Innovation and survival of traditional industries: Measuring barriers using the Best Worst Method

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Abstract

Traditional industries, seen as cultural heritage, need to be innovative to grow and survive in the era of fast technological advancement. Traditional industries are continuously encountering decline. This research aims at identifying and addressing barriers of innovation to make an informed decision for better survival and improvement. A review of literature was used to propose a hierarchical structure of criteria in which innovation barriers were categorized into organizational, environmental, and supply chain dimensions. An online questionnaire was designed based on a multi-criteria decision-making method called Best-Worst Method (BWM) to identify the importance of the barriers. The opinion of 41 experts working in the Iranian Carpet and Leather industries was collected. The results indicate that organizational culture and management support are the most important barriers to innovation in the Leather and Carpet industries. We also found that environmental criteria are the least important criteria in both selected traditional industries. Results illustrated that the two industries have no significant difference in the three perspectives.

***Keywords*:** Innovation; Hierarchy structure of barriers, Traditional industries; Best Worst Method (BWM); Carpet and leather industries.

1. Introduction

Revolutionary advancements in technology and rapid changes in the behavior of both customers and competitors bring about serious challenges for companies to do business. Firms need to be innovative in products, processes, marketing strategies, and business models to increase their survival[1,2,3,4]. The need to be more adaptable to these drastic changes is also crucial for businesses with a long reputable history. Primarily maintaining the current market and secondly expanding the business to new markets are the requirements that justify the innovation in companies.

Increasing profitability and productivity, having access to new markets, and improving organizational performance are among numerous benefits of applying innovation in an organization[5]. Innovative organizations usually save time, money and gain a greater competitive advantage than other companies [6]. Innovation also leads to organizational sustainability because innovative companies are constantly evolving. Not only do the innovative companies respond to the current needs of their customers, but they usually anticipate future trends of services or products [7]. There is a significant number of companies that have attributed their financial losses and even bankruptcy to the lack of innovation. The 300 million dollars loss of PETS[DOT]COM in 2000 and the bankruptcy of TOYS R US with one billion dollars assets in 2017 are among the failures attributed to the lack of innovation [8].To have an innovative organization, companies face a wide range of barriers [9].Identifying and then prioritizing these barriers are the first steps towards having an innovative organization.

Applying innovation is a demanding process in non-research intensive and more mature industries, such as sectors which produce metal, food, plastic, and furniture. These industries can be also named as low-medium technology or traditional industries [10]. The R&D intensity functioning as an engine of innovation, is very low in traditional industries compared to high and medium technology sectors, such as industries producing motor vehicle, medicine and precision and optical

instruments [10,11].Traditional industries can be innovative and surprisingly contribute to the development of modern economies [10].Studying how innovation works in traditional industries has attracted the attention of several researchers (see for instance [12-14]). The innovation literature has not studied the barriers to innovation in traditional industries. By considering the importance of innovation in traditional industries, the main contribution of this paper would be providing a hierarchical structure of barriers which covers various aspects of a company from organizational, environmental, and supply chain dimensions in Iranian carpet and leather industries.

In a general category, Technology-Organization-Environment (TOE) and Human-Organizational-Technological (HOT), which is named as sub-dimensions of organizational and environmental, are usually investigated as dimensions in organization innovation studies. To have an innovative organization, the role of supply chain dimension is undeniable[15]. Because supply chain makes a bridge between the organizational and the environment dimensions, it has been significantly neglected in previous studies while a high percentage of the success of innovative organizations is attributed to the supply chain metrics. For this purpose, by considering the importance of innovation in traditional industries, the main contribution of this paper would be providing a hierarchical structure of barriers which covers various aspects of a company from organizational, environmental, and supply chain dimensions.

The barriers are ranked for Iranian carpet and leather industries. Iran is the world's largest producer and exporter of handmade carpets, producing three-quarters of the world's total output. Leather products have been commonly regarded as a luxury items since the ancient traditions. Persian carpet and leather products have always been a remarkable symbol of art, culture, traditions of the Iranian people all around the world. Although these industries play a significant role in various economic aspects of Iran, the country's global market share has been dramatically declining in

these industries. For instance, the carpet export rate decreased from 500 million dollars in 2011 to 70 million dollars in 2019 which is the lowest rate in the past 40 years in international markets [16]. Despite the leather industry's long history, Iranian products have not achieved a significant place in the international markets [17] , and they are also losing their global market share. The current state of these two industries cannot make a dramatic change to achieve Iran's 20-year vision plan, set out in the national strategic roadmap to reach one-billion-dollar export in 2025. The goal seems to be unreachable unless industries' key actors regain their leading position in the global market by fostering innovation in the products, processes, marketing, or business models. Studying and understanding barriers to innovation in traditional industries to overcome the obstacles is essential. Relatively few studies have focused on innovation in traditional industries in developing countries. We evaluate the barriers of innovation in two traditional industries of Iran, a developing country.

This problem is a multi-criteria decision-making (MCDM) problem. We could use an MCDM method to find the importance of these barriers. Best-Worst Method (BWM) [18,19] as one of the most popular MCDM method is used to, assess the weight of barriers in the leather and carpet industries of Iran. Then using one-way analysis of variance (one-way ANOVA), we perform a statistical test on data provided by the BWM to find whether there is a significant difference among organizational, environmental, and supply chain dimensions for Iranian carpet and leather industries.

Taking into account the literature, we summarized these research goals as follows:

- Identifying and categorizing innovation barriers into organizational, environmental and supply chain pillars.
- Calculating the weight of identified barriers using the opinions of experts and Best-Worst Method (BWM) for two carpet and leather industries of Iran.

