Journal of Industrial Engineering 6(2010) 43-52

Influence of fuzzy Goal Programming in Production Optimization Case study: Cement Industry

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Received 23 Jul., 2010; Revised 30 Jul., 2010; Accepted 6 Aug., 2010

Abstract

Using the mathematic techniques such as Fuzzy approach has useful outcomes for production planning in different sources. In this paper LGP[1] was used to model the objectives such as: avoidance of shortage or surplus of demand, access to maximum of income, using the normal capacity of production and organizing the inventory of warehouse, within the framework of Goal constraints like balancing between demand and inventory, rate of production within every period and the constraints of threshold of inventory at the end of every month. On these lines, the goal programming is one of the best methods for analyzing the multi objective decision making in cement industry management. The most principal disadvantage of goal programming is that all the parameters of model should be defined carefully and all of the objectives and constraints should certainly be determined. For taking over on this problem we introduced the Fuzzy concept. In this research, the mathematic goal programming model in the cement industry is modeled by Fuzzy and absolute approach. This research is intended to answer this question, which one presents the optimal solution for production process planning, Fuzzy or absolute approach? The necessity information to do this research is obtained with using field methods, desk surveys, observations, factory documents, and interviews or questionnaires. In this article we use GP to formulize, AHP[2] for grading and weighting and LINGO for solving. Afterwards, the data are entered in the formula modeled before and are solved using LINGO software.

Key words: Fuzzy linear programming, Analytical Hierarchy Process (AHP), fuzzy goal programming.

1. Introduction

It is a significant factor for each country to accurately and systematically plan for the usage of resources aimed at country progress due to the restrictions in the resources. Cement factory as one of the main resource of building industries has a significant role. So every improvement in it's manufacturing methods has a result at end user's satisfaction, on time response to demand, and better transportation system. More ever it can redound total income percentage, capita income percentage and output of the factory.

Regarding to variation in demand and variety in products, this is not suitable to apply the custom and unmechanized method for production planning. So in this research, mathematic methods such as fuzzy goal programming and AHP aimed at determination quantity of every product, preparation a production planning for responding demand and increasing income of firm has used. This issue is more important for developing countries such as Iran with a view to the necessity to supply necessary resources.

The topic of the research is influence of fuzzy goal programming in production optimization. Having regard to the importance and role of industrial units particularly cement industry, mathematical planning models have a great role in providing a production pattern. The present study considers fuzzy goal planning theory and its application in the optimization of production pattern in cement industry. The findings indicate that by applying flexibility in the fractions of the model and fuzzy trend, the negligence would decrease to a great extend, and the conditions of production pattern would partially improve and the resources would be used in a more favorable way.

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1. Linear Goal Programming
2. Analytical Hierarchy Process

2. Literature Review

In 1998, Lee H. Sing presented a model for transportation planning in Taiwan cement industry. The model solved the transportation planning issue by fuzzy linear planning. The model is based on formulating transportation issues in the locations where factors such as capacity of the origin, response to the order, operational transportation capacity and transportation density restrictions are of significance [5].

Rodriguez et al. presented interactive methods for fuzzy linear models and used the method for solving a linear planning model with full fuzzy parameters. They used a fuzzy ranking method for ranking the values of the targeted function. They offer the decision maker (DM) the optimal solution for several deferent degree of feasibility. [7]

In 2007, Irfan and Nilsen evaluated the production in Turkey. The objective of the research was to develop a fuzzy model for evaluating the performance of cement companies by referring to their income and subjective view of the experts. The selected approach is based on fuzzy AHP, and is used by the experts to determine the weights [8].

Tien fu linage in 2007 presented a fuzzy goal programming approach for solving the integrated PTPD (production/transportation planning decision) problems with fuzzy multiple goals in uncertain environments. The proposed model aims to simultaneously minimize the total distribution and production costs, the total number of rejected items, and the total delivery time with reference to available capacity, labor level and quota flexibility constraints at each source, as well as forecasting demand and warehouse space at each destination [10].

In 2008, Vang and Cheen introduced a goal planning prioritization by using AHP. In that article, they introduced a simple prioritization method, which optimizes linear goal planning by converting normalized fuzzy weights to pair-wise comparison matrix. The proposed LGP priority method is tested with three numerical examples including an application of fuzzy AHP to new product development (NDP) project screening decision making [11].

