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Safety Stock Adjustment in Supply Chain Storage Units

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Abstract :
supply chain is overall system include of suppliers, productive sectors and stock storage, distributers and customers that covers multi-stage structure supplier confidence (delivery with delay) production process (unpredicted equipment damage) and customer demand (over – expectation orders of customer are three factors at supply chain uncertainly. To react properly, we can use safe storage. In this thesis fuzzy multi-purpose model is provided based on total cost and customer service to control safe storage in storage sectors of supply chain. In this model, fuzzy confidence level of suppliers and contractors have been defined based on experts a fuzzy system and there is no hypothesis about demand distribution. To control and modify estimation deviation we used rolling horizon method and various constrains have been determined (production capacity, size of units of production and transfer, financial limitation to sale primary materials ,) finally softy stock had been determined to decrease total cost as 20% and increase service level to above expectation.
To determine approach efficiency, this is implements in Khorasan axial parts company.
Key words: softy stack, customer service level, supply chain programming, fuzzy multi-purpose decision making, expertise fuzzy system.

I. Introduction

Supply chain include of on indirect and direct phases to supply customer demand. The chain is faced to uncertainly. We can cope to them using various mechanisms. Some of them include of belows:

1. Safety time
2. Safety stock
3. Combination of them

We focus on safety stock in this paper:
Safety stock maintenance is necessary issue because of uncertainty of chain that lead to shortage in various phases of supply chain. Shortage may be lead to decrease of sale, immediate transfer and decrease of credits therefore safety stock would we maintain to increase service level. Traditionally, safety stoke has been determined by stochastic inventory theory these models are inefficient when complex supply chain are present with various uncertainty and limitations. Generally confidence level of supplier (delayed delivery) production process (equipment damage) and customer demand are basic factors to uncertainly in supply chain. Also the chain is faced to various limitations as production capacity, unit sizes (production and transfer) and financial limitations to buy primary materials [1].
extensive literature had been provided about stock management models and safety stock control in multistage supply chains that are faced to uncertainly. The goal of models is distribution of material and resource in supply chain network therefore customer service would be supplied and costs would be minimized. There are two different approaches to supply chain operation programing from stock management new.
First approache is based on random stock theory the stock is determined to multi echelon system.
The demand is random variable. Basic decisions include of bellows.

1- Determination of stock condition in various point of supply chain storage
2- Stock allocation to points to create branched production
3- Determination of safety stock in supply chain stock points

Lead times are input variables that are functional capacity of work lead and inventory acceptance.
In this approach, safety stock is part of problem the approach logic is defined based on clark and scarf researches.
Second approach is based on mathematical programing Chain programing
In this approach, demand is estimation of any period based on programing horizon that would be added to model. Therefore, safety stocks are input parameters to programing model that should be determined externally. Key decisions include allocation of stock storage units [2-4].
Lead times are input and output variables. Related limitations to capacity are aggregate constraints. Above two approaches are different from safety stocks are part of problem but in second approach, safety stocks are in parameters to programing model that should be determined externally. In this paper we

focus on second approach. Therefore we can use extensive literature that would be categorized to simulation studies (without providing optimal solution) and optimization model [5].

In relation to second approach, various simulation studies have been performed, that would be pointed eilon and Elmaleb performed simulation studies to compare performance of five stock control policies that include of seasonal demand pattern that is faced to fluctuations. Results include of simulation of several non-linear curves that she the relation between fuelling and middle stock ration.

The relation between fulling and middle stock ration [6].

Three policies include of safety stock but there is no discussion about estimate safety stock.

Wemmelor and why bark provided other simulation experiences to evaluate process of size determination to one-stage system under demand uncertainly cost comparison had been performed based on %99/999 service safety stock had been tested based on routin search method debodt and wassenhove provided.

Case study of company and MRP had been used in dynamic environment (significant demand uncertainly)

Safety stock control has been analyzed based on simulation study several strategies have been defined and analyzed (combination of safety stock and safety time) and results have been provided stock and safety time) and results have been provided in graph showing the relation between customer service and middle level of stock. Using cost effective solution, they provided management view point, but there is no discussion about quality of determination of safety stocks. Callarman and Harmrin compare 3 rules of determination of aggregate sized in MRP system, based on it, demand process is faced to uncertainly. Cost comparison have been performed based on safety stock to maintain 98%, 95% customer service.

