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Research Paper

Investigating the Impact of Supply Chain Innovation on Competitive Advantage through the Mediating Role of Robustness & Resilience Capabilities

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ABSTRACT

In the current highly uncertain external environment for businesses, maintaining a single competitive advantage in the supply chain is difficult in the long run to remain competitive and sustainable in this era, organizations need resilience and innovation capability. The purpose of this study is to propose and validate a theoretical model to investigate the mediating role of risk management capabilities (Robustness Capability and Resilience Capability) on the relationship between Supply Chain Innovation and competitive advantage. Research population consists of 127 companies involved in the Rasht Industrial City. Structural equation modeling and LISREL software were used to test the hypotheses. The results showed that there is a positive and significant relationship between supply chain innovation and competitive advantage. Moreover, it was found that Robustness Capability and Resilience Capability variables play a mediating role on the relationship between supply chain innovation and competitive advantage. Our study contributes to the empirical research on SCI and validates a model that links it to CA through the robustness and resilience capabilities of firms in the construction sector. Our study also provides insights for managerial decisions on investment in technology.

1 | INTRODUCTION

In the context of the development of industry 4.0 embedded in various industries, organizations face stiffening competition from external dynamically changing and unpredictable environments (Garrido-Moreno et al, 2024). Competitive advantage in an organization depends on high-quality production at an optimal cost, and in the production process, the organization's internal and external factors must play an effective role so that the organization's goals are achieved effectively and efficiently (Taghizadeh Yazdi and Zolfi, 2015). Innovation capabilities have attracted the attention of researchers in the past few years, which is due to the ability to use existing resources to successfully develop and discover new ideas and is a determining factor in generating competitiveness. Many previous studies have shown that creating product development processes does not necessarily lead to the production of innovative products or improved firm performance due to the complexity and extensive nature of innovation capabilities. Therefore, to achieve this goal (innovation effectiveness), companies must have a set of characteristics that positively affect the continuous development of innovative activities. One of the most important of these characteristics is the correct choice of supply chain strategy (Bani and Babaei, 2010). In fact, firms seeking to achieve a competitive advantage (CA) need to incorporate innovation into their supply chain as it creates value in organizations (Lyles, 2014). In the supply chain management framework, supply chain risks must be effectively managed to maintain competitive advantage (Baryannis et al, 2019). In the current global economy that is gradually becoming more complex, organizations are increasingly looking at supply chain innovation as an important factor for competing in the industry and changing their business strategies (Fawad Afraza et al, 2021).

However, very few studies have explored, and empirically tested, the impact of SCI at multiple analytic levels (Wong and Ngai, 2019). And still fewer have studied its impact on supply chain RMCs or the competitive advantage of firms (Kwak, Seo, and Mason, 2018). In addition, the moderating impact of supply chain integration in the relationship between SCI and CA (mediated by robustness and resilience) has not been empirically tested in an integrative manner. This link represents a key challenge, in particular in industries where firms are heavily dependent on suppliers. Therefore, this study proposes an original theoretical model based on a contingent resource-based view of the organization and investigates the relationships among SCI, RMC (robustness and resilience capabilities) and CA.