- Testing the significance of difference of carpet and leather industry from organizational, environmental and supply chain dimensions using one-way ANOVA.
- Providing managerial insights to deal with the identified barriers.

The remainder of this paper is organized as follows. Section 2 starts by reviewing relevant existing literature and then we propose a framework of barriers that contribute to the failure of innovation in selected industries. In Section 3, we discuss the methodology used in this study, followed by explaining data collection method in Section 4. The weight of barriers in the leather and carpet industries is discussed in Section 5. In Section 6, we report the measures taken to validate our findings in the previous step. Managerial implications and recommendations to overcome the innovation barriers in the two traditional industries are presented in Section 7, and we present our conclusions and suggestions for further research in Section 8.

2. Research background

To evaluate the barriers affecting the lack of innovation, we present a framework consisting of three dimensions, i.e., organizational, environmental, and supply chain. We look at the innovation from different angles and then clarify the barriers categorized into the three dimensions. To identify the relevant barriers affecting leather and carpet companies' innovative performance, we review texts and tables of relevant studies. We based the level of influence and control of the organization's management to categorize the identified criteria into organizational, environmental, and supply chain pillars.

2.1. Innovation

In a changing world, innovation is a critical element for all businesses [20,21]. Schumpeter (1934) argued that innovation is vital to economic development. He also noted that innovation is specified

by new processes, raw materials, products, markets, and organizational forms [22]. According to Plessis [22], innovation can directly cause performance improvement and create added value for the organization. Wong et al.[23] defined innovation as the effective application of the processes and products new to the organization and designed to benefit the organization and its stakeholder. Uzkurt et al. [24] also argued that innovation is the technique that gains knowledge and shares it and creates new information to improve or develop new products and services. According to the Organization for Economic Co-operation and Development (OECD), innovation is defined as introducing novel products or development of available products, operation of the new process, new marketing methods, a new organizational form in business, workplace organization, and external relation [25]. According to Kogabayev and Maziliaukas [26], innovation causes change in all or some part of a system (e.g., create a quality leap and break the old rules). They also argued that the innovation is not equal to improvement (shift taking place without significant changes in operations), novelty (new solutions to commercialization) and invention (new technical solutions which lead to commercialization).

Despite all companies' investments to accelerate innovation, the innovation performance is not always satisfactory [27]. In the literature, criteria that contribute to the invasion/lack of innovation are usually categorized into organizational/internal and environmental/external dimensions (see for instance [28]). As presented by Zimmerman et al. [15], to have an innovative organization, the role of the supply chain dimension is undeniable. To improve the evaluation process, we introduce the supply chain as a new dimension in this research along with organizational and environmental dimensions.

Organizational barriers indicate the internal component of organizations, supply chain dimensions states barriers affecting the supply of raw materials and selling products, and environmental

dimension denotes the external barriers influencing the organizations' activities. In the following sections, we will explain the concept and review the related studies in these domains.

2.2. Organizational barriers

Hussinki et al. [29] and Camisón and Villar-López [30]introduced innovation in the organization as the main resource for competitive advantage in the market. According to Marković et al. [31], one of the most important drivers of innovation from an organizational aspect is management support. They also stated that enterprise management can include managing processes in different areas such as knowledge management, human resource management, and strategic management, which positively influence innovation in everyday operations of the company. Cardoni et al.[32] argued that management usually plays several roles in business which are critical to transferring information and making decisions. According to Clancy [33], improper enterprise management can cause barriers to innovative activities in developing countries.

Un et al. [34] stated that research and development (R&D) prepares ideal conditions to properly guide the organization towards innovative products, so it is assumed as a vital resource for the organization to achieve an innovative structure. Calantone et al. [35]argued that R&D, which focuses on creativity or making new value for customers, can increase different aspects of innovation capability. Studies by Audretsch and Belitski [36]Arora and Athreye [37], and Parisi et al. [38] also pointed that there is a strong relationship between R&D and innovation.

Human resources (HR) management is closely related to innovation in an organization. Luiza [39] stated that effective human capital can guarantee innovative behavior among the organization's staff by creating and sharing knowledge and information. Jimenze-Jimenze and Sanz-valle [40] stated that the implementation of HR practice boosts the employees' knowledge, capability, motivation, talent, skill and, innovation. Similarly, Torella et al. [41], Andries and Czarnitzki [42], Lee et al. [43], and

Calabrese et al. [44] introduced the direct effects of HR on innovation capability. According to Rohlfer and Zhang [45], the effect of organizational culture on innovation has been recognized as a vital element of participation in economic development, organizational growth, and international management. Dobni [46] argued that organizational culture that encourages innovation includes actions that show the appreciation of creativity and new idea, freedom, teamwork, confidence, respect, and accurate communication. According to Tellis et al. [47], those sorts of innovations that are developed by culture can guarantee long-term success, growth, and business survival. Do et al. [48] , Pedersen et al. [49], Tellis [50], and Terziovski [51] have also pointed that organizational culture encourages innovation.

The impact of technology on innovation is undeniable. According to Fagerberg et al. [52] and Talebi et al. [53], technology is tied to innovation forever. Ettlie [54] defined innovation as new technology or several technologies that create value. In the same vein, some researchers such as De Jesus and Mendonça [55], AlSanad [56], Movahedipour et al. [57], and Stewart et al. [58] highlighted the relationship between technology and innovation.

