DETERMINING GAS PIPELINE OPTIMUM ROUTE BY USING INTEGRATED FAHP/GRA MODEL

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ABSTRACT

This paper is aimed at selecting optimum route of gas pipeline over three other recommended routes in Fars state by exploiting MCDM. The main criterias used here, include technical and engineering, environmental and socio-economic criterias that are based on sustainable development. Each of these criterias has some subcriterias which we have obtained their importance by FAHP then routes were classified by GRA. One of the advantages of this project is using subjective and objective datas to order alternatives simultaneously. Results show that in spite of the first expectation, the best route is not necessarily the shortest one and by considering sustainable development criterias among these recommended routes the best one is Eghlid to Sadeh.

Keyword: *Sustainable development, Fuzzy Analytical Hierarchy Process(AHP), Grey Relation Analysis(GRA), Optimum Route.*

1.INTRODUCTION

In traditional approach technical and financial principles are used to select gas and petruleom pipeline optimum route, while conducting these projects have some great influence on environment and people. The main gas pipeline number 2 exploiting after imposing war is a good evidence on this issue. One of the most important project that has a great influence in each country (esp. which have gas resources like Iran) is to transmit and export gas via pipeline. Economics of these countries extremely depends on fluent operations of the pipelines. In order to transmitting huge volume of gas energy , there are different ways such as sailing or land roads (trucks) and pipelines which have the most reliability to use. Effective management and enhancing reliability of this routes can be possible by drawing the optimum route properly. Different investigations show that constructing these pipelines affect on environment and people, these interferences include eliminating forests, farms and inhabitant. So for selecting optimum route we need an integrated model which is possible by using sustainable development approach. In sustainable development, technical analysis as well as environmental impact and socio-economic impact is considered.

In this paper according to the issues above, the possibility of constructing the projects are studied by providing an integrating model, simultaneously usage of Fuzzy Analytic Heirarchy Process (FAHP) and Grey Relation Analysis (GRA) make that possible so that we can utilize the experts ideas (who have a lot of experience about conducting project in energy sector) as well as using real datas which can be exploited for each of this routes. The point to note is that everybody assumes the shortest route is the optimum one because the shortest the route is the fewest pipes and pump stations needed. But the integrated approach used in this paper doubt about this issue due to considering environmrental and socio-economic index.

A few researches have been done about determinig gas and petruleom pipeline optimum route. Gutierrez et al,.(2002) determined gas optimum route in Campeche Mexico by a quantitative method and they used YAPP and a series of certain mathematics equations. Ecological and risk evaluation have been done at the same time and by exploiting experts in order of priority, the optimum route has been selected. Dey and Gupta (2006) investigated about the influences of pipeline on environment and economics of India. They established a model based on AHP and utilized the real information just for financial calculations. Their model includes three general criterias for evaluating the environmental, socio-economic impact and technical analysis. Consequently it makes it possible to evaluate optimum route financially. This model is the base of sustainable development considered in this paper.

2. FUZZY ANALYTIC HIERARCHY PROCESS (FAHP)

AHP is one of the methods for multicriteria decision making (MCDM) that is useful to decide and select an item among several items of decision, according to indexes determined by the decision makers. This method was invented in 1980 by Saaty. AHP reflects humans natural behavior and thoughts. In the real process of decision making, a variety of different kinds of lack of certainity and inaccuracy are encountered that needs specific instruments. Probability theory is condusive to show the nature of eventual decision analysis but it is not able to measure inaccuracy which is the base of humans behavior. According to MCDM, this means the decision maker can not express his preferences for each certain item accurately so deal with this kind of inaccuracy, evaluation and making remarks are done by linguistic statement and Fuzzy Logic.(Bevilacqua .et.al , 2006 :18)

The theory of fuzzy number is used for solving problems that have no precise defined criterion which was given by Zadeh in 1965. There are different kinds of fuzzy numbers, each is used for analyzing vague structure. In this research we used fuzzy numbers since those numbers can be useful for quantifying. Triangular Fuzzy Numbers (TFN) have also extensive usage in literature and among the different forms of fuzzy numbers,it can be managed by decision makers very easily.

