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Efficiency Score Assessment of Iranian Automotive and Food Industries

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Abstract

Environmental Impact Assessment (EIA) is a compulsory program for industrial projects once before the final approval of projects. The initial screening of projects by the Iranian evaluator team sounds an imminent channel to extend the data analysis for the decision making systems and classify the industries based on the nominal capacity of industries. The present research empirically united the additive model of Additive Ratio Assessment (ARAS) with the Data Envelopment Analysis (DEA) to classify Iranian Food Industries (IFI) and Iranian Automotive Industries (IAI) pertaining to efficiency score. The objective of current research encompassed to execute the materials and energy stream in IFI and IAI as well as developing a relevant database in this regard. Both Kendall and Friedman tests were provided the weight values for the input and output criteria using SPSS software. A classification was come out for the IFI and IAI via the DEA model combined with the ARAS model.

Keywords: Iranian industries, DEA, EIA, Efficiency score.

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1. Introduction

DEA is a mathematical programming model for evaluating the performance of decision-making units with multiple inputs and multiple outputs. Performance measurement has always been of interest to researchers because of its importance in evaluating the performance of a company or organization. In fact, DEA is based on a series of optimizations using linear programming, also called nonparametric methods. In this method, an efficient boundary curve is created from a set of points determined by linear programming. Two fixed and variable return to scale assumptions can be used to determine these points. The linear programming method after an optimal series determines whether the decision-maker unit is on or outside the performance boundary. In this way, efficient and inefficient units are separated. The DEA technique covers all data and is therefore called data envelopment analysis. One of the most basic and yet the most common ways to measure performance is to use ratios. These ratios are used in various financial, economic and industrial contexts. If efficiency is defined as the proportion of outputs to inputs, it will be easy to calculate and analyze for single-input-output units, but in most cases the real-world equilibrium faces units with multiple inputs and outputs, and we, therefore, need methods that combine inputs and outputs into a single index to achieve the appropriate benchmark for performance measurement. One of the capabilities of the DEA method is the application of different patterns corresponding to the returns to different scales as well as measuring the returns to the scales of units. Performance is a management concept that has a long history in management science. Performance shows that an organization has used its resources to produce the best performance possible over time. Whenever the decision-making unit has an input and an output, its efficiency is defined as the ratio of output to the input of the same unit. Outputs can be divided into inputs if they are in the same unit, for example, both input and output are money. But for input and output with variable units, more computation and data normalization are needed [1].

Project evaluation as an environmental management tool for demystifying sustainable development has been in progress since 1994, and the number of projects required to be evaluated is increasing according to the Supreme Environmental Protection Council of Iran. The usefulness of projects assessment as a channel to project development planning and management is broadly relative to the initial levels of decision-making and execution. Evaluating projects requires basic information and data collected as subject literature, which is provided by evaluator teams around the world. The EPA and the Industries Organization need to be aware of the results of project evaluations to obtain project authorization. At the stage of introducing a proposed project, the in-charge project assessment organizations are required to screen the project in order to identify the effects and consequences of its activities. Screening is the first part of evaluating a project and is allocated as a part of the responsibility of government bodies. Some international organizations and many governments provide three general criteria for screening. (1) Type of project or development activities (2) Project size (3) Project location or accommodation. The screening stage is devoted to collecting physical, biological and social data along with reporting the above. It was found around 57 and 71 various kinds of automotive and food industries according to our collected data in Iran. In this current study, data were collected from the screening stages of Iran's industrial projects (automotive and food industries) and were used to determine the project's efficiency score as a followed objective. This information was collected by the evaluator teams once before the industries were established.

2. Literature review

There is no relevant literature or research on the study of the DEA in industries clusters, especially using a software-based weighting style and associated with the evaluation of industries prior to construction stages. The study of the evaluation of 405 types of Iranian small and medium-sized industries was carried out in a Ph.D. thesis by the corresponding author in the same way. But our efforts in finding the studies of efficiency assessment via additive models do not result in a study that resembles an utmost approach to specific industry groups in the evaluation phase before the industries are built. Therefore, the author of the article calls out the readers' attention to the similar studies published by the corresponding author in various journals.

DEA models use various inputs and outputs criteria including miscellaneous dimensions to pursue the efficiency scores. The study done by Nemati and Matin [2] followed the purpose of resource allocation and efficiency determination of production units for 60 firms. Taking into consideration the input criteria as labor, pressing, packaging and dyeing and outputs in good and bad criteria divisions the research performed. The location optimization for the co-firing biomass plants has been scrutinized with regard to environmental, economic and social aspects of biomass plants across 30 independent experiments via the DEA model. Findings declared that Ilam, Semnan, Kohgiluyeh and Boyer-Ahmad, South Khorasan, and Chaharmahal and Bakhtiari are the optimum locations among 30 provinces [3]. Ulengin et al. [4] evaluated 45 countries using DEA model. 82 automotive industries passed through of DEA model to utilize the high performance in using resources in the Konya chamber of industries. It resulted to develop a ranking system [5]. Woo et al [6] estimated operational efficiency for shipping industries. The data gathered from Thomson One Banker from 2001-2013. Azadi et al [7] attempted to rank the twenty-four green suppliers via the fuzzy double frontier DEA model in Iran. Applying the integrated VIKOR and DEA models ended in the calculation of efficiency scores associated with multiple inputs and outputs [8]. The assay by Izadikhah et al [9] estimated the efficiency score of seventeen suppliers pertains to sustainability dimensions such as economic, environmental and social encompassing forty-one criteria. Also, Mirhedayatian et al [10] used a novel dual-factor DEA model for supplier selection of ten companies regarding five main criteria and twenty-six alternatives. To assess of wind turbines exploited two-sub process DEA model in China. So, the models evaluated wind turbines based on power generation efficiency [11].

