THE ROLE OF TECHNOLOGY ADAPTATION IN OPTIMIZING SUPPLY CHAIN PRACTICES FOR COMPETITIVE ADVANTAGE IN PAKISTAN'S TEXTILE INDUSTRY

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Abstract

This research paper investigates the impact of supply chain practices and technology adaptation on the competitive advantage of Pakistan's textile industry. Through a quantitative approach, data was collected from various textile companies in Pakistan using surveys and statistical analysis. Conducted over the course of one month in a natural setting without disrupting normal work processes, the study employed purposive sampling to select participants from the Pakistani textile manufacturing sector. Of the 600 questionnaires distributed, 165 responses were collected, with 40% from women and 60% from men, representing diverse roles within the textile sector. The survey included multiple-choice questions and Likert scale items to assess participants' experiences in achieving competitive advantages through technological adaptation. The findings from direct effect path analysis support hypotheses that customer relationship positively influences flexibility, quality, and technological adaptation. Similarly, information sharing positively impacts flexibility, quality, and technological adaptation. Moreover, technological adaptation positively influences flexibility and quality. The specific indirect effect path analysis reveals that technological adaptation mediates the relationships between customer relationship and flexibility, as well as between information sharing and flexibility. However, technological adaptation does not mediate the relationship between customer relationship and quality. Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were used to assess and test the measurement model's reliability, rationality, convergent validity, and discriminant validity. Bootstrapping in SmartPLS software was applied to examine the relationships between factors. The study underscores the critical role of technological adaptation in leveraging customer relationships and information sharing to improve flexibility, quality, and organizational performance, highlighting the importance of strategic alignment in driving competitive advantage in the textile industry of Pakistan.

Keywords: Supply Chain Practices, Technology Adaptation, Competitive Advantage, Textile Industry

INTRODUCTION

Supply chain management (SCM) practices combined with technology adaptation have significantly influenced competitive advantage across various industries, including the textile sector. The integration of SCM practices with technology in the Pakistani textile industry can lead to a higher level of competitive advantage. Sinaga et al. (2021) highlighted that SCM practices positively impact competitive advantage in areas such as price competition, product quality, delivery, product innovation, and time to market. Basheer et al. (2019) explored the relationship between total quality management (TQM) practices, SCM practices, information technology capabilities, supply chain technology adoption, and firm performance, emphasizing the need for a comprehensive approach that integrates these elements to achieve superior

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performance.

In the textile industry, the integration of SCM practices with technological adaptation is crucial for enhancing competitive advantage. This study aims to explore the mediating role of technological adaptation in the relationships between customer relationships, information sharing, flexibility, and quality within the textile industry and how it impacts competitive advantage. The theoretical framework of this research focuses on SCM practices, technological innovation, and organizational performance. By investigating how technological adaptation mediates the relationships between customer relationships and flexibility, information sharing and flexibility, customer relationships and quality, as well as information sharing and quality, this study aims to provide insights into how technology can enhance operational capabilities and strategic outcomes in the textile industry. Relevant literature on SCM practices, technological innovation, information sharing, flexibility, and quality will be reviewed.

The study will draw upon existing research that has shown the positive impact of SCM practices on technological innovation (Warsi et al., 2020), the significance of information sharing in enhancing adaptive capacity (Lyu et al., 2022), and the role of technology capability in facilitating information sharing and global competitiveness (Idris & Mohezar, 2019). Furthermore, the research will explore how technological adaptation influences organizational flexibility, quality standards, and customer relationships, building on studies that have examined the mediating effects of technology on supply chain performance (Tarafdar & Qrunfleh, 2016), information sharing on supply chain learning and flexibility (Huo et al., 2020), and SCM practices on customer satisfaction through technology adoption (Saad et al., 2023).

Rationale of the Study

The textile industry is a complex and dynamic sector that relies heavily on efficient SCM practices and technological adaptation to maintain competitiveness and sustainability. In recent years, there has been a growing recognition of the importance of integrating technology into supply chain operations to enhance flexibility, quality, customer relationships, and overall performance. However, there is a need to further explore the mediating role of technological adaptation in these key relationships within the textile industry to understand its impact on competitive advantage (Ramos et al., 2023). This study aims to address this gap by investigating how technological adaptation influences the relationships between customer relationships, information sharing, flexibility, and quality in the textile industry. By examining these relationships and the mediating effects of technology, the study seeks to provide valuable insights into how the strategic integration of SCM practices with technology adaptation can drive competitive advantage in this sector. Drawing on existing literature on SCM practices, technological innovation, and organizational performance, this research will contribute to a deeper understanding of the mechanisms through which technology can enhance operational capabilities and strategic outcomes in the textile industry (Saleem & Anjum, 2023) .

By exploring the interplay between technological adaptation and key supply chain elements, such as customer relationships and information sharing, the study aims to offer practical recommendations for textile firms in Pakistan seeking to leverage technology to improve their efficiency, product quality, and overall competitiveness (Khan et al., 2022). Through a comprehensive analysis of the relationships between technological adaptation, SCM practices, and competitive advantage in the textile industry, this study seeks to provide valuable insights that can inform strategic decision-making and enhance the performance of textile enterprises in an increasingly competitive market environment (Nicholls & Bumgardner, 2018). By shedding light on the mediating role of technology in supply chain dynamics, this

research aims to contribute to the advancement of knowledge in the field of SCM and technology integration within the textile industry.

