DETERMINATION OF DELAY FACTORS IN DOMESTIC PASSENGER FLIGHTS USING AHP TECHNIQUE

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ABSTRACT

Currently, the issue of delays of flights is one of the important and considerable issues in flights, which caused the reduction of desirability of air voyages and widespread dissatisfaction of passengers around the World. It has numerous and various causes. In addition, in accordance with studies performed throughout the World, considerable costs are incurred by flight companies, airports and passengers because of it. The important point is that the delays in air transportation is a very complicated and multi-dimensional issue and phenomenon, the understanding of which requires researches in the field of determination of the main factors in its occurrence and evaluation of them, taking into account various conditions. Some issues are indicated below for the determination of causes and factors effective on the occurrence of flight delays in Iran. Naturally, such selection cannot be made only on the basis of imaginations and

personal views, but decisions should be taken on this issue on the basis of scientific methods with the application of all effective factors. Six distinct data bases are found out on the basis of the above and existing papers and documents. Finally, an Analytic Hierarchy Process was achieved on the basis of a combination of these sources to determine factors with effects on the occurrence of flight delays, taking into account the objective of project. It is noteworthy that Analytic Hierarchy Process (AHP) is the performed scientific process, which is a flexible, powerful and simple technique used for taking decisions in conditions, where conflicting decision making criteria make it difficult to select from among options. The results of studies and researches include the determination of several level-1 criteria as well as sub-criteria on levels with different importance, each with a certain share on the occurrence of delays in internal flights of Iran. This may considerably help the specification of priorities of the solutions of modification or improvement of the existing conditions of the air transport industry. At the end it is noteworthy that IATA delay codes are the most comprehensive and detailed categorization presented for the causes of flight delays. On the basis of a decimal categorization the main causes are indicated with one digit codes and secondary causes with two digit codes. Therefore, a considerable part of categorization of criteria and sub-criteria is made on the basis of the above method taking into account the objective of project and limitations mentioned.
Key Words: Delay Factors, Domestic Passenger Flights, AHP Technique

INTRODUCTION

Today there are various categorization ways of the causes for delays in passenger flights which deal only with the main and general reasons of delays in flights. On the other hand we may use appropriate techniques to study the associated causes and factors more widely and to specify and analyze shares of such factors in the delays of domestic passenger flights of Iran in the light of the defined criteria and sub-criteria. As a result, major problems will be identified and priorities will be established for correction of the existing situation. The delay causes are presented by general categorization in the reports of the Civil Aviation Organization. The delays are presented by only general categories. They included those caused by "performance", "technical defects" and "weather conditions".

In fact, each delay presented by the Civil Aviation is caused by several reasons. They are however classified in one category. In a case where a delay can be placed in none of the existing categories, it will be classified under the "others" category.

A glance at the corresponding statistics and data of delays in the country reveals that considerable portion of them is classified as "other causes". To analyze the delay causes of flights, the Deputy Director's Office of Aviation and International Affairs of the Civil Aviation Organization has recently classified the main reasons effective on the occurrences of delays as follows:

Arrival delays, flight control, fuelling, Guards Corps Protection Unit, customs, passport control, frost, and airport police delays.

Some of such causes are related to international flights, which are not dealt with here. Others are taken into account in analyzing their shares in delays happened in the domestic flight network.

OBJECTIVES OF THE RESEARCH

By this research we are going to determine delay causes of domestic passenger flights of Iran and to analyze their shares using AHP techniques as a multi criteria evaluation method. The software which was used to analyze the shares is named "EXPERT CHOICE".

TYPES OF FLIGHT DELAYS

To identify delay types, the presentations of domestic and foreign authorities were studied. Domestic authorities such as Civil Aviation Organization and Iran Air classify the delay causes by three main categories of "inside of organization" "outside of organization" and "consecutive".

<u>Inside of organization</u>: They include factors for which an airline company is somehow responsible. The above include airport service, technical, operations, transport, catering, trading and miscellaneous factors.

<u>Outside of organization</u>: If a delay is attributed to any source other than the airline company such cause will be classified under "outside of organization". Such causes include air traffic control (ATC), police, passport control, protection guards, airport facilities, Guards Corps, weather, customs, as well as some other such factors.

