

# Research Article

# An Analysis of Factors Influencing Accidents outside Urban Areas in Sistan and Baluchestan Province

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Road accidents have become one of the most controversial issues in the field of transportation due to heavy human and financial costs to families and countries. For this reason, analyzing the effective factors in increasing this type of accident is highly significant. The present study aimed to identify the factors affecting the occurrence and increase of road accidents in the Sistan and Baluchestan province. In this descriptive study, the factors affecting road accidents in Sistan and Baluchestan province were classified into human factors, vehicle status, road status, and environmental factors after studying and interviewing experts familiar with the subject. In this study, the pairwise comparison questionnaire and network analysis process technique were used to collect data and rank its criteria and indicators. In addition, 30 people were selected as the sample size related to the specialists and experts. The findings indicated, human factors are the most significant factor in increasing road accidents in Sistan and Baluchestan province, while vehicle status, road status, and environment were in the second to fourth ranks, respectively. Furthermore, decision-making was in the first rank, while the ability of sight and hearing power, haste, high speed, as well as tire wear and air were in the next rank.

### 1. Introduction

Today, transportation has become one of the main characteristics of the economy and development of any country [1] and one of the main challenges facing metropolises due to population growth and the complexity of human societies [2, 3]. The inefficiency of this system disrupts the functioning of the city and negative social, environmental, and economic consequences that can affect the economies of countries in the macro dimension [4, 5]. In addition, road safety has become one of the most significant issues with the daily increase of vehicles [6], so about 518-billion \$ is imposed on countries annually around the world due to accidents [7, 8]. Statistics indicate that developing countries bear a higher share of road casualties than developed countries more than 960,000 people die annually due to road accidents in the developing countries [9]. Even the number of people killed in road accidents in Benghazi in 2011 was more than the number of those killed in the war in the same year [10]. Based on the World Health Organization (WHO) studies, road accidents in 2020 are ranked third among the 10 main factors of death in the world, while this factor was ranked ninth in 1990. A large number of road accidents and their effects on the society justify the importance of analyzing the factors affecting the creation and increase of road accidents. Because of the financial and life losses caused by road accidents have a direct impact on the social and economic environment of countries [6].

Nowadays, in Iran as a developing country, road accidents are increasing and traffic accidents in Iran are the second leading cause of death, and more than a third of hospital beds are allocated to the victims of such accidents [11, 12]. Statistics of the Forensic Medicine Organization in 2018 indicated that 16,400 people died and 367,451 were injured in the road accidents, while these figures were lower in 2017 (16,171 deaths and 335,995 injured). These findings indicated a 1.4% increase in fatalities leading to death in road accidents and a 9.4% increase in the number of injured. Road casualties to the population in Iran are 0.02%, which is about five times the ratio of road casualties to the population in the European Union, which is 0.004%. The presence of 100,000 disabled people and 300,000 injured people in Iran is a shocking number. The Ministry of Interior of Iran estimates that the damages caused by road accidents are more than 9,000-billion per year, which is 4% of the GDP. Therefore, the increase in road accidents in Iran has caused a lot of financial losses to families and the government. Since that financial, life, mental, and potential damages are irreparable in some cases, it is necessary to investigate the main factors of these accidents to prevent the damages of these accidents. In this statistic, Sistan and Baluchestan province had 986 deaths and 7,794 injured [13]. Since road accidents are one of the most controversial issues in the transportation field due to high human and financial costs on the families and countries, especially Iran, investigating the approaches to increase road safety has become one of the most significant issues in Iran.

However, the study of factors affecting road accidents is still rare [4], largely due to the lack of accident data. Therefore, it is vital to study the characteristics of road accidents and explore the most significant factors that affect accidents. Since the main reasons for the high number of accidents and related damages in Sistan and Baluchistan province are not known, the present study aimed to examine the most important causes of road accidents in Sistan and Baluchestan province and provide some solutions to increase safety in the field of road transport in this province several road accidents by observing these strategies. Therefore, this study aims to answer the following questions:

- (i) What are the most significant factors in the occurrence of road accidents in Sistan and Baluchestan province?
- (ii) What is the prioritization of the factors affecting the occurrence of road accidents in Sistan and Baluchestan province?
- (iii) What is the weight of each effective factor and component related to the occurrence of road accidents in Sistan and Baluchestan province?
- (iv) What are the solutions related to road accident reduction in Sistan and Baluchestan province?

1.1. Related Works. The problem of road accidents has a long history so the accident of a vehicle with an electric engine in 1902, as well as the overtaking of a person by a mechanical vehicle in 1903 [14], are some examples of this event over history. There are some examples of this event throughout history. Here is a review of studies related to the factors affecting road accidents.

