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

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

7 Abstract

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

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 Manegement 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

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 Province.

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35 **1** Introduction

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

46 et al., 2011).

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

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

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

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

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

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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 summent research
- 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.
- (2008) define social groups as networks of nodes linked by social ties. This approach investigates
 people and groups in the context of the communications of the group members.
- By identifying and measuring the potential of actors, Haghigahtnaeini, Houdasni, Ashrafi, and
 Golzari (2022) concluded that there are many actors in this field, but the government and public
 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 Karimigoghari, Rezaiemoghaddam, and Rezaie (2018) with review Social network analysis, a new approach to explain pluralistic extension and education system found that the dynamic 124 institutional network lacked the interaction of all actors in the context of extension-educational 125 126 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 weavers, Ahmadifard and Karamidehkordi (2018) found that the weavers' main information 128 129 sources were employers and "FMs" in the employer-based systems while local actors and market actors were the most essential information source in the self-employed system. 130

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

damwatershed concluded that governmental had higher centrality (authority) than non 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

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

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

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

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3 Materials and Methods

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

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

- and Trade Organization. Subsequently, Zanjan, Tarom, Mahneshan, and Khodabandeh counties
 were accorded higher priority, as they were identified to have the greatest concentration of
 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.
- Subsequently, the researchers acquired contact details for rural district governors within these designated villages through the Rural District Office and the Governor's Office of Zanjan province. They reached out to these officials to request information about the most prominent weavers in each village who possessed extensive social connections within the HSCI.
- 4. Following this, the snowball sampling technique was utilized to expand the pool of
 participating weavers and estimate the total count of silk carpet weavers within each village.
- Following the county selection, one or more districts with the greatest concentration of weavers were identified. Subsequently, the rural districts boasting the highest numbers of weavers were chosen from each of these districts. Villages were then categorized into four groups based on the number of weavers, ranging from 1 to 100. Employing the Korjesi and Morgan formula with a 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**3.1Concepts in NA**

191 **3.1.1** Centrality indices(CIs)

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

Betweenness centrality (BC) is the measurement of a node that has a mediating role in the network. If a node is located on the only way that other nodes should pass through, such as communications, links, transportation, or transactions, it must be an important node and it may 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,
- the node has a high CC (Wasserman & Faust, 1994; Zhang & Luo, 2017).
- Eigenvector centrality (EC) is another index that is based on the idea that an actor is more central if it is linked to other actors that are themselves central. Accordingly, it can be argued that the centrality of a node depends on not only the number of adjacent nodes but also its centrality value (Pradhan, Angeliya, & Jalan, 2020; Ruhnau, 2000).
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207 3.1.2 Cohesion indices

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

- **Transitivity** shows network stability (Eshaghi, Hejazi, Hosseini, and Rezaie, 2020). 212 213 *Fragmentation* is the reverse scale of the measurement of links or link abundance in a network (Makagon, McCowan, and Mench, 2012). The diameter is the longest distance between two 214 nodes in a network (Makagon et al., 2012). It is the highest eccentricity in whole the graph. 215 216 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).
- Average distance is the average of the shortest distances between two nodes in the network. This index represents a concept of the closeness of the members of a community. A higher index means that not so many individuals in the social network know each other directly and their relationships are established through more mediators (Zandian, Moradian, and Hassanzadeh, 2018).

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

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

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

233 **4 Results**

- The descriptive statistics show that the respondents were, on average, 40 years old. In age, the highest frequency (46%) was for the 38-48 group, and in gender, the highest frequency (52%) was for women. In the educational level, the highest frequency (60.4%) was for people with basic literacy. The mean history of weaving was 21-30 years. Regarding the production methods, the
- highest frequency (73%) was for the Family owned production system.
- The next sub-section reports the results of analyzing the interactive relationships of the weaverswith 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

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

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

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

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

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		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

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

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269 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 270 the communications showed that in the weak tie status, the weavers in Koloeim Cillage of Tarom 271 County with the self-employed production system and a frequency of 0.357 had the most number 272 273 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 274 275 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 276 system and a frequency of 0.095 had the highest number of ties (Fig 3). 277

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.

285 Based on the BC, in the weak tie status, the weavers in the village of Koloeim in Tarom with the 286 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 287 288 network of ties was for the weavers in the village TekmehDash in Zanjan County with the Shared-289 based production system and a frequency of 0.046. In the strong time status, the weavers in Koloeim in Tarom with the Family owned production system and a frequency of 0.013 had the 290 highest mediating power. Based on the CC, in the weak tie status, the weavers in Koloeim in 291 Tarom County with the self-employed production system and a frequency of 0.596 had the 292 293 highest rate of access. In the moderate tie status, those in the villages of TekmehDash and 294 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 295

- 296 Meshkin in Tarom and Zanjan counties with the self-employed and Shared-based production
- system and a frequency of 0.464 had the highest CC.
- **Table 2.** CIs for weavers' interactions with other actors in KISHCs.

