

INTEGRATION OF TQM FRAMEWORK WITH AI

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Abstract: The importance of quality is becoming increasingly prominent across all areas of society, including modern management. The heightened competition in the global market has made quality a crucial strategic element for achieving business success and a vital principle for organizations aiming to secure a competitive edge in a landscape marked by liberalization, globalization, and a more educated customer base. The introduction of Total Quality Management (TQM) has played a significant role in shaping contemporary management practices. Implementing TQM is essential for enhancing product and service quality, boosting customer satisfaction, strengthening competitive advantages, increasing market share, and improving a company's reputation and value. In today's competitive environment, TQM is vital for fostering continuous improvement and upholding high standards. With the advent of Artificial Intelligence (AI), businesses can further enhance their TQM practices. This article examines how the integration of the Total Quality Management Framework with AI is revolutionizing quality management practices, resulting in more efficient and data-driven processes.

Key words: TQM, business excellence, quality management system, quality of product-service, AI, Jeda.ai.

1. INTRODUCTION

At the dawn of the new century, we have observed many significant changes and new challenges confronting the management of modern companies. As markets have globalized, businesses are facing intensified competition and more informed customers. Only those organizations that consistently enhance their skills and performance can thrive under these circumstances. Quality has emerged as a crucial element for companies to adapt to environmental changes, making quality management one of the most essential responsibilities for their leadership. Total Quality Management (TQM) is a comprehensive strategy aimed at achieving long-term success through prioritizing customer satisfaction and enhancing quality. The integration of AI into this framework introduces innovative aspects to TQM by leveraging technology to streamline decision-making, minimize human error, and boost operational efficiency.

In today's competitive business environment, Total Quality Management (TQM) continues to be crucial for fostering continuous improvement and upholding high standards. The integration of Artificial Intelligence (AI) empowers companies to enhance their TQM practices even further. This article examines how the Total Quality Management Framework, augmented by AI, is revolutionizing quality management practices and resulting in more efficient, data-driven processes. The study consists of three mayor stages.

The first stage considers the transition from the concept of quality control to digital-friendly TQM. The second stage considers possible challenges related to introducing digital innovations into the company's practice. Practical example of integrating the TQM with AI is elaborated in the third stage. For this purpose, AI Jeda has been used. Jeda.ai is the world's first Multi-model AI Online Whiteboard, utilizing Multimodal Generative AI technology to produce a range of visual contents including AI Flowcharts, AI Diagrams, AI Wireframes, AI Arts and more. The multimodal Generative AI Workspace enhances ideation, collaboration, and decision-making processes.

2. TQM IN THE CONTEXT OF DIGITALISATION

Total quality management (TQM) is a term first used to describe a management approach to quality improvement. Since then, TQM has taken on many meanings but at its core it describes a management approach to long-term success through customer satisfaction. It is a systemic approach that realizes connections between different elements of the organization, so that the overall effectiveness of the system is greater than the sum of the parts. All this shows that TQM is not an

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isolated activity, as well as the specific situation nor stable situation, but it is a dynamic and multi-dimensional concept that includes a large number of elements. [1]

Total Quality Management (TQM) in the context of digitalization refers to a management approach focused on improving organizational processes, products, services, and culture by emphasizing quality in all aspects of the business, leveraging digital technologies. Key aspects include: [2]

Data-Driven Decision Making: Utilizing data analytics tools to gather insights from operations, customer feedback, and market trends to inform decisions.

Continuous Improvement: Implementing digital tools that facilitate ongoing assessment and refinement of processes (e.g., agile methodologies, Kaizen).

Customer-Centricity: Using digital platforms to enhance customer feedback loops, enabling better understanding of customer needs and preferences.

Integration of Technology: Employing software and systems (like ERP and CRM) to streamline workflows, improve communication, and ensure consistency in quality standards.

Employee Involvement: Engaging employees through digital collaboration tools, fostering a culture of quality and empowerment across all levels of the organization.

By integrating TQM principles with digitalization, organizations can enhance operational efficiency, improve customer satisfaction, and drive overall quality improvements.

While many established IT solutions are currently utilized in the development stage of TQM, such as electronic document management (EDM), enterprise resource planning (ERP), and customer relationship management (CRM) systems, these technologies heavily rely on people, their knowledge, and skills. In this context, digital transformation represents a significant advancement by transitioning manual quality management tasks into a digital format. A prominent trend in the digitalization of TQM is the registration and analysis of data, which are among the most labor-intensive aspects of implementing a Quality Management System (QMS). By reducing costs and enhancing the efficiency of information storage and processing systems, organizations can measure and record all factors that impact product quality. Big data systems enable the analysis of complex and rapidly evolving datasets from multiple sources [3]. The evolution of Quality Management has been illustrated in the Figure 1.