Effati et al. [15] analyzed the severity of accidents on twolane intercity roads, and considered vehicle technical defects, noncompliance with safety standards in vehicle design, and the use of old vehicles as the most significant factors affecting the severity of accidents on the old Qazvin-Rasht axis. Kamyabi and Sayyed ali pour [16] evaluated road accidents

in different weather conditions on the roads of Semnan province. By evaluating the accidents on the main axes of Semnan in terms of climatic conditions, clear and sunny weather, making the road more crowded was considered as the main cause of increased accidents on these roads. As a result, high heat leads to driver fatigue, and eventually the overturning of vehicles. Vakilaroaya and Zargar [17] stated that fatigue as one of the human factors, which ultimately leads to a decrease in efficiency, especially in the dark, is one of the causes of accidents. Further, human factors had the largest share in road accidents, and the proposed safety programs should focus on this issue. Modarresi [18] studied the effect of the human factor, vehicle, and variables related to road accidents and casualties and stated that the issues such as overtaking and speeding, left turn, and disregard for the right of way are the indicators of the human factor. In addition, vehicle tire wear and noncompliance with standards by the automaker as the indicators of vehicle factor are the effective factors in road accidents on the Ardabil-Moghan axis. Moslem et al. [19] identified the factors affecting traffic accidents using data mining. The results of this study on the Tehran-Qom freeway indicated that in the proposed model, the type of collision, sight barriers, accident location, road conditions, and accident geometry are the most significant factors in accidents.

Amirifar et al. [20] studied the factors affecting road accidents in Isfahan and considered human mistakes as the most critical factor among human mistakes, technical defects of the vehicle, road and movement defects, and natural and environmental factors. Concerning these cases, the strategies such as transportation safety training to change the behavior of users, monitoring the condition of roads, building standard vehicles, and having accuracy in road construction to reduce accidents and losses. Elvik et al. [21] analyzed the factors affecting bridge accidents in Norway during 2010-2016 and recorded 1,368 road accidents by surveying 6,824 bridges in Norway. In these documents, 90% of the bridges had no record of traffic accidents. In this study, daily traffic volume was the most significant cause of accidents. Based on studies, this factor is the most essential (approximately 72%) of accidents on these bridges. In addition, the results indicated that longer bridges are safer than shorter bridges and new bridges are safer than older ones. Zeng et al. [22] analyzed the severity of accidents on freeways using the Bayesian spatial generalized ordered logit model. The results of this research showed that factors such as driver, season, the volume of traffic, the response time of emergency medical centers, vehicle type, season, time of day, weather condition, road type, and accident type have a significant impact on the severity of the accident. It was also suggested to implement measures related to driver training, the implementation of traffic laws, vehicle and road engineering, and emergency services to reduce the severity of freeway accidents.

Eboli et al. [6] evaluated the factors affecting the severity of road accidents and classified the factors into three categories of road, environmental, and driver. The results of this study indicated that road-related factors are the most significant factors. In addition, environmental factors have a

greater effect on accidents with fewer financial and human losses, while human factors have a significant effect on the probability of collision in serious accidents. Fernandez et al. [23] prioritized the factors affecting road accidents using hierarchical analysis. The results of this study showed that unfamiliarity with traffic signs and rules and driving, driver misbehavior, driver physical and emotional condition, driver education and intelligence and senses, trainings related to traffic signs, and rules are the most significant factor and driver misbehavior is the least significant factor. Zhao et al. [8] investigated the factors that affect the severity of injuries of nonmotor vehicle occupants in an accident with motor vehicles. In this research factors such as human characteristics, vehicles, road characteristics, and environmental conditions were identified. He stated that human factors were recognized as an important factor affecting accidents, and it was suggested to give proper training to drivers, especially older drivers in rural areas. In addition, road conditions are important in increasing the severity of injuries in accidents, and it was suggested to improve transportation infrastructure such as roadside guards and improve the light conditions at night. Also, separating the traffic lanes of heavy vehicles from other vehicles using guard rails has been effective in reducing the number of injuries and it was suggested to have standard rules for collecting information and data related to accidents and training the police force to reduce this type of accident. Table 1 shows the factors affecting the occurrence of road accidents according to the research background.

