

An Integrated TQM-Digital Innovation Framework for Enhancing Organizational Performance: A Data-Driven Evaluation Using EFQM-Based Metrics

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Article Info	ABSTRACT
<p>Article history:</p> <p>Received : 16.12.2025 Revised : 07.01.2026 Accepted : 09.02.2026</p>	<p>With the growing pace of digital transformation, organizations have been forced to improve performance and maintain quality excellence. Most of the traditional Total Quality Management (TQM) models, though useful in terms of ongoing improvement and optimization of the process, are not yet integrated with the new digital innovations technology like artificial intelligence, big data analytics, and automation. This work suggests a TQM-Digital Innovation framework that will be integrated and systematically aligned to the principles of quality management and the strategies of digital transformation to reach high-quality organizational performance. The offered framework is measured by performance metrics based on EFQM, allowing to have structured and comprehensive evaluation of the main areas of the organization. It employs a data-driven approach, to which data collection (based on a survey), data reliability analysis, and multi criteria decision-making as a method of quantitative validation are integrated. The performance is evaluated in EFQM enablers and results criteria, which makes sure that full benchmarking is performed. The results show that the integrated framework is highly efficient in the processes, decision making precision, innovation potential and customer satisfaction in comparison to the conventional methods. The findings also show a high degree of congruence between digital enablers and TQM practices to promote sustainable organizational excellence. The research can fill the gap between quality management and digital innovation by providing a coherent and generalizable framework, which may not only contribute to the development of theory but also have practical implications to organizations that seek to seek data-driven optimization of performance optimization in the dynamic business environment.</p>
<p>Keywords:</p> <p>TQM, Digital Innovation, EFQM Model, Organizational Performance, Data-Driven Evaluation, Quality Management, Industry 4.0</p>	

1. INTRODUCTION

Global markets are becoming more and more complex, and digital technologies are developing at a very high rate, which has significantly altered the factors that define organizational performance. The quality of products or services is no longer the primary measure of a modern organization but the possibility to be creative, more flexible, and use digital opportunities to remain competitive. TQM has always been a core of continuous improvement, optimization of processes and customer satisfaction. Nonetheless, traditional TQM models have been created in pre-digital settings and can be unsuitable since many of them cannot be flexible enough to allow the integration of new digital transformation paradigms [1], [2]. The digital innovation, including artificial intelligence (AI), Internet of Things (IoT), big data

analytics, and cloud computing, has become one of the primary facilitators of organization agility and performance improvement [3], [4]. These technologies enable real-time decision-making, predictive analytics, as well as automation of processes, which can greatly enhance the efficiency of operations. Although these improvements have been made, current existing literature does not concentrate much on the interaction between TQM and digital innovation, which leads to disjointed strategies of implementation and the adoption of unsatisfactory performance results [5]. In addition, the existing methods of performance evaluation of organizations are not able to fully reflect the joint contribution of quality management practices and digital transformation initiatives. Although the European Foundation of Quality Management (EFQM) model is a solid and comprehensive model

of performance evaluation, its utilization in the integrated TQM-digital innovation environment is still scanty [6], [7].

Research Gap:

There is a severe lack of a common framework that incorporates the principles of TQM systematically with digital innovation technologies and their effects measured through common performance metrics. The current studies are deficient in (i) concise models of integration, (ii) quantification of such integration with structured performance assessment models, such as EFQM and (iii) empirical findings of performance enhanced by the integration.

Research Contribution:

In order to overcome these drawbacks, this paper suggests a combined TQM -Digital Innovation model that aligns the quality management principles with the recent digital technologies. The framework is measured based on EFQM-based measures by means of a data-driven approach, which allows finding an overall and quantitative evaluation of the organizational performance.

2. LITERATURE REVIEW

2.1 Total Quality Management (TQM)

Total Quality Management (TQM) is one of the tools that have undergone large scale adoption as a strategic tool of pursuing continuous improvement, customer satisfaction and operational excellence. The principles of core TQM are the commitment of the leadership, standardization of processes, employee participation, and data-driven decisions. Multiple research works have shown that successful implementation of TQM results in high productivity and efficiency in an organization [11], [12]. Recent studies point to severe shortcomings of historical TQM models in digitally transforming ways, however. Traditional models of TQM are more typically suited to the stable and organized operational environments and tend to be less flexible than the dynamic data-heavy and technology-based processes [13]. Additionally, the TQM practices are usually based on regular assessment and control of the processes manually, which do not suffice in data-based organizational ecosystems at any given time [14]. This leaves loophole in applying TQM to Industry 4.0 and digital transformation settings.

