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IMPACT OF TOTAL QUALITY MANAGEMENT, SUPPLY CHAIN RESILIENCE AND ORGANIZATIONAL CULTURE ON SUSTAINABILITY AND OPERATIONAL PERFORMANCE, AN EMPIRICAL STUDY OF PHARMACEUTICAL INDUSTRY IN PAKISTAN

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Abstract:

Background: *The pharmaceutical industry's performance in the global economy has been significantly influenced by the increasing competition stemming from globalization, economic liberalization, and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. To maintain excellence and sustain competitiveness in the global market, organizations need to integrate Total Quality Management (TQM), Supply Chain Resilience (SCR), Organizational Culture (OC), and sustainability practices into their core objectives. This research aims to*

investigate the impact of TQM, SCR, and OC on the sustainability and operational performance (OP) of the pharmaceutical industry in Pakistan, and to explore their interlinkages. ***Methodology:*** *A conceptual framework was developed to test hypotheses based on existing literature. A quantitative research approach was adopted, with data collected through a survey of pharmaceutical professionals across Pakistan using convenient sampling, resulting in 203 completed questionnaires. The research model was tested using Partial Least Squares Structural Equation Modelling (PLS-SEM).* ***Finding:*** *The results demonstrate that TQM, SCR, and OC have significant positive impacts on both sustainability practices and operational performance. Additionally, sustainability mediates the relationship between TQM and OP, SCR and OP, and OC and OP. These findings contribute to the literature by showing that implementing TQM, SCR, and OC practices can significantly enhance sustainability and operational performance in the pharmaceutical industry.* ***Conclusion:*** *This study is the first to examine the direct and indirect effects of TQM, SCR, and OC on OP, considering the mediating role of sustainability. The insights from this research can guide policymakers and industry leaders in implementing these practices to achieve a competitive advantage in the pharmaceutical sector.*

Keywords: Total Quality Management, Supply chain, Sustainability, Resilience, Organizational Culture, Operational performance, Pharmaceutical Industry

Introduction: This research study seeks to investigate the intricate impacts of Total Quality Management (TQM), Supply Chain Resilience (SCR), and Organizational Culture (OC) on the sustainability and operational performance (OP) of the pharmaceutical industry in Pakistan. Furthermore, the study delves into the interconnectedness of these elements to provide a comprehensive understanding of their collective influence. The primary objective is to elucidate the distinct characteristics of TQM, SCR, OC, and sustainability, as well as their roles in enhancing operational performance within the pharmaceutical sector in Pakistan.

The pharmaceutical industry is experiencing heightened levels of global competition, driven by rapid technological advancements and increasing market pressures (Azeem et al., 2021; Siddique & Asim, 2019). In the digital age, organizations face a dual challenge: internal demands for superior quality and external pressures from competitive forces and technological evolution. For

The pharmaceutical sector, these pressures are particularly acute, given the industry's critical role in public health and the stringent regulatory environment it operates within. Externally, pharmaceutical companies confront a rapidly evolving landscape marked by significant technological improvements, increasing market saturation, and intense global competition. Internally, the focus is on enhancing product quality, accelerating time-to-market, and maintaining competitive pricing, all while navigating complex regulatory requirements. As a result, organizations must address various dimensions of business efficiency, including product quality, cost management, speed, innovation, employee engagement, and customer responsiveness, to secure a competitive advantage (Anwar, 2018; Wenjing et al., 2018). The pharmaceutical industry is undergoing a transformative phase, characterized by an unprecedented demand for high-quality products and rigorous quality management (Lee & Trimi, 2018; Emond & Taylor, 2018). Given the critical nature of pharmaceutical products and their direct impact on patient health, quality management is of paramount importance. Any lapse in product quality or manufacturing processes can have severe, potentially life-threatening consequences (Mohammed et al., 2019). Therefore, the ability to deliver high-quality products consistently and efficiently is crucial for pharmaceutical companies (Gollu, 2017; Sangshetti et al., 2017). Total Quality Management (TQM) has emerged as a key approach for enhancing quality across industries. TQM is fundamentally a proactive philosophy that emphasizes preventing defects rather than detecting them after they occur (Zhu et al., 2020). By fostering a culture of continuous improvement and employee involvement, TQM contributes to achieving sustainable competitive advantage through enhanced product quality and operational efficiency (Sinha & Dhall, 2018). In the context of the pharmaceutical industry, TQM practices can lead to improved product quality, greater customer satisfaction, and reduced operational costs (Sinha & Dhall, 2018; Zehir et al., 2012). Supply Chain Resilience (SCR) has gained prominence as a critical area of focus in recent years. Organizations increasingly recognize the importance of resilient supply chains that can withstand and adapt to disruptions (Mwangola, 2019; Ambulkar et al., 2015). Traditional supply chain management strategies prioritized speed and cost efficiency, but contemporary practices emphasize the need for resilience to handle unexpected challenges and fluctuations in demand (Wong et al., 2012; Lee, 2004). Organizational Culture (OC) plays a pivotal role in shaping operational performance. OC influences various organizational processes and employee behaviors, making it a crucial factor in achieving high

Performance (Akpa et al., 2021; Pathiranage et al., 2020). Cameron and Quinn's framework categorizes organizational cultures into four types: adhocracy, clan, hierarchy, and market. Each culture type has distinct implications for organizational effectiveness and performance (Azeem et al., 2021; Stefano et al., 2019). Sustainability, defined as the capacity to operate with minimal environmental and social impact while optimizing resource use, has become a significant focus for organizations (Davenport et al., 2018). Implementing sustainability practices not only helps organizations comply with regulations but also enhances customer and employee satisfaction, thereby improving operational performance (Khoja et al., 2017; Khalil & Mezher, 2020). In the context of global competition and increasing market demands, sustainability is increasingly seen as a strategic lever for achieving long-term success.