Based on the research background, some factors are equally effective in all studies, while their effect varies according to the studied location. Traffic accidents are the second leading cause of death in Iran also, more than a third of hospital beds are allocated to the victims of such accidents, and statistics of the Forensic Medicine Organization in 2018 indicated that 16,400 people died and 367,451 were injured on the road accidents, while these figures were lower in 2017 (16,171 deaths and 335,995 injured). In addition, since in most intercity roads of Sistan and Baluchestan province, illegal fuel transfer has been made, leading to increased speed on the intercity roads of this province, therefore the results of other studies cannot be generalized to this province. So, evaluating, identifying, and prioritizing the factors affecting the creation and increase of road accidents in Sistan and Baluchestan province, as well as providing solutions to reduce such accidents are of great importance. Therefore, to identify the factors affecting the creation and increase of road accidents in Sistan and Baluchestan province and to design the research model, research literature was studied and interviews with experts, drivers, and passengers were conducted. Figure 1 shows the research conceptual model based on the background of research and interviews with people. This model shows the most important factors affecting road accidents.

1.2. Research Steps. According to the purpose of the current research, the research process has been carried out as follows:

(i) In the first stage, to identify and classify the factors and indicators related to the factors affecting the increase in road accidents, the research background was studied. Also, at this stage, experts, passengers, and drivers in Sistan and Baluchestan province were interviewed to identify factors affecting the increase in road accidents. The results of the first stage of the research are classified in Table 2.

- (ii) In the second stage, a questionnaire was designed, and its validity and reliability were examined. After checking the validity and reliability, the questionnaire was distributed and collected among the research sample.
- (iii) In the third stage, the research data were analyzed using the analytical-network-process (ANP) method. The steps of the ANP process are described in the ANP section.
- (iv) Finally, according to the findings of the research, conclusions and suggestions have been made.

#### 2. Method

In the present descriptive study, the research background was reviewed. Then, experts, drivers, and passengers were interviewed to identify the main factors and indicators affecting the increase in road accidents in Sistan and Baluchestan province. After analyzing the findings of the first Step, 4 main factors and 35 related indicators that were more important were selected. According to that, the questionnaire (the expert questionnaire) was designed to check the importance and prioritization of these factors. Table 2 showed the main factors affecting the occurrence of road accidents in Sistan and Baluchestan.

The statistical population included experts and researchers, and specialists in the field of transportation and were selected based on the convenience sampling. So, 30 people were selected as the sample size related to specialists and experts for the questionnaire. Therefore, in the beginning, to build a network model, a network structure is designed on three levels, including the goal, factors, and indicators (Figure 2).

To conduct pairwise comparisons, weigh, and prioritize the factors affecting the incidence of road accidents, the expert questionnaire was designed to include three subsections:

(1) The importance of the main factor based on objective and (2) internal relations as well as (3) the importance of the indicators in relation to each other according to each criterion (mutual correlation) were examined and compared two by two. Significance comparisons for pairwise comparisons were according to Table 3. To obtain overall priorities, internal importance vectors are entered into the appropriate columns of a matrix. As a result, a super matrix is obtained, each part of which shows the relationship between the goal, factors, and indicators in the system. To achieve overall priorities in a system with mutual effects and to form a super matrix and transform it into a limit super matrix, the internal importance vectors are entered in the appropriate columns of a matrix.

By replacing the internal importance vector of elements and triple levels in the initial super matrix, the unbalanced super matrix is obtained. Then, by normalizing the weighted

Factors	References
Human factors: nonobservance of the right of way, neglect of the front, deviation to the left and aggression to the left due to overtaking Technical factors Managerial factors Environmental factors: seasons, road slipperiness, and fog	Meshkini et al. [24]
Human factor Vehicle factor Spatial factor and geometric plan of the road Environmental factor	Effati et al. [15]
The human factor Vehicle-related factors Environmental factor	Goniewicz et al. [25]
The human factor Vehicle-related factors Road-related factors Environmental factor	Rasouli et al. [26]
Type of weather Snow or rain Clear or sunny weather Temperature Wind	Pourghahimi Sarvestani [27]
Human factors: speeding, drunk driving, distraction, passing a red light, avoiding safety issues such as not wearing a seat belt, not adhering to driving on the road	Deepalakshmi et al. [28]
Human errors Vehicle defect Defect of road and movement path Natural and environmental factors	Amirifar et al. [20]
Gender riders, age of riders Weather condition, season, accident time, light condition, visibility level Type of vehicles, overload status of vehicles Road type, road linearity, type of roadside protection, road structure, road surface condition	Zhao et al. [8]
The main factors affecting road accidents	

TABLE 1: Classification of factors affecting the occurrence of road accidents.



FIGURE 1: Conceptual research model: the main factors affecting road accidents.

super matrix, the limit super matrix is calculated by raising all elements of the weighted super matrix to the power until the divergence is achieved.

