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Development of a Non-Radial Network Model to Evaluate the Performance of a Multi-Stage Sustainable Supply Chain

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Abstract

The purpose of this paper is to present a new model of non-radial data envelopment analysis that is able to evaluate the systems one of these complete networks is supply chain of cement industry.
In this paper, using a non-radial model in data envelopment analysis, a model with a network structure that can assess the sustainable supply chain of strategic industries is evaluated. In addition to commonly used financial and technical indicators, undesirable outcomes and sustainability criteria should be considered in the supply network.
The new model was tested on the basis of actual data from 42 existing cement companies in the stock market. The results showed that this model could well evaluate performance in a networked structure. Based on the implementation of this model, 7 supply chains have been able to achieve efficiency.

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Introduction:

Considering the competitive world, economic conditions and financial resources, companies and manufacturing organizations and services need to measure their supply chain performance in order to maintain durability and sustainability. The supply chain is like a network of value cells whose goal is to deliver a high-quality product, not only at the lowest cost, but also fast and valuable in all aspects of product design (Kiani et, al. 2014).

In recent years, sustainability supply chain discussions have been very much considered. This supply chain has been proposed with a grid structure and has a particular complexity that includes indicators such as social responsibility, cultural climate, adverse outcomes (greenhouse gases, toxic leaks and other environmental pollutants) that play an important role in the changes They play an ecosystem and contribute a lot to inactivating many companies (Azadi& Jafarian, 2015).

Managers try to identify effective factors on the sustainable yield in the chain of the chain by developing appropriate methods and use them to measure the efficiency and estimate the cost of reducing pollution and adverse factors. For this reason, data envelopment analysis is used as a tool for evaluating the performance of units with multiple inputs and outputs (Liou, 2013).

Stable supply chain performance assessment in the industry is a sample of multi-stage and network decision-making units (Govindan, 2016).

In traditional DEA models, the relative efficiency of the decision maker is evaluated with respect to the inputs used to generate the final outputs. One of the problems with these models is to ignore middleware products and to link activities between different parts of the system. So, to fix this problem and improve the classical models of this paper is a model in which each activity or belong to the input or output, not both; accordingly, the evaluation conducted in two stages by means of a step Intermediate products are used as outputs, and in the second step are inputs that are the same as the network model.

The most important form of these models is to ignore the product of a multi-component or intermediate component, in which the output of the first part is used directly in one step. Another problem is that it usually does not pay attention to carrying out transitional activities and internal communication of components over several consecutive periods. In this case, the only simple network optimization model is not suitable for performance evaluation because it ignores the private or shared communication of the internal parts of the system and does not interact with the ability to measure performance and performance over several consecutive periods. Many similar investigations have been carried out in the evaluation of listed companies based on classical and networked models.

The main purpose of this paper is to provide a new model of data envelopment analysis that is both non-radial and network-centric. In order to test the model, the performance of the stable cement chain of the cement industry in the stock exchange is used as a complex system.

To achieve this goal, the article is organized in this way; in the second section, the literature is presented. The third part is devoted to methodology. In the fourth section, the findings and the new model are presented and, finally, the discussion and conclusion are expressed.

Literature overview:

Sustainable Supply Chain Management (SSCM)

The business climate in a competitive environment is such that it has forced subsidiaries to continually seek competitive advantage and reduce their costs for their survival and development. As a result, these companies are turning to new managers such as Chain Management (Kannan, 2014). Sustainability management in supply chains is defined as a network of strategic business activities to minimize environmental, economic, and social sustainability risks, maximizing corporate value, including shareholder value.

Data Envelopment Analysis (DEA)

After presenting the CCR model by Charens, Cooper, and Rhodes, this model was the basis for a "research in operation" called Data Envelopment Analysis (Jahanshahloo et,al , 2008). Following the introduction of this model, other models such as the BCC, SBM model, and collective model ... were introduced to strengthen DEA [7, 8, 9]. The calculation of efficiency in DEA models is divided into two categories of radial models

And non-radial models. In radial models, the contraction of the input variables and the expansion of the output variables to a certain ratio, but in non-radial models, the contraction of the input variables and the expansion of the output variables are not proportional to the size.

