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Research Article

DECISION MAKING MODEL & SIMULATION IN PROJECT OF ESTABLISHING ANIMAL FEED PRODUCTION UNIT USING FUZZY ANALYSIS & ARTIFICIAL NEURAL NETWORK (CASE STUDY: TEHRAN PROVINCE-IRAN)

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ABSTRACT
In this research Iran's provinces were considered for being invested in livestock & poultry concentrate production units and priority. Then the area of Varaminin Tehran province were studied and compared with other areas. In this research The Fuzzy TOPSIS Method was used for ranking the provinces and regions. Then optimal limits of Investment in livestock & poultry sector determined. Two methods which were Time series Regression & Artificial Neural Network used for estimating the range of predicted price for each kilo's of concentrate. Finally added value of concentrate production calculated for coming years by getting average benefit of services, financial intermediary, transportation, and storage sectors. The results show that in optimistic, pessimistic and uncertainty states, Varaminregion has first grade among Tehran province townships. Comparing the provinces shows that, Tehran has 3th or 4th grade in all 3 situations.

Keywords: *Decision Support System, Concentrates Live Stock Production Units, Project, Fuzzy Multi Criteria Decision Making, Artificial Neural Network*

INTRODUCTION
For having a successful investing in uncertainty state, based on risk avoiding low each economic activity which has most added value and lowest financial risk must be chosen. One of the effective solutions to reduce probability of risk is choosing appropriate regions for investment.

Using Fuzzy TOPSIS Algorithm or Similar Techniques Such As Fuzzy AHP Indifferent Projects, to Choose the Appropriate Manufacturer or Choosing a Suitable Location for the Project

Supplier selection is an important issue in supply chain management in recent years, determining the best supplier in the supply chain has become a key issue. It consists of several categories or criteria and usually requires either a compromise or consensuses about possible causes were opposite. Therefore multi criteria decision making is a practical procedure to solve these kinds of problems. The researchers developed a technique to solve the problem of supplier selection by a fuzzy comprehensive based on FTOPSIS and multi-choice goal programming.

Pi & Low (2005) developed a technique to solve the problem of supplier selection by a fuzzy comprehensive based on FTOPSIS and multi-choice goal programming supplier evaluation and selection is complex and requires a multi-criteria decision in examining a supplier for both quantitative and qualitative criteria.

The main criteria to select a suitable supplier are: The delivery price, quality, productivity, location of suppliers, technical ability, management, history and reputation, experience, performance and maintainability by Weber *et al.,* (1991).

Chen and Chen (2010) adduction a Fuzzy multi criteria decision making approach to select appropriate supplier and evaluated criteria in their study were: being beneficial supplier, close relationship, technological capability, quality and resolve the possible conflicts.

Faez *et al.,* (2009), stated that, in recent years the combination of different methods for selecting suitable suppliers has attracted much attention. Önüt *et al.,* in 2009 used AHP & TOPSIS combination to select a vendor to help a telecommunications companies.

Ha & Krishnan in 2008 used a hybrid model involves use of NN (Neural network), AHP (Analytical Hierarchy Process) and DEA (data envelopment analysis) to select the best supplier. The goal of all activities in the supply chain is to enhance the competitiveness.

Two tools are widely being used for this purpose. The first is integration of organizations and the second one is more coordination between materials, information and financial flows by Marqueza & Blanchar (2004).

Selecting the location of service centers, industrial and commercial units is the most important activity in the strategic planning for the wide range of public and private companies. For this purpose a multi-criteria decision method must be used. It should be noted that the classical approach cannot effectively be used for the selection of project sites because quantitative and qualitative information can be vague and imprecise.

Coyle *et al.*, (2003) the project location selection is a multi-criteria decision problem and may involve conflicting criteria such as the political environment, proximity to markets and clients, supplying network, development potential, living standards and cultural issues, and so on.

Chou *et al.*, (2002) most of the features that are used as criteria in the selection of locations are not represented as exact numbers and should be evaluated by understanding the individual, therefore they have a vague nature so linguistic variables must be used in the calculations of fuzzy techniques.

