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EVALUATION OF IRANIAN CHEMICAL INDUSTRIES

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ABSTRACT

The chemical industry is part of the industries, which supply the chemicals needed by other industries through the conversion of raw materials into the required products. The current cluster study of Iranian Chemical Industries (ICI) encompassed all input and output materials streams, ICI energy demands and technologies applied based on the assessment carried out by both Iranian Industries Organization (IIO) and Iranian Environment Protection Agency (IEPA). Then the raw data were empirically evaluated via traditional to novel decision-making models, SPSS software and Excel 2013 to make a decision about the classification of ICI and pave the way for further industrial ecology studies in a certain cluster as the objective of current research. T-test analysis had presented no significant difference among the main criteria of ICI such as the number of staff, power, water, and fuel demands and the land area occupied by ICI individually. Finally, the obtained values in the weighing and ranking systems and Data Envelopment Analysis (DEA) was composed to classify ICI as a cluster ranking and prioritized them from the highest weighting value and efficiency score to the lowest one based on the main criteria and an inventory of availability.

Contribution/Originality: This study contributes in the existing literature to Environmental Impact Assessment (EIA) of industrial projects conducted by the Iranian evaluator team. The screening of ICI scrutinized the existing properties of projects as a first report. The methodology employed traditionally to new decision-making models towards sustainable development of projects.

1. INTRODUCTION

The chemical industry is part of the industries, which supply the chemicals needed by other industries through the conversion of raw materials into the required materials. Refineries and petrochemical units that convert petroleum raw materials into fuel, solvent, resin, etc. are examples of the chemical industries. Small industries in most countries of the world are considered as the most important executive program to achieve a fair distribution of income and wealth, job creation, productivity growth, economic growth and the most efficient way to reduce dependence on oil revenues. In this regard, the provision of suitable platforms for entrepreneurship has been seriously considered in the direction of the economic development of the country. A large part of the small and medium industries of each country is dedicated to the chemical industries sector [1].

Globally the chemical industries comprise 4 clusters as (1) manmade fibers & chemical products (2) Chemical products (3) chemical products (content) (4) petroleum products. The chemical industries are included a cluster of around 118 various types of both small and medium manufacturing units plus a separate cluster including about 21 kinds of various plastic industries according to the database of IIO. The current study has only covered 118 various types of chemical industries and excluded to explain and evaluate the plastic industries.

According to our knowledge, all industrial projects need to pass through the economic, environmental, technical, and financial assessments once before getting the license to construct. The projects should pass through some steps and decision making processes to get acceptability for the establishment. The stages are called preparation of engineering projects including the timing for implementation of the plan, the location of the project, the drafting and design of the plant, the design of the factory and the final selection of technology and equipment. Acquisition of permits and necessary administrative procedures claim to obtain initial permissions such as licensing, registration of companies, as well as the principled approval and passing of related administrative procedures in this field. Negotiation and contracts for project financing, technology acquisition, plant building, facilities, machinery and equipment for the operational phase are also done. Establishment, construction and facility implementation involve preparing the site for the construction of a factory, buildings and other construction works, along with the installation of facilities and equipment according to timetables. The experimental operation stage of the project is usually periodic short, but technically this stage is very sensitive and important. This step connects the pathways and the previous periods to the project operation phase. The investment phase involves very heavy financial commitments and any major modifications to the project that will have significant financial implications. The operational phase should be examined from two short and long-term perspectives. Problems that may appear in the short term, in the early stages of launching the project and starting operations, are often involved with issues related to the deployment of technology, the commissioning, and operating machines and equipment, or the lack of specialized staff or workforce desirability [2].

The present study encompassed all input materials streams, energy consumed and technologies implemented for ICI individually based on findings of in charge organizations in this regard. Then the raw data were evaluated via DEA, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Simple Additive Weighting (SAW), Additive Ratio ASsessment (ARAS), Weighted Aggregated Sum-Product Assessment (WASPAS), COmbinative Distance-based ASsessment (CODAS), Multi-Attributive Border Approximation area Comparison (MABAC) and Measurement Alternatives and Ranking according to COmpromise Solution (MARCOS) models to decide on the classification of ICI as the objective of current research.