2 | LITERATURE REVIEW

2.1 | Supply Chain Innovation

According to Schumpeter, innovation is a process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. In the same way, innovation is a process that combines science, technology, economics and management, as it is to achieve novelty and extends from the emergence of the idea to its commercialization in the form of production, exchange, consumption (Abderrazak and Youssef, 2022). Supply chain is a network of individual organizations and their suppliers that produce and distribute a specific product and service to customers (Benzidia and Makaoui 2020). Supply chain represents the necessary steps taken to deliver a product or service to customers. According to supply chain council, these steps can be managed with the help of the SCOR model that consist of the Plan, Source, Make, Deliver, Return processes (Büyüközkan and Göçer, 2018). Innovation in logistics and SCM has always existed. People, organizations, companies and even governments have always looked for new ways to manufacture, pack and transport goods, to store them and to handle them. Process innovations have also regularly transformed the way of sourcing, producing and distributing, but also of supporting and recovering certain products (Fabbe-costes, 2020). Supply chain innovation (SCI) is recognized as a major source of competitive advantage and its potential to drive improvements in corporate performance depends on a set of factors known as innovation capabilities (IC) (Teece, 2018). Innovation capabilities are the abilities to explore existing resources to successfully develop new ideas (Zimmermann et al, 2020). Many researchers argue that innovation capabilities positively affect business performance (Mir et al, 2016), but the factors and conditions that favor or weaken this relationship are not yet known (Saunila et al, 2014). In general, innovation in products, organizations, and ultimately innovation in the supply chain is important for success and competitive advantage. In supply chains, organizations expect supply partners to adopt innovation from an internal motivation to generate various benefits (Kim and Chai, 2017). Most importantly, while suppliers play an important role in effective supply chain management, they have increasingly accepted the responsibility of encouraging innovation, such as innovation in the production of existing products and new product development, partnerships to enhance innovation, design and process innovation (Azadegan and Dooley, 2010). Buying companies in the supply chain try to encourage suppliers to adopt innovation, but supplier innovation faces many challenges such as customer power in the supply chain, cultural and geographical differences, increased business risks and coordination costs (Henke and Zhang, 2010).

An important part of supply chain management is the adoption of a supply chain strategy so that the company's management in the field of product sourcing has the ability to plan, convert raw materials, manage demand, communicate with supply chain actors and deliver products and services (Arora et al, 2016). It is believed that a good fit between innovation capabilities and supply chain strategy will have a positive impact on gaining competitive advantage (Wu et al, 2014). It is very important for proper management in the different stages of the supply chain process. According to the GSCF model, this management consists of customer relationship, customer service, demand, order fulfillment, production, supplier relationship, product development, delivery, and return management (De Barros et al, 2015). As a result of globalization, the traditional supply chain has faced difficulties in dealing with changing environments to manage the relationships optically. Today's modern supply chain is more complex than the traditional one due to widespread disruptions, increasing pressure, lower product life cycle, and increased customer demand all over the world. However, digital technology has broken down the barriers to managing the supply chain and has made significance changes in visibility and efficiency (´Slusarczyk et al, 2020).

2.2 |Competitive Advantage

Competitive advantage refers to the features-driven and resources driven ability (Tseng et al., 2008). By competitive advantage, an organization defends itself against competitors and also includes features that allow the organization to distinguish itself from its competitors (Li et al., 2006). Competitive advantage is an organizational ability to achieve higher level of competitiveness for products and services in an industry compared to its competitors. This competitiveness comes from the trim of production and operational cost, better products and services, and higher customer satisfaction (Chen 2019). Porter (1985) considers competitive advantage within the framework of competitive strategy. He considers the competitive strategy as a determinant for the company position in a competitive environment. The goal of competitive strategy is to guide the market by understanding and anticipating economic factors, especially the behavior of other competitors. Competitive strategy enables the company to produce a product that cannot be produced by competitors. Obviously, it is not possible to gain competitive advantage accidentally and organizations can only achieve it by thinking and planning. Dubey et al. (2021) state that the common indicators of competitive advantage are better control and superior performance. Elrefae and Nuseir (2022) state that competitive advantage depends on how an organization defensively acts in front of its rivals, for example, new product and service innovation, competitive price, product quality, and delivery systems. However, in the competitive market environment, to gain a competitive advantage in supply chain management In order to define competitive advantage, one must go beyond financial management issues. Aspects of competition related to human resource management and marketing are considered (Gallardo and Sanchez, 2014). Considering that the concept of competitive advantage arises from strategic management concepts, it can be said that competitive advantage is the result of a dynamic and continuous process that, taking into account the external and internal situation of the organization, originates from the performance of the organization and, through the ability to properly utilize resources, capabilities are created that, when utilized, bring competitive advantages to the firm (Lotti and Darwishan, 2016).

