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The Mediating Role of Supply Chain Integration in the Relationship between TQM and Innovation Performance

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Abstract: The purpose of this study is to provide a theoretical framework that studies the mediating role of supply chain integration (SCI) in the relationship between total quality management (TQM) and innovation performance (IP). This Practical research was done by using the descriptive-correlation method. The statistical population of the study consisted of managers of SMEs in Golpayegan industrial town in Iran. The sampling method was simple random, and 137 companies were selected to determine the sample size by G*Power software. The validity of the questionnaires was confirmed using content and construct validity, and Cronbach's alpha was used to assess their reliability. The data was analyzed by structural equation modelling in the SMART_PLS software. The research findings showed that TQM has a significant effect on IP and SCI. The impact of SCI on IP is also significant and positive. In addition, the mediating role of SCI in the relationship between TQM and IP was confirmed.

Keywords: Innovation performance; SMEs; supply chain integration; Supply Chain Management; Total Quality Management

1 INTRODUCTION

The survival of companies in manufacturing organizations has been threatened due to the increase in competition both at the local and global levels. For this reason, these organizations have turned to improving innovation performance to achieve competitive advantage and competition [1]. In general, economic growth is related to innovation, and one of the key results of innovation is innovation performance [2]. Among manufacturing companies, small and medium-sized companies play an important role in creating innovation and economic progress, especially in developing countries [3]. SMEs are committed to taking risks to be the first to introduce new products, services, and operational technologies, which indicates that these companies are highly inclined to implement innovative strategies [4]. However, few SMEs embed good innovation processes in their companies, which can lead to the loss of their competitive advantage. Accordingly, SMEs should maintain innovation by keeping their employees' creativity active and identifying opportunities [5].

Organizations use different methods to improve innovation performance in providing new products, processes, and services, which can be referred to as total quality management and supply chain integration. Companies that implement total quality management and continue to improve product quality can improve their competitive position and business success and differentiate their products [6]. Quality management (QM) improves teamwork among employees of organizations and causes employees to provide innovative ideas to improve products, services, and processes. This has finally made organizational structures flexible, which is one of the vital factors in creating innovation [7]. The key to business success is recognizing the importance of innovation and quality. Companies should pursue both innovation and quality in the implementation phase. Accordingly, both TQM and innovation appear to be critical to the success of organizations [8].

In addition, in today's chaotic business environment, manufacturing companies are trying to improve their performance by strengthening their supply chain management (SCM) processes. For this reason, the concept of supply chain integration (SCI) was developed to strengthen the SCM of companies. SCI can be defined as a coordinated collaboration between different functions within the organization on the one hand and between the organization itself and its external partners, suppliers, and customers on the other hand, to effectively manage materials, services, information, money, and decisions. Supply chain integration helps companies develop and launch innovative products and services and improves innovation performance in organizations [9]. Also, just as total quality management and supply chain integration help to improve the performance of companies, total quality management can help to integrate and improve the companies' supply chain [10].

Ahinful et al. (2023) [11], Mushtaq et al. (2022) [12], and Kulenović et al. (2022) [6], in their research, concluded that total quality management has an impact on innovation performance. Yani (2022) [13], Tarigan and Kristianto (2019) [14], and Thai and Jie (2018) [10], concluded in their studies that total quality management impact on supply chain integration. Also, according to the research done by Bwaliez (2021) [9], Kumar et al. (2020) [15], and Somjai and Girdwichai (2019) [16], supply chain integration affects innovation performance.

As can be seen in the review of the background of the research, so far no research has been conducted that has studied the mediating role of supply chain integration in the relationship between total quality management and innovation performance, and for this reason, the present research has been conducted.

In the continuation of this paper, the theoretical foundations are first introduced, then the proposed model and its hypotheses are presented, and the research method is explained. The desired model is tested in a practical study and finally, according to the obtained results, a discussion and conclusion are made.

