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TQM PRACTICES AND SUSTAINABLE PERFORMANCE: THE MEDIATING ROLE OF QUALITY CULTURE AND DIGITAL TRANSFORMATION

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A B S T R A C T

The objective of our study is to examine the extent to which Total Quality Management (TQM) practices influence the sustainable organizational performance of Moroccan manufacturing SMEs, while also examining the mediating roles of quality culture and digital transformation. Our study, which falls within the theoretical framework of dynamic resources and capabilities, proposes and empirically tests a structural model implemented using partial least squares structural equation modeling (PLS-SEM) applied to data from a survey of 247 executives of Moroccan manufacturing SMEs. The results show that TQM practices, notably leadership commitment, customer orientation, continuous improvement, employee involvement, and process management, have a positive and significant impact on sustainable performance across its three dimensions: economic, environmental, and social. Quality culture and digital transformation play a mediating role in these relationships. These findings contribute to the ongoing discussions surrounding the concept of Quality 4.0 and provide practical guidance to SME leaders and public sector actors in emerging economies seeking to combine quality excellence with sustainability requirements.

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1. INTRODUCTION

The convergence of quality management philosophy with sustainability objectives represents one of the most fruitful areas of research in contemporary management studies. Indeed, over the past three decades, Total Quality Management (TQM) has evolved from a set of operational tools for reducing defects into an organizational philosophy focused on customer orientation and an awareness of the systems approach imposed by the market economy (Dean & Bowen, 1994; Flynn et al., 1994). At the same time, the sustainability agenda driven by mounting societal, regulatory, and competitive pressures forces organizations to rethink how they define and measure performance (Elkington, 1997).

This study focuses on developing countries, particularly Morocco. SMEs employ a large number of people in the manufacturing sector and also contribute significantly to GDP. However, they face structural constraints, including limited resources, fragmented quality systems, and inadequate digital infrastructure, which hinder their transition to sustainable practices. In this context, TQM-based management offers a locally rooted solution that strengthens both operational excellence and broader sustainability outcomes.

Despite the growing body of literature on the link between TQM and sustainability, significant theoretical and empirical gaps remain. First, few previous studies

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have been conducted in the context of African SMEs contexts characterized by complex institutional environments, cultural norms, and resource constraints that differ significantly from the Western contexts that dominate research. Second, the mechanisms through which TQM practices translate into sustainable performance have not yet been sufficiently theorized. Two potential mediators are particularly salient but under-explored in combination: quality culture and digital transformation. Quality culture refers to the integration of quality values and practices within the organization (Schein, 2010; Zu et al., 2008), and digital transformation aims to reconfigure organizational processes through digital technologies (Vial, 2019; Ghobakhloo, 2020). Finally, as the Quality 4.0 paradigm which integrates Industry 4.0 technologies into TQM frameworks (Saihi et al., 2023; Sureshchandar, 2022) gains traction, the call for empirical studies in developing-country contexts is becoming increasingly urgent.

This study addresses these theoretical gaps through three questions that we consider fundamental: (QR1) To what extent do TQM practices influence the sustainable performance of Moroccan manufacturing SMEs? (QR2) Does quality culture mediate the relationship between TQM practices and sustainable performance? (QR3) Does digital transformation mediate the relationship between TQM practices and sustainable performance? By addressing these questions, this research makes four distinct contributions. Theoretically, it extends the RBV-dynamic capabilities theoretical framework to the TQM-sustainability relationship within an emerging economy context. Empirically, it provides PLS-SEM based evidence from an African manufacturing context. Methodologically, it employs a reflexive-formative hierarchical component model to capture the multidimensional nature of TQM. Practically, it offers nuanced guidance for Moroccan SME leaders and industrial policymakers.

The remainder of this article is organized as follows. Section 2 reviews the theoretical foundations and outlines the research hypotheses. Section 3 describes the research methodology. Section 4 presents the empirical results. Section 5 discusses the results in light of the existing literature. Section 6 concludes by outlining the implications, limitations, and avenues for future research.

2. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

2.1 TQM Practices: Conceptualization and Dimensions

TQM is globally recognized as a multidimensional management philosophy that enhances competitiveness and organizational effectiveness by systematically involving all members of an organization in quality improvement efforts (Flynn et al., 1994; Kaynak, 2003). Although researchers have proposed various dimensional frameworks, a consensus set of fundamental TQM practices has gradually emerged in the literature, notably thanks to the seminal work of Deming (1986), Juran (1988), and subsequent empirical taxonomic studies (Samson & Terziovski, 1999; Kaynak, 2003; Zu et al., 2008).

