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AN EVALUATION OF THE EFFECTIVENESS OF ANOMALOUS SYSTEMS IN GAS SUBSIDIARIES (A CASE STUDY OF THE ALBORZ GAS COMPANY)

Abstract: An anomaly is an unsafe condition or action that has the potential to cause an accident. These conditions, or unsafe practices in gas companies, play a very important role in the occurrence of gas leaks and fires. Any unsafe acts can lead to unpleasant incidents for citizens, their homes, and property. This study aims to increase the effectiveness of anomalous systems in the gas subsidiaries of Alborz province. To conduct this study, the Tripod Beta technique was used to draw a diagram of the analysis of gas accidents in homes in the Alborz province, and the hierarchical analysis method was used to assess the risk of injuries, casualties, and unintentional house fires. In the first stage, information on gas leaks, and fires were collected by reviewing the documents related to the winter events of 2020. Then the sum of the mentioned conditions was studied as a hypothetical model. In the second step, the mentioned model was analyzed using the Tripod Beta method, and the causes of the accidents were determined by the capability of the study method. The obstacles studied were technical safety regulations, and the creation of a safe environment. The primary reason attached to the technical safety regulations was the lack of proper understanding of valve openings and closing signs. Another immediate reason for the need to create a safe environment was the lack of safety equipment. The precondition for not understanding the open and closed sign of the valve, lack of sufficient knowledge, and the precondition for not using safety equipment, buying unsafe equipment, and the hidden reason for the lack of sufficient knowledge, lack of training, and the hidden reason for buying unsafe equipment, was the poor economic situation. The results of this study indicated that fire-related conditions are of the utmost importance in assessing the risk of unintentional house fires. Failure to pay attention to safety points while using gas-related equipment, the poor condition of the building, and more male residents have the most anomalies in causing gas company accidents.

Keywords: anomaly, urban gas accidents, tripod beta, AHP, effectiveness

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1. Introduction

One of the most important sources of energy is natural gas [1, 2]. This energy source, if misused, can pose a significant risk to society. Risk management helps maintain the operational safety of the gas network [3]. Fire is one of the disasters that can be fatal to people, and infrastructure is destroyed due to its severity, and delays in rescue [4]. Many people have an attitude that fire does not happen to them [5, 6], and therefore do not worry about fire safety in their homes. Preparing for a fire with an alarm can make people less likely to think that their family will be harmed by the fire, or that a house fire is a serious problem [6, 7]. People generally underestimate the risk of fire, and have a higher risk perception in buildings that are not their own homes, even if the risk of injury, or death is higher in their own homes. People often underestimate the risk of fire because they do not know that smoke, not heat, causes 90–95% of deaths [6]. Accidental house fires usually start in areas of the house where people spend most of their time. Most of the cause of the fire is related to the activities of the residents. Smoking is the most common cause of fire [8]. Investigating fire incidents has always been difficult due to the complexities of the occurrence, and development of fires, and the non-recurrence of similar fire incidents [9]. The causes of anomalies in gas systems have been investigated in various studies. Wang et al. [10] used Bayesian networks as a tool to detect anomalies in sensor gas monitoring networks in underground coal mines. Based on their study, the Bayesian network model can learn the cyclical baselines for gas concentrations, thus reducing false alarms. They showed that the system could learn the relationships between concentration changes in several gases and at different locations. They defined and identified new varieties of events that would occur in an exceeding sensor network. Supported by the results, the proposed Bayesian approach will be able to detect spatio-temporal anomalies for a large range of sensor networks. In the research of Akouemo and Povinelli [11], they introduced a possible approach for detecting anomalies, especially in fossil fuel statistical data. Within the fossil fuel field there are different types of anomalies, each of which occurs for various reasons from varyingsources. Supported by statistical data that had not been seen before, the system detects anomalies by employing a linear regression model with weather inputs. This method can even detect anomalies of an unknown origin. Thus, the likelihood of an information point being anomalous for anomalies of both known and unknown origin is featured. This method was employed to detect possible abnormalities in a reported fossil fuel consumption data set. Bai et al. [12] proposed a brandnew method for detecting abnormalities using standard datasupported by nonlinear autoregression with the network of exogenous inputs andcombining it with previous knowledge. In their research, the concept of extracting a traditional turbine model was proposed for the first time. They extracted the feature without changing the conventional pattern from normal historical data andused its changes to detect the anomaly. Experiments on real data showed that the proposed method achieved a 99.96% detection accuracy for error data, and a 98.67% detection accuracy for ordinary data. Baldacci et al. [13] conducted a study on the predictions of gas consumption to diagnose abnormalities. Their results clearly showed that the prediction techniques used supported the room operators in detecting abnormal consumption. The prediction is that the beginning of creating a whole expert system that makes it easier for advanced operators to interpret gas network behavior, and suggests less skilled people react correctly in the event of bizarre events. An anomaly means an anomaly. Since various anomalies with the use of gas in homes cause fires and explosions, and these accidents cause great loss of life and property for residents, it is necessary during this study to analyze the effectiveness of anomalous systems in gas subsidiaries.