Nader Andalib, student of Tarbiat Modares University in 2004 presented a multi product, multi stage and multi period production planning in cement factory. In this research GP has been researched [1].

Reza Farahi student of Tarbiat Modares University in 2006 presented a mathematical model for production planning in Shiraz oil refinery. In this research production planning a fuzzy model has been organized and finally tested in Shiraz oil refinery [4].

3. Fuzzy Linear Programming

In the classic linear planning, it is supposed that the decision maker has set a preferred level of Z for intended outcomes and the restrictions are considered to be fuzzy sets. Then the fuzzy linear planning model (FLP) would be as below [2]:

$$\begin{array}{ll} C^T x \succ -Z & \\ Ax \prec b & \Rightarrow \begin{array}{l} Bx \prec d \\ x \geq 0 \end{array} \\ x \geq 0 & \end{array}$$

The model has M+1 rows and each is showed by a fuzzy set bearing member function. Having regard to the definition of membership function, the fuzzy set of the said decision would be as below:

$$\mu_{\tilde{D}} = \min_i \{\mu_i(x)\} = \min\{\mu_.(x), \mu_1(x), \ldots, \mu_m(x)\}$$

In which $\mu_i^{(x)}$ shows the degree where X satisfies the inequity $B_i x \prec d_i$. Now assume that the decision maker is looking for a definite answer within the fuzzy set. Then:

$$\max \min_i \{\mu_i(x)\} = \max \mu_{\tilde{D}}(x)$$
$$x \geq 0 \qquad\qquad x \geq 0$$

The maximum answer of the fuzzy set would be considered as the optimum answer. Now consider the same fuzzy restrictions as shown in figure 1:

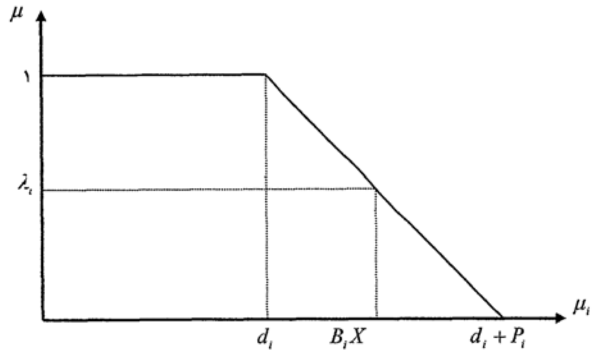

Fig 1: Restriction less than or equal to i[th] phase

In this chart d_i is the starting point of i and pi is the permitted variance from i^{th} and B_{ix} is the range of i^{th} constraint in accordance to x answer. As shown if the degree of B_{ix} limit is less than d_i, the degree of full limit satisfaction would be one (1) and if the limit is bigger than $d_i + p_i$, the figure would be zero. If the limit is within the range of $[d_i, p_i]$, the limit satisfaction degree can be arrived at by the similarity of triangles drawn in the graph. [2]

$$\mu_i(x)=\begin{cases}1 & B_i x\le d_i\\ \dfrac{(d_i+p_i)-B_i x}{P_i} & d_i<B_i x<d_i+p_i\\ 0 & B_i x\ge d_i+p_i\end{cases}$$

4. Goal Programming

Goal programming tries to mix optimal logic and the preference of the decision maker in the mathematical programming in order to satisfy several goals. The decision making environment determines basic concepts including goal and system restrictions and decision and target function variables. In other words, goal planning shows the way toward simultaneous goals achievement. [3]

Weighted goal planning is a capable tool since it includes several factors simultaneously in decision making processes; and at the same time considers system restrictions. In this model, attention should be given to prioritization of goal restrictions and/or fraction of fines considered for variances which are out of the competency of this model. [5]

On the other hand, using qualitative and intangible factors or criteria are out of the competency of this planning model. Therefore merging AHP and a supplementary tool capable of solving the shortcomings of weighted goal planning can shape a suitable model for organizational decision making such as optimizing product mixture. It is necessary to add that AHP is not a comprehensive tool for decisions such as determining the composition of products. The reason lies in failure to consider restrictions such as budget, material etc. in decision making and the inability to select or prioritize options in large numbers. Thus using two tools together can cover the weaknesses and provide the ground for using strength points. [9]

5. Existing Goals

The objective function is defined in the form of goals. To set goals, viewpoints of experts are used. It means three main goals are selected after categorizing their viewpoints as below:

Goal 1: selling is the goal; in this case, we prefer the negative and positive variance in the left side of the equation to be minimized compared to right hand side.

