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Identifying and prioritizing road transport performance indicators related to regional employment using the circular intuitionistic fuzzy SWARA method

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190

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Abstract

Regional employment generation is a priority in economic policymaking, yet road transport performance indicators have received less attention. This study aims to identify and prioritize road transport performance indicators according to their perceived importance for regional employment generation from the experts' perspective; it does not estimate the causal effect of the indicators on employment. The study is applied in purpose and descriptive-analytical in approach. Ten indicators were drawn from the literature and evaluated by 14 experts in transport and regional development, selected through purposive sampling and weighted according to their expertise, experience, and place of work. Each expert independently rated each indicator on a nine-level linguistic scale, and the ratings were converted into intuitionistic fuzzy numbers. The ratings were aggregated with the intuitionistic fuzzy weighted averaging operator, and the radius of the circular intuitionistic fuzzy number was calculated to reflect the dispersion of expert opinions. The indicators were then scored, ranked, and weighted with the SWARA method. A sensitivity analysis showed that the ranks of the two highest- and the two lowest-ranked indicators do not change when the score parameter varies. The experts gave the highest priority to access to important economic centers, the volume of freight and passengers transported, and transport costs, whereas access to major markets and logistics centers and the availability of alternative and secondary roads had the lowest priority. The findings provide an expert-perception-based framework for infrastructure policy-making and regional development planning.

Keywords

Circular intuitionistic fuzzy SWARA
fuzzy multi-criteria decision-making
regional employment
road transport
road transport performance indicators

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1. Introduction

Structural transformations in the global economy, from the Industrial Revolution to the age of globalization, have shown that transport infrastructure, particularly in developing countries, is one of the most effective instruments for reducing spatial inequalities and accelerating regional development (Rodrigue et al., 2020). In Iran, road transport is the backbone of the national transport network and accounts for the dominant share of freight and passenger movement. However, this infrastructure faces several structural challenges. The geographical dispersion of the road network, inequality in the distribution of facilities across provinces, and high logistics costs have limited its economic efficiency. These challenges call for more careful analysis, especially concerning regional employment generation. Despite extensive investment in the country's road network, there is still insufficient knowledge about investment priorities among road transport performance indicators for maximizing regional employment generation. The main question of this study is "which road transport performance indicators, from experts' perspective, have the highest priority in relation to employment generation at the provincial level, and how experts prioritize these indicators."

Previous studies have mainly addressed the overall effects of transport infrastructure on economic growth, without analyzing specific performance indicators (against the mere quantity of infrastructure). For example, a study using data on national expressway construction in China showed that transport infrastructure development can moderate firm-level employment fluctuations through labor supply and demand channels (Yuan et al., 2024). Likewise, a European Parliament report on the relationship between EU cohesion policy and transport infrastructure emphasized the direct link between infrastructure investment and regional employment levels (Medeiros, 2024). In the methodology of multi-criteria decision-making, Bouraima et al. (2023) applied a hybrid spherical fuzzy SWARA approach to prioritize strategies for sustainable regional transport infrastructure and showed that this approach can systematically model experts' subjective judgments under uncertainty. However, few studies have specifically examined road transport performance indicators with a fuzzy multi-criteria decision-making approach in direct connection with regional employment generation. In Iran, existing studies are either macro-level or limited to a specific region; therefore, there is no analytical framework that can be generalized to the national level for prioritizing these indicators.

Accordingly, the present study pursues three main objectives: first, to identify the key road transport performance indicators related to regional employment generation; second, to weight and prioritize these indicators using the circular intuitionistic fuzzy SWARA method; and third, to develop an analytical framework for transport policy-making aimed at promoting regional employment at the national level. The remainder of this article first reviews the theoretical foundations and the research background, then describes the circular intuitionistic fuzzy SWARA methodology, and finally presents the findings, discussion, and conclusion.

2. Theoretical foundations

2.1. Road transport and regional development

From an operational perspective, road transport refers to the infrastructure and services that enable the movement of goods and passengers over the land road network and, by reducing transaction costs, play an intermediary role in connecting markets (Rodrigue et al., 2020). In the theoretical literature on regional development, three main frameworks explain this intermediary role. Central place theory (Christaller, 1933), which has been revisited and extended by later studies in regional science (Mulligan et al., 2012), regards accessibility as the main factor shaping the hierarchy of economic centers; the better the road access of a location to higher-order centers, the greater the likelihood that economic activities will concentrate there. The infrastructure-led growth hypothesis, emphasizing the productivity spillovers of infrastructure investment, suggests that improving the road network can reduce production costs and increase the capacity to attract private-sector investment (Calderón & Servén, 2014). Spatial justice theory, in turn, presents transport as a means of reducing inequality of access between advantaged and less advantaged regions; from this perspective, an unbalanced distribution of road infrastructure can intensify regional economic inequalities (Rodríguez-Pose, 2018).

Taken together, these three frameworks indicate that road transport not only facilitates exchange but also serves as a structural variable in shaping the spatial patterns of economic activity. The next section

redefines this point in terms of measurable performance indicators. The link between these three theoretical frameworks and the four conceptual components of the study indicators (Table 1) can be stated more explicitly. Central place theory, which emphasizes the hierarchy of access to economic centers, is the main theoretical basis of the "access and connectivity" component (indicators C2, C3, and C7); this link is also consistent with the empirical findings of Rokicki et al. (2021), who examined the role of transport accessibility and road investment in output and employment in Polish regions using a general equilibrium model. The infrastructure-led growth hypothesis, which focuses on reducing production costs through the quantitative and qualitative expansion of the road network, is the theoretical basis of the "technical and infrastructural" component (indicators C1, C5, and C8); at the country level, this mechanism has also been confirmed by Laborda and Sotelsek (2019) using multi-country panel data, although they reported a nonlinear (Kuznets-type) relationship between road density and employment, which calls for caution in interpreting this relationship linearly. Spatial justice theory, which emphasizes the balanced distribution of access among regions, is more closely linked to the "operational and traffic" and "support" components (indicators C4, C6, C9, and C10), because these indicators measure the actual quality of benefiting from infrastructure rather than its mere existence in different regions; this approach is consistent with the framework proposed by Faghihinejad et al. (2022) for assessing the link between transport access and economic outcomes in the Iranian context, as well as with the evidence of Banerjee, Duflo, and Qian (2020) on the asymmetric effects of road access on regional economic growth in China.

2.2. Road transport performance indicators

In the transport assessment literature, the distinction between a "performance indicator" and an "output indicator" is methodologically important. An output indicator merely measures the quantity of infrastructure (such as road length), whereas a performance indicator reflects the quality of that infrastructure's functioning in achieving economic objectives, such as reducing travel time or increasing safety (ITF-OECD, 2001).