2 LITERATURE REVIEW

2.1 The Influence of TQM on Innovation Performance

Quality management systems such as TQM have a significant impact on the reputation of organizations and the trust of customers by introducing new products and services, and for this reason, quality has become the most important decision-making factor [17]. The impact of TQM on innovation performance is explained by Barney's (1991) resource-based theory, which considers TQM as a capability that allows organizations to achieve innovation performance. Innovation performance is considered an intangible resource of the organization that is impossible to imitate [11]. TQM and innovation have the same importance and goals in improving the performance of organizations and enabling companies to increase competitive advantage by considering customer expectations. The amount of organizational and product development, which are the main goals of innovation, is different from the implementation of TQM [8].

2.2 The Influence of TQM on Supply Chain Integration

Integration is an important principle in SCM literature. SCI includes internal company procedures and external procedures with customers and suppliers. Manufacturers who have properly connected their internal processes to external suppliers and consumers in supply chains are the most successful [18]. Increased performance in companies is achieved through the strategic integration of SCI and TQM principles. TQM acts as a systematic framework for quality management, permeating organizational structures and emphasizing the integration of quality principles into all operational dimensions. Likewise, supply chain integration facilitates coordinated interactions between companies, suppliers, and customers in an integrated system [19]. The implementation of TQM affects the integration of internal cooperation between supply chain departments. Quality management is needed to improve supply chain integration for the proper implementation of SCM inside and outside organizations [13].

2.3 The Influence of SCI on Innovation Performance

From a dynamic capability perspective, a company may be able to modify its SCM capabilities to better align with supply chain objectives. This includes having an enabling SCI that can significantly contribute to innovation performance. For example, customer integration is an important dimension of SCI that improves innovation performance. It is argued that establishing long-term and close relationships with important suppliers reduces opportunistic behaviour and irregularities in transactions, improves product quality, and reduces monitoring, delivery, and performance costs, thereby improving innovation performance [5]. Improving SCI is one way to achieve innovation. SCI is a key driver in improving product innovation. SCI improves organizational functions such as innovation performance through the coordination of activities and information flow between a company and its suppliers and customers [20].

2.4 SCI Mediates the Relationship between TQM and IP

The philosophy of quality management is used in business, industry, and services to ensure maximum efficiency and effectiveness, which can increase stability, increase efficiency, and prevent mistakes in the decision-making process of managers. If the quality management system is implemented properly, it can be effective in improving the management and increasing the effectiveness, and improving the decision-making processes and the performance of the organization. In addition, the findings of studies have shown that TQM has a positive correlation with the innovative performance of companies [21]. One of the important dimensions of TQM is management commitment, which is a prerequisite for achieving an integrated supply chain. In addition, the impact of SCI on the performance of companies has been confirmed. Integration enhances company performance by allowing better coordination and collaboration within the company between different departments. In this regard, achieving high innovation performance is possible if companies establish a strong relationship with foreign partners and then penetrate deep into foreign companies to gain access to valuable information and resources for the company [5]. According to the mentioned reasons, SCI can play a mediating role in the relationship between TQM and innovation performance.

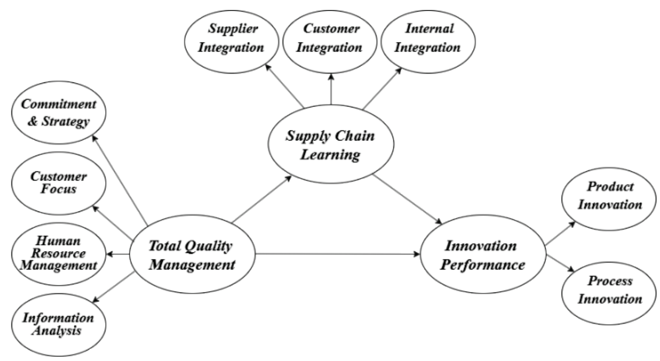

Figure 1 The conceptual model of research

Fig. 1 illustrates the proposed conceptual model. As it is known, the independent variable in this research is TQM, the dependent variable is IP, and the mediating variable is SCI. Accordingly, the hypotheses of the present research are as follows:

H1: TQM impacts innovation performance.
H2: TQM impacts supply chain integration.
H3: SCI impacts innovation performance.
H4: SCI mediates the relationship between TQM and IP.