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right)+dn_t-dp_t=g_t \qquad t=1,2,\dots,T$$

Goal 2: demand is the goal. In this case, we prefer the negative variance of the left hand to be minimum compared to the right hand.

$$S_{ijt}+IS_{ijt-1}-IS_{ijt}-dp_{ijt}+dn_{ijt}=D_{ijt}$$
$$i=1,2,\dots,m$$
$$j=1,2,\dots,n$$
$$t=1,2,\dots,T$$

Goal 3: inventory is the goal. In this case, we prefer the positive variance of the left hand of the in equation to be minimum compared to the right hand.

$$IS_{ijt}-dpa_{ijt}+dna_{ijt}=ID_{ijt}$$
$$i=1,2,\dots,m$$
$$j=1,2,\dots,n$$
$$t=1,2,\dots,T$$

6. Goal Programming Model in Definite Format

The goal planning in definite format is as below:[1]

$$MinZ = W_1 dn_t + W_2\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dn_{ijt} + W_3\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dpa_{ijt}$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right)+dn_t-dp_t=g_t \qquad t=1,2,\dots,T$$

$$S_{ijt}+IS_{ijt-1}-IS_{ijt}-dp_{ijt}+dn_{ijt}=D_{ijt} \qquad i=1,2,\dots,m \qquad j=1,2,\dots,n \qquad t=1,2,\dots,T$$

$$IS_{ijt}-dpa_{ijt}+dna_{ijt}=ID_{ijt} \qquad i=1,2,\dots,m \qquad j=1,2,\dots,n \qquad t=1,2,\dots,T$$

6-1-Constraint of model

For modeling the production line 9 stage has been considered and for every stage there are respective constraints as bellow:

Subject to:

$$X_{1ilt} \le C.Cap_{1ilt}.V_{1ilt} \qquad i=1,2,...,m \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$X_{2ilt} \le C.Cap_{2ilt}.V_{1ilt} \qquad i=1,2,...,m \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$F_{lt} \le F.Cap_{lt}.u_{lt} \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$O_{ilt} \le O.Cap_{ilt}.W_{ilt} \qquad i=1,2,...,m \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$M_{ilt} \le M.Cap_{ilt}.y_{ilt} \qquad i=1,2,...,m \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$S_{ilt} \le S.Cap_{ilt}.A_{ilt} \qquad i=1,2,...,m \qquad l=1,2,...,n \qquad t=1,2,...,T$$

$$\sum_{l=1}^{n} V_{1ilt} \le 1 \qquad i=1,2,...,m \qquad t=1,2,...,T$$

$$\sum_{l=1}^{n} V_{2ilt} \le 1 \qquad i=1,2,...,m \qquad t=1,2,...,T$$

$$\sum_{l=1}^{n} u_{lt} \le 1 \qquad t=1,2,...,T$$

$$\sum_{l=1}^{n} W_{ilt} \le 1 \qquad i=1,2,...,m \qquad t=1,2,...,T$$

$$\sum_{j=1}^{n} y_{ilt} \le 1 \qquad i=1,2,...,m \qquad t=1,2,...,T$$

$$\sum_{j=1}^{n} A_{ilt} \le 1 \qquad i=1,2,...,m \qquad t=1,2,...,T$$

$$IX_{1t} \le b_1 \qquad t=1,2,...,T$$

$$IX_{2t} \le b_2 \qquad t=1,2,...,T$$

$$IF_t \le b_3 \qquad t=1,2,...,T$$

$$IO_t \le b_4 \qquad t=1,2,...,T$$

$$\sum_{l=1}^{n} Z_{lt} \le b_5 \qquad t=1,2,...,T$$

$$IM_t \le b_6$$

$$IN_t \le b_7$$

$$\sum_{i=1}^{m}\sum_{l=1}^{n} X_{1ilt} = IX_{1t} \qquad t = 1,2,\ldots,T$$

$$\sum_{i=m}^{m}\sum_{l=1}^{n} X_{2ilt} = IX_{2t} \qquad t = 1,2,\ldots,T$$

$$\%A[IX_{1t}] + (1-\%A)[IX_{2t}] = \sum_{l=t}^{n} F_{lt} \qquad t = 1,2,\ldots,T$$