2.3 |Resilience

Generally, most of the literature defined logistics resilience (LR) as the ability to facilitate organizations to survive, adapt, respond, as well as grow in confronting unpredictable disruptions, and, to enhance abilities to make modifications according to adversity and the changing external environment. By combining and reconfiguring the firm's available resources and capabilities, such an ability is developed (Piprani, et al, 2020). With the extension of SC network, the entities and practices involved in logistics services have become more diverse and complex, deepening their connection. At the same time, the emergence of new requirements in logistics, such as shorter lead times, the pursuit of lower costs, and diverse customer demands, as well as the occurrence of unexpected events such as inclement weather, transportation network disruptions or congestion, and incompetent service from logistics partners, have posed additional operational challenges to the logistics services provided by LSPs (Liu et al, 2018). For LSPs, logistics resilience is a company's capacity to respond to such changes and the ability to exceed them. In other words, logistics resilience can help companies achieve better operational performance. For LSPs, logistics resilience is not only the ability to recover from interruptions and sustain its stability and consistency of business operation, but also the capability to deal with changing market conditions (Deng and Noorliza, 2023).

2.4 |Robustness

In the supply chain context, robustness refers to the ability to deal with all possible future situations in an effective manner (Klibi, Martel, and Guitouni, 2010). It has further been defined as "..... the possession of the flexibility to leave many options to be decided under all plausible future scenarios". Christopher and Peck (2004) argued that physical strength is the best tool to explain robustness as it is the ability to handle variability and errors in SCM. Klibi et al. (2010) stated that robustness is considered to be more suitable for persistent low-impact events, regular fluctuations, or reasonable variations to sustain ordinary supply chain innovations (Tang, 2006). Robustness in the SC is referred to the ability of the system to keep its function smooth or nearly unchanged when confronted with turbulence. It has also been described as the ability of the SC to carry out its operations in a variety of plausible upcoming scenarios.

2.5 |Supply Chain Innovation, Robustness and Resilience Capabilities

According to Fisher (1997), despite the fact that businesses perform much better because of supply chain innovation, it can cause demand unpredictability which in turn affects supply chain and logistics operations. Thus, in these circumstances, managers need to pursue a balanced approach while considering the risks and opportunities of supply chain innovation. In this respect, managers should have a reasonable understanding of how new technologies can be used in order to safeguard themselves from major risk scenarios resulting from innovations (Taplin and Schymyck, 2005). One way to achieve this is by keeping a balance in the supply chain resilience and robustness capabilities of firms. Pettit et al. (2010) found that effective management of operational risks directly improves firms' financial performance. Firms with a more innovative environment may be more resilient to environmental disruptions and technology uncertainties, as innovation enables them to strengthen the dynamic capabilities that definitely impact the RMC of the firm. In a systematic literature review, Sabahi and Parast (2020) found that innovation can directly impact the dynamic capabilities of firms, including knowledge sharing, agility, and flexibility, which then significantly enhance their resiliency. In a similar, Vein, Klibi et al. (2010) maintained that firms need to manage recurrent low-impact risk events through robustness capability. In light of the above discussion, we can argue that the level of supply chain innovation may affect the level of both the robustness and the resilience aspects of risk management capabilities. This brings us to formulate the following hypotheses

H1: Supply chain innovation positively affects the robustness capability of supply chains.
H2: Supply chain innovation positively influences the resilience capability of supply chains

2.6 |Supply Chain Innovation and Competitive Advantage

Simatupang, Wright, and Sridharan (2004) concluded that organizations increasingly look at SCI as a critical factor to remain competitive in industry and to change their business strategies accordingly. Organizations tend to utilize a number of strategies to enhance CA, such as improved quality, enhanced reliability, new product development, increased customer service, and less time to market (Li, Ragu-Nathan, Ragu-Nathan, and Rao, 2006). Innovation in the supply chain can thus play an important role in improving the CA of organizations through efficient processes (Flint, Larsson, and Gammelgaard, 2008). According to Braunscheidel and Suresh (2009), firms need agility and innovation in their supply chain in order to respond to higher levels of uncertainty and turbulence as well as intense competitive pressure. Therefore, the following baseline hypothesis is formulated.
H3: Supply chain innovation positively affects the firm's competitive advantage