2. LITERATURE REVIEW

By the present study, it was attempted to classify and rank initial data of the Iranian evaluator team for ICI and conduct them towards decision making systems from traditional to novel models. The efficiency score classification of ICI is a method that rarely we can find it in the literature review for Iranian industries in the EIA plan. It encountered a bereavement of a similar study in this regard. So, it proves the necessity and importance of present research towards designing a framework of the database for Iranian industries.

Roshandel, et al. [3] assigned the Fuzzy TOPSIS approach for assessment of 4 suppliers of Tripolyphosphate comprising the initial input materials stream to generate the detergent powder about 25 important criteria in an Iranian industry. Obtained results led to developing a weighing system and ranking of data. Rahdari [4] studied the connections among three major criteria such as corporate governance, corporate social responsibility, and corporate financial performance via AHP-TOPSIS in the Iranian petrochemical industry as a case study that resulted to offer a weighting system along with the ranking of alternatives. Hosseini, et al. [5] weighed and ranked around fifty large industries on Tehran Stock Exchange depending on some criteria such as liquidity, operation, and profitability and leverage ratios via the TOPSIS model and questionnaire procedures since 2009- 2011. Onat, et al. [6] used the TOPSIS model to rank and weigh the existing sustainability efficiency of alternative vehicles via expert opinion and experience and data collection by questionnaire methods. So findings approached to offer that both hybrid and plug-in hybrid electric vehicles were the excellent options to supersede. Tobiszewski, et al. [7]

assigned the TOPSIS method to assess the environmental distribution of solvents, so it reported that both alcohols and esters were posed as harmless hydrocarbons in comparison with aromatic hydrocarbons and in the following they have ranged from 1 to 78 chemical groups. Indahingwati, et al. [8] applied the TOPSIS procedure based on some criteria such as price, tree size, fruit size, flavor, number of fruits and leaf amount. So obtained results classified 4 kinds of fertilizer based on the aforementioned criteria and ranking system designed to select. Georgiadis, et al. [9] conducted a study to figure out an overwhelming technique of weapon systems by taking into account a variety of criteria and weighing systems to judge. The TOPSIS method employed to integrate the existing criteria and arrange them as a decision-making framework. The research completed by Mehdiabadi, et al. [10] upon 15 various sectors of industries resulted to rank efficient units via DEA and TOPSIS procedures along with some recommendations like identification of 8 efficient units. By the way, the chemical industry took into consideration as the most attractive industry for investment. Tash and Nasrabadi [11] employed the TOPSIS model to rank Iran's Monopolistic Industries and realizing the most dominant industries in this field. Kavousi and Salamzadeh [12] utilized the TOPSIS model to classify and arrange criteria influenced by the outcome promotion program in National Iranian Copper Industries. So, the weighing and ranking of factors were the output of research. Farzami and Vafaei [13] assigned the TOPSIS model to select the best contractor for implementing a project, regarding lots of qualitative and quantitative factors in terms of work experience and ability to run and execute different directions of the project in Kermanshah Gas Company. Results proved that the Nil AbMostahkam Gharb Company comprised lots of qualified parameters to lead and conduct the project in an excellent way based on ranking and weighing systems developed. Dace, et al. [14] used the TOPSIS technique to select a relevant catalyst about CO_2 conversion rate and CH_4 selectivity to stop culminating greenhouse gasses components dissipated into the environment. By the way, lots of factors and criteria integrated to find the best alternative catalyst. Thus, the ranking system revealed that the RU based catalyst can be included the required involvements for the defined purpose.

Aikhuele, et al. [15] applied the Fuzzy TOPSIS model for identification of the main causes of defeat in offshore boat engines considering a wide range of major reasons in the field. By the way, expert's based opinions revealed the research purposes as a ranking system and classification of overall scores. Rostami, et al. [16] utilized the TOPSIS Model to assess the financial performance of chemical companies outlined as large industries in the Tehran stock exchange from 2013-2015. Thus, findings revealed an efficiency classification among the companies so Ahvaz Petrochemical Company, Persian Gulf Petrochemical, and Iran chemical industries companies have encompassed the highest efficiency. Askarifar, et al. [17] evaluated Mokran coasts in terms of existing investment opportunities for public demands, so the availability and requirements prepared as an inventory and the TOPSIS model assigned to integrate and rank the criteria. Obtained results came out with determining potential areas for implementing public applications and requirements as prioritized items. The study accomplished by Dinmohammadi and Shafiee [18] included a method of evaluation to figure out and align the different practices of operation for wind turbine systems via the TOPSIS Model. Therefore, the wide range of factors and sub-alternatives taken into account and prioritized to make the decision-making process applicable and discernible. Forghani, et al. [19] determined the priority among 4 suppliers of the pharmaceutical chain via TOPSIS equations considering some factors such as product quality, its price, and past record documentation, etc.