$$\%B\sum_{l=t}^{n} F_{lt} = IF_{t} \qquad t = 1,2,\ldots,T$$

$$IF_{lt} = \sum_{i=1}^{m}\sum_{l=t}^{n} O_{ilt} \qquad t = 1,2,\ldots,T$$

$$\%C\sum_{i=1}^{m}\sum_{l=t}^{n} O_{ilt} = \sum_{i=1}^{m}\sum_{l=t}^{n} IO_{ilt} \qquad t = 1,2,\ldots,T$$

$$\%N[IO_{t}] + (1-\%N)\left[\sum_{l=1}^{n} Z_{lt}\right] = \sum_{l=t}^{m}\sum_{j=1}^{n} M_{ijt} \qquad t = 1,2,\ldots,T$$

$$\sum_{i=1}^{m-1}\sum_{j=1}^{n} M_{ijt} = IN_{t} \qquad t = 1,2,\ldots,T$$

$$\sum_{i=m}^{m}\sum_{j=1}^{n} M_{ijt} = IM_{t} \qquad t = 1,2,\ldots,T$$

$$IM_{t} + IN_{t} = \sum_{i=1}^{m}\sum_{j=1}^{n} S_{ijt} \qquad t = 1,2,\ldots,T$$

$$All\ Variable \geq 0$$

$$V_{1ilt}, V_{2ilt}, u_{lt}, W_{ilt}, y_{ijt}, A_{ijt} = 0 \ or\ 1$$

6-2-Variables and Parameters

The variables of model are:
Z :Summation of undesirable deviation of goals
d_{nt}, d_{pt} : Positive and negative deviation of selling
d_{nijt}, d_{pijt} : Positive and negative deviation of demand
d_{paijt}, d_{naijt} : Positive and negative deviation of inventory
i :Number of machines in stone breaker and mill
j :Sort of product
l :Range of hardship of middle product
t :Number of periods for programming
X_{kilt} :Amount of product (k, limestone k=1, argile k=2) produced by machine (i) and hardship (l) at period (t)
The Parameters of Model are:
$C.C_{apkilt}$:Most capacity of machine for producing the product (k, limestone k=1, argile k=2) by machine (i) and hardship (l) at period (t)
V_{kilt} :machine (i) produce only one product (k, limestone k=1, argile k=2) hardship (l) at period (t)
IX_{1t} :Amount of broke and saved argil at period (t)
IX_{2t} :Amount of broke and saved limestone at period (t)
b_1 :Most capacity of warehouse for saving broke limestone
b_2 :Most capacity of warehouse for saving broke argil
Fl_t :Amount of produced powder, hardship (l) at period (t)
Ul_t :machine produce only one product, hardship (l) at period (t)
%A : Percentage of limestone to produce powder, hardship (l)
1-%A :Percentage argil of a to produce powder with hardship (l)
$F.C_{aplt}$: Most capacity of mill for producing the product, hardship (l) at period (t)
IF_t :Amount of saved powder at period (t)
b_3 :Most capacity of raw material store
%B :Output of raw material mill station

