**An Integrated Approach to Assess Potential and Sustainability of Handmade Carpet Production in Different Areas of the East Azerbaijan Province of Iran**

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**Abstract:** A handmade carpet is one of the most well-known handcrafts around the world. Iranian handmade carpets are known as luxury products in domestic and international markets due to their strength and product value. The main objective of this research is to apply a geographical information system (GIS)-based, spatially-explicit approach to assess the sustainability of handmade carpet production in the East Azerbaijan Province of Iran, which is internationally famous for the diversity and quality of its handmade carpets. To achieve this goal, we employed 23 criteria in four main clusters: population characteristics, education status, employment status, and business activities related to the carpet industry. In order to determine the significance of each criterion, an integrated approach of fuzzy and network analysis processes was applied. Accordingly, the GIS aggregation function was employed to map and identify the areas that are suitable and of high potential for handmade carpet production. The results indicate that there is a very high potential for handmade carpet production in some areas of Tabriz, Osku, Marageh, Heris, and Meyaneh counties. However, high sustainability also extends to some areas in Marand, Bonab, and Kalaybar counties. The obtained maps present the potential of each city and village for handmade carpet production. The research also aims to evaluate and suggest relevant policies and practices to overcome the identified challenges in order to promote, develop, and preserve the handmade carpet sector. The results of this research are of great importance for different stakeholders in the handmade production and for decision makers and authorities in the East Azerbaijan Province. The results can be used to determine the potential of each area for handmade carpet production and to highlight potential challenges. This research also presents a new approach for sustainability assessments in studies on handcrafts and, in particular, carpets.

**Keywords:** handcrafts; business; markets; cultural heritage; sustainability assessment; the East Azerbaijan province; Iran

**1. Introduction**

Handcrafts are among the most important products of human societies, representing patterns of culture, art, custom, tradition, and events that characterize a society. In this context, handcraft products can be considered as cultural heritage. In many countries, some significant and unique aspects of cultural heritage are retained in handcrafts [1]. The term “handcraft” is employed to denote “craft artefacts”, which are associated with the lifestyles and social and cultural structures of each society at a given time and place.
Technically, craft traditions are localized versions of inherent patterns, such as cultural heritage and prescriptive knowledge. Handcrafts represent critical information about the tradition and cultural heritage residing in pieces of art and various other types of behaviors and traditions. Handcrafts are localized formulations of cultural heritage that are passed from one generation to the next via various mediums and different actors [2–4]. Thus, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) inscribed handcrafts as intangible forms of cultural heritage. Intangible cultural heritage has unique characteristics that distinguish it from other types of heritage. In fact, handcrafts exhibit many mysteries and traditions that represent the cultural background of a given society. For example, in the context of Iranian handmade carpets, based on the cultural and socioeconomic characteristics of the country, it is assumed that the pattern of handmade carpets represents the heritage of the ancient and the rich culture of Iran. The patterns recorded on Iranian handmade carpets are rooted in the myths and customs of the local people. Expert analyses of Iranian handmade carpets have shown that the pattern, color, and textural concepts contained therein are impacted by the custom and the tradition of the areas in which they were woven [5]. At present, Iranian handmade carpets (HCs) are regarded as good examples of the rich art history of the country, and also represent other historical, social, religious, and cultural identities [6,7].

Handmade carpets (HCs) are among the most well-known handcrafts around the world. Since HCs are typically produced in traditional areas, they are mostly based on available raw materials such as silk and wool. Culturally speaking, this type of handcraft represents inherent patterns of the customs, religious beliefs, history, and social aspects of the area in which it takes place. Based on the long history of HCs, any change in pattern, quality, and material can be considered as a symbol of the evolution of that civilization [8]. The history of Iranian HCs goes back to 2000 BC [9]. Iranian HCs are known as luxury products in domestic and international markets due to their strength and value [10]. According to the national perspective, Iranian HCs embody economic, social, cultural, and national dimensions [11]. These valuable handcrafts are major artistic and cultural product of Iran in terms of their cultural significance. Moreover, the rich variety of Iranian HCs is a testament to the different cultures and traditions that exist in the country. Thus, HCs are not only commercial products, but are also a heritage symbol of Iran’s rich cultural, artistic, historical, and social background [12].

Iranian HCs are produced in two major categories: rustic and nomadic [13]. It is known that the climate, landscape, culture, tradition, and costumes of each region are represented in the designs and patterns that appear on HCs. Thus, carpets and their patterns can be considered as symbols of the cultural background of the society in which those carpets have been manufactured. The major conceptual designs of Iranian HCs include Shah Abbasi (palmetto floral design), Eslimi (arabesque), Afshan (floral design), Botteh Jeghegh (paisley), Tress, Hunting ground, Panel, In and out fish, Golfarang, Mehrabi (Prayer design), Vase design, Moharamat, Tribal, Geometric, Vagireie, and Adaptive group, which have been developed in different parts of the country based on the traditions, customs and lifestyles of the weavers [12,13].

