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Duggan Brothers (Contractors) Ltd. ("DBL") was founded in 1923 and is one of Ireland's leading general building contractors with over 120 managerial staff. As a medium-to-large sized construction company, we have successfully completed c.1,000 projects (and counting) in both the public and private sectors. These

projects range in value from €5m to €80m across commercial, pharmaceutical, educational, healthcare, residential, and industrial sectors. Construction Excellence is at the heart of everything we do, and we are proud to continue to deliver high-value and high-quality projects for our clients.

Author



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Overview & Background to the Lean Initiative

DBL began its Lean journey in 2014 through attending many of the LCi events and conferences. DBL could see real value in adopting Lean principles and tools to enhance what we do for our clients and customers. Through adopting a leaner approach, we continue to review and improve our systems to ensure we deliver value across our projects for the benefit of all, including our staff, design team members, clients, and end users. Our continuous improvement and learning organisation approach has helped DBL to review many aspects to our company and seek out opportunities for improvement.

One area of our company that has developed greatly is our approach to quality control and quality assurance, and how we manage our entire quality process. DBL first achieved the ISO9001 Quality Management Standard in 1993, and we are proud to retain this standard year-on-year. We recently carried out a Lean project on our quality management systems across all our projects to identify opportunities for improvement. Our comprehensive quality auditing process gathers valuable information to allow each project team to become aware of what is required to be addressed to improve the results for each individual project and our company overall.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

This case study focuses on our organisation's quality audit process to ensure we comply with our company's own quality requirements and to the requirements of ISO9001:2015 international standard. The purpose of this project was to identify areas for continuous improvement within our quality control and quality assurance processes.

The desired outcome of this project was to ensure that our company standards, along with local and international standards, are effectively implemented and maintained throughout the lifecycle of our quality management processes. The purpose of this Lean initiative was to identify ways to eliminate waste in our systems and to deliver an efficient service to both our internal and external customers, namely, internal staff and external third parties.

Through gathering information during our internal quality auditing assessments, this process improvement project identified several opportunities that could be improved.

One of the key aspects to developing our Lean approach was to adopt PDCA across all aspects of our company, whilst implementing the various Lean tools to improve our approach to delivering high-quality projects for our clients. Control measures, such as standard working procedures, along with implementing regular continuous improvement workshops ensure we become a leaner construction company as we remove waste from various processes.

Our continuous improvement approach has allowed us to become leaders in the industry and enabled our staff to develop initiatives to improve many areas of our organisation, both on-site and off-site, including our office-based staff.

Quality Assurance and Quality Control is a centre point to DBL delivering high-quality projects for our clients. Our quality management objective is to achieve "Right First Time Every Time" within every aspect of our company in order to deliver the most efficient and cost-effective projects for our clients.

Our company's policy is to maintain and continuously improve our record of providing buildings of the highest quality in conformance with our client's specified requirements, safely, on time, and within budget. We endeavour to work as a team in a spirit of cooperation with our clients and their professional representatives to achieve our successful project outcomes. It is essential that everyone working in our company is fully aware of their role within the organisation and their responsibility for carrying out this function to the highest standard as part of an overall team effort, and in full compliance of ISO 9001:2015.

This Lean initiative allowed us assess the current state and future state of our quality management processes, and the findings from this initiative were reviewed in detail to improve what we do. Our quality audits are carried out to ensure that we comply with

ISO 9001:2015 Quality Management Standard. Each audit is scored to evaluate the compliance criteria, and these scores provide a mechanism to assess the compliance of our system through the construction stage of each project. The results and findings from each audit provide an opportunity to improve our quality management system for both internal and external customers. The findings and results of each audit are assessed and then calculated and placed within the following compliance ranges:

- Compliant: 95-100
 - Mainly Compliant: 90-94
 - Non-Compliant: 0-89

Each audit report is then circulated to the relevant project teams for action as required. Through our continuous improvement programme, and flexible approach with adopting our quality auditing processes, we have successfully gathered valuable information to allow our systems to be improved.

We recently carried out an A3 Lean project to assess our overall findings between Aug 2018 and March 2021, and our average score in 2018-2019 was 93.68, which was within our mainly compliant range. In 2019-2020, we improved our average score to 94.25. It should be noted that the project stages change over time and therefore the items being audited may vary from project to project depending on the stage of the project. DBL sets a high standard when it comes to quality control and quality management, and thus projects that reach the mainly compliant range are achieving a high result. That said, there is always room for improvement in any process, and thus our commitment to continuous improvement is integral to who we are. Figure 1 outlines our assessment of the current conditions and the Voice of the Process during an assessment from Sep 2019-Sep 2020, plus the average scores noted in Aug 2018-Aug 2019.