O_{ilt} : Amount of produced clinker by stove (i), hardship (l), at period (t)
$O.C_{apilt}$:Most capacity of stove (i) for producing the product, hardship (l), at period (t)
W_{ilt} :Stove (i) produce only one product, hardship (l), at period (t)
IO_t :Amount of saved clinker by stoves at period (t)
Zl_t :Most additive storable material, hardship (l), at period (t)
b_4 :Most capacity of warehouse for produced clinker at 5th stage
b_5 :Most capacity of warehouse for mixed material
%C : Output of 5th stage
M_{ijt} :Amount of cement produced by machine (i), sort (j), at period (t)
$M.C_{apijt}$: Most amount capacity of machine(i) ,for producing the product ,sort(j) ,at period(t)
Y_{ijt} :Machine (i) produce the product sort (j), at period (t)
%N : Percentage of clinker with additive material for producing the product sort (j)
IM_t :Amount of saved cement at period (t) in big warehouses
IN_t :Amount of saved cement at period (t) in small warehouses
b_6 :Most capacity of big warehouses
b_7 :Most capacity of small warehouses
S_{ijt} :Ready for selling cement in final stage, packaging (i), sort (j), at period (t)
$S.C_{apijt}$:Most capacity for producing Cement, packaging (i), sort (j), at period (t)
A_{ijt} : Single cement machine produce only one product ,sort(j) ,packaging(i),at period(t) and packaging cement machine produce only one product ,sort(j) ,packaging(i),at period(t)
IS_{ijt-1} :Amount of inventory of cement, packaging (i), sort (j), at previous period
IS_{ijt} :Amount of inventory of cement, packaging (i), sort (j), at period (t)
ID_{ijt} :Most storable inventory of Cement, packaging (i), sort (j), at period (t)
D_{ijt} :Demand of Product, sort (j), packaging (i), at period (t)
G_t: Income at the end of period (t)

7. Cement Industry fuzzy goal production Programming model

In definite planning model, all fractions of the target function and limits are definite. In definite models ≤, ≥ and = signs are used and the maximum and minimum indicates an affirmative definite sentence. The decision maker may bring the target to a given number instead of maximizing and minimizing it. Or the limits may be vague and imprecise i.e. ≤, ≥ and = are imprecise, or a small variance from limits are acceptable which signifies fuzzy model.

In the said model, since the demand is defined in accordance to demand projections or orders accepted before the course, changes may happen during the course because the demand has never been precise. In addition, due to changes in the demand and production, the precise projection of the total income and end-term balance is not logical; therefore, in order to have an objective reality-based model aimed at covering illusions and impreciseness, we preferred to accept a degree of variance. It is evident that removing that illusion needs spending costs. Therefore the following adjustments are necessary:

7-1- Constraints of fuzzy model

Since the limitations are of equal type, their fuzzy model is as below [4]

7-1-1- Constraint of Income

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right) + dn_t - dp_t - P_t\lambda \geq \; G_t - P_t$$
$$t = 1,2,\ldots,T$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right) + dn_t - dp_t - P_t\lambda \geq \; G_t + P_t$$
$$t = 1,2,\ldots,T$$

Where G_t is full satisfaction of income in each course and P_t stands for permitted variance from the full satisfaction, whose figures are shown in table 1.

7-1-2 –Constraint Of Demand

$$S_{ijt} + IS_{ijt-1} - IS_{ijt} - dp_{ijt} + dn_{ijt} - P_{ijt}\lambda \geq D_{ijt} - P_{ijt}$$
$$i = 1,2,\ldots,m$$
$$j = 1,2,\ldots,n$$
$$t = 1,2,\ldots,T$$

$$S_{ijt} + IS_{ijt-1} - IS_{ijt} - dp_{ijt} + dn_{ijt} + P_{ijt}\lambda \leq D_{ijt} + P_{ijt}$$
$$i = 1,2,\ldots,m$$
$$j = 1,2,\ldots,n$$
$$t = 1,2,\ldots,T$$

Where D_{ijt} is the full satisfaction limit of product j with packaging i in period t, and P_{ijt} is the permitted variance from full satisfaction, whose figures are shown in table 5.

7-1-3- Constraint Of end-term inventory

$$IS_{ijt} - dpa_{ijt} + dna_{ijt} - Pa_{ijt}\lambda \geq ID_{ijt}$$
$$i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \qquad t = 1,2,\ldots,T$$

$$IS_{ijt} - dpa_{ijt} + dna_{ijt} - Pa_{ijt}\lambda \leq ID_{ijt}$$
$$i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \qquad t = 1,2,\ldots,T$$

Where ID_{ijt} is the full satisfaction limit of the cap of product j inventory with i packaging in term t and P_{aijt} is the permitted variance from full satisfaction, whose figures are shown in table 5.
It is necessary to note that in all cases, the permitted variance is calculated based on interviews with the experts.