Research Aims and Objectives: The primary aim of this research is to explore the effects of TQM, SCR, and OC on sustainability and operational performance within the pharmaceutical industry in Pakistan. Additionally, the study aims to examine the interrelationships among these factors to provide a holistic understanding of their combined impact. The specific objectives of the research are:

1. **To investigate the impact of TQM on sustainability practices:** Assess how the implementation of TQM principles influences sustainability efforts within pharmaceutical companies.
2. **To evaluate the effect of TQM on SCR:** Examine the relationship between TQM practices and the resilience of supply chains in the pharmaceutical industry.
3. **To assess the influence of TQM on OP:** Determine how TQM contributes to enhancing operational performance.
4. **To investigate the relationship between SCR and sustainability practices:** Analyze how supply chain resilience affects sustainability initiatives.
5. **To determine the impact of SCR on OP:** Evaluate the influence of supply chain resilience on operational performance.
6. **To analyze the effect of OC on sustainability practices:** Explore how organizational culture impacts sustainability efforts within pharmaceutical organizations.

7. **To examine the impact of OC on SCR:** Investigate the relationship between organizational culture and supply chain resilience.
8. **To assess the influence of OC on OP:** Determine how organizational culture affects operational performance.
9. **To evaluate how sustainability practices, affect OP:** Analyse the impact of sustainability practices on operational performance.
10. **To explore the mediating role of sustainability between TQM and OP:** Investigate whether sustainability practices mediate the relationship between TQM and operational performance.
11. **To examine the mediating role of sustainability between SCR and OP:** Assess if sustainability practices mediate the impact of supply chain resilience on operational performance.
12. **To analyse the mediating role of sustainability between OC and OP:** Determine if sustainability practices mediate the relationship between organizational culture and operational performance.
13. **To examine the correlation among TQM, SCR, and OC with sustainability and OP:** Explore the overall relationships among TQM, SCR, and OC with sustainability and operational performance.

Significance of the Study: This research represents a pioneering effort to explore the direct and indirect effects of TQM, SCR, and OC on operational performance, with a particular focus on the mediating role of sustainability. The findings of this study will significantly contribute to the existing body of knowledge by demonstrating how these factors collectively impact sustainability and operational performance within the pharmaceutical industry. By providing insights into the mechanisms through which TQM, SCR, and OC influence organizational performance, this study will aid policymakers and industry practitioners in formulating strategies to enhance competitive advantage. The research will offer practical guidance for implementing effective TQM practices, fostering resilient supply chains, and cultivating a conducive organizational culture to improve overall industry performance. The study's findings will also help organizations refine their policies and procedures, thereby enhancing their competitive position and operational efficiency in a globalized market.

Research articles available until August 2023 were systematically gathered from various search engines and publishing platforms including Emerald, Taylor and Francis, Google Scholar, and Science Direct using the following keywords: TQM, SCR, quality management, supply chain management, supply chain resilience, plant-level SCM, plant-level quality practices, organizational culture, organizational performance, sustainability, agility, pharmaceutical industry, firm performance, and operational performance. The application of these multiple keywords facilitated the collection of pertinent research articles. An initial search yielded numerous articles related to quality, supply chain, organizational culture, and sustainability, which are pivotal to operational performance. To narrow down the scope of the current study, the following inclusion criteria were applied:

Articles published in journals and conferences.

Articles addressing research questions related to quality management practices, TQM practices, internal supply management practices, SCR practices, organizational culture, operational performance, and sustainability. Furthermore, a cross-referencing technique was utilized to shortlist relevant research papers. Approximately 115 research papers were found to be strictly relevant to the study. Additionally, a descriptive analysis was performed to observe the trend over the years in this research domain. The classification of research articles was based on their research objectives.

Total Quality Management (TQM): Hsu and Shen (2005) emphasize that all work can be viewed as a 'process' and that TQM is a continuous improvement process applicable to organizations, individuals, and groups. TQM is generally defined as a guiding philosophy that identifies a path for continuous improvement (Irani et al., 2004). The literature widely acknowledges TQM as a means for business excellence (Sinha and Dhall, 2018). Multiple researchers have concluded a positive correlation between TQM and operational and sustainability performance. Abbas (2020) highlighted TQM as a key factor in achieving sustainable performance for businesses of all sizes (Saha et al., 2022). A comprehensive review identified five practices frequently evaluated and tested: top management support (TMS), customer focus (CF), research and development management (RDM), product quality (PQ), and total productive maintenance (TPM) (Zu et al., 2008). TQM positively influences PQ (Prajogo and Sohal, 2003). Organizations must maintain a

customer orientation and monitor customer expectations continuously (Mehra and Ranganathan, 2008; Nguyen and Harrison, 2018; Sadikoglu and Olcay, 2014). Early customer involvement in internal improvement processes is crucial for ensuring total customer satisfaction (Baird et al., 2011). Research indicates that leadership, people management, and CF are strong predictors of operational performance (Oakland, 2011; Corredor and Goñi, 2011).

