Journal of Applied Research on Industrial Engineering

Vol. 2, No. 3 (2015) 168-179

Journal of
Applied Research on Industrial Engineering

Designing Reverse Logistics Network with a Social Approach to Recycle Great household Waste under Uncertainty Conditions

Atefeh Salimi[1] , Reza Tavakoli Moghadam[2*], Mehdi Bashiri[3]

[1] Department of Industrial Engineering, Najafabad Branch, Islamic Azad University, Najafabad, Iran (Asalimi7@sin.iaun.ac.ir)

[2] Professor of Industrial Engineering, Pardis Engineering faculty, Tehran University, Tehran, Iran (Tavakoli@ut.ac.ir)

[3] Associate Professor, Department of Industrial Engineering, Faculty of Engineering, Shahed University, Tehran, Iran (Bashiri@shahed.ac.ir)

A R T I C L E I N F O

Article history :
Received:
Received in revised format:
Accepted:
Available online:

Keywords :
recycling, solid waste management, reverse logistics network design

A B S T R A C T

The importance of social responsibility in organizational and business units have been increasingly stressed by the researchers in recent years. As the supply chain plays an important role in today's business environment, the issue of social responsibility must be carefully considered in designing and planning supply chain.This paper considers the social responsibility to be one of the goals of designing the reverse logistics network for recycling large household waste in terms of uncertainty. To deal with the uncertainty in proposed model, scenario-based random planning is used, and the proposed model has been solved by using GAMS Software. Since the objective function value has been taken into consideration for the model of social responsibility as one of the objectives, the objective function value is more than basic model one; we tried to present an approach as a motivational factor for enterprises to move towards the adoption of social responsibility towards society.

1. Introduction

Logistics include the physical sector of supply chain and mainly include the activities related to the flow of materials and goods from raw materials to final product stage, including transport, storage and so on. One of the new trends in logistics management is the recycling or the reuse of products. In this way, the products that reach the end of its useful life again are purchased by the final consumer and after disassembly parts of the product that are reusable again come to life cycle in the form of salvage products. Designing and implementing reverse logistics network for returned product not only reduce the costs of inventory and transportation, but also will increase customer loyalty (Lee, Gen, and Rhee, 2009). Reverse logistics because of the many competitive advantages associated with it have gained the popularity. Environmental regulations and economic interests, consumer awareness and social responsibility to the environment of this area are the main stimuli (Bagheri-neghad, Kazemzadeh, and Asadi, 2013).

On the other hand, in recent years, Corporate Social Responsibility (CSR) is defined as a result of corporate activities on various social groups (or stakeholders). Also it is taken into consideration in the field of environmental protection, human rights, safe working conditions for the employees and so on (Carter and Jennings, 2002). Today, the necessity and the importance of corporate social responsibility will help the managers and the planners to highlight corporate social responsibility in their missions, visions, values and strategies (Cruz and Wakolbinger, 2008). On the other hand, the states with regard to their role of governance always pay attention to non-economic aspects of development and excellence of the country in laws and programs. For example, in Iran in the field of the social responsibility Article 28 of the constitution of the equal employment opportunity has stated that "everyone has the right to choose a job which is not contrary to Islam and the public interests and would not infringe the others' rights. The government must respect the need of society to the various occupations for all individuals and give the equal conditions for creating jobs and obtaining employment." Likewise, in Articles 20, 30 and 31 social justice and basic needs of all people are emphasized by the government as well. The future twenty-year perspective of the Islamic Republic of Iran has been drawn by 2025 has specified the most important strategic document of moving and developing the country during this period and adopted the right orientation to all-round development.

Despite the importance of social responsibility in supply chain, the literature is not extended and in fact the social aspect of the supply chain has less attention in the literature related to a serious vacuum. Based on studies in supply chain in management literature, few papers have been published in this area. For instance, Dehghanian and Mansour (2009) presented the four social indicators as follows: (1) local development, (2) employment, (3) hazardous working conditions and (4) the risk of each product. Rating each product was considered based on an analytic hierarchy process and function as a separate objective in their mathematical models. Pishvaiei and colleagues (2012) by developing the above-mentioned criteria presented a practical definition and ultimately applied them as the decision variables in the objective function. The four indicators discussed in this reference are including: (1) the number of potentially harmful products, (2) the number of days lost due to work injuries, (3) the amount of waste generated and (4) the number of jobs created in the social objective function. They are alongside other objectives of the stability such as to minimize environmental impacts and economic costs. Devika et al. (2014) also considered the measures of (1) the number of potentially harmful products (2) the number of days lost due to work injuries in the social objective function model and minimized two other objectives such as environmental and economic sustainability.