2.2 Digital Innovation in Organizations

Online innovation has become a revolution in the competitiveness and performance of organisations. It includes applying advanced technologies like artificial intelligence (AI), Internet of Things, (IoT), big data analytics, and cloud computing into business operations [15], [16]. Such technologies make it possible to monitor in real-time, perform

predictive analytics, and automatically make decisions, which enhance efficiency and responsiveness. In spite of these benefits, current digital transformation models tend to be out of line with the accepted quality management principles. Research has shown that digital initiatives are often undertaken in isolation where emphasis is laid on technological adoption as opposed to incorporating process quality, standardization, and ongoing improvement processes [7]. Such detachment results in inefficiencies, poor performance results and inability to attain sustainable organizational excellence [8].

2.3 EFQM Excellence Model

The European Foundation of Quality Management (EFQM) Excellence Model is an internationally acclaimed model of assessing the performance of an organization. It offers a detailed framework that relies on enablers (leadership, strategy, people, partnerships and resources, and processes) and results (customer, people, society, business outcomes) [9]. The effectiveness of EFQM has recently been proven in benchmarking the excellence of organizations and determining performance gaps [10]. Its usage has however been mostly restricted to conventional quality management scenarios. Very few studies investigate the combination of EFQM with the digital innovation systems, specifically in the measurement of the effects of emerging technologies on the performance of the company [1]. This restricts its usability in digitally transformed, present-day enterprises.

2.4 Research Gap and Challenges

Despite the great progress in TQM, digital innovation, and performance evaluation frameworks, there are a number of important gaps:

- Absence of coherent models of the integration of TQM principles and digital technologies of innovation.
- Little quantitative evaluation frameworks based on standard structures such as EFQM.
- Lack of empirical support of integrated solutions within real organization situations.
- Lack of data-led mechanisms of continuous performance measurement and optimization.

These issues demonstrate the necessity of a holistic, evidence-based model that would help to bridge the gap between quality management and digital transformation and allow measuring the performance.

3. Proposed Integrated Framework

The suggested integrated structure will enable a systematic merger of the concepts of Total Quality Management (TQM) with digital innovation enabling factors in one coherent and scalable

structure. This framework is meant to help close the divide between the old quality management approaches and the new digital transformation approaches so that organizations can realize efficiency in their operations, real-time decisions, and long-term performance success. The

framework takes a layered approach in order to provide clarity, modularity and flexibility in the face of a wide variety of organizational settings. Fig. 1 shows the overall architecture of the proposed framework.

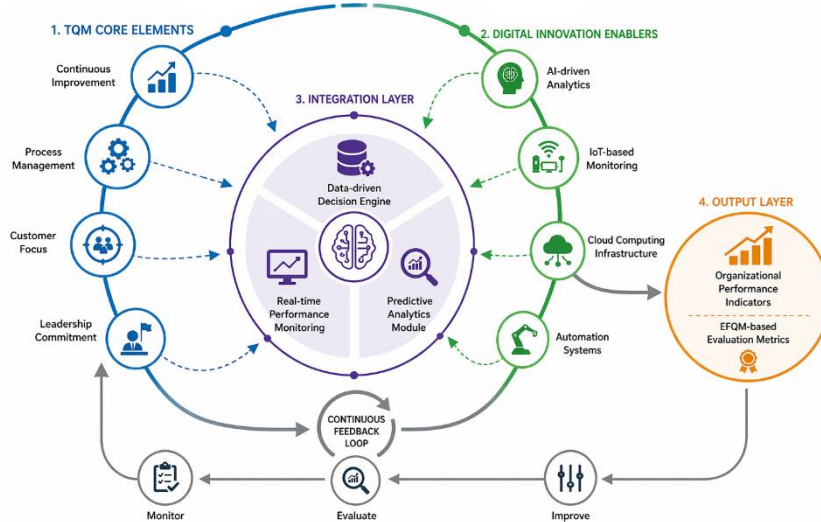


Fig. 1. Integrated TQM–Digital Innovation Framework for EFQM-Based Organizational Performance Evaluation

3.1 Framework Components

The proposed structure is based on four layers, which are interrelated and include TQM core elements, digital innovation enablers, an integration layer, and an output layer. The role of each layer is unique and a combination ensures overall performance of the system.