2. Method section

In this section, first, the research variables are introduced before the research method is described. This research is descriptive, and the present research is applied. The Tripod Beta method is used to analyze events, and the Analytic Hierarchy Process (AHP) technique is used to measure the effectiveness of anomalous systems for each criterion. All incidents of the Alborz gas distribution network constitute the statistical population of this research. The variables studied in this study include risk factors for unintentional house fires, and risk factors for injuries/casualties of unintentional house fires.

2.1. Definition of variables and Tripod Beta technique

Table 1 shows the research variables.

The Tripod Beta analysis method springs from the Tripod method, which successively relies on the Swiss cheese model [15, 16]. This model, developed by Reason in 1990, shows that an accident occurs as a result of a mix of errors, and negligence at different levels of the organization. This model is named cheese because it shows the failure as a hole within the slices of Swiss cheese.

Table 1. Important parameters of risk of unintentional house fires, injuries, and deaths [14, 15]

Grouping	Risk factors for unintentional house fire injuries/fatalities	Symbol	Risk factors for unintentional house fire incidents	Symbol
Resident characteristics	Families with more people under 5 years old	AA	Families with more people under 5 years old	A
	Families with more people over 65 years old	BB	Families with more people under 15 years old	B
	More residents	CC	Families with more people under 18 years old	C
	More male residents	DD	More residents	D
	Families with highly vulnerable people*	EE	More male residents	E
	People with disabilities	FF	Fewer residents over 65 (families with people over 65 are associated with reduced risk)	F
	Lonely people	GG	Low-income, or low-value assets	G
	Low-income, or low-value assets	HH	Families with unemployed people	H
	Families with unemployed people	II	–	
Resident behaviors	Smoking	JJ	Smoking	I
	Alcohol, or drug abuse	KK	Not paying attention to safety points when using gas-related devices	III
	No warning when smoking	MM	–	
Property characteristics	Small apartments, and houses	NN	Apartments, and other buildings compared to single-family homes	J
	Rental property, owned by the municipality, and other, organizations	OO	Rental property, owned by the municipality, and other, organizations	K
	Old property (over 19 years)	PP	Building in poor condition	M
	Demolished buildings and buildings that are in a state of disrepair	QQ	–	–
Fire-related circumstances	No possible helper**	RR	–	–
	Flames in the living room	SS	–	–
	Flames in the bedroom	TT	–	–
	Flames at night	UU	–	–
	Flames on the weekend	VV	–	–
	Flames in the winter months	WW	–	–
	The person was alone when the fire started	XX	–	–
	The person was asleep when the fire started	YY	–	–
	The person was in the burning room when the fire started	ZZ	–	–
	Combustion source: a heating device	AAA	–	–
	Drugs	BBB	–	–
	Combustibility very close to heat	CCC	–	–
	Human behavior	DDD	–	–

* Defined as a person under 5 years of age, older than 64 years, with a cognitive or physical disability, or a disorder due to alcohol and/or drug use during a fire event.

** Defined as a person between 5 and 64 years old, without a cognitive or physical disability, and the use of alcohol and/or drugs when a fire breaks out.

A number of these factors include failures in human activities within the workplace, and other failures associated with organizational management factors. Organizational failures are the most frequent causes of accidents that remain hidden within the system for a protracted time. These hidden factors are always related to technical, and human errors that play a role in the occurrence of an accident [15, 16]. In this model, several layers of barriers are designed to reduce or prevent errors. This model is analogous to system layers, in each of which some holes indicate a security defect. Having a hole in one layer may cause an accident because the opposite layer acts as a protector. Conversely, if the holes in each layer are aligned, a mistake occurs that indicates that there are not any obstacles to forestall the error occurrence. In keeping with this model, the causes of the accident are classified into four levels [16]:

1) organizational effects,
2) unsafe monitoring,
3) preconditions for unsafe actions,
4) unsafe actions.

2.2. Analytic Hierarchy Process

One of the multi-criteria decision-making methods is the hierarchical analysis process which is done to weighing the criteria and selecting the optimal option. The AHP method stands for the Analytical Hierarchy process. This method was introduced by Thomas Saati in 1983. The purpose of this method is to prioritize criteria or options. Once the goal has been identified, criteria for decision-making must be identified. These criteria are compared, and their weight is determined. Finally, the options are paired with each other based on each criterion, and the final priority of the options is determined.

3. Results

This research was conducted in the area covered by Alborz Gas Company. In the first stage, information on gas leaks and fires were collected by reviewing the documents related to the winter events of 2020. Table 2 shows the characteristics of gas emission accidents in Alborz province.