3 RESEARCH METHODOLOGY

3.1 Measurement Instrument

A questionnaire tool was used to measure the research variables. The questionnaire consisted of two parts. The first part included the demographic information of the respondents and included 4 items (Industry sector, Respondent's work experience, Duration of the company and No. of employees). The second part was the items related to the research variables, which were measured based on a fivepoint Likert scale from 1 (strongly disagree) to 5 (strongly agree). The following studies were used to measure the research variables.

TQM: For the total quality management variable, we used the Vanichchinchai and Igel (2011) questionnaire. This questionnaire measures TQM with 17 items and includes 4 dimensions: commitment and strategy (4 items), customer focus (3 items), human resource management, and information analysis (3 items) [22].

SCI: For the supply chain integration variable, we used the Thai and Jie (2018) questionnaire. This questionnaire measures SCI with 12 items and includes 3 dimensions: customer integration (4 items), supplier integration (4 items), and internal integration (4 items) [10].

IP: For the innovation performance variable from the questionnaire of Escrig-Tena et al. (2018), we used. This questionnaire measures IP with 9 items and includes 2 dimensions of product innovation (5 items) and process innovation (4 items) [23].

Also, to check the content validity of the survey, two expert academicians and two senior industry experts reviewed the survey items.

3.2 Sample Size and Data Analysis Approach

The statistical population of this research consists of quality managers of small and medium companies in Golpayegan Industrial Town in Iran. A simple random sampling method was used to collect data in the winter of 2024. To determine the required sample size in PLS-SEM, G*Power software was used to perform power analysis related to model settings [24]. In this research, 137 observations were needed to reach 80% statistical power and detect R^2 values of at least 0.1 with a 5% error probability by G*Power software.

Because the sample size of the study was small (n=137), and by performing the Kolmogorov-Smirnov (K-S) test, it was determined that the distribution of the structures was not normal at the level of $\rho = 0.05$; for this reason, PLS-SEM was used to analyze the data [25]. In this paper, SEM was used because it performed confirmatory factor analysis (CFA) to explore the theoretical and conceptual dimensions of observable and latent scales in complex models. The causal inference appears to be accurate due to the nature of access and correction of observed measurement errors in the analysis [26].

4 RESULTS

These results were obtained in the analysis of demographic variables. In the industrial sector, the Manufacturers of construction materials, with 24.82%, equivalent to 34 companies, were the most frequent, and the Manufacturers of chemical products were the least frequent with 6.57%, equivalent to 12 companies. Regarding the respondent's work experience, less than 10 years with 47.45%, equivalent to 65 people, had the most frequency, and more than 20 years with 16.05%, equivalent to 22 people, had the lowest frequency. Regarding the duration of the company, companies with 10 to 20 years of operation had the highest frequency, with 51.83%, equivalent to 71 companies, and companies with less than 10 years of operation had the lowest frequency, with 21.90%, equivalent to 30 companies. In addition, about the number of employees, companies with fewer than 50 employees were the most with 45.98%, equivalent to 63 companies, and companies with more than 200 employees were the least frequent, with 6.57%, equivalent to 9 companies.

Regarding research variables, according to Chin (2010), the analysis of studies by PLS consists of two stages of evaluation of the external model (measurement) and estimation of the internal model (structural), and the tests of the measurement model are used to check the validity and reliability of the structures [27]. As can be seen in Tab. 1, all factor loadings of the constructs are above 0.7, which indicates the validity of the proposed model [28].

Table 1 Measurement Model

Construct	Label	Factor	*C-α*	*CR*	*AVE*
Commitment and Strategy	CS1	0.815	0.810	0.876	0.640
	CS2	0.870			
	CS3	0.815			
	CS4	0.712			
Customer focus	CF1	0.858	0.752	0.858	0.669
	CF2	0.793			
	CF3	0.802			
Human resource management	HRM1	0.840	0.893	0.916	0.610
	HRM2	0.847			
	HRM3	0.758			
	HRM4	0.755			
	HRM5	0.744			
	HRM6	0.757			
	HRM7	0.756			
Information analysis	IA1	0.835	0.758	0.860	0.673
	IA2	0.819			
	IA3	0.807			
Customer integration	CI1	0.743	0.758	0.846	0.580
	CI2	0.811			
	CI3	0.731			
	CI4	0.757			
Supplier integration	SI1	0.844	0.819	0.881	0.651
	SI2	0.813			
	SI3	0.705			
	SI4	0.857			
Internal integration	II1	0.854	0.833	0.889	0.667
	II2	0.816			
	II3	0.783			
	II4	0.811			
Product Innovation	PrI1	0.783	0.880	0.913	0.677
	PrI2	0.811			
	PrI3	0.857			
	PrI4	0.825			
	PrI5	0.837			
Process Innovation	PsI1	0.843	0.861	0.906	0.706
	PsI2	0.881			
	PsI3	0.866			
	PsI4	0.768			