MATERIALS AND METHODS

Materials

FTOPSIS Methodology (Chen and Chen, 2010)

In this method, decision making matrix elements and weight of the criteria or both of them, evaluated by linguistic variables were presented by fuzzy numbers, and thus overcame the technique, for Order-Preference by Similarity to Ideal Solutions problems. Steps involved in this method are as follows:

1-Forming the decision matrix with fuzzy numbers
2-Forming the Measures weight matrix
3-Scaling out the fuzzy decision matrix
4-Determining the fuzzy weighted decision matrix
5-Finding the Fuzzy Positive Ideal Solution (Fuzzy Positive Ideal Solution: FPIS) and Fuzzy Negative Ideal Solution (Fuzzy Negative Ideal Solution: FNIS)
6-Calculating the distance from the FPIS and FNIS
7-Calculating the similarity index
8-Ranking the options

The criteria considered in this study are:

C1: Credits paid to each province agricultural sector in million Rials. Most of the agricultural activities required financing from banks or other financial institutions, to farmers, dairy farmers, poultry and fish producers, to be able to supply the necessary equipments such as farm machineries and irrigation equipments. That's why the provinces have a higher agricultural potential, can absorb more of the facilities provided by the banks. So this is one of the main factors has been considered for ranking provinces in agriculture livestock and poultry. Whatever agricultural production in a province is much richer, supplying the raw materials for the producer of concentrated will be easier.

C2: The cost of food, including meat, milk and eggs in million Rial. Much higher percentage of urban population and increased consumption of dairy and proteinaceous products can stimulate the activity of livestock and poultry. That's why many large chicken farms have been established around the towns.

C3: Annual household income in million Rials. Due to the high price of animal products, relatively higher annual household incomes could be one of the factors that influence the sale of animal and proteinaceous products, but its impact is less than the food cost of households because the households with higher incomes will be expended a part of their income on food supply and its main part may be used for the other needs.

C4: Cultivation area of wheat, barley, corn, soybean, alfalfa, canola for each province in to hectare. higher area under cultivation crops can reduce the transportation costs of raw materials needed, For example, to supply bagasse or wheat bran and rice from sugar units or units of wheat flour and rice milling units, if any, in situ.
C5: Animal population. Population increases especially heavy livestock, like cattle, increased feed intake as concentrated form. Thus this factor considered as one of the major influences in concentrate production.
C6: Capacity in chicken farms. Due to that number of poultry in each province expressed by provincial capacity of poultry farms, its impact intended somewhat lower than livestock population.
C7: Provincial investment in poultry & livestock sector in million Rials. More investment in poultry & livestock sector will develop the activities in this field in terms of supplying new equipment and creation of new producing units. So this is one of the main factors for ranking in terms of desirability for construction Poultry & Livestock concentrate production units.

Forming the Decision Matrix with Fuzzy Numbers

In this research, triangular fuzzy numbers were used for desired criteria. After determining the maximum and minimum values obtained for each province, the data set mediocrity specified by averaging the values of previous years. Due to the high inflation rate in Iran, it is possible that the lower amount of investments accomplished in previous years had more value than newer investments. Because of this matter to obtain the actual increase or decrease in amount of investment following formula were used.

(Relation 1) $F = P(1 + i)^n$

In the above equation i is the real interest rate and it is equal to Inflation – nominal interest. The value of i been considered %12 for agricultural facilities and total investment in poultry & livestock sector. But for other items such as income, the inflation rate considered. Data collected on loans paid to the agricultural sector are from the period of 2004 to 2009. Collected data on production units capital are the years between 2006-2009.

Forming the Measures Weight Matrix

In Fuzzy TOPSIS method to determining the weight of the indicators the same method has been used in AHP through questionnaire survey among experts in livestock & poultry and activists. To determine the weight vector matrix instead of using linguistic terms using a questionnaire and providing comments on the livestock and poultry producers and actors, Numerical ranges for the three categories are as follows: optimistic, pessimistic and uncertainty are considered. By using FTOPSIS method, similarity index of the provinces obtained and their ranking given in the table of results.