Table 2. Accidents caused by gas emissions in Alborz province

Accident ID	Date of incident	Cause of the accident	The amount of damage	Description of the incident
1	29.02.2020	Gas leak	Financial	At 11:20 am, a joint phone call was sent to the rescue unit. At 11:20 am, the rescue unit was sent to the scene. After investigating the cause of the fire, there was a gas leak, and the shared gas was cut off
2	7.03.2020	Fire	Financial	No information was provided to the gas department at the time of the accident, and only the accident report has been completed based on the fire station report
3	22.02.2020	Fire, and internal leakage	Financial: A residential house caught fire Injured or poisoned: An injured person was rushed to the hospital.	Upon announcing the fire, they immediately went to the scene and found that the house was on fire. The gas valve was closed, the regulator was opened, and the fire was extinguished by the fire brigade. The subscriber guided them to the engineering system
4	13.02.2020	Gas poisoning	One death	According to the announcement of the 194 system, a case gas leak was reported to the relief unit at 9:33 PM. The rescue workers immediately went to the scene, cut off the gas, and were referred to the engineering system
5	24.01.2020	Fire	Financial	At the time of the accident, no contact was made with the gas department
6	15.02.2020	Fire Unintentional – due to a city gas leak	Financial	According to the available evidence, and technical studies, the fire was done unintentionally due to the non-observance of safety standards in city gas, and related equipment, branches, connections, and patches. Also, because of the improper installation of the H-chimney, which is connected to the water heater in the kitchen, the pilot of the water heater was turned off due to the wind, and has led to the gradual leakage of city gas, which with the accumulation of gas in the place, and its saturation in the environment after reaching the pilot of the heater, which is on, has caused combustion, and started the fire, and directed it to the neighborhood, and other parts, and kitchen

Table 2. cont.

7	24.01.2020	Gas leak from the water heater pilot due to not installing a suitable chimney	Civil, mechanical, or electrical installations, furniture, or property	The accident caused damage to civil engineering, mechanical, or electrical installations, furniture, and property. The damage is due to the occurrence of a city gas leak and reaching the naked flame of a gas heater
8	9.02.2020	Fire	Financial	The fire in the two-floor residential house was extinguished by the fire brigade, the common gas was cut off, and the subscriber was guided
9	7.02.2020	Residential unit explosion	Unfortunately, a 22-year-old woman lost her life due to a gas leak, and an explosion. Demolition of walls, doors, and windows of the building, and burning of its accessories such as sofa, sound system, curtains, carpets, refrigerator, and some beds, mirrors, and candlesticks, etc.	On 7.02.2020, at 15:35, to the fire department, and municipal safety services
10	7.02.2020	Fire, and explosion	Financial loss Loss of life: 1 person, death of a 22-year-old woman	According to the owner, the accident occurred on 07.02.2020, but the gas department was not informed. The scene was visited, and the water heater on the wall, and the building caught fire. The gas was cut off from the regulator
11	27.01.2020	Fire, and explosion	Financial	No information was provided to the gas department at the time of the accident
12	21.01.2020	Fire	–	G4 meter opened. The fire broke out a few days ago, and the fire was controlled
13	16.01.2020	Fire	Financial The whole house was on fire	–
14	16.01.2020	The fire was caused by a gas heater inside the living room.	The building was destroyed. Carpet, sofa, TV, curtains, bedding, vacuum cleaner, ironing board, cabinet, shoe rack, wall clock, and panel	On Thursday, 16.01.2020, at 12:02 PM, during a telephone call with the fire department, and safety services of the new city municipality regarding a residential fire, a firefighting team was immediately dispatched to the scene. They extinguished the fire using two water pipe straps, and two capsules of gas powder and returned to the station at 12:50 after securing the place
15	7.12.2019	Explosion	Financial loss Loss of life: Death of one person	After a face-to-face visit and the rescue team arrived at the scene due to the blast wave (according to the fire department report), which led to cracks in the wall of the building, and its collapse, and according to the forensic report, it resulted in the death of the family child (due to severe burns)
16	11.09.2019	– Not using gas appliances equipped with thermocouples, and gas flow circuit breakers – Non-observance of gas safety principles by the consumer subscriber – Illegal, and unsafe use of natural gas sharing, and endangering the lives, and property of building occupants	Life loss: three people were injured by burns (one tenant of the relevant unit) Financial loss: The destruction of the property that was the site of the explosion, and caused damage to six adjacent residential units in the same block. In the opposite block, an explosion wave broke the glass of several units.	Explosion incident of phase 4 of the new Hashtgerd

Accident ID	Date of incident	Cause of the accident	The amount of damage	Description of the incident
16 cont.	11.09.2019	– Uncertainty about the closing of the gas inlet valve of the building before the residents leave the residential unit – Lack of gas valve handle on the connections with valve, and the existence of unauthorized connections on gas outlets	A car parked at the bottom of the park building was damaged due to the throwing of building materials due to the intensity of the blast wave. Social consequences: creating panic due to the dimensions of the accident	–

3.1. Tripod Beta analysis results

Then, the sum of the mentioned conditions was studied as a hypothetical model. In the second step, the mentioned model was analyzed using the Tripod Beta method, and the causes of the accident were determined by the capability of the study method. Figure 1 shows the diagram of Tripod beta analysis in the analysis of gas accidents in homes of Alborz province in winter 2020. Obstacles studied are technical safety regulations and the creation of a safe environment. The primary reason attached to the technical safety regulations is the lack of proper understanding of whether the sign of the valve is open or closed. Also, the primary reason for creating a safe environment is not using safety devices. The precondition for not understanding the open and closed sign of the valve was a lack of sufficient knowledge, and the precondition for not using safety devices was having bought unsafe equipment. The hidden reason for the lack of sufficient knowledge was a lack of education, and the hidden reason for buying unsafe equipment was a poor economic situation.

3.2. Hierarchical analysis of effective factors in the effectiveness of anomalous systems

3.2.1. Risk assessment of unintentional house fires

According to Figure 2, fire conditions are of the utmost importance in assessing the risk of unintentional house fires. Failure to pay attention to safety points while using gas-related equipment, poor condition of the building, and more male residents have the most anomalies in causing gas company accidents.