To check the reliability of the external model, Cronbach's alpha (*C-α*), composite reliability (*CR*), and average variance extracted (*AVE*) were used, which, as can be seen in Tab. 1, *C-α* and *CR* are more than 0.7, and the reliability of the variables has been confirmed. *AVE* was also higher than 0.5 for all constructs, which was confirmed [24].

In addition, the value of *CR* was higher than *AVE*, which indicates the confirmation of composite reliability [29]. Tabs. 2 and 3 show the discriminant validity results. It is shown in Tab. 2 that all the variables are consistent with the criteria proposed by Fornell and Larcker (1981) because all the AVE squares of the variables were higher than the correlation of that variable with other variables [30]. Tab. 3 also shows that the HTMT indices were less than 0.9, and discriminant validity is established [31].

Table 2 Fornell and Larcker coefficients

	CS	*CF*	*CI*	*HRM*	*IA*	*II*	*PsI*	*PtI*	*SI*
CS	**0.800**								
CF	0.580	**0.818**							
CI	0.303	0.351	**0.761**						
HRM	0.517	0.461	0.203	**0.781**					
IA	0.321	0.326	0.134	0.349	**0.820**				
II	0.370	0.446	0.217	0.457	0.642	**0.817**			
PsI	0.257	0.191	0.438	0.248	0.273	0.341	**0.840**		
PtI	0.348	0.308	0.174	0.385	0.539	0.521	0.251	**0.823**	
SI	0.358	0.278	0.532	0.287	0.163	0.329	0.605	0.271	**0.807**

Table 3 HTMT criterion

	CS	*CF*	*CI*	*HRM*	*IA*	*II*	*PsI*	*PtI*	*SI*
CS									
CF	0.737								
CI	0.388	0.464							
HRM	0.602	0.558	0.244						
IA	0.398	0.426	0.176	0.415					
II	0.451	0.563	0.269	0.528	0.820				
PsI	0.300	0.236	0.537	0.274	0.339	0.397			
PtI	0.407	0.378	0.212	0.435	0.660	0.609	0.284		
SI	0.440	0.355	0.669	0.332	0.198	0.398	0.728	0.315	

In the analysis of the structural model of the research, a three-step approach including R^2 value, Q^2 model quality, and the significance of the path coefficient of the structural model was used [32], and its results can be seen in Tabs. 4 and 5 and Figs. 2 and 3.

According to the three values of 0.25, 0.50, and 0.75 (low, medium, and high), the R^2 value for *SCI* and *IP* was between low and medium [33]. According to the three values of 0.02, 0.15, and 0.35 (low, medium, and high), the redundancy index structural model of *SCI* and *IP* was medium [24]. In addition, the commonality index for *SCI* and *IP* was medium to high. Finally, considering the three values of 0.1, 0.25, and 0.36 (low, medium, and high) suggested by Tenenhaus et al. (2005), goodness of fit test (*GOF*) was used to evaluate the overall research model, and the overall value of the research model was high [34].

Table 4 R^2, cross validity redundancy and communality

Variables	R^2	Redundancy index	Communality index
Supply chain integration	0.343	0.113	0.266
Innovation performance	0.478	0.192	0.316