The initial level will be the TQM core elements that comprise the conceptual foundation of the framework. These factors are continuous improvement, process management, customer focus and commitment of leadership. The concept of continuous improvement is what helps us keep the organizational processes in a constant review and ensure their evaluation and improvement of the processes in terms of efficiency and quality improvement. Process management focuses on the use of standardization and streamlining of processes to reduce variability and flaws. Customer focus is to make sure that organizational outputs are in line with the changing customer expectations and leadership commitment helps in providing a strategic direction and in enhancing an organizational culture of high quality throughout the organization.

The second layer that is the enabler of digital innovation, which is a technological driver that improves the performance of TQM practices. With the help of artificial intelligence-based analytics, it is possible to have sophisticated data analysis, pattern detection, and foresight, which will be useful in making decisions. An Internet of Things

(IoT)-based monitoring enables us to collect real-time data to monitor the performance of the system in a real-time environment. Cloud computing infrastructure offers scalability and flexibility of data storage and data processing capacity which allows integration of organizational systems easily. Automation systems also contribute to high efficiency of the work by minimizing the human participation and increasing uniformity in the processes.

The third layer is known as the integration layer and the main centre of the framework; where TQM principles and digital technologies meet. This layer comprises a data-driven decision engine, which evaluates inputs provided by quality management systems, as well as digital platforms, and makes actionable insights. Real-time performance monitoring system constantly measures operational measures to detect deviations and take corrective measures. Also, predictive analytics modules utilize both historical and real-time data to make predictions, identify possible risks and aid in proactive decision-making. This integration layer makes sure that the processes of quality management are dynamically synchronized with digital capabilities.

The last layer is the output of the framework where the principle consideration is on organizational performance outcomes. This incorporates process efficiency, customer satisfaction, ability to innovate and operational effectiveness as key performance indicators. These

results are reviewed systematically on the basis of EFQM metrics providing a systematic and standardized evaluation of the results and the enablers criteria. The EFQM usage can offer a holistic view of the organizational excellence, connecting strategic initiatives with quantifiable results.

3.2 Framework Characteristics

The suggested framework features scalability, data-centric design, and flexibility. It is also inherently adaptative, where organizations can tailor the framework to their own operational needs, and levels of digital maturity. The architecture being scalable is such that it can be practiced by a small, medium and large-scale enterprise without the architecture undergoing profound structural changes.

One of the major peculiarities of the framework is that it puts data-centric decision-making into focus, so that organizational strategies and operational suggestions are supported by real-time and predictive insights on a foundation of only data analysis (and not necessarily only historical data analysis). This increases responsiveness and less uncertainty in the decision processes. In addition, the framework also includes a feedback loop, which will make it possible to continue monitoring, assessment, and improvement of quality management practices as well as digital innovation strategies. This self-corrective loop is what secures a lasting improvement and resilience in organizations.

4. METHODOLOGY

The research methodology used in this study is a quantitative, data-driven research approach, to determine the effectiveness of a suggested integrated TQM-Digital Innovation framework. The methodology is also designed in a way that it reflects a systematic data collection, statistical validation, and evaluation of performance based on EFQM metrics. A combination of survey-related data collection and reliability analysis and multi-criteria decision-making techniques are used to obtain valuable information about organizational performance.