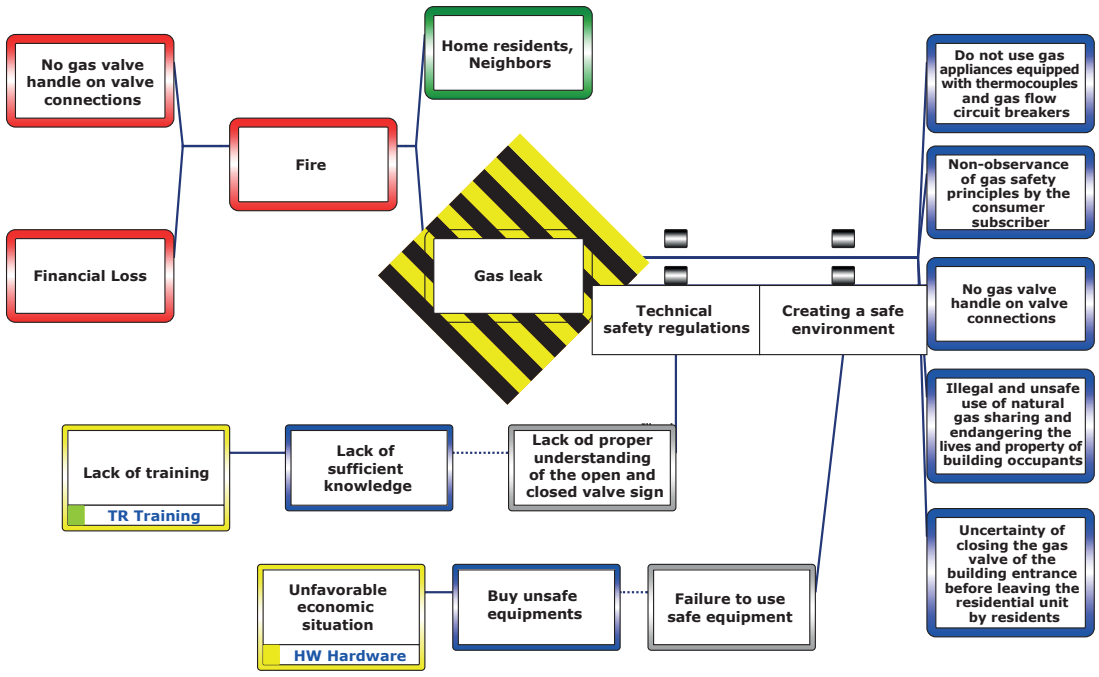

Fig. 1. Diagram of tripod beta analysis in the analysis of gas accidents in homes of Alborz province in winter 2020

Sub-criteria related to the criteria of resident characteristics include families with more people under 5 years old, families with more people under 15 years old, families with more people under 18 years old, more residents, more male residents, Fewer residents over the age of 65 (families with people over 65 are associated with reduced risk), Low-income, or low-value assets, and families with the unemployed. According to Figure 3, the sub-criterion of more male residents in homes exposed to gas accidents is most important in the effectiveness of anomalous systems. Low-income, or low-value assets, fewer residents over 65 (families over 65 are associated with reduced risk), and families with more than 15 under are next in line with the importance of the effects of anomalous systems. The inconsistency rate in this hierarchical analysis was calculated to be 0.01.

Criteria for resident behaviors include sub-criteria of smoking, and not paying attention to safety points while using gas-related devices. Failure to pay attention to safety points when using gas-related devices is most important in the hierarchical analysis of residents' behaviors regarding the effectivenessof anomalous systems (Fig. 4). The inconsistency rate of the hierarchical analysis of the sub-criteria of resident behaviors is zero.

Criteria for property characteristics have sub-criteria of apartments, and other buildings compared to single-family homes, rental property, owned by the municipality and other organizations, and poor building condition. Inadequate building conditions are more important than other sub-criteria in the effectiveness of anomalous systems (Fig. 5). The inconsistency rate in this analysis is zero.

The total inconsistency rate of the hierarchical analysis of the risk of unintentional house fires was 0.01.