Required safety stock has been determined based on service level decision rule (SLDR) SLDR is result of linear regression analysis of simulated sizes of factors as estimated error, demand variance coefficient of expected time between inventories. Therefore, to achieve related service level, SLDR had been used to trialand error method. Kohler – gudum, Dekok provider safety stock adjustment procedure (SSAP) the goal is determination of safety stock to achieve goal level. This method is general and may be used to multi – product and multi-stage systems in this method, there is no hypothesis about demand distribution or prediction model.

In this method, over-demand would be compensate as delayed inventory

Optimization models (mathematical programing) would be categorized as certain, probable and combinative models.

In relation to certain models, gravesand willems provided multi-stage distribution production supply chain based on probable demand they used guaranteed service model as single – goal nonlinear model to determine safety stock in multi stage supply chain.

They extended model to determine safety stocks in supply chain any stage of supply chain would be controlled by basic storage policy assuming upper limit to customer demand level.

They hypothesized normal distribution to demand. To any stage, there is certain time but there is no capacity limitation. Pengqiyon and Grossman used mixed-integer non linear programming model to adjust safety stock levels in supply chain network. This model include of two scales. The first is economic and the second is related to supply chain response to customer demand economic scale may be measured using current net value while second scales would be measured using lead time that include of transfer, production lead and running times. The goal of MTNLP models is maximizing current net value and minimizing load time. Young sung provided linear programing model to adjust safety stock in multi-stage supply chain. In this model the variables of safety stock control (goal stock level that are applied in production timing and programing models and basic stock level in stock policy in ware houses) and service levels that have been used in production phase and warehouses have been defined as decision variables Boulaksill and his callegues defined the problem of determinal of safety stocks in multi-stage and multi-product stock systems. These systems are faced to demand uncertainly. There approach to determine safety stock levels have been simulation. Simulation study have been based on solving supply chain programing problem in rolling horizon (formulated as mathematical programing model) it is assumed that demand process and re-fulling by safety stock level are independent and all deficients of system and supply chain stages are delayed inventories that would be compensated.

There is no hypothesis about demand form and estimation process because by this, there is lower limitation (especial probability density function).

In relation to probable models, abde-malek adjusted safety stock in multi-stage supply chain using queue theory. This chain is related to some contractors using bid or long term cooperation supply chain include of series of tandem queue and safety stock is adjusted that is include of continious relation to contractor to provide services.

In relation to combination models, inderfurth and minner used dynamic programming to salve the problem of adjustment of safety stock level in multi-stage stock system also to external demand, normal distribution have been provided. In this paper high demand items have been evaluated and dispersed demanded items have been ignored (items may be repaired)inventory system follow basic stock policy based on periodical review they assumed any stock point is faced to limitation of service level and customer demand in final stock points would be supplied without delay. Evaluated models include of limiting hypothesizes that are for from reality (assuming special distribution to demand, unlimited production capacity lead time certainly, …) therefore, there is no effective method to adjust safety stock (simulation studies) in this paper, there are limitations as production capacity. Unit size, transfer, financial limitation to buy primary materials. Lead time and primary material orders are fuzzy limitations there is no hypothesis to demand distribution. Confidence index to foreign suppliers (primary materials suppliers) lead suppliers (contractors and production equipment) have been calculated using fuzzy expertise system (using MATLARS software) to cover customer demand uncertainly, rolling horizon method has been used.

This approach would be repeated to solve supply Chain programing model problem. Programing model has been solved without safety stock.

After any repeatition, delayed orders would be registered. Also all non-responded demands are delayed orders, at end of simulation based on delayed orders, safety stocks would be determine to achieve desirable service level (99%) and decrease total cost as 20%

In this paper, fuzzy two-goals model is provided to adjust safety stock in stock units of Khorasan axial parts company. In second part, the problem is defined and research hypothesises is described. In thira part, recommended approach would be eraluated. In fourth part, fuzzy two-goals model would be salved. In fifth part, model efficiency would be simulated to Khorasan axial parts company and results would be analyzed. Finally findings and conclusion would be provided.

II. Model hypothesis:

- over expectation demands of customers would be delayed orders that would be compensated next periods.
- issuing orders, demand process and filling by safety stock are independent.

There is no specific density are foreign suppliers

- supplier confidence is percentage of orders that would be supplied immediately.