To assess the validity of the identified factors, the questionnaire was first provided to available professors and it was confirmed. Also, the questionnaire had the necessary validity since the probability of not considering a variable in the comparisons is zero, and all of the factors were studied in the evaluation and there is no specific orientation in designing the questionnaire [29]. In addition, the inconsistency rate was calculated to check the reliability of the questionnaire. The inconsistency rate is an index that measures the consistency of experts' responses to evaluations and pairwise comparisons. In other words, with the help of the inconsistency rate index, it is possible to find out whether there is consistency between two-by-two and pairwise comparisons in our questionnaires. If it is less than or equal to 0.1, the inconsistency of the comparison matrix will be confirmed [30]. After collecting the questionnaire from the respondents, the data of the questions were entered into the super decision software and to check the reliability of the questionnaire, the inconsistency rate was calculated. The obtained values of the inconsistency rate for pairwise comparisons of factors and indicators are less than or equal to 0.1. Therefore, based on Table 4, indicating the values of inconsistency rate for criteria (factor) and indicators, this questionnaire was reliable and the consistency quality of pairwise-comparison matrices is confirmed.

Finally, after ensuring validity and reliability, the expert questionnaire was distributed among 30 experts and professors and analyzed using the ANP technique.

TABLE	2: Main factors affecting the occurrence	of road accidents in Sistan and Balı	ıchestan.
Environmental factors (E)	Road-related factors (R)	Vehicle-related factors (V)	Human factors (H)
Road lighting (amount of road illumination at night) (E1) Weather conditions (E2) Lighting or darkness (accident time) (E3) Temperature (E4) Seasons (E5)	Road control tools (R1) Road quality (R2) Road quality (R2) Geometric features of road (R3) Status of resorts and Parking lots (R4) Lack of roadside installations (R5) Visibility barriers (R6) Road width (R7)	Nonstandard vehicle (V1) Vehicle design (V2) Type of vehicle (V3) Tire wear and air (V4) Technical defects (V5)	Age (H1) Skill (H2) Experience (H3) Gender (H4) Fatigue and sleep (H5) Nonobservance of rules (H6) Nonobservance of rules (H6) Nonobservance of rules (H6) Driver's characteristics (H8) Haste (rush in driving) (H9) Inappropriate driving (H9) Distraction (H11) High speed (H12) The Ablility of sight and hearing power (H14) Level of education (H15) Unfamiliarity with the road (H17) Human trafficking and fuel smurgeling (H18) Lack of familiarity with the road (H17) Human trafficking and fuel smurgeling (H18)



FIGURE 2: The structure of the network model.

	TABLE 5: Saaty s 1–9 scale of pairwise comparisons.					
Intensity of importance	Definition	Explanation				
1	Equal importance	Two activities contribute equally to the objective				
3	Moderate importance	Experience and judgment slightly favor one activity over another				
5 Strong importance		Experience and judgment strongly favor one activity over anothe				
7	Very strong	An activity is favored very strongly over another				
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation				
2, 4, 6, 8	Intermediate values	Intermediate values between the two adjacent judgments				

TABLE 3: Saaty's 1–9 scale of pairwise compariso
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TABLE 4: The values of inconsistency rate for criteria (factor) and indicators.

Pairwise comparisons	Inconsistency rate
Pairwise comparison of criteria (factor) based on purpose	0.057
Pairwise comparison of criteria (factor) based on human factors	0.014
Pairwise comparison of criteria (factor) based on vehicle-related factors	0.062
Pairwise comparison of criteria (factor) based on road-related factors	0.069
Pairwise comparison of criteria (factor) based on environmental factors	0.077
Pairwise comparison of indicators of human factors	0.075
Pairwise comparison of indicators of vehicle-related factors	0.084
Pairwise comparison of indicators of road-related factors and environmental factors	0.048
Pairwise comparison of indicators of environmental factors	0.031

2.1. Analytical-Network-Process (ANP). Decision-making has become a major part of human life in recent years and, new methods such as multicriteria decision-making have been considered by the researchers since many of these decisions are the selection of one solution from different solutions and indicators [31]. ANP is one of the multicriteria decision-making methods introduced by Saaty [32] in 1996 and, has been widely used in various fields such as supply chain management, waste management, risk assessment, medical sciences, and management [33-36] and accepted as an effective method for decisionmaking. Compared to the analytic hierarchy process method, ANP provides a more general and inclusive framework for making decisions on dependencies between different decisionmaking levels, while AHP fails at providing the possibility to measure and evaluate the probable dependencies between the factors [37]. Furthermore, this technique provides the possibility of weighting the criteria (factor) and indicators and using the pairwise comparison technique to determine the indicators weight [38].

The APN model consists of three elements: (1) goal, (2) criteria (factor) and indicators, and (3) alternatives. These elements are divided into dimensions and attribute enablers in the determined hierarchy. Identifying dimensions and attribute enablers and their relationships at each level is very important for developing the decision-making model. The aim of this hierarchy is ultimately to find the best alternatives [39].