In the pharmaceutical industry, R&D is a critical department currently facing significant productivity challenges (Mendigorri et al., 2016; Luo and Sheu, 2010). Productivity is a critical factor in operational performance (Yadav et al., 2018; Gautam and Pan, 2016). Increased competition has led to a 20% decrease in the sales of pharmaceutical products, while R&D expenditures have increased by 60% (Larkin, 2015; CMR International, 2006). Poor-quality products can negatively impact economic sustainability and lead to wastage of natural resources, thus failing to achieve environmental sustainability (Abbas, 2019). Therefore, maintaining a strong focus on quality is crucial in the competitive pharmaceutical market

Supply Chain Resilience (SCR): Modern organizations compete not only with each other but also with their competitors' supply chains (Carr and Karmarkar, 2005). Effective supply chain practices, including strategic supplier relationships, information sharing, inventory management, and purchase management, are essential for creating value across the entire supply chain (Srivastava, 2007; Ketchen and Hult, 2007; Kleindorfer and Saad, 2005; Truong et al., 2017; Dubey, 2015). Supply chain strategies may vary between manufacturing units (Trkman and McCormack, 2009; Brun and Castelli, 2008). Cost-effectiveness in SCM is achieved through efficiency at each node (Chin et al., 2004). Time and robustness are critical factors in SCM activities as organizations strive for quick and uninterrupted product supply at minimal cost (Gunasekaran et al., 2001). Flexibility and speed are essential in meeting market and customer requirements (Han et al., 2017; Hilletofth, 2012). Efficient communication networks, material flow, and information sharing are strong pillars of SCM (Chase et al., 2007; Lummus et al., 2003). Long-term strategic supplier relationships are crucial for maintaining these networks (Theodorakioglou et al., 2006; Akrout et al., 2016; Teller et al., 2016; Kumar and Rahman, 2015).

In the 21st century, environmental and social factors have made the purchasing process complex, requiring consideration beyond cost, such as raw material shortages and sustainable practices

(Carter, 2004; Famiyeh et al., 2018). Global sourcing and distribution have increased the complexity and uncertainty of pharmaceutical supply chains, making them more vulnerable and riskier (Aigbogun et al., 2014). Sustained competitive advantage is achieved through innovation and quality, particularly in supply chain resilience (Arthur, 2017). Numerous studies have highlighted the critical role of SCR in achieving sustainable competitive advantage (Alfarsi et al., 2019; Lima et al., 2018; Dabhilkar et al., 2016; Scholten et al., 2014; Pettit, 2008; Haohua, 2007; Haimes, 2006; Sheffi, 2005; Christopher & Peck, 2004). However, the widespread application of SCR practices faces multiple challenges (Noorfa & Andrew, 2009; Cheng & Zhu, 2010). Ponomarov & Holocomb (2009) suggested further conceptualization of the resilience paradigm from different perspectives. Mahmood & Shahab (2011) emphasized the need for a holistic strategy combining various quality management concepts to bring competitive advantage.

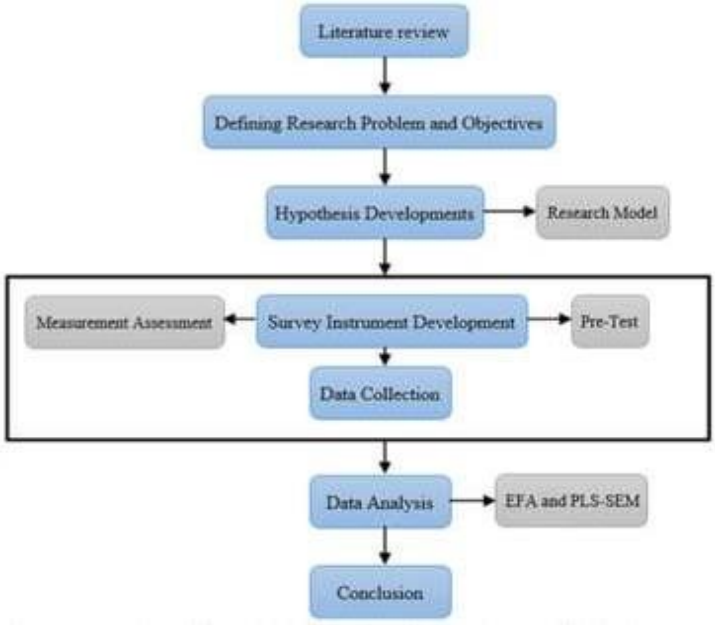
Organizational Culture (OC): Organizational culture (OC) is essential for business competitiveness as it drives high-performance culture and significantly influences employee attitudes and organizational performance (Azeem et al., 2021; Suellen et al., 2014). Schein defines OC as the shared values, beliefs, or perceptions of employees regarding the organization and its environment (Edgar et al., 2004). OC is crucial for knowledge sharing, organizational innovation, quality management, and sustainability practices (Abdi et al., 2018). In Pakistan's pharmaceutical sector, cultural transformation is challenging due to a lack of knowledge about the importance of OC in organizational progress. Despite its importance, there is a scarcity of empirical evidence on the integrated phenomenon of OC and operational performance leading to competitive advantage. Therefore, there is a need for empirical research to better understand and explain the links between OC, quality management, sustainability, and operational performance in the pharmaceutical industry of Pakistan. OC is recognized as organizational capital and a core competency that aligns organizational goals with employee beliefs, contributing to organizational performance (Tan, 2019; Cameron and Quinn, 2000). OC encompasses the unique characteristics of how an organization operates, distinguishing it from competitors. Effective management of OC is vital for ensuring sustainable operational performance and achieving unique organizational outcomes (Anand et al., 2019). Research indicates that OC is a critical strategic factor for long-term competitive success (Azeem et al., 2021; Benn et al., 2006; Russell and McIntosh, 2011). OC influences behavior and decision-making, impacting the organization’s strategic orientation and

attitudes towards change and innovation, thereby enhancing operational performance (Fietz and Günther, 2021).

