

1 **An analysis of the actors' communication network in the knowledge and**
2 **innovation system of the handmade silk carpet industry in the rural areas of**
3 **Zanjan province**

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5 **Elham Ahmadifard¹, Homayoun Farhadian^{1*}, Esmail Karamidehkordi¹, and**
6 **Hossein Shabanali Fami²**

7 **Abstract**

8 Effective communication is pivotal for the prosperity of businesses as it facilitates the exchange
9 of ideas, thoughts, and emotions. It is also crucial for motivation and awareness. Rural
10 handwoven carpet weavers, particularly in the context of handmade silk carpet production,
11 grapple with significant challenges concerning recognizing all stakeholders and establishing
12 timely connections. These challenges have a substantial impact on the adoption of innovation in
13 carpet production and the overall enhancement of productivity. This research was conducted to
14 scrutinize the communication network of carpet weavers within the Knowledge and Innovation
15 System (KIS) of handmade silk carpet production in rural areas. Data were gathered through
16 interviews with 270 rural households in Zanjan province, specifically in the Tarom,
17 Khodabandeh, and Zanjan counties, utilizing a structured questionnaire. Social Network Analysis
18 (SNA) in UCINET was employed to examine the interactions among these actors, and graphical
19 representations were created using Net Draw. The results revealed that the network's density
20 varied across different levels, showing weakness in some cases, moderate strength in others, and
21 strong connections in select instances. The findings suggest that interactions within the network
22 of handmade silk carpet weavers are predominantly confined to local connections. Given that
23 production occurs under a Family owned production system, and weavers acquire their skills
24 from "FMs" (family members) or other individuals in their villages, their interactions are
25 primarily concentrated on these "FMs" and "WNVKRs" (weavers in the same neighborhood or
26 village or with kinship relations). Therefore, considering the status of the weavers'
27 communication network and its importance in the knowledge and innovation system, it is
28 suggested that through training courses, workshops, festivals and such programs, communication
29 between the weavers and other key actors is established, and the weavers Get to know the roles
30 and duties of other actors in the handwoven carpet production chain so that they can refer to them
31 when needed.

¹ Department of Agricultural Extension and Education, Faculty of Agriculture, Tarbiat Modares University, Tehran, Islamic Republic of Iran.

² Department of Agricultural Management and Development, Faculty of Agriculture, University of Tehran, Islamic Republic of Iran.

*Corresponding author; e-mail: h.farhadian@modares.ac.ir or HomayonFarhadian@gmail.com

32 **Keywords:** Handmade Carpet, KIS, Network Analysis, Production Actors' Interactions, Zanjan
33 Province.

34

35 1 Introduction

36 Thorough knowledge of a product with all its cultural and artistic features establishes a chain of
37 trust between producers and consumers (Egharloo and Allameh, 2022). Handicrafts in
38 developing countries have cultural and identity values that set them apart from the products of
39 industrial countries and foster capacities for international cultural exchanges and the
40 development of cultural heritage for communities. So, it seems necessary to learn about the
41 competitive advantage of Persian handmade carpets (HCs) as one of the most important
42 handicrafts. The artistic potential of these carpets reveals the need for scholarly accounting for
43 their competition and globalization (Mirzaei, 2015). Handicrafts, including HCs, are a major
44 source of non-petroleum exports (Kashyazadeh and Daroukola, 2021). Iran is a leading carpet
45 producer and exporter in the world (Shojaei et al., 2023; Ahmadifard, & Farhadian, 2023; Bilgin
46 et al., 2011).

47 Despite the significance of HCs in exports and job creation, this industry has been struggling
48 with many challenges in recent years. The managerial changes in HC officials in these years have
49 been harmful to the body of the HC art industry due to the differences in their decisions and
50 interests. The HC has various problems, such as sanctions and the entailing issues like raw
51 material shortage for production and the higher end price of the carpets, the lag of producers and
52 weavers from production, and the old and outdated designs due to the fear of non-sale of new
53 designs (Akbari and Abbasi, 2019). The export of HCs has fluctuated over time. Other effective
54 parameters, including competitors, have destabilized the economy of this industry (Kashyazadeh
55 and Daroukola, 2021).

56 The industry also suffers from technical backwardness, low productivity relative to other
57 economic activities (Mohammadi Ostad Kolayeh and Bayat, 2016), weaving by Family owned
58 production system that results in low quality and quantity, a traditional system of skills training,
59 inadequate and ineffective supervision by employers, and low investment by cooperatives in raw
60 material supply (Mirkatouli, 2009). Carpet-weaving at home is practically impossible to control.
61 Therefore, this industry struggles to meet the preferences and demands of foreign customers. In
62 Iran, 90 percent of the carpets are Woven in rural areas, where the weavers have no adequate
63 knowledge of customer demands in international markets (Pishkhani, 2024; Bilgin et al., 2011).
64 The handmade silk carpet industry (HSCI) Zanjan province, Iran started in 1969. The first silk
65 carpet weavers resided in Qom province. Then, rural weavers from Zanjan learned the skill at
66 their workshops and developed the initiative in the rural areas of Zanjan province (Ahmadifard

67 and Karamidehkordi, 2016). Presently, the silk carpets Woven in Zanjan are of high quality and
68 can rival the products of Isfahan, Qom, and Kashan. However, its carpets are often exported
69 under the name of other provinces, especially Qom, for various reasons, such as the similarity of
70 texture and designs of carpets produced in other provinces and in some cases (Ahmadifard and
71 Karamidehkordi, 2018), the lack of market knowledge and sales skills. As a result, the added
72 value of the carpet decreases, which leads to a decline in the number of weavers (Zanjan carpet
73 expert, 2023).

74 Given these challenges and problems, it is necessary to examine the interaction between silk
75 weavers in rural areas of Zanjan and other actors. Communication refers to the verbal or non-
76 verbal transfer of ideas, thoughts, and emotions between a sender and a receiver. This transfer is
77 crucial for businesses (Stupnikova, 2023; Genç, 2017). Regardless of the business size,
78 communication is key for business success. It is a process that allows for achieving public
79 relations goals. Communication is vital because it fosters awareness, persuasion, motivation, and
80 mutual understanding (Purwanto, Wafa, & Sanjani, 2023; Genç, 2009). In a production chain,
81 information flows along with the flow of inputs. Concerning the information flow, the
82 components are linked bilaterally, and communication is key for decision-making to develop and
83 maintain production units. The information enables production units to make optimal decisions
84 and maximize profit (Ahmadifard and Karamidehkordi, 2018).