By investigating how technological adaptation mediates the relationships between customer relationships, information sharing, flexibility, and quality, this research contributes to the theoretical understanding of the role of technology in supply chain dynamics (Tarafdar & Qrunfleh, 2016). Drawing on established theories of SCM practices, technological innovation, and organizational performance, the study aims to provide a comprehensive framework for analyzing the interplay between technology and key supply chain elements in the textile industry. This theoretical contribution will enhance knowledge in the field of SCM and technology integration, particularly in the context of the textile sector. The findings of this study are expected to offer practical implications for textile firms in Pakistan seeking to leverage technology to enhance their operational efficiency, product quality, customer relationships, and overall competitiveness. By identifying the mediating effects of technological adaptation on customer relationships, information sharing, flexibility, and quality, the research will provide actionable insights for firms looking to optimize their supply chain processes through technology integration (Huo et al., 2020; Idris & Mohezar, 2019). These practical implications can guide textile enterprises in making informed decisions regarding technology adoption, process improvements, and strategic initiatives to drive competitive advantage in the market. This study aims to provide a comprehensive understanding of how technological adaptation can be strategically integrated with SCM practices to enhance competitive advantage in the textile industry. By addressing the identified research gap, it seeks to contribute both theoretically and practically to the field of SCM and technological innovation, offering valuable insights for the textile industry in Pakistan and beyond.

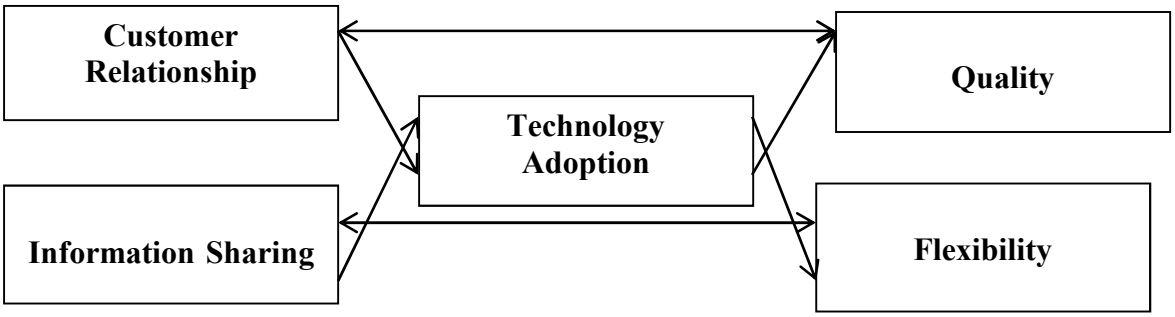

Figure 1: Conceptual Model

LITERATURE REVIEW

The textile industry is a significant player in the global economy, with the competitiveness of textile firms being influenced by factors such as supply chain management practices, technological adaptation, and strategic positioning. This literature review aims to present a comprehensive overview of existing research related to competitive advantage in the textile industry, focusing on the mediating role of technological adaptation in supply chain relationships. Competitive advantage is a crucial driver of success in the textile industry. Studies have indicated that factors like competitive advantage and strategic supply chain practices can enhance the performance of textile firms (Purwanto, 2019). The integration of supply chain management practices with technological innovation is essential for achieving competitive advantage, as emphasized in works such as "Supply Chain Management: Strategy, Planning & Operation"

(Chopra & Meindl,2007). In the textile industry context, the competitiveness of firms is influenced by various factors, including innovation in the supply chain, customer relationships, and information sharing. Research by Prasetyani et al. (2020) highlights the significance of innovation in the supply chain to boost competitiveness, while Shao and Stalker (2016) point out that labor-intensive processes in the textile industry can impede the modernization of supply chain management practices. Moreover, studies focusing on comparative advantage and trade performance in the textile sector shed light on the challenges and opportunities faced by textile industries in different regions. For example, research by Gautam and Lal (2020) delves into the constraints to enhancing competitiveness in the textile sector and proposes policy measures to tackle these challenges. Additionally, Kilduff and Chi (2006) discuss the evolution of textile complexes and the integration of manufacturing functions to enhance competitive advantage.

Customer Relationship, Technological Adaptation, and Quality

The relationship between customer relationship management, technological adaptation, and service quality is essential for enhancing customer satisfaction, loyalty, and overall business performance. Several studies have explored the intricate connections between these factors, shedding light on their impact on organizational success. Storbacka et al. (1994) emphasized the importance of managing customer relationships to improve customer profitability, highlighting the dynamic nature of relationship quality in driving business outcomes. Wong (2004) further delved into the role of emotional satisfaction in service encounters, linking service quality to emotional satisfaction, customer loyalty, and relationship quality, underscoring the significance of emotional connections in fostering customer relationships. Petzer and Tonder (2019) discussed the importance of loyalty intentions and relationship quality constructs in enhancing customer engagement and satisfaction, emphasizing the role of customer commitment, satisfaction, trust, and value creation in building strong relationships. Wang et al. (2020) explored the impact of capability interactions and adaptation to demand-side changes, revealing how repeated customer relationships can influence a firm's technological capabilities and adaptation performance. Moreover, Tobing and Yuliati (2022) highlighted the mediating role of relationship quality in the impact of customer experience quality on customer loyalty in the insurance industry, emphasizing the importance of trust and integrity in fostering long-term customer relationships. Additionally, Zineldin (2005) discussed the strategic use of quality and customer relationship management as a competitive strategy in the banking industry, emphasizing the critical role of meeting customer expectations in maintaining customer satisfaction and loyalty.

