Case Study Title: Framework to determine Cost of Quality on Construction Projects

Company Overview | KIRBY GROUP ENGINEERING | kirbygroup.com

Founded in 1964 in Limerick, Kirby Group Engineering is a leading mechanical and electrical engineering contractor operating across Ireland, the UK and mainland Europe, and directly employing over 1,500 highly skilled professionals.

Kirby provides full mechanical and electrical contracting services as well as specialist high voltage (HV) and medium voltage (MV) design and construction services to clients across a number of different sectors including Data Centres, Life Sciences, Industrial, Commercial, and Substations and Renewables.
Kirby also has 2,500 indirect employees and a turnover in 2021 of €400m. Kirby is a "values" driven business as illustrated in Figure 1.

Figure 1: Kirby Core Values

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Overview & Background to the Lean Initiative

This case study sought to address a problem identified with tracking and quantifying the cost of quality on construction projects. The hypothesis to address this was firstly to establish the level of knowledge and awareness relative to the cost of quality in construction projects and then develop a robust solution, which included process updates, a training programme and tracking mechanism for data capture. The Lean/Six Sigma methodology of Design, Measure, Analyse, Improve and Control, together with lean tools, was used to deliver the improvement project as shown in Figure 2 DMAIC Methodology and Tools.

Figure 2: DMAIC Methodology & Tools

The objective of the project was to utilise operational data to determine the cost of quality and then reduce costs and increase efficiency.

Figure 3: Project Objectives

The Prevention Appraisal Failure model (PAF) was used to determine the cost of quality across a portfolio of construction projects completed in 2021.

Type of Cost	Items to be measured		Criteria	Scope
	Item	Description		
Prevention	Requirements	Contract review	Price Hours PM	Projects 2021
		CTQ Matrix	Price Hours PM	Projects 2021
	Planning	QA Plan	Price Hours QC Staff	Projects 2021
		ITP	Price Hours QC Staff	Projects 2021
	QA	Quality Management System	Salary of QA Employees	Total for the company
	Training	Internal Quality Training	Price Hours QC Staff	Total for the company
		External Quality Training	Price courses	Quality training
Appraisal	Verification	PM, SS & Directors Inspections	Price Hours PM, SS. Directors	Including hours invested for the trip to the project's sites.
		Walk-downs	Price Hours	Projects 2021
	Audits	Internal Audits Projects and Offices	Price Hours QC Staff + invoices	Projects 2021
		External Audits	Price Audit	Invoice & Expenses
	Supplier rating	Internal Audits to Supplier	Price Hours QC Staff	Projects 2021
Internal failure	Internal NCR	Unnecessary work Defective product Reworks, Etc.	Price Hours Staff + Others costs according to NCRs	Total for the company
	Snags	Defects	Price Hours Staff + Others costs as materials, etc.	Projects 2021
External failure	QIA	N/A	Price Hours Staff + Others costs according to QIA	Projects 2021
	External NCR	N/A	Price Hours Staff + Others costs according to NCRs	Projects 2021
	Warranty claims	N/A	Price Hours Staff + Others costs according to the claims	Projects 2021

Figure 4: Prevention Appraisal Failure (PAF) model

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Define

Challenge Based Strategy

A Challenge Based Strategy was completed to define the project. As Kirby Group is a learning organisation, this strategic tool is used extensively as a collaborative approach to learn, while solving complex problems.

The strategy involves outlining the overall challenges, benefits, and a guiding policy to develop a coherent action plan to move the project forward.

Three challenges were detailed within the challenge-based strategy as follows:

- Challenge 1: Establish the current state of the cost of quality using the PAF model
- Challenge 2: Establish the awareness level of senior management in the area of cost of quality on projects.
- Challenge 3: Create a robust framework to include process updates, training programme and tracking mechanism for data capture.

Benefits: In summary, the implementation of this Challenge Based Strategy, will bring the following benefits to the business:

- Recognise the importance of quality in construction.
- Build a base for lessons learned.
- Ability to develop data driven decisions.
- Ability to attract future efficiencies through prevention initiatives and right first time.
- Potential for data driven predictive project decision making.

SIPOC

The Suppliers, Inputs, Process, Outputs and Customers (SIPOC) model was used to assist in defining the Challenge Based Strategy and to explain inputs and outputs for the project. This was also an excellent communication tool throughout the project and provided transparency for key stakeholders, which added to the success of this improvement project.