85 Sociology studies the communication patterns among people, organizations, institutions, and
86 governments at different levels of society (Wasserman and Faust, 1994). The study of KISs helps
87 understand the current situation of the KISHC and identify gaps and issues (Wieczorek and
88 Hekkert, 2012). Regarding innovation, "SNA" can reveal how actors interact, how information
89 and resources flow among them, and how their roles and relationships are organized. The data
90 for "SNA" are usually based on measuring the relationships between actors and a set of players
91 and their characteristics.

92 93 **2 LITERATURE REVIEW**

94 The network science methods have proven to provide a deeper understanding of a system along
95 with more traditional approaches and qualitative knowledge (Valeri and Baggio, 2021).

96 Network analysis (NA) is a research approach that focuses on the relationships between social
97 units rather than their personal characteristics (Brown et al., 2016). "SNA" is a common tool to
98 study systems (networks) of interconnected people and evaluate how much people and personal
99 communications help the system's performance in terms of the selected indices. NA allows the

100 ranking of the network elements to improve the communication of the research results (Gava,
101 Favilli, Bartolini, and Brunori, 2017).

102 The NA shows the relationships in terms of the networks of nodes and ties. Nodes are the
103 individual actors in the network, and ties are the connections between them. The results of graph-
104 based structures are often complex. Networks play a critical role in determining how to solve
105 problems, manage organizations, and measure their success in achieving their goals (Hekkert et
106 al., 2011).

107 There is extensive literature on SNA. With a long history as a research instrument in sociology,
108 SNA is a method of program assessment. Social networks are used in various fields, especially
109 in commerce (Cross, Cross, and Parker, 2004) and emerging innovation (Gloor, 2006). The
110 literature review shows that research on the social network of the HC industry has been scarcely
111 studied, which justifies the current research.

112 Valeri and Baggio (2021) concluded that network science methods could be quite useful and
113 effective. They can also help a very precise methodological approach that may rationalize a
114 messy set of ideas, models, and theories. Broda, Granger, Chow, & Ross (2023) and Wey et al.
115 (2008) define social groups as networks of nodes linked by social ties. This approach investigates
116 people and groups in the context of the communications of the group members.

117 By identifying and measuring the potential of actors, Haghigahtnaeini, Houdasni, Ashrafi, and
118 Golzari (2022) concluded that there are many actors in this field, but the government and public
119 sectors practically dominate and the private sector and local communities play a minor role.

120 Montemurro, A. (2023) with review social investment strategies in European education
121 concluded that NA answer the need for new research sensibilities and new methods and concepts
122 to better comprehend the new actors, organizations, forms of relationships and participation.

123 Karimigohari, Rezaiemoghaddam, and Rezaie (2018) with review Social network analysis, a
124 new approach to explain pluralistic extension and education system found that the dynamic
125 institutional network lacked the interaction of all actors in the context of extension-educational
126 activities. There was also an imbalance of power between governmental organizations and non-
127 governmental organizations. In an analysis of the information network of rural silk carpet
128 weavers, Ahmadifard and Karamidehkordi (2018) found that the weavers' main information
129 sources were employers and "FMs" in the employer-based systems while local actors and market
130 actors were the most essential information source in the self-employed system.

131 Gholifar, Abbasi, Pezeshkirad, Salehi, and Rezaie (2018) with analyzing information and
132 interaction network among active actors in aquaculture activities management in Alborz

133 damwatershed concluded that governmental had higher centrality (authority) than non-
134 governmental organizations in the information sharing, cooperation, and participation.

135 This study investigated the participants involved in the production of handmade silk carpets
136 within the rural regions of Khodabandeh, Tarom, and Zanjan counties, which were chosen as the
137 primary units of analysis due to the abundance of weavers in these areas. The list of villages can
138 be found in Table 2. The primary objective was to scrutinize the network of interactions among
139 the key weavers within households and other stakeholders within the KIS of silk handmade carpet
140 (HC) production.

141 Stakeholders in the KISHC include all actors who are involved in the different stages of
142 production (before, during and after production). Despite the importance of some activists, the
143 weavers do not even know about their existence in the production chain. The weavers' awareness
144 and in the next stage their communication with key actors will play an important role in the
145 development and strengthening of the weavers' CN. These stakeholders encompassed the public
146 sector, associations, market participants, and local actors, as detailed in Table 3.

147 The study of the interactions and communications of the actors involved in the production in the
148 knowledge and innovation system of the handmade carpet (KISHC) needs to be investigated due
149 to the importance of communication and information sharing in the transfer of ideas and the
150 creation of innovation in production industries and units and the need for innovation in the
151 industry of HCs. These actors include public and private organizations, weavers, and market
152 actors. The research questions are: Which actors (formal and unformal, market and local) play a
153 role in the KISHC production? Which actors do the weaver households communicate more with?
154 Which actors are more important in the communication network (CN)?

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156 3 Materials and Methods

157 The study employed a quantitative survey approach to examine the network of connections
158 between weavers and various stakeholders in the KIS of the HSCI. Data were acquired through
159 structured interviews with rural households engaged in silk carpet-weaving, utilizing quantitative
160 research techniques (questionnaire). Network theory was applied to assess the configuration of
161 interactions between the primary weavers and other participants within the KIS. The SNA was
162 employed to investigate the connections among a multitude of diverse actors, offering tools for
163 visualizing, quantifying, and evaluating these relationships, as described by Borgatti (2006).

164 The study's statistical population encompassed all silk carpet weavers located in Zanjan, Tarom,
165 and Khodabandeh counties. To determine the estimated count of silk and wool carpet weavers in
166 various counties, information was obtained from the Carpet Office within the Industry, Mining,

167 and Trade Organization. Subsequently, Zanjan, Tarom, Mahneshan, and Khodabandeh counties
168 were accorded higher priority, as they were identified to have the greatest concentration of
169 weavers based on the provided data.

170 A multi-stage stratified sampling approach was employed for the sample selection process.

171 1. Initially, to address limitations related to both budget and time, the sampling scope was
172 narrowed down to encompass three counties with the highest concentration of silk weavers:
173 Zanjan, Tarom, and Khodabandeh.