$$GOF = \sqrt{\overline{AVE} \cdot \overline{R}^2} = 0.518$$

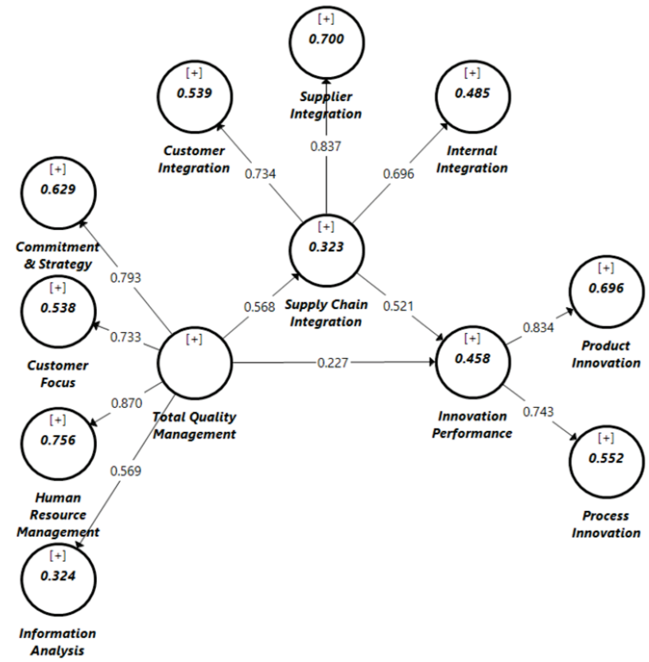

Figure 2 Path coefficient result

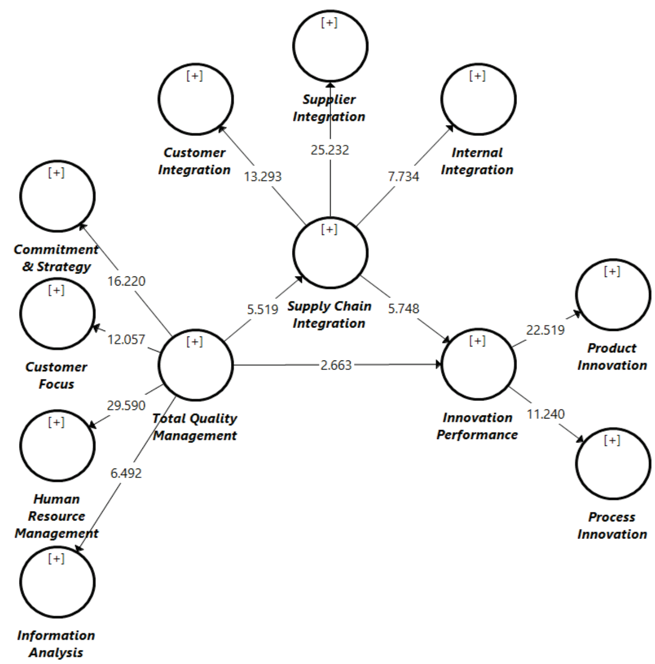

Figure 3 Z-value significant coefficients

Table 5 Hypotheses testing results

Hypothesis	Path coefficient	*SE*	*t*-value	*p*-value	Decision
TQM → *IP*	0.227	0.085	2.663	0.009	Supported
TQM → *SCI*	0.568	0.103	5.519	0.000	Supported
SCI → *IP*	0.521	0.091	5.748	0.000	Supported

Finally, for the structural model, the path coefficients test and the bootstrap technique were used to determine the strength of the relationship between research hypotheses, and as can be seen in Fig. 3 and Tab. 5, TQM has an impact on *IP* and *SCI*. In addition, the results show that *SCI* affects *IP*.

4.1 Mediation Test

Preacher and Hayes (2008) approach and bootstrap method were used to test the mediation effect of the research [35]. This approach is completely suitable for the PLS-SEM method and has been implemented in Smart-PLS software. First, the research model should be implemented without the presence of the mediating variable, i.e., *SCI*. If the effect of the independent variable (TQM) on the dependent variable (*IP*) is significant, the effect of the mediator variable should be analyzed [24].