A good model of decision making needs to admit vagueness because being unknown and vagueness are the common features in most of decision problems. When decision makers prefer inaccurate answers than accurate amongs, changing their qualitative desires in to point estimates may not be sensible.(Lee ,et.al, 2006 :4) So in AHP we may see some kinds of inaccuracy in pairwise comparison.

In general, when fuzzy linguistic approach can show pessimistic and optimistic , TFNs are well advised for evaluating priorities instead of equivalent numerical method. There fore according to Wen (2002) FAHP compare to traditional AHP is more effective and useful for inaccurate environment.

In literature FAHP , various kinds of methods have been described whose the obvious difference is in their theory structure. Accounting and complication of their process make it hard to use them very often. Give the fact that the process of Changs Extent Analysis (EA) is fairly easier than other FAHP approaches and similar to traditional AHP so we prefer that. EA method was presented by Chang, a Chinese researcher, in 1996. Numbers use in this method are TFN.(Bozbura ,2006 :7)

In EA , for each of rows of pairwise comparison matrix, the value of S_k –that is a TFN- is calculated as follow :

$$S_k = \sum_{j=1}^{n} M_{kj} \times [\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij}]^{-1}$$

Where

$$[\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij}] = \left(\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij}, \sum_{i=1}^{m}\sum_{j=1}^{n} b_{ij}, \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}\right)$$

Inversing the vector above :

$$[\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij}]^{-1} = \left(\frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}}, \frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n} b_{ij}}, \frac{1}{\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij}}\right)$$

Where k represents number of a row, i and j represent alternatives and indexes respectively. After calculating S_k , we should compare the degree of possibility among them. In general, if M_1 and M_2 are two TFNs , then degree of possibility of M_1 by M_2 can be like this :

$$V(M_1 \geq M_2) = 1 \qquad \text{if } m1 \geq m2$$

$$V(M_1 \geq M_2) = hgt(M_1 \cap M_2) \quad \text{o.w}$$

$$hgt(M_1 \cap M_2) = \frac{u_1 - l_2}{(u_1 - l_2) + (m_2 - m_1)}$$

degree of possibility of a TFN from k triangular fuzzy numbers is obtained as follow:

$V(M_1 \geq M_2 , \ldots , M_k) = V(M_1 \geq M_2 , \ldots , M_1 \geq M_k)$

For calculating the weight of indexes in pairwise comparison matrix we shoud do this :

$w´(xi) = \min \{V(Si \geq Sk)\}$ $\quad k = 1, 2 , \ldots , n \ \& \ i= 1 , 2 , \ldots , n \quad , k \neq i$

finally the vector for the weight of indexes will be as follow :
$W´ = [w´(x1) , w´(x2) , \ldots , w´(xi)]$
And normalized weight :

$$W_i = \frac{W_i'}{\sum Wi'}$$

$W = [w (x1) , w (x2) , \ldots , w (xi)]$
W is not a TFN.
Linguistic scales shoud be changed in to a fuzzy scale in order to mathematical calculation directly. In the Table (1) we can see triangular fuzzy conversion scale that is used in the model.

Table 1 Triangular fuzzy conversion scale

Linguistic scale	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Just equal	(1,1,1)	(1,1,1)
Equally important	(1/2,1,3/2)	(2/3,1,2)
Weakly more important	(1,3/2,2)	(1/2,2/3,1)
Strongly more important	(3/2,2,5/2)	(2/5,1/2,2/3)
Very strongly more important	(2,5/2,3)	(1/3,2/5,1/2)
Absolutely more important	(5/2,3,7/2)	(2/7,1/3,2/5)

3- GREY RELATION ANALYSIS (GRA)

Grey Theory has been used extensively for solving problems with uncertainity and insufficient or discrete datas for the first time by Deng in 1982. GRA method is the most general one used for analyzing the relations between the groups of discrete datas and MCDM. The strength point og grey theory is calculating simply and directly so the results are based on real datas. Also it has a lot of flexibility in decision making.(Wu, 2003 :211) mathematic can be combined with general systems theory, information theory and MCDM approach by grey theory in order to solve problems when there is no enough information. GRA is used for realizing while there is consistency between trend changes or not and also discovering possible mathematic relationships among different factors or inside each of them.(Tseng,et.al, 2003 :2472)

GRA is really and effective method for measuring the relationship between two systems or elements. Generally Grey systems have different scopes such as Grey Prediction, Grey Modelling, Grey Decision making, Grey controlling and Grey Relation Analysis.