174 2. The Industry, Mining, and Trade Organization of Tehran province furnished a list of villages
175 within these three counties that had the highest numbers of weavers.

176 3. Subsequently, the researchers acquired contact details for rural district governors within these
177 designated villages through the Rural District Office and the Governor's Office of Zanjan
178 province. They reached out to these officials to request information about the most prominent
179 weavers in each village who possessed extensive social connections within the HSCI.

180 4. Following this, the snowball sampling technique was utilized to expand the pool of
181 participating weavers and estimate the total count of silk carpet weavers within each village.

182 Following the county selection, one or more districts with the greatest concentration of weavers
183 were identified. Subsequently, the rural districts boasting the highest numbers of weavers were
184 chosen from each of these districts. Villages were then categorized into four groups based on the
185 number of weavers, ranging from 1 to 100. Employing the Korjesi and Morgan formula with a
186 5% margin of error, a sample of 270 households involved in weaving was drawn from the total
187 pool of 3,312 silk weavers across the three counties.

188 Numerous variables can be calculated for NA and can be used depending on the research goal.

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190 3.1 Concepts in NA

191 3.1.1 Centrality indices(CIs)

192 Degree centrality shows the relative importance of a node in a network. In general, it is
193 calculated for a certain node X as the ratio of the nodes connected to the node to the total number
194 of nodes in the network (reduced by 1) (Bródka, Skibicki, Kazienko, & Musiał, 2011)

195 Betweenness centrality (BC) is the measurement of a node that has a mediating role in the
196 network. If a node is located on the only way that other nodes should pass through, such as
197 communications, links, transportation, or transactions, it must be an important node and it may
198 have high BC (L. C. Freeman, 1977; Zhang & Luo, 2017).

199 **Closeness centrality (CC)** means the measurement of the total distances of a node from the other
200 nodes. If the shortest distance of the paths of node N with other nodes in the network is small,
201 the node **has a high CC** (Wasserman & Faust, 1994; Zhang & Luo, 2017).

202 **Eigenvector centrality (EC)** is another index that is based on the idea that an actor is more
203 central if it is linked to other actors that are themselves central. Accordingly, it can be argued that
204 the centrality of a node depends on not only the number of adjacent nodes but also its centrality
205 value (Pradhan, Angeliya, & Jalan, 2020; Ruhnau, 2000).

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207 3.1.2 Cohesion indices

208 **Density** shows the intensity of network use and specifies the ratio of the likely ties that exist. It
209 is based on the assumption that all ties and links that exist in a network are known and a
210 distinction is made between ‘de facto’ and ‘potential’ relations (Leon, Rodríguez-Rodríguez,
211 Gómez-Gasquet, & Mula, 2017).

212 **Transitivity** shows network stability (Eshaghi, Hejazi, Hosseini, and Rezaie, 2020).

213 **Fragmentation** is the reverse scale of the measurement of links or link abundance in a network
214 (Makagon, McCowan, and Mench, 2012). *The diameter* is the longest distance between two
215 nodes in a network (Makagon et al., 2012). It is the highest eccentricity in whole the graph.

216 **Eccentricity** is the highest distance that the node can have from the other nodes
217 (Emamgholizadeh, 2014). *Radius* is the lowest eccentricity of the whole graph
218 (Emamgholizadeh, 2014).

219 **Average distance** is the average of the shortest distances between two nodes in the network. This
220 index represents a concept of the closeness of the members of a community. A higher index
221 means that not so many individuals in the social network know each other directly and their
222 relationships are established through more mediators (Zandian, Moradian, and Hassanzadeh,
223 2018).

224 **Norm distance** refers to the extent to which the actors in an international network share common
225 innovation, organizational culture, value systems, or language (Fang and Pigneur, 2007).

226 Data required for the analysis of the network of the actors in the KISHC were collected by a
227 questionnaire composed of structured questions. The questionnaire was filled out by 270 silk
228 carpet-weaving households in the rural areas of Zanjan, Tarom, and Khodabandeh.

229 The research used the network theory to analyze the structure of the relations between the actors
230 of this system. All mathematical calculations were performed by UCINET. The graphs were
231 drawn in Netdraw, which is an auxiliary tool of UCINET.

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233 **4 Results**

234 The descriptive statistics show that the respondents were, on average, 40 years old. In age, the
235 highest frequency (46%) was for the 38-48 group, and in gender, the highest frequency (52%)
236 was for women. In the educational level, the highest frequency (60.4%) was for people with basic
237 literacy. The mean history of weaving was 21-30 years. Regarding the production methods, the
238 highest frequency (73%) was for the Family owned production system.

239 The next sub-section reports the results of analyzing the interactive relationships of the weavers
240 with other actors in the KIS of handmade silk carpet production.

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242 **4.1 The analysis of the CN between weaver households and other actors in the KISHC**

243 Due to the high number of weaver households (270 households), the studied villages and the
244 production method were selected as the criteria for analyzing the actors' CN.

245 The ties of the actors with the weaver households in each village were evaluated over a scale
246 from weak (households with no ties = 0; households with ties = 1) to moderate (households with
247 no ties or one or more ties per year = 0; households with more than one or more ties per year =
248 1), and strong (households with no ties or one or more ties per year and season = 0; households
249 with more than one or more ties per season = 1).

250 The results regarding the coherence indices of the communications (Table 1) showed that the
251 highest value of the density was for the weak ties with the actors. This index can be reduced by
252 reinforcing the links and establishing closer and stronger ties. The highest transitivity of the ties
253 was 0.852 for strong communication, reflecting the high stability of the network. The comparison
254 of fragmentation among the three states shows that it can be increased to 0.673 by reinforcing
255 the relationships. The diameter was 4 in all three states. Also, the radius was 2 in all three
256 communicational states.

257 The average distance is a concept of the closeness of a community's members. A higher average
258 distance means that fewer people in the social network know each other directly and the ties are
259 based on more mediators. As the links are reinforced, this index reduces. It is 2.016 for strong
260 relationships, implying that the direct ties of the weavers with the weaver families increase in
261 stronger relationships. As the ties are reinforced and when stronger ties are requested, more
262 people who lack strong ties are discarded from the network, which increases the norm distance.
263 As people's distance increases from one another, the norm distance increases. It was 2.265.