2.7 |Robustness & Resilience Capabilities and Competitive Advantage

Managing risks in a proactive manner can become a source of competitive advantage for organizations as it encourages them to take a more strategic view of risks and helps them to plan for unforeseen SC disruptions (Henke, 2009). Therefore, organizations that are willing to compete better in a volatile business environment need to develop crucial supply chain risk management capabilities which can lead to both differentiation and cost reduction (Colicchia and Strozzi, 2012). Therefore, organizations that respond efficiently to disruptions with well-prepared risk management practices not only create many opportunities for distinctive value but also minimize risk transfer costs through greater bargaining power and the ability to attract more potential customers. As a consequence, the organization can gain a larger market share through competitive advantage. This leads to the formulation of the following hypothesis:

H4: Robustness capability positively influences competitive advantage.
H5: Resilience capability positively influences competitive advantage

The conceptual model of this research was designed based on theoretical fundamentals and the research background and to enhance the Competitive advantage through Supply chain innovation and Robustness & Resilience capabilities, as shown in Figure 1.

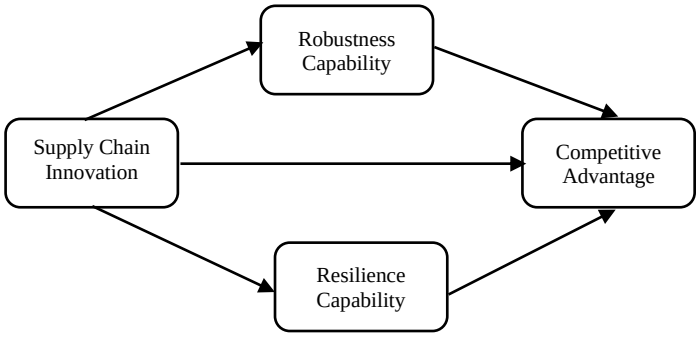

Figure 1: Conceptual Model

3 | METHODDOLOGY

The present research is applied in terms of its nature, because its purpose is to gain understanding and knowledge to determine a tool by which a specific need can be met. On the other hand, its results can be used by different groups of planners and managers of companies located in Rasht Industrial Park, so it is considered an applied research. Also, this research is considered a descriptive-analytical research in terms of its research method. Because it describes and analyzes the performance conditions of enterprises. The research method is survey research. Survey research is research that focuses on behaviors that do not require control and focuses on current events. The required data was collected through a questionnaire based on the study of Fuad Afraz et al. (2021), and quantitative methods were used to analyze the collected data. This research is of causal type in terms of examining variables because it examines the effects between the variables of innovation in the supply chain, competitive advantage and risk management capabilities together and the result, if confirmed in the sample, is generalized to the entire society. In terms of time, it is also a cross-sectional research. In terms of the method of collecting information, it is considered a documentary and field method because books, articles and theses were used to collect theoretical foundations and a questionnaire was used to collect data. Finally, considering that the researcher did not interfere with the independent variables, in this respect it is a post-event research. The statistical population of the present study includes all companies located in the industrial parks of Rasht. The mentioned companies include all industries. 188 companies are located in the Rasht Industrial Park. Therefore, the number of the statistical population of the study was 188 companies. The reason for choosing the aforementioned companies was the favorable scope and space for researchers, which provides access to the statistical population. The next important issue is the size or volume required for the sample. Since the population in this study is limited and the number of small and medium enterprises in Rasht Industrial Park is 188 units, the limited population formula was used to calculate the sample size. First, the variance of 30 questionnaires was obtained and according to the calculations, the sample size is 127 enterprises.

$$n = \frac{N z_{\frac{\alpha}{2}}^2 s_x^2}{(N-1)\varepsilon^2 + z_{\frac{\alpha}{2}}^2 s_x^2} = \frac{188 * 1.96^2 * 5039^2}{(188-1) * 0.05^2 + 1.96^2 * 5039^2} = 127.09$$

N = Size of the statistical population; n = Sample size; = Size of the variable under study according to the standard normal distribution with an uncertainty level of 5%; ε^2 = Error rate; = Sample variance; = Uncertainty level equal to 0.05. A non-probability method of availability was used for sampling, in such a way that the only criterion for selecting individuals was their availability and the possibility of responding. Because it is not possible to assign the same chance to all respondents. In this study, the field method was used to collect the required data and information. Also, in some cases, the library study method was used to better analyze the information obtained. The specialized questions section of the questionnaire included questions related to the research variables, which are presented in Table (1).