Customer Relationship, Technological Adaptation, and Flexibility

Customer relationship management, technological adaptation, and organizational flexibility are critical components that influence operational efficiency and strategic outcomes in various industries (Saad et al., 2022). Saad et al. (2023) highlighted the positive impact of operational resilience, responsiveness, and product/service quality on customer loyalty, emphasizing the importance of flexibility and technology adoption in fostering customer relationships. This underscores the significance of adapting services to meet customer needs and enhancing service quality to drive customer loyalty. Moreover, Xu (2023) emphasized that information technology capabilities drive innovation in small and medium enterprises (SMEs) by expanding the scope of information sharing and promoting collaboration among enterprises. This highlights how technology can enhance organizational flexibility and responsiveness to market demands, ultimately improving customer relationships. Furthermore, Ramos et al. (2023) discussed the

importance of organizational flexibility, integration, and agility in supply chain management, emphasizing the role of constant information sharing and joint planning in enhancing operational flexibility. This demonstrates how technology-enabled information sharing can facilitate organizational adaptability and responsiveness to changing market conditions, thereby strengthening customer relationships.

Information Sharing, Technological Adaptation, and Quality

The integration of information sharing, technological adaptation, and quality management is crucial for enhancing operational efficiency and service excellence in various industries. Liu and Kumar (2011) emphasizes that information sharing is a cornerstone in supply chain technology, facilitating seamless communication and collaboration across organizational boundaries to enhance operational efficiency and quality management. This underscores the importance of leveraging technology to enable effective information sharing practices that drive quality improvements. Moreover, Xu (2023) highlighted the role of information technology capabilities in driving innovation in small and medium enterprises (SMEs) within the sharing economy context. By expanding the scope of information resources and promoting collaboration among enterprises, technology-enabled information sharing can lead to enhanced quality management practices and innovative activities. This demonstrates how technological adaptation can facilitate information sharing and drive quality enhancements in SMEs. Furthermore, Gosain et al. (2004) discussed the significance of high-quality information in making effective inferences and improving operational efficiency. They emphasized that specific and timely information, tailored to the knowledge needs of enterprises, is essential for driving quality improvements and operational excellence. This highlights the critical role of information sharing technologies in enhancing the quality of decision-making processes and operational outcomes.

Information Sharing, Technological Adaptation, and Flexibility

The interplay between information sharing, technological adaptation, and organizational flexibility is crucial for enhancing operational efficiency and strategic outcomes in various industries. Riege (2005) highlighted that knowledge sharing fundamental to organizations' knowledge management strategies, emphasizing the importance of information sharing in fostering organizational flexibility. This underscores the significance of effective information sharing practices in driving organizational adaptability and responsiveness. Furthermore, Wang et al. (2017) discussed the importance of flexible sensing electronics in health monitoring, emphasizing the role of technological adaptation in achieving mechanical flexibility and stretch ability. By employing elastic materials and flexible structures, organizations can enhance their technological capabilities to improve flexibility in health monitoring systems, demonstrating the impact of technological adaptation on operational flexibility. Moreover, DeSanctis and Poole (1994) explored the complexity in advanced technology use through adaptive structuration theory, highlighting how technology-enabled information sharing can facilitate organizational flexibility. By leveraging advanced information technologies, organizations can adapt their processes and structures to enhance flexibility and responsiveness to changing business environments.

Summary of Hypotheses

Hypothesis 1(H1): Customer Relationship positively influences Flexibility.
Hypothesis 2(H2): Customer Relationship positively influences Quality.
Hypothesis 3(H3): Customer Relationship positively influences Technological adaptation.

Hypothesis 4(H4): Information Sharing positively influences Flexibility.
Hypothesis 5(H5): Information Sharing positively influences Quality.
Hypothesis 6(H6): Information Sharing positively influences Technological adaptation.
Hypothesis 7(H7): Technological adaptation positively influences Flexibility
Hypothesis 8(H8): Technological adaptation positively influences Quality.
Hypothesis 9(H9): Technological adaptation mediated the relationship between customer relationship and flexibility
Hypothesis 10(H10): Technological adaptation mediated the relationship between Information Sharing and flexibility.
Hypothesis 11(H11): Technological adaptation mediated the relationship between customer relationship and Quality
Hypothesis 12(H12): Technological adaptation mediated the relationship between Information Sharing and Quality.

