



A mathematical SSCM model for minimizing the CO2 emission with considering economic goals and social benefits

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ABSTRACT

Nowadays the main problem in the world is environmental pollution. One of the main sources which impact on the environment is Industrial factories. In this regards, we define a mathematical model for finding a solution for minimizing CO2 emission. According to SSCM model, we define three objective functions: 1- minimize CO2 emission which are coming from SCM Process, 2- maximizing profit 3- Maximizing social benefits. For details, first, we define decision variables in the SCM process, second, we normalize the variables with using fuzzy logic algorithm, third we set the objective functions accordingly, and finally we define constraints with considering Carbon Credit, Demands, Production rates, Investment, numbers of Jobs and value added. For implementation and case study, considering two factories, four kind of products in the variety of EFP-UEFP range, gathering their data and implement the model accordingly. After solving, we do sensitive analysis for finding other solutions, then we define a degree for EFP-EUFP range that we can measure EFP degree for products by Likert Scale. We found that in addition to government limitations, demand quantities should be changed by customers.

Key words: SSCM, Mathematical Model, EFP, EUFP, Social benefit, Carbon Emission

INTRODUCTION

Managing and optimizing sustainable supply chain presents multiple challenges involving social, economic, and environmental issues. With regard to social issues the purpose of sustainability includes meeting the needs of increasing numbers of people, creating jobs in society, and contributing to communities by providing scholarship, support for cultural events, sporting events and charity programs. Maximizing profit and minimizing generated waste and pollution are goals of economic and environmental sustainability respectively.

However, in many real world applications these objectives can be in conflict. For example, social responsibility can conflict with the aims of marketing, which classify customers into different categories with different priorities for business. For example classifying customers in a customer pyramid as platinum, Gold, Iron, and lead is a popular concept in marketing literature. The main purpose of this classification is not satisfying the needs of more customers but it is done to provide better services to the top tiers of the pyramid specifically.

The current study explores the mathematical model that the stakeholders can trust for obtaining the profit and on the other side, the government can trust that the factory products are EFP and do not cause bad effect for environment. SCM shares the stakeholder focus with

the concept of business sustainability. There is also a growing effort to incorporate the other characteristics of sustainability into SCM. In today's globalized supply chains, environmental issues are of critical importance. During the past decade, carbon emissions and pollution associated with economic development have caused serious issues such as the greenhouse effect, abnormal climate, and environmental degradation. Hence, it has become a consensus worldwide to reduce carbon emission and pollution. Both consumers and regulators continuously exert pressure on firms to innovate in ways that will reduce their impact on the natural environment (Sarkis et al., 2011), as increasing government regulation and stronger public mandates for environmental accountability have made environmental issues a crucial business concern. Business firms are particularly under increasing pressure to reduce the negative environmental impact of their supply chains, to the point where environmental consciousness has become critical in the design and operation of globally integrated supply chain networks (Sundarakani et al., 2010).

LITERATURE REVIEW

Many avenues of research have been pursued under the umbrella of SCM (Mentzer et al., 2001). Since the introduction of the concept in the early 1980s, SCM has been used to describe the planning and control of materials, information flows, and the logistics activities internally within a company and also externally between companies (Cooper et al., 1997). Over time, research on SCM has continued to broaden in focus (Burgess et al., 2006). Initially, SCM focused primarily on material flows. More recent research emphasizes additional aspects of SCM, such as risk (Colicchia and Strozzi, 2012), performance (Hassini et al., 2012), and integration (Fabbe-Costes and Jahre, 2007). There is also a growing emphasis on information flows, internal and external networks of relationships (Stock et al., 2010), and governance of supply networks (Pilbeam et al., 2012).

Since the definition of sustainability, or sustainable development, was published by the World Commission on Environment and Development in late 1980s (WCED, 1987), it has been recognized as one of the greatest challenges facing the world (Bateman, 2005; Espinosa, Harnden, & Walker, 2008; Ulhoi, 1995; Wilkinson, Hill, & Gollan 2001). Along with the proliferation of globalization over past two decades, sustainability has been transformed from a technical concept into the political and subsequently business mainstream (Liu, Leat, & Smith, 2011). According to the markets and competition theory, there are three important decisive factors which determine business environment and subsequently company strategies: demand (e.g. customers and interest groups), supply (all parties in the supply chains), and the general environment (e.g. regulations, society and natural resources) (Svensson, 2007).