This theory just needs a few datas to assess uncertainity systems behavior. By the last 20 years, researchers have tried to use grey theory successfully in searching about industries, social, ecological, economical, geographic and management systems. In short, grey theory is mainly aimed at constructing relation analysis model for uncertainity conditions, various data inputs, discreting datas. Insufficient information in decision making and prediction. (Wen, 2002: 23)

Generally GRA has these features :

1- it does not need a sample with an accurate size.
2- The model is constructed with some series of real datas and results are based on them.
3- We can calculate easily with this methods.
4- It is not necessary to have normal data distribution (Tseng,et.al, 2003 :2472)

Grey Relation Analysis needs two groups of datas called "Reference Sequence" and "Comparative Sequence" which are used for making a relation in a grey system and the correlation of reference sequence shoud be considered with comparative sequence. To explain the issue: if x_0 is a series of data then

$$\boldsymbol{x}_0 = \left(x_0(1), x_0(2), \ldots, x_0(n)\right)$$

and we have a series in meeting around related factor

$$x_i = \left(x_i(1), x_i(2), \ldots, x_i(n)\right)$$

Finally the real numbers are like this

$$\gamma(X_0, X_i) = \frac{1}{n}\sum_{k=1}^{n} \gamma(x_0(k), x_i(k))$$

That can explain these four hypothesis :

1- The Property of Normality

$$0 \le \gamma(X_0, X_i) \le 1 \text{ and } \gamma(X_0, X_i) = 1 \Leftrightarrow X_0 = X_i$$

2- The Property of Wholeness

$$\forall X_i, X_j \in X = \left\{X_S s = 1,2,\ldots m; m \ge 2\right\}$$

where

$$\gamma(X_i, X_j) \ne \gamma(X_j, X_i), (i \ne j)$$

3- The Property of Pair Symmetry

$$\gamma(X_i, X_j) = \gamma(X_j, X_i) \Leftrightarrow X = \left\{X_i, X_j\right\}$$

4- The Property of Closeness

The less $\left|x_0(k) - x_i(k)\right|$ the more $\gamma(x_0(k), x_i(k))$. $\gamma(X_0, X_i)$ is represented for the Degree of Grey Incidence of X_i regarding to X_o and $\gamma(x_0(k), x_i(k))$ is to show Incidence Coefficient of X_i regarding to X_o in k.

The hypothesis above indicates :

a) $\gamma(X_0, X_i) \in (0,1]$ implies that each series of datas in a system can be without any relationship.

b) The Property of Wholeness indicates the effectiveness of environment on grey expansion. When the environment changes , the degree of grey expansion does, too. (Sifeng & lin , 2006: 96)

c) The Property of Pair Symmetry indicates that each series of grey expansion datas just includes two series on its own.

d) The Property of Closeness implies the relation of expansion degree so the grey degree coefficient formula is as follow:

$$\gamma(x_0(k), x_i(k)) = \frac{\Delta\min + \zeta \cdot \Delta\max}{\Delta_i' + \zeta \cdot \Delta\max}$$

where $\Delta_i(k) = |x_0(k) - x_i(k)|$ and by multipliying relative weights to difference values between series, Δ_i' can be obtained.

$$\Delta_i' = \sum_{k=1}^{n} w_k \Delta_i(k)$$

$$\Delta\min = \min_i \min_k \Delta_i(k) \qquad \Delta\max = \max_i \max_k \Delta_i(k)$$

k = 1,2,…,n & i = 1,2,….m

ζ is a parameter in gret theory that is called Distinguishing Coeffecient and changes from zero to one, $\zeta \in (0,1)$, it almost always 0.5 that reflects competitive environment. If ζ =0 , it means the effectiveness of environment was neglected and if ζ =1 , the environment is completely effective. (Tseng,et.al, 2003 :2472)
By changing ζ , the degree of Distinguishing among series will be determined. If ζ =1 , the grey relation coefficient will decrease to the least amount and if ζ =0 , grey relation coefficient will increase to the most amount. (Huang,et.al, 2007 :20)