Edward and Delbridge [59] argued that in a competitive business environment, cooperation among organizations (linkage capability) seems to be essential to the acquisition of skills, abilities, expertise, and knowledge. There are various types of linkage capability, one of which is that the company exchanges its information and techniques with suppliers. In a second way, the company transfers its products and coordinates the design with the partners and, cooperates on research and allows others to use their technology. According to Un et al. [34] , collaborating with others is a positive innovative method to achieve organizational innovation since it facilitates gaining access to more resources, information, knowledge, technique, and technology which may not exist in the

organization.I In some cases, collaboration with competitors has negative effects on innovation, so they highly recommended that the manager should choose the collaborator carefully.

2.3. Environmental barriers

According to Fabrizio et al. [60] , government policy is a vital driver of boosting innovation. Patankul and Pinto [61] stated that the government must have an innovative policy, directly or in a supportive role, which increases the level of innovation among economic institutions at the micro-level. Guan and Yam [62] concluded that governmental tools such as rules and structure, financial support, educational and health requirements have an important effect on innovation, so the governmental policy can either support or preventive innovation.

Hansen [63] highlighted that innovation is high in the primary level of the life cycle and decreases as the industry is developed and becomes mature. Innovation is higher at the first levels, i.e., introduction and growth levels, while its role is more important in the following levels of maturity and decline. Competition was also introduced as a crucial driver of innovation [60]. Fallah and Lechler [64] stated that the firms competing on worldwide levels need an innovative approach immediately in products, services, and processes. Wang and Dass [65] argued that the manager should be careful to make decisions in a competitive environment since the high-risk situation can cut back innovation.

Mansfield and Mundial [66] identified the alliance between universities and the industry as the most effective external factor influencing innovation. Salimi and Rezaei [67] stated that the linkage between educational situations and universities can boost innovation. Guan et al. [68] found that the collaboration among universities and the industry mainly happens by transferring R&D results and

technology that help an innovative idea and improve the products. Betts and Santoro [69] argued that the latest technologies can be incorporated into the industry through universities. Lebeau et al. [70] and Lin and Bozeman [71] mentioned that the university-industry collaboration is positive for both parties since they can permit access to knowledge, skills, techniques, and human capital. Archibugi et al. [72] introduced economic stability of society as a prominent factor for being innovative. They argued that the economic conditions and crises in society decrease the organizational opportunity since these problems cause firms to refuse to invest in long-term and risky programs, and most companies react to this situation by reducing the number of innovative projects.

The environmental concern (e.g., global warming, air pollution, waste disposal, ozone layer depletion) is introduced as a major driver for innovation [73,74]. The activities of the industry have negative impacts on the environment and resource usage; a rise in destructive effects, customer awareness, pressures from environmental activists, and strict governmental rules have forced companies to move towards innovative methods and ideas to reduce environmental pollution [73,74]. Kemp and Pearson [75] introduced the eco-innovation concept as a factor that directly affects the innovation process of organizations.

2.4. Supply chain barriers

According to Narasimhan and Narayanan [76], innovation is the process of changing products, processes, or services that can create value for the firm and its customers through the knowledge generated by the company and/or its supply chain partners. Zimmerman et al. [15] stated that innovation in an organization is assumed to be a collaborative process where the supply chain's role is critical and undeniable, so most companies depend on the supply chain to be innovative. Lindgardt et al. [77] noted that organizations can achieve innovation by their networks such as suppliers, retail stores, customers, and customers' taste.

Zheng et al. [78] stated that organization survival is dependent on innovation and customer satisfaction. Mannan and Haleem [79] proposed that customer awareness and market demand are vital factors in the innovation structure. Fabrizio et al. [60] suggested that market demand is critical to the country's innovativeness. According to Sweetman et al. [80], there is a positive relationship between innovation and customer orientation. Based on Rautela [81], the organizational dependency on raw materials highlights the critical role of suppliers in innovation. Companies are free to choose their supplier based on customer needs, and this freedom helps them to think innovatively about how to use raw materials, deliver products, reduce the cost of materials, and increase profit.

2.5. Decision making methods to study barriers

Evaluation of barriers to innovation, having multiple dimensions and multiple criteria per dimension, is a multi-criteria decision-making (MCDM) problem[82,83]. We could use an MCDM method to find the importance of these barriers. Different types of MCDM methods have been used by several researchers to study the barriers to innovation. Talebi et al. [53] using ANP (analytical network process), identified the rank of influencing factors on innovation in Iranian small- and medium-sized enterprises (SMEs). The level of the industry's life cycle, demand, and industry-university linkage were ranked as the most influential factors. Bayarçelik et al. [84] analyzed SMEs' innovation barriers using the AHP (analytic hierarchy process) technique and found that the financial factor is the most influential element in the case of innovation. Marković et al.[31] employed fuzzy AHP to prioritize the innovation factors of SMEs in Serbia. The results indicated that human resource management is the most important barrier, followed by management and financial investment in R&D. Mannan et al. [85] adopted the fuzzy approach to model the sustainable factors in innovation in Indian SMEs. They classified the barriers into two major parts: dominating power and dependence variables. According to the result of that research employee nature and working

culture were identified as most important factors in dependence variables and governance regulation was ranked as the first barrier in dominating power part.