Sustainable supply chain management has emerged to address the triple bottom line (i.e. people, planet and profit) issues from the supply perspective of business (Carter & Rogers, 2008; Mollenkopf, Stolze, Tate, & Ueltschy, 2010), and green marketing has emerged to identify and target socially and environmentally-conscious consumers, i.e. the demand side of business (Sharma, Lyer, Mehrotra, & Krishnan, 2010; Smirnova, Henneberg, Ashnai, Naude, & Mouzas, 2011). In parallel, debates on environmentally-friendly and socially-responsible business have been widely undertaken from both demand and supply perspectives.

As corporations attempt to move toward environmental sustainability, their managements must extend their efforts to improve their environmental practices across their supply chains. However, this complex job requires the collaborative efforts of many related parties including governments, supply chain firms, customers, and the community (Sommerville et al., 2010). Environmental collaboration was defined specifically to focus on inter-organizational

interactions between these supply chain members, including aspects such as joint environmental goal setting, shared environmental planning, and working together to reduce pollution or other environmental impacts (Vachon and Klassen, 2008). However, taking environmental issues into account influences the company's relationships both upstream and downstream (Beske et al., 2008). The activities of reducing negative externalities (caused by pollutants and carbon emissions) come with a financial burden viewed as the additional expenses of manufacturing the EFP. These expenses include additional investments incurred due to greening efforts, and penalties levied for not meeting the required environmental standards (Barari et al., 2012). Hence, profitability is a concern that must be addressed in the context of sustainable investments. Moreover, sustainability requires increased dependency between supply chain partners, and it is often difficult to distribute the costs and the benefits between partners (Ageron et al., 2012). Bowen et al. (2001) outline the difficulties that companies face when assessing the economic gains derived from their environmental practices. Often, a company is unlikely to take the initiative to invest in environmental technologies without effective government supervision and policy incentives. Even supply chain members intending to reduce emissions usually try to comply with environmental constraints without a systematic plan or collaborative activity, which often not only leads to emission violations and high penalties but also high costs (Letmathe and Balakrishnan, 2005).

As environmental protection is never a single party's responsibility, it is crucial to promote the principle of producer responsibility for environmental protection via collaboration among supply chain firms. However, in the supply chain context, individual interests may conflict with collective interests. Hence, whether or not all members of the supply chain will willingly and collaboratively improve their environmental performance depends on the individual member's tradeoffs of cost-benefit, coordination of the members' interests, the collective benefits of the supply chain, and collaborative investment in environmental technologies. These factors interrelate with government environmental policies and affect profit allocation within the supply chain, and thus they need to be fully understood to achieve a long-term reduction of carbon emissions and pollutants in the supply chain. However, there is still limited research work on this aspect in the extant literature. Furthermore, the environmental behavior of soft partner firms may influence the supply chain's value transformation process (Klassen and Vachon, 2003).

Changes in value transformation represent opportunities for the supply chain member store consider their collaborative relationship, as inevitably, the members' collaboration is the crucial factor for determining whether or not environment-friendly behaviors will last. Another issue that needs to be addressed is the economic feasibility of investments in environmental technology involving the production of environmental friendly products (EFP). In a competitive market, the EFP may be considered as an analogous product that competes with the existing environmental unfriendly product (EUFP). However, environmental regulations place supply chain firms at a competitive disadvantage in the marketplace in the long run, when compared with their unregulated rivals (Jaffe et al., 2002; Thomas, 2009).

The trade-off between environmental practices and profitability has been emphasized in the literature (e.g., Pagell and Wu, 2009; King and Lenox, 2002), and one argument indicates that environmental-friendly behavior is unlikely to be compatible with firms' profit-seeking motivation. Hence, faced with the cost disadvantage of producing the EFP, supply chain firms opting for green investment would struggle with the economic feasibility of their decision.