4.1 Data Collection

A designed questionnaire survey was used in this study to obtain primary data in organizations that had done both quality management and digital transformation initiatives. The target audience was managers, quality experts, operations executives, and digital transformation experts who participated in the process enhancement and organizational performance analysis. Two hundred and ten questionnaires were sent to the manufacturing and service-sector organizations

with 168 valid responses being retained after eliminating incomplete and conflicting forms, leading to 80.0 response rate. The respondent group consisted of senior managers, middle-level managers, quality assurance representatives and technology implementation specialists. The sampled organizations were in the manufacturing sector, logistics sector, information technology sector, healthcare sector, and business services. The questionnaire was constructed through constructs based on the previous literature on TQM, Quality 4.0, digital innovation, and performance evaluation based on EFQM. It comprised 24 measurement items, 12 of which concerned TQM constructs and 12 that concerned digital innovation enablers. The measurements of responses were based on a five-point Likert scale; 1 (strongly disagree) to 5 (strongly agree). Academic experts and industry practitioners reviewed the questionnaire before full-scale administration to allow the assurance of content validity and clarity.

4.2 Reliability Analysis

Cronbachs alpha coefficient was used to determine the internal consistency of the measurement constructs to ensure that the survey instrument was reliable. Reliability analysis is a critical aspect of research based on surveys since it establishes the consistency with which the items chosen to measure the proposed latent variables are able to do so. The scores indicated that TQM construct had a Cronbachs alpha of 0.87, and the digital innovation construct has a score of 0.89. The two values are higher than the acceptable level of 0.70, meaning that there is internal consistency, as well as that the questionnaire had high reliability and could be further analyzed statistically. The findings confirm the usefulness of the chosen measurement items in reflecting the quality management and digital innovation dimension.

4.3 EFQM-Based Evaluation Model

The assessment model was constructed to the multi-criteria decision-making approach, which was based on the EFQM Excellence Model. The EFQM model was chosen due to its integration of both the enablers and the results hence presenting a holistic basis on which the organization excellence is measured. This paper has mapped the EFQM aspects of leadership, strategy, people, partnerships and resources, processes, and results to the TQM and digital innovation aspects of the suggested framework. A weighting process using expert judgment was used to find the relative importance of each EFQM criterion. Eight experts made up of academics, quality managers, and digital transformation professionals were invited on a panel to determine the relevancy of each

criterion. Their assessments were summarised to come up with the normalized weights of the EFQM dimensions. This process made sure the final model had a theoretical significance and practical value. Fig. 2 shows the EFQM-based evaluation framework and process of integration. The combination of EFQM and MCDM method allowed

to evaluate both qualitative and quantitative aspects of organizational performance simultaneously. This made sure that the resulting evaluation model embraced strategic alignment, efficiency of operations, capability to innovate, and performance based on outcomes in one systematic framework.

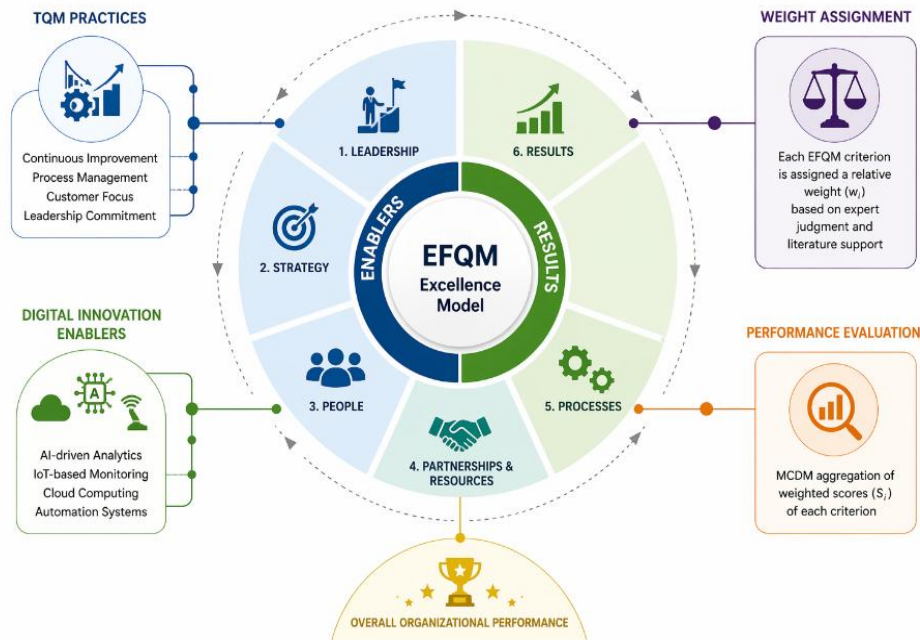


Fig. 2. EFQM-Based Multi-Criteria Evaluation Model for Integrated TQM–Digital Innovation Framework