Table 1: Weight matrix of criteria for the pessimistic condition

criteria	**C_1**	**C_2**	**C_3**	**C_4**
weight	0.04,0.06,0.08	0.11,0.12,0.14	0.06,0.08,0.1	0.08,0.1,0.12
criteria	**C_5**	**C_6**	C_7	
weight	0.25,0.27,0.3	0.18,0.2,0.22	0.11,0.12,0.14	

Table 2: Weight matrix of criteria for the optimistic condition

criteria	**C_1**	**C_2**	**C_3**	**C_4**
weight	0.08,0.1,0.12	0.15,0.16,017	0.09,0.11,0.12	0.11,0.12,0.14
criteria	C_5	C_6	C_7	
weight	0.25,0.3,0.35	0.2,0.22,0.25	0.13,0.14,0.15	

Table 3: Weight matrix of criteria for the risk and uncertainty condition

criteria	**C_1**	**C_2**	**C_3**	**C_4**
weight	0.04,0.08,0.12	0.11,0.13,0.15	0.06,0.09,0.12	0.08,0.11,0.14
criteria	C_5	C_6	C_7	
weight	0.25,0.3,0.35	0.18,0.2,0.25	0.11,0.13,0.15	

Determining the Optimal Investment Index

To determine the optimal amount of investment in the poultry & livestock sector under the condition of risk and uncertainly, the investing index according to the following equation can be used:

$$\text{Investment Index} = \frac{CC_i}{\sum_{i=1}^{n} CC_i} \times 100 \text{(Relation 2)}$$

Ranking the Regions (Townships) in Tehran Province

With attentive the small area of Tehran province unlike the other provinces and its many roads and highways for better and suitable access to other regions, credits for agricultural, cost of food and Annual household income didn't consulted. The weight of criteria shows in tables1, 2, and 3.

Table 4: Weight matrix of criteria for the optimistic condition

minimum	average	maximum	Criteria	
30	38	45	Population of live stock	**C1**
30	33	35	Capacity of poultry	**C2**
20	25	30	Under cultivated area	**C3**

Table 5: Weight matrix of criteria for the pessimistic condition

minimum	average	maximum	Criteria	
30	35	40	Population of live stock	**C1**
25	33	35	Capacity of poultry	**C2**
20	22	25	Under cultivated area	**C3**

Table 6: Weight matrix of criteria for the risk and uncertainty condition

minimum	average	maximum	Criteria	
30	36	45	Population of live stock	**C1**
25	32	35	Capacity of poultry	**C2**
20	24	30	Under cultivated area	**C3**

After determining the similarity index, townships ranking in 3 situations (Optimistic, Pessimistic & Uncertainty), results shown in part 4 tables.

Determining the Optimum Investment Index

For estimating the optimum value or a range to invest in livestock & poultry sector in townships of Tehran province we used uncertainty status weights and results. Relation number 2 has been used to determining the investment index.

Choosing and Learning an Artificial Neural Network to Estimating Concentrate Price

In this step the price of materials such as bagasse, beet pulp, rice bran, wheat bran, sunflower, cotton seed, soybean meal, alfalfa and wheat chaff considered as input and price of 5 types of concentrate as the output values.

For making the ANN capable to predict after it's training the new input must be entered. To estimate the new input, time series regressions have been used. Likewise time series used to predict probability price of concentrate for 2 next years. Finally predicted prices by both methods compared and a price range specified.

Next added value of concentrate production calculated for next year's by getting average benefit of services, financial intermediary, transportation and storage sectors in Tehran province between 2004 – 2011 and achieved minimum and maximum percent of benefit in optimistic and pessimistic status 10 to 18% for Varamin township.

To determine the maximum benefit of selling per kilogram of concentrate produced maximum price multiplied to 18% and for minimum benefit, 10% multiplied to minimum predicted price. All of the achieved values by ANN, time series regression and FTOPSIS methods showed in results and discussion section.