From the literature review, we found the following research gaps:

- According to the literature, barriers that contribute to the invasion/lack of innovation are usually categorized into organizational and environmental dimensions. To have an innovative organization, the role of supply chain dimension is undeniable. To improve the evaluation process, we introduce the supply chain criteria as a new dimension in this research.
- According to the literature review, several criteria influence the invasion/lack of innovation; a study that included all of them was not found. Considering the criteria, as presented in Figure 1, we propose a framework of 18 barriers categorized into the organizational, supply chain, and environmental pillars for the first time. The hierarchal structure including references and definition of criteria are presented in Table A in Appendix A.
- Although there are several works that investigate the weight of criteria contribute to the lack of innovation, there is not a study focused on the lack of innovation in indigenous industries in a developing country. To this end, we evaluate the barriers of innovation in two indigenous industries of Iran, a developing country, for the first time.
- In this study, we aim to use Best-Worst Method (BWM) [18,19] as we think it is not possible to evaluate barriers with the least possible risk using other MCDM techniques presented in the literature. The Best-Worst Method (BWM) compared to other MCDM methods employed in the literature so far, has several advantages. For instance, fewer pairwise comparisons and accordingly better consistency ratio [86,87], besides less anchoring bias

during the pairwise comparisons process [88] are among the reasons justify the application of the BWM over similar methods. The BWM has been employed as a methodology in several studies such as technology evaluation [89-91], location selection [92-94] supply chain management [95-99], performance evaluation [100,102,103], quality assessment [104], quality control [105]risk management[106] and information system management [107]. For more implications of the BWM, we refer readers to Mi et al. [108].

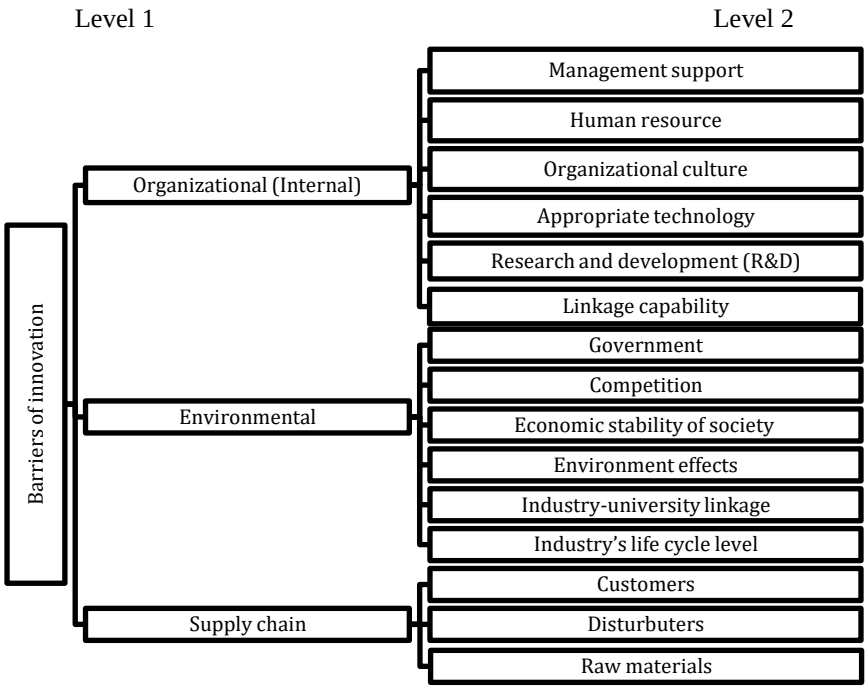

Figure 1. Hierarchical tree of barriers to innovation

3. Research method

3.1. Best-Worst Method (BWM)

BWM is based on the pairwise comparison includes five steps which are described as follow [18,19]:

1. Determine a set of decision criteria. $\{c_1,\ c_2, \dots, c_n\}$.

2. Identify the best (B) and the worst (W) criteria.

3. Determine the preference vector of the best over all the other criteria i.e. $A_B = (a_{B1}, a_{B2}, \ldots, a_{Bj}, \ldots, a_{Bn})$ by a number from 1 to 9 where 1 is 'equally important' and 9 is 'extremely more important'. Note that a_{Bj} indicates the preference of indicator *B* over indicator *j* .

4. Determine the preference vector of all the criteria over the worst $i.e. \text{vector}\, A_w = (a_{1W}, a_{2W}, \ldots, a_{jW}, \ldots, a_{nW})$. Note that a_{jW} indicates the preference of criterion *j* over criterion *W*.

5. Calculate the optimal weights $(w_1^*, w_2^*, \ldots, w_n^*)$.

The optimal weights are calculated by minimizing the maximum absolute difference of $\{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$ for all *j* which is translated into the following optimization problem:

$$\min \max_{j} \{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$$

such that

$$\sum_{j=1}^{n} w_j = 1$$

$w_j \geq 0$, for all *j* (1)

Model (1) is converted into:

$\min \xi$

such that

$|w_B - a_{Bj}w_j| \leq \xi$, for all *j*

$|w_j - a_{jW}w_W| \leq \xi$, for all *j*

$$\sum_{j=1}^{n} w_j = 1$$

$w_j \geq 0$, for all j (2)

Model 2 is run for each level of barriers presented in Figure 1. Consistency rate of pairwise comparison (ξ^*) and the local weight of criteria $\left(\text{i. e. } w^* = \left(w_1^*, w_2^*, \dots, w_n^*\right)\right)$ in each level of the hierarchical tree presented in Figure 1 are the results of Model 2. Please note that for ξ^*bigger than the consistency threshold [109], we ask the corresponding respondent to revise his pairwise comparison. To measure the importance of barriers, we need to calculate the global weight of the hierarchical structure of the proposed framework (Figure 1). To this end, we multiply the local weight of barriers that belong to a branch of the hierarchical tree by each other.

3.2. Analysis of Variance (ANOVA)

ANOVA is a statistical test to determine the difference between the means of two or more independent statistical populations. In other words, we use ANOVA to check if two or more groups are significantly different. ANOVA compares the "between-groups" variance of statistical populations with the "within-groups" variance of each statistical population. If the variance of "between groups" is not significantly higher than the variance of "within groups", we can vote for the same mean of the groups. In this research, we used ANOVA to identify the meaningful difference between carpet and leather industries in terms of the organizational, environmental and supply chain innovation barriers.