Goals/Targets

Our overall goal was to increase our audit results to achieve a score of 95 and above by April 2021 following a deep dive into available opportunities, and it can be seen that a number of our projects had already achieved 95 and above at our baseline stage. However, some projects required more focus to bring our average scores across the nine projects into the compliant range. The frequency of the audits was also assessed, and the goal was set to ensure that audits were consistently carried out every 2 weeks on each project, and our target was to achieve 95 and above. Table 1 outlines our baseline scores versus our intended goals and targets to be reached.

Metric	Unit of measure	Baseline	Goal
Specific - The goal and target behind this Lean Project is to increase our overall score rating from being within our Mainly Compliant range to be within our Compliant range.	Score / percentage	Average 93.68	95+
Project 1	Score / percentage	93.09	95+
Project 2	Score / percentage	94.5	95+
Project 3	Score / percentage	96.83	*
Project 4	Score / percentage	95.26	+
Project 5	Score / percentage	97	+
Project 6	Score / percentage	89.14	95+
Project 7	Score / percentage	92.76	95+
Project 8	Score / percentage	95.61	+
Project 9	Score / percentage	94.00	95+
Frequency of Audits to reach goals:	Time	Ranges from 2-4 weeks	2 weeks consistent!

Table I. Baseline Versus Target

Having identified the key items, we were then able to analyse root causes and determine where we needed to focus in order to make improvements. Our quality management team assessed our audit reports in detail and analysed why we were not reaching 95% and above as standard across our projects. Our assessment can be seen in the Cause and Effect Diagram (Figure 2) and Failure Mode Effects Analysis (FMEA) chart (Figure 3).

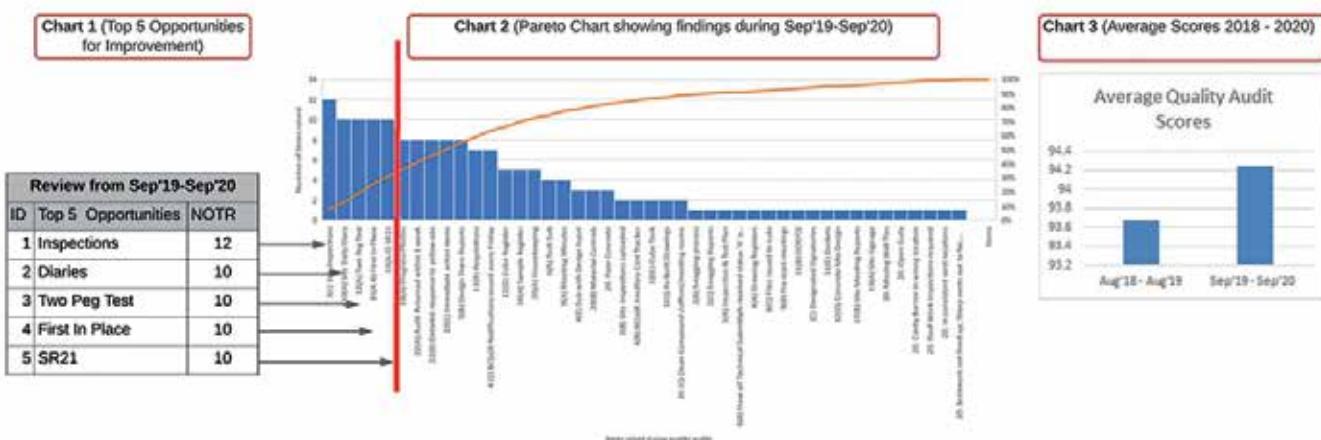


Figure I. Outcome of Current State throughout Sep 2019-Sep 2020

Opportunities for improvement were identified through our bi-weekly quality audits across nine live construction projects at the time of auditing. Key items selected for improving included site inspections, site diary records, two peg test recording, first in place/benchmarking recording, and recording of SR21 granular fill. Once we assessed the opportunities for improvement, we were able to take a deeper dive and outline our goals and targets to make the improvements happen.

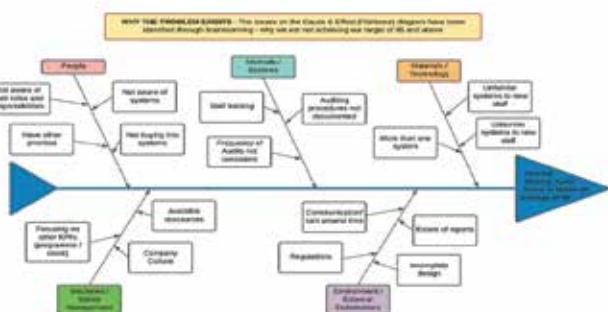


Figure 2. Assessment of Cause and Effect

Our FMEA review outlines the current state (what we do today) versus the future state (what we will do tomorrow) to improve how we work. We assessed our People, Methods/Systems, Materials/Technology, Machines/Senior Management, and the Environment/External Stakeholders in order to outline failures, causes, controls, and future actions to make the improvements happen. The FMEA tool and Fishbone diagram allowed DBL to develop countermeasures and create a Last Planner action plan to implement specific actions required to make sure the opportunities for improvement were actioned by specific team members and by specific dates.

