



**Sustainable Development through Quality Management: A
Multiple-Case Study Analysis of Triumphs, Trials and
Tribulations**

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Sustainable Development through Quality Management: A Multiple-Case Study Analysis of Triumphs, Trials and Tribulations

Abstract:

Purpose: In a highly competitive and globalised era, agile organisations proactively steer towards sustainability. This situation persuaded the organizations to align Quality Management (QM) initiatives to achieve sustainable outcomes. This study aims to explore quality-sustainability linkage, explicitly focusing on attaining the prestigious IAQ *Quality Sustainability Award*. Further it investigates, the impact of QM as a strategy for promoting Sustainability to meet sustainable development goals (SDGs).

Methodology: Due to the lack of substantial literature connecting QM to Sustainability, the current research adopted an explanatory multiple-case study. Six cases were purposively chosen for the study. Three cases of those who have achieved the prestigious IAQ *Quality Sustainability Award* and remaining have been selected that have fallen short of receiving the award. A detailed within-case and cross-case examinations involving six cases that reported their QM achievements aligned with SDGs.

Findings: The findings demonstrate the significant role of QM adoption in achieving positive results from the perspective of SDGs, such as reduced environmental impacts, improved operational efficiency and enhanced quality of life. Effective stakeholder collaboration, proficiency in analytical tools and strategic alignment with SDGs emerged as critical success factors. Conversely, weak linkage with sustainability and unclear approaches were crucial challenges in attaining the IAQ *Quality Sustainability Award*.

Implications: This paper outlines essential commandments for organisations actively seeking to promote Sustainability. It offers valuable insights for decision-makers, facilitating a profound understanding of the challenges and opportunities in pursuing sustainable performance.

Originality: The distinctive nature of this study lies in its dedicated exploration of the intricate relationship between QM deployment and its true impact on the achievement of the SDGs.

Keywords: Quality management, Sustainability, Sustainable Development Goals, International Academy for Quality, Case Studies

1. Introduction

The ever-increasing customer demand for quality products emerges as a substantial environmental concern (Goyal *et al.*, 2019). In an era characterised by dynamic technological, social and environmental changes, an organisation's ability to sustain competitive advantages has become a real challenge. Consequently, agile organisations are progressively steering toward Sustainability. They are committed to embracing multiple strategies to achieve SDGs efficiently and effectively (Abbas, 2020). Indeed, QM principles undeniably stand at the forefront in this world of sustainable development (Kuei and Lu, 2013), playing a pivotal role in enhancing the organisational triple bottom line (TBL) (Alsawafi *et al.*, 2021). Recognising the significance of quality-sustainability linkage, many organisations pursue the prestigious International Academy for Quality (IAQ) *Quality Sustainability Award*, demonstrating their unwavering commitment to excellence while adhering to sustainable practices.

The IAQ *Quality Sustainability Award* was established in 2020 to recognise the strategic utilisation of QM principles, methodologies and tools in achieving a sustainable development approach (IAQ, 2023). While the United Nations (UN) developed a holistic definition of SDGs as part of "*Agenda 2030*", it does not provide explicit guidance on the actionable measures for organisations seeking to embark on a sustainability transition (Medne *et al.*, 2020). Scholars acclaimed the positive outcomes of QM adoption in terms of sustainable development. Nevertheless, it is imperative to stress that achieving sustainable progress in economic, social and environmental dimensions should not be isolated objectives. Instead, the imperative lies in connecting the achieved sustainability initiatives with the overarching SDGs.

Interestingly, this integration is a pivotal criterion for organisations aspiring to attain the prestigious award, underscoring the importance of aligning their sustainability efforts with SDGs (Antony *et al.*, 2023). In this vein, this research attempts to identify the fundamental prerequisites for achieving the IAQ *Quality Sustainability Award* through real-world multiple case studies. In doing so, we aspire to foster a deeper understanding of the challenges and opportunities that await organisations in their quest for a sustainable and prosperous future. More specifically, this paper is guided by the following research objectives (ROs) and associated questions (RQs).

RO1: To determine the critical components for effectively integrating QM with Sustainability.

RQ1a: What QM principles, tools and techniques can align QM projects with Sustainability?

RQ1b: What are the success/failure factors in attaining the IAQ *Quality Sustainability Award*?

RO2: To understand the level of contribution from the execution of QM projects towards sustainable performance.

RQ2a: What results are attained from the perspective of UNSDGs and their impact on case study organisations?

RQ2b: What are the case studies' Key takeaways and managerial/practical implications?

The rest of the article follows this pattern. Section 2 reviews the literature, whereas Section 3 describes the methodology. Section 4 presents the study results, and Section 5 provides a comprehensive discussion. Section 6 concludes the article with reflections and future research ideas.

2. Literature Review

2.1 QM and Sustainability

QM emphasises customer attention, continuous improvement, and fact-based choices via concepts, processes, and tools (Hellsten and Klefsjö, 2000). It pertains to doing things right the first time (De Menezes *et al.*, 2022), essential for demonstrating sustainable development in organisations (Isaksson *et al.*, 2023). QM stems from the recognition that the products supplied to customers and services rendered to them constitute the pivotal element in sustaining and increasing the customer base (Stanciu *et al.*, 2014). Overall, sustainability is becoming a stakeholder expectation and operationalized via the TBL (financial, social, and environmental components) (Alsawafi *et al.*, 2021). Remarkably, the QM toolbox fits sustainability considerations through its inherent focus on meeting and exceeding customers' needs that influence sustainable organisational performance (Bastas and Liyanage, 2018).

The research on integrating QM with sustainable development has evolved significantly, pointing to this conjunction's importance (Carnerud *et al.*, 2020). Siva *et al.* (2016) have focused on the QM methodologies, tools and practices incorporated with sustainable development initiatives through management and environmental management systems. Moreover, Bastas and Liyanage (2018) systematically reviewed the literature on integrating

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3 QM across the supply chains and Sustainability, establishing key research themes, challenges
4 and new avenues for further integration to enhance TBL aspects of Sustainability. Focusing on
5 lean as a QM tool, Martínez León and Calvo-Amodio (2017) reviewed the literature to examine
6 the interrelationships between lean and Sustainability, framing their analysis on Lean impact
7 on the operational, social, financial and environmental performance. Also, De Menezes *et al.*
8 (2022) performed a literature review to investigate how universities could better benefit from
9 QM in achieving sustainable development.

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12 The topic of integrating and executing QM and Sustainability may be answered empirically by
13 researching their relationship. Allur *et al.* (2018) presented a conceptual and empirical study
14 of the literature on the intricate effect of QM on corporate Sustainability in general and
15 environmental practices in specific, mainly from various viewpoints, models, and methods.
16 The results of an empirical study by Olaleye *et al.* (2023) validated the significant influence of
17 TQM deployment on sustainable performance based on data collected among employees in the
18 hospitality sector in Nigeria. However, the findings indicated that the mediating role of
19 perceived organisational support could strengthen this link. Similarly, Fok *et al.* (2023)
20 strongly supported TQM practices and corporate culture on the TBL dimensions of
21 Sustainability by surveying 441 managers in the US business. Ali AlShehail *et al.* (2022), in
22 an empirical study conducted on the public service sector in the UAE, revealed a positive direct
23 impact of TQM on service innovation and sustainability performance.

