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Sustainable Optimization in Supply Chain Network of the Iranian Universities

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Abstract

There has been a lot of problems for Universities that the main problems of the students are obliged to pay high fees for education and also inability of university to provide appropriate services in terms of quality and quantity of the students. These two factors cause psychological and even physical problems in the country's students an after a while their motivation for continuing education greatly get lowers. One of the most important part of the problems mentioned there, are self-services of Universities that in addition to their high cost, provide poor quality of their service level. In this article, we check the one of the self-services of country's Universities and we plan to implement a Sustainable Supply Chain in this section to minimize the costs and the quality of the food served in this sector to reach its maximum to reach the economically optimal point and raise the level of customer satisfaction to at least provide their needs and avoid the creation of adverse effects. We examined a four-level chain that made from distributor, logistics, self-service and customer. We want to use a multi-objective function, dual economic objective (cost) and social (quality) to deliver efficient point and also putting information at each level of the chain to the other levels, to minimize bullwhip effect on the entire supply chain and amount of inventory at each of the levels and therefore reduce total costs in this area and to increase the quantity and quality of cooking.

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Introduction

Today the world is confronted with existential sustainability challenges such as climate change, resource, food and water scarcity, biodiversity losses, and continuing growth of the world's population towards 10 billion people with high unemployment and poverty in many parts of the world (Emmott, 2013). Civil societies, policymakers and Universities increasingly understand and accept that current resource and emission-intensive industry supply chains and product designs are not considered sustainable given the future generations' social, ecological, and economic needs. Specifically, on climate change, the world runs out of time to cut greenhouse gas emissions in order to limit global warming to a 2° temperature increase, while analyses show that we are on a 3-4° temperature increase trajectory with potentially severe and irreversible consequences for nature and human civilization as well as drastic economic losses and costs (IPCC, 2014). Sustainability is one of the prime focus areas in many organizations. This is due to the increasing concern over the environmental effects caused by industrialization, which negatively impacts the quality of people ‘s life and the environment. The depletion of the ozone layer, natural resources, and other hazardous environmental effects are growing concerns of modern society. The population growth rate has come with an increasing demand that has eventually impacted the natural systems, resources, and ecology and therefore there is more need than ever before to focus on environmental hazards caused by organizations (Markley & Davis, 2007). Over the past two decades, many organizations have taken steps to integrate the principles of sustainability into their long- and short-term decision-making. However, sustainability is an issue that extends beyond the boundaries of any one firm (Seuring & Gold, 2013). To that end, there is a rapidly growing body of literature that focuses on the integration of sustainability with supply chain management (SCM). Given the many players in a supply chain (e.g., suppliers, focal firm, distributors, retailers, customers, etc.), Universities incorporating sustainability principles into their business strategies typically set long-term sustainability targets and indicate the timeframe for reaching these targets. For instance, Daimler announced plans to reduce its production and product greenhouse gas emissions by 20% in 2020 compared to the early 1990s (Daimler, 2015). Similarly, policymakers such as in the EU commissions or national ministries of economics and environment, define the period until which sustainability regulations should become effective, e.g. the EU target to reduce absolute annual greenhouse gas emissions by 20% in 2020 compared to 1990 (European Commission, 2014). The (New Zealand Business Council for Sustainable Development, 2003) describes Sustainable Supply Chain management as “Management of the raw materials and services from suppliers to manufacturers/service providers to the customers and back with improvement of social, economic and environmental impacts”. According to Business for social responsibility (2007), A Sustainable Supply Chain is a system associated with business activities throughout the products lifecycle that creates value to stakeholders, ensures ongoing commercial success, and improves the well-being of people and the environment emphasize that sustainability must also integrate issues and flows that extend beyond the core of supply chain management: product design, manufacturing by-products, by-products produced during product use, product life extension, product end-of-life, and recovery processes at the end-of-life (Linton et al, 2007). Today, increasing