Tone said in 2001, a non-radial SBM model was introduced. This model is designed on the basis of auxiliary variables and is stable relative to the change, the input and output units are measured, the performance does not change. This property is also called "free Dimension." Contrary to the radial method, which assumes that the changes are proportional to the input and output, this non-radial model can be used to examine the input and output separately and is expressed as (1) (Tone, 2001).

If we have n, DMU, each containing input and output matrices Y, X, and have (m) input and (s) output, respectively then according to the set of (T_c) generation, the SBM model will be.

$$
\begin{aligned}
\min \quad & P_o = \frac{1 - \frac{1}{m}\sum_{i=1}^{m} \frac{S_i^-}{x_{io}}}{1 + \frac{1}{S}\sum_{r=1}^{s} \frac{S_r^+}{y_{ro}}} \\
s.t \quad & \sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = x_{io} \qquad , \qquad i = 1,2,\dots,m \\
& \sum_{j=1}^{n} \lambda_j y_{ij} - S_r^+ = y_{ro} \qquad , \qquad r = 1,2,\dots,s \\
& \lambda_j \geq 0 \qquad , \qquad j = 1,2,\dots,n \\
& S_i^- \geq 0 \qquad , \qquad i = 1,2,\dots,m \\
& S_r^+ \geq 0 \qquad , \qquad r = 1,2,\dots,s
\end{aligned}
\tag{1}
$$

In the following, Groskopf and Fare (2000) presented a grid data envelopment analysis approach for modeling multistage processes with intermediate inputs and outputs. This model predicts the DMU interfaces and allows us to see within a complex DMU with multiple nodes (Cook et al, 2010). In these systems, the outputs of the process or the first stage are considered to be the inputs of the process or the next stage, which they call the middle data (Gandhi et al, 2010). To calculate the efficiency of a grid system, we need a network DEA model. Contrary to traditional DEA, the DEA model does not have a standard network, but its shape depends on the network structure (Badiezadeh et al, 2017). Generally, there are two types of parallel and parallel structures for the DEA network model. The model presented in this paper is based on series methods.

In the following, some of the prior studies are worth mentioning.

Budaghi and Fazipour Saen (2018) presented a new model of data envelopment analysis to predict the membership of a group of suppliers in a sustainable supply chain, which includes many variables in the field of sales and distribution. In this paper, the Soiuuchi model developed in 1999 has been developed (Boudaghi et al, 2018).

Hatami and Ebrahim Nejad (2017) measured the fuzzy efficiency in the data envelopment analysis using a multi-objective approach in participating companies. In

This paper, a completely new approach to data envelopment analysis has been proposed in which, in addition to fuzzy all inputs and outputs, a multilayer linear programming approach is proposed (Hatami-Marbini et al, 2017).

Sergey Polasky and Vertigo (2017) designed the design of a sustainable chain in the Australian Drink Industry. In this research, using a linear mathematical model, the design of the supply chain network in the beverage industry was discussed Polyakovskiy et al, 2017).

Maridus (2016) presented a stable supply chain management framework based on classical models in the two-stage data capture analysis. This model was used to measure performance in American stock exchanges and is more accurate than previous models Barzegarinezhad et al, 2016).

Liuo (2015) proposed a hybrid model for the integration of green marketing and sustainable supply chain management. This model was used in the European pollutants industry over a 5-year period. The results showed a higher accuracy than previous models (Liou, 2013).

Azadi and Jafarian (2015) proposed a nonparametric method of effective boundary analysis to evaluate performance and improve the performance of sustained suppliers, based on fuzzy systems and genetic algorithms. The results showed that the above algorithm is more flexible than methods Classics (Azadi& Jafarian, 2015).