2.2. Analytical-Network-Process Stages. Step 1: Establish the model and problem structure: in the first stage, the model and structure of the problem should be clearly explained.

Step 2: Determining the relative weight in ANP using the pairwise comparison matrix: Through the relative pairwise comparison, the relative weight of criteria and Indicators can

TABLE 5: Demographic information of the statistical sample.

Personal information	Categories	Frequency	Frequency percentage (%)
Conden	Female	12	40
Gender	Male	18	60
	20–30	4	13.33
Age	30–40	18	60
	Over 40 years	8	26.67
	B.Sc.	4	13.33
Education	M.Sc.	10	33.33
	PhD.	16	53.34

be determined. Saaty introduced a nine-point scale for pairwise comparison of two components. The value of the  $a_{ij}$  score in the pairwise comparison matrix shows the relative importance of the component in row *i* and column *j*. In other words, it specifies  $a_{ij} = w_i/w_j$ , so that the number specifies equal importance and the number nine specifies the highest possible importance of one element compared to the another element.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}, a_{ii} = 1, a_{ji} = \frac{1}{a_{ij}}, a_{ij} \neq 0.$$
(1)

In weight comparisons for components *i* and *j*, instead of assigning the weight of  $w_i$  and  $w_j$ , the relative weight of  $w_i/w_j$  is used. After the pairwise comparison, the weight gain *W* is calculated using Equation (2) as follows:

$$A_{\rm w} = \lambda_{\rm max} w. \tag{2}$$

In this equation, the largest eigenvalue of matrix A is equal to  $\lambda_{max}$ .

Vector i is normalized using the following equation (Equation (3)). The result is w unit. In other words, the sum of each column in the matrix is equal to one.

$$\alpha = \sum_{i=1}^{n} w_i. \tag{3}$$

To determine the compatibility of the comparisons, the compatibility index of the weight of the criteria is used, which is calculated using the following relationship (Equation (4)):

$$CR = \frac{\lambda_{\max} - n}{n - 1}.$$
 (4)

If the CR is less than 0.01, the comparison is confirmed. According to each criterion, the pairwise comparison is done in two stages (at the level of elements and comparison between clusters) and the results of the comparisons will be entered in the supermatrix.

Step 3: Forming the initial supermatrix: ANP elements interact with each other. These elements can be the decision-

making unit, criteria (factor), indicators, results, options, etc. The relative weight of each matrix is calculated based on a pairwise comparison similar to the AHP method. The resulting weights are entered into the supermatrix, which shows the mutual relationship between the elements of the system. The obtained supermatrix is introduced in this step as the initial supermatrix.

Step 4: Forming the weighted super matrix.

Step 5: In the next stage, the weighted super matrix reaches a limit power so that the elements of the matrix converge and its row values are equal. Based on the obtained matrix, the general weight vector is determined (Equation (5)).

$$\lim_{k \to \infty} (W)^k.$$
 (5)

The matrix obtained as a result of reaching the power of the weight matrix is a limit matrix where the values of each row are equal. If the super matrix has a chain effect, we may have two or more supermatrices. In this case, the sum of rows converges under the weighted super matrix in the form of Equation (6).

$$\lim_{k \to \infty} \left(\frac{1}{N}\right) \sum_{i}^{k} W.$$
 (6)

Step 6: Calculate the final weight of the criteria: In the last step, according to the cluster weight table and the limit supermatrix, the final weight of the criteria is calculated [32, 40, 41].

#### 3. Results

In reviewing the descriptive statistics of the questionnaire, Table 5 indicates the demographic information of the statistical sample in which the frequency of respondents is analyzed based on the information like gender, age, and education. A statistical sample is selected from professors and experts (who have researched or have information about transportation and road accidents).

Table 6 shows the descriptive analysis of research variables based on central tendency and dispersion for the factors of the questionnaire. The results of Table 6 have been used to check the normality of the distribution of research data. In general, 30 questionnaires with correct data were

Main factors	Average	Standard deviation	Variation range	Skewness	Kurtosis
Human factors (H)	4.88	0.401	1.96	-0.821	0.695
Vehicle-related factors (V)	4.53	0.483	1.64	-0.808	-0.057
Road-related factors (R)	4.32	0.559	1.6	-0.483	-0.499
Environmental factors (E)	4.16	0.576	2.14	-0.459	-0.374

TABLE 6: Descriptive analysis of research variables.

TABLE 7: Pairwise comparisons and prioritization of main factors based on purpose.