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26 Moreover, Alsawafi *et al.* (2021) demonstrated that internal QM in employee relations,
27 management relations and quality training significantly affected corporate Sustainability based
28 on data collected from UK manufacturing firms. Also, Govindan *et al.* (2014) found a positive
29 influence of Lean on the sustainable TBL performance of the supply chain in a case study
30 conducted on the Portuguese automotive sector. Another interesting study by Ali *et al.* (2021)
31 emphasised the potential role of Lean, Six Sigma and Environmental Sustainability on Small
32 and Medium Enterprises (SMEs) environmental, operational and business performance.

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35 The studies also showed that QM improves environmental, social, and financial outcomes
36 (Besseris, 2012; Cherrafi *et al.*, 2016; Siva *et al.*, 2016; Zhu *et al.*, 2013). For example, Ruben
37 *et al.* (2018) proposed a framework that integrates Lean Six Sigma (LSS) with the
38 environmental aspects associated with the manufacturing process. This framework helps
39 organisations to reduce waste, cost, environmental impact and other operational deficiencies.

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3 Ben Ruben *et al.* (2017) developed a DMAIC (Define, Measure, Analyse, Improve, Control)
4 based LSS approach, incorporating environmental considerations, to minimise carbon footprint
5 within the automotive industry in India. Further, Rathi *et al.* (2022) put forth a structured Green
6 Lean Six Sigma (GLSS) framework to enhance operational efficiency alongside promoting
7 social and environmental Sustainability. Marrucci *et al.* (2020) utilised DMAIC from LSS to
8 evaluate the waste management system in the supermarket, centering the analysis on its carbon
9 footprint. The study reduced 1630.08 kg CO₂-eq in total emissions and generated annual cost
10 savings exceeding € 20,000. Also, Trubetskaya *et al.* (2023) applied LSS with an ISO 50001
11 energy management system to optimise energy consumption in an Irish dairy plant operation,
12 resulting in an almost 50% reduction in CO₂ footprint.
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22 **2.2 Linkage of Sustainable Performance to United Nations Sustainable Development** 23 **Goals (UNSDGs)**

24 In 2015, the UN created 17 sustainable development goals (SDGs) (Figure 1) attained to
25 achieve by the 2030 Agenda (United Nations, 2015). SDGs were introduced to cover
26 environmental, social and business global sustainability issues (Isaksson *et al.*, 2023). For
27 instance, local employment and ensuring the rights of employees to proper welfare and health
28 support Goal 3 (Good Health and Well-being) and Goal 8 (Decent work and Economic
29 Growth), which in turn reduce poverty (Goal 1). Simultaneously, promoting gender equality
30 and fostering inclusive employment practices contribute to Goal 5 (Gender Equality) and Goal
31 10 (Reduced Inequality). Moreover, reducing emissions plays a role in advancing Goal 9
32 (Industry, Innovation and Infrastructure) through the utilisation of innovative technologies
33 while reusing materials contributes to Goal 12 (Responsible Consumption and Production)
34 (Alamouh *et al.*, 2021).
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Figure 1: United Nations 17 Sustainable Development Goals (Source: United Nations, 2015)

Since the time SDGs came into action, organisations worldwide commend their efforts to achieve these goals within their mission and align their organisational goals with the SDGs (Hörisch, 2021). In this vein, Nonet *et al.* (2022) suggested a conceptual framework to promote the successful implementation of SDGs through multi-stakeholder partnerships. Also, NorDan Ap in Sweden focuses on seven SDGs as part of their strategy for sustainable development (Kroslid, 2022). Goals 8 and 11 were selected to resonate with local values, while Goals 3 and 5 were pinpointed to emphasise human resources. Goals 9 and 12 were utilised to manage resource consumption, and Goal 17 was incorporated to engage customers. Additionally, Yang *et al.* (2022) found that the usage of online education technology during COVID-19 establishes a cornerstone for Goal 4 (quality education) and accommodations provided during quarantine support Goal 1 (No poverty). The authors admitted that the procedures to control the virus spread slowed the production, leading to better air quality, aligning with Goal 11 (sustainable cities and communities).

However, a significant question arises as to whether sustainability measures and actions of QM deployment genuinely contribute to achieving the UNSDGs, thus underscoring the primary objective that this study aims to address the RQs put forth in the Introduction section.

3. Research Methodology

Due to the lack of substantial literature connecting emerging QM to Sustainability, the current research adopted an explanatory multiple-case study. This approach aimed to provide preliminary insights and facilitate the development of well-founded, generalisable propositions (Eisenhardt and Graebner, 2007; Flechsig *et al.*, 2022). Therefore, researchers explored the relationship of QM with Sustainability case studies to bridge this research gap. Eisenhardt (1989) suggests that six cases are sufficient to account for maximum variation of the phenomenon by studying six comprehensive phenomenon understudy. The six cases were purposively sampled into three those who have achieved the prestigious IAQ *Quality Sustainability Award*, demonstrating the successful integration of QM principles with sustainability goals. Figure 2 presents an overview of our primary research themes.

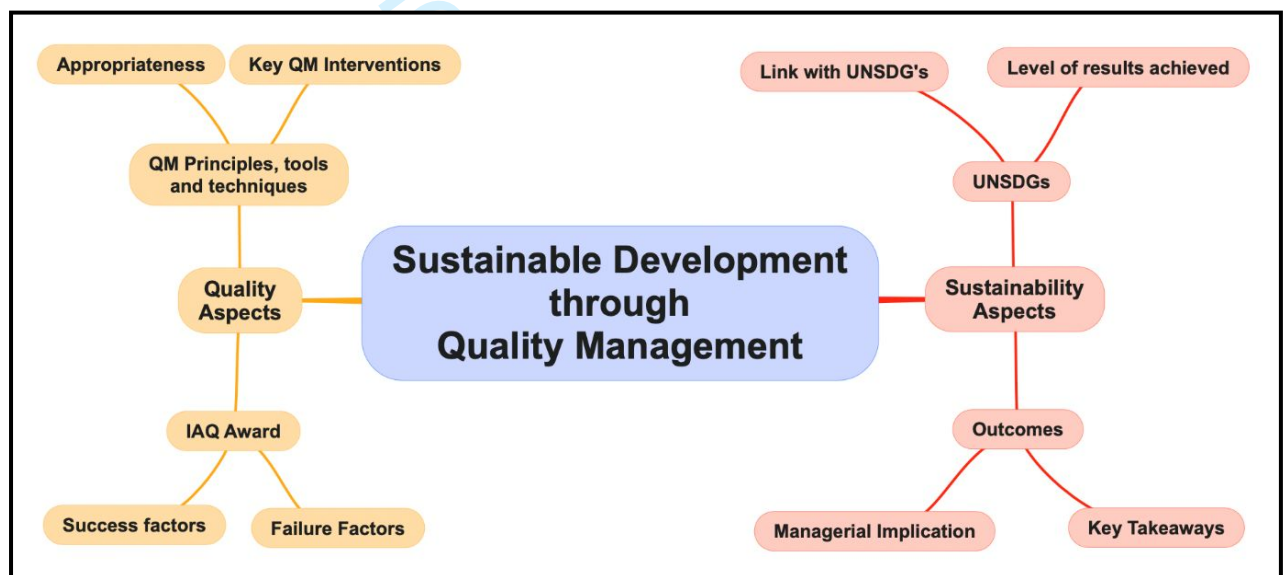


Figure 2: Research Themes

Further, for the analysis, three more cases have been selected that have fallen short of receiving the award to comprehend the lacuna in the projects. This method was chosen due to its capacity to elucidate ambiguous boundaries and interdependencies between the phenomenon of successful relationships between QM and Sustainability and its contextual factors (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). In our paper, the case study refers to individual organisations where QM-linked Sustainability projects are executed and have applied for the award. The authors followed the research model proposed by Stuart *et al.* (2002) to structure the current research process. This model involved several steps: formulating our research questions, designing the study, selecting suitable cases, collecting data, and analysing it.