METHODOLOGY

In this study, a quantitative research method was used. Surveys and statistical analysis were used to collect and analyze data from Pakistan's textile industries. This study looks at how Pakistan's textile industry's competitive advantage is impacted by supply chain practices and technology adaptation. Moreover, this research was carried out in a natural setting, without any changes to or disruptions of normal work processes. The data was collected over the course of one month, making it a cross-sectional study, which is also called a "one-shot" study. Surveys, which are good for quantitative research, were picked as the method for collecting data. Purposive sampling was used to choose the study sample, taking into account the specific population being studied: people who work in the Pakistani Textile manufacturing companies. Each company was considered as a unit of analysis (Campbell et al., 2020). It was determined that at least 100 responses were required to adequately test the hypotheses of this study. The group for the study was made up of both male and female who worked full-time in Pakistani Textile manufacturing companies, with 40% being women and 60% being men. All of them are working in different positions within the Textile Sector, including Supply Chain Managers, Supply Chain specialists, Executives, and support personnel, ranging from junior to senior levels. All participants were directly involved in Implementing one or more Supply chain practices within their organizations. Out of the 600 questionnaires that were sent out, 165 were filled out, with 40% of the answers coming from women and 60% from men. The survey consists of multiple-choice questions and Likert scale items. The Likert scale items required participants to score their responses on a range of 1 to 5, with 1 denoting "strongly disagree" and 5 denoting "strongly agree." The survey was designed to collect demographic information such as gender and to obtain information about the participants' experiences in achieving competitive advantages within the textile industry with the help of technological adaptation. Participants were given access to the online survey questionnaire via various types of means, including email invites, social media Platforms, and professional networks.

In this study, the CFA tool was used to assess the measurement model's rationality, while the SEM was utilized to test the instrument's reliability, rationality, convergent validity, and discriminant validity. Furthermore, CFA was used to estimate and verify the reliability of the conceptual mode; for the data collected (Tanakinjal et al., 2010). The HTMT and composite reliability measures, as well as the estimated factor loading range and discriminant validity, were all calculated using convergent validity. Bootstrapping in the SmartPLS software was applied to examine the relationships between the factors.

RESULTS

The results of the analysis, including convergent validity, reliability, and discriminant validity, are presented in Table 1, demonstrating a high level of reliability and validity in the model.

Table 1
Measurement Model (Convergent Validity, Reliability, Discriminant Validity)

Constructs & Items	Factor Loading	CR	CA (α)	AVE
Customer Relationship				
CR1	0.780	0.904	0.867	0.652
CR2	0.840			
CR3	0.802			
CR4	0.815			
CR5	0.800			
Flexibility				
F1	0.742	0.882	0.834	0.601
F2	0.855			
F3	0.812			
F4	0.755			
F5	0.703			
Information Shared				
IS1	0.761	0.861	0.798	0.553
IS2	0.709			
IS3	0.744			
IS4	0.725			
IS5	0.775			
Quality				
Q1	0.810	0.902	0.856	0.697
Q2	0.834			
Q3	0.869			
Q4	0.825			
Technology Adoption				
TA1	0.831	0.899	0.850	0.691
TA2	0.866			
TA3	0.784			
TA4	0.841			

The Cronbach's alpha results, which are shown in the table above, were more than 0.70, showing the instrument's internal consistency. Similarly to that, average variance extracted (AVE) was used to assess convergent validity. All of the constructs' AVE values were much higher than 0.5, which met the requirements for the least unacceptable level of AVE value results. Additionally, the majority of the items' standard factors loading values were much higher than 0.7, which shows positive results.

Table 2
Correlations and Discriminant Validity by (HTMT) Ratios

	Customer Relationship	**Flexibility**	**Information Sharing**	**Quality**	**Technology Adaption**
Customer Relationship					
Flexibility	0.601				
Information Sharing	0.722	0.678			
Quality	0.714	0.856	0.688		
Technology Adaption	0.707	0.667	0.779	0.692	

All of the results of the heterotrait-monotrait ratio of correlations (HTMT) shown in Table 2 represent high discriminant validity; (All the values did not exceed 0.871) however, a value less than 0.90 is still regarded as acceptable (Schuberth et al., 2023).

Table 3
Correlations and Discriminant Validity by Fornell–Larcker Criterion

	Customer Relationship	**Flexibility**	**Information Sharing**	**Quality**	**Technology Adaption**
Customer Relationship	0.807				
Flexibility	0.524	0.775			
Information Sharing	0.603	0.568	0.743		
Quality	0.625	0.727	0.576	0.835	
Technology Adaption	0.610	0.575	0.641	0.601	0.831

The results of Fornell–Larcker criterion shown in the Table 3 represents high discriminant validity, (All the values did not exceed 0.85, however, the value lesser than 0.90 is still considered acceptable (Roemer, Schuberth, and Henseler 2021). Stone-Geisser's (Q2), path coefficients, coefficient of determination (R2), and Cohen8's (f2) were used to analyze the predictive relevance and strength of the model using the PLS-SEM technique (Cohen 1988). Using the SmartPLS program, this calculation was made. Table 4 shows the results of the Cohen (F2) (Cohen 1988) criterion for small, moderate, and substantial value outcomes, with the majority of the results showing a small to medium effect size.

Table 4
R Squared (R2), Adjusted R2 and Stone–Geisser's (Q2)

	R Square	**R Square Adjusted**
Flexibility	0.417	0.404
Quality	0.488	0.477
Technology Adaption	0.489	0.482

From the above table 4, the Stone-Geisser's (Q2) value was larger than zero, it was determined that the model had predictive relevance (see Table 5). In the same way, the coefficient of determination (R2) results ranged from 0.417 to 0.489; indicating that the effects are within acceptable ranges. These findings also make it clear that Information sharing has the biggest correlation with Technological adaptation. The results of this study are good according to the basic rule of thumb criterion for R2 value effect size, which is small 0.02, moderate 0.13, and significant 0.26 (Cohen 2016; Cohen & Nee, 1984).