Hassanpour [20] employed fuzzy set theory to classify 21 Iranian plastic industries as a cluster study with the same issues so it was developed a classification as below for them. Congressional sheets of Polypropylene and Polystyrene > Flat sheets of Polypropylene and Polystyrene > Polyvinylchloride flooring > Polypropylene bag > Plastic bottle > Polyethylene pipes and fitting > Plastic waste recycling > Polyvinylchloride film for agricultural use > Plastic shaver > Plastic bags > Plastic rope > Polyvinylchloride shoe bed > Cellular Plastic Sheets > Polyvinylchloride pipes and joints > Plastic flashlight = Plastic buttons > Plastic Box (Fruit, Chilli) > Polyvinylchloride hose > Plastic welding artifacts > Polyvinylchloride gum > Plastic products.

CODAS model used to rank and classify alternatives and criteria in lots of studies based on positive and negative distances considering the higher values of positive distances and vice versa [21]. The MABAC model introduced recently regarding the distance of the criterion function of each of the observed alternatives from the approximate border area. So recently this model has been employed in a variety of researches such as patient-centered care, Supplier selection considering the risk factors and lots of other studies [22]. Also, SAW, COPRAS, CODAS, TOPSIS, MABAC models, used to analyze in multi-criteria decision-making problems and difficulties by many scientists such as Mukhametzyanov and Pamucar [23]; Adar and Delice [24]; Milosavljević, et al. [25] etc.

3. METHODOLOGY

3.1. Sampling Design and Procedures

Sampling has done by taking out a single case of each industry and designed to include the ICI as a cluster. The data were analyzed as secondary results. Figure 1 shows the flow-diagram of followed work by the present study in completing the project identification program by the Iranian evaluator team.