Numbers should be normalized before calculating grey relations so it is necessary to identify the nature of each criterias and their utilities in being more or less. In this condition if the nature of being more is desirable, we used this formula:

$$x_i^*(k) = \frac{x_i(k) - \min_k x_i(k)}{\max_k x_i(k) - \min_k x_i(k)}$$

And if the nature of being less is desirable, we can used this formula:

$$x_i^*(k) = \frac{\max_k x_i(k) - x_i(k)}{\max_k x_i(k) - \min_k x_i(k)}$$

4-METHOD
In research by using abtained datas from gas company of Fars, we can select optimum route. Three recommended routes are : Safashahr to Sadeh,Abadeh to Sadeh and Eghlid to Sadeh. This paper works on the datas related to pipeline at the end of 2008. in order to do that by using the concept of sustainable development, the needed criterias for evaluating and selecting the optimum route is extracted.

Sustainable Development
Sustainable development was brought up in 1980s. in addition to environmental basis, none stop efforts based on a lot of experiences were done in this case. Through 1950s and 1960s, the most consideration had been on economical efficiency. The new concept of sustainable development is wholistic and includes social, economical, cultural and other human desires acpects.
Three main criterias of extracted sustainable development (Dey&Gupta : 2002) are :

4.1. Technical criterias
The main technical factors that are used for selecting optimum route of gas pipeline are presented in Table 2.

Table 2 Technical criterias

Criterias	Description
Pipeline length	Governs the capacity requirement of all equipment for entire pipeline project.
Operability	
• Aggregation of liquidity	Due to extreme change of height in places which are very high or very low, liquids aggregate in turnig-point.
• Pressure variation due to height variation	There is pressure variance two times more in places with liquide aggregation
• Increasing of pipeline stations	Gas station are stablished in order to increase the pressure of gas energy in pipeline.
Maintainability	
• Corrosion	In places like swamps and under ground etc. water that can be corroded, we need more stations to prevent corrosion.
• Line break valve (LBV)	It is effective to use LBV for some factors like passing from crowded area, faults, places with too much gradient and where we need to increase the length of pipeline.
• Frizing of pipeline	Removing moisture in winter can form some crystals so it causes blockage inside pipeline.
• Capability of pipeline replacement if it is needed	According to experts idea this variable is considered qualitatively.
Approachability	
• Being near to the main roads	The more reachable the main roads, the utility is more
• Strength of Right of Way (ROW)	ROW can be eliminated due to Being mountainous and surrounded by farms.
Constructability	
• Being flat to build ROW	If the roads are flatter, we can construct ROW easier.
• Natural twist of route	These twist lead to eliminate a lot of farms.
• Passing from Natural barrier	These barriers include lake, mountain pass and etc.
• Passing from artificial barrier	These barriers include asphalt roads,path and railways.

4.2. Environmental criterias

It is usual to have some failures even if the pipelines were drawn with high level of standards. Some times these failures lead to release great volume of gases in environment. In this case if the pipelines were placed far away, there are fewer problems in environment. (Dey, 2002 : 714)

In Table (3), environmental criterias have been given.

Table (3) Environmental criterias

Criterias	Description
Pipeline and station damaging causes firing	Passing from mountainous places and farms causes firing and damaging
Normal operations in stations and valves	
• Blow down	Each of LBVs has a blow down. So blowing down can be done in the number of this LBVs.
• Pigrunning	Pollution that were subsided in pipeline shoud be cleaned off.
Effect during construction	
• Cutting the trees	We have to avoid cutting the trees
• Damaging the pastures	Damaging the pastures has to be avoided
• Passing from lakes, rivers and ponds	Cuasing impossibility in construction and interference in our environment

4.3. socio-economic criterias

The assessment of socio-economic influences is very complicated. Some assumes these assessment are independent and others thinks they are inseparatable. Assessment of social influences is newer than the assessment of economical and environmental influences.

Socio-economic influences that are made by doing project summarized in Table(4).

Table (4) Socio-economic criterias

Criterias	Description
Effect during planning	
• Passing from crowded places	In developing countries,it can be better to passed the road from the criwded places
• Passing from industries and industrial towns that use gas	Industries such as cement, sugar and etc are the main ones in using gas
• Payback period	This index is quantitative and it is calculated according to hot and cold days
Effect during construction	
• Passing from farms and gardens	Constructing pipeline has some bad effects on agriculture
• Limitation of villages developments	According to yhe pipeline limitation, the development in villages can be limited
• Line class	Places with C and D class are very crowded and dangerous

Datas about each roads and its measurement have been extracted from database (Table5). These datas are used as objective datas in GRA.