Table 5
Effect size - Chohen (f^2) f Square

Relationship	**Effect Size (f^2)**	**Interpretation**
Customer Relationship → Flexibility	0.032	Small
Customer Relationship → Information Sharing	0.066	Small
Customer Relationship → Quality	0.073	Small
Customer Relationship → Technology Adaptation	0.128	Moderate
Flexibility → Information Sharing	0.041	Small
Flexibility → Quality	0.069	Small
Information Sharing → Technology Adaptation	0.153	Moderate
Quality → Technology Adaptation	0.229	Substantial

The direct effect path analysis, conducted through Partial Least Squares Structural Equation Modeling (PLS-SEM) with bootstrapping, sheds light on the relationships between the constructs examined in the study, as depicted in Tables 6 and 7. These tables present coefficients, t-values, and p-values, offering insights into the strength and significance of these relationships. Table 6 focuses on direct effects, indicating significant associations between constructs, while Table 7 delves into specific indirect effects and moderation. Together, they provide a comprehensive understanding of how variables influence each other, contributing to the interpretation of research findings.

Table 6
Path Analysis - Hypothesis Testing (Direct Effect)

	Hypothesis	**β**	**T Values**	**P Values**	**Decision**
Customer Relationship -> Flexibility	H1	0.184	1.972	0.049	Supported
Customer Relationship -> Quality	H2	0.344	4.118	0.000	Supported
Customer Relationship -> Technology Adaption	H3	0.351	4.063	0.000	Supported

Information Sharing -> Flexibility	H4	0.273	2.968	0.003	Supported
Information Sharing -> Quality	H5	0.200	2.601	0.010	Supported
Information Sharing -> Technology Adaption	H6	0.429	6.052	0.000	Supported
Technology Adaption -> Flexibility	H7	0.288	2.723	0.007	Supported
Technology Adaption -> Quality	H8	0.263	2.281	0.023	Supported

Table 7

Path Analysis - (Specific Indirect effect): Moderation

	Hypothesis	**β**	**T Values**	**P Values**	**Decision**
Customer Relationship -> Technology Adaption -> Flexibility	H9	0.101	2.136	0.033	Supported
Information Sharing -> Technology Adaption -> Flexibility	H10	0.123	2.544	0.011	Supported
Customer Relationship -> Technology Adaption -> Quality	H11	0.092	1.910	0.057	**Not Supported**
Information Sharing -> Technology Adaption -> Quality	H12	0.113	2.117	0.035	Supported

Hypothesis 1: There is a positive association between customer relationship and flexibility. The direct effect path analysis shows a significant association ($\beta = 0.184$, $t = 1.972$, $p = 0.049$), supporting the hypothesis that stronger customer relationships enhance organizational flexibility. *Hypothesis 2:* Customer relationship positively affects quality ($\beta = 0.344$, $t = 4.118$, $p < 0.000$) in the direct effect path analysis. This suggests that robust customer relationships lead to higher quality outcomes. *Hypothesis 3:* Customer relationship is positively associated with technological adaptation ($\beta = 0.351$, $t = 4.063$, $p < 0.000$) in the direct effect path analysis, indicating that strong customer relationships foster better technological adaptation. *Hypothesis 4:* Information sharing positively impacts flexibility ($\beta = 0.273$, $t = 2.968$, $p = 0.003$) in the direct effect path analysis, supporting the hypothesis that effective information sharing enhances organizational flexibility. *Hypothesis 5:* Information sharing is positively associated with quality ($\beta = 0.200$, $t = 2.601$, $p = 0.010$) in the direct effect path analysis, suggesting that better information sharing improves quality. *Hypothesis 6:* Information sharing positively affects technological

adaptation (β = 0.429, t = 6.052, p < 0.000) in the direct effect path analysis, indicating a strong relationship between information sharing and technological adaptation. *Hypothesis 7:* Technological adaptation positively impacts flexibility (β = 0.288, t = 2.723, p = 0.007) in the direct effect path analysis, suggesting that better technological adaptation enhances flexibility. *Hypothesis 8:* Technological adaptation is positively associated with quality (β = 0.263, t = 2.281, p = 0.023) in the direct effect path analysis, indicating that technological adaptation improves quality. *Hypothesis 9:* Technological adaptation mediates the relationship between customer relationship and flexibility (β = 0.101, t = 2.136, p = 0.033) in the specific indirect effect path analysis, supporting the hypothesis that technological adaptation partially explains the positive impact of customer relationships on flexibility. *Hypothesis 10:* Technological adaptation mediates the relationship between information sharing and flexibility (β = 0.123, t = 2.544, p = 0.011) in the specific indirect effect path analysis, indicating that technological adaptation enhances the effect of information sharing on flexibility. *Hypothesis 11:* Technological adaptation does not mediate the relationship between customer relationship and quality (β = 0.092, t = 1.910, p = 0.057) in the specific indirect effect path analysis, suggesting that the positive effect of customer relationships on quality is not significantly explained by technological adaptation. *Hypothesis 12:* Technological adaptation mediates the relationship between information sharing and quality (β = 0.113, t = 2.117, p = 0.035) in the specific indirect effect path analysis, indicating that technological adaptation enhances the positive impact of information sharing on quality. These findings collectively underscore the crucial role of technological adaptation in leveraging customer relationships and information sharing to improve flexibility and quality within organizations.