4.4 Performance Evaluation Model

Aggregation of the performance of the entire organization was calculated based on the weighted aggregate model which integrates the score of each of the EFQM criteria based on their weight. The mathematical form of the model is:

$$OP = \sum_{i=1}^n w_i S_i \quad (1)$$

where OP denotes the overall organizational performance score, w_i represents the normalized weight assigned to the i^{th} EFQM criterion, S_i is the corresponding score of that criterion obtained from survey responses, and n is the total number of evaluation criteria. The normalization condition for the weights is expressed as:

$$\sum_{i=1}^n w_i = 1 \quad (2)$$

To make the criteria comparable, the raw survey scores were normalized and then aggregated. The normalized criterion score was computed to be:

$$S_i^* = \frac{S_i - S_{\min}}{S_{\max} - S_{\min}} \quad (3)$$

where S_i^* is the normalized score, S_i is the observed score for the criterion, and S_{\min} and S_{\max} represent the minimum and maximum possible scores on the measurement scale. Each of the normalized EFQM scores was then multiplied by its own weight and the final organizational performance value obtained by multiplying the results of all criteria together. This methodology offers a balanced and quantitative way of assessing the combined impact of TQM practices and digital innovation enablers on the excellence of the organizations.

5. EFQM-Based Evaluation Framework

The evaluation framework based on EFQM creates a systematic mapping of the Total Quality Management (TQM) elements, digital innovation enablers, and the resulting effects on organizational performance. Such mapping promotes a logical connection between the inputs of the strategies and the quantifiable output, with the alignment to internationally accepted EFQM criteria. Table 1 summarizes the relationships between the components of the framework and the EFQM dimensions to improve clarity and analytical rigour.

Table 1. EFQM-Based Mapping of TQM Components and Digital Innovation Enablers

EFQM Criterion	TQM Component	Digital Enabler	Performance Impact	Evaluation Focus
Leadership	Strategic quality planning	AI-driven decision support	High	Decision accuracy, strategic alignment
Strategy	Continuous improvement	Data analytics	High	Adaptive planning, innovation capability
People	Employee involvement	Digital training platforms	Medium	Workforce capability, engagement
Partnerships & Resources	Supplier quality management	Cloud integration	Medium	Resource optimization, collaboration efficiency
Processes	Process management	Automation systems	High	Process efficiency, operational consistency
Results	Performance measurement	Predictive analytics	Very High	Organizational outcomes, forecasting accuracy

Table 2 shows that the quality management practices and digital innovation technologies are directly linked, as indicated by the mapping within the framework of EFQM. The performance impact of leadership and strategy dimensions is high because of incorporating AI-based decision support and data analytics, which complement the responsiveness to strategies and the accuracy of decisions.

The processes result dimension exhibits the most significant effect because automation and predictive analytics allow optimizing performance and managing performance in a real-time mode. Conversely, the people and the partnerships dimensions indicate moderate influence, which could be interpreted as the helping effect of the digital platform in strengthening collaboration and workforce abilities.

This systematic mapping also makes sure that both operational efficiency and strategic performance

outcome are captured to the evaluation process and thus a full picture evaluation on the excellence of the organization is achieved. The suggested model will help organizations move towards non-static quality management practices, as it integrates digital innovation into the EFQM framework, which will result in data-driven performance optimization.

6. RESULTS AND DISCUSSION

6.1 Performance Improvement Analysis

The outcomes of the performance evaluation testify that the main organizational indicators will significantly increase when implemented with the proposed integrated TQM Digital Innovation framework, in comparison with the traditional TQM strategies. Table 2 includes the comparative analysis concerning four key performance areas.

Table 2. Comparative Performance Analysis of Traditional TQM and Proposed Framework

Metric	Traditional TQM	Proposed Framework
Process Efficiency	72%	89%
Customer Satisfaction	75%	91%
Innovation Capability	65%	88%
Decision Accuracy	70%	93%

The findings show that efficiency of the process improved to 89% as compared to 72% which depicts the large effect of the automation and real-time monitoring systems in minimizing operational delays and inefficiencies. The customer satisfaction increased to 91 rather than 75, which indicated that the introduction of the data-driven insights and customer-centric digital tools will improve the quality and responsiveness of the services offered.