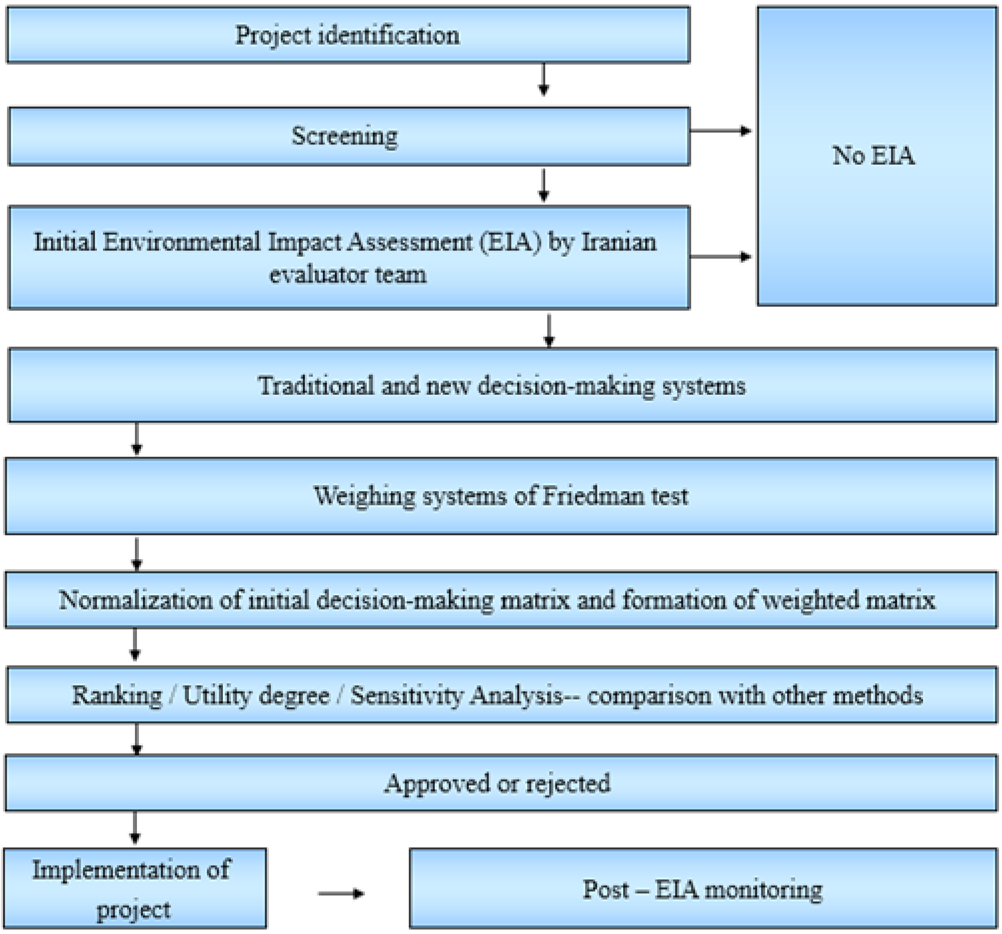


Figure-1. The flow-diagram of followed work by present study in completing the project identification program by the Iranian evaluator team.

The current cluster study of ICI was empirically accomplished to investigate and evaluate their raw data encompassing input and output materials flows and energy required. The initial resource of existing data refers to findings of the IIO database along with the EIA program of IEPA to issue the required license once before the implementation of industries. So present data were gathered from the aforementioned resources as secondary results which we tried to process them. Initial results were undergone the decision-making models supported by

SPSS software (IBM SPSS Statistic 20) and Excel 2013. The 5 main criteria of ICI (water, fuel, power consumptions, number of staff and land area) were composed as the hierarchical classification factors.

3.2. Weighing System

3.2.1. Friedman Test

To find the values of weights for our 5 main criteria was used Friedman test as a special vector initially. The framework of the Friedman test has been made up as a matrix besetting some columns and rows to process the values via SPSS [26]. In the matrix of $[r_{ij}]$ $n \times k$ the entry r_{ij} is the rank of Xij within block i according to Equations 1 to 5. The test statistic is calculated by Equation 5.

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

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

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

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

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

3.3. Ranking Models

3.3.1. TOPSIS Model

The discipline of the TOPSIS technique is based on the notion that the choice option should be the smallest distance with the positive ideal solution and the greatest distance to the negative ideal solution (worst case possible). Assigning the TOPSIS model to calculate the amounts needs to comply with 6 steps as below.

1. Quantify the decision scale matrix.
2. Determining the weight of the index using Hwang's rule.
3. Obtain a non-scale matrix.
4. Identifying an ideal positive solution and an ideal negative solution.
5. Determine relative proximity.

6-Ranking options.

In Equation 6, aij is the numerical value of each industry i.

$$Pij = \frac{aij}{\sqrt{\sum_{i=1}^{m}(aij)^2}} \qquad \text{Normalization of data} \qquad (6)$$

The non-dimension matrix obtained from the first step contains some values as the weights (Wn.n), in which a special vector was conducted to rows of the matrix according to Equation 7. Thus, the special vector (extracted via the Friedman test) was inducted upon the data of the non-dimension matrix (Nd) to collect the values for V.

$$V = Nd \times Wn.n \qquad \text{Special vector} \qquad (7)$$

In the next step to figure out the ideal positive solution (A+) and the ideal negative solution (A-) were employed the Equations of 8 and 9. To carry out the values were highlighted the selected values at each column of the matrix. The best values for positive indicators were assumed as the largest values (Vij), and for negative indicators, the smallest values. The worst values for the positive indicators are the smallest values, and for the negative indicators, are the largest values.

$$A+= \{(\max Vij | j \in J), (\min Vij | j \in j') | i = 1,2, \dots, m\} = \quad (8)$$

$$= \{V_1^+, V_2^+, ..V_j^+, V_n^+\}$$

$$A-= \{(\min i\, Vij | j \in J), (\max Vij | j \in j') | i = 1,2, \dots, m\} = \quad (9)$$

$$= \{V_1^-, V_2^-, ..V_j^-, V_n^-\}$$

To find out the distance between each option from the positive and negative ideal solutions was used the Euclidean distance. By the way, the distance was estimated based on both positive ideal options (dj+) and the negative ideal options (dj-) according to Equations 10 and 11 and the following formula of 12 was applied to determine the relative approach to the ideal solution. The higher the cli+, the higher the weighting value will be released [27].