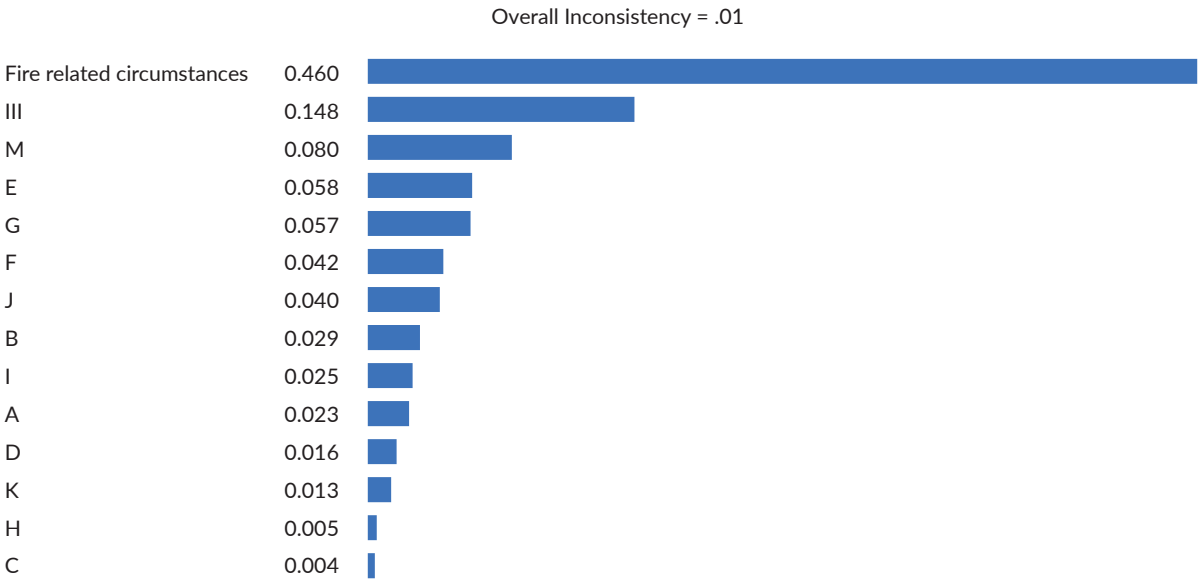

Fig. 2. The final weight of criteria in assessing the risk of unintentional fire accidents in the house

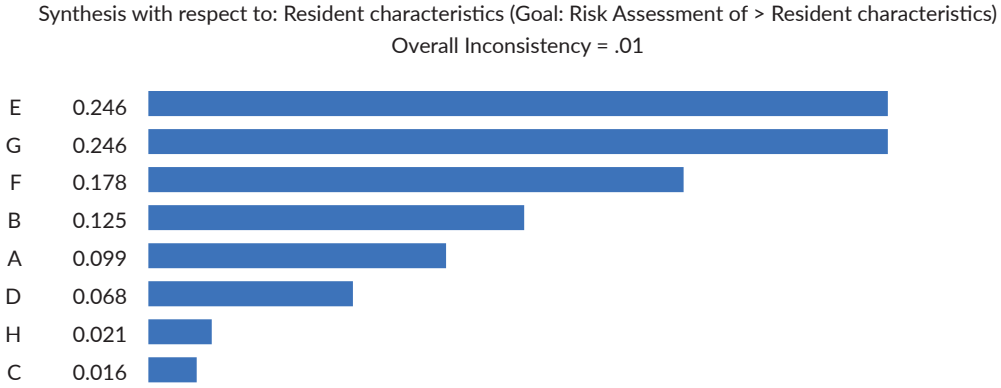

Fig. 3. Final weight of sub-criteria of residents' characteristics

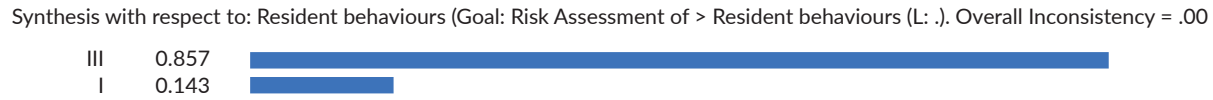

Fig. 4. Final weight of sub-criteria of residents' behaviors

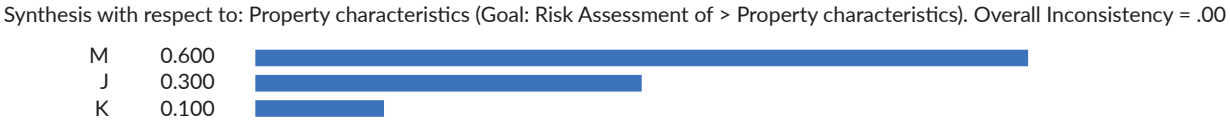

Fig. 5. The final weight of property characteristics sub-criteria

3.2.2. Risk assessment of unintentional house fire injuries/fatalities

Figure 6 shows a hierarchical analysis of the risk factors for injuries, or unintentional fire fatalities. Residents' behaviors are most important in this analysis. The inconsistency rate in this analysis is 0.01.

Resident characteristics criterion in the hierarchical analysis of risk factors for injuries, or unintentional fire fatalities, including families with more people under 5 years old, families with more people over 65 years, more residents, more male residents, families with highly vulnerable people, people with disabilities, lonely people, Low-income, or low-value assets, and families with unemployed people. Low-income or low-value assets are the most important in the effectiveness of anomalous systems. Families with highly vulnerable people, families with unemployed people, and more male residents are in the next ranks in terms of the importance of the effectiveness of anomalous systems (Fig. 7). The inconsistency rate of this analysis is 0.01.

Based on Figure 8, a hierarchical analysis of residents' behaviors on the effectiveness of anomalous systems was performed. Residents' behaviors include smoking, alcohol, or drug abuse, and no warning when smoking. According to the analysis, alcohol or drug abuse is the most important in the effectiveness of anomalous systems. Smoking, and no warning when smoking is among the next priorities in the importance of the effectiveness of anomalous systems, respectively. The inconsistency rate of this analysis is zero.