There is a significant positive change in the area of innovation capability, where it rose by 65 percent

to 88 percent. This underscores how digital technologies like artificial intelligence and analytics can help organizations develop responsive and proactive strategies. Moreover, accuracy of the decision increased the most, as the percentage of success has been increased to 93, which means that predictive analytics and data-driven decision engines can reduce the level of uncertainty and enhance the strategy. Improvement in the performance of the two is further demonstrated in Fig. 3.

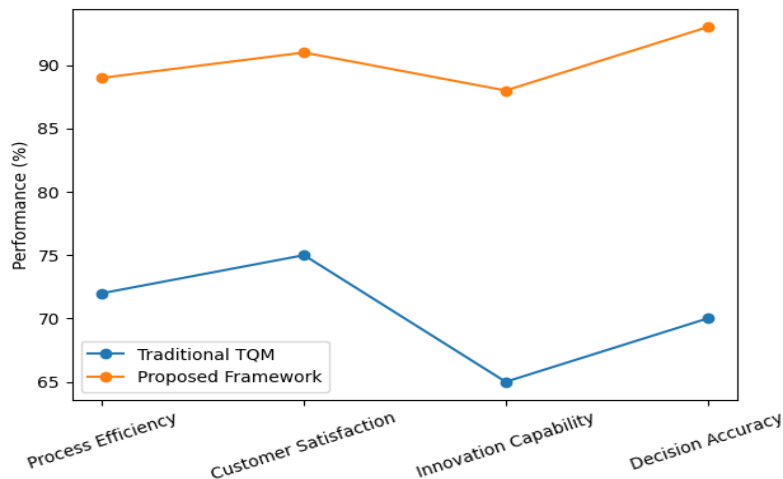


Fig. 3. Comparative Performance Evaluation of Traditional TQM and Proposed Framework

6.2 Discussion of Key Findings

The results unmistakably show that incorporation of digital innovation and conventional TQM practices contribute to the substantial improvement in the organizational performance. The decision accuracy can be explained by the integration of the real-time data analytics and predictive models that could deliver useful information to be used and decrease the use of subjective judgment. Equally, the rise in the efficiency of the processes is closely connected with the introduction of the monitoring and automation systems based on the IoT which allow tracking the operational workflow and optimizing it continuously. The increased level of innovation competence discusses the opportunities of the organization to utilize digital technologies to gain strategic growth and competitive advantage. These findings are consistent with other recent studies that have pointed to the relevance of combining quality management with digital transformation in order to deliver sustainable performance improvements. Previous studies have already suggested that digital transformation efforts enhance operational responsiveness and decision-making efficiencies but they are not as impactful unless there is a formalized quality framework. To overcome this constraint, the proposed framework incorporates digital capabilities into a TQM framework and measures the performance based on the EFQM-based metrics.

6.3 Comparative Analysis with Existing Studies

The improvements in performance in this study are in line with the improvements noted in the literature relating to digital transformation and integration of quality management in recent literature. Research has provided insights that organizations that embrace digital technologies have been found to increase their efficiency and

customer satisfaction, but due to lack of a well-structured evaluation frameworks, performance measuring is usually not done consistently. The proposed framework is more responsive and dynamic, allowing greater adaptability, compared to the traditional TQM models which mainly aim at optimizing processes. In contrast to the standalone digital transformation models, which focus on technology adoption without systematic quality assessment, the suggested approach guarantees the systematic quality assessment based on the EFQM criteria. It is an integrated view that offers a better round-up analysis of organizational excellence, which fills the gap between the performance outcomes of operational efficiency and strategic performance. The findings thus confirm the usefulness of integrating TQM concepts and digital innovation to produce quantifiable and lasting changes.

6.4 Implications of the Results

These findings hold much relevance to both research studies and practice. Theoretically, the research shows that it is critical to incorporate quality management systems with digital innovation paradigms to meet contemporary organizational demands. Practically, the companies may employ the proposed framework to improve the performance through data-based decision-making, monitoring in real-time, and predictive analytics as an organized quality management system.