3.1 | Validity

In the present study, the content validity method was first used. For this purpose, the opinions of experts related to the research topic as well as the professors of the management group were used. After receiving numerous opinions from the professors, the necessary amendments were made and distributed again among 10 professors and more than 95 percent of the questions were approved by them. Then, using confirmatory factor analysis, the overall structure of the research questionnaires was subjected to content validity.

Table 1: Measures and Factor Loadings

Factor	variables	Indicator code	indicator
Supply chain innovation SCI	Leading technology system that can integrate information.	SCI1	0.80
	Leveraging physical assets to drive supply chain innovation	SCI2	0.88
	Innovation in core supply chain processes.	SCI3	0.70
	Agile and responsive processes against changes.	SCI4	0.79
	Agility and responsiveness of processes in the face of changes	SCI5	0.85
	How to use creative methods in the organization	ROB1	0.69
Robustness capability ROB	Stability in the event of internal and external disturbances	ROB2	0.91
	Anticipating and preparing the company to minimize risks	ROB3	0.89
	Managing a significant level of negative consequences of repeated risks	ROB4	0.70
	Investigating the most effective reactions	RES1	0.85
Resilience capability RES	Reengineering logistics processes to adapt to disruptive conditions	RES2	0.76
	Adequately respond to logistics disruptions.	RES3	0.83
	Achieving optimal performance levels	RES4	0.78
	Reducing negative impacts due to speed of response	CA1	0.82
Competitive advantage CA	Competitive advantage in efficient logistics operations	CA2	0.87
	Competitive Advantage in Effective Logistics Operations	CA3	0.94
	Competitive Advantage in Differentiating Logistics Operations	CA4	0.79
	Competitive Advantage in Reputation of Logistics Operations	SCI1	0.80

3.2 | Reliability

In order to examine the reliability of the research questionnaire, first 30 questionnaires were distributed and collected in a statistical sample. Then, SPSS software was used to calculate Cronbach's alpha coefficient. In the present study, the Cronbach's alpha of the questionnaire is as shown in Table (2). Considering that the calculated alphas are higher than 0.86, the research questionnaire has appropriate reliability.

Table 2: Cronbach's Alpha

variables	Cronbach's alpha
Supply Chain Innovation	0.902
Robustness capability	0.867
Resilience capability	0.873
Competitive advantage	0.931
The entire questionnaire	0.931

3.3 |Normality Test of Variables Distribution

The Kolmogorov-Smirnov test was used to examine the normality of the distribution of research variables. According to Table (3), the dependent variable (gaining competitive advantage of companies) is normal at α = 0.05 percent error level. Other independent and mediating variables were also examined. Therefore, the hypothesis of normality of data distribution at the α = 5% probability of error level was examined with the Kolmogorov-Smirnov (KS) test and according to the table, the null hypothesis based on normal distribution is accepted. In other words, the distribution of research data is normal.

Table 3: Kolmogorov-Smirnov Test

variables	statistic	Sig.	information
Supply Chain Innovation	0.678	0.748	normal
Robustness capability	0.574	0.897	normal
Resilience capability	0.716	0.684	normal
Competitive advantage	0.599	0.866	normal

3.4 |Sample Size Adequacy

To analyze the validity and measure the sample size adequacy, first 30 initial questionnaires were distributed among marketing managers of companies located in Rasht and they were asked to answer the questions and also indicate their agreement or disagreement. Then, the KMO index and Bartlett test were used to determine the validity. The values obtained are presented in Table (4). As can be seen, all the values obtained are more than 77 percent. Therefore, it can be claimed that the following table indicates the sample adequacy.