		Weak				Moderate				Strong			
Villages	ID Number	Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector	Degree	Closeness	Betweenness	Eigenvector
Jezla	V11 V12	0/119 0/262	0/546 0/575	0/001 0/029	0/139 0/185	0/071 0/071	0/485 0/485	0/000 0/000	0/147 0/147	0/048 0/071	0/458 0/461	0/000 0/001	0/146 0/166
Bagh	V21 V23	0/143 0/214	0/551 0/565	0/001	0/158 0/170	0/071 0/119	0/485 0/492	0/000	0/147 0/153	0/048	0/458 0/458	0/000	0/146 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
	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
ChanaKandr	V42	0/228	0/570	0/022	0/126	0/071	0/495	0/000	0/147	0/071	0/461	0/001	0/166
ChoreKandy	V42	0/238	0/370	0/022	0/150	0/071	0/485	0/000	0/14/	0/071	0/401	0/001	0/100
	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	<u>V51</u>	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	0/0'/1	0/485	0/001	0/125	0/048	0/458	0/000	0/146
Vononogh	V63	0/190	0/560	0/005	0/1/6	0/16/	0/500	0/014	0/196	0/024	0/455	0	0/074
v ananagn	V / 1 V81	0/119	0/540	0/001	0/139	0/048	0/481	0/000	$\frac{0/110}{0/147}$	0/024	0/455	0/000	0/0/4
Leohahi	V81	0/143	0/551	0/003	0/130	0/071	0/485	0/000	0/147	0/048	0/458	0/000	0/146
Loghum	V83	0/143	0/551	0/003	0/130	0/095	0/489	0/000	0/172	0/071	0/461	0/000	0/166
	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
Valyaran	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
	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
TekmeDash	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
	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
Sohrein	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	0/5/5	0/014	0/192	0/095	0/489	0/001	0/162	0/095	0/464	0/003	0/1/8
Armaghankhaneh	V131 V132	0/119 0/214	0/540	0/005	0/12/	0/071	0/485	0/000	0/14/	0/048	0/438	0/000	0/140
	V132	0/095	0/542	0/000	0/115	0/095	0/489	0/001	0/151	0/071	0/461	0/002	0/157
DizajAbad	V142	0/167	0/556	0/002	0/155	0/071	0/485	0/001	0/147	0/048	0/458	0/002	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
	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
Homayoun	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
Sala	V 193	0/238	0/5/0	0/011	0/17	0/119	0/492	0/002	0/18/	0/095	0/464	0/003	0/1/8
Gogarchinak	V201	0/119	0/546	0/001	0/130	0/048	0/481	0/000	0/172	0/048	0/458	0/000	0/140
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
IZ .1 ·	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
Koloeim	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
Shoot	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
Sileat	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

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

- 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
- 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
- the highest speed of access with frequencies of 0.713 and 0.585, respectively, and in the strong
- tie status, "FMs" with a frequency of 0.534 had the highest speed of access.

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

Actors Betweenness Closeness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness Betweenness	0 Eigenvector
	0 0/000 0/000
O1: Carpet Office of Zanjan province 0/022 0/444 0 0/014 0 0/295 0 0 0 0/295 0	0/000 0/000
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	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	
O4: Iran Business Training Center 0 0/295 0 0/000 0 0/295 0 -0/000 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0 0 0 0 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 0/000<	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 0 0/295 0 0/000	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
O 10: University of Applied Science and Technology 0 $0/295$ 0 $0/000$ 0 $0/295$ 0 $0/000$ 0 $0/295$ 0	0
Office Department of vocational education Zanjan Province 0.089 0.441 0.000 0.0495 0 0.0295 0 0.000 0 0.295 0	0
O12: Department of vocational education - County 0.022 0.432 0 0.003 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
014: State weighter Organization of Iran (SWOI) 0/044 0/447 0/000 0/025 0 0/255 0 0 0 0 0/295 0 0 0 0/295 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0
015: imam Knomenni Kenet Foundation 0/111 0/47/ 0/002 0/064 0 0/255 0 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0/295 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0
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0.125 Using of Ukban HC Cooperative Companie Zanjan 0/150 0/407 0/002 0/060 0 0/275 0 0 0 0 0/225 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0 0/255 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0
0.05: Union of Urban HC Companie-Zanjan 0.067 0.0434 0.001 0.029 0.0444 0.405 0.000 0.025 0 0.0295 0	0
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O30: Belonging to the market who have and sell silk carnets $0/333 - 0/34 - 0/014 - 0/161 - 0/022 - 0/403 - 0 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0 - 0/255 - 0/016 - 0/016 - 0 - 0/255 - 0/016 - 0/0$	0
$\begin{array}{c} \textbf{O}(11) \textbf{D}(12) \textbf{D}($	0
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O33: Darner 0/044 0/438 0/000 0/020 0 0/295 0 0 0 0/295 0	0
$\mathbf{O34: Designer} \qquad 0.022 0.426 0 0.012 0 0.225 0 0 0 0.225 0$	0
Ods: 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	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	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	0/197