numbers of students eager to study, is one of the biggest problems come into existence in Iran, because according to past infrastructure for a limited number of student education, Universities are not able to fix all the requirements of incoming students using low-cost, so the fee for education of students increased, on the other hand, despite receiving high costs, quality and quantity of the provided services is very low that mainly due to high inflation in the country. Despite such problems, students have been studying are in trouble financially and also in term of motivation are low. Several studies had been done by experts of psychology at most Universities in the country to investigate the motivation of students to continuing education. These professionals have concluded that because of the low quality of services provided in different parts of Universities, most students that have been studied in the sample had to lack sufficient motivation to continue their education after a certain time. Therefore, Universities in addition to challenges related to reducing the costs of tuition are faced with another challenge. Self-service of Universities is one of the areas that most students' dissatisfaction towards this section and according to research conducted by experts in the field of psychology, this part of the University in addition to receiving high fees for services (serving food), by providing bad quality food, put physical health of students at risk and cause several problems including poisoning and infectious diseases and the cost of living increases for students. Also, the mental health of students affected and most students who use the services of this sector, due to the non-satisfaction the minimum requirements, faced problems during the day such as lack of sufficient focus on classes, Rapid and aggressive response to the surrounding issues, desire to finish classes soon and not doing the homework in classes. Therefore, due to problems the scientific and cultural level in Universities has declined significantly compared to previous years. Sustainable Supply Chain is one of the ways in which Universities can implement it, identified defects in the structure of each of the areas in terms of cost and quality, and by resolving it can optimize their existing structure in the best mood. Therefore, due to problems the scientific and cultural level in Universities has declined significantly compared to previous years. Sustainable Supply Chain is one of the ways in which Universities can implement it, identified defects in the structure of each of the areas in terms of cost and quality, and by resolving it can optimize their existing structure in the best mood.

Material and methods

To simplify the explanation of mathematical formulas provided in the description of the variables shown in the following table:

Symbol	Description
Sets	
Yi	Set of (raw materials ,administrative ,fixed)cost iє [1,2,…I]
Xj	Set of(raw materials, food, product) quality jє [1,2,…J]
Ai	Set of cost function coefficients iє [1,2,…I]
Aj	Set of quality function coefficients jє [1,2,…J]
bj	The effectiveness of the quality of each raw material in the smell of certain foods
Pj	The impact of each raw material in the food smell {Ask the expert chefs}(fuzzy number)
qi	The impact of each raw material in the baking a meal of a food
kj	The impact of each raw material in terms of calories, the calories cooked an entire
Parameters	
C	meal (green herb stew)
L	The amount of funds used
E	The minimum food calories should be cooked in the university's self-service
G	The total cost of kitchen's energy
M	At least amount of food serving
N	The total cost of raw materials
R	The maximum calories in a meal that will prevent the occurrence of factors such as drowsiness
S	Total energy costs dining hall storage cost

T	Storage cost
O	Transportation cost
F	At least taste to be green herb stew (especially food) (the question of expert chefs)
H	Minimum standard quality that should a meal of green herb stew to have. (especially food)
W	The smell of the food at least should have
Decision variables	
Y1	Administrative costs
Y2	Price level of bean
Y3	Price level of rice
Y4	Price level of sauce
Y5	Price level of meat
Y6	Price level of vegetable
Y7	Price level of oil
Y8	Price level of lemon juice
Y9	Price level of onion
Y10	Price level of dried limes
Y11	Price level of salt
Y12	Price level of bread
Y13	The administrative costs of logistics
Y14	Administrative costs of transport
Y15	The administrative kitchen costs
Y16	Price level of transportation (transfer of raw materials)
Y17	Price level of storage
Y18	Price level of kitchen water bill
Y19	Price level of kitchen electric bill
Y20	Price level of kitchen gas bill
Y21	Price level of dinnerware water bill
Y22	Price level of dinnerware electric bill
X1	Price level of dinnerware gas bill
X2	The quality of beans
X3	The rice quality
X4	The quality of tomato paste
X5	The meat quality
X6	The vegetable quality
X7	The oil quality
X8	The lemon-juice quality
X9	The quality of onions
X10	The quality of dried lime
X11	The quality of bread and salt
X12	The quality of cooking
	Quality of Service

$$\textbf{Max F} = \sum_{j=1} \boldsymbol{Aj\ Xj} \quad (1)$$

$$\textbf{Min Z} = \sum_{i=1} \boldsymbol{A_i\ Y_i} \quad (2)$$

Subject to:

$$\sum_{i=1}^{I} A_i Y_i \le M \quad , \quad i=1,2,\ldots,11 \quad (3)$$

$$\sum_{i=1}^{I} A_i Y_i \le W \quad , \quad i=12,13,14 \quad (4)$$

$$Y_{15} \le T \quad (5)$$

$$Y_{16} \le S \quad (6)$$

$$\sum_{i}^{I} A_i Y_i \le E \quad , \quad i=17,18,19 \quad (7)$$

$$\sum_{i}^{I} A_i Y_i \le R \quad , \quad i=20,21,22 \quad (8)$$

$$\sum_{i}^{I} A_i Y_i \le C \quad , \quad i=1,2,\ldots,22 \quad (9)$$

$$\sum_{i=1}^{11} A_i = 1 \quad (10)$$

$$\sum_{i=12}^{14} A_i = 1 \quad (11)$$

$$A_{15} = 1 \quad (12)$$

$$A_{16} = 1 \quad (13)$$

$$\sum_{i=17}^{19} A_i = 1 \quad (14)$$

$$\sum_{i=20}^{22} A_i = 1 \quad (15)$$

$$\sum_{i=1}^{I} A_i Y_i \ge G \quad , \quad i=1,2,\ldots,11 \quad (16)$$

$$\sum_{j=1} bj\ Xj \ge O \quad , \quad j=1,2,\ldots,12 \quad (17)$$

$$\sum_{j=1} kj\ Xj \le N \quad , \quad j=1,2,\ldots,12 \quad (18)$$

$$\sum_{j=1} kj\ Xj \ge L \quad , \quad j=1,2,\ldots,12 \quad (19)$$

$$\sum_{j=1} pj\ Xj \ge H \quad , \quad j=1,2,\ldots,12 \quad (20)$$

$$\sum_{j=1} qj\ Xj \ge F \quad , \quad j=1,2,\ldots,12 \quad (21)$$

In our model the objective function (1), increase the self-service food quality due to the funds allocated. The objective function (2) minimum the total costs (raw

material costs, administrative costs, transportation costs, costs of storage and kitchen. (3) This limitation ensures that the cost of purchasing raw materials is less from a certain cost. (4) This limitation ensures that administrative costs be lower than a certain amount. (5) This limitation ensures that the cost of transport fuel is less than a certain amount. (6) This limitation ensures that the cost of storage is less than a certain amount. (7) This limitation ensures that the energy costs related to the kitchen is less than a certain amount. (8) This limitation ensures that the energy costs related to the dining hall is less than a certain amount. (9) This limitation related total budget that allocated to the chain. (10) This limitation shows that the sum of the coefficients of the variables related to raw materials should be equal to one. (11) This variable indicates that the sum of the coefficients of the variables related to administrative costs must be equal to one. (12) This limitation shows that the sum of the coefficients of the variables related to transport costs must be equal to one. (13) This limitation shows that the sum of the coefficients of the variables related to storage costs must be equal to one. (14) This limitation shows that the sum of the coefficients of the variables related to kitchen costs must be equal to one. (15) This limitation shows that the sum of the coefficients of the variables related to dining hall costs must be equal to one. (16) This limitation shows that food sales exceed a certain amount. (17) This limitation shows that the quality of food's taste must have at least taste. (18) This limitation shows that food's calorie is not more than a specified amount because in case of increased caloric need to increase the volume of food that causes drowsiness and a feeling of heaviness in students. (19) This limitation shows that food's calorie exceeds than minimum calorie that ensure physical and mental health. (20) This limitation shows that the quality of food's smell should be higher from a fuzzy quality number to at least increase students' appetite. (21) This limitation shows that the quality standards should be higher than a fuzzy quality number.

Results

In a case study which is related to a supply chain of a university. We seek to achieve dual overall objective that one of the objectives is minimizing the costs in three parts of the chain. The first part of the costs associated with the logistics in a month which includes the purchase of raw materials needed kitchen for cooking, administrative costs and the cost of transportation. The second part of the study related on the cost of the kitchen for a month which include consumed energy and storage costs and the third part relating to costs in the dining hall for a month which includes the cost of consumed energy. The second goal is to maximizing the quality of food that served in the university's self-service. Increasing the quality of served food that is the important requirement of students and create the most changes in terms of physical and mental of students in their current condition. In this section, according to a survey conducted by related specialists focus on optimizing food's odor, taste, maximum and minimum amount of calories and quality standards were considered that they were most important elements of optimization.