	Н	V	R	Е	Geometric mean	Normal weight	Rank
Н	1	0.731	0.708	0.785	0.741	0.658	1
V	0.591	1	0.232	0.149	0.272	0.187	2
R	0.333	0.188	1	0.065	0.159	0.106	3
E	0.075	0.080	0.060	1	0.071	0.050	4

analyzed. The mean (average) score of the main factors (the second column) was 4-5, and human factors had the highest mean. The mean score shows that the main factors are very important according to the respondents. In addition, the dispersion of changes (variation range) for all factors was less than three, and the highest range of changes was related to environmental factors. The standard deviation of the factors (The third column) was close to zero, and the environmental factors had the highest standard deviation. Also, to check the normality of data distribution, skewness and kurtosis have been calculated. If these values are in the range of 2 and -2, the distribution of research data will be normal. Therefore, since the skewness and kurtosis of the data were in the range of -2 and -2 and the data are aggregated around the average score, the data distribution is normal. So, it can be concluded that due to the low dispersion of research data, the data distribution is normal.

After identifying the criteria and indicators related to each one, the ANP technique was used for prioritization. Based on the analysis, the four main factors including, human factors, vehicle status, road status, and environmental factors, and their indicators were identified and categorized. The questionnaire was distributed among 30 experts and was analyzed after collection.

To analyze and prioritize the data, first, the decision network was formed in the process of network analysis. Then, the main factor was prioritized based on the purpose, internal relationships, and prioritization of the indicators in their respective cluster through pairwise comparisons, initial supermatrix, weighted mean, and finally, the final priorities were determined.

3.1. Prioritization of the Main Factor Based on the Purpose. To understand the interdependencies of the main factors, a binary comparison was made between these factors to obtain the elements of the matrix presented in Table 7. In this matrix, to calculate the importance of each of the main factors, a binary comparison was also made for each of the factors, and Table 7 is provided. Also, the special vector of each factor (its normal weight) is recorded in Table 7. The normal weight of the factors shows the importance, and priority of the factors based on the purpose of the research. Thus, according to the respondents, human factors are the most important and environmental factors are the least important (Table 7).

3.2. Prioritization of Main Factor Based on Internal Relationships. In the next step, assuming that all of the main factors were related to each other, the internal relationships were calculated (the internal relationships of the factors show which of the first and second factors is more dependent on the third factor). For this purpose, a fixed criterion was considered in each stage and other criteria were compared with each other based on this criterion. Table 8 indicates the binary comparison matrix and the ranking of the main factors to each other. For example, if the comparison is based on the human factor, the vehicle-related factors are more dependent on the human factors than the road-related factors and environmental factors. Also, road-related factors are more dependent on human factors than environmental factors. Also, as can be observed in Table 8, if the criteria are compared based on human factors, the factors include vehicle-related factors, road-related factors, and finally environmental factors, respectively. The results of Table 8 indicated that the priority of the main factor is the same as shown in Table 7.

3.3. Prioritization of Indicators Using Pairwise Comparisons. Then, Super Decision software (V3.2) was used to compare the indicators related to each criterion. The results of prioritizing the indicators using pairwise comparisons for each main criterion indicated the indicators of human factors in the order of priority include human trafficking and fuel smuggling, decision-making power, the ability of sight and hearing power, haste, high speed, distraction, experience, lack of familiarity with the road, alertness (drug use, alcohol, and psychotropic drugs), unfamiliarity with traffic signs, skill, fatigue and sleep, nonobservance of rules, inappropriate driving culture, level of education, personal characteristics of the driver, age and gender.

		Com	marisons of main f	actors based on human factor		
	V	R	E	Geometric mean	Normal weight	Rank
V	1	0.232	0.149	0.185	0.591	1
R	0.188	1	0.065	0.111	0.333	2
E	0.080	0.060	1	0.069	0.075	3
		Compar	isons of main factor	rs based on vehicle-related fact	ors	
	Н	R	Е	Geometric mean	Normal weight	Rank
Н	1	0.708	0.785	0.745	0.731	1
R	0.333	1	0.065	0.147	0.188	2
Е	0.075	0.060	1	0.067	0.081	3
		Compa	risons of main facto	ors based on road-related facto	rs	
	Н	V	Е	Geometric mean	Normal weight	Rank
Н	1	0.731	0.785	0.757	0.708	1
V	0.591	1	0.149	0.300	0.234	2
Е	0.075	0.080	1	0.077	0.060	3
		Compar	isons of main factor	rs based on environmental fact	ors	
	Н	V	R	Geometric mean	Normal weight	Rank
Н	1	0.731	0.708	0.719	0.758	1
V	0.591	1	0.232	0.370	0.150	2
R	0.333	0.188	1	0.250	0.066	3

TABLE 8: Priority of the main factors.

TABLE 9: Prioritization of the main factor affecting road accidents.