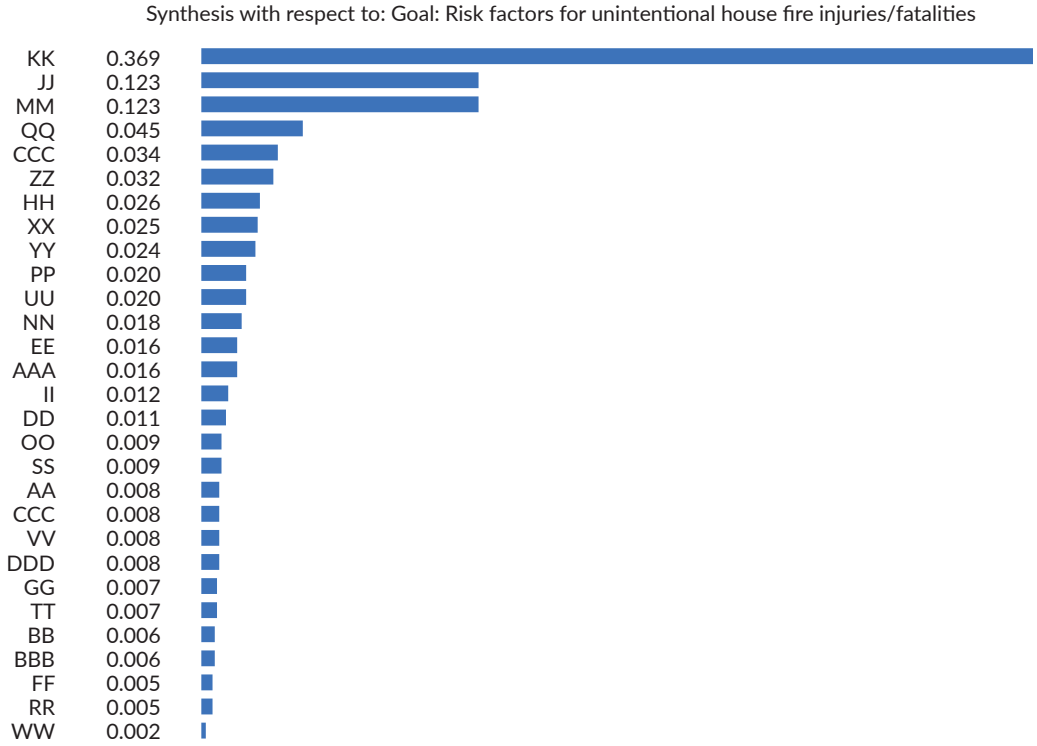

Fig. 6. The final weight of criteria in assessing the risk of unintentional house fire injuries/fatalities

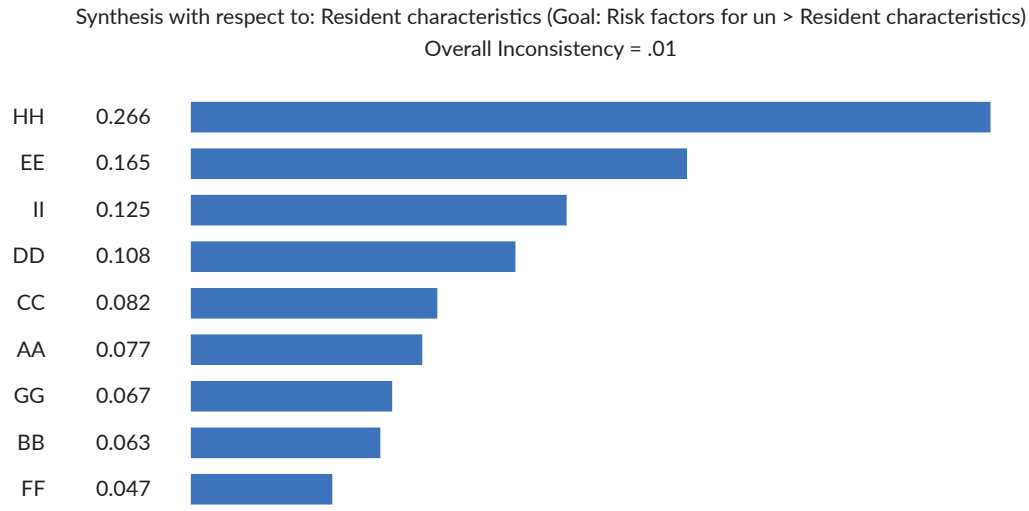

Fig. 7. The final weight of resident characteristics sub-criteria

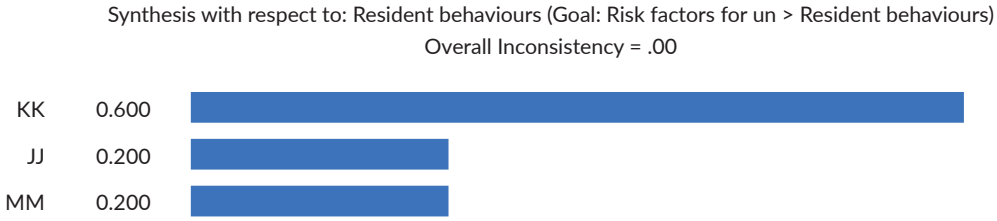

Fig. 8. The final weight of sub-criteria of residents' behaviors

Based on Figure 9, a hierarchical analysis of property characteristics in the effectiveness of anomalous systems is shown. Demolished buildings and buildings that are in a state of disrepair are of the utmost importance in the effectiveness of anomalous systems. Old property (over 19 years), small apartments, houses, and rental property, owned by the municipality, and other, organizations, are among the next priorities in the effectiveness of anomalous systems in the analysis of property characteristics. The inconsistency rate of this analysis was 0.00872.