Accordingly, this study classifies road transport performance indicators into four components: the technical and infrastructural component, the access and connectivity component, the operational and traffic component, and the support component. Table 1 shows this classification together with the component and source of each indicator.

Table 1. Classification of road transport performance indicators by conceptual components

No.	Code	Indicator	Component	Source
1	C1	Road density	Technical and infrastructural	Bouraima & Qiu, 2017
2	C2	Access to major markets and logistics centers	Access and connectivity	Wan et al., 2024; Polyzos & Tsiotas, 2020; Rokicki et al., 2021; Duranton & Turner, 2011
3	C3	Access to highways and transit corridors	Access and connectivity	Wan et al., 2024; Polyzos & Tsiotas, 2020; Salehian et al., 2017
4	C4	Number of road transport terminals	Support	2025; Zhang, 2024; Salehian et al., 2017
5	C5	Availability of alternative and secondary roads	Technical and infrastructural	Zhang & Cheng, 2023; Asher & Novosad, 2020; Lembhe, 2024
6	C6	Volume of freight and passengers transported	Operational and traffic	Rodrigue et al., 2020; Petrović et al., 2023; Yang et al., 2022; Salehian et al., 2017
7	C7	Access to important economic centers	Access and connectivity	Wan et al., 2024; Rosik & Wójcik, 2023; Yang et al., 2022
8	C8	Road quality and safety	Technical and infrastructural	Rosik & Wójcik, 2023; Asher & Novosad, 2020
9	C9	Travel time	Operational and traffic	Wan et al., 2024
10	C10	Transport costs	Operational and traffic	Baranidharan & Mahapatra, 2024; Montoya et al., 2021

2.3. Regional employment generation and its link with transport

Regional employment generation, unlike national-level employment, emphasizes the spatial distribution of job opportunities and reducing migration caused by regional economic imbalance; it is considered a key indicator of spatial justice in the regional development literature (Rodríguez-Pose, 2018).

Road transport affects regional employment generation through two channels. The direct channel relates to employment in roads' construction, maintenance, and operation. The indirect channel, which the literature emphasized, includes increased access to consumer markets and raw materials, reduced logistics costs, attraction of private-sector investment, formation of industrial and service clusters, and increased labor productivity (Ghani et al., 2016).

Empirical evidence supports this link in different contexts. A study based on data from national expressway construction in China showed that transport infrastructure development can moderate firm-level employment fluctuations through labor supply and demand channels (Yuan et al., 2024). At a broader scale, the European Parliament report confirmed the relationship between transport infrastructure investment and regional employment levels in EU member states (Medeiros, 2024). In the context of rural roads, a study combining an adaptive neuro-fuzzy inference system and the fuzzy Delphi technique showed that rural road construction led to increased income and improved access to services (Makrand & Singh, 2019).

2.4. Review of previous studies and the theoretical gap

Table 2 reviews 10 key domestic and international studies in this field and presents their results.

Table 2. Review of previous studies related to road transport and regional employment generation

Authors (year)	Method	Indicators examined	Key result
Salehian et al. (2017)	Fuzzy DEMATEL + ANP	Provincial road transport performance	Provinces were ranked; the performance of most provinces was rated weak
Shahraki Moghadam et al. (2020)	Quantitative-qualitative analysis	Road transit in the Sistan region	Road transit led to growth of the region's rural economy
Bouraima et al. (2023)	Spherical fuzzy SWARA	Strategies for sustainable regional transport infrastructure	Research and development and the institutional framework were identified as priorities
Yuan et al. (2024)	Multi-period difference-in-differences	Expressway construction and firm employment fluctuations	Expressway construction reduced firm employment fluctuations by about 0.9%
Makrand & Singh (2019)	ANFIS + fuzzy Delphi	Effects of rural roads	Rural road construction increased income and access to services
Rokicki et al. (2021)	Dynamic regional computable general equilibrium (CGE) model	Transport accessibility and investment in the high-speed road network of Polish regions	In regions where the private sector had a large share of road investment, dropping the investment would have caused a considerable decrease in gross output and employment; in regions with purely public financing, the effect was almost negligible
Laborda & Sotelsek (2019)	Dynamic panel regression (GMM)	Road density and share of paved roads at the country level	A nonlinear (Kuznets-type) relationship between road density and unemployment was found in low- and middle-income countries
Faghihinejad et al. (2022)	Correlation analysis framework	Transport network access and economic indicators in Iran	Better access to the transport network was correlated with economic growth and lower unemployment across Iranian cities
Banerjee, Duflo, & Qian (2020)	Difference-in-differences with panel data	Access to the highway and railway network in China	Access to the transport network produced asymmetric economic growth across regions; regions close to economic centers benefited more

The summary of previous studies shows that most studies have addressed the overall effect of transport infrastructure on economic growth without analyzing specific performance indicators. More specifically, the international studies in Table 2 (including Rokicki et al., 2021; Laborda & Sotelsek, 2019; Banerjee, Duflo, & Qian, 2020) have mostly either focused on aggregate infrastructure indicators (such as total density or investment) or reported the relationship with employment as nonlinear, context-dependent, or asymmetric across regions, rather than linear and definitive; this heterogeneity of findings reinforces the need for a multi-criteria approach based on disaggregated indicators instead of a single aggregate infrastructure indicator. In the Iranian context as well, the study by Faghihinejad et al. (2022) examined the relationship between transport accessibility and the urban economy at the macro level, but to date no study has been found that has simultaneously prioritized multiple road transport performance indicators using a fuzzy multi-criteria decision-making method. In Iran, fuzzy multi-criteria decision-making methods have also been less used for weighting road transport indicators. Using the circular intuitionistic fuzzy SWARA method, which has a high capacity for managing uncertainty and experts' subjective judgments, the present study fills this gap and provides a generalizable framework for national policy-making in transport and employment.

3. Research methodology

The present study is applied in nature and uses a descriptive-analytical approach. The general approach is based on multi-criteria decision-making using circular intuitionistic fuzzy logic. This approach allows simultaneous modelling of two types of uncertainty: hesitation in experts' judgments and the range of fluctuation of these judgments.

The study's statistical population consisted of experts in road transport, regional planning, urban economics, and infrastructure development at different levels and organizations. Sampling was purposive (judgmental) and was based on specific criteria: at least ten years of professional or research experience in the relevant field, sufficient familiarity with road transport performance indicators, and willingness to participate in the fuzzy weighting process.