Process: Challenge Based Strategy (CBS)			Process Owner: Quality Department			
Suppliers:	Inputs:		Process:	Outputs:		Customers:
(Providers of the required Resources)	(Resources required by process)		(Top Level Description of Activity)	(Deliverables from the process)		(Anyone who receives a deliverable from the process)
		Requirements:			Requirements:	Internal / External
QA Department/ Operations	Quality Team/ Project Personnel	Accurate, agreed with the various stakeholders	Create and Audit Checklist in line with the PAF model	Completed audit checklist	Conforms to Quality Management System/ Complies with ISO9001:2015	Management/ Project Personnel / Client / Third Party Inspectors
QA Department/ Operations	Quality Team	Access to project folder and commercial data	Analyse operational data and complete checklist on construction projects started and finished in 2021	Evidence of all costs associated with cost of quality.	Conforms to Quality Management System/ Complies with ISO9001:2015	Management/ Project Personnel / Client / Third Party Inspectors
QA Department/ Operations	Quality Team/Management/ Project Personnel	Anonymous Survey Questions hosted on Microsoft Forms	Determine the level of awareness of cost of quality on construction projects	Responses to questions for analysis	Conforms to Code of Ethics	Management/ Project Personnel / Client / Third Party Inspectors
QA Department/ Operations	Quality Team	Accurate, agreed with the various stakeholders	Develop a framework for logging and tracking data	Excel based data collection platform	Conforms to Quality Management System/ Complies with ISO9001:2015	Management/ Project Personnel / Client / Third Party Inspectors
QA Department/ Operations	Quality Team/Management/ Project Personnel	Reflect current practice	Update processes and forms	Updated Process and forms	Conforms to Quality Management System/ Complies with ISO9001:2015	Management/ Project Personnel / Client / Third Party Inspectors
QA Department/ Operations	Quality Team	Reflect process and form update	Develop training presentation and knowledge check	Training available on the inhouse training platform	Complies with inhouse training platform, Quality Management System and ISO9001:2015	Management/ Project Personnel / Client / Third Party Inspectors

Figure 5: SIPOC

Measure

Survey

A survey sought to identify the level of awareness currently held by senior management in relation to the cost of quality on projects as shown in Figure 6 Awareness Survey. Target audience for the survey was Business Unit Leaders, Operations Managers and Project Managers all working at a high level of the project delivery process. 20 anonymous surveys were issued with 15 responses received. Survey results show a lack of cohesion and awareness of the cost of quality at management level. 5 out of 20 high level managers did not complete the survey.

Figure 6: Awareness Survey

Audit

The audit was based on the methodology of establishing a consistent measuring system by asking the following questions:

1. What is to be measured?
2. What are the criteria for measurement?
3. What is the scope of measurement?

Preventative costs were measured in terms of what were the "Critical To Quality" measures. An example is the time taken by the Project Manager to review the contract and a percentage of salary was assigned across the 33 projects under review. The appraisal section considered the cost of time applied to checking key operational activities throughout the project life cycle through the quality assurance and quality control audits. Failure costs considered the cost of internal failure or non-conformance and external failure. Analyse

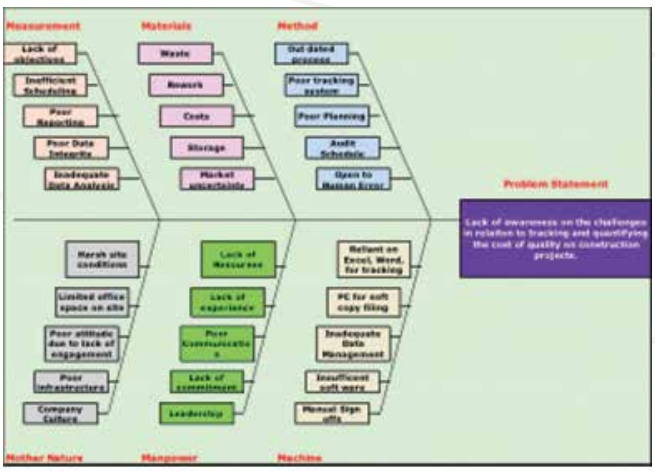

Figure7: Fishbone Diagram

Fishbone and 5 Whys

A Fishbone Diagram and 5 Whys were used to ascertain the root cause of the problem using the 6M methodology (Measurement, Materials, Method, Mother Nature, Manpower and Machine). During a brain storming session with the quality team and operations, it became apparent that the existing company culture, commitment, and leadership were of the top 3 issues that needed to be considered.