III. Approach :

According to said hypothesizes, simulation would be performed as bellow time horizon would be divided to 50 weeks. Demand generators predict demand. Then fuzzy multi-goal model problem would be solved based on material and resource limitations. Model include of integer variables because size unit constraints have been define a to production and transportation. At end of first time cycle, stock level and predictions would be updated. Programing cycle would be repeated on horizon with increase of one period. Also confidence level of material suppliers and contractors have been determine by fuzzy expertise system.

Solving problem of supply programing that would be repeated by demand updating, delayed orders would be defined. New safety stock would be calculated to achieve determined customer service level. Consumer service level would be determined to all products in supply chain. Customer service level would be part of demand that would be responded by stock (fulling ration) fig 4 shows conceptual model of research methodology. Details have been provided at bellow.

3.1. Evaluation of confidence level about foreign and local suppliers:

one of the model uncertainty parameter include of confidence about material suppliers and contractors. Primary material suppliers are foreign suppliers to determine confidence level of foreign suppliers and contractors, fuzzy expertise system have been used. Also sc local units are local supplier to next unit.

Supplier confidence level would be expressed based on expert opinions (managers, engineers, …) using fuzzy logic. Therefore, effective factors on confidence should be defined and the effects of factors on confidence level should be determined.

Assuming uncertainly, fuzzy expertise systems may be used. Also this model would be applied to select and evaluate suppliers and contractors.

We evaluate this issue; coefficients of importance of various scales have been pointed therefore fuzzy expertise systems using comparison methods would be used to determine suppliers and contractor confidence level. Some of scales include of bellow items.

1- Confidence level about supplier and contractor transportation system
2- Guarantee and after-sale services
3- Percentage of empty capacity.
4- Conformity of quality level with standards and specifications

We defined above scales with three lingual expressions. Also we present confidence level by mamdani fuzzy inferential system and MATLAB software, as fuzzy series.

Supplier confidence level is triangle fuzzy number as low, medium and upper. As the output of inferential system is undetermined fuzzy series, the most probable amounts should be defined to predict triangle fuzzy number.

Therefore, we use several operand as mom, lo mans some to defuzzification. Using low, medium and upper amounts, triangle fuzzy number would be obtained.

3.1.1. Local supplier confidence level:
Confidence level of assembly and production sectors would be calculated based on pre-request units. To know confidence level of local suppliers, all foreign suppliers should be introduced with defined confidence level.
The unit with defined all pre-requisites, would be current unit. All parameters of triangle fuzzy number shows confidence level of current unit using average of L,M,U current unit would be added to all units include of defined confidence level. If confidence level of all units had not been defined, above process should be repeated. Sappier confidence level is percentage of orders that would be supplied immediately [7].

3.2. demand generator:
First stage of approach is creation of estimations to demand that is input to supply chain programming. There is no hypothesizes a bout demand distribution using previous data and estimation we can achieve to the best probability density function. To obtain it to demand distribution, distribution parameters should be estimated. They are demand generator inputs. Demand generator produce estimations based on these parameters (δ_d , $\mu_{d,j}$) as random. The first parameter is deviation of predicted error to I th item (δ_{di}). To calculate expected demand from customer, weight average of previous periods demand would be used. In this method, far data include of lower weight and near data include of more weight. If dt (t) is demand to I th item in period, we have :

$$\mu_{d,i} = \sum_{j=n}^{n-n_1+1} w_j d_j(t-j) + \sum_{j=n-n_1}^{1} w'_j \, d_i(t-j) \qquad (١)$$

Wj is weight of near data and Wi is weight of far data, by this, below relation would be defined:

$$\sum_{j=n}^{n-n_1+1} w_j + \sum_{j=n-n_1}^{1} w'_j = 1 \qquad \text{..............................} \qquad (٢)$$

Derivation of predicted error would be calculated as below

$$\delta_{d,i}(h) = \left[\frac{1}{T-1} \sum_{s=-T}^{1} (d_i(t+s) - \hat{d}_i(t+s-h, t+s) \right]^{\frac{1}{2}}$$

This programing horizon cycle and d(++h,t) is prediction of t period of i*th* item. H is estimation horizon. Viewing previous demands, we see demand with as central trend. Therefore, the best formula to demand estimation would be as below

$$\hat{d}_i(t) = a + bt + u\cos\frac{2\pi}{N}t + v\sin\frac{2\pi}{N}t$$

(N=50) is number of periods during cycle, a, b. u, v had been calculated by software MATLAB. but this is not enough to calculate demand because of high errors. In fact above algorism should be used. Based on part demand, there is no fixed behavior to μ_{di} and this is function of time. To calculate μ_{dj} ,below weights should be used (T=50).near data include of more weights and far data include of lower weight. Total of them would be 1.