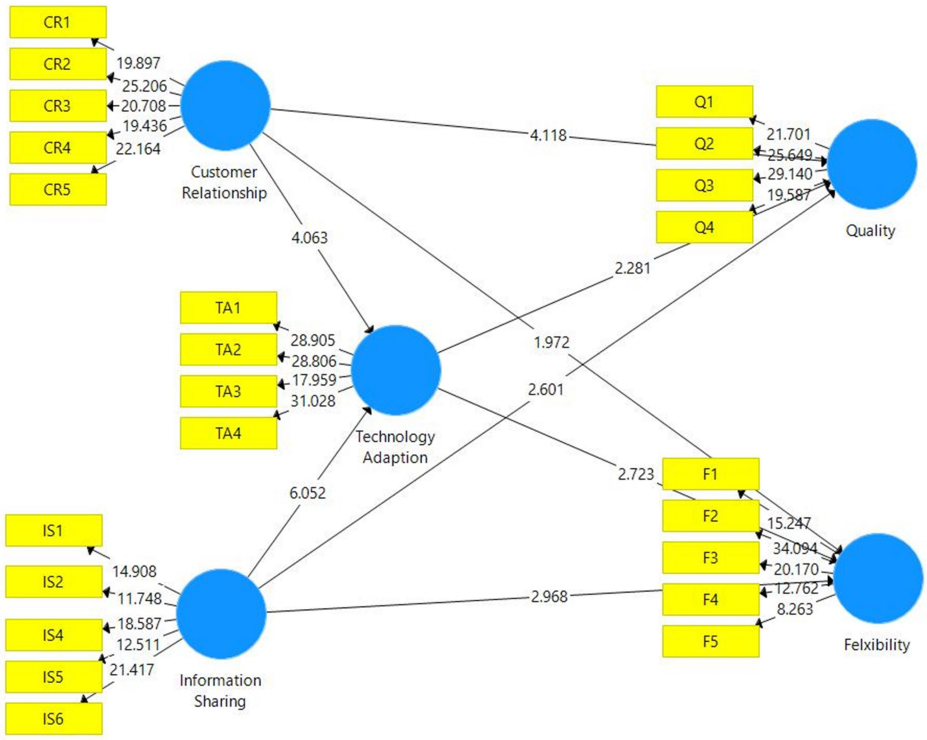

Figure 2: Results of the Analysis

DISCUSSION

The findings from the direct effect path analysis support the hypotheses that customer relationship positively influences flexibility, quality, and technological adaptation. Stronger customer relationships are associated with enhanced organizational flexibility, improved service quality, and better technological adaptation. This underscores the importance of fostering robust customer relationships in driving organizational performance and competitiveness (Petzer & Tonder, 2019; Storbacka et al., 1994). Moreover, the results indicate that information sharing positively impacts flexibility, quality, and technological adaptation. Effective information-sharing practices enhance organizational flexibility, improve service quality, and foster better technological adaptation. This highlights the critical role of information sharing in driving operational efficiency and strategic outcomes within organizations (Huo et al., 2020; Shi et al., 2023). Additionally, the direct effect path analysis reveals that technological adaptation positively influences flexibility and quality. Better technological adaptation enhances organizational flexibility, enabling firms to respond effectively to changing market conditions. Furthermore, technological adaptation leads to improved service quality, contributing to enhanced customer satisfaction and loyalty (Kühn & Mostert, 2017; Mohammed & Mohammed, 2022). The specific indirect effect path analysis demonstrates that technological adaptation mediates the relationships between customer relationship and flexibility, as well as between information sharing and flexibility. This suggests that technological adaptation plays a significant role in explaining the positive impact of customer relationships and information sharing on organizational flexibility (Addury & Pangestu, 2023; Ali, 2020). However, the analysis also indicates that technological adaptation does not mediate the relationship between customer relationship and quality. This suggests that while technological adaptation is crucial for enhancing flexibility and operational efficiency, its role in driving quality outcomes may be more indirect or influenced by other factors (Harjanti et al., 2020; Mokhtar & Sjahruddin, 2019).

Overall, the study underscores the critical role of technological adaptation in leveraging customer relationships and information sharing to improve flexibility, quality, and organizational performance. By strategically aligning customer relationship management, technological adaptation, and information sharing practices, organizations can enhance their operational capabilities, service quality, and competitive advantage in today's dynamic business environment (Anjelisa et al., 2023; Hartanto & Aprianingsih, 2022).

CONCLUSION

The study provides comprehensive insights into the impact of supply chain practices and technology adaptation on competitive advantage in the textile industry of Pakistan. The findings affirm that robust customer relationships significantly enhance organizational flexibility, quality, and technological adaptation. Effective information sharing is shown to positively impact flexibility, quality, and technological adaptation, highlighting its crucial role in supply chain management. Technological adaptation emerges as a key mediator, enhancing the positive effects of customer relationships and information sharing on flexibility and quality. Specifically, it strengthens the impact of customer relationships on flexibility and the effect of information sharing on both flexibility and quality. However, technological adaptation does not significantly mediate the relationship between customer relationships and quality. The study underscores the importance of integrating technological advancements with supply chain practices to maximize competitive advantage. Textile companies in Pakistan should focus on strengthening customer relationships and improving information sharing mechanisms, alongside investing in technological adaptation, to achieve higher flexibility and quality in their operations. These strategic

actions will enhance their competitive positioning and drive sustainable growth in the dynamic textile industry.