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Table 1. The cohesion indicators of the network of interactions with actors in KISHCs

	Density	Average Distance	radius	diameter	Fragmentation	Transitivity	Norm Distance
Weak Network	0/159	2/294	2	4	0/354	0/669	1/010
Moderate Network	0/084	2/167	2	4	0/573	0/759	1/617
Strong Network	0/056	2/016	2	4	0/673	0/852	2/265

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Regarding the CIs, the results in Table 2 revealed that the communications of the weavers differed in the studied rural areas and among different production methods. The classification of the communications showed that in the weak tie status, the weavers in Koloeim Cillage of Tarom County with the self-employed production system and a frequency of 0.357 had the most number of ties (Fig 1). In the moderate tie status, the villages of Qeshlaq and TekmehDash in Zanjan County with the Shared-based production system and a frequency of 0.167 had the highest degree centrality (Fig 2), and in the strong tie, the weavers in the villages of Meshkin, Degahi, and Koloeim in Zanjan and Tarom counties with the self-employed and Shared-based production system and a frequency of 0.095 had the highest number of ties (Fig 3).

Based on the *EC* in the weak tie status, the most influential weavers were in the villages of Koloeim and Valyaran in Tarom and Zanjan counties with the self-employed production system and frequencies of 0.202 and 0.203, respectively. In the moderate tie status, the most influential weavers were in Qeshlaq in Zanjan County with the Shared-based production system and a frequency of 0.196. In the strong tie status, the most influential weavers were in the villages of Meshkin, Degahi, and Koloeim in Zanjan and Tarom counties with the self-employed and Shared-based production system and a frequency of 0.178.

Based on the *BC*, in the weak tie status, the weavers in the village of Koloeim in Tarom with the self-employed production system and a frequency of 0.066 had the greatest controlling and mediating role in the network. In the moderate tie status, the strongest controlling power in the network of ties was for the weavers in the village TekmehDash in Zanjan County with the Shared-based production system and a frequency of 0.046. In the strong tie status, the weavers in Koloeim in Tarom with the Family owned production system and a frequency of 0.013 had the highest mediating power. Based on the *CC*, in the weak tie status, the weavers in Koloeim in Tarom County with the self-employed production system and a frequency of 0.596 had the highest rate of access. In the moderate tie status, those in the villages of TekmehDash and Qeshlaq in Zanjan County with the Shared-based production system and a frequency of 0.500 had the highest *CC*. In the strong tie status, the weavers in the villages of Koloeim, Degahi, and

296 Meshkin in Tarom and Zanjan counties with the self-employed and Shared-based production
 297 system and a frequency of 0.464 had the highest CC.

298 Table 2. CIs for weavers' interactions with other actors in KISHCs.

Villages	ID Number	Weak				Moderate				Strong			
		Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector
Jezla	V11	0/119	0/546	0/001	0/139	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V12	0/262	0/575	0/029	0/185	0/071	0/485	0/000	0/147	0/071	0/461	0/001	0/166
Bagh	V21	0/143	0/551	0/001	0/158	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V23	0/214	0/565	0/007	0/170	0/119	0/492	0/000	0/153	0/048	0/458	0/000	0/146
JalilAbad	V31	0/095	0/542	0/000	0/101	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
ChoreKandy	V41	0/238	0/570	0/012	0/183	0/095	0/489	0/001	0/172	0/071	0/461	0/001	0/166
	V42	0/238	0/570	0/022	0/136	0/071	0/485	0/000	0/147	0/071	0/461	0/001	0/166
	V43	0/143	0/551	0/007	0/145	0/119	0/492	0/002	0/187	0/071	0/461	0/001	0/166
DashTapeh	V51	0/095	0/542	0/000	0/115	0/095	0/489	0/001	0/151	0/071	0/461	0/002	0/157
Gheshlagh	V61	0/167	0/556	0/014	0/148	0/071	0/485	0/001	0/125	0/048	0/458	0/000	0/146
	V63	0/190	0/560	0/005	0/176	0/167	0/500	0/014	0/196	0/024	0/455	0	0/074
Vananagh	V71	0/119	0/546	0/001	0/139	0/048	0/481	0/000	0/110	0/024	0/455	0	0/074
Leghahi	V81	0/143	0/551	0/003	0/144	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V82	0/143	0/551	0/004	0/130	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V83	0/143	0/551	0/003	0/144	0/095	0/489	0/001	0/172	0/071	0/461	0/001	0/166
Valyaran	V91	0/119	0/546	0/002	0/120	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
	V92	0/286	0/580	0/021	0/203	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
TekmeDash	V101	0/167	0/556	0/003	0/158	0/095	0/489	0/001	0/172	0/071	0/461	0/001	0/166
	V102	0/262	0/575	0/021	0/190	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
	V103	0/167	0/556	0/003	0/158	0/167	0/500	0/046	0/176	0/071	0/461	0/001	0/166
Sohrein	V111	0/119	0/546	0/007	0/125	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
	V112	0/119	0/546	0/002	0/120	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
	V113	0/095	0/542	0/000	0/124	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
Meskin	V121	0/143	0/551	0/001	0/158	0/095	0/489	0/001	0/172	0/048	0/458	0/000	0/146
	V122	0/262	0/575	0/014	0/192	0/095	0/489	0/001	0/162	0/095	0/464	0/003	0/178
Armaghankhaneh	V131	0/119	0/546	0/003	0/127	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V132	0/214	0/565	0/032	0/171	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
DizajAbad	V141	0/095	0/542	0/000	0/115	0/095	0/489	0/001	0/151	0/071	0/461	0/002	0/157
	V142	0/167	0/556	0/002	0/155	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
Agkand	V151	0/167	0/556	0/010	0/151	0/119	0/492	0/002	0/187	0/048	0/458	0/000	0/146
Homayoun	V161	0/095	0/542	0/000	0/124	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
	V162	0/143	0/551	0/012	0/114	0/119	0/492	0/024	0/120	0/048	0/458	0/000	0/146
AghcheGhonbad	V171	0/119	0/546	0/001	0/139	0/095	0/489	0/003	0/153	0/071	0/461	0/001	0/166
Sarmsaglo	V181	0/143	0/551	0/001	0/158	0/071	0/485	0/002	0/117	0/048	0/458	0/000	0/146
	V182	0/190	0/560	0/009	0/136	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
Deghahi	V191	0/119	0/546	0/000	0/143	0/095	0/489	0/001	0/151	0/071	0/461	0/002	0/157
	V193	0/238	0/570	0/011	0/17	0/119	0/492	0/002	0/187	0/095	0/464	0/003	0/178
Sole	V201	0/119	0/546	0/001	0/130	0/048	0/481	0/000	0/110	0/048	0/458	0/000	0/146
Gogarchinak	V211	0/119	0/546	0/001	0/139	0/095	0/489	0/001	0/172	0/048	0/458	0/000	0/146
GaraVali	V221	0/095	0/542	0/000	0/124	0/048	0/481	0/000	0/110	0/024	0/455	0	0/074
Gohe	V231	0/119	0/546	0/001	0/139	0/071	0/485	0/000	0/135	0/048	0/458	0/000	0/146
Koloeim	V241	0/167	0/556	0/002	0/167	0/095	0/489	0/001	0/172	0/071	0/461	0/013	0/147
	V242	0/357	0/596	0/066	0/202	0/119	0/492	0/004	0/168	0/095	0/464	0/003	0/178
Sheat	V251	0/095	0/542	0/000	0/124	0/095	0/489	0/001	0/172	0/048	0/458	0/000	0/146
	V253	0/095	0/542	0/004	0/097	0/095	0/489	0/000	0/138	0/048	0/458	0/000	0/146