In this study, we operationalize the TQM into five dimensions: (1) leadership commitment, assessed based on the support provided by management for quality and sustainability objectives; (2) customer orientation, which indicates the extent to which customer needs guide organizational decisions; (3) employee involvement, which measure their contribution to quality improvement initiatives; (4) continuous improvement (kaizen), which assesses the systematic pursuit of incremental process optimizations; and (5) process management, which evaluates the level of documentation, standardization, and control of key processes. This dimensional framework is closely aligned with the EFQM Excellence Model and with recent empirical research validated in emerging market contexts (Ali & Johl, 2022; Boulter et al., 2013).

2.2 Sustainable Organizational Performance

Sustainable organizational performance is consistent with the Triple Bottom Line (TBL) framework, a concept to which Elkington (1997) linked organizational performance by integrating economic, environmental, and social dimensions. Within the literature on quality management shows that Total Quality Management (TQM) and sustainability share common philosophical roots: both foster a mindset centered on sustainability, stakeholder engagement, and process improvement. Economic sustainability encompasses profitability, cost-effectiveness, and competitiveness; environmental sustainability addresses energy efficiency, waste reduction, and ecological impact; and social sustainability covers workplace well-being, societal engagement, and organizational ethics (Elkington, 1997). In the context of SMEs, it is worth noting that sustainable performance also stems from resource constraints, which make quality management an attractive lever since it has the potential to generate efficiency gains in addition to improving quality (Lepisto et al., 2023). Previous research in developing economies has shown positive associations between TQM and sustainability in the manufacturing sector, but primarily in South and Southeast Asian contexts (Ali & Johl, 2022); Africa has been underrepresented thus far.

2.3 TQM Practices and Sustainable Performance: Direct Hypotheses

Various theoretical foundations support the positive relationship between TQM and sustainable performance. Theoretically, Resource-Based View (RBV) theory suggests that the alignment of TQM practices generates organizational capabilities, including precision in process execution, responsiveness to market signals, and

cross-functional coordination, which are valuable, rare, inimitable, and non-substitutable (Barney, 1991). These capabilities help reduce waste and non-compliance costs, as well as improve delivery reliability, which collectively strengthen economic sustainability. In line with the theory of dynamic capabilities (Teece et al., 1997), the implementation of TQM institutionalizes routines for detecting, capturing, and reconfiguring in response to environmental and social requirements, in order to improve the environmental and social dimensions of SME sustainability. Empirically, the work of Kaynak (2003) demonstrates the cascading effects of TQM dimensions on financial and non-financial performance; that of Zu et al. (2008) establishes Lean Six Sigma as a practice closely related to SMM that leads to strong results in terms of operations and sustainability; other studies establish a direct link between SMM and the three TBL dimensions in various contexts.

H1: TQM practices have a positive and significant effect on the sustainable organizational performance of Moroccan manufacturing SMEs.

2.4 The Mediating Role of Quality Culture

Organizational culture whether it consists of shared values, beliefs, or behavioural norms, encompasses the set of perceptions, thoughts, and behaviors exhibited by members of an organization (Schein, 2010). As for quality culture, it is defined, as a specific cultural configuration, as the internalization at all organizational levels of a set of quality-oriented values that is, the daily incorporation of quality-oriented values such as customer focus, continuous improvement, and a zero-defect mindset (Zu et al., 2008). Consequently, a strong quality culture enhances the efficiency of formal TQM systems to the extent that it allows for aligning, at least in part, the organization's informal behaviors with quality objectives. This helps reduce implementation gaps and sustain quality efforts beyond what is formally prescribed by the program (Lagrosen & Lagrosen, 2019; Lepisto et al., 2023).

The mediation logic is as follows: TQM practices, through leadership involvement and participatory improvement activities, have the effect of shifting the organizational culture toward a quality culture (Zu et al., 2008). Once this quality culture is culturally embedded in the organization, it encourages employees to seek process efficiencies, reduce waste, and engage in sustainable development projects, which are then likely to yield measurable gains in sustainable performance. Culture as a mediator clearly illustrates Schein's (2010) model, in which cultural change is driven by leadership through a transformation of artifacts and assumptions at the outset a finding supported by the empirical results of Zu et al. (2008), who found that quality culture fully mediates the relationship between TQM and Six Sigma performance.

H2: Quality culture positively mediates the relationship between TQM practices and sustainable organizational performance.