Category	Risk Type	Current State		Future State		Owner
		Probability	Impact	Probability	Impact	
People						
Project Manager	Project Manager	Medium	Medium	Low	Low	PM
Design Team	Design Team	Medium	Medium	Low	Low	Design
Construction Team	Construction Team	Medium	Medium	Low	Low	Construction
Suppliers	Suppliers	Medium	Medium	Low	Low	Suppliers
External Stakeholders	External Stakeholders	Medium	Medium	Low	Low	External Stakeholders
Methods / Systems						
Design Process	Design Process	Medium	Medium	Low	Low	Design
Construction Process	Construction Process	Medium	Medium	Low	Low	Construction
Quality Management System	Quality Management System	Medium	Medium	Low	Low	Quality
Health & Safety System	Health & Safety System	Medium	Medium	Low	Low	Health & Safety
Environment Management System	Environment Management System	Medium	Medium	Low	Low	Environment
Materials / Technology						
Material Procurement	Material Procurement	Medium	Medium	Low	Low	Procurement
Tool & Equipment	Tool & Equipment	Medium	Medium	Low	Low	Tool & Equipment
Technology	Technology	Medium	Medium	Low	Low	Technology
Machines / Senior Management						
Machine Maintenance	Machine Maintenance	Medium	Medium	Low	Low	Machine
Senior Management	Senior Management	Medium	Medium	Low	Low	Senior Management
Environment / External Stakeholders						
Local Community	Local Community	Medium	Medium	Low	Low	Community
Regulators	Regulators	Medium	Medium	Low	Low	Regulators
Other Stakeholders	Other Stakeholders	Medium	Medium	Low	Low	Other Stakeholders

Figure 3. FMEA Assessment Extract

Lean Initiative Improvements & Impact

Five key areas were assessed to identify areas for improvement and we undertook initiatives to ensure that our continuous improvement approach operated for the benefit of our internal and external stakeholders (see Table 2). A key focus was put on our People and providing further training, a review of our Methods and Systems, the Materials and Technology used, continuous reviews with our Senior Management, and a review of our dealings with External Stakeholders.

Extract from Action Plan	
1. People	Develop a list of Roles and Responsibilities and apply names to each. Allocating tasks to staff members and identifying names on audit check list. More focus on the importance of good QAQC and need for compliance. New staff inductions / training staff
2. Methods / Quality Systems	Become more aware of new starts / develop a training pack / manual. Audits to take place every 2 weeks on every project. Develop a manual to show what items will be deducted a score and by how many points
3. Materials / Technology	Engage early in the project to agree a single platform. Create training plans for staff. Full onboarding / induction programme with follow up reviews
4. Machines / Senior Management	Demonstrate data findings to raise awareness of issues. Continue with Lean Training, holding Lean Meetings and offering an opportunity for staff to suggest better ways of working. Agree names to manage each item on list with entire team and individuals
5. Environment / External Stakeholders	Early engagement with client and their design team. Identify design shortfalls before project starts. Early engagement with project team, further education, raise awareness of issues. Single platform with strict controls in place to manage the flow of information. Early engagement with design team and inspectors - agree status and system to be used.

Table 2. Action Plan Tasks to Achieve Goals

Following the planned actions and improvements achieved, a positive outcome can be seen in the pareto charts, with the updated pareto chart showing findings from quality audits carried out from 01.10.20-26.03.21. The Voice of the Process has changed to show some positive impacts and new opportunities to improve our ISO 9001:2015 Quality Management System. Notably, there was a shift in the audit findings during our review period. Due to the ever-changing complex environment from project to project, the top five common items will inevitably continue to change over time.