3. Methods

The data collected by the Iranian evaluator team for both IAI and IFI were published by the author in the below links and also they provided the required data for conducting the DEA for the mentioned cluster of industries. So, the raw data of current research get back to Tables of the material stream and energy consumed addressed by the links [12].

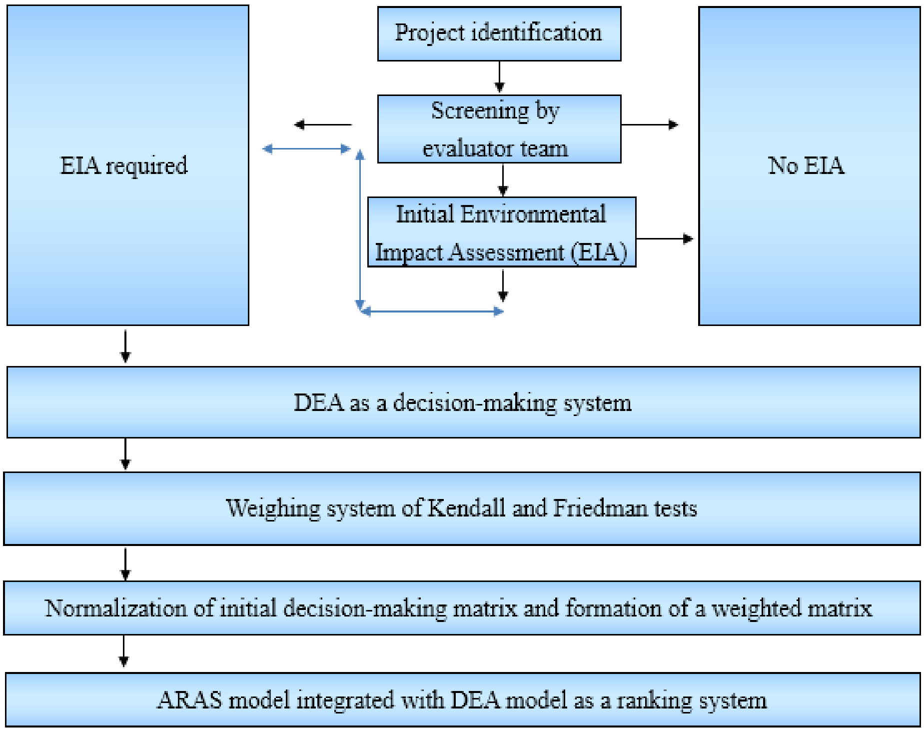

Figure 1. The flow-diagram of followed work [This study]

The steps followed to calculate the efficiency score by current research has presented in Figure 1.

3.1. Weighting systems of Kendall's W and Friedman tests

By the current study, SPSS software was used to denote the weight values for both input and output materials and energy consumption flow entered into industries (IAI and IFI) cycles. The raw data were collected and reported in various scales and then went the processing stages in the statistical analysis. Both Friedman tests (equations 1 to 5) and Kendall (equations 5 to 9) are valuable and famous weighting tests in the SPSS pack. So, here we briefly introduced a few mathematical and statistical formulas to call out the reader's attention towards the application of empirical equations in the pack [13].

$$\hat{r}.j = \frac{1}{n} \sum_{i=1}^{n} rij \qquad (1)$$

$$\hat{r} = \frac{1}{nk} \sum_{i=1}^{n} \sum_{j=1}^{k} rij \qquad (2)$$

$$SSt = n \sum_{j=1} (\hat{r}.j - \hat{r})^2 \qquad (3)$$

$$SSe = \frac{1}{n(k-1)} \sum_{i=1}^{n} \sum_{j=1}^{k} (rij - \hat{r})^2 \qquad (4)$$

$$Q = \frac{SSt}{SSe} \qquad (5)$$

$$Ri = n \sum_{j=1}^{m} (ri, j, ..) \qquad (6)$$

$$Rave = 1/n \sum_{i=1}^{n} Ri \qquad (7)$$

$$S = \sum_{i=1}^{n} (Ri - Rave)^2 \qquad (8)$$

$$W = \frac{12\, S}{m^2(n^3 - n)} \qquad (9)$$

3.2. Additive models of ARAS model to calculate DEA

3.2.1. ARAS model mixed with DEA

The steps outlined in the ARAS model comply with some normalization and weighting stages. First, the raw data

accommodated in Table (matrix) to show an inventory of output and input criteria (Xij in Tablas's columns). To start conducting the normalization procedure the data passed through summation in columns and division of each value to sum of columns individually. The purpose of the normalizing process comprised the uniting various values in dimension as non-scale amounts to release the pure rates. In the second step, the tabulated and normalized values were run up by weights values in special vectors for the input and output criteria separately. In the third step, data were divided into weighted output and input values to calculate the DEA score. The division of weighted outputs to weighted inputs offered a rank value for each industry. To sum up, the normalization, weighting and determining DEA score were done via equations 10 to 12, 13 and 14 to 19 respectively [14].