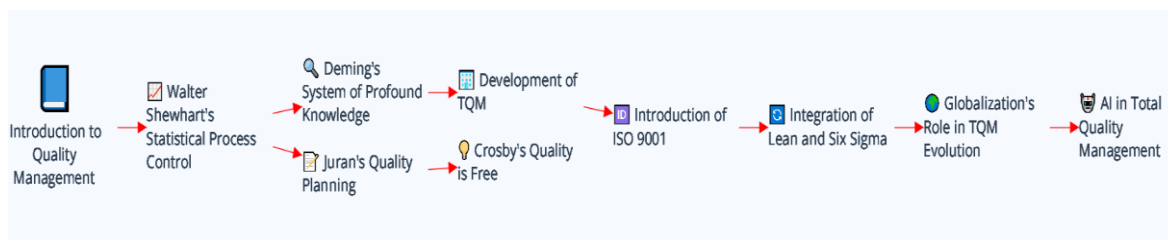


Figure 1 – Evolution process of Total Quality Management powered by Jeda.AI

The term "Quality 4.0" was introduced in 2017 by LNS Research and refers to a collection of modern practices and quality management tools designed for the Industry 4.0 context [4]. Quality 4.0 covers not only production processes but the entire product life cycle, including marketing, research and development (R&D), procurement, production, logistics, sales, after-sales service, as well as administration and management. The advantages of Quality 4.0 include real-time monitoring of processes, data collection, advanced analytics, and predictive modelling. A comparison of the "Traditional quality" and "Quality 4.0" concepts is shown in Table 1.

Table 1 – Traditional Quality vs Quality 4.0

	Traditional Quality	Quality 4.0
Input	Marketing research, management review	Key performance indicators (KPI)
Output	Standards, regulations, instructions	Analytical data

Decision making	Applying Statistical Methods	Application of analytics, software, IT, AI for real time data analysis
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3. THE ADVANTAGES OF INTEGRATING TQM WITH AI

The literature mentions a large amount of evidence which tends to show that companies that have successfully implemented TQM have numerous benefits of TQM, which is most evident in the significantly improved performance [5]-[7].

A fundamental aspect of Total Quality Management (TQM) is the ongoing monitoring and enhancement of processes to attain a high standard of quality. This approach encourages continual improvements as the company, its customers, and the dynamic environment evolve over time. In essence, a quality management system should be viewed as a dynamic entity that adapts, learns from errors, and consistently improves to deliver superior results.

The main application of artificial intelligence involves utilizing machine learning to enhance or substitute human actions and decision-making processes. This is usually achieved by analysing extensive datasets, categorizing them into various areas, and uncovering patterns and insights that can inform and refine the overall model. In this context, a key aspect of machine learning parallels TQM by emphasizing continuous improvement based on insights derived from data [8].

The TQM Framework with AI is transforming the way businesses approach quality and efficiency. At its core, Total Quality Management (TQM) is a strategic approach focused on continuous improvement, customer satisfaction, and eliminating waste to reduce the cost of poor quality (COPQ). This framework promotes collaboration across teams, which ultimately drives consistent process improvement, making it essential for companies looking to thrive in today's competitive market [9].

AI can enhance the Total Quality Management (TQM) framework in several impactful ways:

- **Real-Time Quality Inspections:** The Company implements AI-powered computer vision systems on the production line to conduct real-time quality inspections of parts as they are manufactured. These systems analyse images of the parts for defects, such as scratches, misalignments, or incorrect dimensions.
- **Predictive Maintenance:** Alongside quality inspections, the company uses machine learning algorithms to monitor the performance of machinery. By analysing historical data and IoT sensor readings, AI predicts when a machine is likely to experience a breakdown. This allows the maintenance team to perform proactive maintenance, minimizing unplanned outages that could affect production quality.
- **Customer Feedback Analysis:** Following the sales, the company employs natural language processing (NLP) to analyse reviews and feedback from customers. AI categorizes the comments and identifies common issues or areas for improvement, such as durability or fitment.
- **Continuous Improvement:** Using the insights gained from the quality inspections and customer feedback, the company conducts regular quality improvement meetings. The AI systems provide data-driven recommendations that guide teams in refining production processes and making design adjustments.

By integrating AI into the TQM framework, organizations can achieve greater quality consistency, enhance operational efficiency, and ultimately improve customer satisfaction. By leveraging AI throughout its TQM practices, the company enhances its quality management, strengthens its competitive advantage, and continually evolves its processes based on real-time data and insights.