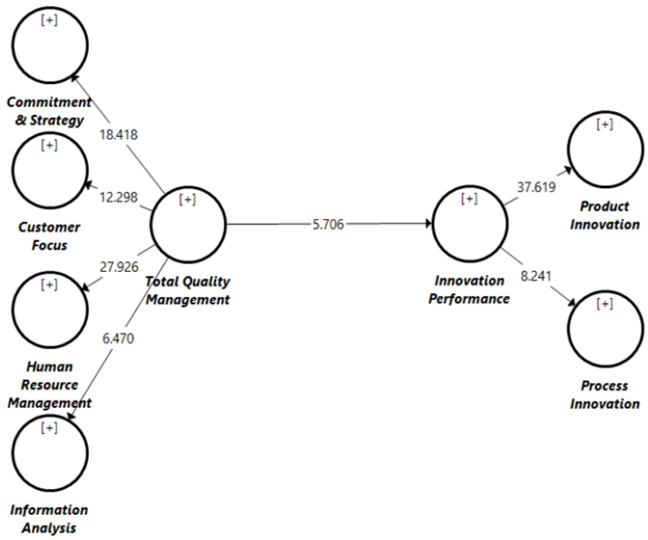

Figure 4 The result of the hypothesis test without the mediator variable

Table 6 The results of the mediator variable test

Hypothesis	Indirect effect	Total effect	*VAF*	Decision
TQM →*SCI*→*IP*	0.296	0.523	0.566	Partial Mediation

As can be seen in Fig. 4, the research hypothesis test was significant without the presence of the mediating variable. Now we have to go to the analysis of the model with the presence of the mediator variable. To measure the effect of the mediating variable in this study, according to Hair et al. (2014), the variance accounted for (*VAF*) was used. Considering that the value of *VAF* was between 0.2 and 0.8, *SCI* plays a partial mediating role in the model [24]. This means that *SCI* accounts for the effect of TQM on innovation performance and mediates it by 56.6%. The results of the mediator variable analysis can be seen in Tab. 6.

5 DISCUSSION

The present research was conducted on SMEs in Golpayegan Industrial Town in Iran. For this purpose, a questionnaire was used to collect data, and the quality managers of these companies were responsive. According to Tab. 5, in the first hypothesis of the research regarding the effect of TQM on *IP*, considering that its *t*-value is 2.663, which is outside the range (–1.96, 1.96), the *p*-value is less than 0.05, and the intensity of the effect 0.227 shows the positive and significant effect of TQM on *IP*. In the second hypothesis of the research about the effect of TQM on *SCI*, considering that its *t*-value is 5.519, which is outside the range (–1.96, 1.96), the *p*-value is less than 0.05, and the intensity of the effect is 0.568. It shows the positive and significant effect of TQM on *SCI*. The third hypothesis of the research is the effect of *SCI* on *IP*, considering that its t-value is 5.784, which is outside the range (–1.96, 1.96) the p-value is less than 0.05, and the intensity of the effect is 0.521. It has a positive and significant effect of *SCI* on *IP*. In addition, according to Tab. 6, it was found that the *SCI* variable plays a mediating role in the relationship between TQM and innovation performance by 0.566.

5.1 Theoretical Implications

The results obtained in this research indicate that for the first time, the mediating role of SCI on the relationship between TQM and innovation performance is studied and considering the importance of SMEs, which has important theoretical implications. The first hypothesis of the research, the effect of TQM on IP, was accepted with an effect rate of 0.227. The results of the research, with the research results of Ahinful et al. (2023), Mushtaq et al. (2022), and Kulenović et al. (2022), are similar. The confirmation of this hypothesis shows that manufacturing companies should support the successful application of TQM practices. TQM contributes to product and process innovation. Innovation and quality are closely related to each other. Hence, TQM helps organizations achieve better innovation performance through commitment to continuous improvement, better decision-making, customer focus, strategic planning, and other quality management practices. This leads to better financial results.

The second hypothesis of the research, the effect of TQM on SCI, was accepted with an effect rate of 0.568. The results of the research, with the results of Yani (2022), Tarigan and Kristianto (2019), and Thai and Jie (2018) are similar. The confirmation of this hypothesis is mainly due to the satisfaction of employees as the key people of organizations. The implementation of TQM in manufacturing companies can facilitate better communication between departments. Management can create good cooperation between the employees of manufacturing companies, so it can create supply chain integration.