Table 5 datas and measurement about roads

Sub-criterias	**Measurement**	Route 1	Route 2	Route 3
Pipeline length	Km	104.5	100	90
Aggregation of liquidity	number	1	2	15
Pressure variation due to height variation	number	2	4	30
Increasing of pipeline stations	station	0	0	2
Corrosion	station	3	3	2
Line break valve (LBV)	number	3	5	10
Frizing of pipeline	number	0	1	10
Capability of pipeline replacement if it is needed	qualitative	2	3	10
Being near to the main roads	number	3	2	0
Strength of Right of Way (ROW)	Km	30	20	80
Being flat to build ROW	percent	95	80	30
Natural twist of route	inch	12	15	1200
Passing from Natural barrier	number	3	5	30
Passing from artificial barrier	number	6	5	3
Pipeline and station damaging causes firing	Km	0	0	60
Blow down	number	3	5	10
pigrunning	Number/a year	1	2	4
Cutting the trees	Km	0.5	2	40
Damaging the pastures	Km	30	30	10
Passing from lakes, rivers and ponds	number	4	4	2
Passing from crowded places	number	69	20	5
Passing from industries and industrial towns that use gas	number	5	3	1
Payback period	year	18.14	20.83	24.3
Passing from farms and gardens	Km	60	60	30
Limitation of villages developments	Km	69	20	5
Line class	number	15	20	8

The model in this paper is used for assessing optimum route which is presented in the following hierarchy chart. It has 3 mani criterias in the first level and 10 sub-criterias in the second level and 24 sub-sub-criterias in the third level.

5- RESULTS

As we said, the model used in this paper contains two parts. The first one is to determined relative weights of each criterias and sub criterias by exploing FAHP. Using this method includes following steps :

1- Defining evaluation criterias to select pipeline route accurately
2- Constructing hierarchy structure by making the problem in to decision details which contains goal, criterias and sub-criterias. (Figure 1)
3- Making pairwise comparison matrices by usinh experts ideas and determining consistency of each matrix by calculating eigen value and eigen vector for each of them.