<u>Consecutive</u>: When a flight delay is caused by arrival delay of the previous flight, such delay is called consecutive.

However, there is a more precise categorization in this field, which is used by some of domestic airline companies too. This is a standard presented by IATA. As this standard is recognized in almost all distinguished airline companies around the World, and the country's airline companies, too, pay attention and refer to this standard, we will use IATA standard as the basis of identification and examination of various delay factors and their components.

Delays may be classified in another way on the basis of the place and time of their occurrence.

<u>Arrival delay</u>: By this we mean the interval between the scheduled time and that of plane arrival to flight gate, which is the actual time of arrival.

<u>Departure delay</u>: It refers to the interval between the time scheduled for the exit of a plane from the flight gate and the actual time of push back to begin the flight.

<u>Ground delay</u>: It includes such flight delay as happens at the flight gate or taxiway.

<u>Airborne delay</u>: It is a delay which happens en route and/or during holding time for landing.

USA is the only country which systematically prepares and analyzes separated statistics and data of its domestic flights and, too, publicizes associated reports. In accordance with a decision taken by Research and Innovative Technology Administration (RITA), which is an affiliated institute of USA Department General of Transportation, the airline companies are bound to present reports about their on-time flights along with other reports on the reasons for delays and cancellations of flights. The airline companies having at least one percent of the income arising out of passenger flights of domestic schedules in USA are subject to such system. The corresponding airline companies report the data about delay causes on the basis of a general and wide categorization system, which consists of five various topics described as follows:
- Air carrier delays: They refer to conditions which are under the control of air carriers such as aircraft maintenance, crew problems, aircraft cleaning, and baggage loading, fuelling, and technical problems.

- Delays because of extreme weather conditions:

Such delays happen because of special weather conditions which cause cancellation or delays of flights in spite of reasonable efforts made by airline companies and airport managements.
- Delays related to National Aviation System (NAS)

They include delays arising out of occurrence of problems or shortcomings in the aviation administration system, such as relatively adverse weather conditions, airport administration, high volume of air traffic, and state of air traffic control.
- Delays arising out of delayed arrival of previous flights

Such delays refer to the conditions in which delayed arrival of a previous flight causes the delays of the next flights of the same airplane to another destination.
- Delays caused by security conditions of airports: This kind of delays happen when a terminal seems required to be evacuated or the passengers and baggage of a plane are required to be evacuated and to embark again after renewed control and supervision before the flight because of security threats.

Delay components (IATA delay codes)

The International Air Transport Association (IATA) defined standard codes for delays to standardize delay factors for air carrier companies. Before that every company used its own special system to identify delay causes. So IATA standardized delay data. Using such codes we may identify delay cause of each flight by data produced by each company. More important, the classification of the existing standard makes it possible to identify all factors somehow having to do with delays. When preparing delay reports, a member air carrier company of IATA is required to indicate the most detailed report on delay causes. At present most distinguished air carrier companies use IATA delay codes in messages sent as movement massages by standard telexes from origin airports to destination airports with respect to flight times. A two digit code stands for each delay cause by IATA standard. Such codes are classified in ten main groups.

The codes of the first group begin with a "0" and so on until the codes of the last, i.e. the 10th, group which begin with the figure "9". It is noteworthy that some codes in IATA standard refer to no reason or cause of delays and are idle.

For the purpose of realization of the considered objectives of the project, 35 specialized sessions were held with some people to be informed of their expert views. Such people and their positions are as follows:

22 people consisting of 12 people in Iran Air, 5 people in Aseman Airlines and 1 person in Kish Airline. They are senior directors with long records and positions and jobs such as deputy director of Airline Company, station head, company's representative in major European airports, experienced pilots, flight crew, working steward, expert, officer of dispatch unit, expert of reparation and maintenance department, employee of airport service companies, flight coordinators and employee of traffic department in an airline company.

As the State Airports Co. is directly related to the issue of flight delays too, the "Airports Management" and "Department General of Flight Control" were taken into account as two informed, effective and important organizations in the field of flight delays and 13 people with the following directing and expert positions were interviewed and their views were gathered during a program:

Directors general of airports of the country, deputy directors of aviation operations of the Airports Co., deputies of directors general of the country's airports, experts of flight control and control tower in various airports, and middle directors of the country's airports.