Both research and practical implementation have been growing steadily in the last decade in SSCM (Seuring and Müller, 2008a; Carter and Easton, 2011; Ahi and Searcy, 2013). Among

others SSCM allows companies to implement corporate responsibility practices and achieve a higher efficiency in logistics performance and resource usage (e.g., Gold et al., 2010; Carter and Easton, 2011) while pursuing the three dimensions of sustainability, i.e., economic, social and environment goals. One driver for such corporate action is constant changes in supply chain configurations, which have raised concerns about how and whether this could contribute to sustainability (Hall dorsson et al. 2009) and demanding strategic actions being taken. This offers a link into another young field of management research, i.e., the dynamic capabilities approach. They were first introduced by Teece and Pisano (1994) to explain firm performance in dynamic business environments, focusing on the capabilities that firms employ to reach a competitive advantage. A first conceptual linkage between the two domains of research has been presented in the paper by Beske (2012); however, this remains at the conceptual level and lacks (any) empirical research. Both theories aim to explain the achievement of a competitive advantage in dynamic business environments.

New business environment resulting from the concept of sustainability not only has significantly influenced the activities companies conduct, but also has caused the shift of the basic values and attitudes of societies towards business. Therefore, working in combination with SRM, SSCM can potentially have a key role to play in such companies meeting their GHG emission targets as part of improved operational performance (Ashby et al., 2012; Hajmohammad et al., 2013; Seuring and Gold, 2013; Gualandris et al., 2014).

THE METHODOLOGY AND MODEL DEFINITION

For modeling, we considered three kinds of variables: Environmental variables (amount of Co2 emission), Economical variables (Costs of SCM processes) and Social Variables. We have some assumptions for modeling and according to them we gather data of variables and parameters, then analysis and evaluate them. We have three dimensional for decision and we have multiple objective functions. (Figure 1)

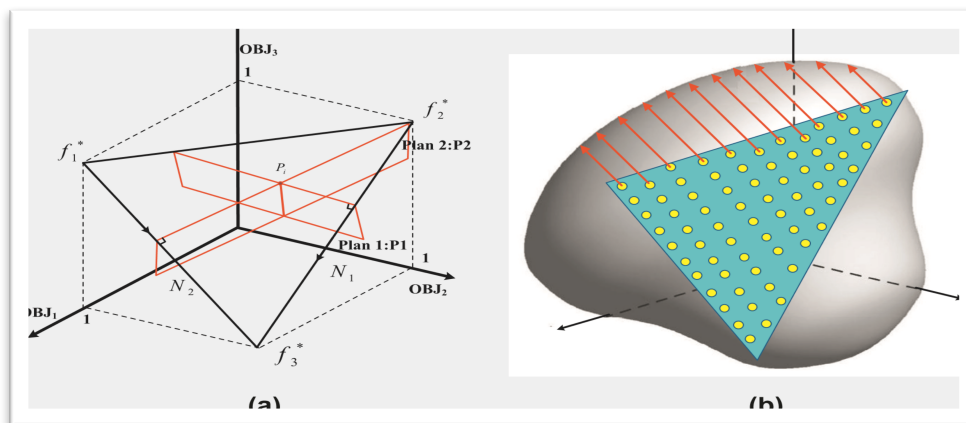


Figure 2: Multiple objective function model (K.Devika., 2014)

After defining the variables, parameters and objective functions, we define the constraints according to our assumptions.

SCM Process

We define six main process for SCM Process as generic process which can apply for every factory per below:

- Marketing Process;
- Designing Process;
- Purchasing Raw Materials;
- Production Process;

- Packing and Marking Process;
- Logistics and Delivery Process.

For our case study The Process are as below:

1- Marketing 2- Designing Process, 3- Purchasing Raw Materials including Colors, Yarn, Silk, Wool, Some tools and so on. 4- Production Process including: Dying, Looming, Weaving and Finishing. 5- Packing and Marking Process, 6- Logistics and delivery to Customers.