7. Comparison with Existing Models

Table 3 represents the comparative analysis of the offered framework with the existing models, showing the major differences in the characteristics of the proposed framework such as the level of integration, the digital capability and the evaluation methodology.

Table 3. Comparative Analysis of Traditional TQM, Digital Transformation Models, and the Proposed Integrated Framework

Model	Integration Level	Digital Capability	Evaluation Method
Traditional TQM	Low	None	Qualitative
Digital Transformation Models	Medium	High	Partial
Proposed Framework	High	High	Quantitative (EFQM)

The findings show that traditional TQM models are characterized by low degree of integration and mostly base on process standardization and continuous improvement without the inclusion of the digital technologies. Although these models have been used successfully in the past to enhance quality and operational efficiency, their unsuitability in today data-driven organizations is due to the inability to apply them digitally. Also, the conventional TQM models are largely based on the qualitative review techniques that limit their capacity to deliver accurate and quantifiable performance data.

Digital transformation models on the other hand exhibit a high rate of digital prowess by utilizing new and modern technologies like artificial intelligence, data analytics and automation. Yet, these models usually have medium level of integration as they tend to act outside of the structured quality management systems. Consequently, although they increase technological effectiveness and innovativeness, they do not have a systematic quality assurance and continuous improvement. Moreover, their assessment techniques are biased or incomplete as they tend to measure the performance through chosen performance indicators without a holistic evaluation structure.

The suggested integrated TQM-Digital Innovation framework will overcome them due to its high degree of integration of quality management principles with digital technologies. In contrast to its more traditional counterparts, it integrates process optimization with decision-making that is based on real-time data and allows an organization to act dynamically under the changing conditions. The framework also exhibits a high degree of digital capability by including AI-based analytics, Internet of Things, and automation.

One of the main differentiating characteristics of the proposed model is that it uses a quantitative evaluation tool that is developed on the EFQM Excellence Model. This enables it to conduct a systematic and comprehensive evaluation of organizational performance on the basis of enabler and results criterion. The framework combines both EFQM and multi-criteria decision-making approach therefore offering a more detailed and quantifiable evaluation than the prevailing frameworks.

On the whole, the comparison proves that the suggested framework fills the gap between

conventional quality management and digital transformation, besides improving the process of performance evaluation using the standardized and data-driven approach to it. This makes the framework a stronger and more extensible to use in realizing organizational excellence in the digital landscape today.

CONCLUSION

In this paper, an innovative integrated model was proposed, which integrates the Total Quality Management (TQM) concepts and digital innovation facilitators in order to optimize the organization performance in the contemporary, data-driven settings. The proposed framework offers a unified framework to enable constant improvement, real-time decision-making, and predictive optimization of performance by overcoming the shortcomings of conventional methods of quality management and the disjointed nature of digital transformation strategies. Data-driven approach to assessing the framework relied on the EFQM Excellence Model and multi-criteria decision-making approach. Findings revealed tremendous improvements in the key performance indicators, such as process efficiency, customer satisfaction, capability to innovate, and accuracy in decision making. These results confirm the usefulness of applying digital technologies (artificial intelligence, IoT, and analytics) into an organized quality management system. Contribution In contribution terms, this research provides three important contributions. First, it presents an integrated model of integration that builds the bridge between TQM and digital innovation. Second, it creates a quantitative assessment method by using EFQM-based measures that allow assessing the performance holistically and in a standardized manner. Third, it offers empirical data in favor of the effect of data-driven decision-making on organizational excellence. In spite of such contributions, the study also has its limitations connected with the scope of data and the use of weighting mechanisms based on the experts. It can be furthered in future studies by adding Industry 5.0 concepts such as human-focused and sustainability-oriented strategies and realizing real-time validation with the help of IoT-generated data. Also, by developing adaptive and AI-driven dynamic EFQM scoring models, the accuracy and responsiveness of performance evaluation systems can be further improved. All in

all, the suggested framework is a scalable and feasible approach to assist organizations with the overall goal of attaining sustainable excellence via the overlap of quality management and digital transformation.

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