The sample size was set at fourteen persons. Unlike qualitative research, which usually relies on the rule of theoretical saturation, sample size adequacy was assessed based on the literature on expert panel size in multi-criteria decision-making methods. A review of applied studies using the SWARA method and similar multi-criteria methods shows that the common range of the number of experts in this type of study varies from three to about 20, and the main concern is the fit of the experts' expertise with the research topic rather than merely the size of the sample; studies on the collection of expert judgment also show that in specialized and relatively homogeneous fields, panels of 10 to 15 persons are adequate, whereas larger panels are mostly recommended for interdisciplinary topics with greater diversity of views. Given the relatively homogeneous and relevant expertise of the members of this panel (road transport, regional planning, urban economics), the number of 14 experts falls within the range of adequacy in the literature. Table 3 shows the characteristics of the 14 participating experts and their scores on the criteria P1 (area of expertise), P2 (work experience), and P3 (place of work), the total score (Pt), and the final normalized weight (We).

Table 3. Characteristics of the participating experts (14 experts)

Expert code	P1 (expertise)	P2 (experience)	P3 (place)	Pt	We
E1	10	20	10	40	0.065
E2	10	10	15	35	0.057
E3	20	8	18	46	0.074
E4	20	11	20	51	0.083
E5	10	20	20	50	0.081
E6	15	5	5	25	0.040
E7	20	15	20	55	0.089
E8	20	14	15	49	0.079

Expert code	P1 (expertise)	P2 (experience)	P3 (place)	Pt	We
E9	10	13	15	38	0.061
E10	10	8	10	28	0.045
E11	15	12	20	47	0.076
E12	20	18	20	58	0.094
E13	15	16	15	46	0.074
E14	10	20	20	50	0.081
Total	1.000				

Based on the review of the theoretical literature presented in the previous section, ten road transport performance indicators were selected as the decision criteria of this study. These indicators are classified into four conceptual components (technical and infrastructural, access and connectivity, operational and traffic, and support). Table 4 presents the operational definition of each indicator together with its component and source.

Table 4. Comprehensive research indicators with operational definitions

Code	Indicator	Operational definition	Component	Source
C1	Road density	Ratio of road network length to the area or population of the region	Technical and infrastructural	Bouraima & Qiu, 2017
C2	Access to major markets and logistics centers	Ease and time of access to major commercial and storage centers	Access and connectivity	Wan et al., 2024; Polyzos & Tsiotas, 2020; Rokicki et al., 2021; Duranton & Turner, 2011
C3	Access to highways and transit corridors	Distance and time of access to the country's main transit axes	Access and connectivity	Wan et al., 2024; Polyzos & Tsiotas, 2020; Salehian et al., 2017
C4	Number of road transport terminals	Number of active freight and passenger terminals in the region	Support	Zhang, 2024; Salehian et al., 2017
C5	Availability of alternative and secondary roads	Number and quality of alternative routes in case of disruption on the main route	Technical and infrastructural	Zhang & Cheng, 2023; Asher & Novosad, 2020; Lembhe, 2024
C6	Volume of freight and passengers transported	Tonnage of freight and number of passengers moved in a given period	Operational and traffic	Rodrigue et al., 2020; Petrović et al., 2023; Yang et al., 2022; Salehian et al., 2017
C7	Access to important economic centers	Ease of access to industrial, mining, agricultural, and tourism centers	Access and connectivity	Wan et al., 2024; Rosik & Wójcik, 2023; Yang et al., 2022
C8	Road quality and safety	Pavement condition, signage, and road crash rates	Technical and infrastructural	Rosik & Wójcik, 2023; Asher & Novosad, 2020
C9	Travel time	Average time required to traverse the key routes of the region	Operational and traffic	Wan et al., 2024
C10	Transport costs	Average cost of moving freight and passengers in the region	Operational and traffic	Baranidharan & Mahapatra, 2024; Montoya et al., 2021

Given the apparent similarity of some of the indicators in Table 4, their conceptual boundaries should be clearly defined. Access to major markets and logistics centers (C2) refers only to the distance and time of access to commercial centers and wholesale warehouses; access to highways and transit corridors (C3) concerns the connection of the region to the national and inter-regional transport network (not to specific economic centers); and access to important economic centers (C7) covers access to production hubs (industrial, mining, agricultural, and tourism). In other words, C2 focuses on the commercial destination, C3 on inter-regional connecting infrastructure, and C7 on the productive destination; these three indicators

were derived from different bodies of research (Table 1) and were defined separately for the experts in the design of the questionnaire.

Data collection instrument

The main data collection instrument was an independent indicator-assessment questionnaire based on a fuzzy linguistic scale. In this questionnaire, the experts were asked to express the importance or intensity of the effect of each indicator on regional employment generation using nine-level linguistic terms, namely “absolutely high,” “very high,” “high,” “fairly high,” “medium,” “fairly low,” “low,” “very low,” and “absolutely low” (Table 5).

The questionnaire was designed based on the intuitionistic fuzzy multi-criteria decision-making matrix, first introduced by Atanassov (1986) and later extended in its circular version by Çakır and Taş (2023). In this framework, each linguistic term is converted into a circular intuitionistic fuzzy number with a three-component structure; the first component indicates the degree of membership, the second the degree of non-membership, and the third the degree of hesitation or uncertainty in the expert’s judgment. The sum of the first two components never exceeds one; the remaining part is the hesitation component. The main advantage of the circular version over the standard intuitionistic fuzzy form is the addition of a radius around each fuzzy number, which explicitly measures the degree of certainty or uniformity in the experts’ judgments.

The main data analysis method is circular intuitionistic fuzzy SWARA (Circular Intuitionistic Fuzzy SWARA). This method has a six-step process, which is described in order below.

Step 1: In the first step of the circular intuitionistic fuzzy SWARA multi-criteria decision-making method, a set of criteria related to the research problem must be identified and the initial decision matrix formed. In this study, given the main objective, namely identifying and prioritizing road transport performance indicators related to regional employment generation, a set of 10 key road transport indicators, based on a systematic review of the theoretical literature and credible research background, as shown in Table 4, was determined as the decision criteria (C = {C1, C2, …, C10}). Next, to evaluate the importance of these criteria, we used the opinions of 14 experts, including university professors, transport specialists, regional planners, and economic experts, selected by purposive sampling (E = {E1, E2, …, E14}). To take into account the effect of different levels of expertise and experience in the opinion aggregation process, a weight was assigned to each expert based on three criteria: expertise, work experience, and place of work. The sum of all experts’ scores was 618, and the final weight of each expert was calculated through normalization. Thus, an initial 10×14 decision matrix (10 indicators and 14 experts) was formed, where each cell represents each expert’s linguistic evaluation of an indicator based on the nine-level scale. This structure provides a suitable basis for the next step (data collection and conversion to the fuzzy intuitionistic scale).