Main factor	Normal weight	Rank
Human factors (H)	0.667	1
Vehicle-related factors (V)	0.212	2
Road-related factors (R)	0.162	3
Environmental factors (E)	0.120	4

Indicators of vehicle status factors in the order of priority are tire wear and air, technical defects, nonstandard vehicle, vehicle design, and type of vehicle.

Indicators of road status factors in the order of priority include visibility barriers, status of resorts and parking lots, lack of roadside installations, road quality, geometric features of the road, road width, and road control tools. Indicators of environmental factors in the order of priority are the amount of road illumination at night, driving in day or night, weather conditions, seasons, and temperature.

3.4. Determining the Final Priority of Indicators. Tables 9 and 10 were extracted to prioritize the main criteria, indicators, and their final ranking, representing the priority of the main factor and indicators, respectively. As Table 9 shows, the prioritization of the main factor affecting road accidents in Sistan and Baluchestan province include human factors, vehicle status factors, road status factors, and environmental factors.

In addition, the final ranking of the indicators affecting the occurrence of road accidents based on Table 9 indicates human trafficking and fuel smuggling, decision-making, the ability of sight, hearing power, haste (rush in driving), high speed, and tire wear and air are the most significant indicators affecting the occurrence of road accidents in Sistan and Baluchestan province.

#### 4. Discussion and Conclusion

Statistical studies indicated that the number of road accidents in Iran is still increasing despite the progress in the road transport industry, leading to an increase in financial and human losses to families and governments. To prevent and reduce the damages caused by accidents, it is necessary to evaluate the factors affecting the occurrence and increase of road accidents and provide solutions to reduce such accidents. In this regard, the present study seeks to identify and prioritize the factors affecting the incidence and increase of intercity road accidents in the Sistan and Baluchestan province.

Based on data analysis, the human factor is the most significant in increasing road accidents in Sistan and Baluchestan province, followed by the factors related to vehicle status, road status, and environmental factors, which are in the next ranks, respectively. The findings of the present study are consistent with the results reported in different studies, and even if the indicators in studies are different, the final results are still the same. For example, the results related to the main factors of this study are consistent with some other studies [23, 42-45]. In addition, ranking the indicators related to the main factors showed that human trafficking and fuel smuggling, decision-making, the ability of sight, haste (rush in driving), high speed and tire wear, and air are the most important indicators, respectively, while season, temperature, driver's characteristics, age and gender are the least important indicators affecting road accidents in Sistan and Baluchestan province. Amini and Salkhordeh [46] stated

TABLE 10: Prioritization of indicators affecting road accidents.

Symbol	Indicators	Normal weight	Rank	Symbol	Indicators	Normal weight	Rank
H18	Human trafficking and fuel smuggling	0.080	1	H2	Skill	0.028	13
H14	Decision-making power	0.069	2	H5	Fatigue and sleep	0.027	14
H13	Ability of sight and hearing power	0.052	3	H6	Nonobservance of rules	0.027	14
H9	Haste (rush in driving)	0.051	4	H10	Inappropriate driving culture	0.026	15
H12	High speed	0.050	5	V2	Vehicle design	0.025	16
V4	Tire wear and air	0.050	5	V3	Type of vehicle	0.024	17
H11	Distraction	0.049	6	R2	Road quality	0.023	18
V5	Technical defects	0.048	7	H15	Level of education	0.016	19
R6	Visibility barriers	0.046	8	R1	Road control tools	0.015	20
H3	Experience	0.033	9	R7	Road width	0.013	21
R5	Lack of roadside installations	0.033	9	E2	Weather conditions	0.010	22
E3	Driving in day or night	0.031	10	R3	Geometric features of road	0.008	23
R4	Status of resorts and Parking lots	0.031	10	E5	Seasons	0.007	24
E1	Road lighting	0.030	11	E4	Temperature	0.006	25
H17	Lack of familiarity with the road	0.029	12	H8	Personal characteristics of the driver	0.006	25
H7	Alertness (drug use, alcohol and psychotropic drugs)	0.029	12	H1	Age	0.005	26
V1	Nonstandard vehicle	0.028	13	H4	Gender	0.005	26
H16	Unfamiliarity with traffic signs	0.028	13		—		—

that high speed is the most critical factor in increasing road accidents. Eboli et al. [6] showed that factors such as accident time are more effective in causing accidents and the factors such as gender, weather, and road surface have a slight effect on accidents. Such results are in line with the findings of the present study. Also, the driver's age results are inconsistent with this study's results. Zeng et al. [22] reported that accident time is the most important factor affecting road accidents which is consistent with the results of this study. Accordingly, the results related to factors such as weather, temperature, age, and gender were significant, but these factors were ranked low in this study, indicating their low significance according to experts in Sistan and Baluchestan province. Lotfi et al. [47] revealed that weather and seasons have a slight effect on accidents in Shiraz, but accident time and vehicle type have a significant effect on accidents. In addition, the results of the other studies [42, 48, 49] are in line with some studies.

