A Goal Programming Approach for Multiple Objective Green Supply Chain Managment

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1

Abstract

Today?s green supply chain management (GSCM) has become a protective approach to increase awareness against SCMenvironmental impact. Green strategies have become vital issue for companies to gain environmental sustainability .last year?s research shows that the production, transportation, storage and consumption of all these goods related environmental aspect such as emission of greenhouse gases. This paper focuseson the design, planning and controlling in supply chain for transportation and facility. There are several methods for solving multi-objective linear programming (MOLP) models, among them we use the fuzzy programming approaches to solve bi-objective model on the other hand weusetriangular fuzzy number to translate the subjective human perception into a solid crisp value and utilize the fuzzy number approach for uncertain demands .one numerical example is presented to show that our proposed method.

Introduction upply chain management system is established by money, component, processes, information flow and the operation in supply chain management and SCM is the most important economic activities in the business. We deal with all aspects of logistic in supply chain management such as transportation, warehouse and inventories, and address are related environmental aspect such as emissions of greenhouse gases, noise that these are the main cause of global warming, air and water pollution , acid rain, etc.

We should balance economics, environmental and social performance to achieve sustainable development is a major business objective of organization due to the challenge of increasing environmental laws and regulations, demanding organizational stake holders pressures and gaining competitive advantage's (Boiral,2006; **??**ee.et al.,2009;Jabbour and Jabbour ,2009). Recently researches shows environmental challenge, such as green decreases by limited energy and resources and green supply chain (GSC) management is now suggested as an efficient tactics to decrease.

Operation research (OR) help us to described it as the science, traditionally supply chain management focuses on minimizing the cost of existing processes but todays it is not only profit, in our opinions operation research must consider impact to be more efficient, so OR help us to identify the trade-offs between environmental aspect such as emission of greenhouses costs also OR suggests more efficient of resource and facilities. An important method in this respect is multi objective decision that reduction emission and decreases the benefits of supply chain.

The body of this paper comprises six sections. This paper starts with this introductory section, which provides a general idea about the research topic. Section2 reviews the literature related to a sustainable facility location in green supply chain, practices and performance for sustainable facility location in green supply chain. Section3 addresses the methodology and Section4 presents themultiple objective decision making model. Section5 illustrates the applicability of the model through a numerical. Finally, Section6 relates the conclusions, implications and poses questions for future research, there by fulfilling the purpose of the paper.

1 II.

2 Literature Review

In order to obtain the greatest benefit from environmental and society, firm must integrate all member in the green supply chain (GSC)(Lee, Kang, Hsu, & Hung,2009).Hence , strategic intercommunity with economically powerful with environmentally socially should be considered within green supply chain(GSC) to reducing lead time and cost ,eliminate wastage, improving quality, so we focus on the structure and discuss the main physical drivers in GSC. We will not different between green logistics and green supply chain management while we mainly focus on transportation; we take a border (supply chain) perspective.

There is a whole stream of research on facility location, which demonstrated by OR, that focuses tradeoff the number and location of distribution centers (DCs). Environmental aspects of network supply chain design and facility location recently received considerable attention. ratio to account the number of depots the uncertain factor in supply chain make the incorrect estimate. Thus uncertain factor of demand will be considered to support more realistic decision to estimate facility location. Within uncertain patterns, fuzzy numbers will be used to describe this uncertain factor. those fuzzy mathematical programming will be adopted for modeling **??**ang In our real-life we faced many uncertain situations so decision makers cannot use exact value such as exact date and exact number /rate.

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based. The idea of fuzzy logic was first advanced by Dr. LotfiZadeh of the University of California at Berkeley in the 1960s. Dr. Zadeh was working on the problem of computer understanding of natural language. Natural language (like most other activities in life and indeed the universe) is not easily translated into the absolute terms of 0 and 1. (Whether everything is ultimately describable in binary terms is a philosophical question worth pursuing, but in practice much data we might want to feed a computer is in some state in between and so we need another way to describe its).Fuzzy logic seems closer to the way our brains work.

It may help to see fuzzy logic as the way reasoning really works and binary or Boolean logic is simply a special case of it.A fuzzy number is a quantity whose value is imprecise, rather than exact as is the case with "ordinary" (single-valued) numbers.

A Fuzzy set ?? ? in X is set of ordered pairs: ?? ? =?(??, μ?? ? (??)??? ? ??? μ?? ? (??) is called the membership function or grade of membership ,often it is appropriate to consider those element of the universe that have nonzero degree of membership in a fuzzy set also membership function can be used in the fuzzy set.