$$Xoj = max\,Xij \text{ if } max\,Xij \quad is\ preferable \tag{10}$$

$$Xoj = min\,Xij \text{ if } min\,Xij \quad is\ preferable \tag{11}$$

$$pij = \frac{Xij}{\sum_{i=1}^{m} Xij} \tag{12}$$

$$\tilde{\tilde{f}} = pij \times Wj, \quad i = o, m \tag{13}$$

$$Si = \sum_{j=1}^{n} normalized\ values\ of\ Xij, \quad i = o, m \tag{14}$$

$$DEA = \frac{\sum_{r=1}^{S} Ur\ Yrj}{\sum_{i=1}^{m} Vi\ Xij} \tag{15}$$

$$Max\ Z = \frac{\sum_{r=1}^{S} Ur\ Yrj}{\sum_{i=1}^{m} Vi\ Xij} \tag{16}$$

$$= \frac{\sum_{r=1}^{S} Ur\ Yro}{\sum_{i=1}^{m} Vi\ Xio}, \quad j = 1,2,3, \dots .n \tag{17}$$

$$Ur, Vi \ \geq 0\ ) \tag{18}$$

$$DEA = \frac{Output\ (1)\ \times Weight\ (1) + Output\ (2) \times Weight\ (2) + \cdots}{Iutput\ (1)\ \times Weight\ (1) + Iutput\ (2) \times Weight\ (2) + \cdots} \tag{19}$$

4. Results and discussion

4.1. IFI base on Nominal Capacity (NC)

IFI comprised many of confirmed industries in the industries organization in Iran such as (1) Barley water (NC=30000000 No), (2) Cake and muffins (NC=650), (3) Canned Beans and Caviar Eggplant (NC=3700 No), (4) Canned fish (tuna) (NC=11000 No+1056t), (5) Canned meat (NC=2800000 No), (6) Canned mushrooms (NC=6500000 No), (7) Compote (NC=8000000 No), (8) Concentrated fructose syrup of corn sugar (NC=2400t), (9) Corn Flakes (NC= 600t), (10) Fantasy Bread (NC=1000000t), (11) Fish food (NC= 12000t), (12) Glucose from starch (NC=2160t), (13) Hamburger (NC=1000t), (14) Margarine (NC= 12000t), (15) Milk, yogurt and pasteurized cream (NC=8255t), (16) Date sap (NC=2000t), (17) Potatoe based foods (NC=800t), (18) Poultry slaughterhouse (NC=3780000 No), (19) Iodinized salt (NC=10000t), (20) Starch from wheat (NC=1580t), (21) Treating fish (NC=1000t), (22) Waffer chocolate (NC=500t), (23) Alcohol from beet molasses (NC= 1500000 No), (24) Mineral water (NC= 12000t), (25) Wheat flour (NC=27000t), (26) Pistachio packaging (NC=1269.5t), (27) Packing grains; peeling off barley (NC= 2430t), (28) Spice Packing (NC=250t), (29) Fruit packaging (NC=10000t), (30) Wafer biscuits (NC=1000t), (31) Corn grits (NC= 5800t), (32) Biscuit (NC=1000t), (33) Soya protein (NC=1900t), (34) Mushroom cultivation (NC=600t), (35) Cheese from fresh milk (NC= 1500t), (36) Cheese Pizza (NC=1500t), (37) Meat and Olive Industrial Powder (NC= 545.5t), (38) Fish powder (NC= 500t), (39) Artificial sausage and sausage coating (NC=243t), (40) Preparation; packaging of honey (NC=24000 No), (41) Purification and packaging of salt (NC=21600t), (42) Cream dyed (NC= 1400t), (43) Dates and liquid sugar (NC=4680t), (44) Smoked fish (NC= 15t), (45) Tomato paste (NC=1500t), (46) Flour string (NC= 24192 No), (47) Olive oil (NC=280t), (48) Oil Seeds from Vegetable Seeds (except soya; olive) (NC=8000t), (49) Drying oils (NC= 1500t), (50) Dried vegetables (NC= 1412000 No), (51) Soya sauce (NC= 60000 barrels+72000 bottles), (52) Ketchup (NC= 16000t), (53) Food sauces

(NC= 4451998 (bottles 300 g)+1250000 (bottles 120g)), (54) Raisin Packaging (NC= 1000t), (55) Dates packaging (NC= 400t), (56) Sausage (NC=1000000t), (57) Ice (NC= 12920t). IFI tabulated with full details of inputs and outputs criteria (Nominal capacity of industries included the output criteria) (Table 1).