Problem Statement	Why	Why	Why	Why	Why	Conclusion/ Recommended Action
Lack of Awareness on the challenges in relation to tracking and quantifying the cost of quality on construction projects	Lack of Leadership and commitment to ensure there are resources in place for the planning of cost of quality analysis	The cost of quality on projects is perceived as cost of rework or repair, preventive and appraisal costs are assigned to overhead.	Silo culture affects the sharing of information across departments	There is a culture absorbing cost of poor quality back into the contingency of the project costings making the real cost of poor quality less transparent.	Construction site culture may not foster an environment where people feel safe to own up to poor quality issues for fear of reprisal	Analyse the operational data for the year 2021 to determine the cost of quality on projects. Provide a structured framework for the gathering of key operational data. Provide training to raise awareness company wide.

Figure 8: 5 Whys.

Lean Initiative Improvements & Impact

Improve

Framework for Data Capture

A framework was developed in MS Excel supported by Power BI to improve data capture capability and presentation. This framework ensured the logging and tracking of key data in terms of impact, contributing factors and costs. This level of information allowed for improved data analysis, on which decisions can be based and actions taken.

A key principle of Total Quality Management (TQM) is fact-based management. We need to ensure decisions are based on fact and not precedent or opinion. Recording of non-conformances increased from 3 in Quarter 1, 2022 to 13 in Quarter 1,660808 2022, due to the increased data capture capabilities.

The process for non-conformance and corrective action was revised to reflect the updated controls as illustrated in Figure 9, Control of Non-Conforming Outputs & Corrective Action Process.

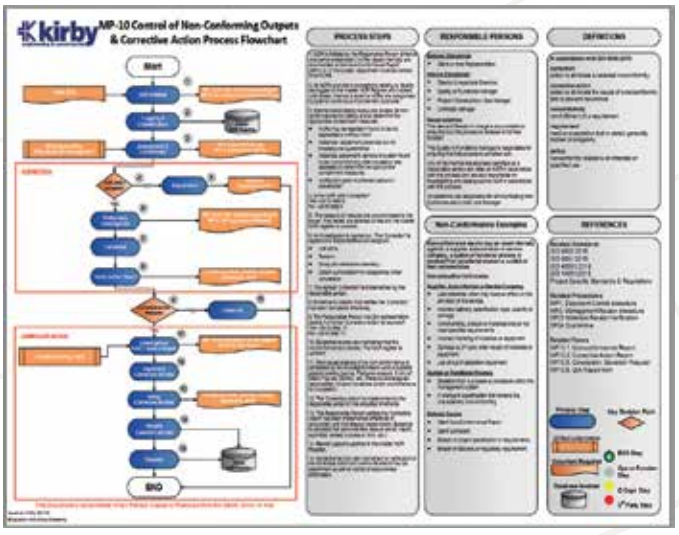

Figure 9: Control of Non-Conforming Outputs & Corrective Action Process

Existing forms were revised to capture detailed operational data at project level. A summary of the details feed into the Non-Conformance Master Register to collate all internal and external failure costs. These forms were developed to ensure the impact of the issues were considered, together with the contributing factors, remedial work, root cause analysis and associated costs.

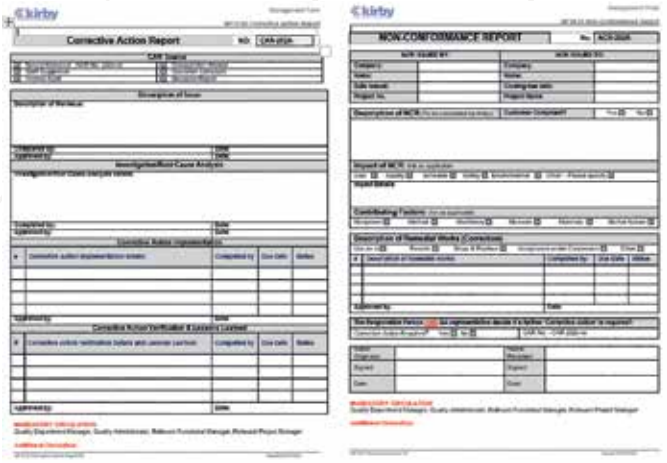

Figure 10: Non-Conformance and Corrective Action Reports

Training Presentation

A Non-Conformance and Corrective Action Training Presentation and knowledge check was developed to communicate the improvements and raise awareness on the impacts of the cost of quality on construction projects, both good and bad. The training, together with knowledge check, was delivered through an in-house, self-delivered training portal that now forms part of the company induction process.