3.1 Study Design and Case Selection

The present research employed a blended inductive-deductive approach to investigate the influence of QM and Sustainability. The authors' connections with the IAQ, the premiere QM Academy, facilitated the search for suitable participants. To ensure external validity, we employed theoretical sampling (Eisenhardt and Graebner, 2007) to select a diverse range of cases, including three organisations with well-established QM and sustainability links, evident through the IAQ awards. Also, we considered three issues from organisations that were unsuccessful in clinching the award. This resulted in the selection of polar opposite cases to account for sufficient variation in the selection of cases (Eisenhardt, 1989). This approach offered insights into potential biases and obstacles hindering successful QM and Sustainability links.

3.2 Data Collection

We contacted participating organisations before the case analysis, outlining the research project and its privacy aspects. These efforts ensured the informants possessed the requisite knowledge (Stuart *et al.*, 2002). We obtained secondary documents about various projects that each organisation considered the best representative of QM and the Sustainability link.

3.3 Data Analysis

The analysis began by deducing main categories from the content, guided by the secondary documents about the QM and Sustainability projects. Subsequently, studies were conducted to extract codes and develop inductive subcategories encompassing QM and Sustainability links. The analysis was subjected to both within-case and cross-case analyses, facilitating the extraction of overarching patterns rather than isolated insights (Eisenhardt, 1989).

4. Results

4.1 Case Study A:

- *About the Company and Problem Statement*

Company A has plants in India, Sri Lanka, and Bangladesh. They make innovative, high-quality tyres for many cars. Despite their excellent sustainability rating, tires produced mainly from petroleum have a significant carbon footprint. Consumption accounts for 98% of the carbon impact. The case study's long-term aim is to reduce carbon emissions by 35% over six

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3 years via annual tyre size reductions and a 35% decrease in Passenger Car Radial (PCR) tyre
4 rolling resistance coefficient (RRC).
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8 • ***QM principles, tools and techniques used***

9 The firm first executed the project using the TQM framework and policy deployment methods.
10 TQM is integrated into technical methods like Finite Element Analysis (FEA), Simulation, and
11 Rapid Prototyping. Engagement with external experts and suppliers has been executed for
12 intellectual interventions. Through policies and processes, the organisation established annual
13 technical objectives. The objective is deployed across the R&D department using the Goal-
14 Mean technique. For verifying and optimising the components, statistical methods such as
15 Analysis of Variance (ANOVA), Hypothesis testing, Design of Experiments (DOE), and
16 Analytical Hierarchy Process (AHP) are used. Kaizens and Quick-win approaches were
17 consistently applied.
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22 • ***Benefits of the projects and their impact on Sustainable Performance***

23 Adopting QM methods and practices has led to competitive results, affecting corporate
24 performance. Company A cut its RRC by 38% and its carbon footprint by 37%. More notably,
25 TRR exceeded its goals and greatly influenced 3 UNSDGs (11, 12 and 13). UNSDG 11 benefits
26 from decreasing air pollution from fuel usage. Tyres' carbon footprint is reduced via the
27 effective use of petroleum resources for vehicle mobility and reduced raw material
28 consumption, boosting UNSDG 12. Progress also reduced carbon footprint and emissions,
29 promoting UNSDG 13.
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42 • ***Key takeaways and linking to learning***

43 The company created QM philosophy, models, and roadmaps for QM project deployment
44 linked to UNSDG. According to the case study, organisational trust, cooperation, and
45 collaboration must be linked to SDGs. Also, new technology, renewable energy and
46 infrastructure are critical for enhancing the firm's energy efficiency. In addition, organizations
47 must train project members in DOE, hypothesis testing, Simulation, and Root-Cause analyses
48 before the projects.
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56 • ***Managerial/Practical Implications***

57 The organisation's "Less is more" approach, continuous improvement, and resource utilisation
58 ensured the projects' success. Ideation, concept creation, idea selection, iterative prototype
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3 testing, and implementation are essential for SDG-related QM projects. Continuously assessing
4 fresh opportunities and process knowledge may turn promise into performance. The project
5 implementation team institutionalized its results throughout the organisation by training
6 additional groups. Each project's approach and methodologies are applied to similar company
7 and supply chain circumstances. Lessons from these activities were embedded in the
8 knowledge management system.
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15 **4.2 Case Study B:**

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17 Company B, the world's largest producer of commercial vehicles based in India, focused on
18 reducing phosphate sludge generation in the Cab pre-treatment line. The company faced
19 challenges in exceeding the authorised limit, which is expected to increase by 20% yearly. To
20 address this, the project focused on process innovation and material optimization to
21 significantly reduce phosphate sludge generation.
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- 28 • ***QM principles, tools and techniques used***

29 The Six Sigma-DMAIC methodology was used to deploy this project and reduce the Phosphate
30 Sludge generation reduction. This structured approach ensured systematic problem
31 identification, measurement of current processes, root cause analysis, solution implementation,
32 and ongoing control to maintain improvements. Further, the Fish Bone (or Ishikawa) diagram
33 was utilised to categorise and pinpoint potential causes of the problem. Also, Risk Analysis
34 was conducted to foresee and mitigate potential challenges associated with solution
35 implementation. Additionally, Control Plans were established to monitor and ensure the
36 consistency of the improved processes. The project also embraced hands-on Gemba
37 observations for real-time insights and conducted various lab tests to validate the proposed
38 solutions' effectiveness.
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- 50 • ***Benefits of the projects and their impact on Sustainable Performance***

51 The mean phosphate sludge has been significantly decreased from 6.92 g/sq.m to 4 g/sq.m,
52 along with water requirements reduction from 180 KL to 120 KL annually, contributing
53 towards UNSDG 6. Furthermore, there was a decrease in the carbon footprint attributed to
54 reduced energy consumption. These transformative outcomes closely align with UNSDG 12.
55 In addition, reduced carbon footprint and emissions impacted UNSDG 13. Eventually, the
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3 project resulted in a financial benefit of 80K USD and improved productivity by 12% by
4 reducing the phosphating process time from 90 seconds to 60 seconds. This contributes towards
5 UNSDG 8.
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10 • ***Key takeaways and linking to learning***

11 The project emphasised the importance of a structured approach to problem-solving using the
12 DMAIC methodology. Challenges like high moisture content in Phosphate sludge and old-
13 generation chemicals were identified through root-cause analysis. Gemba walks and lab tests
14 provided real-time insights, while risk analysis addressed potential challenges. Collaboration
15 with suppliers helped to an exploration of new-generation chemicals. The project's success
16 demonstrates the power of combining quality management philosophy with practical tools and
17 techniques for impactful results.
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25 • ***Managerial/Practical Implications***