From an economic perspective, the HC industry also plays a significant role in the country’s economy and contributes to national gross domestic product (GDP). Accordingly, the development of Iranian HCs plays a critical role in the tourism sector, providing economic benefits for both the government and local communities. Iran joined the World Trade Organization (WTO) in order to expand its nonoil exports and presence in world markets. The importance of being able to compete with other participant countries, with the goal of greater integration into the world economy, is undeniable. In addition, joining the WTO has led to economic benefits in the form of investments [14]. Proximity of HC production workshops to historic sites can provide synergies and benefit both the HC and tourism industries. This is particularly relevant, because Iranian carpets have a special position in the global market and are widely considered as a form of cultural heritage that contributes to tourism [15]. Iranian carpets are of international repute, in part due to their long his-
Every year, a variety of categories of Iranian HCs appear on the international market. Hence, handmade carpets are among the most important nonoil export items of the country, accounting for about 7% of the country’s total employment [16]. Additionally, the Iranian HC industry encompasses Iranian traditions and skills passed down over centuries [17].

As stated, HCs are critical for the sustainable economic development of the country. Therefore, to ensure the continuity of this industry, potential areas for development should be prioritized. However, in recent decades, this market has faced some obstacles [18,19], including issues caused by modernization and industrialization. Modernization has changed the lifestyles and demands of customers; as a result, handcraft products have slowly lost their place in the market [1], and HCs have lost their value in the eyes of the new generation. In addition, HCs are mostly made in rural areas. Young people who grow up in such areas tend to migrate to urban areas and work in modern industries. Therefore, there is a labor shortage in the HC industry [20,21]. UNESCO [22] has indicated that the extinction of this long-standing industry is highly likely. Reviving it would not only prevent this from happening, but would also pave the way for economic growth [23]. In addition, the Iranian HC sector has been faced with several international marketing challenges, notably due to international sanctions that target Iranian international trade. According to a report published by the Iranian National Carpet Center, European Union countries have been major consumers of Iranian HCs for several centuries. However, exports to the European Union have experienced a declining trend in the recent years [24]. In addition, countries, such as India, China, and Pakistan are inspired by the patterns and designs of Iranian carpets, and have become leaders in the global market [17].

Considering the significance of Persian carpets for the economy of Iran and as representations of its ancient culture, it is necessary to evaluate potential areas of HC development. The history of Iranian handmade carpet companies goes back as far as 2000 BC [11]. The region has a long history of weaving and trading handcrafted carpets [25]. Thus, it is essential to develop the HC sector and encourage the new generation to work in this area. This is particularly essential when considering the declining revenues associated with this industry. The workforce has decreased from about 1,809,612 people in 2007 [11] to about one million people in 2020, which indicates a decrease rate of 44.73% [13]. It is argued that identifying and implementing cooperation/competition incentives in the industry will solve the problems related to the development and promotion in the national and the international markets [26]. Clustered firms can achieve benefits provided by an economy of scale and the proximity of involved stakeholders that would encourage cooperation [27]. Therefore, identifying suitable areas for the production of HCs may yield economic benefits. Accordingly, the main purpose of this study is to identify potentially suitable areas for the development of the handmade carpet industry. This research builds on the results of studies in cultural heritage and handcrafts by offering innovative spatial analysis ideas related to the identification of suitable areas for the development of the HC industry.

2. Materials and Methods

2.1. Study Area

The study area is the East Azerbaijan Province (EAP), which is located in the northwestern part of Iran (Figure 1). According to the latest census data of 2016, with a population of 3,909,652, EAP is one of the most populous provinces in Iran, accounting for about 5% of the country’s population. The province has an area of 45,730 km²; it contains 57 cities and 3095 villages. It is an important industrial hub in Iran, and its main industries are agriculture and handcrafts. The area produces a wide range of handcrafts, a large percentage of which are exported [28]. Based on an official report issued by the Organization of Planning and Management of EAP (OPM–EAP), about 35% of all Iranian HCs are produced in the province. Tabriz (the capital city of the province) is internationally renowned for its HCs. Historically speaking, early attempts to valorize carpets as a commercial and cultural product date back to the Safavid dynasty, whose kings showed considerable interest in art and culture.
Under Shah Ismail I, numerous carpet workshops were established all around the country, especially in Tabriz, and weaving carpets obtained a special position as a royal art [29].

![Figure 1. Location of the East Azerbaijan Province and political division.](image_url)

According to a recent report by the National Carpet Center of Iran, there are 6021 business units related to handmade carpets, and 120,075 people work directly as carpet weavers (Table 1). Various categories of carpets exist, according to their color, design, pattern, material, size, and the region of origin. EAP is one of the most-developed states in terms of HCs, and has always produced the best quality carpets in Iran. There are a variety of methods and techniques for producing HCs in the province. Designers and weavers in the region have long been praised for their innovation; they were able to integrate local customs and traditions into carpet patterns and designs. As a result, a rich collection of colors, patterns, and designs have been developed in the area [5,30]. As a consequence of these innovative efforts, several established categories of HCs exist, e.g., Heirs, Meherban, Varzeghan, Osku, and others, all of which are produced in EAP. Figure 2 shows several of the major carpets produced in the region. It should also be noted that HCs are critical for the economy, culture, and tradition of the region. Table 1 shows the current status of HC production. As shown, the HC sector has created job opportunities for many people, and it is essential to take action to allow it to expand further.
### Table 1. Businesses related to the production of handmade carpets in EAP [7].