DETERMINATION OF THE SHARE OF EACH COMPONENT AND FACTOR OF DELAYS DRUGING THE COUNTRY'S PASSENGER FLIGHTS

It was arranged that the techniques of Analytic Hierarchy Process (AHP) be used as a multi criteria method to analyze the factors and to determine their shares.

The evaluation method of Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a flexible, powerful and simple technique used in conditions in which conflicting decision-making criteria makes it difficult to choose from among options.

A) Establishment of a hierarchy structure and form to solve problems.

B) Establishment of priorities by dual comparisons.

C) Establishment of logical consistency among the measurements.

In addition, by this method we may do dual comparisons about criteria or options to show the rates of the consistency or inconsistency of a decision. Such property is counted as an excellent privilege of this technique. Furthermore, the Analytic Hierarchy Process (AHP) enjoys a powerful theoretical basis and is based on a set of self-evident principles.

The process comprises a set of decisions and personal evaluations in a logical way, so that we may say that the technique is dependent upon personal imaginations and experiences used to form and design hierarchy structure on one hand and is associated with logic, comprehension and experiences for final decisions and judgments on the other hand.

Steps of the Analytic Hierarchy Process (AHP):

Here we study various steps of the Analytic Hierarchy Process (AHP) in accordance with the model prepared for determination of shares of factors in causing delays in domestic passenger flights.

- Making a hierarchy structure

The most essential part of the Analytic Hierarchy Process (AHP) is to change the examined issue or problem to a hierarchy structure. In other words the Analytic Hierarchy Process (AHP) simplifies complicated problems by breaking them into minor elements connecting with each other on a hierarchy basis, in which the main objective of a problem is expressly related to the lowest levels of such hierarchy.

On the basis of the above and in accordance with available papers and documentation, 6 distinctive data bases were identified, and a hierarchy structure was finally established for determination of shares of factors having effects on flight delays, in the light of the objective of the project together with data of such sources as follows:

A) Questionnaires presented to passengers in Mehrabad airport

As there were a considerable number of such questionnaires, we achieved appropriate information about particulars and variety of the passengers of internal flights in various aspects and their motivations for air voyages. Such information is quite helpful in quantitative and qualitative study of delays in the internal flights.

B) Data base of the Civil Aviation Organization

This data base is counted as the sole source of authentic quantitative information and has indicated numbers and durations of delays classified by air carriers as well as one of such major factors as company performance, technical defects, weather conditions and others during a time span of more than one year. The above classification is not nevertheless so efficient, because the most important factor of delays is indicated to be "others", which encompasses more than half of the delays with respect to both number and durations.

As it is understood by its title, this factor does not provide a precise definition. However, as it is the only source of information about a considerable period of time, we founded the hierarchy structure on this basis. In this way an instrument was provided for the comparison of quantitative

statistics of delays and specialty views of experts and directors of the field. The first level of criteria was therefore defined in consistency with the four above factors and other classes and categories were made as their subsets.

C) Data base established in the "Aviation Deputy Director's Office" of the Civil Aviation Organization

In this new data base, the delay causes are shown separately by airport, air carrier, and number and durations of delays happened. Although it is more comprehensive than the former way and indicates almost all factors effective on flight delays, however, its statistic time span is too short (one or two months) and then an impediment for it to be used. Because in most cases the total recorded delays of an air carrier or airport does not exceed a dozen of cases and a short period of time of a few months cannot reveal the actual issues. For e.g. the New Year holidays occurred in such a few months making the achieved averages unreliable.

D) Classification of delay causes in other countries

The presented foreign studies deal with delay causes with applied views. Some of the factors may be placed in a more general category. Two factors of "extreme adverse weather conditions" and "delayed arrival of the previous flight" were however used in the hierarchy structure with due attention to the effectiveness of identified elements and factors with considerable shares in associated scientific judgments.

E) IATA delay codes

The most comprehensive and detailed classification of the causes of flight delays are based on a classification in which one digit codes are allocated to major causes and two digit codes stand for subsets. Therefore, a considerable part of criteria and sub-criteria were classified based on the above method and used in view of the objective of the project and limitations mentioned.