Based on the results, the human factor is the most significant cause of accidents and the main source of road accidents in Sistan and Baluchestan province. Therefore, investigating drivers' behavior and finding ways to correct such behaviors are effective solutions for improving performance, reducing the number of accidents, and increasing health in the society.

Sistan and Baluchestan province is one of the border provinces of Iran, and this province is among the five provinces with the most road accidents and fatalities. An important point that is considered in connection with road accidents in Sistan and Baluchestan province is the issue of fuel and human trafficking in this province. The main reasons for this issue are the lack of sustainable employment in the region, and lack of adequate infrastructure to earn adequate income, lack of private and public investors and sustainable income in the province, leading to an unemployment crisis and increased fuel consumption and accidents. It can be said that this factor has been considered in fewer articles related to road accidents. Certainly, a special attention to industry and employment can pave the way for future generations and solve the challenges ahead. Therefore, it is possible to help reduce smuggling in this province with appropriate planning to create employment according to the capabilities of the Sistan and Baluchestan province and appropriate legislation related to human trafficking and border protection helped reduce trafficking in this province. Also, appropriate planning and improving the level of awareness and skills of drivers in the field of traffic safety and accidents, as well as focusing on the adverse consequences of traffic accidents to change incorrect driving habits and show improper violations of the law can control many antisocial behaviors of drivers and prevent serious accidents and casualties. Further, such factors can affect the promotion of lifestyle and increase health in society by improving the social behaviors of drivers. On the other hand, the high speed of the vehicles carrying fuel endangers the lives of drivers and passengers, along with the lives of other drivers passing on the roads, especially in some southern cities of this province. Since fuel and human trafficking are illegal, it increases the speed of drivers and rushes escaping from the police. Therefore, by paying special attention to culture and employment in the province, it is possible to help in reducing and eliminating these factors. In addition, the vastness and dispersion of Sistan and Baluchestan, long distance between cities, and villages, lack of two-lane intercity roads and highways, and high traffic on some intercity roads in this province cause adverse and irreparable incidents. On the other hand, the lack of welfare service complex along the axes in proportion

to the intercity roads in the province, a very low percentage of highways compared to the two-way intercity roads, increased traffic at the unauthorized speed at communication axes, failure to set up a violation registration system in all communication axes of Sistan and Baluchestan, and the absence of traffic police in rural axes have caused adverse and irreparable accidents in the largest province of Iran every year. Education and acculturalization are certainly among the most effective ways to reduce traffic accidents in Sistan and Baluchestan transportation axes and it is necessary to revise some laws which need to be reviewed and stricter rules should be applied. Further, educational programs should be presented continuously for drivers to improve the driving culture in Sistan and Baluchestan province. It is suggested to help improve the factors related to roads by repairing the intercity roads and creating new intercity roads, and placing roadside installations on the intercity roads. To improve the vehicle-related factors, it is necessary to apply the standards related to vehicle safety, and the traffic police should not allow vehicles with technical defects to pass through. Furthermore, the technical training related to the vehicle, safety, technical defects, and vehicle wear should be provided in traffic lessons and some laws should be enacted to let the vehicles have the minimum safety standards (standard brakes and airbags). Regardless of the effect of road-related factors, improving road safety is one of the important strategies in improving and reducing accidents in Sistan and Baluchestan province. For this purpose, preventive measures such as improving the road design, increasing the road width, improving the gable roof slope, installing guardrails and safety signs at intersections, and accident-prone situations, installing a system for registering traffic violations, applying traffic safety countermeasures at school zone, educating drivers to reduce their distractions while driving, replacing oneway roads instead of two-way intercity roads to reduce traffic, installing artificial light, increasing the available sight distance by removing occlusions, and improving pavement markings.

Some limitations remain in the paper. This study was conducted according to the data of Sistan and Baluchestan province and according to the points about the human trafficking and fuel smuggling; thus, the finding may not be valid to other provinces and countries because they have different conditions. Therefore, it is suggested that the researchers examine the present research in other provinces and compare the results obtained with the present research.

#### **Data Availability**

Data supporting this research article are available on request.

#### **Conflicts of Interest**

The authors declare that they have no competing interests.

#### **Authors' Contributions**

AB and SM contributed in the concept and design, acquisition, analysis or interpretation of data, supervision, administrative,

and technical or material support. AB contributed in the drafting of the manuscript and critical revision of the manuscript. All authors read and approved the final version.

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