This member in the fuzzy set may have a larger or smaller membership grade, this membership grades are very often represented by real value ranging in the closed interval between 0 and 1. The red curve (top) represents a triangular fuzzy number; the blue curve (middle) shows a trapezoidal fuzzy number; the green curve (bottom) illustrates a bell-shaped fuzzy number. These three functions, known as membership functions, are all convex (the grade starts at zero, rises to a maximum, and then declines to zero again as the domain increases). However, some fuzzy numbers have concave, irregular, or even chaotic membership functions. There is no restriction on the shape of the membership curve.

Nowadays fuzzy programming approach is being applied for solving multi objective linear programming models. There, becausefuzzy approaches is that they able to measure satisfaction of each objective, in Warners (1988)fuzzy and operator and Tiwari et al (1987)weighted additive approach the FGP are introduced. Goal approach is one of the most powerful, multi -objective decision making approaches in practical decision making. However there are two important difficulties when apply GP to the real life. First one is that decision maker to get desirable level of goal mathematically and the second is the need to optimize simultaneously all goal.in this situations, fuzzy set can help us.

Applying fuzzy set theory (Zadeh, 1965) into goal programming has the advantage for decision maker, which can then be qualified by some natural language term. When vague information related to the objectives are present then the problem can be formulated as a fuzzy goal programming problem. Someof the researchers which worked on the decision problem using in the Fuzzy goal programing theory are presented: such as, Narasimhan (1980) was first on that consider the Fuzzy set theory in goal programming. Narasimhan and Rubin (1984), Hannan (1981), Ignizio (1982) and Tiwari et al, (1986Tiwari et al, (, 1987)) applied the fuzzy set theory in the goal programing. Ramik (2000), Rao et al. (1988), Wang and Fu (1997), Mohamed (1997), Ohta and Yamaguchi (1996), El-Wahed and Abo-Sinna (2001) and Mohammed (2000).

Sometimes the coefficients are defined as triangular fuzzy numbers; the fuzzy vector is defined as follow???= (?? ?? +?? ?? +?? 0)

There are different approaches to solve the problem;one of the approaches combining conventional parameters fuzzy numbers or fuzzy variable stands for a factor in this case is a definite problem into a lineament problem. A combination of methods, parameters is fuzzy numbers using the following formula:c= ?? ?? +4 * ?? ?? +?? 0 6

In science, operations research, different methods to solve multi-objective optimization problems when there are definitive. One of the best ways is to use a phased approach, after application of fuzzy sets is established. Membership functions optimally with any of these methods try to optimize the degree of increase. Therefore, it is first necessary to obtain Optimized membership function.Z 1 l =min (C m -C p) X AX?b X?0 Z 1 u =max

105 (C m -C p)X AX?b X?0 µ z1 (z1)=? 1 ; ?? 1 ? ?? 1 ?? ?? 1 ?? ??? 1 ?? 1 ?? ??? 1 ?? ; ?? 1 ?? ? ?? 1 ? ??

106 1 ?? 0 ; ?? 1 ? ?? 1 ??

107 So that we have:?? 1 = (C m ?C p)??

108 Optimized membership functionZ_2 andZ_3 the same way the following objectives are achieved:µ z2 (X)=

109 ? ? ? 1 ; ?????? > ?? 2 ?? ?????? ??? 2 ?? ?? 2 ?? ??? 2 ?? ; ?? 2 ?? ? ?? 1 ? ?? 1 ?? 0 ; ?????? < ?? 2 ?? µ

110 z1 (z1)=? 1 ; (???? ? ????)?? > ?? 3 ?? (?????????)????? 3 ?? ?? 3 ?? ??? 3 ?? ; ?? 3 ?? ? (???? ? ????)??

111 ? ?? 3 ?? 0 ; (???? ? ????)?? < ?? 3 ??

112 Eventually it becomes a single objective linear programming problem is determined as follows: Maximize

113 ?Subject to ?(?? 1 ?? ? ?? 1 ??) ? ?? 1 ?? ? (???? ? ????)?? ?(?? 2 ?? ? ?? 2 ??) ? ?????? ? ?? 2 ?(?? 3 ??