F) Interviews with and views of the experts of air transportation

The interviews made and views gathered in a wide span of operations associated with the subject have given precious results and compose the basis of evaluation and dual and justification comparisons used in the Analytic Hierarchy Process (AHP). In this respect the major criteria effective on the analysis of delay causes of the domestic flights and their subsets are introduced as follows:
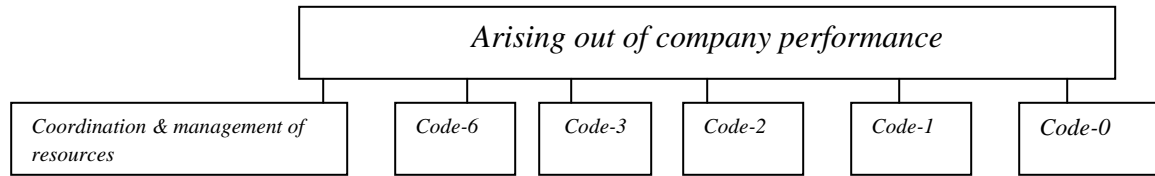
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                    Arising out of company performance

Coordination & management of    Code-6    Code-3    Code-2    Code-1    Code-0
resources
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Figure 1: the criteria "arising out of company performance"

As it is illustrated most of sub-criteria (i.e. 5 of the major cases effective on delays) are placed by IATA in this part and a sub-criterion "coordination & management of resources" is added to this part too. IATA had placed it among the sub-factors. Nevertheless, it is placed in this level because of its importance.
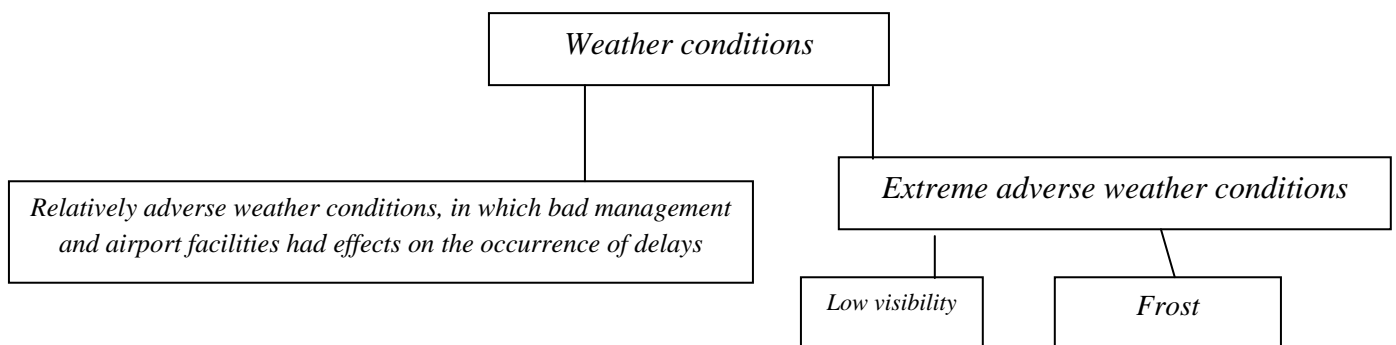
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                        Weather conditions

                                          Extreme adverse weather conditions

Relatively adverse weather conditions, in which bad management
and airport facilities had effects on the occurrence of delays
                                          Low visibility        Frost
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Figure 2: the criteria "weather conditions" and its sub-criteria

There was an applied point of view during the classification of the sub-criteria under "weather conditions" and two sub-criteria were defined. The first sub-criterion (i.e. extreme adverse weather conditions) is deemed to be a factor beyond the powers of human control. In this respect it is useful to indicate it separately because studies show that the actual percentage of cases of this factor is to low and most cases under the general title of "adverse weather conditions" do not belong to this part.

Two subsets of "frost" and "limited visibility" are chosen for this sub-criterion, as the most important adverse weather conditions. It is noteworthy that a wide variety of weather conditions may be attributed to this factor. However, their lower weights and importance caused them to be omitted from the hierarchy structure. In addition, two main factors of limited vision (i.e. "fog" and "dust") may also be separated. It would however have made the model too wide and it is not required too.