Hosseinzadeh Lotfi et al. (2015) in their research presented a non-radial model for evaluating the operation of decision-making units with fuzzy data. This model is used to evaluate performance and decision making in the presence of inaccurate data or inputs and outputs Barzegarinezhad et al, 2016).

Rakhshan and Alireza'i (2014) presented an article on the ranking of decision making units using a non-radial superclass model. For this purpose, developing a model for ranking effective units in data envelopment analysis is the main objective of this research Rakhshan et al, 2014).

Jahani and Manaheti and Rahimi (2013) combined the methods of hierarchy process analysis and data envelopment analysis to rank the existing industries in the stock exchange. The methodology is very flexible in allocating optimal solar power plants and is consistent with environmental conditions and uncertainty Jahani et al, 2013).

Alireza'I and Khayri Chari (2013). In their study to convert the nonlinear model in the presence of undesirable outcomes into linear models of non-critical outputs. In this paper, a non-linear radial non-linear radial model was first introduced, and then it was shown using mathematical transformations that it can be transformed into a model with uncontrollable linear outputs Alirezaei et al, 2013).

Research method

The present research is oriented towards the type of evaluation (applied-development). First, a model for determining the efficiency of multi-stage networks such as a sustainable supply chain based on a non-radial model is presented in the data envelopment analysis. Further, in order to measure the model, the actual data of the existing cement companies will be used in the stock exchange. It is descriptive in terms of purpose and in terms of its implementation process; it is a combination of cross-sections.

In this research, we first need to identify the indicators for constructing the mathematical model. Then, using the previous methods, a new model called "data envelopment analysis" with the network structure is formulated to evaluate the performance of the stable supply chain. Finally, after designing the model, the 42 Stable cement factories in the stock market have been evaluating for three consecutive years.

Presentation of Data Envelopment Analysis Model with Network Structure

In general, a stable supply chain network was considered as the form (1). In order to develop a suitable model, the parameters of the model are defined in Table (1).