In this article, what is reviewed based on the concerns about the social effects of economic activity in the world, national needs and goals of its strategic documents, as well as gaps in the relevant literature is the development of an integrated integer linear programming model in the field of social responsibility at the reverse logistics. In addition, component aspects of social responsibility according to the research community to identify and approach the issue of reverse logistics network design are discussed. Then a random network in the field of recycling of large household waste taken from Chang and Yang work (2013) are presented in addition to minimize the total cost as well as maximizing the social responsibility. In the end, providing a mechanism is considered to encourage the companies and organizations to move toward engaging in social responsibility.

Additionally, the research and the findings will be discussed and the conclusions and recommendations are presented for future research in this paper.

2. Research background

The network studied in the paper is a single-period reverse logistics network for recycling large multi-product household taken from Chang and Yang article (2013). It includes customer, recycling in this paper, and the centers for final disposal with the aim of maximizing the social impacts beside minimum total cost. Distribution of large household wastes is made up of three sub-modes. At first, the great waste of event points is used to a large waste recycling center. With regard to waste position, usable products, usable parts or recycled materials are the output value of a large waste recycling center. They can be delivered to reuse markets corresponding to the profit and the final waste without a final value at disposal site. Because of the uncertainty in supply places a burden is set on network design stability that we will discuss in the research.

It should be noted in the social sphere that (1) employment, (2) the level of development, (3) population density and (4) the risk of consumption of goods in the end markets are used as the indicators described below.

The first indicator belongs to the development of employment opportunities. Creating opportunities of employment is one of the most experienced standards and indicators of social sphere which is explicitly mentioned in the ISO26000 standard. The employment rate is the index of the field which is also frequently used in the literature (see Pishvaee et al., 2012; Devika et al., 2014; Erol, Sencer, and Sari, 2011). In this study like Devika et al. (2014), the creation of stable jobs for the convenience of candidate site S (O_sn) and the variable employment rate is separately examined for the facilitator (〖υo〗_sn). In fact, the variable employment rate is dependent on a large amount of waste produced by the processing “n” mode at the event point i and processing “n” mode, at candidate site S for large waste recycling centers under scenario of generation k of large waste treated (X_isn).

The second indicator addresses the balanced economic development. Construction of facilities in disadvantaged and less developed areas facilitates the balancing of economic development. The importance of local development and a balanced development in the field of sustainability literature (Pishvaee et al., 2012; Devika et al., 2014) has been much stressed. In this way, the lower local development index is more valuable than facilitating the establishment of the socio-economic development. The indicator ed_sreflectsthe level of development of candidate site S and 〖υc〗_(sn)presents the economic value of candidate sites S at processing “n” mode. Economic value of candidate site Sis equal to the amount of investment required and it has been defined for land acquisition, establishment and operation of the center.

The third indicator is associated with the risk of product usage. Since the past, product risk has been considered to be an important factor that can even affect the economic interests of both companies. To measure product risk several indicators are used such as the judgment of experts about the risks in product use, the number of customer complaints related to product risks, the number of customers affected and the number of products with potential risks (Pishvaee et al., 2012; Devika et al., 2014). In the issue under review, the judgment of experts is used for the risk of consumption of the product. Obviously, plastic recycling and coming back it into the production cycle are associated with consumption risks for the consumer, but it is clear that the risk-taking with respect to the consumer can make a difference. In this regard, we have considered the risk of consumption of goods g in end-market m 〖(φ〗 _gm).