Table 1. Annual requirements of IFI [This study]

Industry	Initial feed (t)**	Initial feed (No*)	Initial feed (m)	Initial feed (m^3)	Initial feed (L)	Initial feed (piece)
(1)	1110	60000000.7	0	0	0	0
(2)	485.56	264106.6	0	0	0	0
(3)	950.5	6540	0	0	0	0
(4)	3303	251420	0	0	0	0
(5)	2086	156193	0	0	0	0
(6)	809	64100	0	0	0	0
(7)	2537	16720130	0	0	0	0
(8)	7200	0	0	0	0	0
(9)	692.9	660000	0	0	0	0
(10)	846.75	0	0	0	0	0
(11)	12000	0	0	0	0	0
(12)	2243.654	1206	910	0	0	0
(13)	1048	0	0	0	0	0
(14)	10113.55	300000	0	0	0	0
(15)	85208	2135	0	0	0	0
(16)	2023	6000	0	0	0	0
(17)	990.7	89800	0	0	0	0
(18)	4.045	396900	0	0	0	0
(19)	12190.25	0	0	0	0	0
(20)	1603.88	27200	0	0	0	0
(21)	1353.48	50475	0	0	0	0
(22)	510.78075	867750	0	0	0	0
(23)	5462.6	120057	0	0	4000	0
(24)	0.215	0	0	12000	0	12000
(25)	100	0	0	0	0	0
(26)	1653.2	0	0	0	0	0
(27)	2647.13	232200	0	0	0	0
(28)	269.062	0	0	0	0	0
(29)	13.605	909000	0	0	0	0
(30)	1033.45	0	0	0	0	0
(31)	6000	120000	0	0	0	0
(32)	1022.8	188700	0	0	0	0
(33)	2470	115000	0	0	0	0
(34)	633	303750	0	0	1000	0
(35)	7548.55	18000	0	0	0	0
(36)	49.20	0	0	0	0	0
(37)	1584.625	10284	0	0	0	0
(38)	2500	10000	0	0	0	0
(39)	248	99934	0	0	0	0
(40)	460.28	6965500	0	0	0	0
(41)	23756.25	3281730	0	0	0	0
(42)	1762.55	0	0	0	14000	0
(43)	10586	0	4200	0	0	0
(44)	8483	0	0	0	0	0
(45)	7556	78796	0	0	0	0
(46)	571.27	0	0	0	0	0
(47)	352.5	223600	0	0	0	0
(48)	9102.7	112000	0	0	0	0
(49)	1572	47000	0	0	0	0
(50)	2400	1536292	0	0	2400	0
(51)	167.08	0	0	98000	0	0

(52)	25869.25	565250	0	0	0	0
(53)	1376.16	155176396	0	0	0	0
(54)	11228.8332	113625	170437.5	0	0	0
(55)	5040	201500	0	0	0	0
(56)	940.7	0	2930000	0	0	0
(57)	2	24	0	0	0	0

Nominal capacity (bottles)	Nominal capacity (t)	Nominal capacity (No)	Employees	Power (Kw)	Water (m^3)	Fuel (Gj)	Land (m^2)
0	0	30000000	29520	57960	34200	29880	9800
0	650	0	11880	42480	3960	8280	3100
0	0	3700	16200	48960	13320	11160	8100
0	1056	11000	27000	69480	52200	36720	7200
0	0	2800000	10080	29520	8640	13680	6100
0	0	6500000	14040	110520	12600	24480	5200
0	0	8000000	24480	47880	29160	16560	11900
0	2400	0	11160	25560	2520	1800	3600
0	600	0	10440	49680	5400	17280	7100
0	1000000	0	5040	34200	1800	1800	1600
0	12000	0	6120	629640	1800	6840	3400
0	2160	0	10440	71640	9360	24120	4600
0	1000	0	5760	24120	2520	1080	2200
0	12000	0	18360	115200	8280	78120	8600
0	8255	0	9360	110160	46800	9360	7200
0	2000	0	8640	62640	8280	13320	7100
0	800	0	11160	77760	14040	13320	7900
0	0	3780000	14040	70560	5400	3600	6400
0	10000	0	8640	82440	9720	29520	5700
0	1580	0	18000	63000	3960	6840	5300
0	1000	0	11880	78120	9720	1440	2400
0	500	0	7560	33120	1440	4320	2400
0	0	1500000	14760	47520	18000	86760	7100
0	12000	0	8640	32760	2520	3240	5500
0	27000	0	14760	47520	18000	86760	7100
0	1269.5	0	10440	27720	2880	1440	2700
0	2430	0	6120	32760	1800	720	2900
0	250	0	4680	23040	1440	2160	1700
0	10000	0	14040	43920	18360	14760	4600
0	1000	0	6840	31320	5400	7200	3400
0	5800	0	17640	108360	11160	44280	9700
0	1000	0	6840	31320	5400	7200	3400
0	1900	0	9360	105120	5760	35640	5000
0	600	0	9360	47880	7560	16920	7700
0	1500	0	5040	59040	11880	22680	8000
0	1500	0	6840	27000	11880	7560	3000
0	545.5	0	5760	43200	2880	7200	3000
0	500	0	8280	62280	6840	13320	3000
0	243	0	12600	92880	10440	1440	3100
0	0	24000	4680	21600	1800	6840	3000
0	21600	0	10080	183240	10800	3600	10200
0	1400	0	44640	290520	31320	52200	23800
0	4680	0	23040	188640	14400	37080	16100
0	15	0	6840	24120	5400	1440	2400
0	1500	0	14760	80640	3240	3960	5800
0	0	24192	15840	17640	3600	2520	4800
0	280	0	6840	96840	19800	22320	3400
0	8000	0	11880	46080	3600	21729600	3600
0	1500	0	7920	76680	5400	32040	2000

0	0	1412000	11880	49680	9720	24840	3600
132000	0	0	16200	298080	4680	6120	10700
0	16000	0	12960	123840	3960	18000	10400
5701998	0	0	15840	76680	6120	12600	4500
0	1000	0	11160	38520	5400	2880	7600
0	400	0	5760	69480	1440	1080	2500
0	1000000	0	6840	63720	7920	12960	2900
0	12920	0	6480	90720	19440	1080	2100

*No= Number, **T= ton

In this step, the tabulated data underwent the statistical analysis. It was observed a significant difference (p-value $\leq$ 0.002) for the initial feed (t) values in comparison with 14 various kinds of criteria such as initial feed (No), initial feed (L), initial feed (m),initial feed (m^3), initial feed (pieces), nominal capacity (bottles), nominal capacity (No), nominal capacity (t), employees, power, water, fuel and land via t-test analysis. The pair test had shown no significant difference in the same criteria. The weight values were obtained according to Table 2 for the same criteria using both Friedman and Kendall tests.