Table 4: KMO and Bartlett's Test

variables	KMO	Sig.
Supply Chain Innovation	0.827	0.00
Robustness capability	0.866	0.00
Resilience capability	0.912	0.00
Competitive advantage	0.910	0.00
Overall	0.771	0.00

4 | FINDINGS

Table (5) summarizes the descriptive statistics of the research variables. As can be seen, the supply chain innovation variable has the highest mean and resilience has the lowest dispersion. It was also found that all four variables follow a normal distribution.

Table 5: Descriptive Statistics

variables	Mean	var	information
Supply Chain Innovation	2.96	0.92	normal
Robustness capability	2.95	0.67	normal
Resilience capability	2.94	0.64	normal
Competitive advantage	2.88	0.77	normal

Figures (1) and (2) show the model in the standard estimation mode and the model in the significance mode.

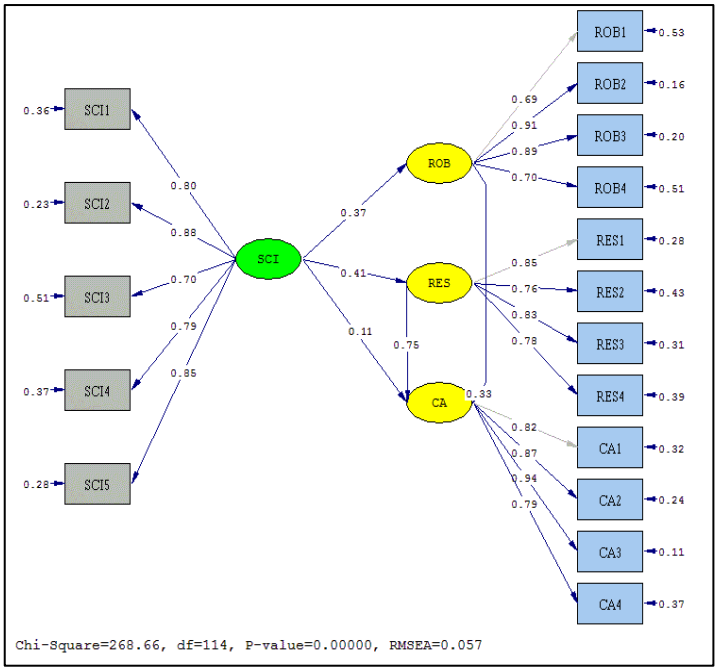

Figure 2: Structural Model in Standard Estimation Mode

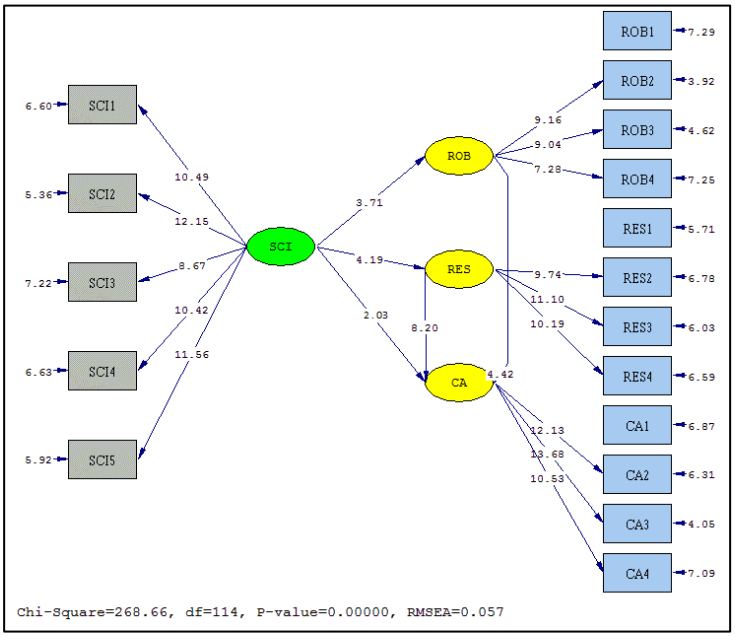

Figure 3: Structural Model Goodness of Fit Significant Coefficients t (T-Values)

According to the standardized coefficient measurement model, it can be concluded that there is a significant correlation between the relevant latent variables and their related indicators. In the present research model, the ratio of chi-square to degrees of freedom is 2.35. Since it is less than 3, it is a desirable value. Also, the value of the root mean square error of approximation (RMSEA) is less than 0.08 and equal to 0.057. Similarly, the adaptive fit index, incremental fit index, normalized fit index, and unnormalized fit index are all greater than 0.9, so the model shows a good fit and is approved. Other characteristics also indicate a good fit of the model.