2.5 The Mediating Role of Digital Transformation

Digital transformation, defined as a company's adoption of digital technologies to change the way it creates value (Vial, 2019), has emerged as a paramount strategic imperative for businesses of all sizes, across all sectors. For SMEs operating in emerging economies, digital transformation also encompasses the adoption of enterprise resource planning (ERP) systems, IoT-based production monitoring systems, data analytics, and digital customer interfaces. All of this is likely to align precisely with the challenges of TQM in terms of process visibility, defect identification, and adaptability to customer demand (Ghobakhloo, 2020; Chiarini, 2020).

The integration of TQM and digital transformation lies at the heart of the Quality 4.0 paradigm (Saihi et al., 2023; Sureshchandar, 2022). Indeed, TQM practices constitute the organizational discipline (standardized processes, a culture of data-driven decision-making, cross-functional teamwork), whereas digital transformation itself can be viewed from a purely technological perspective. In turn, digital tools enable TQM to amplify its capabilities by facilitating real-time quality monitoring, predictive maintenance, and closed-loop improvement cycles. This combination generates sustainable performance enhanced by reduced energy waste and rapid response to defects, enabling transparent sustainability reporting. Empirical results confirm that Industry 4.0 integrated into a Lean management framework generates significant gains in operational performance (Komkowski et al., 2023), and Ali & Johl (2022) show that hard and soft TQM practices facilitate the transition to Industry 4.0.

H3: Digital transformation positively mediates the relationship between TQM practices and sustainable organizational performance.

2.6 Conceptual Framework

By integrating the preceding theoretical arguments, we propose a conceptual model in which TQM practices (five dimensions) exert both direct effects on sustainable performance (H1) and indirect effects mediated by quality culture (H2) and digital transformation (H3).

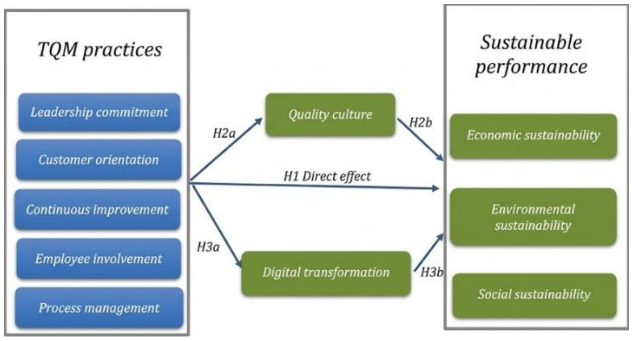


Figure 1. Conceptual Framework

The model is anchored in the RBV-dynamic capabilities theoretical nexus, with quality culture and digital transformation serving as organizationally-based mediating mechanisms that convert TQM investments

into sustainable outcomes. Figure 1 presents the conceptual framework.

3. RESEARCH METHODOLOGY

3.1 Research Design and Epistemological Positioning

This study employs a positivist and deductive research design, consistent with the quantitative method in quality management research (Kaynak, 2003; Flynn et al., 1994). A cross-sectional survey was conducted to collect primary data from a sample of Moroccan manufacturing SMEs. The choice of a survey approach is justified by the need to elicit perceptual data on managerial practices for a large and geographically dispersed population. Furthermore, the prevalence of surveys in empirical studies of the TQM-performance relationship enhances the comparability of results (Samson & Terziovski, 1999; Kaynak, 2003).

3.2 Sample and Data Collection

The target population comprises manufacturing SMEs operating in Morocco, defined according to the Moroccan SME Charter (Law 53-00) as firms with fewer than 200 employees and annual revenue of 75 million MAD or less. The business registry of the OMPIC (Moroccan Office of Industrial and Commercial Property) as well as the directories of the Federation of Chambers of Commerce and the Moroccan Association of Textile and Apparel Industries (AMITH) formed the sampling base, covering 4,200 eligible manufacturing SMEs in the Casablanca-Settat, Rabat-Salé-Kénitra, Tangier-Tétouan-Al Hoceima, and Fès-Meknès regions.
We developed a survey design with the following characteristics: stratified random sampling based on industry sector (food processing, textiles and apparel, chemicals and plastics, metalworking, electronics) and company size (micro: 1–9; small: 10–49; medium: 50–199) of the company, using a questionnaire administered 67% via structured face-to-face interviews and 33% via a self-administered online questionnaire on a secure platform. Respondents included owner-managers, general managers, or quality managers, selected as key informants due to their superior knowledge of quality and strategic management practices (Samson & Terziovski, 1999).
In total, 312 questionnaires were distributed; in return, our survey yielded 261 completed questionnaires, of which only 247 were ultimately retained after eliminating 14 responses deemed excessively incomplete (missing data rate exceeding 10%) and responses exhibiting uniformity of answers (straight-lining) detected by variability analysis. For this sample, we thus obtained an effective response rate of 79.2%. A non-response bias test using the wave method of Armstrong and Overton (1977) allowed us to compare early and late respondents on the study's key variables, with no statistically significant differences found ($p > 0.05$ for all comparisons), which reinforces the representativeness of the final sample.