Sustainability: Technological, social, political, and environmental changes over recent decades have made it challenging for organizations to acquire and sustain competitive advantage (Cancino et al., 2018). These changes have altered customer preferences and demands, increasing awareness of environmental issues such as diminishing natural resources and pollution (Li et al., 2018). Organizations are compelled to adopt environmentally friendly practices and reduce dependence on fossil fuels to mitigate ecological vulnerabilities (Yuan and Xiang, 2018). Sustainable development (SD) requires organizations to meet present needs without compromising future generations' ability to meet their needs (UN, 1987; Abbas, 2020). Corporate sustainability (CS) comprises social, environmental, and economic dimensions, often referred to as the Triple Bottom Line (TBL). The goal of sustainability is to integrate these dimensions into decision-making processes. Organizations increasingly prioritize sustainability and incorporate social and environmental policies into their operations due to its impact on competitive advantage (Artega et al., 2020; Serafeim, 2013). Sustainability practices yield financial benefits, including cost reductions and improved profits (Abbett et al., 2010; Weber, 2008; McDonald and Rundle-Thiele, 2008; Székely and Knirsch, 2005). Benefits arise from waste reduction and process innovation (Delmas et al., 2013; Székely and Knirsch, 2005) Recent literature emphasizes the inclusion of sustainability in quality management systems (Tari et al., 2022; Karon et al., 2017; Natarajan and Wyrick, 2011). However, sustainability can be challenging to implement due to high costs and resource limitations (Elj and Hult, 2017). Future research should focus on examining the impact of sustainability on TQM and operational performance, especially in the pharmaceutical sector of Pakistan. The integration of sustainability with quality management practices can enhance competitive advantage (Artega et al., 2020). The literature review identifies the need for further empirical studies examining the integrated impact of TQM, SCR, OC, and sustainability on operational performance in the pharmaceutical industry of Pakistan. The current body of knowledge lacks comprehensive research addressing these constructs collectively. Therefore, this study aims to bridge this gap by investigating the combined effects of these constructs on operational performance in the pharmaceutical sector of Pakistan.

Given the nature of this research study and the objectives to be achieved, a cross-sectional quantitative analytical approach was adopted. Multiple relevant research studies were reviewed to construct the research model and hypotheses. Subsequently, the collected data was analyzed to test the proposed hypotheses.

Figure 1.0 Research Study Design



(Source: Adapted from Mehdikhani and Valmohammadi, 2019)

Theoretical Background and Development

Total Quality Management (TQM) is a customer-centric philosophy that continuously seeks to meet customer requirements through continuous improvement (Koval et al., 2018). In contrast, Supply Chain Management (SCM) focuses on the efficient flow of raw materials to finished goods from suppliers to consumers (Oghazi et al., 2018). Both TQM and SCM emphasize customer satisfaction as key management philosophies (Vanichchinchai and Igel, 2009).

TQM is integral to ensuring sustainable quality in products and services throughout the supply chain (Svensson, 2016). Implementing TQM increases inventory turnover, reduces logistics costs, ensures on-time delivery, fosters close collaboration with suppliers, and facilitates information exchange through information technology (Vanichchinchai and Igel, 2011). Post-implementation of quality management systems, organizations acquire resources and capabilities that enhance resilience in their supply chain operations (Mwangola, 2018). TQM enhances intellectual capital, aiding in organizational, social, and environmental sustainability (Hudnurkar et al., 2023). There is a direct relationship between TQM and organizational performance, where a holistic approach to quality management yields optimal results (Ramadhanty et al., 2023). Thus, the following hypotheses are proposed:

H1a: TQM practices positively impact sustainability practices.

H1b: TQM practices positively impact operational performance.

H1c: TQM practices positively impact supply chain resilience.

H1d: Sustainability mediates the relationship between TQM and operational performance.

Supply Chain Resilience (SCR) is the proactive capability to limit the actual impact of risk, particularly in an uncertain supply chain environment (Hasani and Khosrojerdi, 2016). SCR enables adaptation, survival, and growth amidst turbulent changes in product and service sourcing, manufacturing, and delivery. Thus, SCR is essential in environments with significant supply chain risk and uncertainty to reduce vulnerability, minimize ripple effects (Dubey et al., 2021), and improve operational performance and sustainability practices. Salam (2017) found that SCR is crucial for achieving superior operational performance. According to Feizabadi et al. (2019), SCR is a driving force behind successful and effective SCM techniques. Chowdhury et al. (2019) demonstrated that SCR practices are vital for establishing consistent capabilities, thereby enhancing operational performance and sustainability practices. Therefore, the following hypotheses are proposed:

H2a: Supply chain resilience positively impacts sustainable practices.

H2b: Supply chain resilience positively impacts operational performance.

H2c: Sustainability mediates the relationship between SCR and operational performance.

Organizational Culture (OC) influences people and processes, providing a platform for understanding the overall system and generating new ideas and procedures (Memon et al., 2020). As a valuable resource within the organizational context, OC facilitates learning, knowledge creation, and sharing during functional tasks (Warrick, 2017). A study of 100 top-ranking firms unanimously described culture as playing a key role in enhancing operational performance, achieving supply chain resilience, and motivating employees to adopt sustainability practices (Wang et al., 2019). Researchers agree that OC is a core competency that drives firm competitiveness, leading to resilient supply chains and sustainable development in societal, economic, and environmental dimensions (Arsawan et al., 2022). Schwartz and Davis identified that corporate culture significantly impacts an organization's ability to achieve goals and objectives related to operational performance and sustainability practices (Azeem et al., 2021). Hence, this study hypothesizes that OC is crucial for achieving operational performance, sustainability, and supply chain resilience. Therefore, the following hypotheses are proposed:

H3a: Organizational culture positively impacts sustainability practices.

H3b: Organizational culture positively impacts operational performance.