Assumptions

- The production lines are independent and there is not any relation between production lines of products X_i .
- The Government enforce legislation by setting constraints in the form of environmental standards and carbon caps that represent the maximum acceptable levels of pollutants and carbon emissions, and also provides incentives so that the manufacturer and supplier would collaboratively produce the EFP through environmental technology investment.
- To motivate supply chain firms to improve their environmental performance, the government enforces regulation by imposing a penalty on EUFP production and provides policy incentives to subsidize EFP production, hence reducing the EFP's cost disadvantage in the marketplace. Grounded on the logic of only compensating for the investment cost of pollution reduction and prevention, we assume that the government subsidized terminal based on partially compensating the average incremental cost of environmental protection. We also assume that the government grants its subsidy directly (or alternatively through consumers) to the manufacturer, who is then motivated to create an environmentally sustainable supply chain, and shares the subsidy with the supplier by adjusting the transfer price through negotiation.
- In reality, the carbon cap is set at a level that is much lower than the normal level of supply chain firms' carbon emissions in producing the EUFP. Hence, supply chain firms need to buy carbon credits to comply with the carbon cap whenever their carbon emissions exceed the cap.
- We assume that supply chain firms place a relatively higher priority on reducing pollutants. To some extent, this is intuitively consistent with reality since pollutant emissions more often incur harm locally; they violate environmental legislation and can be traceable. To comply with environmental constraints (environment standards), supply chain firms would also make an effort to reduce carbon emissions

Variables:

- X_i : Independent Variables = the number of product i (for carpet $X_i = X$ Unit of product i).
- Environmental variables: $E_j (X_i)$: Independent Variables = the amount of carbon emission which is caused by Process number j for producing the product X_i . According to supply chain management process, we consider the main process as per below:
 - Process 1: Marketing process. $E_1 (X_i) =$ The amount of carbon emission which is caused by marketing process by one unit of product X_i ;
 - Process 2: Design Process: $E_2 (X_i) =$ The amount of carbon emission which is caused by Designing process of products through using the materials and fabrication process per one unit of product X_i ;
 - Process 3: Raw material purchasing : $E_3 (X_i) =$ The amount of carbon emission which is caused by Raw materials per one unit of product X_i ;
 - Process 4: Production Process: $E_4(X_i) =$ The amount of carbon emission which is caused by production process per one unit of product X_i ;
 - Process 5: Packing and Marking Process: $E_5 (X_i) =$ The amount of carbon

- emission which is caused by Packing and Marking process per one unit of product X_i ;
- vi. Process 6: Logistics and delivery process: $E_6(X_i)$ = The amount of carbon emission which is caused by Logistics and transportation for delivery to customer per one unit of product X_i ;
- c. The cost Variables are as below: dependent Variables to X_i :
 - i. $C_{c j}(X_i)$ = Cost of process j for producing one unit of product X_i ;
 - ii. $C_{e j}(X_i)$ = Penalty Cost and Cost for removing of effecting of process j on environment per one unit of product X_i which is define by government.
- d. Social Variables (Dependent Variables) are as below:
 - i. $S_{b j}(X_i)$ = The quantity of Job Opportunities (Human per Hour) which is created by producing X_i for one Unit ;
 - ii. $S_{v j}(X_i)$ = The value added which is created by production line

Parameters:

- e. n = The number of Products;
- f. D_i = Average Demand in the year for Product X_i ;
- g. I_i = Maximum Investment rate for product X_i ;
- h. I_e = Maximum Cost for environment protection;
- i. M_{cc} = Maximum Carbon Cap Rate permission per year for factory which is approved by government which is called carbon credit;
- j. S_k = The maximum rate of production Line Number K ;
- k. $P(X_i)$ = Price of Product X_i for one Unit .
- l. $C_{Sbj}(X_i)$ = The total cost for Human resource that should be paid as salary and other rewards for one hour in process j for one Unit of product X_i .