Table 2. Data ranges used in the illustrative example

parameters	Range of values
Demand forecast of each meal	*1300*
Price of meat {rial/kg}	*220000*
Price of bean {rial/kg}	40000
Price of oil {rial/17kg}	*640000*
Price of rice {rial/kg}	34810
Price of vegetable {rial/kg}	18000
Price of lemon juice {rial/bottle}	27850
Price of dried limes {rial/kg}	238000
Price of onion {rial/kg}	24000
Price of sauce {rial/17kg}	612000
Price of bread {rial/unit}	1300
Administrative cost {rial/month}	78727626/88
Transportation cost {rial/month}	75000
Storage cost {rial/month}	4779498/6
Kitchen cost {rial/month}	32363768/8
Dinnerware cost {rial/month}	2581810/5
Amount of renewable waste (intact food, women waste food, men waste food) {kg/4meals}	283
Amount of nonrenewable (oil can junk, plastic cup junk, rice sack junk, sauce can junk) {kg/4meals}	72/28

Table 3. Amount of raw materials for each

parameters	cost
Meat(50gr)	11000
Bean(20gr)	800
Oil(25gr)	941.1
Rice(170gr)	5917.7
Vegetable(100gr)	1800
Lemon juice(2gr)	55.7
Dried limes(2gr)	476
Onion(25gr)	600
Sauce(10gr)	360
Bread(half of unit)	650

The model using this information run by linear programming optimization software Lingo 11.0 for the quality and cost functions and their results will be shown on table (Table 3, 4).

Table 4. Pre-results

```
Global optimal solution found.
Objective value:                              46.80879
Infeasibilities:                              0.000000
Total solver iterations:                             0

                     Variable           Value        Reduced Cost
                           X1        2.227778            0.000000
                           X2        1.000000            0.000000
                           X3        1.000000            0.000000
                           X4        1.000000            0.000000
                           X5        1.000000            0.000000
                           X6        1.000000            0.000000
                           X7        1.000000            0.000000
                           X8        1.000000            0.000000
                           X9        1.000000            0.000000
                          X10        1.000000            0.000000
                          X11        9.000000            0.000000
                          X12        1.000000            0.000000

                          Row    Slack or Surplus      Dual Price
                            1        46.80879            1.000000
                            2        98.00750            0.000000
                            3        0.000000            4.681429
                            4        3.812700            0.000000
                            5        98.65000            0.000000
                            6        4.743070            0.000000
                            7        1.227778            0.000000
                            8        6.772222            0.000000
                            9        0.000000           -5.437214
                           10        8.000000            0.000000
                           11        8.000000            0.000000
                           12        0.000000           -3.336826
                           13        8.000000            0.000000
                           14        0.000000           -12.81800
                           15        8.000000            0.000000
                           16        0.000000           -0.2991686
                           17        0.000000           -5.405574
                           18        8.000000            0.000000
                           19        0.000000           -0.6979843E-01
                           20        8.000000            0.000000
                           21        0.000000           -0.9907457
                           22        8.000000            0.000000
                           23        8.000000            0.000000
                           24        0.000000           -0.1988571E-01
                           25        0.000000           -0.5291771E-01
                           26        8.000000            0.000000
                           27        0.000000            3.391186
                           28        8.000000            0.000000
                           29        8.000000            0.000000
                           30        0.000000           -1.725146
```

Optimal results obtained to increase the cost (second goal) after running the software Lingo will be shown on table 4.

Table 5. Factors Result

```
Global optimal solution found.
Objective value:                              0.1602721E+09
Infeasibilities:                              0.000000
Total solver iterations:                             0

                     Variable           Value        Reduced Cost
                           Y1     0.2285714E+08            0.000000
                           Y2     0.2276038E+08            0.000000
                           Y3     0.4590829E+10            0.000000
                           Y4     0.2244898E+08            0.000000
                           Y5     0.2250000E+08            0.000000
                           Y6     0.2295366E+08            0.000000
                           Y7      2885000.                0.000000
                           Y8     0.2222222E+08            0.000000
                           Y9     0.2266667E+08            0.000000
                          Y10     0.1000000E+08            0.000000
                          Y11      226087.0                0.000000
                          Y12     0.1277778E+10            0.000000
                          Y13     0.1000000E+10            0.000000
                          Y14     0.2436548E+08            0.000000
                          Y15      52500.00                0.000000
                          Y16      3345649.                0.000000
                          Y17     0.2265483E+08            0.000000
                          Y18     0.2266141E+08            0.000000
                          Y19     0.2265021E+08            0.000000
                          Y20      1362235.                0.000000
                          Y21      2403818.                0.000000
                          Y22      1804717.                0.000000
```