And of course the latter index on the basis of the problem is presented in this study as an innovative indicator added to the objective social impact assessment. In fact, considering the direct and inseparable sets and repair / recycle / final disposal of large household waste or some other ways to say reverse logistics process for solid waste management in this research topic, we decided to take advantage of common and consistent criteria on both topics that affect social outputs. By the same population density of urban residential area closest to the candidate site S (μ_s) it is chosen as an indicator of the social impact assessment with regard to areas with higher population density which leads to the development of employment opportunities and the balance of economic development. And since the high population density in the region leads to produce more waste than in areas with lower population density that is a good reason for considering the measure in issue. Indeed, given the importance of the amount of waste produced at the location of recycling centers, perhaps it has been said that entering the index in this model is inevitable and very impressive in results and making a decision. Later in next section the assumptions used in the model are presented.

3. Model Assumptions

There are two sources of uncertainty in the supply of large garbage. One source is unpredictable, for example: location and time of return, and the other is using historical utilization data (past) that is anticipated such as the amount and the quality. The study only looked at event locations. Coordinates of event locations for large waste is considered as a discrete random variables. The following a scenario-based approach is used to model the conditions described.

The number k is assumed to be a large waste recycling network design scenario. For the scenario k, a large waste supply scenario can be as $\{n_i^x(k), n_i^y(k), Pin(k)\}$ whereas n_i^x (k) and $n_i^y(k)$ indicate x-y coordinate point corresponding i, under scenario k in the supply of large waste. $P_{in}(k)$ represents the amount of large waste in the point corresponding it hat is required to treat by the processing mode n under scenario k in the large supply of waste. Costs in recycling large waste systems are linear including the cost of land, facilities and equipment, the costs of processing and transportation.

The cost of transportation from the candidate site S to final disposal site as well as the end markets is supposed a constant.

- Candidate sites of recycling centers of large waste have been characterized.
- Markets of reuse and final disposal sites are given.
- As mentioned in section 2, in index of developing employment opportunities, the creation of stable jobs for a facilitator in one place and creation of variable employment are separately taken into account for the facilitation. The creation of stable jobs, positions such as managers responsible for each job is independent of the facilities' capacity included. In contrast, employment opportunities are quite variable depending on the capacity of the facility.
- Because of undeniable task of corporate social responsibility for public health (particularly in consumer goods manufacturing organizations), to determine the risk of the final

consumption of goods in the end markets of the study, the judgment basis is the effect of goods repaired or recycled materials on human health. In fact, different markets are considered as end markets in which we have three categories of domestic, industrial and health divisions.

4. Model Symbols

4.1. Sets

G: Index of goods that have been reused $g \epsilon G$

I (k): Index of the sets of large waste event locations under scenario of generation k of large waste $k \epsilon K$

N_s: Index of processing "n" mode set that is proper to launch in the candidate site S (for large waste recycling centers) $n \epsilon N_s$

M_g: Index of reusable commodity markets set g $m \epsilon M$

R: Index of final disposal sites $r \epsilon R$

S: Index of candidate sites for large waste recycling centers $s \epsilon S$

4.2. Parameters

B: A large number

C_{is}^1: Unit cost of transport between the incident site i and candidate site S for large waste recycling centers

C_{sgm}^2: Unit cost of transportation of reusable goods g between candidate sites S for large waste recycling centers and market m for reusable goods g

C_{sr}^3: Unit cost of transportation between candidate site S for large waste recycling centers and final disposal site

C_{sn}: Large waste treatment unit cost by processing "n" mode, candidate site S for large waste recycling centers under processing

$d_{is}^1(k)$: Transport distance between the event point i and candidate site S for large waste recycling centers under scenario of generation k of large waste

d_{sgm}^2: Distance of transporting reusable goods g between the candidate site S for recycling centers and large market m for reusable goods g

d_{sr}^3: Distance of transporting between candidate site S for large recycling centers and sites for final disposal r

f_{sn}^1: Cost of launching candidate site S for large waste recycling centers that it will take a processing "n" mode

f_{sn}^{2}: Cost of equipment and setting up processing "n" mode at candidate site S for large waste recycling centers

K: Number of scenarios in the scenario set of large waste

P_{in} (k): Amount of large waste produced in event point I that is required to treat at processing "n" mode under scenario of generation k of large waste

U_{sn}: Maximum processing "n" mode of the candidate site S for large waste recycling centers

L_{sn}: Minimum processing "n" mode capacity of the candidate site S for large waste recycling centers

δ_{ng}: Conversion rate by the ratio of recycled products weight through processing "n" mode to great waste weight, $1 \geq \delta_{ng} \geq 0$; (or in other words, recycle rate)