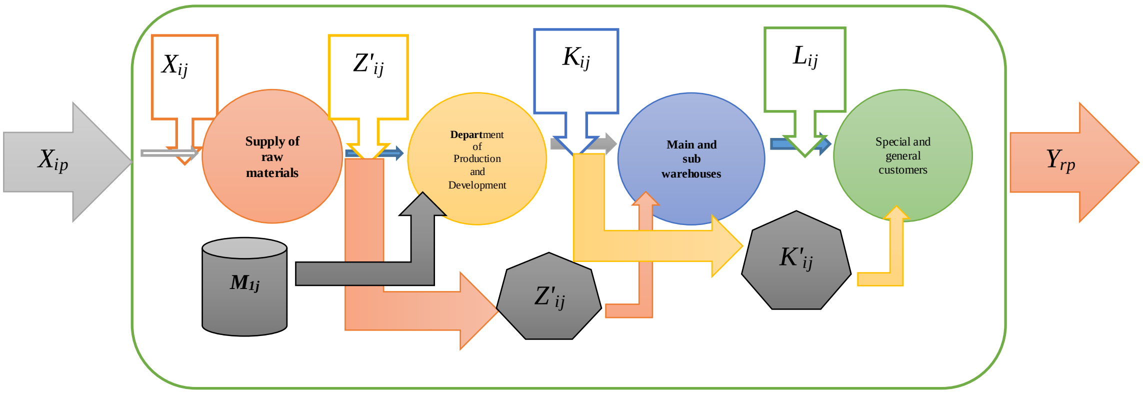


Fig 1. Sustainable chain

Table 1. Describing Symbols and Parameters of the Mathematical Model

Decision parameters and parameters			
Parameters	**Definition**	**Parameters**	**Definition**
P_0	Relative DMU performance value under evaluation	X_{ij}	The decision variable that represents the input of the chain. This vector enters the first stage
j	Number of decision-maker units $j = 1,2,\dots,n$	Z_{ij}	The decision variable that represents the output vector of the first stage. This variable is the Second Stage entry in the chain
i	Represents the number of inputs $i = 1,2,\dots,m$	K_{ij}	The decision variable that represents the Second Stage output vector. This variable is the Third Stage entry in the chain
r	Represents the number of outputs $r = 1,2,\dots,s$	L_{ij}	The decision variable that represents the Third Stage output vector. This variable is the fourth Stage entry in the chain
Ur	Weight of (r) output data	Y_{ro}	The decision variable that represents the final output of the supply chain is stable.
Vi	Weight of (i) input data	Z'_{ij}	The decision variable that represents the output vector of the first stage. This variable is the Third Stage entry in the chain (without intermediaries)
Mi	The amount of output associated with undesired inputs is considered to be the second stage input.	K'_{ij}	The decision variable representing the second stage output vector. This variable is the fourth Stage entry in the chain (without intermediaries)
S^+	Output Slack vectors	μ	Parameter weight control K
S^-	Input Slack vectors	ρ	Parameter weight control K'
V	Parameter weight control X	μ'	Parameter weight control L
W	Parameter weight control Z	U	Parameter weight control Y
		W'	Parameter weight control Z'

Compilation of the objective function

In the objective function of the model under study, we seek to determine the relative efficiency of the SSCM. Given the structure of the SBM model, the objective function of the model is presented as follows. In this new model, (P_0^*) we call the efficiency of the whole input nature. If we have 1, in the intrinsic nature of the universe are generally called efficiently.

$$\min \mathbf{P_0} = \frac{1-\frac{1}{m}\sum_{i=1}^{m}\frac{S_i^-}{|X_{ip}|}}{1+\frac{1}{s}\sum_{r=1}^{s}\frac{S_r^+}{|Y_{rp}|}} \tag{2}$$

The main constraints of the problem

Given the type of relationship between the main variables in the problem and the relationship between the λ_j networks of the supply network, we must formulate the main constraints of the problem so that they first cover the communication and, secondly, the links established by the adverbs are not violated. These two principles are developed in Accordance with the definition of four for the four stages or cells under consideration. This is true for this relationship parameter (10 and 11):

$$\sum_{j=1}^{n}\lambda_j^1 X_j + S_i^- = X_p \tag{3}$$

$$\sum_{j=1}^{n}\lambda_j^1 Z_j \geq \sum_{j=1}^{n}\lambda_j^2 Z_j \tag{4}$$

$$\sum_{j=1}^{n}\lambda_j^1 Z'_j \geq \sum_{j=1}^{n}\lambda_j^3 Z'_j \tag{5}$$

$$\sum_{j=1}^{n}\lambda_j^2 K_j \geq \sum_{j=1}^{n}\lambda_j^3 K_j \tag{6}$$

$$\sum_{j=1}^{n}\lambda_j^2 K'_j \geq \sum_{j=1}^{n}\lambda_j^4 K'_j \tag{7}$$

$$\sum_{j=1}^{n}\lambda_j^3 L_j \geq \sum_{j=1}^{n}\lambda_j^4 L_j \tag{8}$$

$$\sum_{j=1}^{n}\lambda_j^4 Y_j - S_r^+ = Y_p \tag{9}$$

$$\lambda^1 \geq 0 , \lambda^2 \geq 0, \lambda^3 \geq 0 , \lambda^4 \geq 0 \tag{10}$$

$$\sum_{j=1}^{n}\lambda_j^1 = 1 , \sum_{j=1}^{n}\lambda_j^2 = 1 , \sum_{j=1}^{n}\lambda_j^3 = 1 , \sum_{j=1}^{n}\lambda_j^4 = 1 \tag{11}$$