114 ? ?? 3 ??) ? (???? ? ????)?? ? ?? 3 ?? AX?b X?0 ?? [0,1]

115 the main producers of gases are the industrial companies, for green planning the network of supply chain

116 management ,many companies have set voluntary target in term of greenhouse gases emission or set a subject

117 to a new regulation that named capof greenhouse gases emissions ,when the emission carbon dioxide is under

118 the approved emission Scheme carbon dioxide is tradable, also based greenhouse gases emissions reduction target

119 often established by government .the difference between the proposed target and actual target maybe offset by

120 the other things. Also companies that have emission less than the cap target will have sold their credit to make

121 the generate profit. I this paper we used the upper bound for green supply chain that is variable.

3 IV. Problem Definition and Modeling

123 Consider a supply chain network G=(N,A), where N set of node and A set of arc .N composed by the set of

124 supplier ,S, facilities, and customer, C, in this models we consider the CO2 emission in each process of the whole

125 network. Let me define: +? ? l j p ? x ij p i?S j?F p?P Min? ? ? w ? z jl p u j + ? ? ? w ? d ij p x ij p j?J i?S

126 p?P + l?L p?P j?F ? ? ? w ? d jk p x jk p k?C j?J p?P ? x ij p i?S ?? x jk p k?c = 0 ?j ? F , ?p ? P (1) ? x jk

127 p j?F = d k p ? ?k ? C , ?p ? P (2) ? x ij p j?F ? s i p ?i ? S , ?p ? P (3) ? ? r j p x ij p p?P i?S ? u j z jl ?j ?

128 F , ?l ? L (4) ? z jl l?L ? 1 ?j ? F (5) L ? ? ? ? w ? z jl p u j + ? ? ? w ? d ij p x ij p j?J i?S p?P + l?L p?P

129 j?F ? ? ? w ? d jk p x jk p k?C j?J p?P ? U, ?i ? S , ?j ? F , ?k ? C, ?p ? P , ?l ? L (6) x ij p , x jk p ? 0 ?i ?

130 S , ?j ? F, ?k ? C, ?p ? P , ?l ? L (7) z jl? {0,1} ?j ? F ?l ? L

131 The demand in this model is uncertain so we need to change it to DE fuzzy so in this paper use of under

132 formula:?? ?? ?? = ??(??) ?? ?? +4??(??) ?? ?? +??(??) ?? ?? 6**(8)**

133 Above model provide a multi-objective mixedinteger programing for the supply chain network design problem,

134 this model consider environmental investment decision in the supply network design, this model introduce a new

135 category of decision variable to consider environmental issues, and also it can use e specific product or a category

136 of products.

137 This paper consider two objective functions, first objective measures the total cost first and second part is the

138 transportation cost and the third part is the fixed set up cost and last part is the total handling cost. Second

139 objective measures the total CO2 emission; the first part measures the total emission in the all facilities and the

140 other part measures emission during the arc.

141 Constraint (1) note that our model there is no inventory stored in each facility. Constraint (2) requires that

142 the all of the fuzzy demands should be satisfied. Constraint (3) shown that each product p flowing out of the

143 supplier I should not exceed the total supply amount of suppliers. constraint (4)state that the total processing

144 handling in facility j should not exceed the capacity if the facility is open(if facility j is open yj=1 and otherwise

145 yj=0).constraint (5) requires that decision makers choose one level for facility j. constraint (6) consider value of

146 emission cap(a carbon-capped supply chain With this model decision maker should determine:

147 1. Where to set up facility 2. Which supplier should be selected for each facility 3. Which facility should be

148 selected for each costumer 4. How many/much produced should be transported each supplier to each facility 5.

149 How many/much produced should be transported each supplier to each facility V.

4 Computational Experiment

151 We consider 8-node network there are in total 2 supplier, 3facilities and 3 customers in this network with this

152 data and this solved by solver Excel 2010 P=1 CO 2 CAP = (L=1600, U=2500) ?? ???1 1 =(23,26,29),?? ???2

153 1 =(22,26,30) ,?? ???3 1 =(35,38,41) ?? 1 1 = 60 ,?? 2 1 = 80 ?? ??1?? 1 = 10, ?? ??1?? 1 = 12, ?? ??1?? 1 =

154 22, ?? ??2?? 1 = 15, ?? ??2?? 1 = 11, ?? ??2?? 1 = 21, ?? ???? 1 = 20, ?? ???? 1 = 18, ?? ???? 1 = 16 , ??

155 ????1 1 = 21, ?? ????2 1 = 18, ?? ????3 1 = 14, ?? ????1 1 = 12, ?? ????2 1 = 15, ?? ????3 1 = 11, ?? ????1 1

156 = 13, ?? ????2 1 = 14, ?? ????3 1 = 17 C p =5$ f a = 2090 ,f b =2260,f c =2210 ?? ?? 1 = 1, ?? ?? 1 = 1, ??