The distribution of initial feed (t), initial feed (No), initial feed (L), initial feed (m), initial feed (m^3),initial feed (pieces), nominal capacity (bottles), nominal capacity (No), nominal capacity (t), employees, power, water, fuel and land were obtained that are the same by related samples Friedman's two-way analysis of variance by ranks (p-value = 0.00). Therefore, the null hypothesis was rejected.

Table 2. The weight values [This study]

Criteria weights	Friedman test	Kendall test
Initial feed (t)	8.58	8.58
Initial feed (No)	10.16	10.16
Initial feed (L)	3.84	3.84
Initial feed (pieces)	3.70	3.70
Initial feed (m)	4.04	4.04
Initial feed (m^3)	3.85	3.85
Nominal capacity (bottles)	3.88	3.88
Nominal capacity (No)	5.32	5.32
Nominal capacity (t)	7.39	7.39
Employees	10.94	10.94
Power	13.23	13.23
Water	9.96	9.96
Fuel	10.79	10.79
Land	9.32	9.32

Kendall's W=0.691

3.2. IAI based on NC

IAI comprised many of confirmed industries in the industries organization in Iran such as (1) Flasher of automatives (NC=100000t), (2) Automotive rubber parts (NC=400t), (3) Brake pads (NC= 500t), (4) Car camshaft (NC=100000t), (5) Car shatton (NC=350 tons+100000), (6) Car coil (NC=100000t), (7) Car gas condenser (NC= 70000t), (8) Car glass pump (NC=100000t), (9) Car Odometer (NC= 100000t), (10) Car oil filter (NC= 300000t), (11) Car oil sprayer (NC= 100000t), (12) Car sealant (NC= 1350t), (13) Car seat (NC= 21600t), (14) Car tire disc (NC=320000t), (15) Combined tap of gas fueled vehicles (NC= 24000t), (16) Crankshaft (NC=100000t), (17) Discshape brake pads (NC=300t), (18) Dynam fan (NC=200000t), (19) Full car Fly wheel (NC=16200t), (20) Grease pump of car (NC=1200t), (21) Insulated foil car Sunshade (NC= 30000+60000 pair), (22) Lock of car (NC= 150000t), (23) Rubbing clutch (NC=100000t), (24) Safety glass (car bend) (NC= 60000 m^2), (25) Seat belt (NC=50000t), (26) Snow sweeper engine (NC= 100000t), (27) Steering wheel (NC= 20000t), (28) Car water nozzle (NC=1000t), (29) Water pump (NC=100000t), (30) Car wire (NC=1600t), (31) Automatic starter (NC= 100000t), (32) Automatic of signal light (NC=200000t), (33) Automotive starter (NC=20000t), (34) Complete exhaust (NC= 50000t), (35) Oil pump (NC=20000t), (36) Car antenna (NC= 100000t), (37) Mirrors of car and home (NC=1260000t), (38) Car heater (NC= 50000t), (39) Lightweight cars heater (NC=9600t), (40) Car wiper (NC= 100000t), (41) Car brake booster (NC=100000t), (42) Car horn (NC=150000t), (43) Car pedal (NC= 100000t), (44) Propeller motor (fan radiator) (NC= 100000t), (45) Hydraulic brake pump (NC= 50000t), (46) Car Pump (Auto Gas Station) (NC= 52000t), (47) Crankshaft covering (NC=80000t), (48) Car bolts and nuts (NC=1620t), (49) Trans burner torch and fuel sprayer (NC= 100000t), (50) Hand brake (NC=100000t), (51) Car thermostat (NC=120000t), (52) Car strap (NC= 850t), (53) Car light (NC=250000t), (54) Car hazard light warning (NC=100000t), (55) Delco Capacitor (NC=200000t), (56) Car dashboard (NC= 120000t), (57) Car fuel grade and gasoline tank (NC=100000t), (58) Car oil barometer (NC=100000t), (59) Gear knob of gearbox (NC= 100000t), (60) Signal rod (NC=100000t), (61) Delco (NC= 100000t), (62) Brass gear of car gearbox (NC=769230t), (63) Car brake disc (NC=100000t), (64) Car clutch disc (NC= 50000t), (65) Bike and motorcycles rims (NC=200000t), (66) Car wheel rims (NC= 200000t), (67) Car wheel chains (non-metallic) (NC= 40000t), (68) Car bumper (NC= 40000t), (69) Bike and motorcycle speedometer (NC= 20000t), (70) Sibak (NC=350000t), (71) Car alarm system (NC=40000t). IAI tabulated with full details of inputs and outputs criteria (Nominal capacity of industries included the output criteria) (Table 3).