RESULTS AND DISCUSSION

Ranking the Provinces in Optimistic, Pessimistic and Uncertainty

Correspondingly shows in diagram.1 in optimistic and pessimistic status, Mazandaran, Esfahan, Tehran and Khorassanrazavi respectively were in 1 to 4 steps. Livestock population, poultry capacity, livestock & poultry units capital and annual household income are the main reasons for their surpasses. In optimistic & pessimistic cases Fars, Ardabil and Khozestan have close similarity indexes. The reasons are average of poultry capacity and average under cultivation area in Fars and Khozestan provinces and also population of livestock, average cost of food and capital of poultry & livestock units in Ardabil and Khozestan while in these 3 provinces annual household income are close together. Markazi, Hamedan and Ghazvin provinces have same similarity index in Optimistic & pessimistic conditions because of the average livestock population and cost of food in Markaziand Hamedan and also because of average capital of poultry & livestock units in all of them. Ilam and Sistanva Baluchestan provinces in optimistic and pessimistic cases have close similarity index for the maximum & average poultry capacity. Hormozghan, Kohghiloehva Boer Ahmad and Khorassanjonobi have close similarity index in optimistic and pessimistic conditions because of average poultry capacity, maximum food cost and maximum & average of annual household income in Kohghiloehva Boer Ahmad and Hormozgan. Also maximum of livestock population and minimum of food cost in Khorassanjonobi and Kohghiloeh and average capital of livestock & poultry units in Khorassanjonobi and Hormozgan are the main reasons of their closely similarity index and changing their positions in the tables 3 classes.