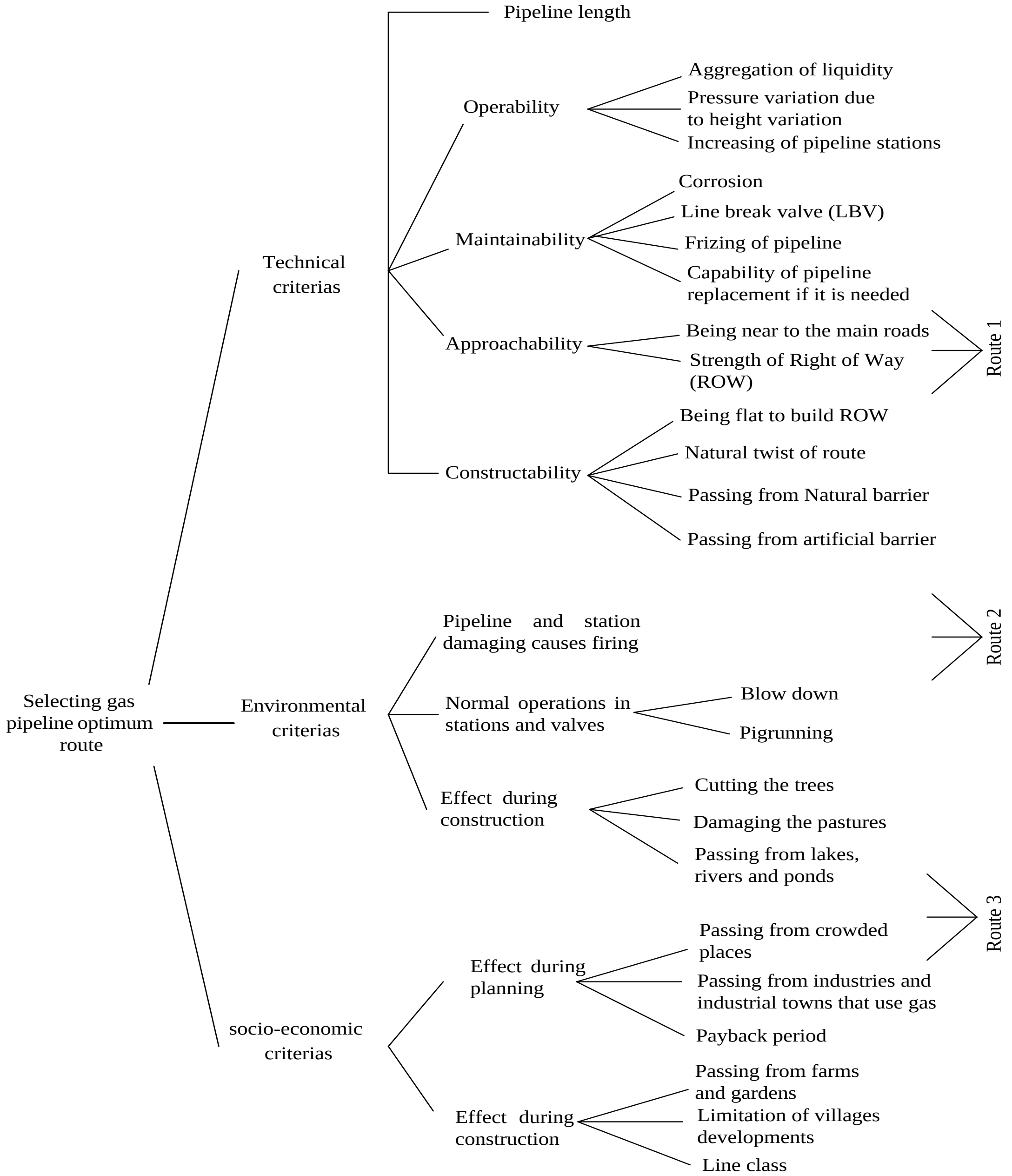

Figure (1) Analytic Hierarchy Process Structure

pairwise comparison matrices where made according to goal, main criteria and sub-criteria. Also the consistency of each of them were calculated by SuperDecision software. Three matrices in this research show more than 0.1 inconsistency so by referring to experts and evaluations, essential correction eas done. Table (6) shows eigen value, inconsistency index and inconsistency ratio after correction by experts for all of matrices.

Table (6) inconsistency ratio of matrices

pairwise comparison matrix	eigen value	inconsistency index	inconsistency ratio
Main criterias	3.114	0.057	0.098
Technical criterias	5.412	0.103	0.092
Maintainability	4.231	0.077	0.086
Approachability	2	0	0
Constructability	4.221	0.074	0.082
Environmental criterias	3.107	0.054	0.092
Normal operations in stations and valves	2	0	0
Effect during construction	3.09	.045	.078
socio-economic criterias	2	0	0
Effect during planning	3.063	.032	.055
Effect during construction	3.10	0.05	0.086

4- *Using Extent Analysis approach and calculating relative wights*. At first pairwise comparison matrix is obtained by using fuzzy scale represented in table (1) and then by utilizing EA, relative wights is calculated for each of these factors.

Table (7) shows sub-criterias which make the second level of hierarchy structure after doing pairwise comparison by EA.

Table 7 relative wights of second level of hierarchy structure

sub-criterias	Relative wights
Pipeline length	0.327
Operability	0.128
Maintainability	0.011
Approachability	0.092
Constructability	0.441
Pipeline and station damaging causes firing	0.457
Normal operations in stations and valves	0.086
Effect during construction	0.457
Effect during planning	0.684
Effect during construction	0.316

Table 8 relative wights of third level of hierarchy structure

sub- sub-criterias	Relative wights
Aggregation of liquidity	0.1579
Pressure variation due to height variation	0.4504
Increasing of pipeline stations	0.3916
Corrosion	0.321
Line break valve (LBV)	0.2182
Frizing of pipeline	0.2617
Capability of pipeline replacement if it is needed	0.1991
Being near to the main roads	0.6842
Strength of Right of Way (ROW)	0.3158
Being flat to build ROW	0.4544
Natural twist of route	0.0162
Passing from Natural barrier	0.3691
Passing from artificial barrier	0.1603
Blow down	0.6842
pigrunning	0.3158
Cutting the trees	0.5007
Damaging the pastures	0.2481
Passing from lakes, rivers and ponds	0.2512
Passing from crowded places	0.5069
Passing from industries and industrial towns that use gas	0.4369

sub- sub-criterias	Relative wights
Payback period	0.0561
Passing from farms and gardens	0.2289
Limitation of villages developments	0.6142
Line class	0.1569

According to relative wights in tables above, by multiplying the wights of each sub-criteria to the wights of higher level main criteria, total wight is obtained for each sub- criteria. These wights will be used for ordering in the next part. Table (9) shows the outputs of FAHP as input datas in to GRA.