Table 3. Annual requirements of IAI [This study]

Industry	Initial feed (t)	Initial feed (No)	Initial feed (L)	Initial feed (mm)	Initial feed (m^2)	Initial feed (m)	Initial feed (m^3)	Initial feed (sheets)
(1)	2.836	1500000	0	0	0	0	0	0
(2)	430.318	0	0	0	0	0	0	0
(3)	537.5	0	0	0	0	0	0	0
(4)	0	150000	0	0	0	0	0	0
(5)	635	501000	0	0	0	0	0	0
(6)	50.357	410000	8000	13334	0	0	0	0
(7)	632.498	504000	0	0	0	0	0	0
(8)	21537.58	400000	0	0	0	0	0	0
(9)	5.169	900232	0	0	0	0	0	0
(10)	0	1833580	0	0	0	0	0	0
(11)	19.77	2300000	0	0	34	0	0	0
(12)	286.23	840240	0	0	0	0	0	0
(13)	564	518400	0	0	257700	0	0	0
(14)	203.6	5115	0	0	0	0	0	0
(15)	90.2	519000	0	0	0	0	0	0

(16)	527.3	3224800	0	0	0	0	0	0
(17)	130.06	333330	0	0	0	0	0	0
(18)	34	202500	0	0	0	0	0	0
(19)	3907.1	0	0	0	0	0	0	0
(20)	36.123	2400	0	0	0	0	0	0
(21)	8285	108600	0	0	0	0	0	0
(22)	14.429	901563	0	0	0	0	0	0
(23)	71.5	1840000	0	0	0	0	0	0
(24)	0	0	0	0	317761.9	0	0	0
(25)	82.537	450000	0	0	0	346500	0	0
(26)	135.3	2100000	0	0	386	0	0	0
(27)	14.768	84000	0	0	0	26213	0	0
(28)	9.732	501000	0	0	0	0	0	0
(29)	8	802000	0	0	0	0	0	0
(30)	10779.53	32000	0	0	0	0	0	0
(31)	34.03	880000	4000	0	0	0	0	0
(32)	2.3	620800	0	0	179	0	0	0
(33)	13.158	2762875	0	0	0	0	0	0
(34)	435	0	0	0	5450	0	0	0
(35)	19.5	441600	0	0	400	0	0	0
(36)	10.496	1100000	0	0	0	0	0	0
(37)	581.626	1272600	0	0	54430	0	0	0
(38)	323.517	2552000	0	0	0	0	0	0
(39)	0	57600	0	0	0	0	0	0
(40)	9.73	900000	0	0	0	40000	0	1060
(41)	893.6	3600000	0	0	0	0	0	0
(42)	138.3	0	0	0	0	0	0	0
(43)	313.78	1300000	0	0	0	0	0	0
(44)	27	5000	0	0	0	0	0	0
(45)	9.95	600000	0	0	0	0	0	0
(46)	26.36	1041300	0	0	0	0	0	0
(47)	52.9	82000	0	0	0	0	0	0
(48)	1747.08	54000	7125	0	0	0	0	0
(49)	184.908	212000	0	0	0	37000	0	0
(50)	133	1200000	0	0	0	0	0	0
(51)	18.07	841255	0	0	0	0	0	0
(52)	3000872	17000	0	0	0	0	0	0
(53)	421.42	526250	0	0	0	0	0	0
(54)	69.215	300000	0	0	0	0	0	0
(55)	5.855	402000	0	0	0	3674	0	0
(56)	1764	124000	0	0	0	0	124	0
(57)	19.491	700000	0	0	0	0	0	0
(58)	5.945	1167000	0	0	0	0	0	0
(59)	43.85	300000	0	0	0	0	0	0
(60)	8.502	4132000	0	0	0	752000	0	0
(61)	44.6	3610000	0	0	0	0	0	0
(62)	83.31	21630	0	0	0	0	0	0
(63)	711	210000	0	0	0	0	0	0
(64)	167.1	412500	0	0	0	0	0	0
(65)	1007.965	307600	0	0	0	0	0	0
(66)	1337.545	0	0	0	0	0	0	0
(67)	148.758	0	0	0	0	0	0	0
(68)	211	300000	0	0	0	0	0	0
(69)	17.972	1651334	0	0	0	0	0	0
(70)	232.95	2407292	0	0	0	0	0	0
(71)	2.013	480100	0	0	295	615	0	0

Industry	Nominal capacity (m^2)	Nominal capacity (No)	Nominal capacity (t)	Nominal capacity (pair)	Employees	Power (kw)	Water (m^3)	Fuel (Gj)	Land (m^2)
(1)	0	100000	0	0	8640	22320	2160	1080	2100