3-3 Supply chain programming model:
This is extended version of moulaksil model based on fuzzy two-goal linear programing. In model of bolaxil and collegues, there is no limitation about buying primary materials. It is assumed that primary material suppliers can respond to all order during determined time while this is not true in recent model, primary material purchase limitions are defined and contractors and material supplier fuzzy level's have been defined using expertise fuzzy system. Supply chain is evaluated and emphasized that include of 5 stage as below fig.

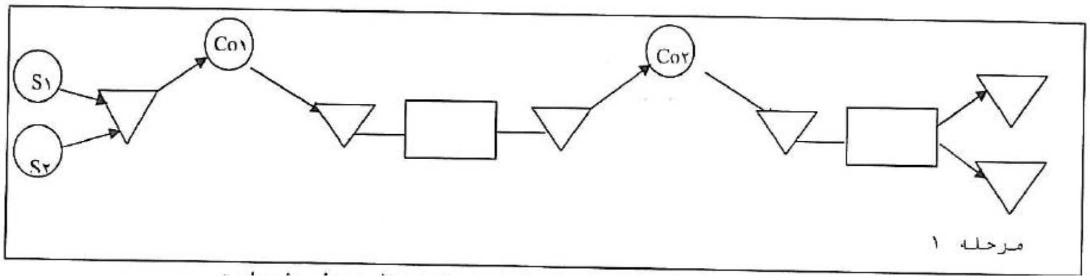


Fig: 5 stages supply chain that are drawn in supply chain programing model.

Programing model has been updated after simulation (stock-level and demand prediction would be updated). Safety stocks are zero ing programing model. The problem should be solved without safety stock. Therefore, delayed orders would be resulted when demand is more than stock. in programming model, all costs have been defined unless safety stock maintenance. Solving model include of issuing orders to production system and determination of stock level in storage points. Issuing orders would be done during lead time (to specific stage and item). Related information would be stored (freeze, period). Based on next repetitions, there would not be change. Now, we evaluate goal functions of mathematical model.

3.3.1. Goal functions :

The first function is total cost minimization. there are several cost coefficient to various stages of supply chain. We have 5-stages chain. Fifth stage is related to upstream and materials would be stored from them.

Material would be sent to contractor and after some operation would be stored in fourth stage (after that in unit). Some operation would be performed (as carving and reaming and untwisting) and half-monufacture park would be stored in third stage. These parts would be transferred to second contractors and after nitrogenization would be stored in second stage. The operation as block assembly, pointing and labling would be performed and final product would be stored in downstream if t (week) is programing horizion and t is determined time period, total items of j th stage would be as $j \in \{1,...,5\}$ a,d nj is specific item to j th stage. Therefore goal function is as below:

3.3.1.1. first goal function

$$MinTC = \sum_{n_1}\sum_{t=1}^{T}\tilde{C}_1.UD_{n_1}(t)+\sum_{n_1}\sum_{t=1}^{T}\tilde{C}_2.P_{n_1}(t)+\sum_{n_1}\sum_{t=1}^{T}\tilde{C}_3.EI_{n_1}(t)$$
$$+\sum_{n_2}\sum_{t=1}^{T}\tilde{C}_4.UDD_{n_2}(t)+\sum_{n_2}\sum_{t=1}^{T}\tilde{C}_5.S_{n_2}(t)+\sum_{n_2}\sum_{t=1}^{T}\tilde{C}_6.EI_{n_2}(t)+\sum_{n_3}\sum_{t=1}^{T}\tilde{C}_7.UDD_{n_3}(t)+$$
$$\sum_{n_3}\sum_{t=1}^{T}\tilde{C}_8.P_{n_3}(t)+\sum_{n_3}\sum_{t=1}^{T}\tilde{C}_9.EI_{n_3}(t)+\sum_{n_4}\sum_{t=1}^{T}\tilde{C}_{10}UDD_{n_4}(t)+\sum_{n_4}\sum_{t=1}^{T}\tilde{C}_{11}.S_{n_4}(t)+\sum_{n_4}\sum_{t=1}^{T}\tilde{C}_{12}.EI_{n_4}(t)$$
$$+\sum_{n_5}\sum_{t=1}^{T}\tilde{C}_{13}UDD_{n_5}(t)+\sum_{n_5}\sum_{t=1}^{T}\tilde{C}_{14}.EI_{n_5}(t)$$

3.3.1.