26 The case study emphasises the need for managers to anticipate potential risks, engage in
27 thorough analysis, and collaborate effectively with stakeholders, such as suppliers, to achieve
28 desired outcomes. It indicates that if QM is integrated with SGDs, outcomes will ensure
29 compliance with regulatory standards and translate to cost savings for the organisation.
30 Furthermore, the QM projects linked to SDGs will provide substantial outcomes when
31 *Innovation* is part of the theme. Overall, the study is a testament to the synergy of strategic
32 managerial oversight and hands-on practical interventions in achieving organisational
33 objectives.
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42 **4.3 Case Study C:**

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44 • ***About the Company and Problem Statement***

45 Company C, based in Jiangsu Province, China, is committed to sustainable development and
46 environmental protection. In 2016, they joined the UN Global Compact and initiated projects
47 to address energy and emission challenges in the steel industry. The company has implemented
48 a QM project in line with the UNSDGs, aiming to achieve ultra-low emissions and energy
49 consumption in the iron and steel industry. The project focused on energy conservation and
50 emission reduction in the steel smelting and rolling process.
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57 • ***QM principles, tools and techniques used***
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3 The project utilised benchmarking analysis for the ultra-low emission transformation of the
4 sintering process, comparing indicators and reference values to set achievable targets.
5 Additionally, the Six Sigma methodology played a pivotal role, especially in reducing unit gas
6 consumption of reheating furnaces. Within the Six Sigma framework, tools such as Voice of
7 Customers (VOC), macro flowcharts, Measurement System Analysis (MSA), Cause-and-
8 Effect matrix, FMEA (Failure Mode and Effects Analysis), Hypothesis testing, DOE, and
9 Control Charts were applied. Tools and methodologies improved energy conservation and
10 emission reduction by identifying inefficiencies, setting targets, and implementing solutions.
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19 • ***Benefits of the projects and their impact on Sustainable Performance***

20 The successful integration of QM methodologies has led to considerable resource efficiencies.
21 Reduction in particulate matter emissions by about 256 tons, sulfur dioxide emissions by about
22 758 tons, and nitrogen oxide emissions by approximately 1,480 tons annually effectively
23 promoted the realisation of UNSDG 3 and UNSDG 9. The outcomes resulted in a financial
24 saving of 2.3 million USD. The total natural gas consumption has reduced by 3 million m³,
25 while freshwater consumption has decreased by 3.2 million tons. The comprehensive energy
26 consumption per ton of steel has recorded a decrease of 5.7%, which is directly in line with
27 UNSDG 7. From a social perspective, the company's recognition as one of the first green
28 factories aligns with UNSDG 12 principles. Furthermore, obtaining three patents indicates a
29 proactive approach to promoting UNSDG 8's sustainable practices.
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39 • ***Key takeaways and linking to learning***

40 Firstly, it is re-confirmed that the selection of appropriate comparable indicators (in this case,
41 particulate matter, SO₂, and NO_x) are always crucial for benchmarking and setting achievable
42 targets. The project highlighted the importance of having a benchmark for comparison to
43 realise project goals. Secondly, measurement emerged as a central theme. The project
44 underscored the significance of considering the influence factors of repeatability and
45 reproducibility among various measurement properties. This focus on measurement
46 demonstrated that continuous assessment is crucial in identifying core challenges and ensuring
47 effective problem-solving. These insights emphasise the necessity of meticulous planning,
48 benchmarking, and continuous evaluation in achieving Sustainability and environmental goals.
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58 • ***Managerial/Practical Implications***

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3 High-emission industries must have a strategic alignment with global environmental goals.
4 This improves their company brand and assures long-term viability in a sustainable
5 environment. Managers should also set SDG-aligned standards and performance measures.
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7 This project's outcome (emission reduction) demonstrates the synergy between Six Sigma and
8 SDGs. Project findings show that global initiatives like the UN Global Compact persuade and
9 support industries to strive for SDG-linked QM projects.
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15 **4.4 Case Study D:**

16 • ***About the Company and Problem Statement***

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18 Company D, based in the UAE, conducted a QM project in the airport to manage a surge in
19 passenger traffic due to increased tourism and business activities. It focussed on innovation,
20 security, and communication to implement strategies to enhance the efficiency and operational
21 capacity of the Hold Baggage Screening (HBS) System and employee productivity. The goal
22 was to increase clearance rates and overall baggage screening efficiency without outsourcing
23 operations, hiring staff, increasing budgets, or involving third-party solutions.
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30 • ***QM principles, tools and techniques used***

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32 The project adopted the TRADE methodology, a comprehensive approach that involves
33 searching for and implementing cutting-edge practices. The methodology emphasises
34 exchanging information and best practices to enhance the performance of processes, goods,
35 and services. The project utilised various situational analysis tools, including the fishbone
36 diagram, PESTLE (Political, Economic, Social, Technological, Legal, Environmental)
37 analysis, SWOT (Strength, Weakness, Opportunity, Threat) analysis, and future foresight
38 trends for airport security. Key Performance Indicators (KPIs) were introduced to monitor the
39 performance in real-time and daily. This helped in assessing the efficiency of the HBS process.
40 The project emphasised the importance of establishing a communication chain and involving
41 higher management and stakeholders in its development. This approach helped to address
42 strategic challenges and ensure alignment with the company's objectives.
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52 • ***Benefits of the projects and their impact on Sustainable Performance***

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54 QM techniques improved baggage clearance rates by 4.53%, improving operational efficiency.
55 This improvement saved 18.3 million USD. By not hiring more screeners, the company saved
56 782 million USD and achieved UNSDG 8. The business also educated 122 screening analysts
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3 and contributed to UNSDG 4. Clearance rates at HBS inspection levels increased, with the 5th
4 level bag count dropping from 58,069 to 15,281, addressing UNSDG 9. Reducing 6th-level
5 passenger summons from 908 to 21 also helped achieve UNSDG 16. (Peace, Justice, and
6 Strong Institutions). Additionally, public awareness campaigns achieved over 270,000 views,
7 and passenger satisfaction rose from 4.33 to 4.39, supporting UNSDG 17. This underlines
8 QM's importance in SDG achievement. Quality has been emphasised to enhance operational
9 and financial elements in 10 months. Other long-term consequences and environmental
10 Sustainability have not been explored.
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19 • ***Key takeaways and linking to learning***

20 The project utilised the TRADE Best Practice Benchmarking Methodology to identify,
21 implement, and evaluate best practices. Tools like Fishbone diagram and PESTLE analysis
22 were used to understand challenges. Real-time KPIs, stakeholder engagement, compliance, and
23 training were emphasised for continuous improvement and achieving QM goals.
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29 • ***Managerial/Practical Implications***

30 The project emphasised the importance of aligning sustainability initiatives with organisational
31 goals, engaging stakeholders, monitoring progress, adhering to legal frameworks, and
32 continuous training. It also highlights the value of refining processes, technology, and resource
33 allocation.
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39 **4.5 Case Study E:**

40 • ***About the Company and Problem Statement***

41 Craft talents are found across India, but product and process quality challenges have limited
42 their ability to reduce poverty and empower women via economic growth. NGOs and small
43 groups have tried to address this issue, but scaling up has been difficult owing to women's
44 unwillingness to leave their homes for employment due to family duties. Company E in
45 Ahmadabad, India, adopted this challenge to ensure women work from home and deliver
46 quality products through the QM project. They also wanted to help the company grow its B2C
47 brand and ensure sustainability.
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57 • ***QM principles, tools and techniques used***

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3 While tools such as Kaizen, Six Sigma, TQM, and Root Cause Analysis served as the
4 foundation for their work, these tools often failed in a rural setting, especially when dealing
5 with illiterate rural women. Thus, they shifted their primary focus to visual communication of
6 defects, their analysis, improvement, prevention, and the cost of defects. The women were
7 made to understand images and videos in the local language and the physical products
8 displayed before them. The team simplified their knowledge of quality processes to make them
9 easily understandable and linked to outputs that the women could easily measure. This involved
10 adapting traditional quality tools to a format that was more accessible and understandable to
11 the rural artisans.