4. Data collection

To address the research objectives, after extensive literature review, a list of potential barriers were identified. We identified and contacted a total of 22 Iranian companies working in carpet and leather manufacturing (15 and 7 respectively) to gather expert opinions. Experts from a total of 9 companies responded (4 and 5 respectively). Using a BWM based questionnaire, we then collected

the opinions of 41 experts identified through social media platforms (e.g., LinkedIn and Instagram), all of which had an academic educational background (10% Ph.D., 60% master's degree, and 30% bachelor's degree) and sufficient work experience (minimum three years). We use the arithmetic mean to aggregate the experts' opinions in this research. The specific information about the respondents is presented in Table 1. We prepare a version of questionnaire in Appendix B.

Table 1
Experts contributed to this research.

Industry	Role	**Number of experts**
Leather	Senior managers (marketing, human resource, and R&D)	15
	Production managers	6
Carpet	Senior managers (marketing, human resource, and R&D)	12
	Production managers	8

5. Result and discussion

We evaluate the weights of barriers contributing to the lack of innovation in both carpet and leather industries based on *organizational*, *environmental*, and *supply chain* dimensions, and then, based on the global weight, the barriers affecting the lack of innovation are ranked for the two industries. Based on the experts' opinions, *organizational related factors are* the most influential factors affecting the lack of innovation in carpet and leather industries (see Table 2). This finding confirms that the role of internal resources such as HR, culture, top management support, and technology is undeniable to maintaining innovative capability [110].

At this level, the *supply chain* dimension is the least important criterion for both industries, according to the experts, because, in most Iranian traditional companies, issues related to logistics and supply chain can be addressed with the direction of the organizations' managers.

Table 2
Weight of barriers in level 1.

	Leather industry		**Carpet industry**	
Barrier	Weight	Rank	Weight	**Rank**

Organizational	0.459	1	0.437	1
Environmental	0.279	2	0.343	2
Supply chain	0.261	3	0.219	3

In the leather industry, among the sub-barriers contributing to innovation in the *organizational* category, *management support* has the highest dominating power, followed by *organizational culture*, *HR*, *linkage capability*, *R&D*, and appropriate *technology* (see Table 3). The role of management in having an innovative organization justifies this type of weighting. Most traditional organizations have non-participatory management style [111]. Obviously, this classical approach can explain the reason why the employees felt they cannot bring up new ideas around managers. They do not put much value on being innovative.

As presented in Table 3, the *government* is weighted as the most prominent innovation barrier in the *environment* category in the leather industry (see Table 3). According to the experts, a lack of governmental support to modernize production equipment and supply high-quality raw material is among the reasons justifying the high production cost and, a lack of innovation in the leather industry. Sanctions decreased the Iranian global share of the market, and Iranian companies cannot stay in touch with professional designers or use new technologies, which indirectly intensifies the barriers to innovation. The importance of governmental role has also been highlighted in other studies. For instance, Abdullah et al. [112] argued that lack of governmental support is one of the most important barriers for organizations to embark on innovation initiatives. In this category, *competition*, *industry-university linkage*, *economic stability*, *industry's life cycle level*, and *environmental concerns* are the other important innovation barriers, with the *environmental concerns* being the least important barrier.

At this level, supplying quality *raw materials* is weighted as a main sub-barrier in the supply chain category in the leather industry (see Table 3). A reduction in the import of raw leather, a rise

in livestock price, and the smuggling of skin, hides, and wet-blue (half-processed leather) to other countries can justify the high weight of the raw materials factor in the leather industry. In this category, *distributors* is the least important barrier compared to the other sub-barriers.

Table 3
Weight of sub-barriers in level 2.

		Leather industry		**Carpet industry**	
Barrier	Sub-Barrier	Weight	Rank	Weight	Rank
Organizational	Management support	0.182	2	0.214	1
	Human resource	0.163	4	0.200	3
	Organizational culture	0.217	1	0.208	2
	Appropriate technology	0.126	6	0.117	6
	Research & development	0.135	5	0.117	5
	Linkage capability	0.174	3	0.141	4
Environmental	Government	0.197	1	0.220	1
	Competition	0.184	2	0.206	2
	Economic stability	0.163	4	0.140	4
	Environment effects	0.132	6	0.136	5
	Industry-university linkage	0.164	3	0.161	3
	Industry's life cycle level	0.158	5	0.134	6
Supply Chain	Customers	0.318	2	0.404	1
	Distributors	0.303	3	0.311	2
	Raw materials	0.377	1	0.284	3

According to the results, *organizational culture* emerged as the most important sub-barrier related to the organizational factors in the carpet industry (see Table 3). It might be explained by the fact that the employees are not encouraged to engage in team working, creativity, risk-taking and being market-oriented [111]. As the share of employees in decision-making decreases, their willingness to engage in an innovation activity also decreases. *Management, linkage capability, HR, R&D, and technology* are ranked as the other important criteria affecting the lack of innovation at this level.

According to the experts, *the government* is the most challenging sub-barrier related to the *environment* category, also in the carpet industry (see Table 3). The reason discussed in the leather industry also applies here. This is in line with the result of Gupta and Barua [113], demonstrating that lack of access to government subsidies and financial incentives have negative effects on

organizational innovation. Hadjimanolis [114] found that more than 50% of companies do not feel any support from the government and most of them consider current innovation measures to be insufficient. *Industry's life cycle level* is the least important sub-barrier compared to the others after *competition, industry-university linkage, economic stability*, and *environmental concerns*.