| Job Description                      | Workshops/Unities | Employees |
|--------------------------------------|-------------------|-----------|
| Concentrated section                 | 13                | 200       |
| Un/concentrated section              | 3854              | 12,180    |
| Workroom                             | 1749              | 947       |
| Designer                             |                   | 133       |
| Generating layout and maps           | 7                 |           |
| Spinning                             | 69                | 78        |
| Dyeing                               | 21                | 108       |
| Carpet washing centers               | 86                | 186       |
| Raw material distribution            | 71                | 935       |
| Accessories distribution             | 44                | 121       |
| Carpet weaver                        | 5914              | 120,075   |
| Sum                                  |                   | 134,963   |

**Figure 2.** Samples of different carpets produced in East Azerbaijan Province (EAP).

### 2.2. Dataset

In this study, we aim to develop a comprehensive research for identifying and presenting the EAP’s abilities to extend the production of the HCs. For this purpose, this research was carried out using the geographical information systems (GIS). The relevant criteria were identified by reviewing the literature, considering cultural aspects and perspectives of the study area, and by interviewing various stakeholders, such as local experts, craftspeople, academic members in the faculty of the carpet (Islamic Art University of Tabriz) and department of economic sciences (University of Tabriz), and authorities from the cultural heritage organization, handcraft, and tourism organization (CHHTO), and management and planning organization (MPO) of the EAP. Therefore, the criteria selection process was based on the expert knowledge, considering the physical, cultural, socioeconomic characteristics of the study area, and data availability. It should be mentioned that hand-
Crafts could represent the inherent patterns of the cultural, economic, and social aspects of the society that are developed over the time. Thus, selection of relevant criteria may vary from one society to another one. Therefore, since there is no universal guideline for indicator selection, as discussed earlier, in this research we selected the criteria based on the literature review, expert knowledge, local characteristics, and data availability. In this context, the required data to recognize areas with potential for HC production is related to the population characteristics, including age, gender, employment status, educational level, related businesses, and the conditions of existing carpet weaving units. In general, the dataset related to this research includes four main clusters of the population characteristics, education status, employment status, and related businesses to the production of the handmade carpets (Table 2). The initial data and statistics were obtained from CHHTO and MPO, and subsequently developed as a GIS dataset. The population data are derived from the results of the latest census in 2016. It should be indicated that there is comprehensive national census every 5 years in Iran. However, in the case of related businesses and employment status, we used the recent data obtained from CHHTO and MPO in September 2020.

Table 2. Dataset that is used to identify the potential of the handmade carpet production in the East Azerbaijan Province.

| Major Criteria                     | Sub-Criteria Title                                                                 | Resources                                   |
|------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------|
| Population characteristics         | Family ratio in urban area                                                        | Statistical Centre of Iran, 2016            |
|                                    | Family ratio in rural area                                                         |                                             |
|                                    | Urban men population                                                              |                                             |
|                                    | Rural men population                                                              |                                             |
|                                    | Population density in the age of 20–60                                            |                                             |
|                                    | Urban women population                                                            |                                             |
|                                    | Rural women population                                                            |                                             |
| Education status                   | Rural women population                                                            | Statistical Centre of Iran, 2016            |
|                                    | Educated men in urban area                                                         |                                             |
|                                    | Educated men in rural area                                                        |                                             |
|                                    | Educated woman in urban area                                                       |                                             |
|                                    | Educated woman in rural area                                                       |                                             |
|                                    | Uneducated men in urban area                                                       |                                             |
|                                    | Uneducated men in rural area                                                       |                                             |
|                                    | Uneducated women in urban area                                                     |                                             |
|                                    | Uneducated women in rural area                                                     |                                             |
| Employment status                  | Employment status in urban area                                                    | Statistical Centre of Iran, 2016            |
|                                    | Employment status in rural area                                                    |                                             |
|                                    | Housewife population                                                               |                                             |
| Related Businesses                 | Related handmade carpet units                                                      | Study Result                                |
|                                    | Village performance                                                               | Land use planning Scheme                    |
|                                    | distance to local markets and trade centers                                        |                                             |
|                                    | Tourism characteristics                                                            |                                             |
|                                    | Weaving units                                                                      | MPO (management and planning organization) 2020 |

2.3. Criteria Selection and Data Evaluation

As indicated earlier, our modeling approach was based on the GIS spatial analysis that makes use of multi-criteria decision analysis (MCDA) techniques. Technically speaking, GIS–MCDA has the ability to manage large-scale location data, and can be used as a high-speed tool for identifying areas suitable for potential development [31]. In addition, GIS–MCDA allows doing comprehensive spatial modeling suitable for different purposes and fields, such as environmental assessment, urban planning, natural hazard management,
tourism, sustainability assessment, etc. [32–36]. Based on this, we aimed to apply a GIS–MCDA for assessments of HC industry’s sustainability in the EAP. The main criteria were selected as casual criteria, which are discussed as follows.