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20 • ***Benefits of the projects and their impact on Sustainable Performance***

21 Company E has achieved the desired results from the perspective of UNSDGs. According to
22 the project, it resulted in tenfold revenue growth, contributing to UNSDG 8, 12 and 17. Also,
23 it created economic opportunities that contributed to UNSDG 1. Furthermore, the attainment
24 of UNSDG 5 is evident through the project's outreach from 350 women in 2015 to 16000
25 women. In addition, there has been a massive increase in customers from 1,000 to more than
26 50,000 since 2015. In addition, the company's expansion from 350 women in 2015 to 16,000
27 women today ensured the attainment of UNSDG 5 and 10. Moreover, the increase in the
28 company's artisans' contribution to household income from 5% in 2015 to over 25%
29 contributed to UNSDG 8. Besides, the tripling of wages for full-time artisans at the company
30 since 2015 helped to address UNSDGs 8 and 10.

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40 • ***Key takeaways and linking to learning***

41 Quality projects in large companies differ significantly from those in remote social businesses.
42 Sustainability involves responsible management of the planet, people, products, packaging,
43 and processes. Current quality processes prioritise efficiency and product quality, reducing
44 rework and resources. QM processes ensure transparency and circularity, as demonstrated at
45 Company E.

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52 • ***Managerial/Practical Implications***

53 The company's model demonstrates decentralised production in rural areas, ensuring product
54 consistency and Sustainability. Local leaders' grassroots quality control suggests a scalable
55 approach for other sectors. Customised and localised solutions yield socio-economic benefits.
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4.6 Case Study F:

- ***About the Company and Problem Statement***

Company F, founded in 2004, manages Jia Ding New City in China, focusing on sustainable practices, a conducive business environment, and residents' quality of life. They identified three challenges in urban development: unsustainable growth, unfavourable business environments, and neglecting residents' quality of life. Despite infrastructure improvements, these initiatives often fail to cater to the holistic well-being and needs of the inhabitants. Thus, QM initiatives are adopted to address SDGs.

- ***QM principles, tools and techniques used***

The Benchmarking approach was used to understand local conditions and highlight regional characteristics compared to other international cities. An Urban Quality Index Model is used and focused on six aspects: economic growth, innovation vitality, urban management, residents' lives, social development, and ecological environment. A Quality-Responsible Matrix was established, including all relevant parties involved in the project construction. On-site recording of Concealed Works was carried out for works with covered processes that are difficult to check. Smart City Management involved constructing an intelligent traffic guidance system and a comprehensive traffic information regional control platform. VOC was conducted to analyse citizens' satisfaction with urban life. Business Environment Evaluation was carried out based on the World Bank's ten indicators of business environment evaluation. These tools and techniques were instrumental in formulating development plans, attracting investment and income to the city, promoting inclusive and sustainable development, and improving living and business environments.

- ***Benefits of the projects and their impact on Sustainable Performance***

The project has resulted in the preservation of 640,000 kWh of electricity and 600 tons of standard coal. Furthermore, it successfully curtailed 1360 tons of CO₂ emissions, significantly reducing the city's carbon footprint and perfectly aligning with UNSDG 11. Moreover, the quality index of urban development is improved. Also, the greening rate has reached 40%, thus contributing to the UNSDG 11 by ensuring an inclusive, safe, accessible, green and sustainable city. Additionally, the number of high-tech enterprises increased by 41%, effectively accomplishing UNSDG 9 by enhancing scientific research and elevating the industrial sector.

- ***Key takeaways and linking to learning***

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3 The project emphasised tailoring urban development plans to Jia Ding's unique characteristics,
4 leveraging the quality index for advanced planning and high-quality outcomes. It also
5 introduced a modern comprehensive service industry model, prioritising first-class functional
6 services for residents.
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12 • ***Managerial/Practical Implications***

13 The project emphasises affordable housing, inclusive planning, and environmental
14 considerations, stressing the need for a holistic approach to urban development. Cities should
15 integrate these facets into their strategies, involving stakeholders and ensuring all parties have
16 a say. QM tools like benchmarking and resident satisfaction evaluations can be generalised for
17 other cities. Cities should prioritise environmental, social, and economic Sustainability in their
18 growth strategies, creating vibrant, inclusive communities and fostering innovation, job
19 creation, and economic growth. Figure 3 provides a summary of all the case studies.
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Case Study	Case Study - Theme	Quality Aspects		Sustainability Aspects	
		Principles, tools and techniques used	Key QM interventions	Benefits realized	Takeaways/ Implications
					