Objective functions

The objective functions are as per below:

- Minimize the Environmental Defects: This objective function is define for minimize bad effect of industries factories for environment.

$$O1: \text{Min} \left(\sum_{i=1}^n \left(\sum_{j=1}^6 E_j(X_i) * X_i \right) \right)$$

- Maximize Profit or net revenues: This objective function is the stakeholder’s objective function that they want to achieve maximum net revenues.

Net Revenues = Gross Revenues – Total Cost

$$O2: \text{Max} \left\{ \sum_{i=1}^n \left(X_i * P_i - \sum_{j=1}^6 X_i * C_{c j}(X_i) \right) - I_i - I_e - S_{b j}(X_i) * X_i * C_{Sbj}(X_i) \right\}$$

- Maximize Social Profit: It means that the factories can increase added value and also job opportunities.

$$O3: \text{Max} \left\{ \sum_{i=1}^n \sum_{j=1}^6 S_{Vj}(X_i) * X_i \right\}$$

$$O4: \text{Max} \sum_{i=1}^n \sum_{j=1}^6 S_{bj}(X_i) * X_i$$

Constraints:

- Government Constraints for carbon credit:

$$1- \sum_{j=1}^6 \left(\sum_{i=1}^n E_j(X_i) \right) < M_{cc}$$

- Demand Constraints:

$$2- X_i \leq D_i$$

- Maximum rate of production lines:

$$3- \sum_{i=1}^n (X_i) \leq \sum_{i=1}^n (S_i) \text{ and}$$

$$4- X_i \leq S_i$$

- Maximum amount of Costs:

$$5- \sum_{j=1}^6 (\sum_{i=1}^n E_j(X_i) * C_{ej}(X_i)) < I_e :$$

This constraint is the limitation of investment by firms for environmental protection.

$$6- \sum_{j=1}^6 (\sum_{i=1}^n C_{cj}(X_i) * X_i + \sum_{i=1}^n \sum_{j=1}^6 (S_{vj}(X_i) * X_i + S_{bj}(X_i) * X_i * C_{Sbj}(X_i))) < I_i$$

$$7- \sum_{j=1}^6 (\sum_{i=1}^n E_j(X_i) * C_{ej}(X_i) + \sum_{j=1}^6 (\sum_{i=1}^n (C_c(X_i) * X_i + S_{bj}(X_i) * X_i * C_{Sbj}(X_i))) < I_e + I_i$$

- 8- $X_i \geq 0$ and Integers
- 9- $E_j(X_i) \geq 0$

Numerical analysis

For implementation the model, we evaluate two factories data and process. The first factory is Hand-made carpet factory in Iran, Kashan (SIFCO Handmade Carpet Factory) and Second factory is Machine-made Carpet. Handmade Factory we considered three kinds of products with different process line for raw materials and dyeing. Machine made factory has one production line with same materials which are totally artificial.

Selected products specification in Hand-made factory are:

- X1: Totally natural raw materials (Natural wool), totally natural dyeing (Planet dyeing), Handmade process;
- X2: Totally natural raw materials (Natural wool), artificial dyeing (Chemical dyeing), Handmade process;
- X3: Artificial raw materials (artificial wool), artificial dyeing (Chemical dyeing), Handmade process;

Selected product specification in Machine-made factory is:

- X4: Artificial raw material (Acrylic material), artificial dyeing (Chemical dyeing), Machinery process.

Defining of SCM Process

We have six main process:

- Marketing process,
- Raw materials process,
- Dyeing Process,
- Production Process,
- Packing and Marking Process,
- Logistic and delivery process.

Environmental variables

Measurement of variables which are the amounts of carbon emission in every process for one unit of product X_i ($i \in \{1, 2, 3, 4\}$, $n = 4$).

For measurement the carbon emission, we get the data of carbon emission in every stage and converted to the numbers. For example, for process one and two, we have same process for four products, and we have same carbon emission and we considered one for all of the products. The carbon emission which is caused of chemical dyeing with machinery process is 520 times more than natural dyeing with traditional hand working.