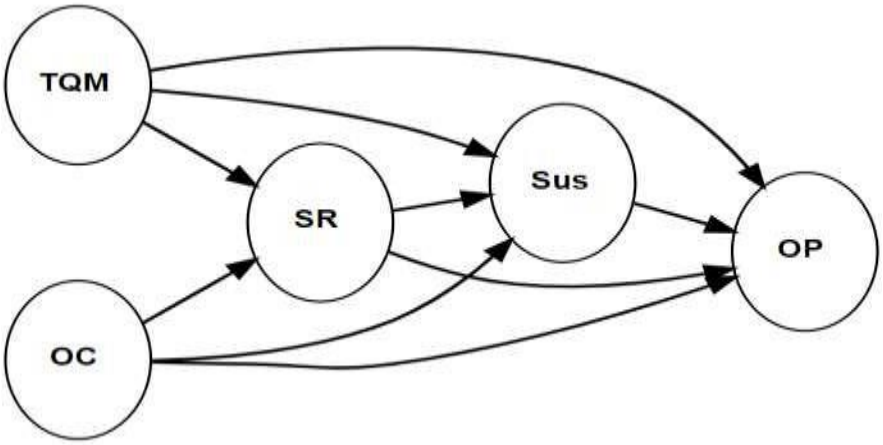
H3c: Organizational culture positively impacts supply chain resilience.

H3d: Sustainability mediates the relationship between OC and operational performance.

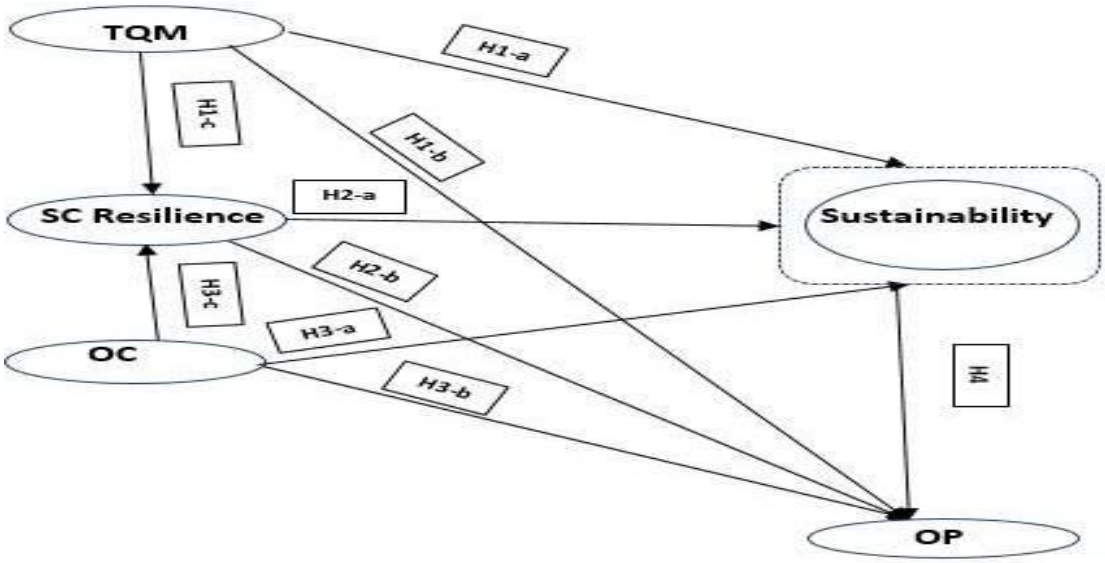
Studies have shown that integrating sustainability into business operations can enhance firm performance. A study by Govindan et al. (2020) confirmed a positive association between various aspects of sustainability and firm performance, finding that the strength of the sustainability-firm performance relationship grows over time. Accordingly, the following hypothesis is proposed:

H4a: Sustainability practices positively impact operational performance.

The proposed conceptual framework is presented in this ***Figure 1.1***



And the Hypothesis Model is given below in ***Figure 1.3***



Study Population and Sampling: The study population comprised professionals in the pharmaceutical industry of Pakistan, including plant managers, production managers, and QC/QA managers/executives. The unit of reference was the pharmaceutical firm, with a sample size of 203, selected using a convenience sampling technique.

Design of the Questionnaire: A survey instrument was developed to investigate the relationships between Total Quality Management (TQM), Supply Chain Resilience (SCR) practices, Organizational Culture (OC), sustainability practices, and operational performance in Pakistani pharmaceutical plants. The questionnaire was based on established scales from the literature and revised for format, sequence, and wording by three industry quality experts. Following Dillman's (2007) methodology, the self-administered questionnaire was distributed to approximately 400 pharmaceutical plants via email and WhatsApp, resulting in 203 responses collected over two months (September-October 2023). The questionnaire comprised seven sections and 46 questions, utilizing a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Data Analysis: Structural Equation Modelling (SEM) was employed to analyze the data, utilizing R-Language to mitigate measurement error bias and explore relationships between observed and latent variables. Data feasibility for factor analysis and SEM was assessed by evaluating sample size, multicollinearity, and common method variance (CMV). The Kaiser-Meyer-Olkin (KMO) test indicated a value of 0.912, meeting the minimum requirement of 0.6, while an R^2 value of 0.941 confirmed the data's suitability for factor analysis.

Model Assessment and Factor Analysis: Exploratory Factor Analysis (CFA) was conducted to ensure uni dimensionality and validity of the measurement model. Reliability was assessed through composite reliability and Cronbach's alpha, with a value of 0.914 meeting the requirements of Peterson (1994) and Molina et al. (2007). Model validity was examined via convergent and discriminant validity. Convergent validity was confirmed if indicators loaded above 0.70 and the Average Variance Extracted (AVE) exceeded 0.5. Discriminant validity was ensured if constructs had higher variance with their indicators than with other constructs, verified by Fornell and Larcker's (1981) criteria and correlation pairs not exceeding 0.9 as per Hair et al. (2010).