Recommendations

- Textile companies should prioritize adopting lean manufacturing concepts and improving inventory management to reduce waste, enhance efficiency, and achieve cost reductions and better operational performance.
- Investing in ERP systems, RFID tagging, and advanced data analytics is crucial for enhancing supply chain visibility, accountability, and decision-making capabilities, leading to improved coordination, reduced lead times, and better responsiveness to customer demands.
- Building robust relationships with suppliers, manufacturers, and distributors, along with setting up efficient communication channels and developing collaboration platforms, can enhance overall supply chain performance and mitigate disruptions (Kumar et al., 2006).

REFERENCES

Addury, M. M., & Pangestu, D. R. (2023). Interactive marketing and relationship quality in Islamic banking: A Parepare case study. *Asian Journal of Islamic Management (AJIM)*, 83-95.

Ali, O. M. (2020). The roles of relationships and service quality as drivers of customer loyalty: An empirical study. *Open Journal of Social Sciences*, *8*(4), 14-32.

Anjelisa, A., Fatmawati, I., & Nuryakin, N. (2023). Measuring the Effect of Islamic Service Quality, Customer Relationship Management, Customer Satisfaction, and Loyalty in Indonesian Islamic Banking. *Al Qalam: Jurnal Ilmiah Keagamaan dan Kemasyarakatan*, *17*(5), 3001-3014.

Basheer, M., Siam, M., Awn, A., & Hassan, S. J. U. S. C. M. (2019). Exploring the role of TQM and supply chain practices for firm supply performance in the presence of information technology capabilities and supply chain technology adoption: A case of textile firms in Pakistan. *Uncertain Supply Chain Management*, *7*(2), 275-288.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing*, *25*(8), 652-661.

Chopra, S., & Meindl, P. (2007). *Supply chain management. Strategy, planning & operation* (pp. 265-275). Gabler.

Cohen, J., & Nee, J. C. (1984). Estimators for two measures of association for set correlation. *Educational and Psychological Measurement*, *44*(4), 907-917.

Cohen, S. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan & S. Oskamp (Eds.), *The social psychology of health* (pp. 31–67). Sage Publications, Inc.

Cohen, J. (2016). A power primer. In A. E. Kazdin (Ed.), *Methodological issues and strategies in clinical research* (4th ed., pp. 279–284). American Psychological Association. https://doi.org/10.1037/14805-018

DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science, 5*(2), 121-147. doi: 10.1287/orsc.5.2.121

Gautam, S., & Lal, M. (2020). Analysing competitiveness and trade performance: evidence from Indian textile industry and its select competitors. *Transnational Corporations Review*, *12*(4), 406-424.

Gosain, S., Malhotra, A., & El Sawy, O. A. (2004). Coordinating for flexibility in e-business supply chains. *Journal of management information systems*, *21*(3), 7-45.

Harjanti, D., Theodore, E. K., & Ali, S. (2020). *Does quality matter? A study on customer expectation in motorcycle repair provider in Surabaya, Indonesia* (Doctoral dissertation, EDP Sciences).

Hartanto, B., & Aprianingsih, D. (2022). The Effect of Website Quality, Trust, and Ease of Use on Customer Loyalty: Customer Satisfaction as a Mediation. *Frontiers in Business and Economics*, *1*(1), 16-23.

Huo, B., Haq, M. Z. U., & Gu, M. (2021). The impact of information sharing on supply chain learning and flexibility performance. *International Journal of Production Research*, *59*(5), 1411-1434.

Idris, S., & Mohezar, S. (2019). Sustaining businesses in a global turbulent environment: The role of information sharing. *Management & Accounting Review (MAR)*, *18*(1), 25-40.

Khan, S. A. R., Waqas, M., Honggang, X., Ahmad, N., & Yu, Z. (2022). Adoption of innovative strategies to mitigate supply chain disruption: COVID-19 pandemic. *Operations Management Research*, *15*(3), 1115-1133.

Kilduff, P., & Chi, T. (2006). Longitudinal patterns of comparative advantage in the textile complex–part 1: An aggregate perspective. *Journal of Fashion Marketing and Management: An International Journal*, *10*(2), 134-149.

Kuhn, Stefanie & Mostert, Pierre. (2017). Relationship intention and relationship quality as predictors of clothing retail customers' loyalty. The International Review of Retail, Distribution and Consumer Research. 28. 1-25. 10.1080/09593969.2017.1380067.

Liu, Rong & Kumar, Akhil. (2011). Leveraging information sharing to configure supply chains. Information Systems Frontiers. 13. 139-151. 10.1007/s10796-009-9222-8.

Lyu, T., Guo, Y., & Lin, H. (2022). Understanding green supply chain information integration on supply chain process ambidexterity: The mediator of dynamic ability and the moderator of leaders' networking ability. *Frontiers in Psychology*, *13*, 1088077.

Mohammed, M. L., & Mohammed, Y. I. Critical Examination of Service Quality and Relationship Marketing in Establishing Sustainable Long Term Customer Relations in Commercial Contexts.

Mokhtar, S., & Sjahruddin, H. (2019). An examination of the relationships between customer relationship management quality, service quality, customer satisfaction and customer loyalty: The case of five star hotels. *Advances in Social Sciences Research Journal*, *6*(2).