157 ?? 1 = 1 ?? ?? =

5 Conclusions

159 In this paper, we introduce a green supply chain network design model with fuzzy demand which facility location

160 is the main problem the main causes of cost in the green supply chain are the fixed costs to set up a facility,

161 the transportation cost to move goods and the cost of emissions generated on the shipping lanes. The model is

162 a multi-objective model which consists of minimizingtotal cost and environmental influence for solve this model

163 we use of fuzzy method which consider Best and worst objective function value for two objectives then consider

5 CONCLUSIONS

membership of them and solve, on the other hand, in this model we consider upper and lower bound for CO2 emission that these bounds depend on the government policy .We use normalized normal Constraint method to solve the model by general EXCEL solver2010. After that, we test the model by a eightnodeexample finally we observethat improving the capacity of the network and increasing the supplyto the facilities can decrease CO2 emission because more distributioncenters be opened to decrease vehicle travel distances.In the network and all of thatminimize the total cost. For The feature our model can be extend with many fuzzy variables with consideration of environmental element in the handling and transportation process, can solvethe uncertain demand with DE fuzzy method, and cansolve it with another solver,You can also considermachine downtime, customer satisfaction, consider the
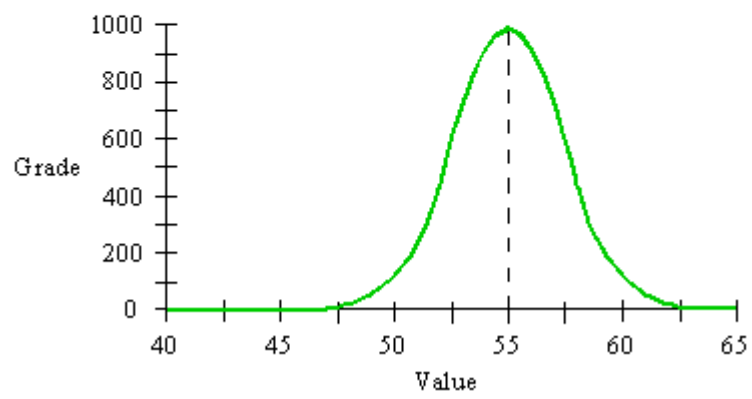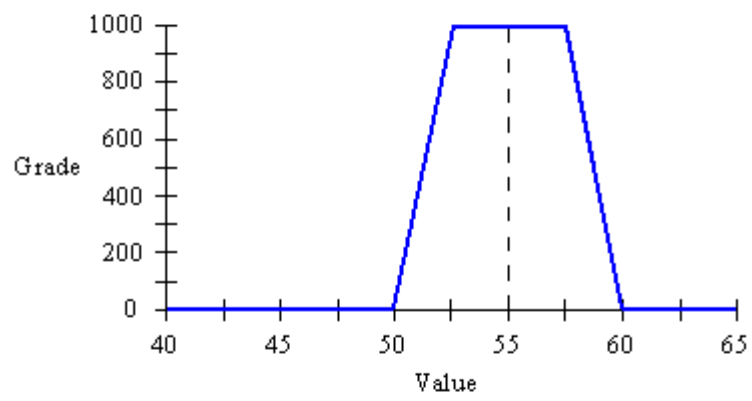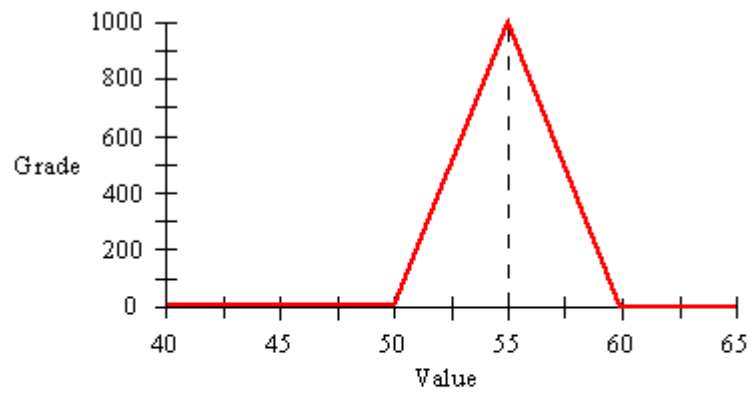

Figure 1:

4

Figure 2: BAp

5   CONCLUSIONS

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