or poor data still affect reliability. Training must be verified in practice.

Embedding RCA and reviewing results regularly maintains safety. It gives teams a factual basis for decisions while meeting legal and professional standards.

In short, RCA is essential. Applied consistently, it improves safety, accountability, and long-term resilience.

6 Bibliography

Health and Safety Executive, 2025. *Managing risks and risk assessment at work*. [Online]
Available at: <https://www.hse.gov.uk/simple-health-safety/risk/index.htm>
[Accessed 19 October 2025].

Innova Search, 2025. *HEALTH, SAFETY & ENVIRONMENTAL PROFESSIONALS*. [Online]
Available at: <https://www.innova-search.co.uk/health-safety-and-environmental>
[Accessed 19 October 2025].

Institute of Mechanical Engineers, 2025. *SAFETY AND RISK*. [Online]
Available at: <https://www.imeche.org/training-qualifications/topics/safety-and-risk>
[Accessed 23 October 2025].

International Organisation of Standardisation, 2018. *Occupational health and safety management systems*. [Online]
Available at: <https://www.iso.org/standard/63787.html>
[Accessed 23 October 2025].

Secretary of State for Work and Pensions, 2015. *Managing risks and risk assessment at work*. [Online]
Available at: <https://www.hse.gov.uk/simple-health-safety/risk/index.htm>
[Accessed 19 October 2025].

Tandridge District Council, 2025. *Health and safety at work*. [Online]
Available at: <https://www.tandridge.gov.uk/Business-support-and-licensing/Health-and-safety-at-work#:~:text=By%20law%20employers%20must%20review,safety%20and%20welfare%20at%20work>
[Accessed 20 October 2025].

The National Archives, 2015. *Health and Safety at Work etc. Act 1974*. [Online]
Available at: <https://www.legislation.gov.uk/ukpga/1974/37/section/1/2015-02-26>
[Accessed 20 October 2025].

7 Appendices

.....

FIGURE 1 - FATAL ACCIDENTS IN THE UK MANUFACTURING SECTOR (HEALTH AND SAFETY EXECUTIVE, 2025)	
.....	3
FIGURE 2 - RELATIONSHIP BETWEEN PDCA AND THE FRAMEWORK IN THIS DOCUMENT (INTERNATIONAL ORGANISATION OF STANDARDISATION, 2018).....	5
FIGURE 3 - REDUCED RPN SCORE OF ALL INCIDENTS BEFORE AND AFTER MITIGATION METHODS	10
FIGURE 4 -THE SUM OF ALL RCA METRICS OF ALL INCIDENTS BEFORE AND AFTER CONTROL MEASURES WERE APPLIED.....	10
TABLE 1 - ROOT CAUSE ANALYSIS OF REWORK IN SUB-ASSEMBLIES	8
TABLE 2 - SCORING OF RCA AFTER CORRECTIVE ACTION.....	9

Long Term Goals (5 to 10 years)

- Become a competent mech. Engineer with strong practical and technical ability
- Build skills in technical writing, fault analysis and engineering reports
- Work towards professional recognition and chartership later in my career.
- Continue developing confidence, communication and leadership skills for future responsibilities.
- Be able to justify decisions clearly through good writing

Short Term Goals (0 to 5 years)

- Strengthen writing for university work and workplace reports – clearer and more professional.
- Build consistent study habits across modules to hit high grades
- Develop a clearer approach to planning workload, deadlines and engineering tasks
- Strengthen research for academic work.

Goal	Objective	Resources Required	Measurement	Target Date
Complete strong technical report for my current module	Understand report criteria. Optimise lecturers knowledge and guidance.	Lecture notes Examples of technical reports	Report submitted on time and meets the required standards	8 Dec. 2025
Improve my RCA ability	Build RCA skills, and ability to identify causes. Link actions to reduce risk	RCA templates Workplace examples	Complete RCA with clear outline of cause and response.	8 Dec. 2025
Achieve high marks in university modules	Focus on clear and concise writing. Thorough research and completing tasks ahead of deadlines	Module material Planning tools Feedback from lecturers	Consistently achieving high marks due to maximum input	Ongoing
Develop technical writing	Practice writing structure. Use appropriate language and techniques	Lecturer feedback Reading example reports	Obvious development in writing shown by better structure in assignments and grading	2025
Develop understanding of analysing engineering problems	Practise break down issues. Identify risks and suggest controls.	Case studies Workplace examples Module content	Accurate reasoning shown in future assignments	2025