Table 9 total wights of sub-criterias

The second and the third level sub-criterias	Total wights
Pipeline length	0.149
Aggregation of liquidity	0.0092
Pressure variation due to height variation	0.0263
Increasing of pipeline stations	0.02287
Corrosion	0.0017
Line break valve (LBV)	0.0012
Frizing of pipeline	0.0014
Capability of pipeline replacement if it is needed	0.0011
Being near to the main roads	0.0289
Strength of Right of Way (ROW)	0.0133
Being flat to build ROW	0.09164
Natural twist of route	0.0037
Passing from Natural barrier	0.0744
Passing from artificial barrier	0.0323
Pipeline and station damaging causes firing	0.0391
Blow down	0.0051
pigrunning	0.0023
Cutting the trees	0.0196
Damaging the pastures	0.0097
Passing from lakes, rivers and ponds	0.0098
Passing from crowded places	0.1585
Passing from industries and industrial towns that use gas	0.1366
Payback period	0.01755
Passing from farms and gardens	0.0331
Limitation of villages developments	0.0866
Line class	0.02265

According to the brought up model, the next part of this paper uses GRA for ordering the routes which contains the following steps :

1- *determining the behavior and the nature of each criterias and datas*. The nature of criterias and datas means finding whether being more or less for each of them can be better or not and also being qualitative or quantitative for each criteria should be determined then the qualitative criterias need to be changed in to quantitative criterias.
2- *Transforming obtained datas to comparative series.* In order to be able to compare routes, each of them should be considered as a data series. In this step, it is important to select reference sequence. The most ideal manner is used in this research so that changing reference sequence does not have any effect on selecting optimum route.
3- *Normalizing numbers in each series before calculating grey relation.* In this step normalization is done according to introduced formulas and by considering the nature of each criteria that shows being more or less is better. The most number is one and the least number is zero in each series.

4- *Calculating the difference between series.* In this part the difference between each series and reference sequence is obtained. The Table (10) shows this differences where Δ_1 indicates the difference between the first series and reference sequence, Δ_2 indicates the difference between the second series and reference sequence and Δ_3 is to show the difference between the third series and reference sequence.

5- *Inserting obtained relative wights from FAHP in GRA formula.* the wights obtained from FAHP is used in formula so that this wights are inserted in denominator of grey incidence coefficient in $\Delta_i(k)$ and multiplied to obtained difference between series that we saw in the Table (10).

Table 10 Total weights and series differences

The second and the third level sub-criterias	Δ_1	Δ_2	Δ_3	Total wights
Pipeline length	0.1388	0.0957	0	0.149
Aggregation of liquidity	0	0.0667	0.9333	0.0092
Pressure variation due to height variation	0	0.0667	0.9333	0.0263
Increasing of pipeline stations	0	0	1	0.02287
Corrosion	0.3333	0.3333	0	0.0017
Line break valve (LBV)	0	0.2	0.7	0.0012
Frizing of pipeline	0	0.1	1	0.0014
Capability of pipeline replacement if it is needed	0	0.1	0.8	0.0011
Being near to the main roads	0	0.3333	1	0.0289
Strength of Right of Way (ROW)	0.125	0	0.75	0.0133
Being flat to build ROW	0	0.1579	0.6842	0.09164
Natural twist of route	0	0.0025	0.99	0.0037
Passing from Natural barrier	0	0.0667	0.9	0.0744
Passing from artificial barrier	0.5	0.3333	0	0.0323
Pipeline and station damaging causes firing	0	0	1	0.0391
Blow down	0	0.2	0.7	0.0051
pigrunning	0	0.25	0.75	0.0023
Cutting the trees	0	0.0375	0.9875	0.0196
Damaging the pastures	0.6667	0.6667	0	0.0097
Passing from lakes, rivers and ponds	0.5	0.5	0	0.0098
Passing from crowded places	0	0.7101	0.9275	0.1585
Passing from industries and industrial towns that use gas	0	0.4	0.8	0.1366
Payback period	0	0.1107	0.2535	0.01755