Although the second criterion (i.e. "relatively adverse weather conditions, in which bad management and airport facilities had effects on the occurrence of delays") may be analyzed and studied under other parts, such issues are placed under adverse weather conditions because they are usually dealt so (in Iran and other countries). However, it is clear for all that essential steps may be taken to decrease the indirect effects of the adverse weather conditions on the occurrence of delays or cancellation with the strengthening of aviation facilities, exploitation of airport equipment and installations, and use of state of the art fleet.
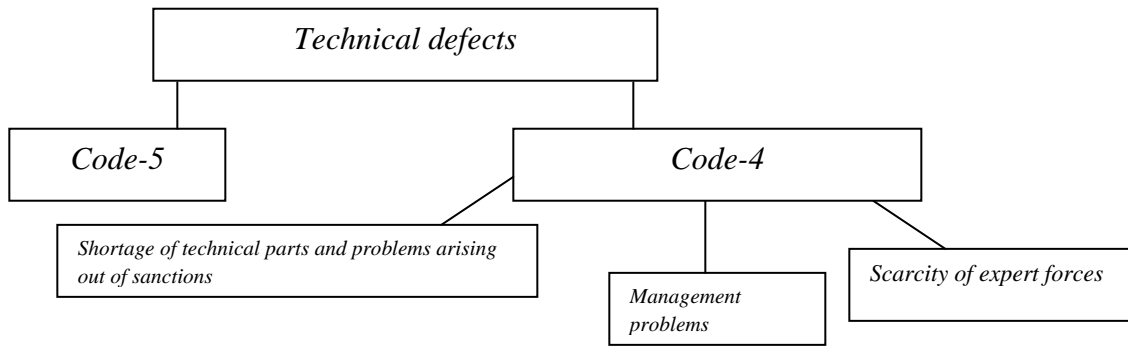
Figure 3: the criterion "technical defects" and its sub-criteria

The sub-criteria considered for the criterion "technical defects" are in full conformity with IATA classifications. On the basis of the above, the codes "4" and "5" are placed in this part. Three factors "Scarcity of expert force", "Management problems" and "Shortage of technical parts and problems arising out of sanctions" compose its most essential elements in accordance with numerous interviews with authorities of corresponding sections.
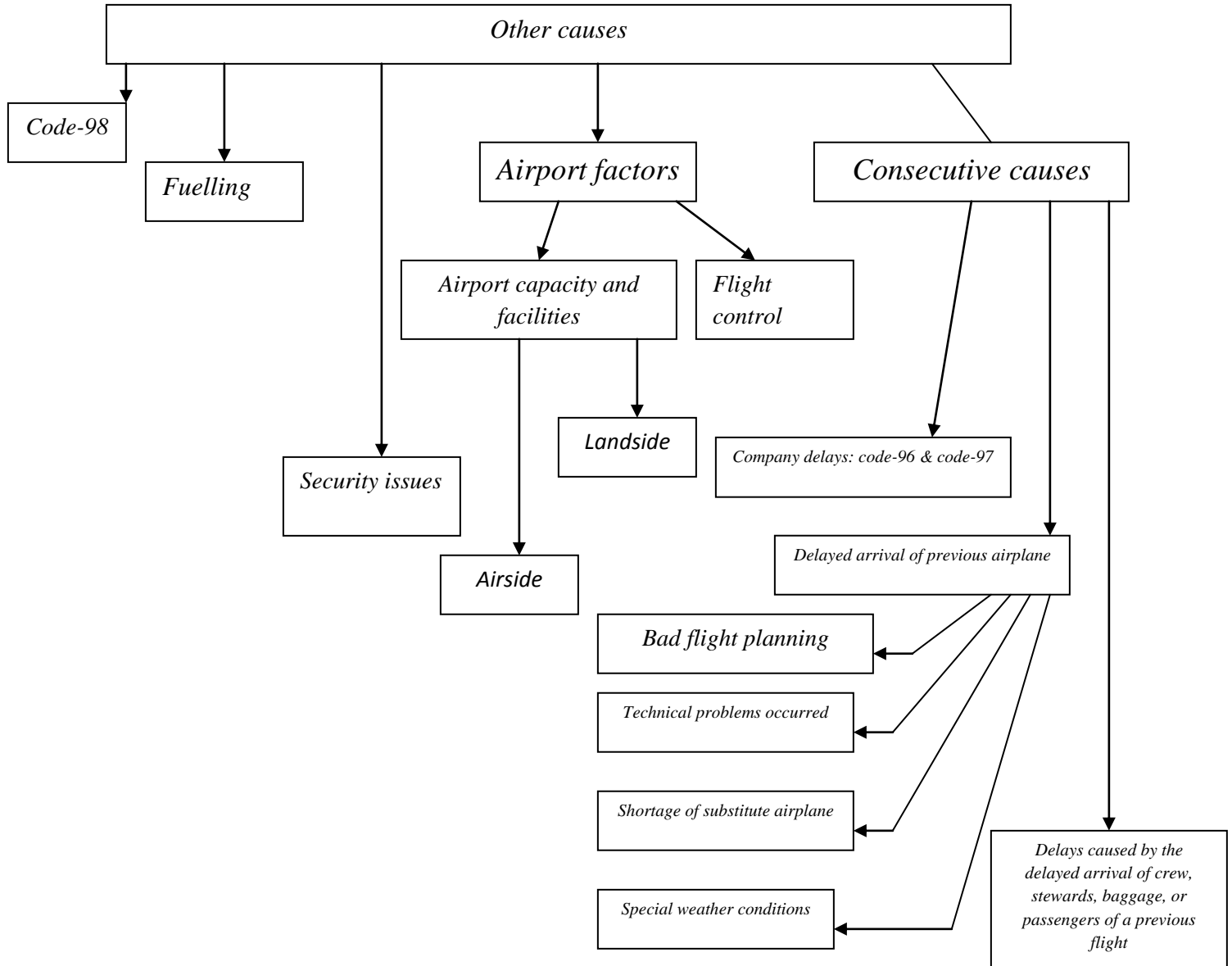
Figure 4: The criterion "other causes" and its sub-criteria