A	Sustainability through Fuel Efficiency 	<ul style="list-style-type: none"> TQM ANOVA Story Board DOE ANOVA Inferential Statistics AHP Simulation 	<ul style="list-style-type: none"> Kaizen activities boosted project team confidence and motivation. Policy deployment ensured top level management engagement. Statistical techniques enabled robust inference. Rapid prototyping and simulation maximised resource usage. 	<ul style="list-style-type: none"> Introduced the product a year in advance of the schedule. Reduced RRC by 38% and carbon footprint by 37%. The lower carbon footprint directly influences UNSDG 12. Reduced emissions impacted UNSDG 13. Reduced air pollution from lower gasoline use affects UNSDG 11. 	<ul style="list-style-type: none"> Company-wide deployment requires cross-functional teams. Empowering team members to coach other groups expands activities. Supplier ecosystems must be included to maximise advantages. System effectiveness requires knowledge management and learning.
B	Reducing Hazardous Waste for Sustainable Production 	<ul style="list-style-type: none"> Six Sigma DMAIC Methodology Cause Validation Fish Bone Diagram Risk Analysis Control Plan Gemba Observation Change Management Actions Feasibility Studies Control Charts 	<ul style="list-style-type: none"> MSA played a vital role in the project. Root-cause analysis helped to identify and validate potential causes. The team reduced waste by innovating the process. Risk analysis assured solutions did not harm other metrics. The initiative modified control methods, trained, and shared case studies. 	<ul style="list-style-type: none"> The project decreased phosphate sludge from 6.92 to 4 g/sq.m, supporting SDG 12. The initiative lowered energy use and carbon footprint, supporting UNSDG 13. The project reduces DM water requirement from 180 KL to 120 KL, supporting UNSDG 6. By lowering phosphating time from 90 to 60 seconds, the project saved 80K USD and increased productivity by 12%, supporting UNSDG 8. 	<ul style="list-style-type: none"> Targeted interventions significantly reduce hazardous waste. Innovation optimises resource use and production quality. Reduced energy use helps fight climate change. Sustainable practices increase economic development and productivity. Quality culture allows companies and locales to replicate successful actions. Sustainability efforts meet regulatory requirements and global goals.
C	Transformative Sustainability in Steel Production 	<ul style="list-style-type: none"> Six Sigma Methodology Macro Flowchart VOC MSA CE Matrix FMEA Hypothesis Testing DOE Control Chart 	<ul style="list-style-type: none"> Benchmarking Analysis helped to set the project metrics. Process Excellence and Variability Reduction helped regulate the process. Data-driven decisions yielded reliable results. Systematic Experimentation optimised processes. Quality increased with continuous monitoring. 	<ul style="list-style-type: none"> Particulate matter, sulphur dioxide, and nitrogen oxide reductions supported UNSDG 3 and 9. Reduced natural gas, freshwater, energy, and electricity consumption per tonne of steel by 3 million m³, 3.2 million tonnes, and 23.58%, supporting UNSDG 7 conservation efforts. The initiative won the First Prize in State Scientific and Technological Progress Award, promoting UNSDG 8 and 12. 	<ul style="list-style-type: none"> Supporting environmental goals has several benefits. SDG-aligned benchmarks ensure impactful outcomes. Innovative technologies help to achieve SDG targets. Continual assessment is vital to SDG alignment. Conservation initiatives promote Sustainability. Sustainable innovations drive growth. Green factory status underscores Sustainable Production.
D	Merging Quality Management with Innovation for Enhanced Safety and Efficiency 	<ul style="list-style-type: none"> TRADE Best Practice Benchmarking Methodology Fishbone Diagram PESTLE Analysis SWOT Analysis Future Foresight Trends for Airport Security Situational Analysis Tools. 	<ul style="list-style-type: none"> Real-time KPIs improved performance monitoring. Better luggage screening was achieved with a new inspection level. Public awareness initiatives reduced luggage restrictions. Collaboration assisted in legal compliance. Training and skill development enabled deployment successes. Engagement and stakeholder input improved quality. 	<ul style="list-style-type: none"> Financial benefits and savings in hiring costs helped to achieve UNSDG 8. Trained 122 screening analysts and contributed to UNSDG 4. Improvement in inspection addressed UNSDG 9. Reduced passenger summoning helped to attain UNSDG 16. Public awareness campaigns assisting in achieving UNSDG 17. 	<ul style="list-style-type: none"> Compliance with regulations is essential. Sustainability initiatives must align with legal frameworks. Set and surpass targets for optimal outcomes. Training boosts sustainable performance. Effective Communication aids sustainability goals. Embrace continuous improvement. Skill and technology integration are critical. Engage stakeholders for sustainable success.
E	Empowerment through Sustainable Craftsmanship 	<ul style="list-style-type: none"> Kaizen Six Sigma TQM Root Cause Analysis Visual Communications Decentralized Quality Control 	<ul style="list-style-type: none"> Distributed Manufacturing Model helped decentralization. Quality at source improved productivity. Visual Communication reduced defects. Traceability System reduced waste. Simplified Traditional Tool Adaptations reduced change resistance. Direct B2C Sales Platform improved performance. 	<ul style="list-style-type: none"> A tenfold increase in revenue contributes to UNSDG 8 The firm helped 16,000 women & achieved UNSDGs 5 and 10. The company's craftspeople promote UNSDGs 8 and 10 by contributing 25% to household income. Since 2015, the platform has grown to cover UNSDGs 12 and 17. The company's wage tripling since 2015 addresses UNSDGs 8 and 10. 	<ul style="list-style-type: none"> QM needs local context adaptation. Visual Communication assists in error-proofing Decentralized production maximises resource use. Empowerment leads to Economic Growth Supply chain management is critical for Sustainability QM and sustainability projects need traceability. A holistic quality approach is needed to achieve SDGs. Sustainable beyond profit thinking supports SDGs QM must be considered as a Tool for Sustainability
F	Sustainable Urban Development with a Holistic Approach 	<ul style="list-style-type: none"> Benchmarking Quality Index Model of Urban Development Quality-Responsible Matrix VOC Business Environment Evaluation 	<ul style="list-style-type: none"> Comparing procedures and performance to industry standards revealed gaps and enabled adjustments. Measured economic growth and ecological environment in urban development. Project charted helped to achieve the goals. Recorded self-inspection and random inspection image data for covered processes. An intelligent traffic guiding system and regional traffic information control platform were implemented. Assessed city convenience for business using World Bank factors. 	<ul style="list-style-type: none"> Improving urban development quality addressed UNSDGs 11.3 and 11.7. Increasing sewage treatment, residential waste treatment, and garbage categorization coverage helped achieve UNSDG 11.6. Enhanced initiation and delivery rates for affordable home building facilitated the accomplishment of UNSDG 11.1. Increased high-tech businesses in the city boosted UNSDG 9. 	<ul style="list-style-type: none"> Urban Development Quality Index ensures sophisticated planning and development. Business Environment Evaluation encourages inclusive city development and investment. A complete service paradigm for modern communities is established by Community Services. KPIs helps to aligning with sustainable city goals. Environmental sustainability is achieved through eco-development. Environmental sustainability can be achieved through improved residential areas and affordable home building. More high-tech companies and better business environment scores promote growth.

Figure 3: Summary of Within-Case Analysis

4.7 Cross Case Analysis:

4.7.1 QM tools and technique usage

The QM tools and techniques used in the case studies vary based on the nature of the challenges addressed in each case study. The case studies utilised analytical tools such as SWOT Analysis, PEST/PESTLE Analysis, and Benchmarking Analysis to assess the current situation, identify opportunities for improvement, and compare with best practices or standards. Both the B and C case studies from the first set (A, B, C – successful in winning IAQ Award) and the F from the last set (D, E, F –unsuccessful in winning IAQ Award) utilised Six Sigma methodology to eliminate defects and improve processes.

The first three case studies (A, B, C) utilised more technical QM tools and techniques such as Taguchi Robust DOE Techniques, Process Decomposition, and Flue Gas Denitration Technology, focusing more on technological improvements in manufacturing and production processes. In contrast, the last three case studies (D, E, F) utilised more strategic and holistic QM tools and techniques, such as Urban Development Quality Indexes, Quality Index Model of Urban Development, and Quality-Responsible Matrix, focusing more on strategic planning and urban development. In the first set of case studies, the QM tools and techniques are more specific to the problems being solved. For example, Hypothesis Testing, Process Capability Studies, DOE, Six Sigma, and Variable Control Charts are all used to solve specific problems. In the last set of case studies, on the other hand, the QM tools and techniques used are more general. They can be used by novice users to solve problems, like with the Fishbone Diagram, KPIs, Benchmarking and SWOT.

4.7.2 Integration of QM and SDGs

All six case studies leverage QM principles, methods, and tactics to solve challenges and advance numerous SDGs. Each of these solutions involved several stakeholders to solve problems systematically. The first three case studies focused on manufacturing and its environmental impact. However, the next three case studies simultaneously addressed urban and societal expansion. The first three scenarios show how production and manufacturing technology may reduce environmental impact. The next three case studies address airport security, handcraft production, and urban development using technological, social, and strategic methods.

4.7.3 UNSDG Linkage, Coverage and Leverage

UNSDG Linkage: The first group of case studies primarily concerned with environmental Sustainability and economic growth, such as access to clean water and sanitation facilities, low-cost and renewable energy sources, and climate action [UNSDGs 3, 6, 7, 8 (twice), 9 (twice), 11, 12 (thrice), 13 (twice)]. In contrast, the second group places a greater emphasis on social development and global collaborations, with targets including universal primary education, gender equality, decreased inequality, and global justice and peace [UNSDGs 4, 5, 8, 9 (twice), 10, 11, 12, 16, 17 (twice)].