Nicholls, D. L., & Bumgardner, M. S. (2018). Challenges and opportunities for North American hardwood manufacturers to adopt customization strategies in an era of increased competition. *Forests*, *9*(4), 186.

Petzer, D. J., & Van Tonder, E. (2019). Loyalty intentions and selected relationship quality constructs: The mediating effect of customer engagement. *International Journal of Quality & Reliability Management*, *36*(4), 601-619.

Prasetyani, D., Abidin, A. Z., Purusa, N. A., & Sandra, F. A. (2020). The Prospects and The Competitiveness of Textile Commodities and Indonesian Textile Product in the Global Market. *Etikonomi*, *19*(1), 1-18.

Purwanto, S. (2019). The effect of competitive advantage and commodity strategic supply chain on Indonesia textile industry. *Uncertain Supply Chain Management*, *7*(2), 133-144.

Ramos, E., Patrucco, A. S., & Chavez, M. (2023). Dynamic capabilities in the "new normal": a study of organizational flexibility, integration and agility in the Peruvian coffee supply chain. *Supply Chain Management: An International Journal*, *28*(1), 55-73.

Riege, A. (2005). Three-dozen knowledge-sharing barriers managers must consider. *Journal of knowledge management*, *9*(3), 18-35.

Saad, Nourhan & Elgazzar, Sara & Mlaker Kač, Sonja. (2023). Investigating the impact of supply chain management practices on customer satisfaction through flexibility and technology adoption: Empirical evidence. Business Strategy & Development. 7. 10.1002/bsd2.326.

Saad, N. A., Elgazzar, S., & Mlaker Kac, S. (2022). Investigating the impact of resilience, responsiveness, and quality on customer loyalty of MSMEs: Empirical evidence. *Sustainability*, *14*(9), 5011.

Saleem, A., & Anjum, S. (2023). Effects of Supply Chain Management Practices on Technological Innovation in Restaurant Industry of Pakistan: The Mediating Role of Guanxi. *Journal of Entrepreneurship and Business Venturing*, *3*(1).

Schuberth, F., Hubona, G., Roemer, E., Zaza, S., Schamberger, T., Chuah, F., ... & Henseler, J. (2023). The choice of structural equation modeling technique matters: A commentary on Dash and Paul (2021). *Technological Forecasting and Social Change*, *194*, 122665.

Shao, F., & Stalker, I. (2016). E-business Utilization in Supply Chain Management of UK Textile Manufacturing Industry. In *Joint 2016 International Conference on Economics and Management Engineering (ICEME 2016)* (pp. 97-100). DEStech Publications, Inc.

Shi, J., Huang, F., Jia, F., Yang, Z., & Rui, M. (2023). Mass customization: The role of consumer preference measurement, manufacturing flexibility and customer participation. *Asia Pacific Journal of Marketing and Logistics*, *35*(6), 1366-1382.

Sinaga, J., Anggraeni, E., & Slamet, A. S. (2021). The effect of supply chain management practices and information and communication technology on competitive advantage and firm performance (Case study: Smes of processed food in Jakarta). *Indonesian Journal of Business and Entrepreneurship (IJBE)*, *7*(1), 91-91.

Storbacka, K., Strandvik, T., & Grönroos, C. (1994). Managing Customer Relationships for Profit: The Dynamics of RelationshipQuality. *International journal of service industry management*, *5*(5), 21-38.

Tanakinjal, G. H., Deans, K. R., & Gray, B. J. (2010). Innovation Characteristics, Perceived Risk, Permissibility and Trustworthiness in the Adoption of Mobile Marketing. *J. Convergence Inf. Technol.*, *5*(2), 112-123.

Tarafdar, M., & Qrunfleh, S. (2016). Agile supply chain strategy and supply chain performance: complementary roles of supply chain practices and information systems capability for agility. *International Journal of Production Research*, *55*(4), 925–938. https://doi.org/10.1080/00207543.2016.1203079

Tobing, A., & Yuliati, E. (2022, March). The Impact of Customer Experience Quality on Customer Loyalty in Motor Vehicle Insurance Industry: The Mediating Role of Relationship Quality. In *Proceedings of the 4th International Conference on Economics, Business and Economic Education Science, ICE-BEES 2021, 27-28 July 2021, Semarang, Indonesia*.

Wang, T., Aggarwal, V. A., & Wu, B. (2020). Capability interactions and adaptation to demand-side change. *Strategic Management Journal*, *41*(9), 1595-1627.

Wang, X., Liu, Z., & Zhang, T. (2017). Flexible sensing electronics for wearable/attachable health monitoring. *Small*, *13*(25), 1602790.

Warsi, S. A. A., Asim, D. M., & Manzoor, S. (2020). The effects of supply chain management practices on technological innovation: a case of the manufacturing sector of Pakistan. *CenRaPS Journal of Social Sciences*, *2*(1), 58-75.

Wong, A. (2004). The role of emotional satisfaction in service encounters. *Managing Service Quality: An International Journal*, *14*(5), 365-376.

Xu, Ning. (2023). How Information Technology Capabilities Drive Innovation in SMEs in The Context of the Sharing Economy. 10.2991/978-94-6463-102-9 91.

Zineldin, M. (2005). Quality and customer relationship management (CRM) as competitive strategy in the Swedish banking industry. *The TQM magazine*, *17*(4), 329-344.