As it was mentioned before, the item "other causes" was given beside other three criteria for the purpose of the conformity with the structure of delay factors in the data base received from the Civil Aviation and for the purpose of better comparison. For e.g. the "consecutive causes" and "airport factors" seem to be more important than the factors "weather conditions" and it was more appropriate to deal with them in the same level. Anyhow, in the light of the importance of the sole considerable data base available, "other cause" was considered as an important factor, which encompasses a wide range of essential factors.

The logical relation governing the Analytic Hierarchy Process (AHP) is one of its advantages because it helps the people to understand the process easier.

The first level, where there are essential criteria, is of special importance because the points of such criteria are finally divided between various sub-criteria. The matrix of dual comparisons is established on the basis of the above and in accordance with the specialty viewpoints.

The causes and factors of flight delays are analyzed by means of geometrical average method, which is less complicated and more frequently used in manual calculations. We determine geometrical average of each row and make them normal. These normalized values are the same as the importance indexes of factors and are calculated as presented below. It is noteworthy that more precise methods are used by the software utilized to analyze and evaluate delay factors. Exactly the same method is used to establish other 11 matrices of dual comparisons. As it was mentioned before, this method is different from the software "expert choice" in one way or another. They are compared in table 1 (importance indexes). As you see the differences between the manual and computer calculations are so trivial and therefore both methods are reliable and practical.

Table 1: comparison of importance indexes of criteria in two methods "manual calculation" and "computer calculation"

Importance indexes	A	B	C	D
Manual calculation	0.261	0.060	0.214	0.465
Computer calculation	0.260	0.061	0.211	0.468

As it was mentioned before, the four major criteria of analysis and evaluation are presented in accordance with the classification of delay factors used by the State Civil Aviation Organization.

Determination of importance indexes of criteria and sub-criteria

To determine importance indexes (weights) of the criteria and sub-criteria, we do dual comparisons on them. The objective of the project, i.e. the determination of the shares of factors effective on delays, is the basis of the judgments about such advantages.