$$di+= \left\{\sum_{j=1}^{n} \left(Vij - Vj+\right)^2 \right\}^{0.5} ; i, = 1,2,3, \dots m \quad (10)$$

$$di-= \left\{\sum_{j=1}^{n} \left(Vij - Vj-\right)^2 \right\}^{0.5} ; i, = 1,2,3, \dots m \quad (11)$$

$$cli+= \frac{di-}{di(+) + (di-)} \quad i = 1,2,3,4,5,6 \quad (12)$$

3.3.2. Additive Ratio Model Based on ARAS Model to Calculate DEA

Actually, additive models are introduced as a mix of DEA model with ranking systems when we have a variety of units, dimension, and scale for criteria. Therefore, the normalization process is a way to form non-dimension criteria. Equations 15 to 17 included the way to achieve normalized values. By the way, the ARAS model mixed with DEA to divide the weighted average of output amounts (Ur * Yrj) to the weighted average of input amounts (Vi * Xij) and determine the efficiency score.

$$Xoj = max\ aij\ if\ max\ aij \quad is\ preferable \quad (13)$$

$$Xoj = min\ aij\ if\ min\ aij \quad is\ preferable \quad (14)$$

$$pij = \frac{aij}{\sum_{i=1}^{m} aij} \quad (15)$$

$$\tilde{\imath} = pij \times Wn.n, \quad i = o, m \quad (16)$$

$$Si = \sum_{j=1}^{n} normalized\ values\ of\ aij, \quad i = o, m \quad (17)$$

$$DEA = \frac{\sum_{r=1}^{s} Ur\, Yrj}{\sum_{i=1}^{m} Vi\, Xij} \tag{18}$$

$$Max\ Z = \frac{\sum_{r=1}^{s} Ur\, Yrj}{\sum_{i=1}^{m} Vi\, Xij} \tag{19}$$

$$= \frac{\sum_{r=1}^{s} Ur\, Yro}{\sum_{i=1}^{m} Vi\, Xio}, \quad j = 1,2,3, \dots .n \tag{20}$$

$$Ur, Vi \geq 0 \tag{21}$$

$$DEA = \frac{Output\ (1) \times Weight\ (1) + Output\ (2) \times Weight\ (2) + \cdots}{Iutput\ (1) \times Weight\ (1) + Iutput\ (2) \times Weight\ (2) + \cdots} \tag{22}$$

3.3.3. ARAS Model

To allocate a ranking system for classifying ICI were applied the Equations 13 to 17 plus 23. The degree of utility of each option was investigated by Equation 23. The $S.$ is the greatest weighted and normalized value in the matrix.

$$Ki = \frac{Si}{S.} \; ; \qquad i = o, m \tag{23}$$

3.3.4. SAW Model

To conduct a ranking system in the SAW model, normalization is the first step following by inducing the values of weights by a special vector. So the steps were done using Equations 24 and 25 respectively.

$$Pij = \frac{aij}{\sum_{i=1}^{n} aij} \qquad i = \Gamma, m; \;\; j = \Gamma, n \tag{24}$$

$$D = \frac{aij\, .Wn.n}{\sum_{i=1}^{n} aij} \qquad i = \Gamma, m; \;\; j = \Gamma, n \tag{25}$$

3.3.5. WASPAS Model

WASPAS model also needs normalization and in the following the weighing process. To do the ranking system Equation 26 was applied to normalize the data. The calculation of the relative importance of the alternatives accomplished via Equations 27 and 28. The value for λ was assumed around 0.5 in Equation 29 [28].

$$pij = \frac{\mathrm{aij}}{\mathrm{Max\ aij}} \tag{26}$$

$$Qi(1) = \sum_{j=1}^{n} \mathrm{pij} \times Wn.n \tag{27}$$

$$Qi(2) = \prod\nolimits_{j=1}^{n} (\mathrm{pij})^{wj} \tag{28}$$

$$Qi = \lambda Qi(1) + (1-\lambda)Qi(2), \qquad \lambda = 0, \ldots, 1 \qquad (29)$$

3.3.6. CODAS Model

This model uses various ways to prioritize the alternatives such as normalization Equation 30, assigning a special vector of weight values Equation 31, determining the minimum V Equation 32, Euclidian and Taxicab distances Equations 33 and 34. Equations 35 to 37 were used to set up the relative assessment matrix where k associated with (1, 2… n) and ψ offers a threshold function to check the equality of the Euclidean ($t = 0.02$) and confirm the highest rank value released [29].