Among the sub-barriers categorized into *supply chain* dimensions, the *customer* is the most influential factor in the carpet industry. Since the carpet is a luxury product, the organization should adopt luxury marketing strategies such as merging the customer needs with the innovation process, which is difficult when they cannot keep in touch with their customers. When they do not receive feedback from customers, they lose their ability to be innovative. According to the experts, *distributors* and *raw materials* are the other important barriers in this category (Table 3).

Global weight

According to the results obtained from BWM, *management support* with a global weight of 0.093 is the most challenging barrier affecting innovation for the leather industry (see Table 4). *Organizational culture* with a global weight of 0.099 is the most important barrier explaining a failure in the implementation of innovation in the carpet industry (see Table 4).

Among the sub-barriers presented in Figure 1, *industry's life cycle level* and *environmental concerns* (by a very small margin) are the least important barriers affecting innovation programs in both carpet and leather industries (see Table 4). The less importance of environmental concerns in developing countries can explain the lower weight of environmental concerns in both industries.

Table 4
Global weight of sub-barriers.

Industry	Barrier	Global weight	Rank
Leather	Organizational culture (c_1)	0.099	1
	Raw material (c_2)	0.098	2
	Management support (c_3)	0.083	3
	Customers (c_4)	0.083	4

Table 4
Global weight of sub-barriers.

Industry	Barrier	Global weight	Rank
	Linkage capability (c_5)	0.079	5
	Distributors (c_6)	0.079	6
	Human resource (c_7)	0.075	7
	Research & development (c_8)	0.062	8
	Appropriate technology (c_9)	0.057	9
	Government (c_{10})	0.055	10
	Competition (c_{11})	0.051	11
	Industry-university linkage (c_{12})	0.045	12
	Economic stability of society (c_{13})	0.045	13
	Industry's life cycle level (c_{14})	0.044	14
	Environment effects (c_{15})	0.037	15
Carpet	Management support (c_3)	0.093	1
	Organizational culture (c_1)	0.091	2
	Customers (c_4)	0.088	3
	Human resource (c_7)	0.087	4
	Government (c_{10})	0.075	5
	Competition (c_{11})	0.071	6
	Distributors (c_6)	0.068	7
	Raw materials (c_2)	0.062	8
	Linkage capability (c_5)	0.061	9
	Industry-university linkage (c_{12})	0.055	10
	Research & development (c_8)	0.0511	11
	Appropriate technology (c_9)	0.051	12
	Economic stability of society (c_{13})	0.048	13
	Environment effects (c_{14})	0.0461	14
	Industry's life cycle level ($\boldsymbol{c_{15}}$)	0.046	15

Figure 2 shows the global weight of sub-barriers in the carpet and leather industries simultaneously. Eleven barriers have the same rank in both industries, and only 4 of them have significant differences in the two industries (Figure 2). According to the graph, the importance of *raw materials* (C2) in the leather industry is much more prominent than its weight in the carpet industry. The high price of raw materials, the high volume of exports, and the smuggling of raw materials and semi-finished leather justify this difference. As presented in Table 4 and Figure 2, the fluctuation of the weight of barriers in the carpet industry is more than the leather one. In both industries, the least important barriers belonged to the environmental category (C_{13} to C_{15}). It can

be concluded that traditional Iranian industries are affected almost the same way, especially from the barriers categorized in the environmental dimension.

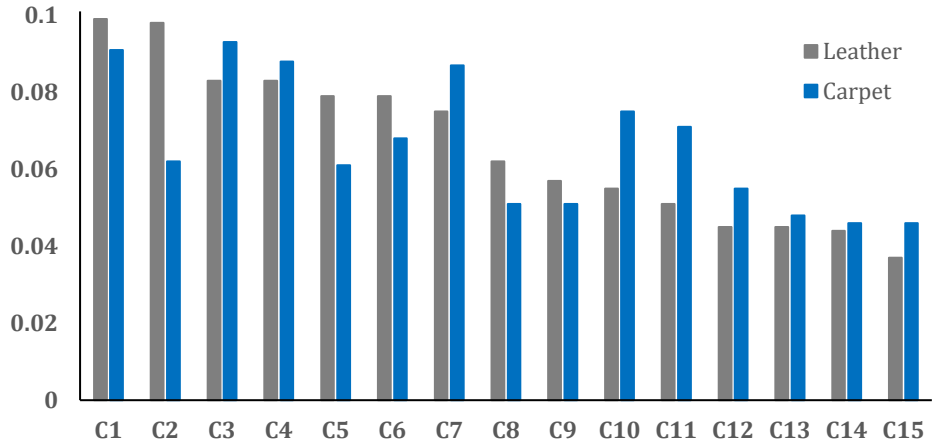

Figure 2. Weight of barriers in the carpet and leather industries

Investigating meaningful difference among main dimensions

We are interested in finding significant differences among the three dimensions of the two traditional industries considering the weight of criteria in level 1 as presented in Figure 1 (i.e., *organizational*, *supply chain*, and *environmental* dimensions). For this purpose, since the opinion of experts are independent and the result of comparisons follows a normal distribution, given each dimension, employing one-way analysis of variance (one-way ANOVA), we investigate whether there is a statistically significant difference in the opinion of experts who are employed in the two industries.

As indicated in Table 5, the statistic tests show that there is no significant difference between the two industries in terms of organizational, supply chain and environmental dimensions. The one-way ANOVA reveals that there is not a meaningful difference between the median of the data for the two industries in the three dimensions (P-Value> 0.05). To be able to perform the one-way ANOVA, the equality of variances of data for the two industries was checked by the Levene test.

Table 5
Results of ANOVA for carpet and leather industries in terms of the three dimensions.