δ'_{n}: Conversion rate that is the ratio of final waste weight created through processing "n" mode to the great waste weight. $1 \geq \delta'_{n} \geq 0$; (or the final disposal rate)

w1: Coefficient (weight) of the importance of job creation index in the second objective function (maximization of social accountability)

w2: Coefficient (weight) of indicator importance of developing level of the candidate site for the second objective function (maximization of social accountability)

w3: Coefficient (weight) of population density of the nearest urban area in the second objective function (maximization of social accountability)

w4: Coefficient (weight) of the importance of consumer goods risk index in the second objective function (maximization of social accountability)

O_{sn}: Number of permanent job opportunities created by the construction of site S for the processing "n" mode

υo_{sn}: Variable number of job opportunities created by the construction site S for the processing "n" mode

υc_{sn}: Economic value of a recycling center in candidate site S

ed_{s}: Development level of the candidate sites for constructing site S

μ_{s}: Population density of urban residential area closest to the candidate site S

ξ_{s}: Set of population density of urban residential areas closest to candidate site S

φ_{gm}: risk goods usage g in the marketplace m

4.3.Variables

$X_{isn}(k)$: Large amount of waste produced at the event point I by the processing "n" mode, candidate site S for large waste recycling centers under scenario of k generation of treating large waste

$X'_{sgm}(K)$: Amount of reusable items g at the candidate site S to treat large waste recycling centers and send to the market m under scenario of generation K of large waste

$X''_{sr}(K)$: Ultimate waste of candidate site S for large waste recycling centers r to final disposal site under scenario of generation k of large waste

$Y_{isn}\ (k) = \begin{cases}1\\0\end{cases}$: Variable 0 or 1 if the waste produced by event point I and the processing "n" mode has been set up at candidate site S for large waste recycling centers to treat under scenario of generation k of large waste1, otherwise 0.

$Z_{sn} = \begin{cases}1\\0\end{cases}$: Variable 0 or 1 if the processing "n" mode of large waste recycling centers S is launched 1, otherwise 0.

$\theta_{sgm}(k) = \begin{cases}1\\0\end{cases}$: Variable 0 or 1 if goods g of the candidate site S under the scenario k of a large waste is sent to market m 1, otherwise 0.

5. The proposed mathematical model

Symbols used in mathematical models examine the issue in above parts defined by using mixed integer linear programming model for integrated logistics network design in order to minimize the costs and maximize the social effects that are provided below:

$$\begin{aligned}\text{Min } f_1 = &\sum_{s\in S}\sum_{n\in N_s}(f^1_{sn}\times Z_{sn}) + \sum_{s\in S}\sum_{n\in N_s}(f^2_{sn}\times Z_{sn}) + \frac{1}{K}\left\{\sum_{k\in K}\sum_{s\in S}\sum_{n\in N_s} c_{sn}\sum_{i\in I(k)} X_{isn}\,(k)\right\}\\ &+\frac{1}{K}\left\{\sum_{k\in K}\sum_{i\in I(k)}\sum_{s\in S} c^1_{is}d^1_{is}(k)\sum_{n\in N_s} X_{isn}\,(k)\right\}\\ &+\frac{1}{K}\left\{\sum_{k\in K}\sum_{s\in S}\sum_{g\in G}\sum_{m\in M_g} c^2_{sgm}\, d^2_{sgm}(k)X'_{sgm}(k)\right\} + \frac{1}{K}\left\{\sum_{k\in K}\sum_{s\in S}\sum_{r\in R} c^3_{sr}d^3_{sr}X''_{sr}(k)\right\}\end{aligned} \tag{1}$$

$$\begin{aligned}\text{Max } f_2 = &[w_1\times(\sum_s\sum_n O_{sn}Z_{sn}) + \frac{1}{k}(\sum_s\sum_n\sum_k \upsilon o_{sn}X_{isn}(k))] + [w_2\\ &\times\sum_s\sum_n Z_{sn}\,\upsilon c_{sn}\,(1-ed_s)] - [w_3\times\sum_g\sum_{m_g}\varphi_{gm_g}\,\theta_{gm_g}]\\ &+\left[w_4\times\sum_s\sum_n(\frac{\sum_{s\epsilon\xi}\mu_s}{\mu_s})\,Z_{sn}\right]\end{aligned} \tag{2}$$

s.t.