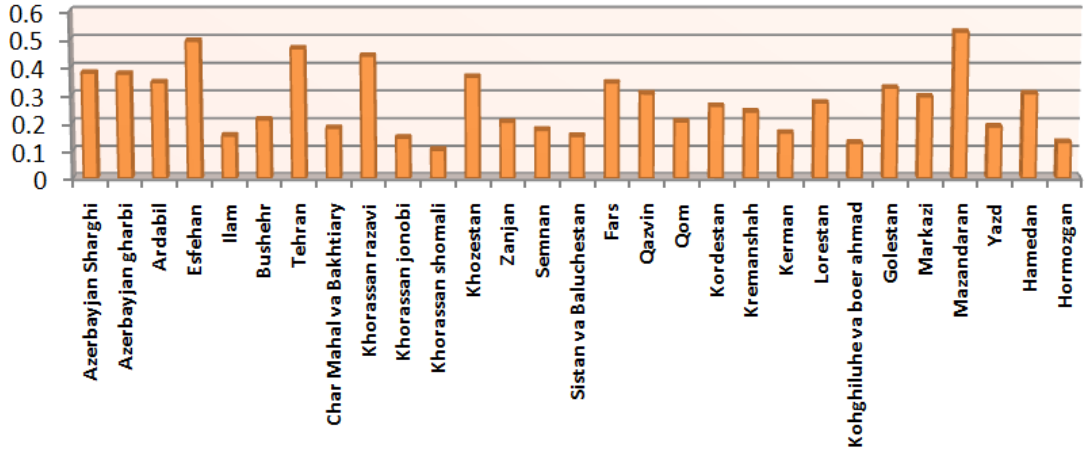

Figure 1: Provinces Similarity index in optimistic case

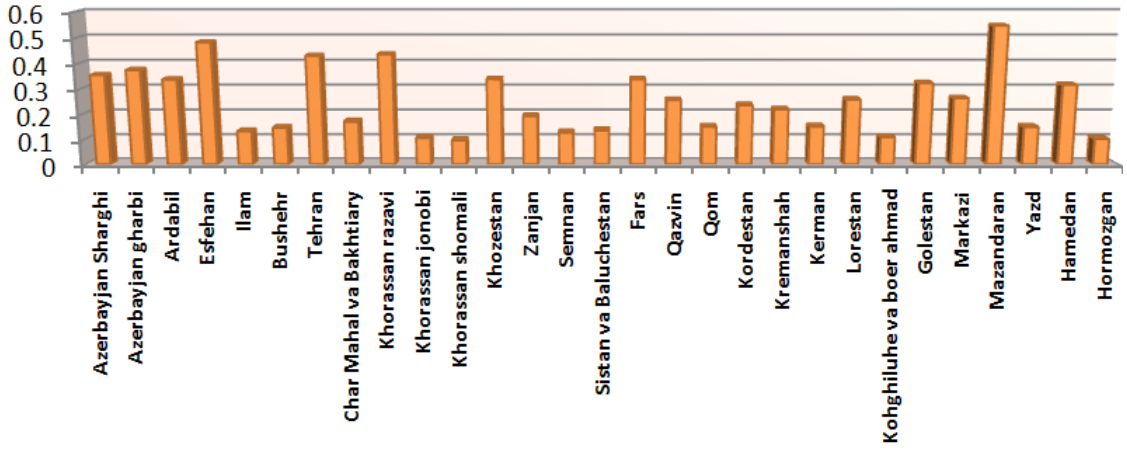

Figure 2: Provinces Similarity index in pessimistic case

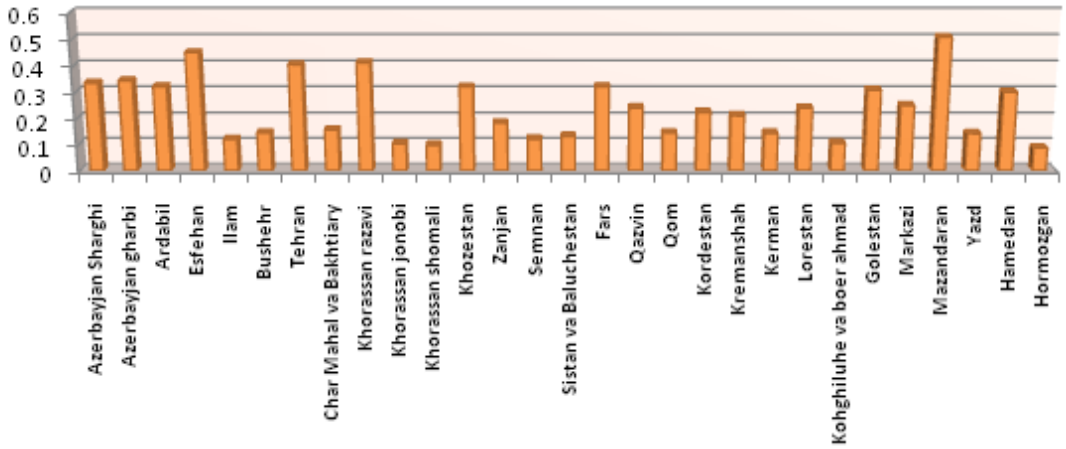

Figure 3: Provinces Similarity index in uncertainty case

In Gholastan and Hamedan provinces close values of minimum poultry capacity, under cultivation area, cost of food, average and minimum of livestock, average and minimum of annual household income and poultry units capital are the main reasons to have semi similarity index. About Kerman and Yazd provinces maximum and average cost of food, maximum capital of livestock and poultry units, annual household income are the factors which causes the similarity indexes being closer.

Ranking the Tehran Province's Townships Based on Considered Criteria

As shown in table 7 and 8, Varamin have the first grade of similarity index in 3 status for investing in establishing animal feed production unit. Time series regression results for predicting concentrate and its materials prices for predicting by the time series regression and using its results in ANN, the model which had the best R^2 been selected. Results are shown in the table 10.

Table 7: Ranking Tehran province's townships in pessimistic & optimistic conditions

Pessimistic condition				**Optimistic condition**			
township	Similarity index	grade	level	township	Similarity index	grade	level
Varamin	0.7111	1	1	Varamin	0.6878	1	1
Shahriar	0.2943	2	2	Ray	0.2881	2	2
Ray	0.2917	3	2	Shahriar	0.2847	3	2
Pakdasht	0.1779	4	3	Pakdasht	0.1773	4	3
Eslamshahr	0.1488	5	3	Eslamshahr	0.1451	5	3
Damavand	0.0708	6	4	Damavand	0.0703	6	4
Robatkarim	0.0692	7	4	Robatkarim	0.0674	7	4
Firozkoh	0.0285	8	5	Firozkoh	0.0283	8	5
Tehran	0.0249	9	5	Tehran	0.0252	9	5
Shemiranat	0.0040	10	6	Shemiranat	0.0042	10	6

Table 8: Ranking Tehran province's townships in Uncertainty condition

Uncertainty condition				**Uncertainty condition**			
township	Similarity index	grade	level	township	Similarity index	grade	level
Varamin	0.6956	1	1	Damavand	0.0697	6	4
Ray	0.2876	2	2	Robatkarim	0.0670	7	4
Shahriar	0.2856	3	2	Firozkoh	0.0277	8	5
Pakdasht	0.1767	4	3	Tehran	0.0246	9	5
Eslamshahr	0.1449	5	3	Shemiranat	0.0037	10	6