The second and the third level sub-criterias	Δ_1	Δ_2	Δ_3	Total wights
Passing from farms and gardens	0.5	0.5	0	0.0331
Limitation of villages developments	0.9275	0.2174	0	0.0866
Line class	0.35	0.6	0	0.02265

6- *Selecting the highest degree of Grey Relation to determine the best alternative.* According to the majority of researches in literature and because the effectveness of environment and its uncertainity is considered rationally, the value of Distinguishing Coeffecient is assumed 0.5. In Table (11) results will be described by using obtained values and grey incidence coefficient formula.

Table 11 Results

	Route 1	Route 2	Route 3
$\sum \Delta_i'$	0.556	0.289	0.157
$\Delta \max$	1	1	1
$\Delta \min$	0	0	0
ζ	0.5	0.5	0.5
γ	0.7608	0.633	0.4737
Priority	1	2	3

Figure (2) shows the position of the routes for different values of distinguishing coefficient from 0.1 to1. Indeed distinguishing coefficient can have different values without any change in final result.

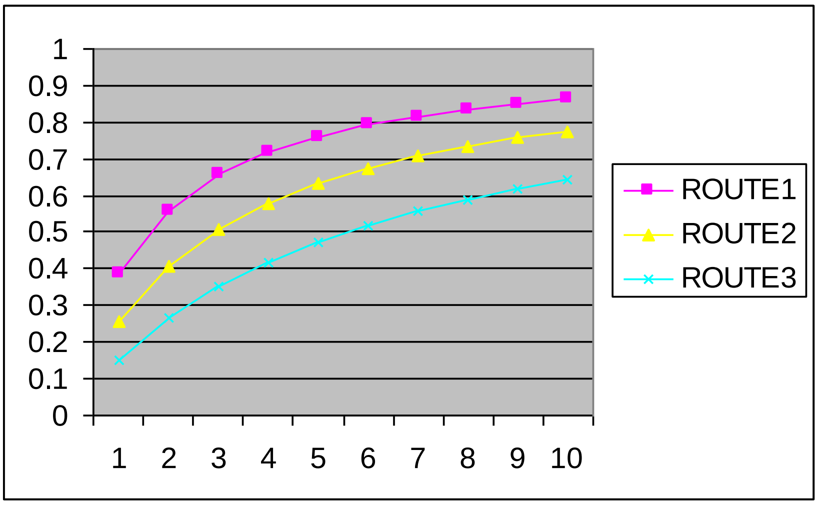

Figure (2)Sensitive analysis for different values of distinguishing coefficient

The best route for transmiting gas to Sadeh according to the priority ontained from Table (11) based on grey incidence coefficient, is the route 1 and from Safashahr.

6- CONCLUSION

The results show, however, the shortest route is the third one but it is in the lowest priority so it implies that for selecting the best route in projects, we try to choose the shortest one, but the obtained result in this paper is in contrast with the traditional approach. Paying attention to the concept of sustainable development and experts ideas, essential criteria and sub-criterias for determining the optimum route was recognized and according to calculated datas, experts have allocated a very low wight to the environment. Indeed, the reason for not selecting the shortest routes was the difficulty to construct pipeline technically and it costs a lot but not considering environmental factors. As an advantage, we can utilize objective and subjective datas in this research simultaneously. Because we can use FAHP which has inserted objective and subjective datas in the model and exploit GRA which has enabled us to use objective datas simultaneously, in selecying the optimum route both of those datas was available and made the model valid. Also fuzzy approach has enabled the decision makers to reflect their desires in the form of linguistics variables.

One of the limitation encountered in this research is that for socio-economic assessment, only the factors that were changeable to quantitative form have been considered but if we need more extensive view we must provide a questionnaire survey and have some local samples. Some another factors such as soil materials through different parts of routes, faults, protected areas were not considered due to not having enough database and accurate geographical information system. Evidently by using those factors we have been able to analyse more accurately so that we had a more rational decision.

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