2.3.1. Population Characteristics

The connection between population growth and economic growth has been studied and addressed widely [37]. The importance of population growth for the economic development of countries is also widely acknowledged. Accordingly, both demographers and economic development experts highly rely on the population growth in their analyses [38]. Additionally, depending on a country’s stage of development, the impacts of population growth may vary. Moreover, the way population growth occurs may have impacts on the state of development [39]. A number of studies have found that population growth has a positive effect on economic growth [40–42]. Population growth and in particular its characteristics (e.g., education, cultural, technical background, and capabilities) have impacts on many aspects, such as the movement of human resources, economic disparities, and the characteristics of a nation’s work power [43]. Thus, the analysis of the age characteristics of the population was examined. In the present study, gender and age composition were examined to identify people who can be employed in the carpet producing places as labor force. Child labor and unfair wages are still a concern for the carpet industry. Therefore, participants were aged between 20 and 60 years to consider the restrictions on the employment of children in this industry [44]. We also used family ratio as one criterion that is significantly important for handmade carpet production. Historically and culturally speaking, handmade carpet weaving is known as self-employment and family business in Iran. Therefore, in families with several members (e.g., father, mother, and children), handmade carpet could be a successful business, and to consider such characteristics, we intended to employ a family ratio as one of the criteria.

2.3.2. Education Status

Human capital evaluation should be done by considering qualifications of various actors involved in economic activities [45]. This can indicate the importance of the education level in each region. Moreover, improvement of education would enable an easier transition of the economy to a higher level of development [46]. In the context of the EPA, it is known that public education facilities in rural areas are generally limited to the elementary and secondary schools. Thus, many students have no chance to continue their education, and their education is limited to elementary and/or secondary school study. With such limited levels of education, most of them lose the chance of getting official occupations and have to work in rural areas as labor force in farming or crafting industries. Traditionally and historically speaking, uneducated female populations in rural areas have worked in the handmade carpet industry. Moreover, traditional norms have discouraged female populations from pursuing higher education and have favored domestic work, such as handmade carpet weaving. Based on this traditional belief, which has evolved as a kind of lifestyle, particularly in rural areas, the female population mostly stay at home, while the males are responsible for engagement in other activities such as farming, animal husbandry, etc. Therefore, the uneducated or under-educated population and in particular female population mainly work in self-employed sectors, such as those related to HCIs. Thus, in the present study, the rate of uneducated population in rural areas was used as proxy for workforce in the carpet-weaving sector. In addition, educated people in urban and rural areas were employed in businesses related to carpet weaving such as map design, quality control units, modern marketing, and advertising. On the other hand, education plays an important role in the national economic system and it is responsible for the development of qualified and competent human resources that act as labor force in the labor market. Moreover, there is an undeniable relationship between social and labor relations with the education sector [47].
2.3.3. Employments Status

Unemployment is a major socio-economic issue that negatively impacts the economy, and its rate is one of the most commonly used criteria in the labor analysis [48]. Therefore, by analyzing the rate of urban and rural unemployed populations in different counties of the EAP, an attempt was made to identify areas that need further attention. The global, national, and local unemployment rates also highlight the importance of this issue. In this regard, the rate of global unemployment was 5% in 2018 [49]. Based on the national level data, in Iran, the unemployment rate in 2019 was 10.8%. Moreover, at the local level, the unemployment rate in EAP in 2019 was 10.9%, which turned to be even higher than the unemployment rate in Iran. The province’s number of active populations is 1,376,462, of which 1,228,780 are employed and 144,296 are not [50].

2.3.4. Related Businesses

Business-related criteria linked with the handmade carpet industry can be considered in two categories: (a) directly related criteria including the number of weaving units and related units, (b) indirectly related criteria that include distance to sale centers, village performance, and tourist potentiality. Information and statistics associated with businesses related to the handmade carpet industry were obtained from the national carpet center of Iran and converted into GIS layers compatible with spatial processing. In addition, we also obtained data about the village performance in relation to their impact on the development of handmade carpet production. In this context, it was assumed that the villages with functionality of agricultural activity and livestock jobs have potential to be involved in the production of handmade carpets on a part-time basis, at least for 6 months of the year. Thus, the villages were classified and categorized, based on their performance, in five classes including agricultural, animal husbandry, handcrafts, industry, and service orientation.

It has also been argued that the tourism functionality is one of the major characteristics of some villages in the EPA such as Kandovan and Liqvan. The development of tourism in rural areas is also a positive advantage to the development of local markets for the presentation of handcraft products, for instance, handmade carpets. According to the output of our interviews with local stakeholders, as well as, a report that is published by MPO (2020), national and international tourists are major buyers of Iranian handmade carpets. Thus, proximity to tourist destinations can also be considered as a significant criterion for sustainability assessment of the HC production. In addition, the importance of tourism for mitigating income disparity between urban and rural areas is widely acknowledged. Locating handmade carpet units in touristic areas can increase economic benefits of villagers through enabling synergies that can be achieved in combination with other potential economic activities, such as ecotourism [48]. Ecotourism, as a subset of tourism, is more related to rural areas. Therefore, based on a study conducted by Ghorbanzadeh et al. [51], it can be argued that areas with high potential for ecotourism have more advantages to establish local markets for handcrafts and handmade carpets. The northern part of the EAP, especially the Kaleybar forest area and the Aras riverbanks, demonstrate high potentiality for ecotourism development [52]. Based on this statement, in this research we aimed to consider the tourism potentiality/characteristics as one of the main criteria.