Opportunity	Last Planner	Review Sep 19-Sep 20		Review Oct 20-March 21		Status	
		ID	Top 5 Opportunities	NOTR	ID	Top 5 Opportunities	NOTR
1. Inspections	12	1	DT reports	13	New Opportunity		
2. Dianes	10	2	Minutes	10	New Opportunity		
3. Two Peg Test	10	3	Inspections	08	Positive Impact		
4. First In Place	10	4	Dianes	10	No Change		
5. SR21	10	5	First In Place	06	Positive Impact		
			Two Peg Test		Positive Impact - no longer in top 5		
			SR21		Positive Impact - no longer in top 5		



Figure 4. Last Planner and Action Plan Extract

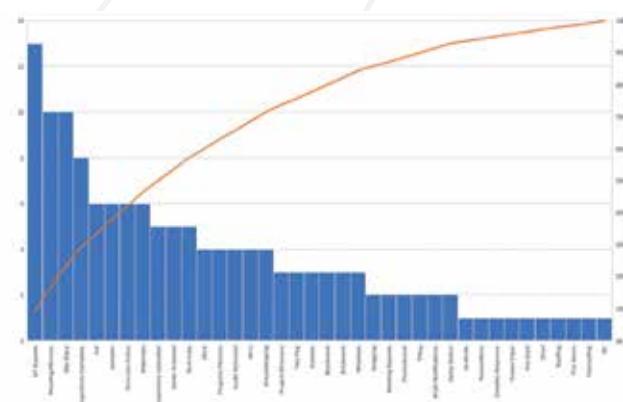


Figure 5. Pareto Chart Showing New & Updated Opportunities

It should also be noted that our quality audits consist of approximately 80 subject items which are assessed during each audit, and which includes a documentation review both on-site and off-site, including a visual inspection of our works on-site. Table 3 presents the top five opportunities identified ('NOTR' = number of times raised) during Sep 2019-Sep 2020 and Oct 2020-March 2021 with notable changes in the opportunities between these periods.

Review from Sep 19-Sep 20			Reviewed Oct 20-March 21			Status
ID	Top 5 Opportunities	NOTR	ID	Top 5 Opportunities	NOTR	
1. Inspections	DT reports	13	New Opportunity			
2. Minutes	Minutes	10	New Opportunity			
3. Inspections	Inspections	08	Positive Impact			
4. Dianes	Dianes	10	No Change			
5. First In Place	First In Place	06	Positive Impact			
	Two Peg Test		Positive Impact - no longer in top 5			
	SR21		Positive Impact - no longer in top 5			

Table 3. Top 5 Opportunities Identified

DBL also took the opportunity to Value Stream Map its auditing process so as to adapt and change to improve the system for our auditors. This allowed us to review our list of items within the audit

check sheet and the time it took to conduct an audit. The sequence of questions was also reviewed to correspond with our filing system to make the system most efficient for our auditors. Our visual inspection lists were also assessed at that time to ensure that we captured a sufficient range of construction elements that required inspection across all CSA and MEP elements.

Additional items are assessed during each audit, and it is clear where improvements have been made along with new opportunities for our staff and teams to focus on. There have been 412 audits carried out across 23 projects in recent years, which demonstrates our continued focus on Quality Control within DBL. The number of audits depends on the number of projects live at any given time, and 37 audits were carried out between 01.10.20 and 25.03.21. The average score over this period was 95.6 which was achieved following a key focus on our action plan items and the top five common items identified during that period.



Figure 6. Audit Findings

Overall, our target to reach 95 and above was achieved and this is a successful outcome for our organisation. DBL will continue to raise

its standards and achieve those high expectations with our Quality Management System throughout our company to ensure that we continue to deliver best-in-class service to our internal and external customers including our clients and end users.

The next phase of the project will be to focus on improving new opportunities identified during the period 01.10.20-26.03.21, and we have seen improvements with the current status showing consistency in achieving 95 and above from Mar 2021-Aug 2021. DBL also monitors its KPIs on a monthly basis, and this is a critical aspect to improving all opportunities identified on an ongoing basis and coincides with our PDCA procedures. The cycle of continuously improving will continue as data is gathered throughout the auditing process to identify opportunities that can and will be improved to raise our standards further.

In terms of training and development, 85 of our staff have undertaken various Lean training courses, including the LCi Lean Pass (via Crystal Lean Solutions), Yellow Belt training, Green Belt training and Diploma in Quality Management – Lean Systems at the University of Limerick. Our focus on Continuous Improvement, Automation, and Standardisation is key to the continued success at DBL, and we look forward to our ongoing Lean Construction journey. DBL has managed to retain its target of 95 and above average, and, in some cases, projects have exceeded 96. Benefits from our regular audits are shared amongst our project teams and clients, by way of reducing waste through eliminating defects, rework, introducing change management, and eliminating over-production for the benefit of the project. Other benefits to our comprehensive auditing system include ensuring that we continue to deliver a competitive service and continuation of delivering high-quality right first time everytime. Our systematic approach ensures our Quality Management system minimises rework, which is closely linked with our auditing system. Credit must be given to our project management and quality management team and quality auditors for their continued endeavours to deliver high-quality projects for our clients on each and every project.