299 Family owned production system=1, Self-employed production system= 2, Shared-based production system=3,
 300 Vmn=m=Village Code, n= Production Method.

301

302 According to Table 3 about the CIs, in the weak and moderate tie statuses, “WNVKRs” and
303 “FMs” with a frequency of 1 had the highest level of communications, and the strong tie status,
304 “FMs” with a frequency of 1 had the highest degree centrality.

305 Concerning the *EC* index for the actors, it was found that in the weak and moderate tie statuses,
306 “WNVKRs” and “FMs” had the highest frequencies (0.467 and 0.604, respectively), and in the
307 strong time status, “FMs” with a frequency of 0.701 had the highest effectiveness in the network
308 with abundant links with other influential actors.

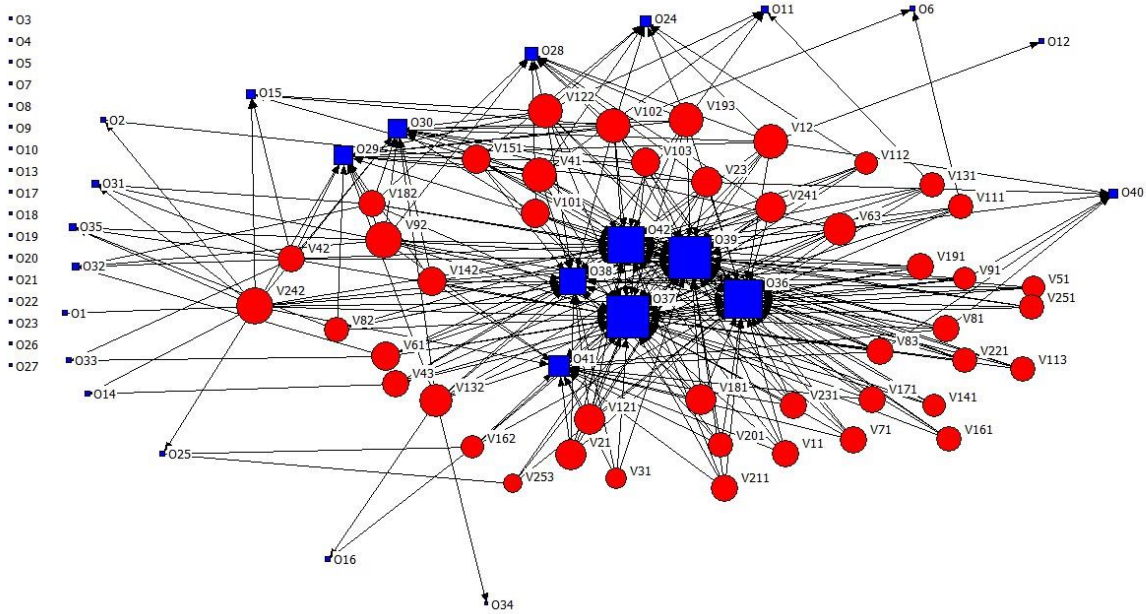
309 The *BC* of the actors revealed that in the weak and moderate time statuses, “WNVKRs” and
310 “FMs” with frequencies of 0.128 and 0.158, respectively had the highest controlling and
311 mediating power, and in the strong time status, “FMs” with a frequency of 0.170 had the highest
312 controlling and mediating power.

313 *CC* for the actors showed that in the weak and moderate tie statuses, “WNVKRs” and “FMs” had
314 the highest speed of access with frequencies of 0.713 and 0.585, respectively, and in the strong
315 tie status, “FMs” with a frequency of 0.534 had the highest speed of access.

316

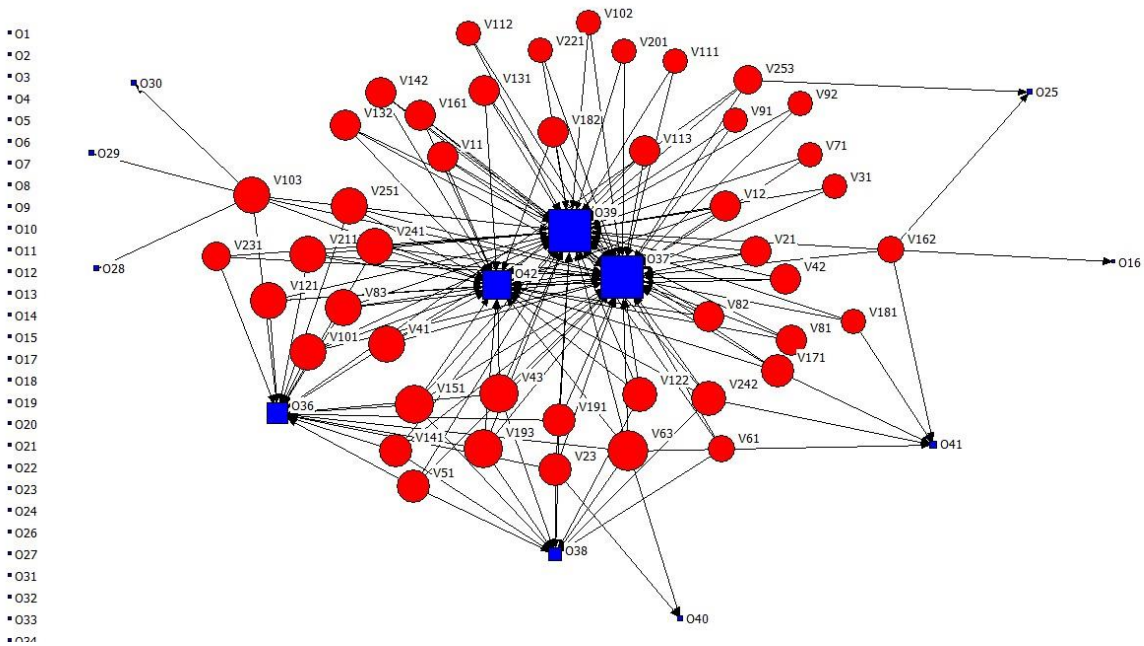
317 **Table 3.** Indicators of the centrality of interactions of different actors' in KISHC.