Table 9: Ranking Optimum percent of Investment in Uncertainty condition in Tehran province

Township	Optimun percent of Investment in Uncertainty condition	Grade in Uncertainty condition	Level	Investment range(million Rials) min	average	max
Varamin	0.39	1	1	99860	153034	208675
Shahriar	0.16	2	2	41329	63336	86346
Ray	0.15	3	2	40965	62778	85603
Pakdasht	0.098	4	3	25240	38679	52742
Eslamshahr	0.081	5	3	20899	32028	43672
Damavand	0.038	6	4	9946	15242	20784
Robatkarim	0.038	7	4	9730	14911	20332
Firozkoh	0.015	8	5	4002	6134	8364
Tehran	0.013	9	5	3507	5374	7328
Shemiranat	0.002	10	6	567	869	1185

Table 10: Selected time series regression models for prediction animal feed price

Model	R-Square	2014	2015	Produced
Log linear	0.95	7491	8748	Milky cattle concentrate
Log Linear	0.979	6598	7171	Cattle on feed concentrate
Log Linear	0.907	3022	3728	bagasse
Linear	0.916	6463	5476	Beet pulp
Linear	0.979	2541	2623	Rice bran
Log Linear	0.937	5231	4095	Wheat bran
Log Linear	0.872	12633	16676	sunflower
Log Linear	0.835	12218	14808	Cotton seed
Log Linear	0.812	13295	15603	Soybean meal
Log ARIMA	0.898	13176	21250	alfalfa
Log Linear	0.897	1669	2964	Wheat chaff
Log Linear	0.862	16077	19810	Before seeding concentrate
Linear	0.856	17446	16723	After seeding concentrate
Log Linear	0.86	15062	18487	Inter seeding concentrate

Table 11: Comparing ANN & time series results

Produced	2014	2015	method	Produced	2014	2015	method
Milky cattle concentrate	6854	6810	ANN	Milky cattle concentrate	7491	8748	time series regression
Cattle on feed concentrate	4697	8734		Cattle on feed concentrate	6598	7117	
Before seeding concentrate	11230	19312		Before seeding concentrate	16077	19810	
After seeding concentrate	4134	3521		After seeding concentrate	17446	16723	
Inter seeding concentrate	9676	22889		Inter seeding concentrate	15062	18487	

To determine a range for the price, declared added value of different sectors (financial intermediary, transportation, storage and services and etc.) averaged between 2004 to 2011 then minimum and maximum values of annual averages obtained as benefit range. Based on the mentioned range the amount of added value in concentrate production is between 10 – 18 %.

Table 12: Optimistic & Pessimistic benifit

year	production	Maximum price	Maximum added value	Optimistic benefit	Minimum price	Minimum added value	Pessimistic benefit
2014	Milky cattle concentrate	7491	0.18	1348	6854	0.1	685
	Cattle on feed concentrate	6598	0.18	1187	4697	0.1	470
	Before seeding concentrate	16077	0.18	2893	11230	0.1	1123
	Inter seeding concentrate	15062	0.18	2711	4134	0.1	413
	After seeding concentrate	17426	0.18	3136	9676	0.1	967
2015	Milky cattle concentrate	8748	0.18	1574	6810	0.1	681
	Cattle on feed concentrate	8734	0.18	1572	7117	0.1	711
	Before seeding concentrate	19810	0.18	3565	19312	0.1	1931
	Inter seeding concentrate	21889	0.18	3940	18487	0.1	1848
	After seeding concentrate	16723	0.18	3010	3521	0.1	352

Conclusion

Attentive to the results shows that Tehran province has the 3rd or 4th grades in the 3 involved situations and Varamin zone has 1stgrade among townships in Tehran. In this region it's possible to export products to adjoining provinces (such as Markazi, Semnan, Qazvin and Qom) because of their lower grades. Investing optimum range in varamin and financial feasibility, comparing various projects on economical efficiency in optimistic & pessimistic conditions, leads investors to invest in animal feed units or other projects with less economical risk or more benefits.

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