2.4. Methodology

The research methodology was established based on the GIS spatial analysis, combined with multi-criteria decision analysis (GIS–MCDA). GIS–MCDA was applied for data collection, evaluation and ranking, as well as, data aggregation. The required spatial data were gathered from the related organizations (see Table 2) and accordingly developed as a GIS dataset. Since several criteria were employed to achieve the research goal, an integrated approach of fuzzy method and analytic network process (ANP) was applied to compute the criteria weights. In general, ANP was used to obtain the superiority of the criteria, and fuzzy method was used to determine the internal weight of each criterion. Besides, the layer’s fuzzification leads to the overlay of data with different features. The ef-
ficiency of this integrated approach has already been reported in earlier research [53,54]. Figure 3 depicts the main steps of the research methodology. Due to the mixed method nature of the research, all casual criteria were collected and developed as a GIS spatial dataset, which uses the different functions (point density, feature to raster) and separates fields of information. Accordingly, a standardization technique was applied to present all data on a scale suitable for criteria weighting and aggregation. Figure 4 represents the spatial format of the casual criteria for sustainability assessment of handmade carpet production.

Figure 3. The research scheme methodology.

Figure 4. Spatial format of the causal criteria includes: (a) rural female population, (b) rural male population, (c) urban male population, (d) urban female population, (e) educated woman in urban areas, (f) educated woman in rural areas, (g) educated men in urban areas, (h) educated men in rural areas, (i) uneducated women in urban areas, (j) uneducated women in rural areas, (k) uneducated men in urban areas, (l) uneducated men in rural areas, (m) family ratio in urban areas, (n) family ratio in rural areas, (o) employment status in rural areas, (p) employment status in urban areas, (q) housewife’s population, (r) population density in the age of 20–60, (s) related handmade carpet units, (t) weaving units, (u) village performance, (v) distance to local markets and trade centers, and (w) tourism characteristics.

Figure 4. Cont.
2.4.1. Assigning Weights to the Criteria Using Analytical Network Process

Understanding the relationship between spatial data and sustainability analysis has great importance due to the exploitation of different criteria. Thus, criteria weighting is turned to be a critical step, and an effective technique for assessing the significance of the criteria for data combination [55]. The pairwise comparison techniques have been widely used for obtaining the criteria weights. The analytic network process (ANP) is a method that is commonly used for this purpose [56]. When dealing with complex entities that have a network structure, ANP can be used to facilitate decision making [51]. In the present study, 23 criteria including four main clusters were employed for the ANP modeling in Supper Decision software to compute the criteria weights. For this purpose, pairwise comparisons were performed following the ANP method. Accordingly, 35 questionnaires for initial ranking of the criteria were completed during the interview with experts, authorities,
and decision makers. This process was performed using a survey of people working in fields related to the handmade carpet industry and handcrafts (e.g., faculty of carpet in Islamic-Art University of Tabriz and department of economic sciences in University of Tabriz, and stakeholders and authorities in CHHTO as well as craftspeople and HCs weavers). The different stages of the ANP process and implementation are represented in Figure 5. The computation background and mathematical equations for the ANP implementation are also presented in Table 3. We also reported the computed ANP weights in Table 4.

Figure 5. The research scheme for implementation of analytic network process (ANP).

Table 3. The hierarchical process equations.

| Raw | Equation                  | Description            | Components                                |
|-----|---------------------------|------------------------|-------------------------------------------|
| 1   | $CI = \frac{\lambda_{\text{max}} - 1}{n - 1}$ | coefficient index     | $CI$: compatibility index                |
|     |                           |                        | $\lambda_{\text{max}}$: maximum eigenvalue of the judgment matrix |
| 2   | $CR = \frac{CI}{RI}$     | compatibility rate     | $CR$: consistency ratio                 |
|     |                           |                        | $CI$: compatibility index                |
|     |                           |                        | $RI$: random index                      |
| 3   | $AW = \lambda_{\text{max}} W$ | eigenvector matrix    | $A$: pair-wise comparison matrix        |
|     |                           |                        | $W$: eigenvector                        |
|     |                           |                        | $\lambda_{\text{max}}$: maximum eigenvalue of the judgment matrix |
| 4   | $W_L = \lim_{K \to \infty}^{\frac{\lambda_{\text{max}}^{K+1}}{K}}$ | limit super matrix    | $W$: weighted super matrix              |
|     |                           |                        | $K$: exponent determined by iteration   |
Table 4. Computed weights for criteria using ANP.

| Cluster                  | Criteria                                  | ANP Weights |
|--------------------------|-------------------------------------------|-------------|
| Population Characteristics| Family ratio in urban area                 | 0.0076      |
|                          | Family ratio in rural area                 | 0.0134      |
|                          | Urban men population                      | 0.0073      |
|                          | Rural men population                      | 0.0173      |
|                          | Population density in age of 20–60         | 0.0257      |
|                          | Urban women population                    | 0.0085      |
|                          | Rural women population                    | 0.0341      |
| Education status         | Educated men in urban area                | 0.0062      |
|                          | Educated men in rural area                | 0.0141      |
|                          | Educated woman in urban area              | 0.0093      |
|                          | Educated woman in rural area              | 0.0272      |
|                          | Uneducated men in urban area              | 0.0231      |
|                          | Uneducated men in rural area              | 0.0387      |
|                          | Uneducated women in urban area             | 0.0218      |
|                          | Uneducated men in rural area              | 0.0491      |
| Employments status       | Employment status in urban area           | 0.1115      |
|                          | Employment status in rural area           | 0.1291      |
|                          | House wife population                     | 0.0357      |
| Related Business         | Related handmade carpet units              | 0.1213      |
|                          | Village performance                       | 0.0258      |
|                          | Distance to local markets and trade centers| 0.0207      |
|                          | Tourism characteristics                    | 0.1160      |
|                          | Weaving units                            | 0.1356      |