Limitations of the current balance

$$\sum_{n\epsilon N} \delta_{ng} \sum_{i\epsilon I(k)} X_{isn}(k) = \sum_{m\epsilon M_g} X'_{sgm}(k) \qquad \forall s \in S, g \in G, k \in K \qquad (3)$$

$$\sum_{n\epsilon N} \delta'_n \sum_{i\epsilon I(k)} X_{isn}(k) = \sum_{r\epsilon R} X''_{sr}(k) \qquad \forall s \in S, k \in K \qquad (4)$$

$$\sum_{s\epsilon S} X_{isn}(k) = P_{in}(k) \qquad \forall i \in I(k), n \in N, \forall \in K \qquad (5)$$

Capacity constraints of facilities

$$\sum_{i\epsilon I(k)} X_{isn}(k) \leq U_{sn} \cdot Z_{sn} \qquad \forall s \in S, n \in N_s, k \in K \qquad (6)$$

$$\sum_{i\epsilon I(k)} X_{isn}(k) \geq L_{sn} \cdot Z_{sn} \qquad \forall s \in S, n \in N_s, k \in K \qquad (7)$$

Rational allocation limitations

$$\sum_{i\epsilon I(k)} Y_{isn}(k) \leq B \cdot Z_{sn} \qquad \forall s \in S, n \in N_s, k \in K \qquad (8)$$

$$Z_{sn} \leq \sum_{i\epsilon I(k)} Y_{isn}(k) \qquad \forall s \in S, n \in N_s, k \in K \qquad (9)$$

$$X_{isn}(k) - B[Y_{isn}(k) - 1] \geq P_{in}(k) \qquad \forall i \in I(k), s \in S, n \in N, k \in K \qquad (10)$$

$$X_{isn}(k) + B[Y_{isn}(k) - 1] \leq P_{in}(k) \qquad \forall i \in I(k), s \in S, n \in N, k \in K \qquad (11)$$

$$\sum_{s\epsilon S} Y_{isn}(k) \leq P_{in}(k) \qquad \forall i \in I(k), n \in N, k \in K \qquad (12)$$

$$B \sum_{s\epsilon S} Y_{isn}(k) \geq P_{in}(k) \qquad \forall i \in I(k), n \in N, k \in K \qquad (13)$$

$$X'_{sgm}(k) \leq B \,.\, \theta_{sgm}(k) \qquad \forall s \in S, g \in G, m \in M, k \in K \qquad (14)$$

Domain Restrictions

$$Y_{isn}(k) \in \{0,1\} \qquad \forall i \in I(k), s \in S, n \in N, k \in K \qquad (15)$$

$$Z_{sn} \in \{0,1\} \qquad \forall s \in S, n \in N \qquad (16)$$

$$\theta_{sgm}(k) \in \{0,1\} \qquad \forall s \in S, n \in N \qquad (17)$$

$X_{ism}(k) \geq 0$ $\forall \mathrm{i} \in \mathrm{I(k)}, \mathrm{s} \in \mathrm{S}, \mathrm{n} \in \mathrm{N}, \mathrm{k} \in \mathrm{K}$ (18)

$X'_{sgm}(k) \geq 0$ $\forall \mathrm{s} \in \mathrm{S}, \mathrm{g} \in \mathrm{G}, \mathrm{m} \in \mathrm{M}, \mathrm{k} \in \mathrm{K}$ (19)

$X''_{sr}(k) \geq 0$ $\forall \mathrm{s} \in \mathrm{S}, \mathrm{r} \in \mathrm{R}, \mathrm{k} \in \mathrm{K}$ (20)

In two parts of the equation (1), total fixed costs are including the costs of land and the total expected costs of transport operations. Equation (2) maximizes social accountability. Description of indicators used in social purpose is presented in section 3.

Relationships (3) to (5) are the limitations of the current balance. Equation (3) shows the balance of reusable goods, in fact the percentage of treated waste collected at the processing "n" mode. It indicates commodity reusable g multiplied by the total treated waste collected from the event point i at the site S by processing "n" mode. It is equal to the amount of reusable goods g that finds a path to market m from a candidate site S. Equation (4) shows the balance of the final waste. Equation (5) calculates the total waste collected in the event point i treated by the processing "n" mode in all sites, the candidate must be a total waste of large production under scenario k in point event i that needs processing "n" mode.