2. second goal

Second goal is related to customer service that should be maximized. In fact second goal and first goal have intraction. second goal is as below:

$$Max\ (\frac{1}{T}.\Sigma(1-\frac{UD_{n_1}(t)}{ID_n(t)})) \qquad (۶)$$

3.3.2.

Model limitation

First stage :

$$I_{n_1}(t) = I_{n_1}(t-1) + P_{n_1}(t) - TD_{n_1}(t) \qquad n_1 = 1,...,N_1 \qquad t = 1,...,T$$
$$TD_{n_1} = [(2 - defuzzy\ (\tilde{r}_1)).ID_{n_1}(t)] - UD_{n_1}(t-1) + UD_{n_1}(t)$$
$$0 \le P_{n_1}(t) \le \tilde{P}_{n_1 \max}$$

Second stage:

$$I_{n_2}(t) = I_{n_1}(t-1) + S_{n_2}(t) - DD_{n_2}(t) - UDD_{n_2}(t-1) + UDD_{n_2}(t) \qquad n_2 = 1,\dots,N_2 \quad t = 1,\dots,T$$

$$DD_{n_2}(t) = BOM_{n_2,n_1}.(2 - defuzzy(\tilde{r}_2)).\sum_{n_1} P_{n_1}(t - L_1) \quad , \quad n_2 = 1,\dots,N_2 \quad t = 1,\dots,T$$

$$0 \le S_{n_2}(t) \le \tilde{S}_{n_2\,\max}$$

Third stage:

$$I_{n_3}(t) = I_{n_3}(t-1) + P_{n_3}(t) - DD_{n_3}(t) - UDD_{n_3}(t-1) + UDD_{n_3}(t) \qquad n_3 = 1,\dots,N_3 \quad t = 1,\dots,T$$

$$DD_{n_3}(t) = BOM_{n_3,n_2}.(2 - defuzzy(\tilde{r}_3)).\sum_{n_2} P_{n_2}(t - L_2) \quad , \quad n_3 = 1,\dots,N_3 \quad t = 1,\dots,T$$

$$0 \le P_{n_3}(t) \le \tilde{P}_{n_3\,\max}$$

Fourth stage:

$$I_{n_4}(t) = I_{n_4}(t-1) + P_{n_4}(t) - DD_{n_4}(t) - UDD_{n_4}(t-1) + UDD_{n_4}(t) \qquad n_4 = 1,\dots,N_4 \quad t = 1,\dots,T$$

$$DD_{n_4}(t) = BOM_{n_4,n_3}.(2 - defuzzy(\tilde{r}_4)).\sum_{n_3} P_{n_3}(t - L_3)$$

$$0 \le P_{n_4}(t) \le \tilde{S}_{\max\,n_4}$$

Fifth stage:

$$I_{n_5}(t) = I_{n_5}(t-1) + O_{1n_5}(t) - O_{2n_5}(t) - DD_{n_5}(t-1) + UDD_{n_5}(t) + UDD_{n_5}(t-1) \quad n_5 = 1,\dots,N_5 \quad t = 1,\dots,T$$

$$DD_{n_5}(t) = BOM_{n_5,n_4}.(2 - defuzzy(\tilde{r}_5))\sum_{n_4} P_{n_4}(t - L_4)$$

$$O_{1n_5}(t) = K_3.Q_{1,n_5}$$

$$O_{2n_5}(t) = K_4.Q_{2,n_5}$$

$$\sum_{t=1}^{T}(O_1(t) + O_2(t)) \lesssim M\tilde{P}\,RC$$

$$TLT_{1,\min} \le TLT_1 \lesssim TLT_{1,\max}$$

$$TLT_{2,\min} \le TLT_2 \lesssim TLT_{2,\max}$$

Non-negative variables of model are include of :

$$I_j(t), P_i(t), UD_j(t), UDD_j(t), DD_j(t) \ge 0 \quad j = 1,\dots,5,\ t = 1,\dots,T, i = 1,\dots,4$$

$$O_1(t), O_2(t) \ge 0$$

3.3.2.1. limitations explanation:

Based on limitations among supply chain stages.