2.4.2. Fuzzification and Aggregation

An integrated Fuzzy–MCDA approach can be considered as an analytic method to evaluate the advantages and disadvantages of the criteria within a multiple criteria evaluation approach [57,58]. It is known that in the GIS–MCDA process, different criteria from various resources are taken into the account. Thus, due to the heterogeneous nature of the GIS–MCDA based on modeling tasks, standardization and fuzzification is needed. This involves making comparisons/judgments in fuzzy environments for improving model robustness and efficiency [34,59–63]. In addition, Fuzzy–ANP (FANP) was further applied to address uncertainty concerns in criteria weighting through a GIS–MCDA approach [63]. It is acknowledged that FANP is a suitable method because it accounts for interactions among different criteria and facilitates decision making and evaluation judgements based on linguistic expressions [64]. If we combine fuzzy logic with MCDM techniques, it would be possible to deal with the issue of lack of clarity that may occur when using linguistic expressions [58]. In order to combine the ANP method with the fuzzy logic, we employed the fuzzy membership function in the ArcGIS software, and all criteria were standardized in the scale of 0–1 by considering the cost and benefit nature of the criteria for the handmade carpet production. Figure 6 presents the standardized version of the criteria. After the fuzzification step, in order to aggregate the criteria and develop a sustainability map for HC production, GIS based on the weighted overlay aggregation function was applied to produce the final result. In this context, the ANP weights were employed as the significance of each criteria in the overly step, and the final sustainability map was produced and is shown in Figure 7.
Figure 6. Standardized version of the causal criteria includes: (a) rural female population, (b) rural male population, (c) urban male population, (d) urban female population, (e) educated woman in urban areas, (f) educated woman in rural areas, (g) educated men in urban areas, (h) educated men in rural areas, (i) uneducated women in urban areas, (j) uneducated women in rural areas, (k) uneducated men in urban areas, (l) uneducated men in rural areas, (m) family ratio in urban areas, (n) family ratio in rural areas, (o) employment status in rural areas, (p) employment status in urban areas, (q) housewife population, (r) density of population aged 20–60, (s) related handmade carpet units, (t) weaving units, (u) village performance, (v) distance to local markets and trade centers, and (w) tourism characteristics.
3. Results

As indicated, the substantiality assessment for the handmade carpet (HC) production was done based on the GIS aggregation function. Figure 7 shows the results of the final sustainability map derived from the aggregation of 23 causal criteria through GIS–MCDA. As presented in Figure 7, the sustainability categorization varies from low sustainability to very high sustainability. In order to interpret the results and compare the capability of each county and area, we aimed to add the residential area and population density to the obtained sustainability assessment map. As Figure 8 shows, the very high sustainable areas include those in a partial zone in Tabriz, Osku, Marageh, Heris, and Meyaneh counties. However, high sustainability also extends to some partial areas in Marand, Bonab and Kalaybar counties. Our detailed results indicate that the potentiality for the handmade carpet production in rural areas is much higher than in urban environments. Results also acknowledge that most of the handmade carpets are essentially produced in rural areas. However, since the local markets and trade centers are located in urban environment, these are known as urban carpets without recognizing their rural origin.

To better represent the potentiality, we enlarged the identified hotspot areas for handmade carpet production. Figure 8 shows the enlarged sustainability maps. As Figure 8E shows, rural areas around Tabriz (the capital city) show a very high potentiality, which is generally due to the proximity to the market and the trade centers, as well as the population density, with a high number of housewives in the population. Similar conditions were also observed in the rural areas of Ahar and Meyaneh (see Figure 8A–D). The rural areas around Azarshahr and Hashtrood also show high potentiality (Figure 8A–C). Comparing the obtained sustainability levels indicates that in the rural environments characterized by major activities such as agriculture and animal husbandry, there is a very high potentiality for the handmade carpet production. It should be highlighted that handcrafts, and, in particular, the handmade carpet production, are generally considered as a part-time occupation in Iran, especially in rural areas. Thus, most farmers in rural areas work on handmade carpets during the autumn and winter seasons when the agricultural activities are stopped or limited. On the other word, the handmade carpet production is essentially considered a
seasonal occupation for many farmers. However, it is also true that housewives in rural areas also work in the handmade carpet production as well, which provides additional potential for the handmade carpet production.

Figure 8. Enlarged hotspots in the sustainability map, including: (A) hotspots in Hashtrood and Mianeh; (B) Marand; (C) Azarshahr; (D) Ahar; (E) Tabriz; and (F) Maraghe.