<i>I</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>Xi</i>	1 Square Meter	1 Square Meter	1 Square Meter	1 Square Meter
<i>E1(Xi)</i>	1	1	1	1
<i>E2(Xi)</i>	1	1	1	1
<i>E3(Xi)</i>	1	35	115	115
<i>E4(Xi)</i>	1	51	235	520
<i>E5(Xi)</i>	1	3	5	15
<i>E6(Xi)</i>	1	1	1	1

Table 1: The amount of carbon emission in every process for one square meter of product i,

The data which is mentioned in table 1 is shown the amount of carbon emission of products X2, X3, and X4 with comparison X1.,

Economical Variables

The Costs for every process for one square meters of products ($i = \{1, 2, 3, 4\}$, $n=4$). In the below table we consider cost of every process for producing one square meters of product i.

<i>I</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>Xi</i>	1 Square Meter	1 Square Meter	1 Square Meter	1 Square Meter
Cc1(Xi)	1	1	1	1
Cc2(Xi)	300	300	300	10
Cc3(Xi)	1300	900	400	30
Cc4(Xi)	1100	1100	1100	8
Cc5(Xi)	15	15	15	2
Cc6(Xi)	10	10	10	10

Table 2: The data for cost of each process

Social variables:

	1	2	3	4
Sb1(Xi)	59	21	12	1
Sb2(Xi)	22.5	22.5	7.3	0.01
Sb3(Xi)	85.6	12	12	0.01
Sb4(Xi)	115	115	115	0.02
Sb5(Xi)	0.01	0.01	0.01	0.01
Sb6(Xi)	0.005	0.005	0.005	0.005
Sv1(Xi)	0	0	0	0
Sv2(Xi)	0	0	0	0
Sv3(Xi)	7%	2%	2%	13%
Sv4(Xi)	9%	9%	3%	3%
Sv5(Xi)	0	0	0	0
Sv6(Xi)	0	0	0	0
CSb1(Xi)	100	100	100	200
CSb2(Xi)	250	250	120	185
CSb3(Xi)	80	20	20	130
CSb4(Xi)	50	50	50	140
CSb5(Xi)	60	60	60	10
CSb6(Xi)	3	3	3	3

Table 3: The Data for Social Variables**Parameters**

For parameters, we gathered and evaluated one year data of both factories, then calculated the average of the data, we consider as the parameters.

I	1	2	3	4
N	1	2	3	4
Di (Square Meter)	500	1200	3500	35000
Ii (\$)	500000	500000	500000	500000
Ie(\$)	1000	2000	3000	700000
Mcc (Unit/year)	200000	200000	200000	200000
Sk	2000	2000	4000	30000
P(Xi) / Square meter	3000	2800	2500	300

Table 4: The data for parameters

We used Excel software for solving the model

The results are as below:

	1	2	3	4
Xi	183	215	273	8333
Total Cost	498675	499875	498225	499980
Carbon Cap	1098	19565	97461	5433116
Total Income	549000	602000	682500	2499900
O1(Environment)	49227	82560	86814	-
				3433196
O2 (Economic)	50325	102125	184275	1999920
O3 (Job) Human Hour	51627	36660	39943.995	8791.315
O4 (VA)	8%	5%	2%	9%

Table 5: Results after solving model

The data in Table 5 presents the optimum amount for producing Xi with considering minimizing carbon emission and maximizing profit and social benefits.

THE FINDING AND DISCUSSION

With solving the model with current data and current rules and conditions for production the products, still the number of EUFP products in comparison with EFP are very high. The main reasons are cost and profit. According to Table 5 and evaluation of results, we find that because of high demand for X3 and X4 and also low cost for processes, whatever the amount of carbon emission are very high, however the number of those products are considerable. It means that if we want to decrease more the amount of that products and increase X1 and X2, we should have more constraints or we should decrease the amount of Mcc which is defined by Government and on the other side, governments will increase the penalty for carbon emission for factories.

For obtaining other solutions which help environment and low carbon emission, we can consider several solution as per below:

- Considering big amount as penalty for factories who have big amount of carbon emission and insert one constraint to the model;
- Decreasing the Mcc or carbon credit for factories;
- Set a rules for factories that they should do some process for cleaning the environment and spending costs for environmental aims. For setting this rule, we can define some variables and add in the model as cost of SSCM.