First stage: formula (7) shows stock balance at storage point. N item stock at end of t period is equal t, stock level at end of t-1 period and item production at t period subtracted from total demand of this itemat t period. According to definition of confidence level of foreign and local suppliers, if customer ordered IDn during first stage, supply would be done based on defuzz (r1).

($FD_\eta \in t$) this shows independent demand of customer as (1t….) from first stage when confidence level is equal to 1. This means increase of delayed orders due to fuzzy confidence of $\tilde{r}_1$ .as delayed order should be responded total demand is equal to independent deman plus to delayed orders of n item among previous period that should be subtracted from delayed orders. Infect independent demand is input to programing model. Formula (9) show limitations of production capacity

Second stage:

As first stage, formula 10 is drawn. Total demand is equal to depended demand plus to delay orders of n2 item during previous period that should be subtracted from delayed orders of this item. Demand is depended to first stage that is equal to multiple of produced n, item to BOM factor of (1+[1….) (based on first stage explanation)

Formula (13) show capacity of half-manufactured parts that have been sent by second contractor to this company.

Third stage:

As first and second stage, formula 14 is drawn. Total demand is equal to depended demand to second stage plus to delayed orders of n3 item among revious period that should be subtracted from delayed orders of this item. Demand is depended to second stage that is equal to multiplication of produced n2 items in BOM factor in [1t(…….)]

Formula 16 shows limitations of half-manufactured part production capacity

Fourth stage:

Formula (17) is drawn. Total demand is equal to depended demand to third stage plus to delayed orders of not item during previous period that should be subtracted from delayed orders of item in period 18. Demand is depended to third stage that is equal to multiplication of produced n3 items in BOM factor in (1+[1….)(also time is changed during any stage as lead time of previous stage)

Formula 19 show capacity of half manufactured parts delivery from first contractor (Mashhad) to this company.

Fifth stage:

In this stage formula (2) is drawn to stock balance. In this stage total demand is equal to depended demand to fourth stage pulse to delayed orders of ns items during previous period that should be subtracted from delayed orders of this item during this period (21). Depended demand to fourth stage is equal to multiplication of produced n4 items in BOM factor in (1+[1-….) (the time is changed as lead time of fourth stage).

In this stage ordered items from foreign and local suppliers should be integer multiple of Q yg, Qy of primary material unit size that should be supplied by suppliers (formula 22,23).

Also total ordered primary material of suppliers should not be more than max primary purchase of MPRC. This equation is fuzzy (financial limitation) (22-24) primary material lead time to supply from abroad would be more than TLTmin =13 weeks but real time is faced to uncertainly due to reasons that are provided in fig (1-3), therefore related limitations are shown by fuzzy non-equation (TLT max.I=17 week).

The lead time to order primary material as localywould be more than TLTmin1=4 weeks but real time would be faced to uncertainly. Therefore related limitations are shown by fuzzy non-equation (TKT max=9 weeks) (formula 24,25)

4. Solving model:

As the model is include of carious and multiple goals, we used goal programing methods to solve them that are the most important multi-goal decision making methods. Results of goal programing are common that minimized deviations.

Developing fuzzy series theory, researchers attempted to determine dominant principles and variable coefficients to design model near to reality.

To discuss about fuzzy goal programing problem, we should point to certain goal programing model as below

$$
\begin{aligned}
& Min\ A = \{g_1(n_1, p_1), g_2(n_2, p_2), \ldots, g_k(n_k, p_k)\\
& S.to:\\
& f_i(x) + n_i - p_i = b_i \qquad i = 1,2,\ldots,m \\
& X, n_i, p_i \geq 0
\end{aligned}
\tag{27}
$$