Table 5: Goodness of Fit

Index	χ2/ df	RMS EA	CF I	NF I	NN FI	PN FI	IFI	RF I	AG FI	PG FI
Criterion	>3	0.08≥	0.>9	0.>9	0.>9	0.>9	1-0	1-0	1-0	1-0
Value	2.35	0.057	0.97	0.95	0.95	0.91	0.97	0.92	0.89	0.82

Table 6: Test Results of the Main Research Hypotheses

Hypotheses	Description	Standardized path coefficient	T- Value	Result
H1	SCI→ROB	0.37	3.71	Supported
H2	SCI→RES	0.41	4.19	Supported
H3	SCI→CA	0.11	2.03	Supported
H4	ROB→CA	0.33	4.42	Supported
H5	RES→CA	0.75	8.20	Supported

According to the results of the hypothesis test, it was determined that innovation in the supply chain, considering the mediating role of risk management capabilities, has a positive and significant effect on the competitive advantage of companies located in the Rasht Industrial Park. In this way, innovation in the supply chain, considering the role of resistance capability, has an effect with a coefficient of 12 percent, and innovation in the supply chain, considering the role of resilience, has an effect with a coefficient of 31 percent on the competitive advantage of companies. While innovation in the supply chain directly has an effect with a coefficient of 11 percent on the competitive advantage of companies. It was also determined that risk management capabilities moderate the relationship between innovation in the supply chain and competitive advantage. Among them, resilience plays a more effective role.

SCI→CA	0.11
SCI→ROB→CA	0.37*0.33=0.12
SCI→RES→CA	0.41*0.75=0.31

5 | DISCUSSION AND CONCLUSION

The aim of this study is to investigate the role of risk management capabilities in the relationship between supply chain innovation and gaining competitive advantage in companies located in Rasht Industrial Park. According to the research findings, the standard coefficient between supply

chain innovation and resilience is 0.37. The standard coefficient between supply chain innovation and resilience is 0.41. The standard coefficient between supply chain innovation and competitive advantage is 0.11. The standard coefficient between resilience and competitive advantage is 0.33. The standard coefficient between resilience and competitive advantage is 0.75. The results of these hypotheses are consistent with the research of Fouad Afraz et al. (2021). Also, Taghizadeh Yazdi and Zulfi (2015) have investigated the effect of supply chain measures on organizational sustainability with the mediating role of competitive advantage in Saipa Company. The results of the structural equation model indicate a positive and significant causal relationship between supply chain measures and competitive advantage. Also, the direct and indirect relationship between supply chain measures and sustainability was confirmed. Considering the impact of risk management (resilience and resilience) on competitive advantage, it is suggested that in order to develop risk management capabilities, including resilience and resilience, companies should acquire and use various skills and inter-organizational knowledge. Considering the impact of innovation in the supply chain on risk management, it is suggested that companies continuously pursue innovation in the main supply chain processes and consider agile and responsive processes to changes. And use creative methods for product delivery. Companies should try to improve the level of technology used in the production process by investing in research and development. Senior managers of enterprises should give significant independence in the innovation process to middle managers. Considering the impact of innovation in the supply chain on competitive advantage, it is suggested that in order to gain competitive advantage, employees should be made aware that they are ultimately responsible for improving the company's products and processes. Therefore, it is necessary to guide the resources and references of strategy formulation with a strong entrepreneurial perspective and also to have a strong connection between innovation and value recognition by customers. In order to conduct future research, it is suggested that the present issue be conducted for a specific industry to take into account the specific characteristics of the industry. It is also suggested that macroeconomic variables be entered into the model as moderating variables.

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