	Source	DF	Adj SS	Adj MS	F-Value	P-Value
Organizational	Factor	1	0.0032	0.00320	0.00	0.956
	Error	44	45.8305	1.04160		
	Total	45	45.8337			
Environmental	Factor	1	0.3999	0.3999	0.43	0.517
	Error	39	36.4340	0.9342		
	Total	40	36.8339			
Supply chain	Factor	1	0.0031	0.003093	0.00	0.952
	Error	39	32.5128	0.833661		
	Total	40	32.5159			

6. Validation of the results provided by BWM

To validate the results of the BWM, we follow an experimental approach presented by Salamirad et al., [115]. We interviewed 12 experts, who participated in the weighting part, in the leather and carpet industries, six for each. All the experts had sufficient experience and knowledge with regard to the implementation of innovative projects in their organization. Each interview lasted 20-30 minutes. We asked them to explain their opinions about why they agreed or disagreed with the results provided by the BWM.

The results of the interviews are presented in Table 6. With regard to the ranking, *organizational* and *government* with 6 (out of 6), and *management support* with 5 (out of 6) votes in favor received the highest score. As presented in Table 5, the results of the BWM were confirmed by the experts with a $\geq$ 50% vote. We summarized the comments of experts in Table 6. For possible differentiation in Table 6, we refer readers to the local weight of criteria (Tables 2 and 3) indicating that the experts did not agree on specific barriers.

Table 6
Results of interview.

Industry	Dimensions	Category	No. of agree	No. of disagree	Positive reasons	Negative reasons
Leather	Organizational	-	6	0	- Most important barriers in the leather industry are organizational factors. - Suitable training and teamwork activities cause a tendency to participate in innovation projects.	-
	Organizational culture	Organizational	4	2	- Organizational culture is required to accept and implement innovative activities.	- With effective management, the organizational culture becomes less significant.
	Government	Environmental	6	0	- Inadequate support of the government is one of the most important barriers of innovation projects.	
	Raw materials	Supply chain	3	3	- Shortage of raw materials in most cases causes significant problems in the innovation projects.	- Failure to attract new customers plays a more important role in innovation projects.
Carpet	Organizational	-	6	0	- Most important barriers in the carpet industry are organizational factors. - Appropriate management is necessary to create innovation projects.	
	Management support	Organizational	5	1	- Decision and policy of innovation projects in organizations are made by management.	- Lack of appropriate technology can contribute to innovation project failure.
	Government	Environmental	6	0	- Improper regulations and policies which are legislated by government have directly influence on the innovation projects.	
	Customers	Supply chain	4	2	- Understanding customer needs is at the center of innovation projects.	- Lack of raw materials and delay in the supply of raw materials lead to innovation crisis.

7. Managerial implications

Considering the weight of innovation barriers, there are some suggestions for managers to overcome these barriers:

- Identifying the barriers to innovation and evaluating them are essential steps for the managers to overcome the barriers more efficiently. More precisely, by knowing the importance of each barrier, the managers can put and spend more energy and time to overcome the ones with higher priority.
- The managers have to define explicitly clear goals and plans to act as an innovative organization and keep in touch with the personnel to support and encourage them to present their ideas.
- Since an innovative idea will not result in financial outcomes unless there is a collaboration among experts and implementers, it is important to connect the employees in the firm who share ideas with others who are in charge of commercializing them[116]. In this regard, forming a coalition involving a wide range of employees is an excellent strategy.
- The lack of proper design and global standard requirements are among the main problems of innovation in traditional industries. In this regard, upgrading production methods (i.e., design, materials, and techniques) with the help of prominent domestic and foreign experts can be one of the best strategies.
- Considering customers as innovators is highly recommended. The customers not only play an essential role in creating and modifying products but also have valuable information. They can be allowed to determine and develop the next products since they can be a valuable source of innovation.

- Using comprehensive marketing strategies has positive effects on innovation in traditional industries. Identifying the proper marketing channels, especially by employing information technology and social media and creating a sense of need among the customers, are other insights that lead to innovation.
- Market segmentation and identifying the desired product features in each market can help resource efficiency in traditional industries. We recommend that traditional organizations build a team for analyzing the market conditions and customer needs and turn the gained insights into innovative products and services.

8. Conclusion

Organizations aim to create the necessary infrastructure for innovation to offer new products and services to customers and stakeholders. The increasing importance of innovation is due to the globalization of markets and the pressure of competition on companies, which have affected the nature and stability of organizations. To have an innovative organization, we need to prioritize the contribution of barriers influencing innovation. To this end, we proposed a framework of innovation barriers categorized into the organizational, environmental and supply chain aspects which provides a much more comprehensive view of barriers compared to the existing literature.We ranked the barriers to innovation in two traditional industries of Iran. To do so, the Best Worst Method was employed as a methodology. The results revealed that *organizational culture* and *management support* have a significant contribution to the innovation of Iranian leather and carpet industries. Comparing the result of the two industries, it was illustrated that the importance of innovation barriers that were categorized into *environmental* dimension is approximately the same in our two selected traditional industries.

The hierarchal structure of barriers itself can be used in different types of industries (such as traditional and high-tech), sectors (such as health, agriculture, and energy), and geographical contexts (such as developed and developing countries). Therefore, the framework is a generic approach and can be used in other regions and contexts. The findings can only be generalized to the traditional industries in countries with similar commercial conditions to Iran.

The hierarchal structure of barriers provides useful insights for both practitioners and policymakers. Using the suggested framework, they can prioritize the barriers of innovation in various industries, which can help them save time and money throughout the weighting process. Considering the results of this research and employing a multi-criteria approach as a methodology, the score of strategies to overcome the barriers can be evaluated in different manufacturing industries, which is a valuable avenue for future research.