A: goal function

B: K(nk,Pk): deviation variable function with K priority

bi= right value of ith goal

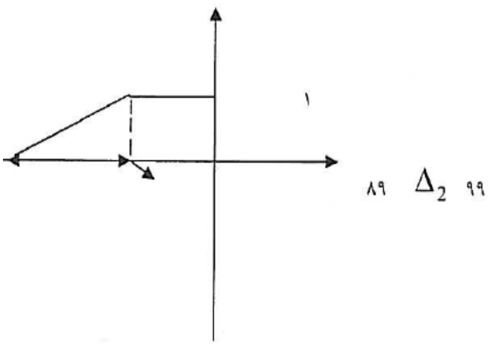
ni= negative deviation from goal

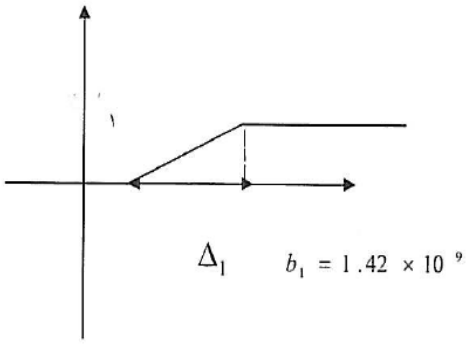
pi=positive deviation from goal

fi(x)= function of decision variable in ith goal

using goal function to goal programing, we want to minimize non-desirable deriations.

I relation to profit, negative deviations and in relation to costs, positive deviations, should be emphasis by this, first goal function (f1) is related to total cost and second goal function (f2) is related to customer service level that are evaluated during previous chapter. Right value of first goal (total cost) is equal to b1=1.92 $\times 10^9$ and right value of second goal (customer service level) is equal to b2=99 %. First goal upper limit is $\Delta t = 6 \times 10^8$ and second goal upper limit is $\Delta z = 10$ goal membership function are as below:





Hanan model is max model and first goal is cost function. Therefore, cost function and right value are multiplied in negative sign.
In thesis model, we have 4 limitations (2k=2*2) and solve 705 decision variables in fuzzy multi goal programing model [n+2k+1=700, 2*2 +1] (also limitation of basic model should be emphasized)

V. Evaluation of sample and simulation of results:

5.1 Model application to khorasan axial parts company:

Khorasan axial parts company is one of the most important producers of axial parts of motor and gearbox that supply requirements of companies as Iran Khodro, mega motor and other productive sectors of Iran vehicle industry. This company include of 3 productive sites and 3 product warehouse. This company manufacture 60 various products that are related to motor and gear box.
Fig (1) shows schematic of part supply chain. Upstream stages are related to material supply chain. Primary material have been transported from company warehouse to first contractor.
After contractor operation (lathe and bore) manufactured parts have been transferred to company. The company performs operation as reaming, de bagging, grinding and removing wastes. Half manufactured parts would be delivered to second contractor (Tehran) to perform nitrogenization.
Then the parts would be transported to manufacturing site to perform final operation (assembly test, labling, assembly, painting and bulk test). Then the parts have been stored in wave houses 1,2. Final product would be delivered to foreign customers from warehouse (B2B)
As we say in previous chapters, programing model output include of optimized amount in relation to delayed orders during various stages of supply chain below table show results of fuzzy expertise system.
Table1: confidence level of foreign suppliers and contractors about expertise system.

5.2. result analysis:

According to this issue that is one of goal is maximizing customer service, more stock should be stored in 23 ware house and decrease of delayed orders would be lower comparing to other stages. Increasing stocks in ware houses lead to increase of local demand from other stages. Other stages are faced to various limitations due to delivery and supply half manufactured parts. Therefore delayed orders would be increased. As we need to high quality materials to produce and supplying these materials are faced to limitations in our country, we should supply them from abroad. Therefore, lead time would be increased and we are faced to uncertainly. By this, delayed orders would be increased in material warehouse.
Therefore, delayed orders should be compensated two times during supplying locally (66 ton) and from abroad (82.5 ton). Infact, we should calculate safety stock t0 5- stages based on above condition.

VI. Conclusion and recommendation:

In this thesis, the model is introduced to adjust safety stock in multi-stages supply chain with several products. the chain is faced to uncertainly the goal of this model is minimizing costs and increase of customer service to determined level in all stages of chain. To determine uncertainly about primary material supply and half manufactured parts, we used fuzzy expertise system. Therefore we can define contractor and foreign suppliers fuzzy confidence level. also to create conformity between predicted demand and real condition, we used rolling horizon method.
There is no hypothesis about demand distribution. Also various limitations have been emphasized in model. the basic rule is that non-responded demand is equal to delayed orders. To evaluate validity, the model is implemented in Khorasan axial parts company and results have been desirable.
As our customer are industrial customer (B2B) they accept back rent. Therefore, said assumption would

be emphasized. But consumers don't accept back rent (B2C) and sale would be nullified, during next researches we can evaluate lost sale but more complex statistical methods would be required. In fact observed sale would be as ignored sample of demand. In these methods, stock management processes that have been implemented to products should be identified.

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