7-2- The objective function of fuzzy goal model

The model is a minimum type. The limitations of objective function of the model are as below:

$$MinZ = W_1 dn_t$$
$$+ W_2 \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dn_{ijt} + W_3 \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dpa_{ijt} +$$
$$P\lambda \leq Z + P$$

Where Z is the result of definite model and P is the permitted variance that the manager is ready to spend costs to remove illusions from fuzzy model i.e. the cost the management is ready to pay for actual variances. This amount was calculated to be 30 percent in the meetings with the managers.

7-3- The Final Format Of Fuzzy Goal Model In Cement Industry

With a view to the objective function of fuzzy goal model and restrictions already explained, the model of this article in the cement industry is as below:

$$MinZ = W_1 dn_t +$$
$$W_2 \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dn_{ijt} + W_3 \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{t=1}^{T} dpa_{ijt} +$$
$$P\lambda \leq Z + P$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right) + dn_t - dp_t - P_t\lambda \geq \ G_t - P_t$$
$$t = 1,2,\ldots,T$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{ijt} * P_{ijt}\right) + dn_t - dp_t - P_t\lambda \geq \ G_t + P$$
$$t = 1,2,\ldots,T$$

$$S_{ijt} + IS_{ijt-1} - IS_{ijt} - dp_{ijt} + dn_{ijt} - P_{ijt}\lambda \geq D_{ijt} - P_{ijt}$$
$$i = 1,2,\ldots,m \quad j = 1,2,\ldots,n \quad t = 1,2,\ldots,T$$

$$S_{ijt} + IS_{ijt-1} - IS_{ijt} - dp_{ijt} + dn_{ijt} + P_{ijt}\lambda \leq D_{ijt} + P_{ijt}$$
$$i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \qquad t = 1,2,\ldots,T$$

$$IS_{ijt} - dpa_{ijt} + dna_{ijt} - Pa_{ijt}\lambda \geq ID_{ijt}$$
$$i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \qquad t = 1,2,\ldots,T$$

$$IS_{ijt} - dpa_{ijt} + dna_{ijt} - Pa_{ijt}\lambda \leq ID_{ijt}$$
$$i = 1,2,\ldots,m \qquad j = 1,2,\ldots,n \qquad t = 1,2,\ldots,T$$

$$All\ Variable \geq 0$$

As soon as we made certain that goals are acceptable through the experts, some questionnaires must be prepared to determine the weight of each goal. In this line, nine criteria were identified under the name of effective criteria or independent variables in cement sector after consultations with the experts. The criteria are in accordance to table 1.

Then some questionnaire were prepared and sent to 25 organizational experts, and they were asked to determine the degree of significance of each criterion in achieving the goals. The questionnaires were based on three matrixes where the goal appeared on the rows and criteria on the columns. The elements of the matrix were the result of evaluation and measurement of goals on the basis of criteria. The scoring method of questionnaire is based on Likert scoring; that is each five options of Likert take a given value.

Ultimately the viewpoints of all experts are collected and the weight of each is calculated as shown in table 2 based on geometric average relations (relation no. 1).

$$a_{ij} = \left[\prod_{k=1}^{N} a_{ij}^{(k)}\right]^{\frac{1}{n}}$$

Relation no.1 geometric mean

Table1
impressed indexes

Sort of index	Name of index
negative	Index of looses
negative	Index of cost
positive	Index of export
negative	Index of import
positive	Index of comparison in market
positive	Index of verity of product
positive	Index of exchange ration
positive	Index of strategic planning
positive	Index of stock of market

Then Expert Choice software and AHP solution is applied and the weight and priority of each one is defined as below.

$$\begin{bmatrix} 0.960436 \\ 0.914316 \\ 0.331364 \end{bmatrix} \qquad A1>A2>A3....$$

Table 2
Experts point about indexes and goals

goal \ index	1	2	3	4	5	6	7	8	9
Sale	6.43	8.96	8.96	5.87	7.83	7.83	6.92	7.83	8.96
Demand	5.42	7.83	۷.۴۲	7.36	5.92	7.54	6.25	7.32	6.92
Inventory	6.92	5.38	6.92	7.34	5.21	6.35	5.82	7.68	5.92

8. The Validity and Reliability of the Questionnaires

The validity of the questionnaire tests what is going to be tested and the degree of efficiency. The validity is checked by asking the views of the experts in the field. To this end, content validation method is used. In this method, Cronbach alpha of the questionnaire was calculated; the closer the figure to one, the more the internal coherence and the more homogenous the questions. It is evident that if alpha is low, the questions must be reviewed to see the omission of which will lead to higher alpha. In this article, alpha was 0.86.