Findings: As mentioned earlier, the direct and indirect effects of TQM, SCR and OC on OP and sustainability were studied in this research. The proposed hypotheses were analyzed through PLS-SEM. To ensure reliability and validity of the measurement instrument, a pilot study was conducted by collecting 25 responses from the pharmaceutical companies located in Quaid-e-Azam Industrial State, Lahore. The internal consistency (Cronbach's alpha) noted was

0.80–0.9, well above the threshold limit of 0.7, as suggested by Hair *et al*. (2010). Considering the initial survey's results, the comprehensive survey was initiated. As per the results, it is clear that all constructs met the discriminant validity requirements proposed by Fornell and Larcker (1981) and Hair *et al*., (2010). On the basis of the above-mentioned results, it can be said that the model fulfils the goodness requirements and the instrument has the required reliability and validity to test the hypotheses.

Table 1.0: Reliability and Validity of the instrument

Constructs	Factor Loading Ranges	Cronbach's α	Composite Reliability	AVE
Top management support	0.761-0.934	0.932	0.911	0.637
Customer focus	0.712-0.899	0.921	0.842	0.612
Research and Development	0.742-0.919	0.972	0.847	0.613
Product quality	0.701-0.896	0.882	0.891	0.629
Total productive maintenance	0.799-0.952	0.952	0.912	0.633
Supply chain (re)-engineering	0.701-0.922	0.902	0.842	0.684
Supply chain collaboration	0.732-0.923	0.912	0.815	0.593
Supply chain Agility	0.706-0.914	0.882	0.899	0.621
Supply chain risk management culture	0.798-0.942	0.938	0.913	0.636
Innovation	0.824-0.895	0.975	0.879	0.661
Teamwork	0.711-0.883	0.943	0.823	0.712
Employee Involvement	0.719-0.921	0.974	0.819	0.642
Employee Commitment	0.821-0.945	0.889	0.853	0.648
Communication	0.868-0.922	0.971	0.892	0.614
Social Sustainability	0.714-0.875	0.907	0.867	0.659
Economic Sustainability	0.731-0.903	0.901	0.843	0.672
Environmental Sustainability	0.830-0.961	0.887	0.901	0.635

Construct	TMS	CF	R&D	PQ	TPM	SCE	SCC	SCA	SRM	INN	TW	EI	EC	COM	SS	ECS	ENS
TMS	**0.798**																
CF	0.475	**0.782**															
R&D	0.533	0.529	**0.783**														
PQ	0.542	0.499	0.522	**0.793**													
TPM	0.462	0.520	0.483	0.511	**0.800**												
SCE	0.465	0.498	0.542	0.531	0.533	**0.827**											
SCC	0.495	0.586	0.593	0.455	0.518	0.524	**0.770**										
SCA	0.483	0.557	0.498	0.534	0.486	0.435	0.583	**0.788**									
SRM	0.513	0.607	0.510	0.481	0.543	0.469	0.524	0.489	**0.797**								
INN	0.479	0.593	0.611	0.582	0.539	0.524	0.458	0.502	0.582	**0.813**							
TW	0.593	0.488	0.483	0.527	0.472	0.485	0.621	0.531	0.452	0.442	**0.844**						
EI	0.603	0.612	0.532	0.614	0.495	0.468	0.485	0.456	0.485	0.492	0.532	**0.801**					
EC	0.493	0.484	0.457	0.485	0.467	0.481	0.573	0.459	0.573	0.538	0.485	0.531	**0.805**				
COM	0.529	0.475	0.539	0.455	0.498	0.535	0.488	0.603	0.472	0.619	0.540	0.514	0.521	**0.789**			
SS	0.499	0.495	0.582	0.501	0.540	0.463	0.520	0.593	0.468	0.488	0.547	0.385	0.594	0.583	**0.766**		
ECS	0.557	0.542	0.607	0.452	0.601	0.603	0.590	0.466	0.503	0.606	0.610	0.568	0.475	0.465	0.543	**0.831**	
ENS	0.510	0.462	0.531	0.609	0.589	0.481	0.599	0.523	0.605	0.461	0.384	0.611	0.594	0.623	0.589	0.529	**0.809**

Table 1.2: Discriminant Validity of the Constructs (Fornell-Larcker Criterion)

According to Kaynak, (2003) there are seven indicators that determine the goodness of fit of a measurement model, namely chi-square to degree of freedom (χ^2/df), comparative fit index (CFI), goodness of fit index (GFI), normative fit index (NFI), adjusted goodness of fit index (AGFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). The present research also included the Tucker-Lewis index (TLI) to further determine the measurement and structural models' goodness of fit. The χ^2/DF value for the measurement model is 1.146, which is less than 2 as recommended by Byrne (1989) and also complies with Bagozzi and Yi (1988) requirement of less than 3. Additionally, the values for the other fit indices, such as NFI= 0.921, GFI=0.914, AGFI 0.911, CFI=0.959, and TLI=0.961, are also well above the recommended value of 0.9 suggested by Bagozzi and Yi, (1988), Bollen (1986) and Byrne (1989). Moreover, the values of SRMR of 0.0363 and RMSEA of 0.027 are also well below the cut-off limit of 0.080 as proposed by Hu and Bentler (1998) and 0.08 as suggested by Browne and Cudeck (1992), respectively. The analysis of the structural model also indicated significant results (refer to Table 4.3 for further details). Considering these results, it can be confidently said that the model shows an excellent fit from the collected data.