3.3 Measurement Instrument

All constructs were operationalized using multi-item reflective scales adapted from valid instruments in the literature on TQM and sustainability. TQM practices were measured using 20 items adapted from Kaynak (2003), with five items per TQM dimension. Sustainable performance was operationalized using 15 items adapted from Elkington (1997), covering economic (5 items), environmental (5 items), and social (5 items) sustainability. Quality culture was assessed using 8 items adapted from Zu et al. (2008) and Schein (2010). Digital transformation was measured using 9 items adapted from Ghobakhloo (2020) and Vial (2019), capturing digital strategy, digital operations, digital customer engagement, and digital enablement.
All items were rated on a seven-point Likert scale anchored at 1 (strongly disagree) and 7 (strongly agree). The questionnaire was initially developed in English, translated into Arabic and French by two bilingual management researchers, and then back-translated into English to verify semantic equivalence (Brislin, 1970). A pilot study involving 32 SME executives confirmed the comprehensibility of the items and led to minor reformulations of four items.

3.4 Analytical Strategy

The hypotheses were tested using partial least squares structural equation modeling (PLS-SEM), implemented in SmartPLS 4.0 (Ringle et al., 2022). PLS-SEM was chosen for three reasons: (1) the study involves complex models with constructs that are both reflexive and formative; (2) the research is prediction-oriented in the context of an exploratory emerging economy; and (3) PLS-SEM is robust with non-normal data distributions (Hair et al., 2019). TQM practices were modeled as a second-order reflexive-formative hierarchical construct, with the five sub-dimensions serving as formative indicators at the second level.
The analytical procedure followed a two-step approach. In the first step, the measurement model was evaluated for the reflexive constructs using Cronbach's alpha, composite reliability (CR), average extracted variance (AEV), and discriminant validity via the Heterotrait-Monotrait ratio (HTMT) (Henseler et al., 2015). In the second step, the structural model was evaluated by examining path coefficients, their significance via bootstrapping with 5,000 subsamples, and mediation effects using the Product of Coefficients approach (Preacher & Hayes, 2008). Effect sizes (f^2) and predictive validity (Q^2 via blindfolding) were also calculated. Common-method bias (CMB) was addressed procedurally and statistically using Harman's one-factor test and the marker variable technique (Podsakoff et al., 2003).

4. RESULTS

4.1 Sample Profile

Table 1 presents a descriptive profile of the 247 respondents. Companies in the agri-food sector account for the largest share (29.1%), followed by textiles and apparel (24.3%), metalworking (18.6%), chemicals and plastics (15.8%), and electronics (12.1%). In terms of size, microenterprises account for 22.3%, small enterprises for 51.4%, and medium-sized enterprises for 26.3%. The majority of respondents hold executive (41.3%) or quality management (38.1%) positions.

Table 1. Sample profile (N = 247)

Characteristic	Category	n (%)
Sector	Agri-food	72 (29.1%)
	Textiles and apparel	60 (24.3%)
	Metalworking	46 (18.6%)
	Chemicals and plastics	39 (15.8%)
	Electronics	30 (12.1%)
Size	Micro (1-9 employees)	55 (22.3%)
	Small (10-49 employees)	127 (51.4%)
	Medium (50-199 employees)	65 (26.3%)
Respondent position	Owner-manager	51 (20.6%)
	General Manager	102 (41.3%)
	Quality Manager	94 (38.1%)
ISO 9001 Certified	Yes	151 (61.1%)
	No	96 (38.9%)

The age of the companies ranges from 3 to 38 years, with an average of 14.2 years (φ = 8.7). ISO 9001 certification is held by 61.1% of the companies in the sample.

4.2 Evaluation of the Measurement Model

Table 2 presents the reliability and convergent validity indicators for all reflective constructs. The five sub-dimensions of the TQM, quality culture, digital transformation, and the three dimensions of sustainable performance, exhibit Cronbach's alpha coefficients ranging from 0.817 to 0.924, exceeding the conventional threshold of 0.70 (Nunnally, 1978).