Control

Training Programme

Roll out of the cost of quality training programme and knowledge check commenced in December 2021, with invites from the inhouse training platform issued to relevant roles within site and management staff. To date, 91 out of 347 direct employees have completed the training and knowledge check as shown in Figure 11, Completion of

Figure 11: Completion of Cost of Quality (COQ) Training

Cost of Quality (COQ) Training. Due to the success on the uptake of the training, it will be rolled out to all site staff, engineers, and management before the end of 2022.

The implementation of the improvements will be monitored in line with the internal function audit process. This process is written in accordance with the requirements of the international standard ISO9001:2015 for quality management systems requirements and ISO19011, Guidelines for auditing management systems.

Results

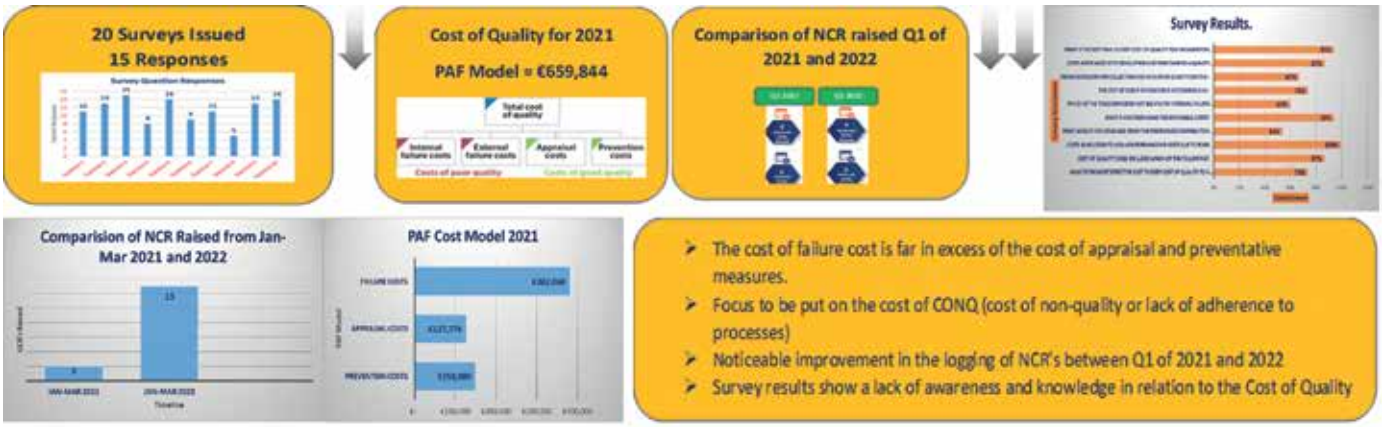

Figure 12: Results

Summary and Lessons Learned

This lean improvement project fulfilled its objectives by creating a structured framework to which vital operational data could be gathered to determine the true cost of quality and the rollout of a training presentation to create awareness around the total cost of quality.

This research resulted in the following outputs:

- Introducing the Prevention Appraisal Failure (PAF) model that will support the decision-making capabilities of management.
- Creating an understanding of all the elements of cost of quality, both good and bad.
- Creating an understanding of the causes of failure and the importance of root cause analysis through the corrective action process.
- The development of a structured framework to act as a single source of truth to record issues and become a source of lessons learned for future projects.

While data gathering may have had limitations initially in terms of the siloed company culture, and a reluctance to disclose the costs, the implementation of the structured framework for data collection and training presentation were instrumental in changing the mindset and behaviour in a positive way. The improvements were rolled out in 2021 and their success can be verified by the increase in non-conformance reporting from Quarter 1 in 2021 to Quarter 1 in 2022.

This project illustrates how efficient and effective the DMAIC methodology is at providing a framework to drive continuous improvement. Using this methodology led to the provision of a transparency around the cost of quality that had not previously existed. The success of this project demonstrates the value adding capabilities of the DMAIC methodology and how it could greatly benefit other areas of the industry.