4. IMPLEMENTING A TQM FRAMEWORK WITH AI

A fundamental aspect of Total Quality Management (TQM) is the ongoing assessment and enhancement of processes to achieve high-quality standards. This approach supports continuous improvement as the organization, its customers, and the dynamic environment evolve over time. In essence, a quality management system should be viewed as a living entity that learns from its errors and strives for ongoing improvement to deliver superior results.

TQM is essential across multiple industries, ensuring that products and services not only meet established standards but also surpass customer expectations. With the continuous advancement of technology, the incorporation of artificial intelligence (AI) is transforming traditional business processes. In this blog, we will delve into the significant impact of AI on quality management, emphasizing its ability to improve efficiency, accuracy, and decision-making in the quality process [10].

In the future, AI might allow for more personalized products and services, enhancing the customer experience. Businesses will be able to cater to individual customer preferences by analysing detailed data insights. As AI technologies advance, we may see autonomous systems managing quality control without human intervention. This could redefine the Framework with AI, driving even greater efficiencies in TQM practices.

Table 2 presents concepts of applying AI in TQM in different industries:

Table 2 – Industry applications of AI in TQM

Industry	Concept of AI application in TQM
Manufacturing	In the manufacturing sector, AI is crucial for quality management. AI-powered visual inspection systems are employed to assess product quality, detect defects, and maintain product consistency.
Healthcare/Life Sciences	The use of AI in healthcare and life sciences greatly impacts quality management. AI-driven algorithms play a crucial role in medical diagnosis and quality assessment, facilitating accurate and timely evaluations. Additionally, real-time monitoring of patient safety through AI systems helps prevent adverse events and ensures the delivery of optimal healthcare quality.
Software Development	In software development, AI-driven testing and code quality analysis are vital for delivering high-quality software products. AI facilitates automated bug detection and resolution, which minimizes software defects and enhances overall product quality.
Food & Beverage Industry	Quality control is essential in the food and beverage industry for maintaining product safety and consistency. AI is employed to monitor and analyze multiple parameters during production and packaging processes. AI-driven systems can identify contaminants, ensure proper labeling, and optimize quality assurance protocols.
Energy and Utilities	AI is increasingly applied in quality management within the energy and utilities sector. In renewable energy systems like solar panels and wind turbines, AI-driven monitoring systems can detect performance deviations, enabling timely identification of maintenance needs and optimization of energy production.

Following steps should be taken in order to create a TQM framework using the AI.

4.1. Step 1: Identify Key Quality Metrics

Start by defining the key quality metrics you want to track, such as customer satisfaction, defect rates, and employee engagement. AI tools can assist in measuring and tracking these metrics automatically.

4.2. Step 2: Choose AI Tools That Fit Your Needs

To effectively implement a Framework with AI, select AI tools tailored to your industry and business needs. Examples include machine learning algorithms for predictive analytics or chat-bots for customer feedback collection.

4.3. Step 3: Integrate AI into Existing Processes

Seamless integration of AI into your TQM processes is vital for success. Ensure your AI solutions are compatible with existing systems and train your team on how to utilize them effectively.

4.4. Step 4: Monitor and Adjust

AI models need continuous monitoring to ensure they provide accurate results. Establish a regular review process to assess the effectiveness of AI solutions in your Total Quality Management Framework and make adjustments as necessary.

The illustrative example of integration of Jeda.ai to create the TQM Framework for Car wrap & branding workshop with the aim at owners seeking to improve business performance and expand the existing market, has been presented in Figure 2.