Table 2. Measurement model: reliability and convergent validity

Construct (1st order)	Sigle	Items	Outer Loadings (Min - Max)	Alpha (α)	CR (ρ_c)	AVE
Leadership Commitment	LD	4	0.742 - 0.835	0.891	0.918	0.612
Customer Orientation	CO	4	0.728 - 0.811	0.878	0.912	0.598
Continuous Improvement	CI	4	0.735 - 0.824	0.863	0.904	0.604
Employee Involvement	EI	4	0.719 - 0.802	0.847	0.896	0.583
Process Management	PM	4	0.702 - 0.789	0.817	0.876	0.511
Quality Culture	QC	8	0.761 - 0.849	0.924	0.941	0.647
Digital Transformation	DT	9	0.738 - 0.832	0.908	0.929	0.623
Economic Sustainability	EconS	5	0.745 - 0.828	0.871	0.908	0.617
Environmental Sustainability	EnvS	5	0.721 - 0.814	0.856	0.901	0.594
Social Sustainability	SocS	5	0.711 - 0.795	0.843	0.889	0.571

Composite reliability (CR) values range from 0.863 to 0.941, all above the 0.80 threshold recommended by Hair et al. (2019). The CVM values range from 0.511 to 0.647, all exceeding the 0.50 threshold required for convergent validity (Fornell & Larcker, 1981). These results confirm satisfactory internal consistency and convergent validity for all reflective constructs (Table 3).

Table 3. Discriminant Validity

Construct	LD	CO	CI	EI	PM	QC	DT	EconS	EnvS
LD	—								
CO	0.624	—							
CI	0.598	0.641	—						
EI	0.612	0.587	0.618	—					
PM	0.544	0.576	0.603	0.591	—				
QC	0.663	0.701	0.718	0.694	0.628	—			
DT	0.571	0.618	0.641	0.609	0.587	0.721	—		
EconS	0.498	0.534	0.561	0.512	0.489	0.740	0.668	—	
EnvS	0.412	0.478	0.499	0.461	0.438	0.791	0.634	0.712	—

Discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio (Henseler et al., 2015). All HTMT values between pairs of constructs are below the conservative threshold of 0.85 (range: 0.412–0.791), confirming that each construct captures a unique theoretical domain. Furthermore, the HTMT confidence intervals calculated via bootstrapping do not include unity for any pair of constructs, providing additional evidence of discriminant validity.

4.3 Formative Outer Weights of the TQM Dimensions

In Table 4 and Figure 2, we examine the outer weights (w) of the five dimensions of the TQM, reflecting their respective contributions to the formative second-order construct.

Table 4. Formative outer weights of the TQM dimensions

Dimension Formative TQM	Outer Weight (w)	Standard Error (STDEV)	t-value	p-value	95% CI Bootstrap	VIF
Continuous Improvement (CI)	0.312	0.0298	10.470	< 0.001	[0.261 ; 0.361]	1.84
Process Management (PM)	0.291	0.0296	9.831	< 0.001	[0.240 ; 0.341]	1.76
Customer Orientation (CO)	0.219	0.0308	7.110	< 0.001	[0.162 ; 0.276]	1.53
Employee Involvement (EI)	0.204	0.0303	6.733	< 0.001	[0.148 ; 0.261]	1.61
Leadership Commitment (LD)	0.174	0.0295	5.898	< 0.001	[0.118 ; 0.231]	1.48

More specifically, the outer weight w is interpreted as the multiple regression coefficient. In other words, the higher the w, the more the dimension contributes to defining the TQM construct as a second-order construct. This metric

differs from outer loadings (λ), which measure the unique relative contribution of dimensions to reflexive constructs on the one hand, and measure simple correlation with the latent construct on the other (Hair et al., 2019).

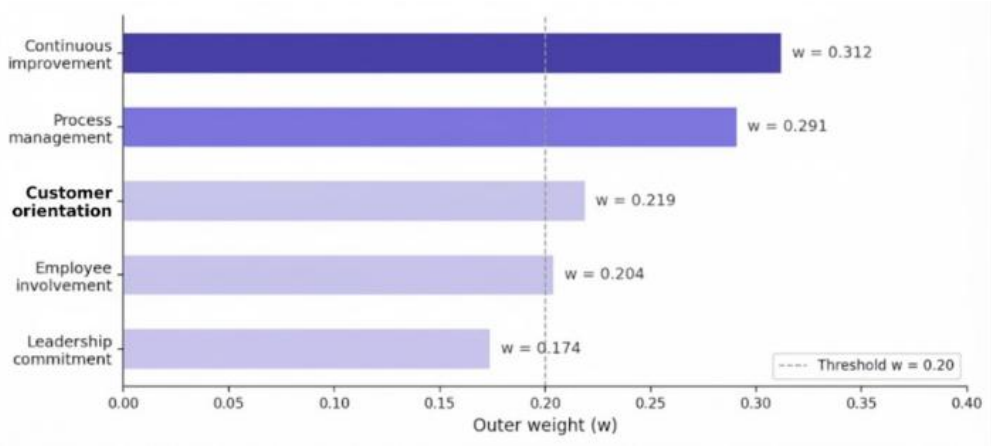


Figure 2. Formative outer weights for the five TQM dimensions

Note that w: TQM = 0.174·LD + 0.219·CO + 0.312·CI + 0.204·EI + 0.291·PM + ε. This formula represents the weighted contribution of each dimension to the latent score of the second-order construct, which is then used to estimate the effects on sustainable performance, quality culture, and digital transformation.