Given the fact that we have a weight limit on the problem and the need for a duel of this model is necessary, first we linearize the above model and write the main form of it:

$$\min \ \varphi - \frac{1}{m}\sum_{i}^{n}\frac{S_i^-}{|x_{ip}|} \tag{12}$$

$$Q\Big(q + \frac{1}{s}\sum_{r=1}^{s}\frac{S_r^+}{|Y_{rp}|}\Big) = 1 \tag{13}$$

$$V\Big(-\sum_{j=1}^{n}\lambda_j^1 X_j - S^- + X_p q\Big) \geq 0 \tag{14}$$

$$W\Big(\sum_{j=1}^{n}\lambda_j^1 Z_j - \sum_{j=1}^{n}\lambda_j^2 Z_j\Big) \geq 0 \tag{15}$$

$$W'\Big(\sum_{j=1}^{n}\lambda_j^1 Z'_j - \sum_{j=1}^{n}\lambda_j^3 Z'_j\Big) \geq 0 \tag{16}$$

$$\mu\Big(\sum_{j=1}^{n}\lambda_j^2 K_j - \sum_{j=1}^{n}\lambda_j^3 K_j\Big) \geq 0 \tag{17}$$

$$\rho\Big(\sum_{j=1}^{n}\lambda_j^2 K'_j - \sum_{j=1}^{n}\lambda_j^4 K'_j\Big) \geq 0 \tag{18}$$

$$\mu'\Big(\sum_{j=1}^{n}\lambda_j^3 L_j - \sum_{j=1}^{n}\lambda_j^4 L_j\Big) \geq 0 \tag{19}$$

$$U\Big(\sum_{j=1}^{n}\lambda_j^4 Y_j - S^+ - Y_p q\Big) \geq 0 \tag{20}$$

$$u_0^1\Big(\sum_{j=1}^{n}\lambda_j^1 - q\Big) = 0 , u_0^2\left(\sum_{j=1}^{n}\lambda_j^2 - q\right) = 0 , u_0^3\Big(\sum_{j=1}^{n}\lambda_j^3 - q\Big) = 0 , u_0^4\Big(\sum_{j=1}^{n}\lambda_j^4 - q\Big) = 0 \tag{21}$$

In order to apply weight restrictions, the two models of the above model are written according to the relationships (22-29), and we add the weighted constraints (relations 30) to that end. So the idea was added to the model to help you more accurately estimate and measure the performance of a stable supply chain.

$$max \ \varphi \quad (22)$$

$$-VX_j + WZ_j + W'Z_j{}' + u_0^1 \le 0, \forall j \quad (23)$$

$$-WZ_j + \mu K_j + \rho K_j' + u_0^2 \le 0, \forall j \quad (24)$$

$$-W'Z_j{}' - \mu K_j + \mu' L_j + u_0^3 \le 0 \ , \forall j \quad (25)$$

$$-\rho\, K_j' - \mu' L_j + UY_j + u_0^4 \le 0 \ , \forall j \quad (26)$$

$$\varphi\left(\frac{1}{S|Y_{rp}|}\right) - u_r \le 0 \ , \forall j \quad (27)$$

$$-v_i \le \frac{-1}{m|x_{rp}|}, \forall j \quad (28)$$

$$\varphi + VX_P - UY_P - u_0^1 - u_0^2 - u_0^3 - u_0^4 \le 1 \quad (29)$$

φ *and* $U\mathrm{ij}_0$ *Free in the sign*

$V, U, W, \mu, \mu', W' \ge 0$

$$(30)$$

$$V_1 \ge \frac{0.174}{0.146}V_2 \qquad V_2 \ge \frac{0.146}{0.133}V_5 \qquad V_5 \ge \frac{0.133}{0.120}V_7$$

$$W_6 \ge \frac{0.165}{0.132}W_3 \qquad , W_3 \ge \frac{0.132}{0.116}W_7 \qquad W_7 \ge \frac{0.116}{0.103}W_8$$

$$\mu'_3 \ge \frac{0.147}{0.146}\mu'_2 \qquad \mu'_2 \ge \frac{0.146}{0.140}\mu'_6 \qquad \mu'_6 \ge \frac{0.140}{0.122}\mu'_1$$