Coverage: The first group of case studies looked at ways environmental consequences may be mitigated by applying technical advancements to manufacturing and production processes. In contrast, the last group of case studies tackled issues with wider societal and economic implications by looking at airport security, handicraft manufacturing, and urban development.

Leverage: The case studies in both groups used various methods and instruments. However, these varied in character depending on whether the problems they tackled were technical or strategic.

4.7.4 The Critical Success Factors (CSFs) for Winning IAQ Awards

- The first three case studies that won the IAQ Sustainability Award were precisely aligned with UNSDGs, significantly impacting these goals and thus receiving higher scores (Figures 4 and 5).
- Successful projects correctly used appropriate quality methods and tools, such as Six Sigma DMAIC, MSA, Pugh, Hypothesis testing, process control, and risk analysis, which helped them integrate QM with SDGs.
- Projects that won the award had a clear roadmap to institutionalising the outcomes achieved and advancing SDGs.

4.7.5 The Critical Failure Factors (CFFs) of Missing IAQ Award

- Projects with a weak linkage with Sustainability or were more focused on quality than Sustainability received lower scores.
- Projects that lacked clarity in the approach and how it linked to the results achieved could not clinch the award.
- Projects with limited potential to be leveraged to other products, processes, or organisations received lower scores.

- Projects that were more akin to starting a business or an investment program rather than a quality or sustainability project fell outside the scope of the award and received lower scores.

In addition, Figures 4 and 5 summarise the cross-case analysis. Figure 4 displays the IAQ-created criteria used to evaluate the project for the prizes. It uses "No or very little indication (0-2 Marks)", "Some indication (3-4 Marks)", "Indication (5-6 Marks)", "Clear Indication (7-8 Marks)" and "Widespread Indication (9-10 Marks)" with weightage in a ten-point scale. The same scale and results are used for the analysis in this project.

Note: Rubrics for the analysis - No or minimal indication; Some indication; Indication; Clear Indication; Widespread Indication










Particulars 			Quality Aspects 			Sustainability Aspects 			Won IAQ Award?
Case Study	Country	Type of the Industry	Are appropriate QM tools and techniques selected and used?	Is the link between the QM approach and UNSDGs clear?	Is the project innovative and a breakthrough to attain UNSDGs?	Are good and trustworthy results achieved with appropriate links to UNSDGs?	Can the results be leveraged to other products /processes/organizations?	How many UNSDGs are addressed, and what is their impact?	
A	India	 Manufacturing	Clear Indication	Indication	Clear Indication	Clear Indication	Indication	Clear Indication	Yes
B	India	 Manufacturing	Clear Indication	Clear Indication	Clear Indication	Clear Indication	Clear Indication	Clear Indication	Yes
C	China	 Manufacturing	Clear Indication	Indication	Indication	Clear Indication	Indication	Clear Indication	Yes
D	UAE	 Service	Widespread Indication	Indication	Some Indication	Some Indication	Indication	Some Indication	No
E	India	 Manufacturing	Some Indication	No or Very Little Indication	Indication	Clear Indication	Clear Indication	Clear Indication	No
F	China	 Service	Some Indication	Some Indication	Indication	Clear Indication	Some Indication	Clear Indication	No

Figure 4: Meta-Analysis of Case Studies








IAQ Award	QM Tools and Techniques	Integration of QM with UNSDGs	UNSDG Linkage, Coverage and Leverage	Critical Success/Failure Factors
  Successful case studies (A, B, & C)	 <ul style="list-style-type: none"> • Policy Deployment • AHP • DOE • Hypothesis Testing • Kaizens and Quick-win Opportunities • Six Sigma DMAIC Methodology: • MSA • Process Capability Studies • Variable Control Charts • Risk Analysis • Process Decomposition • Benchmarking Analysis Method 	 <p>Nature of Challenges Addressed: Focused on industrial processes and their environmental implications, such as tyre rolling resistance, carbon footprint, phosphate sludge formation, and air pollution.</p> <p>Specific UNSDGs Targeted: Mainly contributed to UNSDGs related to environmental Sustainability, such as UNSDG 6, 9, 11, and 13.</p> <p>Scope of Impact: Focused on technological and environmental advancements in manufacturing and production processes to decrease environmental effects.</p>	 <p>Linkage: UNSDGs 3, 6, 7, 8 (twice), 9 (twice), 11, 12 (thrice), 13 (twice)</p> <p>Coverage: Environmental Sustainability</p> <p>Leverage: Computer-aided simulation, statistical tools, technology roadmap approach, Six Sigma DMAIC Methodology, MSA, Process Capability Studies, Process Decomposition, Benchmarking Analysis Method, SCR Flue Gas De-nitration Technology.</p>	 <ul style="list-style-type: none"> • Clear Alignment with UNSDGs • Use of Appropriate Quality Methods and Tools • Institutionalization of results
 Unsuccessful case studies (D, E, & F)	<ul style="list-style-type: none"> • Fishbone Diagram • PESTLE Analysis • Future Foresight Trends • KPIs • Benchmarking Methodology • Distributed Manufacturing Model • Visual Communication of Defects • Urban Development Quality Indexes • PEST Analysis • SWOT Analysis • Quality-Responsible Matrix 	<p>Nature of Challenges Addressed: Broadened to encompass social and urban development issues such as airport security, rural women artisans, and urban development quality.</p> <p>Specific UNSDGs Targeted: Contributed to a broader range of UNSDGs, including those related to social development and economic growth, such as UNSDG 1, 5, 8, 12, and 16.</p> <p>Scope of Impact: Used technological, sociological, and strategic methods to improve airport security, handicraft manufacturing, and urban development, affecting society and the economy.</p>	<p>Linkage: UNSDGs 4, 5, 8, 9 (twice), 10, 11, 12, 16, 17 (twice).</p> <p>Coverage: Social development, Economic growth, Environmental Sustainability</p> <p>Leverage: Fishbone Diagram, PESTLE and SWOT Analysis, Benchmarking Methodology, Distributed Manufacturing Model, Visual Communication, Urban Development Quality Indexes, Quality Index Model of Urban Development, Quality-Responsible Matrix</p>	<ul style="list-style-type: none"> • Weak Linkage with Sustainability • Lack of Clarity in Approach and Results • Limited Leverage Potential • Outside of the Award, the Scope

Figure 5: Cross-case Analysis of Case Studies

5. Discussion

The case studies demonstrate the importance of integrating QM principles with sustainability goals to address specific challenges and contribute to achieving various SDGs. The managerial and practical implications highlighted in the case studies include the need for strategic alignment with global sustainability goals, proactive engagement with stakeholders, continuous monitoring and evaluation, and adopting new technologies and innovative approaches. Similar outcomes are highlighted by Bhat *et al.* (2023) in their research from the perspective of effective deployment of QM initiatives. For example, one case study emphasises the need for managers to anticipate potential risks, collaborate effectively with stakeholders, and integrate innovation into their strategies to achieve desired outcomes and ensure compliance with regulatory standards. This means quality managers must foresee risks and consider their initiatives' environmental effects. However, this contradicts the findings of Husnaini and Tjahjadi (2020), who believe QM may hurt green innovation. Another case study highlights the importance of regularly refining processes, harnessing technology for efficiency, conducting public awareness campaigns, and judiciously allocating resources. Besides, one