(2)	0	400	0	0	30600	141840	8280	37080	9000
(3)	0	500	0	0	27000	94320	5040	5760	4100
(4)	0	100000	0	0	11880	55800	2880	1800	5700
(5)	0	100000	350	0	43920	141120	7920	7560	6900
(6)	0	100000	0	0	10080	21960	1800	1080	1800
(7)	0	70000	0	0	35640	104040	8640	2880	9900
(8)	0	100000	0	0	10080	32760	2160	1440	2600
(9)	0	100000	0	0	5400	17280	1800	720	1200
(10)	0	300000	0	0	10080	65880	2160	1440	2600
(11)	0	100000	0	0	10080	17280	1800	1440	2300
(12)	0	1350	0	0	29880	93960	5400	2880	4700
(13)	0	21600	0	0	24480	120600	7200	12600	12600
(14)	0	320000	0	0	7200	22680	1440	1080	1900
(15)	0	24000	0	0	9000	34920	2520	2880	5200
(16)	0	100000	0	0	12960	52560	3960	2160	7900
(17)	0	300	0	0	13320	236160	4680	1800	3200
(18)	0	200000	0	0	5040	10800	1080	720	1300
(19)	0	16200	0	0	11880	111240	2520	4320	3600
(20)	0	1200	0	0	4680	5760	1080	720	1300
(21)	0	30000	0	60000	17280	57600	3600	2880	4800
(22)	0	150000	0	0	6840	12600	1440	720	1500
(23)	0	100000	0	0	9720	27720	2160	1800	3600
(24)	60000	0	0	0	12960	196200	2880	2160	5200
(25)	0	50000	0	0	7200	33480	1800	2880	2100
(26)	0	100000	0	0	13320	40320	2880	1800	3200
(27)	0	20000	0	0	15120	123480	4320	5040	7200
(28)	0	1000	0	0	9360	13680	1800	1080	2000
(29)	0	100000	0	0	14400	86400	2880	1800	3000
(30)	0	1600	0	0	21240	49320	6120	1800	6000
(31)	0	100000	0	0	12960	13320	2520	1800	2500
(32)	0	200000	0	0	10800	13680	2160	720	1600
(33)	0	20000	0	0	8280	23760	2880	1440	2300
(34)	0	50000	0	0	17280	84240	3960	1800	3700
(35)	0	20000	0	0	13320	43200	2880	2160	3500
(36)	0	100000	0	0	12600	106920	3240	2880	4200
(37)	0	1260000	0	0	14760	50040	4320	1440	4900
(38)	0	50000	0	0	18360	78840	6120	7200	5800
(39)	0	9600	0	0	10800	28440	2880	3240	5600
(40)	0	100000	0	0	8640	29160	2160	1080	1900
(41)	0	100000	0	0	14400	44640	3240	1800	5200
(42)	0	150000	0	0	9360	54720	2160	1440	2900
(43)	0	100000	0	0	14400	69480	3240	1440	3000
(44)	0	100000	0	0	5400	25560	1440	720	1300
(45)	0	50000	0	0	8280	20880	1440	1080	2100
(46)	0	52000	0	0	9720	28080	2160	1440	2400
(47)	0	80000	0	0	11160	54360	2520	1800	3200
(48)	0	1620	0	0	17280	140760	12600	13680	12600
(49)	0	100000	0	0	8640	16200	2160	1440	2700
(50)	0	100000	0	0	10440	36000	3240	18000	2900
(51)	0	120000	0	0	9720	27360	2160	1440	2500
(52)	0	850	0	0	29520	137520	10080	66600	7600
(53)	0	250000	0	0	14400	133560	3600	8280	4900
(54)	0	100000	0	0	15840	38160	3240	1440	2300
(55)	0	200000	0	0	6840	19440	1440	1080	1700
(56)	0	120000	0	0	28800	99360	6120	6840	5800
(57)	0	100000	0	0	10800	43200	3240	1800	2500
(58)	0	100000	0	0	10080	20160	2880	1440	2000
(59)	0	100000	0	0	6480	21600	1800	1440	2200

(60)	0	100000	0	0	10440	16200	1800	1080	2000
(61)	0	100000	0	0	11160	50760	2520	1440	4100
(62)	0	769230	0	0	7200	75240	1800	1800	2600
(63)	0	100000	0	0	10080	54720	2520	1800	3300
(64)	0	50000	0	0	11880	47160	2520	1440	2500
(65)	0	200000	0	0	19440	93600	9720	3240	5900
(66)	0	200000	0	0	16560	149400	5760	4680	4500
(67)	0	40000	0	0	34200	115200	7920	2520	5000
(68)	0	40000	0	0	9720	104400	3600	1800	6700
(69)	0	20000	0	0	8640	30960	2520	720	1600
(70)	0	350000	0	0	25560	115560	4680	43200	2700
(71)	0	40000	0	0	5400	15840	1440	720	1500

The available data in Table 3 was passed through the statistical analysis via SPSS software. It was observed no significant difference among 17 various kinds of criteria such as initial feed (t), initial feed (No), initial feed (L), initial feed (mm), initial feed (m^2), initial feed (m), initial feed (m^3), initial feed (sheet), nominal capacity (m^2), nominal capacity (No), nominal capacity (t), nominal capacity (pair), employees, power, water, fuel and land via t-test analysis. The weight values were obtained according to Table 4 for the same criteria using both Friedman and Kendall tests.

The distribution of initial feed (t), initial feed (No), initial feed (L), initial feed (mm), initial feed (m^2), initial feed (m), initial feed (m^3), initial feed (sheet), nominal capacity (m^2), nominal capacity (No), nominal capacity (t), nominal capacity (pair), employees, power, water, fuel and land were observed that are the same by related samples Friedman's two-way analysis of variance by ranks (p-value=0.00). Therefore, the null hypothesis was rejected. Using equations 10 to 19 and following the procedure described resulted in DEA ranks and score for IFI and IAI according to Table5.