9. Information of Demand

One of the main factors in production projections is planning. Therefore the demand for production is of high significance. The intended company sales forecasts (periodical demands) for products are done by the relevant units; the figures are shown in table 3.

Table 3
Information about next 6 period demands

	Period 1	Period2	Period3	Period4	Period5	Period6	Deviation of goal percentage
Single cement Sort 1	40000	45000	45000	45000	45000	47000	5%
Packaging cement sort1	40000	30000	30000	30000	30000	45000	10%
Single cement Sort 2	50000	45000	45000	45000	45000	45000	6%
Packaging cement sort2	13000	15000	15000	15000	15000	17000	4.5%
Single cement Sort 3	6000	7000	7000	7000	7000	7000	4.7%
Packaging cement sort3	12000	16000	16000	16000	16000	16000	10%
Single cement Sort 4	25000	30000	30000	30000	30000	30000	7.8%
Packaging cement sort4	35000	25000	25000	25000	25000	25000	9.5%

10. Information of Products Price

The intended company provides sales price forecast by relevant units; which is shown in table 4.

Table 4
Forecasting of prices

Row	description	Prices of every ton
1	Single cement Sort 1	29000
2	Packaging cement sort1	32200
3	Single cement Sort 2	31500
4	Packaging cement sort2	34500
5	Single cement Sort 3	32000
6	Packaging cement sort3	35800

11. nformation of Inventory

In order to answer the unforeseen demands for each product, some products are kept as inventories. On the other hand, due to high inventory maintenance costs, a cap is defined for each product kept as inventory. The inventory of each product in the beginning of the planning course by the warehouse department is illustrated in table 5.

Table 5
Information about inventory

Row	description	Most inventory at the end of period	Most inventory at the first of period	Allowanced deviation of inventory at the end of period
1	Single cement Sort 1	-	-	
2	Packaging cement sort1	3000	2500	5%
3	Single cement Sort 2	-	-	
4	Packaging cement sort2	3000	2000	5%
5	Single cement Sort 3	-	-	
6	Packaging cement sort3	3000	2500	5%
7	Single cement Sort 4	-	-	
8	Packaging cement sort4	3000	3000	5%

12. The Amount of Goals

As already put, there are three goals; the amounts of which are explained here:

- Having the information on concerned units in mind, the target sale is equal for all courses and is proposed to be 1,900,000,000 unit of currency. Target deviation is set to be 10 percent by the management.
- In addition to that demand rate is equal to the figures forecasted for each end product inserted in table 3.
- The target figures for maximum inventory are contained in table 5.

13. Conclusion

The research was put forth as an applied research with the following question:

Can the fuzzy planning model optimize the production components as compared to definite position?

The presented model is based on a multi-product, multi-procedures and multi-course production planning system, and since the company officials did not provide us with information on the profit of each individual product, we maximized the sales instead of profit, and by presenting it as a target we tried to minimize the unfavorable variances of the target. In accordance into findings, it is evident that the total company income in definite status is 1,921,432,231 and in fuzzy status is 1,960,245,162 which have increased 2.02%.

Another subject optimized is output of company. We calculated the total output as below,

Output = (total products/incoming)*100

According to found responses, the output of company in definite status is 161.45% and in fuzzy status are 166.54 which have increased 5.09%.

In addition to the last calculated subject is per capita income. We calculated that as below,

Per capita income = (total income/total incoming)*100

In accordance into finding, the per capita income in definite status is 534.38 and in fuzzy status are 547.42 which have increased 2.44%.

The obtained result confirms the authenticity of the questions of research and we conclude the fuzzy approach has a preference compared to definite approach.

14. Suggestion

According to importance of operation costs and expense of raw material of cement factory, a new model containing these costs, aimed at maximizing revenue can be presented.

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