4. Discussion

The main purpose of this study was to apply an integrated approach to recognize potentially suitable areas for the handmade carpet production in the East Azerbaijan Province (EPA). Results indicated the inherent potentiality of each part of the EPA for HC production. As pointed out in the introduction, it is believed that handcrafts and, in particular, the HCs, represent the culture, tradition, and custom of their origin area. Thus, their production costs are different based on different weaver wages, and depending on the geographic region. In addition, different types of raw and available materials (e.g., wool, silk, etc.), as well as their prices and costs, also matter and make a difference [25]. From the business and marketing perspective, the HC sales department and commercial centers consist of two major markets: internal and external. In addition, there is changeable demand for different types of the HC in both internal and external markets. Some of the HCs have special customers and sell better in the local markets, such as Tabriz, Tehran, and other large cities. In contrast, others represent high potentiality for the external market, and are more suitable for international export. Right now, HCs of Iran are exported to many countries, and although the traditional Iranian carpet markets, such as USA, Italy,
Germany, Japan, United Arab Emirates, etc. are considered major markets, there has been a considerable increase in exports to Brazil, Africa, and China [3]. Hence, it is important to understand which category is more different in terms of the production and marketing [19].

As indicated previously, the Iranian carpet has a long history that leads to its recognition as a valuable commercial and cultural product. The Iranian HC industry still holds a top position in the global market, although some major competitors from other countries, such as China, have merged, and offer HCs at lower prices [8]. According to the Iranian national carpet center (2019), the EPA has produced about 35% of all national handmade carpets. Many countries have been able to overcome the unemployment and poverty problems by considering traditional arts and cultural heritage [59,60]. Based on the annual economic report of the EPA, the handmade carpet and its related businesses created jobs (permanent or seasonal) for 45,000 people. This report also indicated that there were 121 weaving units and workshops, 1200 carpet trade markets, 71 trade markets for businesses related to raw materials of the handmade carpet, 45 industrial units for producing the waving tools, 70 dyeing units, and 60 carpet designing units in the EPA during 2019 (OPM–EAP, 2020). These statistics clearly show the importance of the HC for the economy of the EAP.

The HCs in the EPA have traditionally been woven by the normal rural and urban residents, as well as by artisans associated with royal families. Accordingly, these HCs represent different cultures and traditions. Analyzing the pattern, design, and context of the HCs that are produced in the EPA shows that HCs woven in different parts of the EPA are essentially known for their unique production methods and their distinguished patterns. HCs produced by the villagers are characterized by features, such as high quality wool, bright colors, and specific traditions that are rooted in their lifestyles and customs [7]. Culturally speaking, different HCs in the EPA are based on the geographical characteristics of each area. For example, the Herris carpet, which is known as one of the most traditional HCs in the EPA, is essentially woven using wool and available local materials. Due to the availability of high-quality wool produced by several tribes in this area (e.g., Shahsovan, Arsbaran), the main design, and pattern of the HCs tended to be based on the wool, which is famous as a Herris handmade carpet.

The Tabriz handmade carpet is one of the most well-known carpets in the EPA; it is also known globally. Historically speaking, Tabriz carpet is considered one of the most famous carpets of Iran. Tabriz carpets were exported to different countries around the world from the 12th century. Tabriz weavers began considering the tastes of European buyers more than before and they made carpets that matched their interests [29]. The handmade carpet production in Tabriz was at a high point in the period from the 12th to the 16th centuries. During the 19th century, Tabriz was known as the home for some of the most celebrated carpet-weaving artisans, who carried on the tradition that was started hundreds of years earlier. Artisans in the city led the way in a renaissance of the handmade carpet production, which targeted the Iranian market, as well as that of other Asian and European countries [64]. In 2015, Tabriz was registered as the global hand-woven rug city by the World Crafts Council [65–67]. Different high quality HCs have been produced in Tabriz over the past centuries. Tabriz silk HC is one of the major HCs produced in the city and has become more popular in recent years. Tabriz is located on the “Silk Road” and, due to the long history of silk trade in its well-known Historical Bazaar (inscribed as UNESCO world Heritage site), silk HCs are mainly produced in Tabriz and its suburbs. Meanwhile the HCs in other areas, such as Herris, Marand, and Maraqgeh are produced using local material, such as wool.

In spite of such capabilities and potentialities, over the past decades, carpet production in the EPA have faced a number of serious challenges. This is due to various factors, such as lifestyle change, intensive rural-urban migration, and the increase in modern and machine-based products (e.g., machine carpet, rug, etc.). As indicated, most of the carpets used to be produced in rural areas in the EPA. However, this reduced significantly due to the migration from rural areas to large cities (e.g., Tabriz, Marageh, Marand, etc.). In addition, due to significant increase in the costs of producing handmade carpets (e.g.,
raw materials, tools, etc.), along with low income and challenges in exporting the carpets under the impacts of international sanctions, the handmade carpet production has lost its value for the younger generation. From a sociological perspective, it should be noted that increased migration from rural to urban environments results in major changes in lifestyles. As a result, most migrants lose their interest in the handmade carpet production for many reasons, such as occupation (another job), limitation of space in urban houses, etc. It is understood that these challenges have significant impacts on the handmade carpet production through, for example, reduced carpet production rates, as well as reduced popularity. These issues are obvious in the EPA, which is known as one of the main hubs of handmade carpet production, and has played a major role in the development of the decorative arts in Iran (and at the international level).