Table 1.3: Model Fit Measures

The goodness of fit measures	CMIN/DF	NFI	GFI	AGFI	CFI	TLI	RMSEA	SRMR
Recommended Value	≤ 3[1]	≥ 0.9[2]	≥ 0.9[2]	≥ 0.9[2]	≥ 0.9[2]	≥ 0.9[2]	≥ 0.08[3]	≥ 0.08[4]
Measurement Model	1.146	0.921	0.914	0.911	0.959	0.961	0.027	0.0363
Structural Model	1.151	0.953	0.979	0.961	0.951	0.959	0.031	0.0331

[1](Bagozzi and Yi, 1998)
[2](Bagozzi and Yi, 1998; Bollen, 1968; Byrne, 1989)
[3](Browne and Cudeck, 1992)
[4](Hu and Bentler, 1998)

Regarding the Harman's single-factor test, it was observed that explained covariance by single factor was 26.86% (see Appendix 2), which indicates that common method bias is not a potential concern in the current study. As for as the test for non-response bias is concerned, the result of the *t*-statistics indicated no significant differences between early and late response groups, which shows that non-response bias

did not occur in this research. Once reliability and validity of the data were established in evaluating the measurement model, the next stage was to test the structural model. For this, the bootstrapping was run with 1500 samples to estimate the higher-order constructs model. Bootstrapping provided the values of path coefficients, t-values, and p-values, where the importance and significance of the construct's path relationships be determined. Figure 4.1 demonstrates the standardized path coefficients for all endogenous and exogenous constructs and the coefficient of determination (R^2) for endogenous constructs. Table 4.4 shows R^2 values for endogenous constructs, whereas Table 4.5 shows results of hypothesis testing. In the first step, direct effect of the independent variables on the dependent variables were examined, whereas in the second step, the indirect effect of the independent variables on the dependent variables was examined in the presence of a mediator i.e., sustainability. Total 12 hypotheses were tested in this study, and out of these, 11 hypotheses were found significant and positive whereas one hypothesis was found to be insignificant.

Following results were drawn:

- The standardized coefficient for the path between TQM and sustainability was 0.005 which is significant at $p < 0.05$ (*t-value* = 1.083), confirming that TQM positively and significantly contributed to sustainability. This supports the hypothesis H1a, which posits that TQM practices have a positive impact on sustainability practices. These results substantiate earlier findings (Wassan et al., 2022; Abbas, 2019) that TQM is referred to as essential strategy that industrial firms need to build up to be effective in achieving long-term sustainability.

- The standardized coefficient for the path between TQM and OP was 0.096 (*t-value* = 4.118, $p < 0.05$), confirming that TQM positively and significantly contributed to OP. This supports the hypothesis H1b, which posits that TQM practices have a positive impact on operational performance. The results are consistent with previous studies (Kebede and Virdi, 2021; Latifah *et al*., 2021; Rezaei et al., 2018), which investigated the interlinkage of TQM and OP. The results imply that organizational culture fosters both marketing and technology innovation.

- The standardized coefficient for the path between TQM and SCR was 0.446 (*t-value* = 6.031, p < 0.000), confirming that TQM positively and significantly contributed to SCR. This supports the hypothesis H1c, which posits that TQM practices have a positive impact on supply chain resilience. The results of this study are supported by the previous research findings (Latifah *et al*., 2021; Karamouz *et al*., 2021) that conclude that TQM has been deemed as the motivator in incorporating resilience in supply chains, which consequently aims to improve and deliver high products to customers on continuous basis.

- The standardized coefficient for the path between SCR and sustainability was 0.307 (*t-value* = 5.063, p < 0.05), confirming that SCR positively and significantly contributed to sustainability. This supports the hypothesis H2a, which posits that supply chain resilience has a positive impact on sustainable practices. These results are in accordance with the earlier studies (Pu *et al*., 2023; Soyer *et al*., 2023; Junaid *et al*., 2023) which proved that supply chain resilience strategies have the maximum impact on all the three dimensions of sustainability i.e., social, economic and environmental.

- Concerning the relationship between SCR and OP, the results of this study, although provide empirical evidence on the links SCR and OP and are in line with previous empirical support (Afcha, 2020; Artz et al., 2019), SCR did not exert any significant effect (β = -0.066, *t-value* = 0.007, *p*-value = 0.982) on operational performance of pharmaceutical industry, lending no support for H2b, which posits that supply chain resilience has a positive impact on operational performance. These results can be justified by the fact that in a developing country like Pakistan, there might be a lack of awareness about the potential benefits of building resilient supply chains. Apart from this, organizations might face resource constraints limiting their ability to invest in technologies, training and infrastructure needed to enhance supply chain resilience. This means that focusing on resilient supply chains does not necessarily contribute to enhanced operational performance of the Pakistani pharmaceutical industry.