Criteria for fire-related circumstances include No possible helper, Flames in the living room, Flames in the bedroom, Flames at night, Flames on the weekend, Flames in the winter months, The person was alone when the fire started, The person was asleep when the fire started, The person was in the burning room when the fire started, Combustion source: a heating device, Drugs, Combustibility very close to heat, and Human behavior. Combustion is very close to heat, a feature that is most important in the effectiveness of anomalous systems in the study of fire-related circumstances. The inconsistency rate of this analysis was calculated to be 0.01 (Fig. 10).

The total inconsistency rate of the model for assessing the risk of injuries, or fatalities of unintentionally fired houses is calculated to be 0.013.

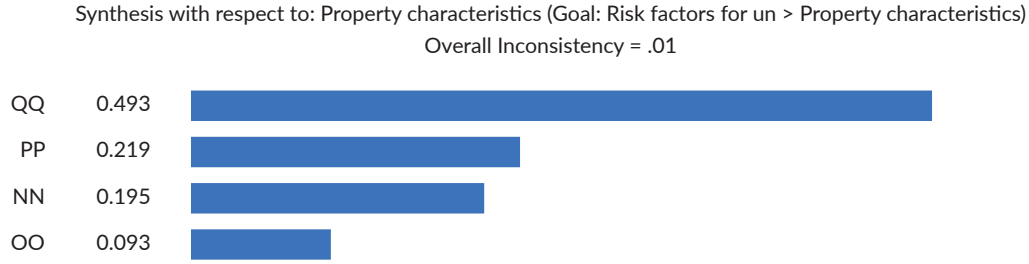

Fig. 9. The final weight of property characteristics sub-criteria

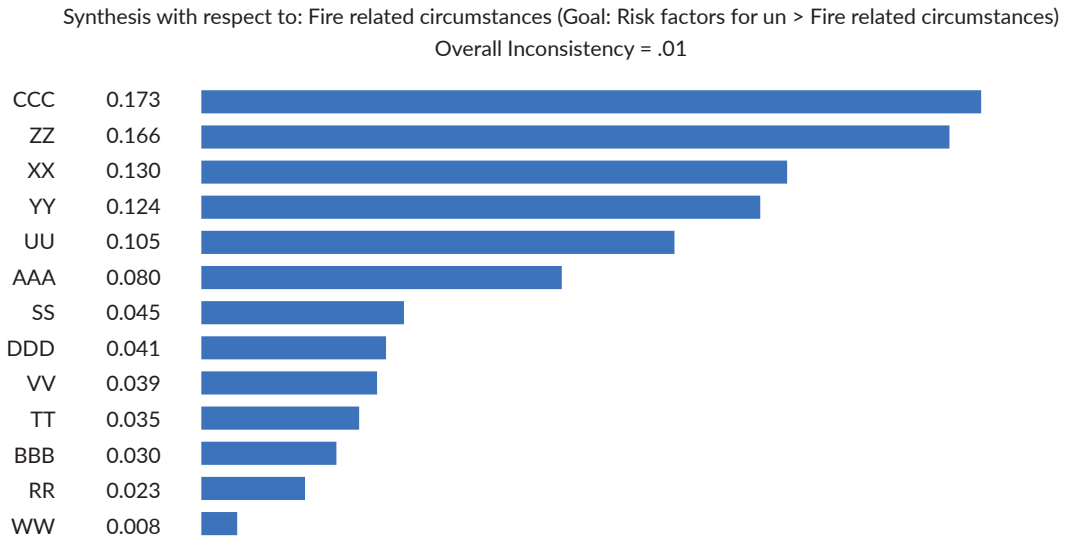

Fig. 10. The final weight of the sub-criteria of fire-related circumstances

4. Discussion

This research was conducted in the area covered by Alborz Gas Company. In the first stage, information on gas leaks and fires were collected by reviewing the documents related to the winter events of 2020. Then the sum of the mentioned conditions was studied as a hypothetical model. In the second step, the mentioned model was analyzed using the Tripod Beta method, and the causes of the accident were determined by the capability of the study method. The two obstacles to technical safety regulations and the creation of a safe environment, the preconditions, and their root causes are identified in this diagram. After studying the documentation of fire incidents in the winter of 2020 in Alborz province, the total conditions were studied as a hypothetical model. The obstacles studied were technical safety regulations and the creation of a safe environment. The primary reason attached to the technical safety regulations was the lack of proper understanding of the valve opening and closing sign. Another immediate reason for creating a safe environment was the lack of safety equipment. The precondition for not understanding the open and closed sign of the valve was a lack of sufficient knowledge, and the precondition for not using safety equipment was having bought unsafe equipment. Meanwhile, the hidden reason for a lack of sufficient knowledge was a lack of training, and the hidden reason for buying unsafe equipment was poor economic situation. Fire-related circumstances are of the utmost importance in assessing the risk of unintentional house fires. Failure to pay attention to safety points while using gas-related equipment, poor condition of the building, and more male residents have the most anomalies in causing gas company accidents. The sub-criterion of more male residents in homes exposed to gas accidents is of the greatest importance in the effectiveness of anomalous systems. Gender as a risk factor in the studies of Ballard et al. [17], Marshall, Runyan [18], Ducic and Ghezzo [8], Karter et al. [19], Barnett [20], and Xiong et al. [21] have also been reported that properties with a larger number of male residents are at risk of increasing cigarette fires, and minor house fires. The results of their study are consistent with the present study. Low-income, or low-value assets, fewer residents over 65 (families with people over 65 are associated with reduced risk), and families with more people under the age of 15 are next in line with the importance of the effects of anomalous systems, respectively. According to studies by Ballard et al. [17], and Xiong et al. [21], Low-income, and low asset value were associated with an increased risk of injury, and death from fire, but according to a study by Greene [22], no relationship was found between income and risk of fire. According to Greene [22], families with more people under 5 years old, according to Ducic and Ghezzo [8], families with more people under 15 years old, and according to Greene [22], families with more people under 18 years old are at higher risk for home fires. Runyan et al. [23], and Marshall et al. [18] reported that children under 5 years are also at risk of fatal fires. According to the present study, families with more people under 5 years of age have little importance in the effectiveness of anomalous systems. According to a study by Runyan et al. [23], families with more people between the ages of 5, and 17 are associated with a reduced risk of death. This result is consistent with the present study. According to the present study, families with more people