Actors	Weak				moderate				strong			
	Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector
O1: Carpet Office of Zanjan province	0/022	0/444	0	0/014	0	0/295	0	0	0	0/295	0	0
O2: Ministry of Industry, Mine and Trade of the city	0/044	0/450	0/000	0/025	0	0/295	0	0/000	0	0/295	0	0/000
O3, O17: Iran National Carpet Center	0	0/295	0	-0/000	0	0/295	0	-0/000	0	0/295	0	0/000
O4: Iran Business Training Center	0	0/295	0	0/000	0	0/295	0	-0/000	0	0/295	0	0/000
O5: ECommerce Development Centre Of Iran	0	0/295	0	0/000	0	0/295	0	0/000	0	0/295	0	-0/000
O6: The Academic Center for Education, Culture and Research	0/044	0/435	0/000	0/022	0	0/295	0	0/000	0	0/295	0	0/000
O7: Work and Knowledge Conservatories -Zanjan	0	0/295	0	0/000	0	0/295	0	0/000	0	0/295	0	0/000
O8: Work and Knowledge Conservatories -County	0	0/295	0	-0/000	0	0/295	0	0/000	0	0/295	0	0
O9, O18: Colleges of Art	0	0/295	0	0/000	0	0/295	0	0/000	0	0/295	0	0
O10: University of Applied Science and Technology	0	0/295	0	0/000	0	0/295	0	0/000	0	0/295	0	0
O11: Department of vocational education Zanjan Province	0/089	0/441	0/000	0/049	0	0/295	0	0/000	0	0/295	0	0
O12: Department of vocational education -County	0/022	0/432	0	0/013	0	0/295	0	0	0	0/295	0	0
O13: Carpet-Weaving Private Educational Institutions	0	0/295	0	0/000	0	0/295	0	0	0	0/295	0	0
O14: State Welfare Organization of Iran (SWOI)	0/044	0/447	0/000	0/025	0	0/295	0	0	0	0/295	0	0
O15: Imam Khomeini Relief Foundation	0/111	0/477	0/002	0/064	0	0/295	0	0	0	0/295	0	0
O16: Missouri Basij Organization	0/044	0/435	0/000	0/020	0/022	0/398	0	0/011	0	0/295	0	0
O19: Research Institute of Color & Cover Science & Technology	0	0/295	0	0/000	0	0/295	0	0	0	0/295	0	0
O20: Iran Carpet Research Institute	0	0/295	0	0/000	0	0/295	0	0	0	0/295	0	0
O21: Iran Nanotechnology Innovation Council	0	0/295	0	0/000	0	0/295	0	0	0	0/295	0	0
O22: Trade Union of Manufacturers and HC Weavers	0	0/295	0	0	0	0/295	0	0	0	0/295	0	0
O23: Trade Union of Carpet Sellers and HC materials	0	0/295	0	0	0	0/295	0	0	0	0/295	0	0
O24: Union of Rural HC Cooperative Companie-Zanjan	0/156	0/467	0/002	0/086	0	0/295	0	0	0	0/295	0	0
O25: Union of Urban HC Cooperative Companie-Zanjan	0/067	0/454	0/001	0/029	0/044	0/403	0/000	0/023	0	0/295	0	0
O26: Union of Urban HC- County	0	0/295	0	0	0	0/295	0	0	0	0/295	0	0
O27: Trade Union of HC Weaver	0	0/295	0	0	0	0/295	0	0	0	0/295	0	0
O28: Lessors or Sellers of Maps	0/222	0/485	0/004	0/124	0/022	0/403	0	0/016	0	0/295	0	0
O29: Sellers of Other Raw Materials	0/333	0/534	0/014	0/181	0/022	0/403	0	0/016	0	0/295	0	0
O30: Belonging to the market who buy and sell silk carpets	0/333	0/534	0/014	0/184	0/022	0/403	0	0/016	0	0/295	0	0
O31: Dyer	0/089	0/464	0/001	0/048	0	0/295	0	0	0	0/295	0	0
O32: lint Collector	0/089	0/450	0/001	0/044	0	0/295	0	0	0	0/295	0	0
O33: Darner	0/044	0/438	0/000	0/020	0	0/295	0	0	0	0/295	0	0
O34: Designer	0/022	0/426	0	0/012	0	0/295	0	0	0	0/295	0	0
O35: Chelekeshan	0/089	0/464	0/001	0/048	0	0/295	0	0	0	0/295	0	0
O36: Businessmans or Employers of HCs	0/867	0/668	0/091	0/412	0/400	0/465	0/020	0/275	0/022	0/385	0	0/016
O37: WNVKRs	1	0/713	0/128	0/467	1	0/585	0/158	0/604	0/933	0/520	0/131	0/677
O38: Fellow Villager Weavers or Relatives living in the city	0/556	0/577	0/037	0/275	0/244	0/431	0/005	0/166	0/133	0/399	0/001	0/106
O39: FMs	1	0/713	0/128	0/467	1	0/585	0/158	0/604	1	0/534	0/170	0/701
O40: Local brokers only buying carpets	0/133	0/450	0/001	0/066	0/044	0/406	0/000	0/032	0	0/295	0	0
O41: Local intermediaries between the employer and the weaver	0/444	0/538	0/020	0/217	0/111	0/419	0/002	0/069	0	0/295	0	0
O42: Village council members	0/822	0/655	0/082	0/399	0/600	0/494	0/042	0/400	0/244	0/412	0/005	0/197