The founder of the Analytic Hierarchy Process (AHP) introduced a table with 9 various points given for the comparison of elements as follows to quantify and to equalize the judgment basis:

Table 2: Classification of dual comparison of the criteria under 9 groups

Points of importance	Definition	Description
1	Equal importance	The two criteria are of the same importance
3	A little more important	Experiences show that "i" is a little more important than "j".
5	More important	Experiences show that "i" is more important than "j".
7	Much more important	Experiences show that "i" is much more important than "j".
9	Absolutely more important	It is absolutely established that "i" is more important than "j".
2, 4, 6 or 8		Used for cases which are to be placed between the above items.

Determination of final points of criteria and sub-criteria

In this step, mathematical calculations are performed for a sub-criterion in the hierarchy structure to determine its points, i.e. its share. On the basis of the above, the final structure of the Analytic Hierarchy Process (AHP) is formed after execution of mathematical operations by software. Accordingly, the final points and percentages of criteria and sub-criteria are as follows in accordance with the calculations made by the software "expert choice":

The criterion "company's performance": 26 percent

Sub-criterion with code "0": 0.060
Sub-criterion with code "1": 0.062
Sub-criterion with code "2": 0.011
Sub-criterion with code "3": 0.021
Sub-criterion with code "6": 0.024
Sub-criterion "coordination and management of resources": 0.082

The criterion "weather conditions": 6.1 percent

Sub-criterion "relatively adverse weather conditions effective because of bad management": 0.046
Sub-criterion "extremely adverse weather conditions": 0.015
- Sub-criterion "frost": 0.003
- Sub-criterion "limited visibility": 0.012

The criterion "technical defects": 21.1 percent

Sub-criterion with code "5": 0.035
Sub-criterion with code "4": 0.176
- Sub-criterion "scarcity of expert forces": 0.023
- Sub-criterion "bad management": 0.024
- Sub-criterion "technical parts and problems arising out of sanctions": 0.129

The criterion "other causes": 46.8 percent

Sub-criterion "special cases" with code "98": 0.027
Sub-criterion "fuelling": 0.027
Sub-criterion "security issues": 0.025
Sub-criterion "airport factors": 0.128
- Sub-criterion "flight control" (code: 8): 0.032
- Sub-criterion "airport capacity and facilities": 0.096
--Sub-criterion "airside": 0.019
--Sub-criterion "landside": 0.077
Sub-criterion "consecutive causes": 0.261
- Sub-criterion "delays caused by delayed arrivals of crew, stewards, passengers and/or baggage from the previous flight": 0.024
- Sub-criterion "company's delays" (codes: 96 and 97): 0.039
- Sub-criterion "delayed arrival of the previous airplane" (code: 93): 0.198
--Sub-criterion "bad planning": 0.016
--Sub-criterion "scarcity of substitute airplanes": 0.055
--Sub-criterion "special weather conditions": 0.046
--Sub-criterion "technical problems happened": 0.081

- Study of consistency of judgment

The inconsistency was calculated by the software "expert choice". Therefore, after the calculation of inconsistency index, 12 matrices were formed. The corresponding results are shown in table 3. We can find out that the judgments made by all 12 matrices are correct.

Table 3: Results taken from the control of consistencies of the 12 dual matrices

Matrix No.	1	2	3	4	5	6	7	8	9	10	11	12
Matrix grade	4	6	2	2	2	3	5	3	4	2	2	2
L-n	0.27	0.62	0	0	0	0.116	0.448	0.116	0.27	0	0	0
Matrix inconsistency	0.04	0.05	0	0	0	0	0.04	0.03	0.06	0	0	0
Acceptable	√	√	√	√	√	√	√	√	√	√	√	√
	all the indexes of inconsistency are lower than 0.1											

CONCLUSION

The purpose of this study to determine the issues of delay in domestic passenger flights in Iran. For this purpose, AHP method was used. According to the results of this study, seven factors are effective in flight delays. The most important of these are arising out of company performance, technical defects and company's performance. An interesting finding in this study was that weather Conditions have low share in flight delays.

REFRENCE

Http://en.wikipedia.org(IATA Delay Codes)

http://www.rita.dot.gov

Http://ww.cao.ir