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3 more company manifests its commitment to efficient resource management through its concern
4 for society, reflecting a positive approach toward Sustainability and emphasising a culture of
5 continuous improvement. The above findings are supported by the study of Siva *et al.* (2016),
6 who mentions similarities between managing quality and Sustainability, including focusing on
7 customer satisfaction and continuous improvement. Thus, quality managers can effectively
8 integrate and manage Sustainability projects if a supporting ecosystem is established.
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15 It is important to note that case studies D, E and F could not clinch the award due to their
16 inability to establish a transparent correlation between QM-driven outcomes and their tangible
17 role toward sustainable objectives, including the crucial connection to UNSDGs. In Case Study
18 D, the project's limited integration with sustainability principles and weak alignment with
19 UNSDGs impacted its chance of receiving the award. While the achievements of Case Study
20 E are impressive, the project failed to provide a detailed demonstration of how QM tools were
21 instrumental in achieving these significant results. More importantly, the QM methodologies
22 used in this project are subject to failure within the rural context if they are not clearly
23 understood. Thus, the company has adapted the methods based on the idea that "simplification
24 can help to achieve the same results faster". Still, it is imperative to recognise that sustainable
25 performance surpasses achieving immediate results by building a culture of excellence and
26 continuous improvement. Hence, it becomes crucial to establish a more distinct connection
27 between the QM practices and their influence on achieving the UNSDGs. In addition,
28 Company F failed to receive the award due to a lack of link with established quality methods,
29 and the project outcomes were challenging to replicate.
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43 Overall, the results underscore the importance of a systematic approach to problem-solving,
44 stakeholder engagement, technological innovation, and efficient resource management in
45 achieving organisational objectives and contributing to sustainable development (Antony *et*
46 *al.*, 2023). This has broader implications for society as it promotes inclusive and sustainable
47 development, enhances corporate reputation, and ensures long-term viability in a world
48 increasingly focused on Sustainability.
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55 From a QM perspective, addressing UNSDGs involves ensuring that processes are efficient,
56 effective, and sustainable. For the first set of case studies, the focus on environmental
57 Sustainability (UNSDGs 6, 7, 12, 13) suggests an emphasis on managing processes to minimise
58 environmental impact, an essential aspect of QM (Antony *et al.*, 2023). For the second set of
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3 case studies, the focus on social equality, peace, and partnerships (UNSDGs 4, 5, 10, 16, 17)
4 suggests an emphasis on managing processes to ensure social equity and collaboration, which
5 are also essential aspects of QM.
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10 Based on the research outcomes, the authors would like to propose ten commandments for
11 effectively integrating QM with SDGs (Figure 6). These proposed commandments are
12 established based on the implications and lessons learned from 6 case studies. Nevertheless,
13 the proposed commandments are limited because they need to be validated. Thus, more case
14 studies will be considered in the project's next phase to validate the proposed ten
15 commandments. In addition, a Delphi study will be adopted to improve and bring robustness
16 to the commandments.
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24 **Theoretical implications**

25 The article's case studies demonstrate how organisations may strategically connect their
26 objectives with SDGs, integrate important stakeholders, monitor in real-time, comply with
27 regulations, emphasise training and innovation. This strategy is theoretically supported by
28 QM's basic tenets, such as customer focus, continual improvement, and evidence-based
29 decision-making (Talib *et al.*, 2013). The article's outcomes are also consistent with prior
30 research on green practices and sustainable performance, focusing on organisational culture
31 and comprehensive QM (Fok *et al.*, 2023) and the effect of supply chain management practices
32 on Sustainability (Govindan *et al.*, 2014). The research bridges theory and practice by showing
33 how QM ideas may be used in the real world to address sustainability concerns and achieve
34 organisational objectives.
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45 **Practical Implications**

46 This study might improve operating efficiency, environmental impact, and attainment of SDGs.
47 The case studies may help the organisation strive for competitive advantages, save money,
48 increase its reputation, and secure long-term success. The findings may be used in the
49 classroom, and policymakers will better understand the pros and downsides of merging QM
50 with Sustainability. An approach for analysing QM projects' impact on sustainable
51 performance is discussed. It discusses implementation challenges when merging QM with
52 environmental goals.
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Contribution to the Society

Findings illustrate how to integrate QM into sustainability activities. This provides an overall picture to organisations to adopt UNSDGs to improve environmental, social, and economic outcomes. It also emphasises aligning business goals with global environmental goals. The public views proactive organisations more favourably. The case studies also indicate that QM and Sustainability improve operational efficiency, environmental impact, and product and service quality, raising living standards. Notably, the article emphasises stakeholder participation for effective QM and Sustainability projects, advocating a more collaborative and inclusive approach to sustainability concerns.



Figure 6: Ten commandments for integrating QM with SDGs based on the outcomes of research

6. Conclusions

The case studies indicate that a structured approach to problem-solving is critical to integrating QM projects with Sustainability. In addition, collaboration with stakeholders and proficiency in analytical and statistical tools are crucial components for aligning QM projects with SDGs. Moreover, it is observed that to integrate QM with SDGs, it is essential to have a quality culture, teamwork, collaboration, adoption of new technology, and innovation. Besides, it is ascertained that "Effective Alignment with UNSDGs", "Appropriate use of Quality Tools and Techniques", and "Scope for Institutionalization Outcomes" were the CSFs that clinch the *IAQ Quality Sustainability Award*. On the other hand, it is derived that "Weak Linkage with Sustainability", "Lack of Clarity in Approach and Results", and "Limited Leverage Potential" were the CFFs to attain the award.

The case studies demonstrate that the execution of QM projects can lead to positive results from the perspective of UNSDGs, such as reduced environmental impacts, improved operational efficiency, and enhanced quality of life. Organisations that successfully integrate QM with SDGs achieve their immediate project goals and contribute to broader sustainability objectives, thereby gaining a competitive advantage. This integration fosters a culture of continuous improvement and innovation, which is essential for long-term viability. Moreover, it enhances the organisation's reputation and stakeholder relationships by demonstrating a commitment to ethical and sustainable practices. These impacts are not confined to specific sectors or regions. However, they are generalisable across different types of organisations aiming to achieve a balance between QM and Sustainable Development.

Besides, the case studies indicate that anticipating potential risks, engaging in thorough analysis, collaborating effectively with stakeholders, and integrating innovation into strategies help to achieve desired outcomes. Also, the research outcome emphasises the need for strategic oversight and hands-on practical interventions to achieve organisational objectives and contribute to Sustainable Development. Eventually, case studies in the article demonstrate that integrating QM principles, tools, and techniques with sustainability goals can lead to significant improvements in sustainable performance and contribute to the advancement of the UNSDGs.

The case studies are based on companies located in the Asian continent, which may limit the generalizability of the findings to other regions or countries with different cultural, economic,

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3 or regulatory contexts. Also, the case studies focus on specific sectors, which may limit the
4 applicability of the findings to other sectors or industries. However, multiple-case study
5 analysis can establish causal relationships between the variables studied. The scope for further
6 research includes expanding the geographical and industrial scope of the study, conducting a
7 detailed analysis, implementing longitudinal and quantitative studies, exploring policy
8 implications, gathering stakeholder views, examining the impact of technological
9 advancements, developing standardised metrics, and conducting comparative studies between
10 successful and unsuccessful organisations. These avenues will contribute to the existing body
11 of knowledge to develop a roadmap for the effective integration of QM and SDGs.
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