Equations (6) and (7) are facility capacity limitation. These functions are a reference of contingency planning model. In fact, the amount allocated from the large waste is a consistent treatment capacity for processing "n" mode at candidate site S under scenario generation k of large waste.

Equations (8) to (14) can be rational allocation restrictions and limit unreasonable allocation of large waste. Equation (8) ensures that if the processing "n" mode is launched at site S, resulting in treating a large waste in the event point i (the processing "n" mode) sending to the site.

Equation (9) prevents the unreasonable allocation, if no large garbage at the event point I need to treat (in the processing "n" mode). It allocates to the site S, as a result the processing "n" mode is not launched in the site S. Equations (10) and (11) determine that if the allocation was done Y_{isn} *(k)* =1, all great waste at event point i have been transported from a candidate site S to great waste recycling centers and treated by the processing "n" mode under scenario of generation k of large waste. Equations (12) and (13) for unnecessary decisions are including dispelling large garbage if there are no large waste at this point scenario under a certain generation. Equation (14) is defined to allocate the goods reusable, recycled materials or products at appropriate markets to each other in accordance with any commodity at the end market. In fact, if commodity g moves from the candidate site S to the market m, $\theta_{sgm}(k)$=1; and if good g does not move from a candidate site S to the market m $\theta_{sgm}(k)$ =0, which in both cases, there is a reasonable relationship in limits.

Equations (15) to (20) are range limitations. Equations (15) to (17) specify that Y_{isn} *(k)*, Z_{sn} and θ_{sgm}(k)variables are 0 and 1. Equations (18) to (20) indicate that Y_{isn} *(k)*, Z_{sn} and $\theta_{sgm}(k)$ as non-negative variables.

6. Findings

In this section, to demonstrate the applicability of the model, sample problem is solved by software GAMS 23.5.1 and using solver CPLEX and the validity of which is investigated. It is necessary to mention that the method of determining the parameters of the basic model, according to an article on the study has made the changes, if necessary. Of course, in determining the parameters required for the expansion of the model in the environmental dimension, Devika et al. (2014); Eskandari et al. (2012) has been helping the information contained in this research. The distance between the two places is intended as an orthogonal (metropolitan) to get the transport costs between the candidate sites and end markets as well as final disposal sites. Distances between them are multiplied by a constant 15. Also for dealing with model uncertainty, stochastic programming scenario is used. In this regard, to deal with uncertainty in the location of large household waste in the event points, four scenarios have an equal chance to examine the values used in the model. After solving the problem, the objective function value for the base model is equal to 40701105. Proposed model considers the social model as well as at least the cost that is equal to 40711910. Then comparing answers of basic model and the social model, as well as minimizing the cost is presented.

6.1. Analysis of Results

It is clear that the objective function value to a proposed model is higher than the base objective one, actually the costs that companies should be tolerant towards social responsibility is undeniable. In other words, perhaps the difference between the values of the objective function based on the proposed model represents the cost the company pays to its social responsibility. The difference between the values of the objective function and application is important in two respects: (1) Organizations will be able to provide the difference in cost, effort and its performance on social responsibility of the community and report them to stakeholders; (2) the states with regard to the role of governing always allocate incentive subsidies in line with the social responsibility of companies and organizations to their community.

The index is a good measure for determining the allocation of state subsidies. In this regard, in many countries, including Iran, the states have adopted costs for companies, governments, policies and incentive benefits to support organizations that are in line with its social responsibility of the community to keep pace. For example, in Iran, for companies that constructed manufacturing centers in deprived areas (less developed), low-interest loans and tax breaks are considered. In line with the above issues, it is the role and importance of loans, as a motivational factor for investors and companies move towards sustainable development acknowledged, but it is important to determine the amount of these loans that we offer as the solutions in the model. To achieve this objective, the proposed model is used for social impact, regardless of the fixed cost of land and installation (f_{sn}^1), then we solve the objective function by value 40,671,898, in which case the objective function value size is 40012 less than the model proposed with regard to the effect of fixed costs on the community and launching. The difference between these two objectives can be considered as long-term loans from the government, investors and institutions. The importance of taking into account the fixed costs of land and setting up a long-term loan can be described as companies and organizations at the beginning of each business that requires substantial capital to grant loans such as fixed costs of land and set up at the beginning of working in a the long-term form that can be a very effective incentive. Also, the objective function in the model of social effects, regardless of the fixed costs and launching is equal to 29,207 fewer than solving the basic model (without considering the social effects). It can be fixed if the cost of land and launching as a long-term loan from the government put at the disposal of investors and organizations, the difference between the values of the objective function model to create social impact, regardless of the cost of the fixed installation. Basic models can be highly motivational factor influencing the investors and the organizations towards social responsibility against society.