Discussion

As we can see in the quality output of Lingo software, our optimal point in the quality equal 46.80879 and our decision variables equal to these parameters. The required bean quality = 2.227778, the

required rice quality = 1, the required tomato paste quality = 1, the required meat quality = 1, the required vegetables quality = 1, the required oil quality = 1, the required lemon juice quality = 1, the required onion quality = 1, the required dried lemon quality = 1, the required bread and salt quality = 1, the cooking quality = 9, the quality of service = 1. Anywhere the decision variable equal to one this does not mean that these variables have no effect on the quality but also because of the lack of restrictions that chain has not adhered on its. The results of the model are fuzzy numbers ranging from 1 to 9.

Now we can use the data to optimize the current chain, this means that in areas that variable decision has a higher value, we increase the sensitivity and maturity amount and by changes in the current chain, we achieve the highest possible quality that is the optimized point. Our costs after optimization in Lingo software decrease to 75790304.8 rials for a month in a considered food so we must rebuild the current chain according to the values given for the decision variable and pay the same amount intended for variables to chain become stable in costs. The differences between decision variables with existing state after optimization have been showed in table 5.

Table 6. Final Results

	Status Qu	**Optimum**
Beans	1040000	799999.99
Meat	14300000	11000000
Rice	7693010	5917698.8
Sauce	468000	68752005
Vegetable	2340000	1800000
Oil	1223430	941100.06
Lemon juice	72410	57700
Onion	780000	599999.94
Dried-Lemon	618800	476000.07
Salt	3250	2500
Bread	845000	65000.013
Workers to goods supply	849642.2	13800002
Transportation workers	270648.675	4200000
Kitchen workers	77606432	23999998
Transportation	75000	52500
Store	4779498.6	3345649
Kitchen Water consumption	15071937.6	10550354
Kitchen Power consumption	6571810.6	4600267.4
Kitchen gas consumption	10720020.6	7504014.4
Self-service Water consumption	793259.87	555281.91

Self-service Power consumption	597437.3	418206.11
Self-service Gas consumption	1191113.4	833779.38

Conclusions

In this paper, two linear programming model with the goal of minimizing the costs in each level of the supply chain in Islamic Azad University of Zanjan including 1-costumer 2- self-service (dining area for teachers and students) 3-kitchen related to self-service 4- Supplies, has been done for reducing costs received from students for services, as well as maximizing the quality of the food served in self-service to increase student satisfaction and consequently reduce the amount of physical and mental damage. Lingo software used to solve these two linear programming models and after putting data and its implementation by the application we get the current optimal chain. According to such optimizing conditions, it was found the ability of each goal of cost and quality to significantly reduce them. To implement this plan, there are some restrictions that reduced movement and speed of plan. For example, chef working in the kitchen has a low literacy level, therefore, obtaining some information from them takes a lot of time, and in some cases the information given by them, because of failing to understand the questions, were incomplete, it was not possible to get some information from the University and the self-service's data wasn't up to date. After the implementation of a sustainable chain at the desired level of self-service by decreasing the cost of managing the university's self-service, not only food prices significantly dropped to students pay the lower cost to use before services, also University could purchase higher quality raw materials for cooking the food. With implementation of optimized quality structure, the food quality according to conditions intended had increased dramatically that this was confirmed by the questions in the form of questionnaires from students and after the implementation of the project within the specified period, by studying psychology experts the mental and physical health and also the students' motivation to study greatly increased. At the end of this article can be additionally optimized operations in a Sustainable Supply Chain, provide recommendations that Universities can optimize the quality and costs more than current condition, for example, by giving the necessary training to chefs to cook better in term of cooking health and also increased the taste of food, the quality and food safety or in the chain by taking a collection center inside or outside the university used generated waste to rebuild and create raw materials. Future research can be done in the context of this article, it is possible to use artificial neural networks or fuzzy approaches used to value investment for decision variables.

Appendices

There are no appendices.

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