From the socio–economic perspective, HC weaving is considered a part-time occupation in Iran and its output is hardly enough to cover the household costs. Thus, most of the craftspeople are struggling with financial issues. In addition, except for social insurances (accounting for 27% of the total monthly charge), there is no other tangible social support for craftspeople in Iran. Analyzing the list of HC craftspeople in the EPA shows that about 95% of weavers gain knowledge of the HC weaving essentially in family environments and the HC workshops/units rather than having academic/vocational education. About 61% of the HC weavers are not educated or their education is limited to the elementary and secondary levels. Socially speaking, HC weaving is considered a low-level occupation. According to the results of our interview with craftspeople, about 45% to 57% of the HC weavers choose this occupation inadvertently (e.g., having no other options). Moreover, the rate of child labor in this industry is high. Historical analysis shows that HC has been known mostly as a family business and has been common in rural environments with limited access to education facilities. HC weaving also used to be one of the main self/family-based occupations. Thus, most professional weavers learned HC skills within these family/workshop units. Our investigation also shows that HC weaving in the province is dominated by female weavers. The number of males is not low. However, in rural areas and tribal environments, males often consider HC as a seasonal occupation.

From a marketing perspective, nowadays, digital marketing is an important aspect of international marketing with tangible results for sellers and customers [2]. Despite this, the lack of proper and modern sales and marketing management is one of the main weaknesses of handmade carpet marketing in the EAP. In fact, carpet weavers still seek customers using traditional techniques [63–65]. As our results pointed out, rural areas, with high levels of under-education, have the highest potential for handmade carpet production. Unfortunately, in most cases, carpet weavers are unable to use the power of digital marketing to sell their products—it is one of the major weaknesses of HC marketing that should be considered.

Results of this research also indicated that despite the considerable potentials of the EAP for the handmade carpet production, there are serious issues in terms of proper management and development of sustainable programs for HC production. Low quality of raw material (e.g., wool and dyeing material), insufficient education of weavers, lack of professional managers, authorities, and decision makers, lack of marketing knowledge, lack of digital marketing, and the impacts of international sanctions for exporting carpets are some of the main issues that threaten the production sustainability of HCs in the EPA. Our detailed results indicated that the EPA has a very high potential for the handmade carpet production that can benefit the country’s economy and help promote the culture and tradition of the country, as an intangible world heritage. It is understood that the handicrafts industry is a clean industry—considering sustainable development—particularly for developing countries, such as Iran, where environmental issues are serious [68–77]. Thus, developing reasonable policies for supporting and producing handicrafts, such as social support for craftspeople, facilities for exporting handicrafts, international marketing, and tourism development will be critical for sustainable development. Results of this research, therefore, provide important information for sustainable development. In this
context, the proposed methodology will support researchers and authorities around the world to apply an integrated GIS–MCDA-based method, and develop sustainability assessment maps towards better-informed decision making. Indeed, GIS–MCDA has proven useful for many purposes [78–83], and results of this research confirm that it can also be applied for sustainability assessment of the HC industry.

5. Conclusions and Future Research

Handcrafts are known as important products that represent societal cultures and traditions. Thus, analyzing the potential of different areas for handmade carpet production could facilitate evidence-based decision making towards sustainable development. In this research, we aimed to apply an integrated approach to assess potential and sustainability of the handmade carpet production in the EAP that is globally famous for its high-quality handmade carpets. The province is the origin of well-known and famous carpets, such as Tabriz carpets. However, the HC industry has faced a number of challenges under the impact of intensive rural–urban migration, as well as modernization and lifestyle changes. As there is a lack of academic research related to this topic, this study aimed to provide an innovative method to identify the issues and provide solutions for revival of the HC industry as an intangible heritage in the EAP. According to the results, the handmade carpet weaving in the EPA demands a significant attention of decision makers and authorities. There is a need for implementation of new policies for extending social support mechanisms to ensure livelihood security of the craftspeople. Results of this research also indicated that most craftspeople learn the HC weaving skills in their family and about 95% of craftspeople have no academic training. Thus, by considering the critical situation of the HCs in Iran, such as low income and lifestyle changes, and intensive international competition for producing HCs, organizing short/long-term workshops can be proposed as a solution to improve the quality of HCs. As indicated, the younger generation has already lost its interest in HC weaving. Based on the critical condition and the associated challenges, it is assumed that the Iranian HC production will be reduced significantly in the coming decades. Considering the significance of HCs as symbols of Iranian art and culture in the international level, it is necessary to figure out the issues and challenges and minimize their impacts on HC production. Based on this statement, the results of this research can be used by decision makers and authorities for analyzing the current situation of the HC in the EPA, and for developing appropriate plans to ensure the sustainability of the industry. In addition, other stakeholders (e.g., from the HC industry and the market) can use the results of this research to understand what suitable areas for investment are.

From the methodological perspective, we aimed to apply a GIS–MCDA-based approach for sustainability assessment of the handcraft production in the EPA. According to the results, the proposed approach allows considering the relevant criteria for enhanced handcraft production. The results are also important for introducing an efficient approach for the future research in the domain of handcraft potentiality and sustainability assessment. In this context, it should be highlighted that the proposed approach can be applied to larger scale case studies at the national and global scales. It is also worth mentioning that due to the lack of universal guidelines for selecting the relevant criteria, analysis based on expert opinions and local characteristics of the study area can be considered as an efficient technique. Due to such limitations, and others, such as data availability, in this research we only applied this method at the provincial scale. To further expand the scope of the research, future research will focus on a country-based analysis (for Iran) to also examine results and variations across different socio–economic and cultural contexts and backgrounds.

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