7. Conclusion

In this article, based on concerns about the social effects of economic activity in the world, national needs and aiming strategic documents, as well as gaps in the relevant literature, the social aspect of the issue of reverse logistics network design is discussed. On the other hand, by designing the reverse logistics network and considering common indicators of solid waste management issues, a random network in the field of recycling of large household waste was taken from the paper of Yang & Chang (2013). In addition, minimizing the total cost considers a maximum of minimizing social impacts. Increasing the value of the objective function in the model than the base model indicates the costs companies should be tolerant towards its undeniable social responsibility in society. In this regard, since the governments with regard to the role of governing always allocate incentives subsidies in line with environmental protection to companies and organizations, the index is a good measure for determining the allocation of state subsidies. Accordingly, we strive to provide a way to determine the value of some these loans. It should be note that in this study due to the novelty of the subject of research, the most important constraints are the lack of actual data that led to use the hypothetical data for testing the model and producing the example. From the issues that can be addressed in future research are environmental aspect as one of the goals of the development model and the network model for a period and taking into account the uncertainty in the amount, timing and quality of the returned product in reverse logistics network design.

8. References

Lee, J., Gen, M. and Rhee, K. (2009). “Network model and optimization of reverse logistics by hybrid genetic algorithm”, *Computers & Industrial Engineering*, Vol. 56, No. 3, pp. 951-961.

Bagheri-neghad, Z. and Kazemzadeh, R. and Asadi, R. (2013). “Identifying and ranking of success factors in automotive reverse logistics through interpretive structural modeling (ISM)”, *journal of Management Research in Iran*, Vol. 17, No. 1, pp 21-40.

Carter, C.R. and Jennings, M.M. (2002). “Social responsibility and supply chain relationships”. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 38, No. 1, pp. 37-52.

Cruz, J.M. and Wakolbinger, T. (2008). “Multiperiod effects of corporate social responsibility on supply chain networks, transaction costs, emissions, and risk”, *International Journal of Production Economics*, Vol. 116, No. 1, pp. 61-74.

Dehghanian, F. and Mansour, S. (2009). “Designing sustainable recovery network of end-of-life products using genetic algorithm”, *Resources, Conservation and Recycling*, Vol. 53, No. 10, pp. 559-570.

Pishvaee, M.S. and Razmi, J. and Torabi, S.A. (2012). “Robust possibilistic programming for socially responsible supply chain network design: A new approach”, *Fuzzy Sets and Systems*, Vol. 206, No. 1, pp. 1-20.

Devika, K. and Jafarian, A. and Nourbakhsh, V. (2014). “Designing a sustainable closed-loop supply chain network based on triple bottom line approach: A comparison of meta-heuristics hybridization techniques”, *European Journal of Operational Research,* Vol. 235, No. 3, pp. 594-615.

Chang, M.S. and Yang, W.C. (2013). “A stochastic network design of bulky waste recycling—a hybrid harmony search approach based on sample approximation”, *International Journal of Applied Operational Research,* Vol. 3, No. 3, pp. 15-40.

Erol, I., Sencer, S. and Sari, R. (2011). “A new fuzzy multi-criteria framework for measuring sustainability performance of a supply chain”, *Ecological Economics,* Vol. 70, No. 6, pp. 1088-1100.

Eskandari, M., Homaee, M. and Mahmodi, S. (2012). “An integrated multi criteria approach for landfill siting in a conflicting environmental, economical and socio-cultural area”, *Waste Management,* Vol. 32, No. 8, pp. 1528-1538.