After defining above variables and constraints, we revise the model and again check the solution. Consider P = the amount of penalty for every unit carbon emission; $\sum_{j=1}^6 (\sum_{i=1}^n E_j(X_i) * P)$ is the total penalty for factory. We consider this penalty in the model as one of the costs that the factory should pay. The Objective function two will be changed to

$$O2-1: \max \left\{ \sum_{i=1}^n (X_i * P_i - \sum_{j=1}^6 X_i * C_{cj}(X_i)) - I_i - I_e - S_{bj} (X_i) * X_i * C_{Sbj}(X_i) - \sum_{j=1}^6 (\sum_{i=1}^n E_j(X_i) * P) \right\}$$

And the Constraints 6 and 7 will be changed to below:

$$6- \sum_{j=1}^6 (\sum_{i=1}^n Ccj(Xi) * Xi + \sum_{i=1}^n \sum_{j=1}^6 (SVj(Xi) * Xi + Sbj (Xi) *Xi*CSbj(Xi)) + \sum_{j=1}^6 (\sum_{i=1}^n Ej(Xi) * P) < Li$$

$$7- \sum_{j=1}^6 (\sum_{i=1}^n Ej(Xi) * Cej (Xi) + \sum_{j=1}^6 (\sum_{i=1}^n (Cc(Xi) * Xi + Sbj (Xi) *Xi*CSbj(Xi)) + \sum_{j=1}^6 (\sum_{i=1}^n Ej(Xi) * P) <Ie + Li$$

With revising model and consider p=50\$ for one unit carbon emission and Mcc decrease to 300,000, we calculate again the model and find below solutions:

	1	2	3	4
Xi	356	423	273	4322
Total Cost	13675	199375	487573	141327
Carbon Cap	213	3849	9746	28179
Total Income	1068000	1184400	682500	1296600
O1 (Environment)	892	12522	86814	-624671
O2 (Economic)	1054325	985025	194927	1155273
O3 (Job) Human Hour	7245	5432	39943.995	4951
O4 (VA)	9%	6%	3%	4.6%

Table 6: The result after revising model

After solving and comparing the result of the first model and revised model, (Table 5 and Table 6), we find that the quantity of EFP (X1 and X2) are increased and the quantity of EUFP (X3 and X4) are decreased.

SUMMARY AND CONCLUSIONS

In this paper, with using the theory of SSCM and three dimensional approach to the factories, we identified a mathematical model in the SSCM context for proposing a solution for minimizing carbon emission by factories with considering economical goals and social benefits.

We define the problem and consider the variables and parameters for modeling, then according to the problem, consider constraints. We consider four types of products with four ranking in Environmental Friendly Product (EFP). The first one is high rank (ranking 8-10 of 10 EFP), second is above average (ranking 6-8 of 10 EFP), Third one is near to average (4-6 OF 10) and last one is Environmental Unfriendly Product (EUFP) ranking is below 4. We solved model for producing these products together. At first stage we find that if we want to produce all of them together without any governmental constraints about maximum carbon cap for every products, the rate of EUFP will be very high because of below reasons:

- Demand: Nowadays because of demand for cheap products, the factories don't like to consider environment and using the materials and production process with minimum carbon emission.
- Profit: The profit of production EUFP is very higher than EFP because of production costs and demand.
- Raw materials accessibility and low cost: Providing natural raw materials are time consuming and the process of obtaining is expensive. Speed for delivery the demands and low cost are another reasons for using chemical materials instead of natural one.

After solving the model, we suggest that for highlighting the environmental dimension in SSCM

model, we consider the minimum carbon emission permission or carbon credit for factories, also add another constraints as rate of penalty for every products. If the factory produce the EUFP, they should pay the high penalty. This penalty should be calculated with comparison the same EFP products costs.

For next research we suggest that the researches can add some more constraints which is effect on cost of production of EUFP and automatically factories intend to produce EFP.

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