Step 2: Scoring the experts and determining their weights. At this stage, after identifying the criteria, forming the decision matrix, and scoring by the experts, three main criteria were considered to weight the experts participating in the multi-criteria decision-making process, using the circular intuitionistic fuzzy SWARA method. The first criterion (P1) concerns the experts’ area of expertise, which receives a score between 10 and 20 depending on the fit of their field and area of activity with the research topic (such as transport and road maintenance, economics and regional development, urban and regional planning, and other related fields). The second criterion (P2) is related work experience and receives a score between 5 and 20 based on the number of years of practical or research experience in related fields. The third criterion (P3) concerns the respondent’s place of work (city/organization), which is assigned a score between 5 and 20. The sum of these three scores for each expert is calculated as the total score (Pt). Then, by normalizing these scores against the total score of all experts, the final weight (We) of each expert is obtained; these weights are determined so that their sum exactly equals 1 and are used in subsequent stages to combine the judgments in a weighted manner. This approach ensures that each expert’s contribution to the final analysis is proportional to his or her level of expertise, experience, and familiarity with the research topic. Table 3 shows the complete values.

Step 3: After collecting the questionnaires completed by the 14 experts, the data were entered into the decision matrix for use in the multi-criteria analysis process. At this stage, the experts’ qualitative and linguistic judgments, expressed on the nine-level scale, were systematically converted into circular intuitionistic fuzzy values. Using a nine-level scale

instead of a five-level scale increases the discriminating precision of the experts' judgments and enables finer distinction among the different levels of indicator importance (Çakır & Taş, 2023).

In intuitionistic fuzzy logic, unlike classical fuzzy logic, each fuzzy value is not described by a membership degree (μ) alone but includes three components:

Degree of membership (μ): indicates the degree of acceptance or belonging of an element to a concept;

Degree of non-membership (ν): indicates the degree of rejection or non-belonging of that element;

Degree of hesitation (π): obtained from the relation π = 1 − μ − ν, it expresses the degree of ambiguity, ignorance, or uncertainty in the judgment.

In this study, after collecting the experts' opinions in the form of linguistic scales, these linguistic evaluations must be converted into intuitionistic fuzzy numerical values for use in the intuitionistic fuzzy decision-making model. To convert the experts' linguistic judgments into intuitionistic fuzzy numbers, the standard conversion in Table 5 was used, which was developed based on the approach of Çakır and Taş (2023):

Table 5. Conversion of the linguistic scale to the fuzzy scale (Çakır & Taş, 2023)

Code	Definition	μ	ν	π
9	Absolutely high (AH)	0.90	0.10	0.00
8	Very high (VH)	0.80	0.15	0.05
7	High (H)	0.70	0.25	0.05
6	Medium high (MH)	0.60	0.35	0.05
5	Fair (F)	0.50	0.45	0.05
4	Medium low (ML)	0.40	0.55	0.05
3	Low (L)	0.30	0.65	0.05
2	Very low (VL)	0.20	0.75	0.05
1	Absolutely low (AL)	0.10	0.90	0.00

Next, using the fuzzy linguistic scale table, the qualitative data were converted into the corresponding intuitionistic fuzzy numbers. This conversion was carried out based on a mapping from the linguistic scale to (μ, ν) pairs. For example:

If an expert has evaluated the importance of an indicator as "High," the equivalent intuitionistic fuzzy value is (μ = 0.70, ν = 0.25). Thus, for each expert and each indicator, the linguistic value was converted into an intuitionistic fuzzy value, and a new matrix was created with numerical values that can be used for the remaining calculation steps in the CIF-SWARA method.

After converting the experts' linguistic data into intuitionistic fuzzy values, the data are organized in the form of an intuitionistic fuzzy decision matrix for multi-criteria decision analysis. In this matrix, each cell represents one expert's evaluation of one indicator and is shown as an ordered pair of intuitionistic fuzzy values. Specifically, each cell contains two values:

m: Membership degree, which expresses the tendency toward or acceptance of the importance of the indicator;

n: Non-membership degree, which expresses the degree of rejection of or opposition to the importance of that indicator.

These values, entered in Microsoft Excel, result from the direct mapping of the experts' linguistic scales to intuitionistic values. Therefore, each cell in the intuitionistic fuzzy decision matrix contains m and n such that the main intuitionistic condition holds, that is: $0 \le m + n \le 1$.

The remaining value π = 1 − m − n is known as the degree of hesitation or uncertainty. In this way, the final decision matrix containing the intuitionistic fuzzy evaluations of all indicators from the experts' perspective is formed and provides the basis for the next stages of analysis, including the aggregation of opinions and the calculation of indicator weights with the fuzzy SWARA method.

Step 4: Aggregation of the experts' opinions with the intuitionistic fuzzy weighted averaging operator (IFWA). According to Equation 1, this operator combines all experts' opinions into a single group evaluation for each indicator.

$$C_i = \mathrm{IFWA}_{W_i}\left(\langle m_{i,1}, n_{i,1}\rangle, \ldots, \langle m_{i,n}, n_{i,n}\rangle\right) = \left\langle 1 - \prod_{j=1}^{n}\left(1 - m_{i,j}\right)^{w_{i,j}}, \prod_{j=1}^{n} {n_{i,j}}^{w_{i,j}} \right\rangle \quad (1)$$

$$W_i = \{w_{i,1}, \ldots, w_{i,n}\},\ w_{i,j} \in [0,1],\ \sum_{j=1}^{n} w_{i,j} = 1$$

In this equation, W_i is the set of expert weights for the i-th indicator ($w_{i,j}$ is the final weight of the j-th expert, that is, We in Table 3); each weight is a number between zero and one, and the sum of all weights equals one (adapted from Xu, 2007; Çakır & Taş, 2023).

Step 5: After aggregating the experts' evaluations with the IFWA operator, each indicator is represented as a circular intuitionistic fuzzy number whose structure is defined as the triple Aj = (m_j, n_j, r_j). In this triple, m_j is the aggregated degree of membership, n_j is the aggregated degree of non-membership, and r_j is the radius of the circular intuitionistic fuzzy number of the j-th indicator. To compare and prioritize the indicators, the classical intuitionistic fuzzy score function is first used, defined as SIF(m, n) = m − n. This value indicates the net tendency toward the indicator in question; that is, if it is positive, the evaluation favors a high importance of the indicator, and if it is negative, it indicates a tendency toward the indicator's low importance. The closer this value is to 1, the more definitive and positive the preference.

In addition, for a more precise analysis of the degree of certainty or confidence in the experts' evaluations, the radius in circular intuitionistic fuzzy logic is used, which is calculated based on the distance of the experts' evaluations from the aggregated point. The radius is obtained using Equation 2:

$$R_i = \max_{1 \le j \le k_i} \sqrt{\left(u_C(C_i) - m_{i,j}\right)^2 + \left(v_C(C_i) - n_{i,j}\right)^2} \quad (2)$$

(Çakır & Taş, 2023; Wang, 2025)

where:

- $uC(C_i)$: the aggregated degree of membership of indicator C_i (for example, obtained by the arithmetic or weighted mean);
- $vC(C_i)$: the aggregated degree of non-membership of indicator C_i;
- $m_{i,j}$: the membership value of the j-th expert for indicator C_i;
- $n_{i,j}$: the non-membership value of the j-th expert for the same indicator;
- k_i: the total number of experts (14 in this study).