The limitation of this work is that even though we strive for identifying the barriers, it may not be the most comprehensive one in terms of innovation.

Doing a comparison study and evaluating the barriers in traditional industries between developed and developing countries would be an interesting study that sheds light on the role of economic frameworks and institutions on barriers. Due to the old-fashioned leadership style and management attitudes of owners and managers of traditional industries, the scientific strategies to overcome the barriers may not be easily implemented in these industries. To facilitate the process of innovation, designing a road map that indicates the details of the implementation steps is suggested as a topic for future research.

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Appendix A

Table A.
Proposed framework including references

Category	Barriers	References
Organizational	Management support	1-3
	Human resource	1,4,5
	Organizational culture	1-3,6-14
	Appropriate technology	12,13,15-19
	Research & development	2,3
	Linkage capability	1,3,12,13,15,17,19-26
Environmental	Government	1-3,11,12,14,27-29
	Competition	3,12,30
	Economic stability	3,12,13,3132
	Environment effects	2,3,31,33
	Industry-university linkage	17
	Industry's life cycle level	17
Supply chain	Customers	11,13,34
	Distributors	29,35-40
	Raw materials	41

Table B.
Description of barriers presented in level 2 of Figure 1.

Barrier	**Descriptions**
Management support	Leadership skills and capacity for risk management.
Human resource	Knowledge resources that consist of skills, experience, expertise, ideas, knowledge, competencies, abilities and the values of employees inside an organization.
Organizational culture	Values and beliefs of individuals working in the organization.
Appropriate technology	Technical expertise and knowledge to find an alternative solution for designing new technologies, materials, and operations.
Research & development	Availability of technical expertise to manage and complete new idea and process.
Linkage capability	Collaboration between different organizational functions and amongst organizations to share resources and technologies.
Government	Government policies, regulations and financial support.
Competition	Level of activities of other companies.
Economic stability	Economic crisis or stability adversely affects firms' decisions on innovation.
Environment effects	Environmental friendly materials for products.
Industry-university linkage	Collaboration with university.
Industry's life cycle level	Including introduction, growth, maturity, and decline phases
Customers	Customer demand, preference, focus and market opportunities.
Distributors	Cooperation with external partners (internationalization).
Raw materials	Local sources for raw materials and the way that material are produced and are supplied.

Appendix B

Explanation about how to fill out a BWM questionnaire

Suppose you wish to select a car based on the following criteria, following the BWM:

A) Price
B) Quality
C) Safety
D) Style

First, we identify the **Most** and the **Least** important criterion among these criteria.
Second, we **compare the most important criterion to the other 3 criteria**.

Last, we compare **the 3 criteria to the least important one**.
In both the second and last step, we use a 9-point scale system for comparison, where:

1 = Equal 3 = Moderate 5 = Strong 7 = Very strong 9 = Extreme 2, 4, 6, 8 are intermediate values

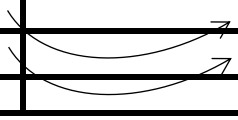
For example, you select **Price** as your most important criterion. First, we compare **Price to the other criteria** and identify that:

	Price	Quality	Safety	Style
Most important attribute (e.g., **A=Price**) to:	1	4	5	9

- 4 means that you Moderately to strongly prefer **Price over Quality**
- 9 means that you Extremely prefer **Price over Style**
- etc.

Note that since there is no difference between the importance of **Price** and itself, the comparison score is 1.
Since **Price** over **Style** is scored highest (9), **Style** is your least important criterion. Second, the comparison of **other attributes to style** is identified as :

	Least important criterion (e.g., **D= Style**)
Price to:	9
Quality to:	2
Safety to:	7
Style to:	1



- 2 means that you Equally to Moderately prefer **Quality over Style**
- 7 means that you Very strongly prefer **Safety over Style**
- etc.

Again, since there is no difference between the importance of Style and itself, the comparison score is 1.

Please select the most important dimension and then compare its relative importance with the other criteria on a scale 1-9:

	Organizational	Environmental	Supply chain
Most important attribute (……) to:			

Please select the least important dimension and compare the other criteria to it on a scale 1-9:

	Least important criterion (……)
Organizational to:	
Environmental to:	
Supply chain to:	

Please select the most important criterion from the Organizational dimension and then compare its relative importance with the other criteria on a scale 1-9:

	Management support	Human resource	Organizational culture	Appropriate technology	Research & development	Linkage capability
Most important attribute (……) to:						

Please select the least important criterion from the Organizational and compare the other criteria to it on a scale 1-9:

	Least important criterion (……)
Management support to	
Human resource to	
Organizational culture to	
Appropriate technology to	
Research & development to	
Linkage capability to	

Please select the most important criterion from the Environmental dimension and then compare its relative importance with the other criteria on a scale 1-9:

	Government	Competition	Economic stability	Environment effects	Industry-university linkage	Industry's life cycle level
Most important attribute (……) to:						

Please select the least important criterion from the Environmental and compare the other criteria to it on a scale 1-9:

	Least important criterion (……)
Government to	
Competition to	
Economic stability to	
Environment effects to	
Industry-university linkage to	
Industry's life cycle level to	

Please select the most important criterion from the Supply chain dimension and then compare its relative importance with the other criteria on a scale 1-9:

	Customers	Distributors	Raw materials
Most important attribute (……) to:			

Please select the least important criterion from the Supply chain and compare the other criteria to it on a scale 1-9:

	Least important criterion (……)
Customers to	
Distributors to	
Raw materials to	

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