Table 4. The weight values for tabulated criteria [This study]

Criteria weights	Friedman test	Kendall test
Initial feed (t)	9.87	9.87
Initial feed (No)	15.46	15.46
Initial feed (L)	5.24	5.24
Initial feed (mm)	5.06	5.06
Initial feed (m^2)	5.89	5.89
Initial feed (m)	5.89	5.89
Initial feed (m^3)	4.98	4.98
Initial feed (sheet)	4.99	4.99
Nominal capacity (m^2)	5.05	5.05
Nominal capacity (No)	14.98	14.98
Nominal capacity (t)	4.98	4.98
Nominal capacity (pair)	5.08	5.08
Employees	14.10	14.10
Power	15.46	15.46
Water	12.13	12.13
Fuel	11.45	11.45
Land	12.39	12.39

Kendall's W=0.862

Table 5. DEA ranks and score for IFI and IAI [This study]

IFI	DEA score	DEA rank	IAI	DEA score	DEA rank
1	0.741878201	3	1	0.291938123	25
2	0.004421899	42	2	0.000326241	70

2	0.000409613	56	2	0.000914311	67
4	0.002513389	49	4	0.284770191	26
5	0.430799689	7	5	0.111098859	45
6	0.680602509	4	6	0.031446893	60
7	0.370833412	8	7	0.087196548	47
8	0.013311109	22	8	0.347571853	19
9	0.003073952	45	9	0.450159489	14
10	12.04252282	1	10	0.64659871	11
11	0.017019966	20	11	0.230805882	31
12	0.009841823	26	12	0.002133542	66
13	0.011330124	23	13	0.011406931	63
14	0.02990293	17	14	2.088816821	3
15	0.007028431	35	15	0.069761867	48
16	0.009290599	27	16	0.132064198	42
17	0.002985973	46	17	0.000478298	69
18	0.518416185	6	18	1.639128818	5
19	0.031466299	16	19	0.039621744	58
20	0.007228188	34	20	0.013220825	62
21	0.00489405	38	21	5.20604576	1
22	0.004677296	39	22	0.674356001	10
23	0.081871763	11	23	0.231791776	29
24	0.008883218	29	24	1.186474789	6
25	0.098484883	10	25	0.052953063	53
26	0.010171238	25	26	0.197144669	35
27	0.020917965	18	27	0.032640984	59
28	0.003790511	44	28	0.004631278	64
29	0.040254415	13	29	0.231618125	30
30	0.008006761	32	30	0.003429416	65
31	0.015535357	21	31	0.131779428	43
32	0.007869365	33	32	0.859032158	8
33	0.008171163	30	33	0.039696123	57
34	0.002372385	52	34	0.121199313	44
35	0.005545741	36	35	0.05884922	51
36	0.010556456	24	36	0.189619575	36
37	0.004598028	40	37	1.805702109	4
38	0.00284869	48	38	0.060501712	50
39	0.001100501	54	39	0.030583041	61
40	0.004280056	43	40	0.041658069	56
41	0.036636197	14	41	0.137473363	41
42	0.00088337	55	42	0.60399595	12
43	0.008121276	31	43	0.215237356	34
44	8.61637E-05	57	44	0.765765048	9
45	0.005543846	37	45	0.22165916	33
46	0.004587316	41	46	0.163888227	38
47	0.001111027	53	47	0.280942526	27
48	0.002430769	51	48	0.000912444	68
49	0.009072526	28	49	0.353938422	17
50	0.118343368	9	50	0.163418081	39
51	0.017801214	19	51	0.40522297	16
52	0.031515348	15	52	0.000152105	71
53	0.537964932	5	53	0.410635384	15
54	0.002925242	47	54	0.327454193	21
55	0.002487829	50	55	1.034043333	7
56	0.774073049	2	56	0.04476185	55
57	0.057782511	12	57	0.297845577	24
58	-	-	58	0.30431938	23
59	-	-	59	0.507205811	13
60	-	-	60	0.047080641	54

61	-	-	61	0.147483794	40
62	-	-	62	2.959667207	2
63	-	-	63	0.338159582	20
64	-	-	64	0.168219774	37
65	-	-	65	0.319745208	22
66	-	-	66	0.349527677	18
67	-	-	67	0.061947785	49
68	-	-	68	0.087492071	46
69	-	-	69	0.054886548	52
70	-	-	70	0.264593689	28
71	-	-	71	0.228867503	32

5. Conclusion

The current research represented a way to classify the IFI and IAI via DEA in combination with the ARAS model. ARAS model as a newly developed model assigns the values of the weights upon both groups of criteria tabulated into input and output criteria to sort the efficiency score. The advantages of present study can comprise the managing the big data into certain channel of decision making systems and classification of alternatives in the simplest way, offering the easiest procedure in economic studies of industries, deploying the data mining, paving the way for novel methods of DEA with regard to shift the raw data to currency, handling the material and energy stream in industries depend on management frameworks and comparison of available data and developed classes with the same information in other nations. Also, the current study as the first research covered and classified IFI and IAI based on initial screening of the Iranian evaluator team before construction of industries associated with NC. However, we recommend the classification of the same industries in certain clusters but considering various NC values in clusters for future studies. Also, one comparison can be made by present classification based on both weighting systems applied at this study with some other relevant weighting systems in future studies.

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