4.4 Structural Model Results

Table 5 presents the results of the structural model, including path coefficients, t-statistics derived from bootstrapping (5,000 subsamples), and effect sizes (f^2).

The overall model accounts for 61.3% of the variance in sustainable performance ($R^2 = 0.613$) and demonstrates highly relevant explanatory power.

Table 5. Explained variance

Endogenous Construct	R^2	Adjusted R^2	Q^2
Sustainable Performance (SP)	0.613	0.607	0.441
Quality Culture (QC)	0.285	0.282	0.387
Digital Transformation (DT)	0.213	0.210	0.351

Table 6. Structural model results

Structural Path / Hypothesis	Path Coeff (β)	STDEV	t-value	p-value	f^2 Effect Size	Decision
TQM → SP (H1)	0.312	0.064	4.871	< 0.001	0.148 (Medium)	H1 Approved
TQM → Quality Culture (QC)	0.534	0.057	9.368	< 0.001	0.398 (Large)	Direct path
Quality Culture (QC) → SP	0.289	0.058	4.983	< 0.001	0.127 (Medium)	Direct path
TQM → Digital Transformation (DT)	0.461	0.059	7.814	< 0.001	0.289 (Medium)	Direct path
Digital Transformation (DT) → SP	0.241	0.062	3.887	< 0.001	0.093 (Low)	Direct path
Indirect: TQM → QC → SP (H2)	0.154	0.034	4.529	< 0.001	—	H2 Approved
Indirect: TQM → DT → SP (H3)	0.111	0.031	3.581	0.001	—	H3 Approved
Total Effect: TQM → SP	0.577	0.048	12.020	< 0.001	—	Total effect

The predictive validity values (Q^2) calculated using blindfolding procedures are all positive for all endogenous constructs (Q^2 SP = 0.441; Q^2 QC = 0.387; Q^2 DT = 0.351) and attest to the model's out-of-sample predictive validity (Chin, 2010).

H1 is confirmed: TQM practices have a direct, positive, and significant impact on sustainable performance ($\beta = 0.312$, $t = 4.871$, $p < 0.001$, $f^2 = 0.148$), reaching a moderate effect size according to Cohen's (1988) criteria. H2 is also confirmed: the indirect effect of TQM

on sustainable performance via quality culture is significant (β = 0.154, t = 4.529, p < 0.001), confirming partial mediation by quality culture. H3 is also confirmed: the indirect effect of TQM on sustainable performance via digital transformation is significant (β = 0.111, t = 3.581, p < 0.001), confirming partial mediation by digital transformation (Table 6)..

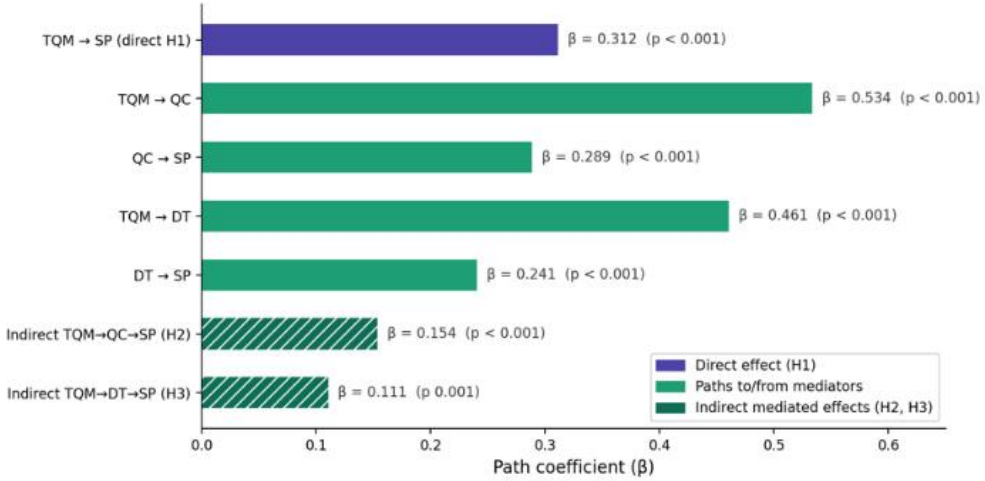


Figure 3. Standardized path coefficients (β) and statistical significance

The variance explained by the two mediators combined is 46.0% [(0.154 + 0.111) / 0.577], indicating that approximately half of the influence of TQM on sustainable performance is channeled through the two proposed mechanisms (Figure 3).