If r_j is large, it indicates greater decisiveness in evaluating the indicator (whether confirming or rejecting its importance); whereas if rj is close to zero, it implies hesitation or strong fluctuation in the experts' opinions. This property of the radius becomes particularly important in decision-making environments with high uncertainty.

For defuzzification and calculation of the final score (Score), Equation 3 was used (Çakır & Taş, 2023; Wang, 2025):

$$S_{\mathrm{CIF}}(C_i) = \lambda S_{\mathrm{IF}}\left(u_C + \frac{r}{\sqrt{2}}, v_C - \frac{r}{\sqrt{2}}\right) + (1-\lambda) S_{\mathrm{IF}}\left(u_C - \frac{r}{\sqrt{2}}, v_C + \frac{r}{\sqrt{2}}\right) \quad (3)$$

$$= (u_C - v_C) + \sqrt{2} r (2\lambda - 1)$$

The defuzzified value lies in the interval [-1, 1]. Compared with classical methods, this formula is more flexible. At the same time, it accounts for the degree of ambiguity, making it very suitable for decision-making analyses under uncertainty.

In this equation, the parameter λ was set equal to 0.5 to balance the influence of membership and non-membership and weight the fuzzy components in a balanced way. This choice of λ aligns with common practice in the literature on circular intuitionistic fuzzy logic and, conceptually, means reducing the effect of non-membership in proportion to the decision-making system's risk-taking.

To examine the stability of the results with respect to the choice of λ, the final scores of the indicators were recalculated, using the aggregated μ and ν values reported in Table 6 and the radius values reported in Table 7, for alternative values of λ equal to 0.3, 0.4, 0.6, and 0.7 (alongside the baseline value of 0.5). The results show that the ranks of the two top indicators, C7 and C6, and the two least important indicators, C2 and C5, remain unchanged across all values of λ. The only shifts are limited to the middle ranks: for λ below 0.5, indicator C3 slightly surpasses C10, and this order is reversed for λ above 0.5; a similar pattern is also observed between C1 and C4. This finding shows that

the main result of the study (the superiority of C7 and C6, and the low importance of C2 and C5) is stable with respect to the choice of λ, although the exact order of the middle indicators is somewhat sensitive to this parameter. This sensitivity analysis was carried out by reconstructing the scoring function from the data published in Tables 6 and 7 of this study and required no additional data or calculation.

Step 6: Ranking and final weighting of the indicators. In this final step, the indicators are sorted in descending order of final score, and in the case of near-equal scores, the radius is used as a secondary tie-breaking criterion. Then, for each indicator, the difference in importance relative to the preceding indicator (S_j, equal to the difference between the final scores of two consecutive indicators; $S_1 = 0$), the adjusted importance coefficient (K_j), and the preliminary weight (Q_j) are calculated according to Equation 4, and finally the final weight of each indicator (w_j) is obtained from Equation 5 (Stanujkic et al., 2015).

$$K_j = S_j + 1, \quad Q_j = \frac{Q_{j-1}}{K_j}, \quad K_1 = Q_1 = 1 \qquad (4)$$

$$w_j = \frac{Q_j}{\sum Q_j} \qquad (5)$$

Data analysis in all of the above steps was carried out using Microsoft Excel.

The study's content validity was ensured in two ways: first, by extracting the research indicators from a rich and credible theoretical background in the field of transport and regional economics; second, by the final confirmation of the list of indicators by the participating experts before the start of the weighting process.

The study's reliability is ensured through full replicability of the method; all mathematical relations and computational steps are presented transparently. Regarding the relative convergence of the final weights (0.07 to 0.14), three methodological explanations are given: first, the gradual division mechanism in the SWARA algorithm (Kj = Sj + 1 and Qj = Qj−1/Kj) inherently brings the weights closer together; second, with 10 indicators and a total weight of one, the inherent average of each indicator is 0.10, and the distance from this average, rather than the absolute values, is the distinguishing feature; third, all indicators are related to a single, unified subject (regional employment), and convergence is epistemologically defensible (Stević et al., 2022).

3.1. Methodology process

Figure 1 visually summarizes the six steps of the circular intuitionistic fuzzy SWARA method, from identifying criteria to the final prioritization of indicators.

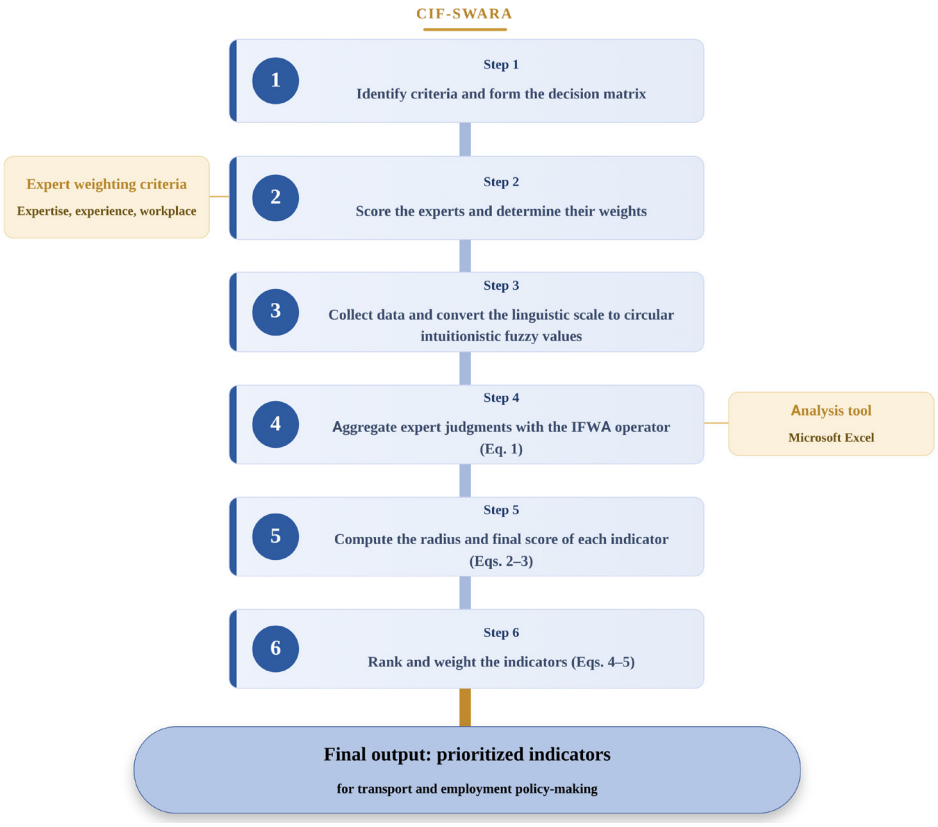


Figure 1. Research method process: circular intuitionistic fuzzy SWARA

4. Findings

This section presents the research findings in four successive steps: first, aggregation of the experts' opinions with the IFWA operator; second, calculation of the radius, uncertainty, and final score of each indicator; third, ranking of the indicators; and fourth, final weighting and analysis of the relative importance of the indicators.