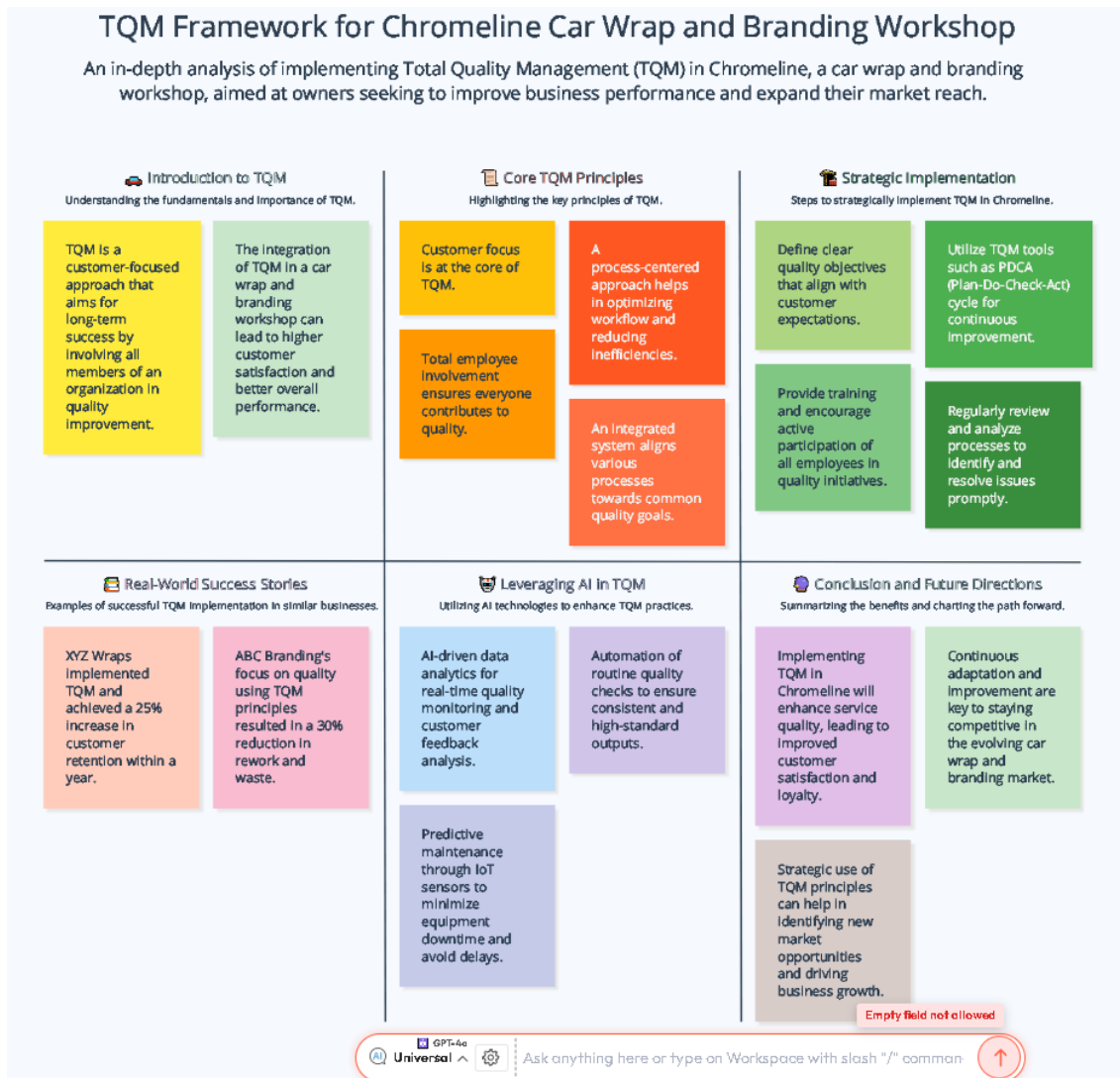


Figure 2 – TQM framework with Jeda.AI integration

Apart from all the benefits that integration of AI in TQM framework brings, following are challenges and considerations that should be taken into account in implementing AI in TQM:

- **Data Privacy and Security**

Implementing AI in a Total Quality Management Framework raises concerns around data privacy and security. Ensure that AI tools comply with industry standards to protect sensitive information.

- **Employee Adaptation**

Employees may require training to adapt to AI-driven tools. Effective change management and communication are essential to help employees embrace new technology.

- **Continuous Monitoring**

AI models need regular updates and monitoring to remain effective. Businesses must allocate resources to ensure that AI tools function optimally.

5. CONCLUSION

TQM is a process whose basic idea is that the quality is not producible but is to be managed. Artificial Intelligence can help us constantly work toward higher-quality systems by helping us know “what” to improve.

The integration of AI into the TQM framework is a game-changer for businesses. It streamlines processes, enhances decision-making, and boosts customer satisfaction through predictive analytics and automation. While AI offers great potential, effective integration and continuous monitoring are key for success. The future of TQM looks promising, with even more advancements on the horizon. If we can simply consider “what we would like to improve” without thinking about “how to achieve this,” wouldn’t that be easier? Providing end-to-end quality powered by Jeda.AI, as shown through some examples in this work, does exactly this.

The Total Quality Management Framework with AI offers a powerful solution for companies aiming to achieve excellence in quality. By integrating AI, businesses can streamline processes, enhance decision-making, and achieve higher levels of customer satisfaction. As technology continues to advance, the TQM framework will evolve, providing even greater opportunities for innovation and growth.

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