$$W_2' \ge \frac{0.139}{0.133}W_1' \qquad W_1' \ge \frac{0.133}{0.103}W_3' \qquad \rho_2' \ge \frac{0.181}{0.163}\rho_1'$$

$$, \rho_1' \ge \frac{0.163}{0.137}\rho_3' \qquad \rho_3' \ge \frac{0.137}{0.134}\rho_4' \qquad u_5 \ge \frac{0.176}{0.158}u_{14}$$

$$u_{14} \ge \frac{0.158}{0.149}u_4 \qquad u_4 \ge \frac{0.149}{0.140}u_6 \qquad u_6 \ge \frac{0.140}{0.139}u_9$$

$$u_9 \ge \frac{0.139}{0.138}u_{12} \qquad u_{12} \ge \frac{0.138}{0.133}u_{13} \qquad u_{13} \ge \frac{0.133}{0.131}u_1$$

Result

As mentioned above, for the purpose of testing the proposed model, the actual data of the countries cement industry, which are present on the stock exchange, has been used for three consecutive years. Accordingly, the indicators are designed according to Table 4 and the relevant data are formulated in GAMS software based on the presented model and the results are as follows.

Model implementation in the cement industry

The data from these indexes are collected from the Stock Exchange Organization, the Environmental Assessment Agency forms, the cement industry employers' class and field surveys.

One of the most important issues in implementing a grid data envelopment analysis model is to determine the input and output indices that are usually unanimous in this regard. Typically, in the general definition of input variables, the index or variable whose reduces the efficiency, and in the general definition of output variables: an index or variable whose increase leads to an increase in efficiency. These two points are considered as a general rule in this article, but due to the existence of adverse effects

Such as dust emissions, greenhouse gas emissions, the presence of non-recyclable materials and abandoned materials in nature that effectively cause inefficiencies and negative performance of the chain they will supply the cement industry with undue influence. Therefore, in this paper, these indicators are considered by the nature of the Input and considering some fines due to performance beyond the standard level. According to the experts, some of the parameters of the model are determined as follows and the model is solved with these coefficients.

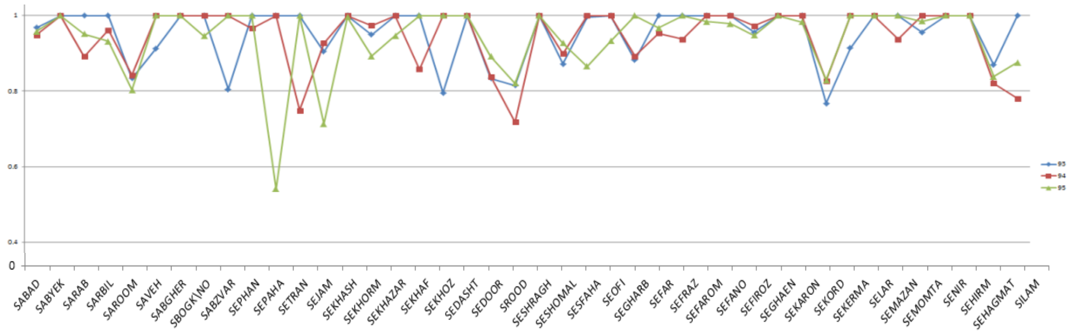
Table 2. Input and output parameters in the sustainable supply chain of the cement industry