4.1. Aggregation of expert opinions with the IFWA operator

Table 6 shows the aggregated intuitionistic fuzzy values of the road transport indicators related to regional employment generation, calculated with the IFWA operator according to Equation 1. In this table, μ denotes the degree of membership (the experts' degree of agreement with the indicator's importance) and ν the degree of non-membership (the degree of disagreement).

Table 6. Aggregated intuitionistic fuzzy values of road transport indicators related to regional employment generation

Indicator	μ	ν
C1	0.56	0.39
C2	0.48	0.47
C3	0.66	0.29
C4	0.56	0.39
C5	0.45	0.50
C6	0.76	0.20
C7	0.84	0.14
C8	0.65	0.30
C9	0.55	0.40
C10	0.66	0.29

The results show that the highest degree of membership belongs to access to important economic centers (C7), with a value of 0.84, which also has the lowest degree of non-membership (0.14) among the indicators. This combination indicates that the experts evaluated this indicator as the highest priority for regional employment generation, with the highest agreement. In contrast, the availability of alternative and secondary roads (C5), with a degree of membership of 0.45 and a degree of non-membership of 0.50, received the lowest level of expert agreement. This pattern is consistent with the theoretical foundations presented in the previous section: indicators that directly facilitate access to economic activity (such as C7), compared with indicators that merely support the network (such as C5), have, from the experts' perspective, a higher priority in relation to employment generation (Mulligan et al., 2012). This finding directly answers the main research question, since it shows that experts' priority is shaped not by the quantity of infrastructure but by the quality of economic access.

4.2. Calculation of radius, uncertainty, and final score

Table 7 shows the radius (R), the uncertainty parameter (π), and the final score (Score) of each indicator, calculated according to Equations 2 and 3. The radius measures each indicator's distance from the ideal point, and the final score, the difference between the degrees of membership and non-membership, determines each indicator's relative importance.

Table 7. Radius, uncertainty, and final score of road transport indicators related to employment generation

Indicator	R	π	Score
C1	0.36	0.05	+0.16
C2	0.26	0.05	+0.01
C3	0.22	0.05	+0.37

Indicator	R	π	Score
C4	0.22	0.05	+0.16
C5	0.21	0.05	-0.06
C6	0.22	0.04	+0.57
C7	0.18	0.02	+0.70
C8	0.21	0.05	+0.35
C9	0.21	0.05	+0.15
C10	0.23	0.05	+0.37

The findings show that the radius ranges from 0.18 for access to important economic centers (C7) to 0.36 for road density (C1). According to Equation 2, a larger radius indicates greater decisiveness in the experts' judgment (whether confirming or rejecting the indicator's importance), whereas a smaller radius indicates greater hesitation or fluctuation in their opinions. On this basis, the relatively small radius of C7 (0.18) indicates that the experts' judgment on this indicator was less decisive than for indicators such as C1 (0.36); nevertheless, since the final score of C7 (+0.70) is clearly higher than that of the other indicators, this difference in the decisiveness of judgment does not affect its first rank. The radius is used as a secondary tie-breaking criterion only where the final scores of two indicators are equal (such as C10 and C3, or C1 and C4; Table 8), and in these cases, in accordance with the definition in Equation 2, the indicator with the larger radius (that is, greater decisiveness) obtained the higher rank. These results align with evidence showing that, compared with network redundancy, access to economic centers has a more direct relationship with investment attraction and labor demand (Yuan et al., 2024).

4.3 Ranking of the indicators

Table 8 shows the final ranking of the indicators on the basis of the score values. The indicators are sorted in descending order of score, and in the case of near-equal scores, the radius is used as a secondary tie-breaking criterion.

Table 8. Priority analysis of road transport indicators related to regional employment generation

Indicator (sorted)	Rank	S_j	K_j	Q_j
C7	1	0.00	1.00	1.00
C6	2	0.13	1.13	0.88
C10	3	0.19	1.19	0.74
C3	4	0.01	1.01	0.74
C8	5	0.02	1.02	0.72
C1	6	0.18	1.18	0.61
C4	7	0.00	1.00	0.61
C9	8	0.02	1.02	0.60
C2	9	0.13	1.13	0.53
C5	10	0.07	1.07	0.50

The ranking results show that access to important economic centers (C7), ranked first; the volume of freight and passengers transported (C6), ranked second; and transport costs (C10), ranked third, achieved the highest positions in the final prioritization. In contrast, the availability of alternative and secondary roads (C5), ranked tenth, has the lowest position. This ranking pattern clearly answers the main research question: indicators focused on economic access and the actual movement of freight and passengers, compared with purely structural indicators, have a higher position in the experts' prioritization.

4.4. Final weighting and analysis of the importance of the indicators

Table 9 presents the final weight of each indicator, calculated from Equation 5, in two formats: first by order of importance (descending), and second by indicator code; the two formats are identical in terms of weight values and differ only in arrangement.

Table 9. Final weighting of road transport indicators related to regional employment generation

Indicator (by importance)	W_j	Indicator (by code)	W_j
C7	0.14	C1	0.09
C6	0.13	C2	0.08
C10	0.11	C3	0.11
C3	0.11	C4	0.09
C8	0.10	C5	0.07
C1	0.09	C6	0.13
C4	0.09	C7	0.14
C9	0.09	C8	0.10
C2	0.08	C9	0.09
C5	0.07	C10	0.11
Total	1.00	Total	1.00

The findings show that access to important economic centers (weight 0.14), the volume of freight and passengers transported (weight 0.13), and road quality and safety (weight 0.10), from the experts' perspective, have the highest priority in the model because of their direct relationship with employment and trade, whereas the availability of alternative and secondary roads (weight 0.07) and access to major markets and logistics centers (weight 0.08), because of their complementary role and greater dependence on the specific conditions of each region, obtained relatively lower weights. This weighting pattern, which focuses on indicators with diverse economic capacities, can provide a basis for targeted national-level policy-making.