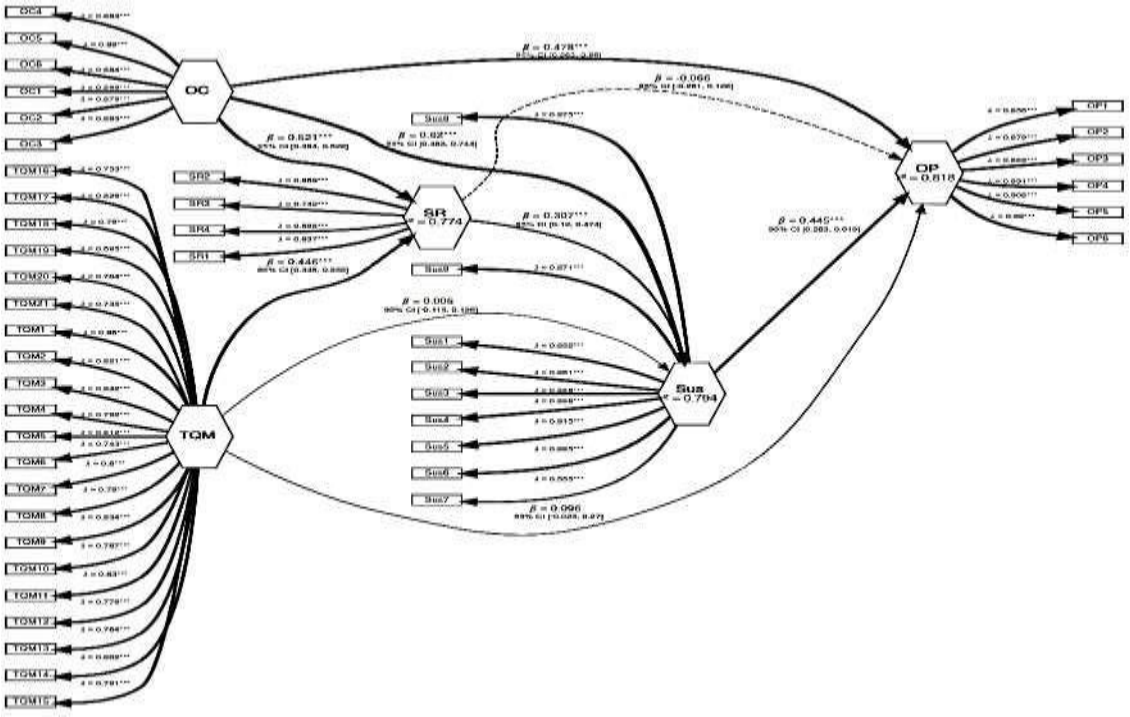


Figure 1.4: R^2 Values for Endogenous Constructs

Endogenous constructs	R^2	Adjusted R^2
Supply Chain Resilience	0.774	0.772
Sustainability	0.794	0.791
Operational Performance	0.818	0.814

OC and Sustainability: The standardized coefficient for the path between Organizational Culture (OC) and sustainability was 0.620 (t-value = 9.654, $p < 0.05$), confirming that OC positively and significantly contributes to sustainability. This supports hypothesis H3a, aligning with recent literature (Kiranantawat and Ahmad, 2023; Siyal et al., 2023; Tai, 2022) suggesting OC is crucial for achieving sustainability objectives in both large and medium-sized organizations. **OC and Operational Performance (OP)**: The standardized coefficient for the path between OC and OP was 0.478 (t-value = 7.045, $p < 0.05$), indicating a positive and

significant contribution of OC to OP. This supports hypothesis H3b and is consistent with previous studies (Kim and Chang, 2019; Krasnicka et al., 2018; Salimi and Aveh, 2016), highlighting the positive impact of organizational values and philosophy on the operational performance of the pharmaceutical industry in Pakistan. **OC and Supply Chain Resilience (SCR)**: The standardized coefficient for the path between OC and SCR was 0.521 (t-value = 8.943, $p < 0.05$), confirming a positive and significant contribution of OC to SCR. This supports hypothesis H3c, corroborating prior research (Ali et al., 2023; Dubey et al., 2022; Zanon et al., 2021) which indicates a strong relationship between OC and operational performance. **Sustainability Practices and OP**: The standardized coefficient for the path between sustainability practices and OP was 0.445 (t-value = 1.771, $p < 0.05$), demonstrating that sustainability practices positively and significantly contribute to OP. This supports hypothesis H4a, aligning with current literature (Hawaj and Buallay, 2022; Le and Ikram, 2022; Pham et al., 2021; Vacchi et al., 2021), which emphasizes the importance of sustainability in enhancing operational performance.

Mediation Effects of Sustainability

TQM and OP: The direct effect of Total Quality Management (TQM) on OP had a standardized coefficient of 0.096 (t-value = 1.083, $p < 0.05$). When considering the indirect effect through sustainability, the coefficient decreased to 0.002, remaining significant ($t = 1.011$, $p < 0.05$), confirming that sustainability partially mediates the relationship between TQM and OP. This partially supports hypothesis H1d. **SCR and OP**: The direct effect of SCR on OP had a standardized coefficient of -0.066 (t-value = 0.007, $p < 0.05$). With sustainability as a mediator, the coefficient increased to 0.137, significant at $p < 0.05$ ($t = 2.523$), confirming that sustainability positively mediates the relationship between SCR and OP. This supports hypothesis H2c. **OC and OP**: The direct effect of OC on OP had a standardized coefficient of 0.478 (t-value = 7.045, $p < 0.05$). The indirect effect through sustainability decreased the coefficient to 0.276, yet it remained significant ($t = 2.211$, $p < 0.05$), confirming that sustainability partially mediates the relationship between OC and OP. This partially supports hypothesis H3d.

Conclusion:

The present study provided the investigational proof on the interlinkage of TQM, SCR and OC

with sustainability and OP. The structural model supports the direct and indirect effects of TQM, SCR and OC on OP. The current study contributes to operations management literature by providing experimental proof of the roles of TQM, OC and sustainability practices in achieving operational performance. Amongst TQM practices, the strong contributors are top management support, product quality, research and development. SCR practices have a positive impact on operational performance through the mediating role of sustainability. The strategic supply chain re-engineering and supply chain risk management culture are the main contributors. Culture with its unique properties helps organizations to improve operational performance and ensure competitiveness. The main contributors of OC are innovation, team work and employee involvement. The study also highlights the synergistic association of TQM, SCR and OC with sustainability. The current study also highlights the mediating role of sustainability between TQM, SCR, OC and OP.

Now-a-days, pharmaceutical industry is facing multiple challenges due to uncertainties. Such challenges cause risks and vulnerabilities in the pharmaceutical industry, while jeopardizing society's health. Therefore, pharmaceutical products require a strong quality focus, efficient production and best customer service. The current study indicates that TQM, SCR, OC and sustainability can play critical role to enhance the operational performance of the pharmaceutical industry in terms of improving quality of products, minimizing production costs and reducing delivery time.

The present study used cross-sectional data to test the research model and was limited to 203 pharmaceutical manufacturing plants only. Furthermore, the study was conducted only on plant-level practices. Additionally, factors like firm age, size, position in supply chain, culture at supplier end and hierarchical structure were not considered in the present study. Operational performance also consists of multiple constructs like competitive performance and business performance, which may include growth and market share of an organization as aspects to be considered in future studies. It is also recommended that longitudinal studies should be preferred since such studies investigate the effect(s) across certain period of time.

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