PARAMETERS X_{ip}	PARAMETERS Z_{ij}	PARAMETERS K_{ij}	PARAMETERS L_{ij}	PARAMETERS Y_{rp}
Quality of suppliers in terms of sustainability in the supply of minerals and consumables	Total available mineral resources	The total tonnage of the clinker factory	Total marketing fee	Total assets
The cost of green education and sustainability to address issues throughout the chain	The total tonnage of raw materials harvested from mines, which should be consumed in the production process	Total cement production capacity	Total Rial of Assets and Available-for-sale Assets Available for Sale	Brand competitiveness and globalization of the factory
Total initial investment in mines and process plants	The tonnage of other chemical and mineral substances consumed in the production process	Total produced dust particles (mg / m3)	The total tonnage of bulk and packet cement sales in the domestic and export markets	Cultural Attitude to Green Building
Total debt of the factory	Total mineral deposits despoiled for use in cold season	Annual NOx releases of greenhouse gases	Total clinker sales tonnage	Total proceeds from product sales
Total cost of purchasing minerals, chemicals and other consumables	The quality of providing a training program for suppliers and staff for sustainable production and TQM	Average annual emissions of CO released gas	The number of cement packs consumed during one year of type pp	Total earnings
The total cost of paying for mines to contractors	Creation of destructive ecological effects on mines	The average annual emissions of SO2 emissions	The cost of the product	Annual growth rate based on performance
Total shipping cost	Total R & D expense	Effect of total water intake and sewage in groundwater		Return on assets ROA
Total financial cost	Total cost of energy payment			Equity returns
Total number of employees	Real industry capacity			Effect of the factory in the area of activity
Total paid salary	Power consumed in one year in kilowatt hours			Customer Satisfaction
	The amount of gas consumed in one year per cubic meter per ton			Estimated total amount due to the weight of abandoned waste in the environment
	The amount of fuel consumed by a petrol in one year in liters per ton			Contamination caused by the release of non-recyclable materials in nature
				Implementation of the principles of quality of work life and social welfare for personnel
				Social responsibility

Parameters Mi	**Parameters Z'_{ij}**	Parameters K'_{ij}
Total fines of generated dust (mg / m3)	Flexibility of suppliers	Reverse Procurement
Annual NOx emissions	Improving relationships throughout the supply chain	Impact of factory performance on negative conditions in surrounding ecosystems
The annual average annual emissions of CO releases	Total cost to increase reliability in the supply chain	The cost of environmental design
Annual fine of SO2 emissions	Paying attention to the principles of legal standards and government regulations throughout the chain	Social accountability
	Flexibility of suppliers	Efforts to use advanced technologies and alternative raw materials

(Rakhshan, 2015), (Gandhi, 2015), (Kiani, 2014) , (Olfat, 2016), (Jahani, 2013)

After solving the model, the results of the status of the 42 chains examined are based on the model presented in this paper in accordance with Table (6). The factories that have a performance score (1.00) are regarded as efficient supply chains and are inferior to this score. The results show that in the year 2015, 24 chains of potassium were able to maintain a good stability and achieve efficiency. In the year 2016 this number has fallen to 21 efficient chains. And in the year 2017, the number of stable supply chains reached 18 efficient chains. Despite the development of laws and regulations on environmental sustainability in the industry, mining and commerce, the performance evaluation process in these three years is declining. It seems that in optimal use of resources and control of production and operations, in terms of producing undesirable and harmful emissions to the environment, there is no desirable performance over supply chains. In addition, the issues of production planning, supply and sales in terms of profitability and related indicators on the path to achieving maximum productivity are not very appropriate. Of course, some of these chains have been able to handle inputs and produce outputs, but in general performance status can be considered in terms of the stability of the chain.



Graph 1. Chart of Changes in the Efficiency of Continuous Supply Chain in the Cement Industry during the Examined Years

Table 6. Results from implementation and solving of data envelopment analysis model with network structure