The third research hypothesis, the effect of SCI on IP, was accepted with an effect rate of 0.521. The results of the research, with the results of Bwaliez (2021), Kumar et al. (2020), and Somjai and Girdwichai (2019) are similar. Confirmation of this hypothesis shows that integration is needed to improve information processing and ultimately achieve product and process innovation. In addition to using internal integration, companies should use external and customer integration to improve their products and processes. Since knowledge is an important factor in promoting innovation, integration with external partners, especially those in the firm's supply chain, facilitates the flow of knowledge and, therefore, improves innovation performance.

Finally, the fourth hypothesis of the research, namely the mediating role of SCI in the relationship between TQM and *IP*, was accepted with an effect size of 0.566. Companies that have chosen TQM in their company are looking for new ways to produce and implement internal processes and introduce new and innovative products and services. For this reason, they must always be learning and increasing their knowledge, especially about their supply chain. In this regard, *SCI* can facilitate the connection between TQM and *IP* by focusing on knowledge learning through the integration of internal, external, and customers in the delivery of products and processes.

5.2 Managerial Implications

The researchers' findings provide implications for managers of SMEs. In connection with the first hypothesis of the research and confirming the impact of TQM on *IP*: 1. Paying more attention to TQM, especially the aspects of Information analysis and Customer focus; 2. Holding educational seminars to increase employees' awareness of the benefits of creating innovation in companies, and 3. Helping employees by providing suggestions and accepting criticisms from company managers to improve innovation performance in products and processes.

About the second hypothesis of the research and confirming the effect of TQM on *SCI*: 1. By establishing more connections between industry and academia, from the elite This area should be used to take advantage of their innovative plans and opinions to take an important step towards improving the quality of products, services and supply chain and 2. Increasing the learning of employees at the supply chain level is effective in improving flexible performance and causes an increase in the quality of products, services, and processes in the organization.

In connection with the third hypothesis and confirming the impact of *SCI* on *IP*: 1. Pay more attention to internal integration than supplier integration dimensions; 2. Employees should be encouraged to learn new skills to improve products and processes, and be aware of any changes 3. Form dedicated learning teams and organize group discussions with suppliers and customers to regularly increase their knowledge to improve the quality of services and products.

In connection with the fourth hypothesis of the research and the confirmation of the hypothesis of the mediating role of *SCI* in the relationship between TQM and *IP*: 1. Choosing managers with risk-taking characteristics to improve quality and create innovation, and 2. More communication with internal and external suppliers and customers to create innovative products and processes.

6 CONCLUSION

The purpose of this article was to analyze the mediating role of supply chain integration in the relationship between total quality management and innovation performance. For this purpose, first, by collecting information in the field of theoretical foundations and literature on the subject, library sources, articles, and scientific databases were used, and finally, by testing the proposed model in SME firms in Golpayegan Industrial Town in Iran, the results were discussed. The findings indicated the effect of TQM on SCI and innovation performance. In addition, *SCI* had an impact on innovation performance. In addition, the results showed that *SCI* has a Partial mediating role in the relationship between TQM and innovation performance. The results showed that *SCI,* as a mediating variable, has a greater effect on the dependent variable than TQM as an independent variable. The dimensions of human resource management and commitment, and strategy from TQM and supplier integration from *SCI* have the greatest impact on innovation performance. In addition, information analysis from TQM and internal integration from *SCI* have the least impact on *IP*.

The research topic is theoretically and quantitatively unique compared to similar studies. On the other hand, according to the field findings, the study of the mediating role of *SCI* in the relationship between TQM and innovation performance was conducted for the first time in the manufacturing industries of the world. The comprehensiveness of the investigated variables and the novelty of the research topic were special advantages of the proposed model. In general, it can be concluded that TQM in SMEs is necessary for the development of *SCI* and innovation performance. Just like a system, TQM is an important input, and *SCI* is a key process, so *IP* is a critical output.

One of the limitations of this research can be mentioned that very few studies have examined the research hypotheses. Also, the research location was limited to SMEs in Iran, and therefore, caution should be exercised in generalizing the findings to other companies. The time of data collection was in the winter of 2024, and therefore, caution should be exercised in generalizing the findings to other times. Researchers are advised to conduct more studies on variables affecting innovation performance in future research. Future researchers are suggested to study the effect of TQM and *SCI* on quality performance in the current model. It is also suggested to investigate the mediating role of supply chain learning and supply chain agility in the relationship between total quality management and innovation performance.

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