4.5. Analysis of priority indicators

According to Table 9, the top five indicators in terms of final weight are access to important economic centers (C7), the volume of freight and passengers transported (C6), transport costs (C10), access to highways and transit corridors (C3), and road quality and safety (C8). The role of each indicator in regional employment generation is described below.

Access to important economic centers (C7): this indicator has the highest weight in the model. Its mechanism of influence operates by reducing the cost and time of firms' access to industrial, mining, agricultural, and tourism centers; better access facilitates the attraction of private-sector investment and increases labor demand in production and service activities. In provinces with industrial, agricultural, tourism, or transit capacities, this indicator is of higher importance, because economic firms in these regions depend more on stable access to markets and raw materials (Ghani et al., 2016).

Volume of freight and passengers transported (C6): this indicator shows the actual use of road infrastructure, not merely its potential capacity. A high volume of freight movement is a sign of the region's economic dynamism. However, a one-directional causal inference about this indicator should be avoided: the volume of freight and passenger movement, in addition to being related to employment in transport, warehousing, and distribution, may itself be a consequence of the region's economic dynamism. Accordingly, in the present study, this relationship is interpreted within the framework of the perceived importance of this indicator from the experts' perspective and its relationship with regional employment generation, not as a definitive causal relationship. Empirical evidence shows that infrastructure development proportionate to actual traffic volume moderates firm-level employment fluctuations (Yuan et al., 2024).

Transport costs (C10): this indicator measures the final

delivered cost of moving goods and labor and directly affects the competitiveness of regional firms. Reducing this cost increases firms' profit margins and strengthens their capacity to expand activity and create new jobs. In regions with industrial or agricultural potential, where a large share of the final cost of the product is allocated to transport, this indicator is of particular importance.

Road quality and safety (C8): this indicator affects employment through two channels: first, the reduction of costs arising from accidents and injuries, which impose a considerable financial burden on the regional economy; and second, the increase in firms' confidence to invest in the long term in regions with safer infrastructure. According to World Bank estimates, the economic cost of road crashes in low- and middle-income countries is equivalent to two to six percent of gross domestic product, which shows the importance of this indicator beyond the mere field of safety (World Bank, 2024).

Access to highways and transit corridors (C3): this indicator connects regional firms to the national and inter-regional transport network and allows them to participate in broader supply chains. Its mechanism of influence operates by reducing the travel time of goods to distant markets and increasing the region's attractiveness for locating transit-dependent industries (Bouraima et al., 2023).

4.6. Analysis of low-priority indicators

In contrast to the five top indicators, two indicators, access to major markets and logistics centers (C2) and the availability of alternative and secondary roads (C5), obtained the lowest weights in the model. The relatively lower importance of these two indicators from the experts' perspective can be attributed to two main reasons: first, their effect on employment generation is mainly indirect and dependent on the specific conditions of each region, rather than a general and uniform effect at the national level; second, the role of these indicators is more complementary to the main indicators (such as access to economic centers) than an independent driver of employment. Nevertheless, under specific conditions, such as regions with an extensive secondary road network or regions whose economic activity is largely concentrated on logistics centers, these two indicators can become more important. This finding contributes to smarter policy-making: the allocation of limited infrastructure resources should, in the first stage, focus on indicators with a direct and broader effect (such as C7, C6, and C8), and investment in complementary indicators such as C2 and C5 can be planned in a targeted manner in line with the economic characteristics of each region.

The findings of this section can be summarized in three sentences: first, access to important economic centers (C7), with a weight of 0.14, the volume of freight and passengers transported (C6), with a weight of 0.13, and transport costs (C10) and access to highways (C3), with a weight of 0.11, have, from the experts' perspective, the highest priority in relation to regional employment generation. Second, the results clearly show that access and actual movement indicators, compared with purely infrastructural indicators such as the number of terminals and the availability of alternative roads, enjoy a higher priority in the experts' view. Third, this prioritization pattern can be one of the decision-making inputs for the allocation of infrastructure resources at the national and regional levels, so that future investments, alongside the current status, the performance gap, and the cost of improving each indicator, focus on the indicators with the highest perceived priority in relation to regional employment generation.

5. Conclusion

The results show that, among road transport performance indicators, indicators directly related to economic access and the actual movement of goods and labor have far greater importance in regional employment generation than purely structural indicators. Access to important economic centers, the volume of freight and passengers transported, transport costs, access to highways and transit corridors, and road quality and safety, taken together, draw a clear picture of the experts' perceived priorities regarding the relationship between road transport and regional employment generation: from the perspective of the participating experts, reducing the cost and time of access to economic activity, rather than the mere existence of infrastructure, is regarded as the most important priority for employment generation.

The economic mechanism of these priorities, namely reduced transaction costs, the actual dynamism of the regional economy, and firms' confidence to invest in the long term, was analyzed in detail in the Findings section.

Main achievement and scientific contribution of the study: beyond the numerical ranking of indicators, the

main achievement of this study can be identified at two levels. First, methodologically, this study applies, for the first time, the circular intuitionistic fuzzy SWARA method, which, by adding the radius component, allows measuring the uncertainty of experts' judgments explicitly, in the field of evaluating transport indicators and regional employment in Iran; this approach, unlike previous aggregate ranking methods (such as fuzzy DEMATEL or ANP), made it possible to discover heterogeneity of priorities among individual indicators. Second, in terms of content, the main contribution of the study is the explicit distinction between two categories of indicators that are usually lumped together in the domestic literature: "actual access and movement" indicators versus "purely infrastructural" indicators; this distinction, supported in the Findings and Discussion sections by empirical evidence and comparison with the international literature, provides a conceptual framework for future research in other regions of Iran.

Limits of inference: alongside these achievements, it must be stated explicitly that what this study measures is the perceived priority of experts, not a causal effect measured on actual employment data; therefore, the results should be used as an input for policy decision-making alongside complementary quantitative evidence, not as a substitute for it. Details of the methodological limitations and the scope of generalizability of the results are presented in the "Limitations of the study" section.

Overall, the study's most important analytical message is the distinction between access and movement indicators on the one hand and purely infrastructural indicators on the other. This distinction has direct implications for prioritizing future investments: quantitatively expanding the road network alone does not guarantee employment growth; from the experts' perspective, improving the quality of access to existing economic opportunities more strongly promotes employment generation.

The main question of this study was which road transport performance indicators, from the experts' perspective, have the highest priority in relation to employment generation at the provincial level, and how these indicators are prioritized based on expert opinion. The findings answer this question clearly: access to important economic centers (C7), with a weight of 0.14, the volume of freight and passengers transported (C6), with a weight of 0.13, and transport costs (C10) and access to highways (C3), with a weight of 0.11, respectively have the highest priority from the experts' perspective in relation to regional employment generation, whereas purely infrastructural indicators such as the availability of alternative roads (C5), with a weight of 0.07, are placed at a lower priority.