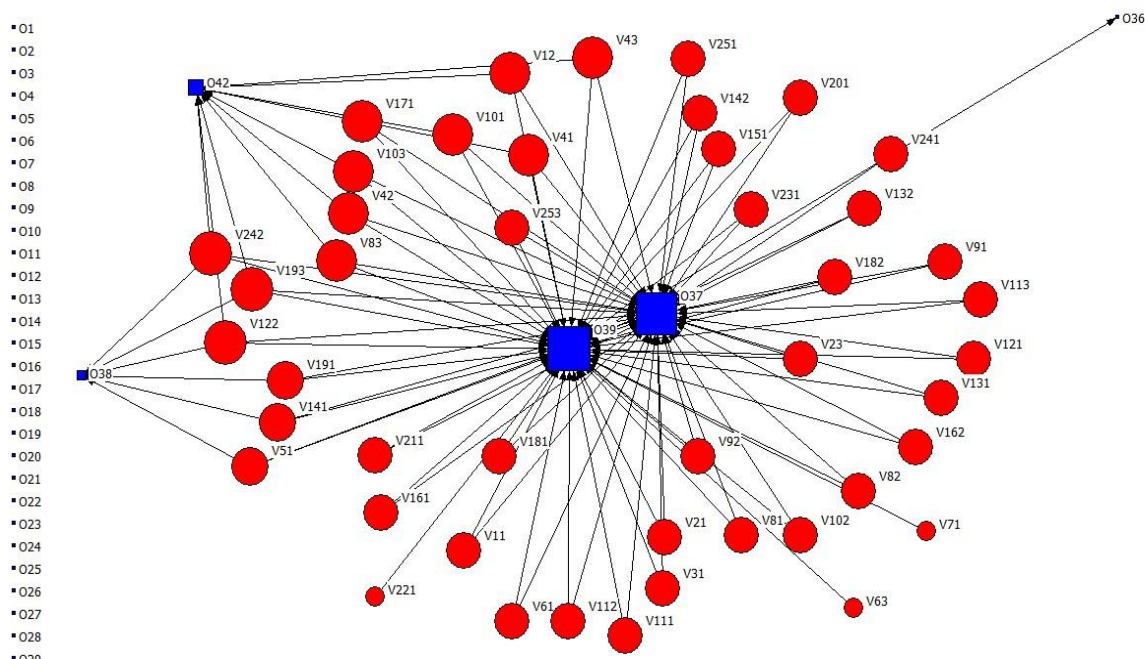
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Figure 1. Network actors' interactions of KISHC with weavers in different rural areas (weak connection).



324
325

Figure 2. Network actors' interactions of KISHC with weavers in different rural areas (moderate connection).



326
327 **Figure 3.** Network actors' interactions of KISHC with weavers in different rural areas (strong connection).
328

329 5 Discussion

330 Communication serves as the means through which information is transmitted from a sender to
331 a receiver, encompassing the exchange and comprehension of opinions, thoughts, and meanings,
332 whether conveyed verbally or non-verbally, intentionally or unintentionally, consciously or
333 unconsciously. The current state of Handmade Carpets (HCs) is a reflection of deficiencies in the
334 communication network for information exchange between the sender and the primary recipients,
335 who happen to be the weavers within each family.

336 Diverse actors and stakeholders are engaged in the preservation and revitalization of the Persian
337 Handmade Carpet Industry, and these actors are interconnected, collectively forming a network.
338 It is, therefore, crucial to identify and investigate these key actors and structurally analyze their
339 relationships. Thus, the primary objective of this study was to scrutinize the network of
340 interactions among actors within the "KIS" of HSCI.

341 The coherence indices indicate that the communication network of weavers with other actors
342 exhibits a notably low density. The findings reveal that the predominant production system in
343 rural areas is Family owned production, where in weavers are responsible solely for weaving,
344 while the selling aspect is managed by employers. Weavers typically need to refer to the
345 employer or their representative to address issues during the weaving process or resolve any
346 related problems. This production method results in limited connections among weavers, driven
347 by concerns about design replication. Consequently, their interactions with other actors in rural
348 areas are limited. In this context, the coherence indices illustrate that connections between

349 weavers and other actors, particularly local actors like WNVKRs, are more prevalent. This
350 observation aligns with the findings of Ahmadifard and Karamidehkordi (2018) and Mirkatouli
351 (2009) and underscores the influence of local actors in the communication networks among rural
352 weavers, contradicting the results of Gholifar, Abbasi, Pezeshkirad, Salehi, and Rezaei (2018).
353 Interviews with households further reveal that most weavers have acquired their weaving skills
354 from "FMs" and "WNVKRs", explaining their extensive connections with these individuals for
355 weaving-related queries and problem-solving.

356 These findings collectively highlight the fact that weavers maintain minimal or, in some
357 instances, no communication with organizations, associations, and market actors. Consequently,
358 they remain uninformed about new facilities, innovations, training programs, and other
359 developments in the realm of HCs. Additionally, weavers have limited connections with
360 associates, corroborating the findings of Naeini, Houdsani, Ashrafi, and Golzari (2022) regarding
361 the limited role of the private sector. As per interview results, individuals who possess carpet-
362 weaving insurance or have family ties to the union head have the most extensive connections.
363 This finding corresponds with the results of Karimigoughari, Rezaeimoghaddam, and Rezaei
364 (2018) concerning the absence of a dynamic network in the interactions of all actors involved in
365 educational and extension activities. Most weavers lack trust in associations, as they have sold
366 their carpets at prices below market value, leading weavers to believe that the union has not been
367 beneficial for them. Consequently, there is a need for strategies aimed at monitoring union
368 activities and enhancing weavers' connections with both formal and informal actors, as these
369 individuals are the implementers of policies and decisions relating to HC production, and
370 improved connections will address numerous HC production challenges.