under 18 years of age have the least importance in the effectiveness of anomalous systems. Runyan et al. [23], Marshall et al. [18], and Xiong et al. [21] stated that older residents (over 65 years) are at risk of injury, or death in case of fire. According to studies by Ducic and Ghezzo [8], and Greene [22], they are less likely to experience a fire in the first place. Karter et al. [19] stated that older people are at greater risk of smoking-related fires. According to the present study, families with more people over 65 years of age are less important than other parameters. Studies [17, 23, 19, 22] also indicate that the risk associated with elderly residents has not been identified. Studies [23, 18, 21] stated that people with disabilities were associated with an increased risk of fire injury, and death. This result is not consistent with the present study. According to this study, people with disabilities have the least importance in the hierarchical analysis of residents' characteristics in the effectiveness of anomalous systems. Marshall et al. [18], and Runyan et al. [23] included a compound variable called "vulnerable people" in their analysis, which included people under 5 years old, over 64 years old, physically, or cognitively disabled, or affected by alcohol or drugs during a fire. Both studies reported that families with "vulnerable" individuals were at risk of more deadly fires, especially those who did not receive a smoke warning or had a potential rescuer (a potential rescuer was defined as a non-vulnerable person) [18]. The results of these studies are consistent with the present study. According to this study, families with highly vulnerable individuals are secondary in importance to the effectiveness of anomalous systems. According to studies more people [17, 22], single-parent families [24], families with many children [24] were also associated with an increased risk of fire, injury, and death. These results do not correspond to the present study. According to the present study, the number of residents is moderate in terms of importance. Runyan et al. [23], and Xiong et al. [21] stated that single-person families are at increased risk of traumatic, and fatal fires, but there is no evidence of an increased risk of house fires. Accordingly, the present study shows less importance in the effectiveness of anomalous systems for the life of single people. Failure to pay attention to safety points when using gas-related devices is most important in the hierarchical analysis of residents' behaviors regarding the effectiveness of anomalous systems. Improper condition of the building is more important than other sub-criteria in the effectiveness of anomalous systems. A hierarchical analysis of the risk factors for injuries or fatalities of unintentional house fires has shown that the behaviors of residents are the most important in this analysis. Low-income or low-value assets are the most important in the effectiveness of anomalous systems. Families with highly vulnerable people, families with unemployed people, and more male residents are in the next ranks in terms of the importance of the effectiveness of anomalous systems, respectively. A hierarchical analysis of residents' behaviors on the effectiveness of anomalous systems was performed. Residents' behaviors include smoking, alcohol, or drug abuse, and no warning when smoking. According to the analysis, alcohol, or drug abuse is the most important in the effectiveness of anomalous systems. Smoking, and no warning when smoking is among the next priorities in the importance of the effectiveness of anomalous systems, respectively. Studies by Ducic and Ghezzo [8], and Greene [22] have shown that families with more smokers are at a higher risk of fires. However, only one study examined the association between smoking and harmful, or fatal fires. For example, traumatic, or fatal fires were six times more likely in families whose residents smoked than in non-smokers. A hierarchical analysis of property characteristics in the effectiveness of anomalous systems has shown that demolished buildings and buildings that are in a state of disrepair are most important in the effectiveness of anomalous systems. Old properties (over 19 years old), small apartments, houses, and rental properties owned by the municipality and other organizations, are the next priorities in the effectiveness of anomalous systems in the analysis of property characteristics.

5. Conclusions

According to the present study, the obstacles in the research model were technical safety regulations and creating a safe environment. The primary reason attached to the technical safety regulations was the lack of proper understanding of the valve opening and closing sign. Another immediate reason for creating a safe environment was the lack of safety equipment. A precondition for not understanding the open and closed sign of the valve was alack of sufficient knowledge, while the precondition for not using safety equipment was buying unsafe equipment. The hidden reason for a lack of sufficient knowledge was the lack of training, while the hidden reason for buying unsafe equipment was poor economic situation. Therefore, there is a connection between education, and reducing the number of accidents, and between the use of equipment, and the reduction of accidents.

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