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





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



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

329 **5 Discussion**

326

328

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

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

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

- weavers and other actors, particularly local actors like WNVKRs, are more prevalent. This
 observation aligns with the findings of Ahmadifard and Karamidehkordi (2018) and Mirkatouli
 (2009) and underscores the influence of local actors in the communication networks among rural
 weavers, contradicting the results of Gholifar, Abbasi, Pezeshkirad, Salehi, and Rezaei (2018).
 Interviews with households further reveal that most weavers have acquired their weaving skills
 from "FMs" and "WNVKRs", explaining their extensive connections with these individuals for
 weaving-related queries and problem-solving.
- These findings collectively highlight the fact that weavers maintain minimal or, in some 356 instances, no communication with organizations, associations, and market actors. Consequently, 357 they remain uninformed about new facilities, innovations, training programs, and other 358 developments in the realm of HCs. Additionally, weavers have limited connections with 359 360 associates, corroborating the findings of Naeini, Houdsani, Ashrafi, and Golzari (2022) regarding the limited role of the private sector. As per interview results, individuals who possess carpet-361 weaving insurance or have family ties to the union head have the most extensive connections. 362 This finding corresponds with the results of Karimigoughari, Rezaeimoghaddam, and Rezaei 363 (2018) concerning the absence of a dynamic network in the interactions of all actors involved in 364 educational and extension activities. Most weavers lack trust in associations, as they have sold 365 366 their carpets at prices below market value, leading weavers to believe that the union has not been beneficial for them. Consequently, there is a need for strategies aimed at monitoring union 367 368 activities and enhancing weavers' connections with both formal and informal actors, as these individuals are the implementers of policies and decisions relating to HC production, and 369 370 improved connections will address numerous HC production challenges.
- The Coherence Indices (CIs) pertaining to weavers' connections across various rural areas and 371 372 production system revealed that the highest frequency was associated with the self-employed production system. In this particular system, weavers assume full responsibility for the entire 373 374 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 network and exert more influence. However, since the majority of weavers in the surveyed 377 378 regions are engaged in the Family owned production system, the density of connections is 379 comparatively lower in the context of coherence indices.

381 6 Conclusions and Recommendations

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

397 In summary, the following recommendations can be proposed:

Recognizing the significance of weavers' interactions with other stakeholders within the
 "KIS", the government should prioritize the enhancement of "CNs" among the KIS participants.
 This can be achieved by introducing innovative practices to the rural carpet-weaving community
 and conducting workshops to increase their understanding of the roles and responsibilities of
 relevant organizations and associations. Such efforts will be instrumental in enhancing the KIS's
 overall performance.

• Supervising the activities of rural governors and members of rural councils and appointing individuals known for their integrity and dedication.

Fostering the development of skilled designers within Zanjan province while encouraging
 the participation of designers from Qom.

• Considering the importance of strengthening the communication network of weavers and its role in market development, use innovations in production and to strengthen the self-employed procuction system, it is necessary to monitor the activities of the main institution of carpet in rural areas. In recent years, except for renewing the carpet weaving insurance card and in some cases the role of the employer and broker in the production, the rural carpet union has not played any other role and from itself main duties that are to support the weavers and act as an

414	intermediary between the education section, research, market with the weavers has distance
415	itself that there is a need untill the Ministry of Industry and Mining, to have the necessar
416	supervision in this field.
417	
418	7 Acknowledgment
419	The research paper originated from a doctoral thesis in the field of agricultural extension an
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423	University of Tehran for their collaboration in facilitating the research and enhancing its quality
424	
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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 احمدي فرد، همايون فر هاديان، اسماعيل كرمي دهكردي، و حسين شعبانعلي فمي
516	چکیدہ
517	ارتباطات موثر نقش مهمی در موفقیت کسب وکارها 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 بهر موری در آن تأثیر بسزایی دارد. هدف این مطالعه تحلیل دقیق شبکه ارتباطی
521	بافندگان با دیگر کنشگر ان در نظام دانش و نو آوری 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	UCINETبررسی شد و گرافهای موردنظر در نرم افزار 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 نمونه های دیگر اتصالات قوی
526	ر ا 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 می آورند، که تعاملات آن ها در درجه اول بر روی «اعضای خانوار»، «بافندگان
529	همسایه، همروستایی و فامیل» متمرکز است. بنابراین با توجه به وضعیت شبکهٔ 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 زنجیرهٔ تولید فرش دستباف آشنا شوند تا در مواقع نیاز به آنها مراجعه کنند.
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