371 The Coherence Indices (CIs) pertaining to weavers' connections across various rural areas and
372 production system revealed that the highest frequency was associated with the self-employed
373 production system. In this particular system, weavers assume full responsibility for the entire
374 production chain, and as their success relies on knowledge concerning input quality and aligning
375 with market requirements, they maintain the greatest number of connections within the
376 production chain. Consequently, self-employed weavers possess a more robust communication
377 network and exert more influence. However, since the majority of weavers in the surveyed
378 regions are engaged in the Family owned production system, the density of connections is
379 comparatively lower in the context of coherence indices.

380

381 **6 Conclusions and Recommendations**

382 In this study, we explored the "CN" of silk carpet weavers in relation to their interactions with
383 various stakeholders within the KIS. Our findings revealed that the most extensive connections
384 were established with local individuals, particularly among weavers who employed the self-
385 employed production system. In cases where weavers are responsible for their own input supply
386 within the self-employed system, their limited network of connections and lack of awareness
387 regarding innovative practices contribute to their production setbacks and a decline in the value
388 of their products. Consequently, it can be inferred that a primary reason why most weavers opt
389 for the Family owned production system is the inadequacy of connections between them and
390 other actors in the production chain. Furthermore, the involvement of intermediaries such as
391 council members and rural governors in the network of connections, along with their
392 shortcomings in raising awareness within the target community, exacerbates this issue.
393 Additionally, the limited connections between market participants and carpet buyers, coupled
394 with a lack of awareness regarding market dynamics, results in reduced incorporation of designs
395 from other regions and traditional motifs. This, in turn, leads to the export of products from this
396 province under the branding of other regions.

397 In summary, the following recommendations can be proposed:

- 398 • Recognizing the significance of weavers' interactions with other stakeholders within the
399 "KIS", the government should prioritize the enhancement of "CNs" among the KIS participants.
400 This can be achieved by introducing innovative practices to the rural carpet-weaving community
401 and conducting workshops to increase their understanding of the roles and responsibilities of
402 relevant organizations and associations. Such efforts will be instrumental in enhancing the KIS's
403 overall performance.
- 404 • Supervising the activities of rural governors and members of rural councils and
405 appointing individuals known for their integrity and dedication.
- 406 • Fostering the development of skilled designers within Zanjan province while encouraging
407 the participation of designers from Qom.
- 408 • Considering the importance of strengthening the communication network of weavers and
409 its role in market development, use innovations in production and to strengthen the self-employed
410 production system, it is necessary to monitor the activities of the main institution of carpet in
411 rural areas. In recent years, except for renewing the carpet weaving insurance card and in some
412 cases the role of the employer and broker in the production, the rural carpet union has not played
413 any other role and from itself main duties that are to support the weavers and act as an

intermediary between the education section, research, market with the weavers has distanced itself that there is a need until the Ministry of Industry and Mining, to have the necessary supervision in this field.

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510 [%](https://www.irna.ir/news/85169028/%D8%AD%D8%A7%D9%84-%D9%86%D8%A7%D8%AE%D9%88%D8)
511 [%](https://www.irna.ir/news/85169028/%D8%AD%D8%A7%D9%84-%D9%86%D8%A7%D8%AE%D9%88%D8)
512 [%](https://www.irna.ir/news/85169028/%D8%AD%D8%A7%D9%84-%D9%86%D8%A7%D8%AE%D9%88%D8)
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514 تحلیل شبکه تعاملات کنشگران در نظام دانش و نوآوری صنعت فرش دستباف ابریشمی در مناطق روستایی استان زنجان
515 الهام احمدی فرد، همایون فرهادیان، اسماعیل کریمی دهکردی، و حسین شعبانعلی فمی

516 **چکیده**
517 ارتباطات موثر نقش مهمی در موفقیت کسب و کارها دارد، زیرا سبب انتقال ایده‌ها و افکار و احساسات می‌گردد و برای
518 ایجاد انگیزه و اطلاع‌رسانی حیاتی است. شناخت و ارتباط کافی و بموقع با همه کنشگران از جمله مسائل مهمی است که
519 بافندگان فرش دستباف روستایی، به ویژه در زمینه تولید فرش دستباف ابریشمی با آن روبرو هستند. این مسائل در کاربرد
520 نوآوری در تولید فرش دستباف و افزایش بهره‌وری در آن تأثیر بسزایی دارد. هدف این مطالعه تحلیل دقیق شبکه ارتباطی
521 بافندگان با دیگر کنشگران در نظام دانش و نوآوری تولید فرش دستباف ابریشمی در مناطق روستایی است. داده‌ها با استفاده
522 از مصاحبه با 270 خانوار روستایی در مناطق روستایی استان زنجان در سه شهرستان طارم، خدابنده و زنجان با استفاده
523 از پرسشنامه ساختاریافته گردآوری شدند. تعاملات بین این کنشگران با استفاده از تحلیل شبکه اجتماعی در نرم‌افزار
524 UCINET بررسی شد و گراف‌های موردنظر در نرم‌افزار Net Draw ترسیم شد. نتایج نشان داد که تراکم شبکه در
525 سطوح مختلف متفاوت است، در برخی موارد ضعیف، در برخی موارد قدرت متوسط و در نمونه‌های دیگر اتصالات قوی
526 را نشان می‌دهد. یافته‌ها نشان می‌دهد که تعاملات درون شبکه بافندگان فرش دستباف ابریشمی عمدتاً به ارتباطات محلی
527 محدود می‌شود. با توجه به اینکه تولید تحت شیوه مزدی خانگی اتفاق می‌افتد، و بافندگان مهارت‌های خود را از اعضای
528 خانواده یا دیگر افراد در روستا بدست می‌آورند، که تعاملات آن‌ها در درجه اول بر روی «اعضای خانوار»، «بافندگان
529 همسایه، هم‌روستایی و فامیل» متمرکز است. بنابراین با توجه به وضعیت شبکه ارتباطی بافندگان و اهمیت آن در نظام دانش
530 و نوآوری پیشنهاد می‌گردد که از طریق دوره‌های آموزشی، کارگاه‌ها، جشنواره‌ها و از این قبیل برنامه‌ها، بافندگان با نقش
531 و وظایف سایر کنشگران کلیدی در زنجیره تولید فرش دستباف آشنا شوند تا در مواقع نیاز به آن‌ها مراجعه کنند.

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