Performance scores in the sustainable supply chain Based on the new model			name of the industry	Row	Performance scores in the sustainable supply chain Based on the new model			name of the industry	Row
Performance score 2017	Performance score 2016	Performance score 2015			Performance score 2017	Performance score 2016	Performance score 2015		
1.000	1.000	1.000	SESHRA	22	0.9572	0.948	0.968	SABAD	1
0.926	0.898	0.872	SESHOM	23	1.000	1.000	1.000	SABYEK	2
0.865	1.000	0.995	SESFAHA	24	0.951	0.891	1.000	SARAB	3
0.932	1.000	1.000	SEOFI	25	0.931	0.9618	1.000	SARBIL	4
1.000	0.892	0.882	SEGHAR	26	0.803	0.842	0.833	SAROO	5
0.967	0.953	1.000	SEFAR	27	1.000	1.000	0.9136	SAVEH	6
1.000	0.937	1.000	SEFRAZ	28	1.000	1.000	1.000	SABGHE	7
0.984	1.000	1.000	SEFARO	29	0.946	1.000	1.000	SBOGK\	8
0.978	1.000	1.000	SEFANO	30	1.000	1.000	0.804	SABZVA	9
0.947	0.972	0.955	SEFIROZ	31	1.000	0.966	1.000	SEPHAN	10
1.000	1.000	0.999	SEGHAE	32	0.540	1.000	1.000	SEPAHA	11
0.9820	1.000	1.000	SEKARO	33	1.000	0.748	1.000	SETRAN	12
0.829	0.827	0.767	SEKORD	34	0.713	0.926	0.9047	SEJAM	13
1.000	1.000	0.914	SEKERM	35	0.996	1.000	1.000	SEKHAS	14
1.000	1.000	1.000	SELAR	36	0.892	0.973	0.949	SEKHOR	15
1.000	0.936	1.000	SEMAZA	37	0.946	1.000	1.000	SEKHAZ	16
0.984	1.000	0.955	SEMOMT	38	1.000	0.858	1.000	SEKHAF	17
1.000	1.000	1.000	SENIR	39	1.000	1.000	0.795	SEKHOZ	18
1.000	1.000	1.000	SEHIRM	40	1.000	1.000	1.000	SEDASH	19
0.838	0.820	0.869	SEHAGM	41	0.841	0.838	0.833	SEDOOR	20
0.875	0.780	1.000	SILAM	42	0.820	0.817	0.815	SROOD	21

Discussion and Conclusion:

In this paper, the non-radial model of network data envelopment analysis is presented to evaluate the performance of the stable chain of chains. In order to test the model, the actual data of the cement industry in the stock market has been used. Most of the models that have been presented so far have examined the supply chain indicators from three strategic, process, and operational dimensions, based on classical models or a simple network of data envelopment analysis, and do not necessarily have to evaluate a multi-stage widespread network. Accordingly, in this paper, a model of nonlinear network coverage analysis was presented to evaluate the complexity of the stable supply chain relationships. The proposed model has the advantage of simplicity in calculations compared to similar models and can be used for similar problems that have more Functional sequences. The non-radially of the model also allows for simultaneous changes in inputs and outputs, and is also more effective in directing Decision makers. Considering the performance evaluation of stock companies in the stock exchange, by the model presented in this paper, it has been observed that, in each period, almost half of the supply chains under investigation have not been able to reach the frontier. Generally based on the results, the stable chain of the industry can be divided into three categories. The first batch of these chains has worked poorly in sustainability and environmental protection, and they have not been able to achieve the appropriate strategic, operational, and operational aspects. It is not desirable to use the inputs and outputs corresponding to them in these chains. Because in addition to generating undesirable outcomes, variables such as sales, revenue and profits are not proportionate to the goals. It is suggested that these chains are modeled from efficient chains, in order to be able to put themselves in good shape in the coming years.

The 10 companies listed on the stock exchange are: Sabad, Sarum, Shemid, Sareem, Sedor, Hymn, Sehmal, Sefiroz, Suchet and Triangle.

The second group is the efficient chain that has been able to maintain good performance over the three periods under review. There are 7 listed cement factories in this category: Sabik, Sabukher, Sashrgh, Sanir, Sohras, Sadasht and Salar.

The number of 28 other cement plants in the third category is volatile. They have been in a good condition for one year and have not been able to maintain their good condition in other years and have been inefficient by reducing the efficiency score.

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