The findings confirmed the research hypothesis that experts' subjective perceptions and preference structures, using the circular intuitionistic fuzzy SWARA method, can yield an accurate and reliable prioritization of road transport performance indicators. Despite the inherent uncertainty of human judgments, the method could provide a coherent, interpretable prioritization of the indicators consistent with the study's theoretical foundations.

The findings of this study, in some respects, aligned with previous studies. The main alignment is seen with studies that regard access to economic centers, beyond the mere quantity of infrastructure, as the determining factor of regional development; for example, the findings of Wan et al. (2024) and the literature review of Rosik and Wójcik (2023) both emphasize that the broader economic effects of transport, such as investment attraction and the formation of economic clusters, depend on the quality of access, not merely on the existence of infrastructure. This alignment strengthens the external validity of the findings of the present study.

In contrast, this study differs from studies that mainly addressed the overall assessment of transport infrastructure performance without distinguishing performance indicators, such as the study by Salehian et al. (2017), which used fuzzy DEMATEL and the analytic network process to produce an overall ranking of provincial transport performance without directly analyzing the employment consequence. This distinction shows that the present study has stepped beyond general infrastructure assessment by targeting the direct relationship between specific indicators and regional employment generation.

Methodologically as well, the use of circular intuitionistic fuzzy SWARA has a clear advantage over more traditional methods such as the analytic hierarchy process or fuzzy DEMATEL: by adding the radius component to the standard intuitionistic fuzzy structure, this method enables the explicit measurement of the degree of certainty or dispersion of experts' judgments, a feature that is usually not covered in conventional weighting methods, such as those used in previous domestic studies.

Beyond recording this alignment and distinction, the more important question is why these patterns occur. The alignment with Wan et al. (2024) and Rosik and

Wójcik (2023) can be attributed to the fact that the economic mechanism underlying this finding, reducing transaction costs through access rather than the mere physical existence of a road, is a general mechanism independent of the specific institutional context; for this reason it appears similarly in very different economies (Eastern Europe, China, Iran). However, the direction of this alignment is not the same: the finding of the present study is a strong and explicit perceived priority on the part of experts, whereas Rokicki et al. (2021) in Poland, using a general equilibrium model and actual investment data, showed that the effect of road investment on regional output and employment depends on the financing context and was almost negligible in regions with purely public financing. This gap between "what experts consider important" and "what macro data show" can stem from several sources: first, experts' perception usually also includes qualitative and institutional channels (such as investor confidence or the ease of firm location decisions) that are hard to measure in econometric models based on official data; second, Iran's institutional context, with its limits on public investment and the unbalanced distribution of infrastructure among provinces, may make the relative importance of access more prominent than in the EU context (with targeted convergence investment). The distinction of the present study from the study by Salehian et al. (2017) is also not only a matter of method but is rooted in the level of analysis: aggregate ranking approaches such as fuzzy DEMATEL and ANP summarize performance in a composite indicator and inevitably blur the heterogeneous effects of individual indicators through averaging; in contrast, decomposing performance into ten separate indicators and linking each to a single outcome (employment generation) made it possible to discover this heterogeneity, which remains hidden in composite studies. Likewise, the nonlinear (Kuznets) relationship Laborda and Sotelsek (2019) found between road density and unemployment at the cross-country level is consistent with this study's finding on the relatively low importance of purely infrastructural indicators (C1, C5), but confirms it from a complementary angle. If Iran is on the descending part of this curve (after passing the minimum infrastructure threshold), purely quantitative road expansion is expected to have diminishing returns, and this is exactly what the experts expressed in the form of a lower priority for purely infrastructural indicators.

5.1. Limitations of the study

This study had limitations whose clarification helps in the correct interpretation of the results. First, the sample size of experts (14 persons) is within the standard range of similar studies; nevertheless, the results still depend on subjective judgments, which the circular intuitionistic fuzzy SWARA method has largely managed through explicit modeling of uncertainty.

Second, although the research approach was designed for the national level, generalizing the results to all provinces should be done with caution; the economic and infrastructural diversity of different provinces can change the relative weight of some indicators under specific local conditions. Third, limited access to secondary quantitative data (such as official sectoral employment statistics or the actual volume of freight moved) has restricted fuller validation of the fuzzy findings; the use of such data in future research is recommended.

Finally, the cross-sectional nature of this study does not allow examination of the indicators' dynamics over time. The relative importance of the indicators may change over time due to macroeconomic conditions or the country's infrastructure policies; therefore, future studies with a longitudinal design can contribute to a better understanding of this dynamic.

5.2. Final summary and overall policy recommendation

This study showed that prioritizing road transport performance indicators using the circular intuitionistic fuzzy SWARA method can provide a valid and reliable tool for transport and employment policy-making at the national level. Indicators related to economic access and actual movement, rather than the mere quantitative expansion of infrastructure, received the highest priority among road transport performance indicators for regional employment generation, from the perspective of the participating experts. Accordingly, this study recommends that policymakers, as a first step, allocate limited infrastructure resources to improving the quality of access to existing economic centers, and pursue road network expansion at a later stage and in proportion to each region's economic capacity.

5.3. Operational framework for classifying provinces by type of economic activity

The final weights in Table 9 were calculated at the

national level and, for this reason, suggest a uniform priority for all provinces, regardless of differences in their economic structure. To turn this national prioritization into a tool usable at the provincial level, the following framework is proposed: provinces are classified, based on the dominant share of their economic activity (according to the Statistical Centre of Iran), into three groups: (a) provinces dominated by industrial and mining activity, in which access to important economic centers (C7), volume of freight and passengers transported (C6), and transport costs (C10) are expected to have higher relative importance than the national average; (b) provinces dominated by agricultural activity, in which access to major markets and logistics centers (C2) and the availability of alternative and secondary roads (C5), indicators that obtained the lowest weights in the national ranking, may become relatively more important than the national average because of the dispersed and seasonal nature of agricultural production; and (c) provinces dominated by tourism services, in which road quality and safety (C8) and travel time (C9) become more important compared with the national average. For each group, it is suggested that the national weights of Table 9 be retained as the starting point and adjusted to each province's economic priorities only through a relative adjustment coefficient (for example, a 20 to 30 percent increase in the weight of indicators related to each group and a proportional decrease in the weight of the other indicators so that the total remains equal to one). This framework provides only a conceptual orientation for turning national results into a provincial policy-making tool, and its exact coefficients should be estimated and validated in future research by collecting provincial-level data.

Authors' Contributions

Atefeh Parandavar (first author): 40%; Khalil Hajipour (corresponding author): 35%; Hassan Izady (third author): 25%.

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Conflict of Interest

The authors declare no conflict of interest in conducting this research.

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