4.5 Mediation Analysis (VAF)

Table 7 presents the decomposition of the total effect of TQM on sustainable performance via the two mediators, according to the Variance Accounted For (VAF) analysis.

Table 7. VAF (Variance Accounted For) analysis

Mediation Path	Indirect (a x b)	Direct (c')	Total Effect (c)	VAF (%)	Type of mediation
TQM to QC to SP H2	0.154	0.312	0.577	26.7%	Partial mediation
TQM to DT to SP H3	0.111	0.312	0.577	19.2%	Partial mediation
Combined mediators	0.265	0.312	0.577	46.0%	Double partial mediation

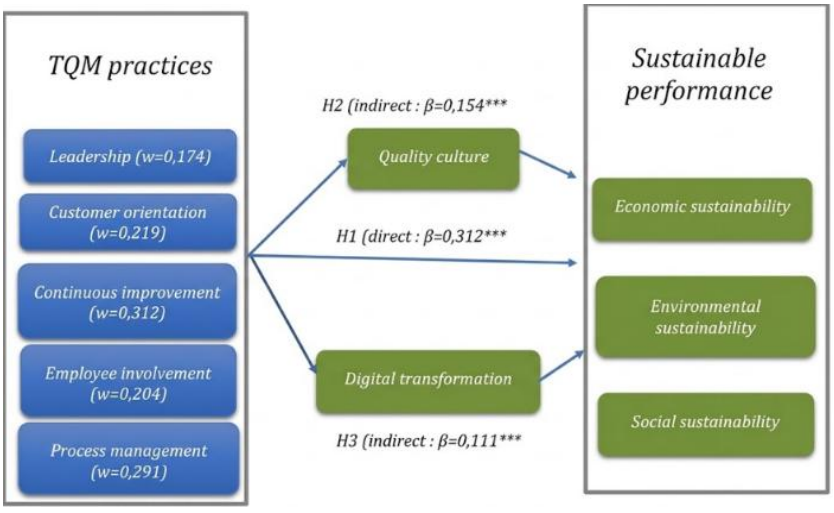


Figure 4. Final conceptual model3

4.6 Final conceptual model

After processing the data, our conceptual model is as follows in Figure 4.

5. DISCUSSION

5.1 The Direct Relationship Between TQM and Sustainability

The confirmation of H1 extends the existing empirical literature on TQM-performance relationships (Kaynak,

2003; Samson & Terziovski, 1999) to the specific context of Moroccan manufacturing SMEs. The significant direct effect (β = 0.312) is consistent in magnitude with meta-analytic estimates of the TQM-performance relationship in developing economies (β range = 0.28–0.41; Sila, 2007), lending cross-contextual validity to our results. Essentially, the result suggests that, even under the resource constraints characteristic of Moroccan SMEs, the sustained implementation of TQM generates sufficient performance dividends across economic, environmental, and social dimensions to constitute a viable sustainability strategy.

A breakdown of TQM effects by dimension reveals that continuous improvement (w = 0.312) and process management (w = 0.291) are the most significant contributors to the predictive power of the second-order TQM construct, followed by customer orientation (w = 0.219), employee involvement (w = 0.204), and leadership commitment (w = 0.174). This pattern differs somewhat from Western findings, where leadership commitment consistently ranks first (Kaynak, 2003). This suggests that, among Moroccan SMEs, operational discipline may be a more direct driver of sustainable performance than management rhetoric, which could reflect the lack of formal management training and the prevalence of governance structures led by owner-managers.

5.2 The Mediating Role of Quality Culture

The confirmation of H2 aligns with the theoretical argument of Zu et al. (2008) that quality culture is the organizational glue through which TQM investments translate into performance outcomes. In the Moroccan context, this mediating pathway holds particular practical significance. Survey data show that the development of quality culture ranks among the TQM outcomes that appear most difficult to achieve, with 62.7% of respondents stating that employee resistance to quality standards represents a significant barrier to implementation. This finding is consistent with the extensive literature on the difficulties of implementing TQM in collectivist cultural contexts with high power distance (Hofstede, 2001; Boulter et al., 2013).

Partial mediation (variance explained by QC = 26.7%) means that quality culture alone cannot explain the TQM-sustainability connection, but it does necessarily contribute to it. This implies that TQM practices drive performance improvements, both through their immediate operational effects (reduced failure rates, improved process efficiency) and through their more long-term but cumulative effects linked to cultural transformation. Managers should therefore invest in cultural transformation programs alongside technical TQM tools, recognizing that the former would have a long-term impact but would yield more robust and self-reinforcing performance improvements.

5.3 The Mediating Role of Digital Transformation

The validation of Hypothesis H3 provides empirical results for the ongoing research on Quality 4.0 (Saihi et al., 2023; Sureshchandar, 2022; Chiarini, 2020) from the perspective of an emerging economy. The finding that digital transformation plays a mediating role in the TQM-sustainability relationship (variance explained by DT = 19.2%) is consistent with theoretical perspectives according to which TQM and digital transformation are complementary rather than substitutive (Komkowski et al., 2023; Ali & Johl, 2022). TQM provides the organizational foundations including process documentation, a culture of data-driven decision-making, and cross-functional coordination that make the use of digital tools effective. These digital tools, in turn, provide real-time visibility, predictive analytics, and automated monitoring that can enhance the efficiency and sustainability impacts of TQM.

One finding adds a nuance: the mediating role of digital transformation is slightly weaker than that of quality culture (β = 0.111 vs. 0.154), which may reflect the embryonic stage of digital adoption among Moroccan manufacturing SMEs. Thus, the results indicate that only 34.4% of our sample reported having implemented at least two digital management tools (ERP, IoT sensors, or data analytics platforms), suggesting that the mediating potential of digital transformation remains partially underutilized. This suggests that as Moroccan SMEs gradually move toward digital transformation, thanks to the national Maroc Digital 2030 program, the mediating role of digital transformation in the TQM-sustainability pathway could grow.

5.4 Theoretical and Practical Contributions

The resource-based view (Barney, 1991) demonstrates how TQM practices constitute valuable, rare, and difficult-to-imitate organizational resources. But in an unstable, emerging environment undergoing digital transformation, it is not only static resources that matter. The theory of dynamic capabilities (Teece et al., 1997) comes into play and shows how Quality Culture and Digital Transformation act as mechanisms for reconfiguration (Sensing, Seizing, Transforming). They enable SMEs to adjust their TQM routines to respond to environmental and social constraints simultaneously.

On a practical level, the results provide actionable insights for at least three stakeholder groups. For SME leaders, the results recommend a dual investment strategy, focusing simultaneously on both TQM operational tools and cultural and digital enablers, thereby facilitating and amplifying the effectiveness of TQM. For policymakers, the results encourage industrial policy initiatives where support for quality certification (ISO 9001) is combined with incentives for digital transformation and the implementation of programs to develop a quality culture. Regarding professional associations, the results suggest that an SME support program focusing solely on the technical tools of TQM is unlikely to enable the full sustainability potential of quality management to be realized, in the absence of complementary attention to culture and digitalization.

6. CONCLUSION

This research examined the relationships between TQM practices, quality culture, digital transformation, and the

sustainable performance of Moroccan industrial SMEs. A sample of 247 executives allowed us to establish, via PLS-SEM, that TQM practices have significant direct and indirect effects on sustainable performance, with quality culture and digital transformation serving as partial mediators (combined VAF = 46.0%). These results extend the TQM-sustainability theory to the context of the Maghreb's emerging economy, advance the debate on Quality 4.0, and offer insights for managerial practices and policy decisions.

Despite its theoretical and practical contributions, this study has three major limitations that should be highlighted. First, the study is cross-sectional in nature, which prevents the establishment of strict causal inferences or the capture of the temporal dynamics of the internalization of a quality culture and digital deployment. Future longitudinal studies or those based on lagged models would be particularly valuable. Second, the data are based on perceptual self-assessments by senior executives, which may introduce a social desirability bias. Although Harman's test and the marker variable technique confirm the absence of any problematic common-method bias, future research would benefit from combining these perceptual data with audited objective indicators. Finally, since the sample is limited to Moroccan manufacturing SMEs, the generalizability of the results to other sectors (such as services) or other countries in the MENA region warrants empirical testing.

Future research should address these limitations while also exploring several promising avenues. Longitudinal panel studies could shed light on the temporal dynamics of the TQM's effect on sustainability. Multi-country comparative studies in North African economies or the MENA region would help test the boundary conditions of the proposed model. Furthermore, incorporating supply chain quality practices as antecedents or moderators of the theoretical model would be valuable. Finally, considering Green TQM practices (Makhlouf et al., 2023), which link quality management and environmental management, would address an important frontier in the Quality 4.0 and sustainability literatures.

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