$$\mathrm{pij} = \frac{\mathrm{aij}}{\sum_{i=1}^{m} aij} \qquad (30)$$

$$\mathrm{V} = \mathrm{pij} \times \mathrm{Wn.n} \qquad (31)$$

$$\mathrm{ns} = \min \mathrm{V} \qquad (32)$$

$$\mathrm{Ei} = \sum_{j=1}^{m}((\mathrm{V} - \mathrm{nsj})^2)^{0.5} \qquad (33)$$

$$\mathrm{Ti} = \sum_{j=1}^{m} |\,\mathrm{rij} - \mathrm{nsj}| \qquad (34)$$

$$\mathrm{Ra} = [\mathrm{hik}]\mathrm{n} \times \mathrm{n} \qquad (35)$$

$$\mathrm{hik} = (Ei - Ek) + (\psi(Ei - Ek) \times (\mathrm{Ti} - \mathrm{Tk})) \qquad (36)$$

$$\mathrm{Hi} = \sum_{k=1}^{n} hik \qquad (37)$$

3.3.7. MARCOS Model

This method also needs to set up a matrix of data (1) initially. The procedure posed to compute the ranks values undergo some steps such as (2) distinguish ideal (AI) and anti-ideal (AAI) solutions (3) according to Equations 38 to 39. B offers a benefit group of criteria, while C offers a non-benefit group of criteria. (4) Normalization process using Equations 40 to 41. Xij and Xai include the elements of the matrix. (5) Assign the values of weight into the matrix according to Equation 42. (6) Utility degree (division between the sum of Normalized and Weighted (NW) values in the matrix of data to the sum of maximum NW values in the matrix) identification using Equations 43 to 45. (7) Determination of the utility function of alternatives f (Ki) associated with AI and AAI, Equations 46 to 48.

$$AAI = \min xij \ if \ j \in B \ and \ \max xij \ if \ j \in C \qquad (38)$$

$$AI = \max xij \ if \ j \in B \ and \ \min xij \ if \ j \in C \qquad (39)$$

$$nij = \frac{Xai}{Xij} \qquad if \in C \qquad (40)$$

$$nij = \frac{Xij}{Xai} \qquad if \in C \tag{41}$$

$$V = nij \times wn.n \tag{42}$$

$$Ki- = \frac{Si}{Saai} \qquad si = 1,2, \ldots m \tag{43}$$

$$Ki+ = \frac{Si}{Sai} \tag{44}$$

$$Si = \sum_{i=1}^{n} V \tag{45}$$

$$\mathrm{f(Ki)} = \frac{(\mathrm{Ki}+)+(Ki-)}{1+\frac{1-\mathrm{f(Ki+)}}{f(Ki+)}+\frac{1-f(Ki-)}{f(Ki-)}} \tag{46}$$

$$\mathrm{f(Ki)} = \frac{(\mathrm{Ki}+)+(Ki-)}{1+\frac{1-\mathrm{f(Ki+)}}{f(Ki+)}+\frac{1-f(Ki-)}{f(Ki-)}} \tag{46}$$

$$\mathrm{f(Ki-)} = \frac{(\mathrm{Ki}\ +)}{(Ki\ +)+(Ki-)} \tag{47}$$

$$\mathrm{f(Ki+)} = \frac{(\mathrm{Ki}\ -)}{(Ki\ +)+(Ki\ -)} \tag{48}$$

3.3.8. MABAC model

To rank the defined criteria along with certain alternatives the MABAC model encompassed some steps such as (1) Normalization of the composed matrix via Equation 49 to 50. The symbols of aj+ and aj- introduce the elements of the initial decision matrix. (2) Set up the weighted matrix via Equation 51. (3) Calculation of the approximate border area matrix using Equation 52. Vij is the element of the weighted matrix, m introduces the number of alternatives. (4) Ranking of options via the sum of the distance of options of the border approximate areas considering Equation 53. By Equation 53 n presents the number of criteria [23].

$$\mathrm{Xij} = \frac{aij - aj +}{(aj +) - (aj -)} \qquad if\ \ Xij \in B \tag{49}$$

$$\mathrm{Xij} = \frac{aj - aij}{(aj +) - (aj -)} \qquad if\ \ Xij \in C \tag{50}$$

$$\mathrm{Vij} = (\mathrm{Xij} + 1).\mathrm{Wn.n} \tag{51}$$

$$gj = \left(\prod\nolimits_{i=1}^{m} Vij\right)^{1/m} \qquad , i = 1, m; j = 1, n \tag{52}$$

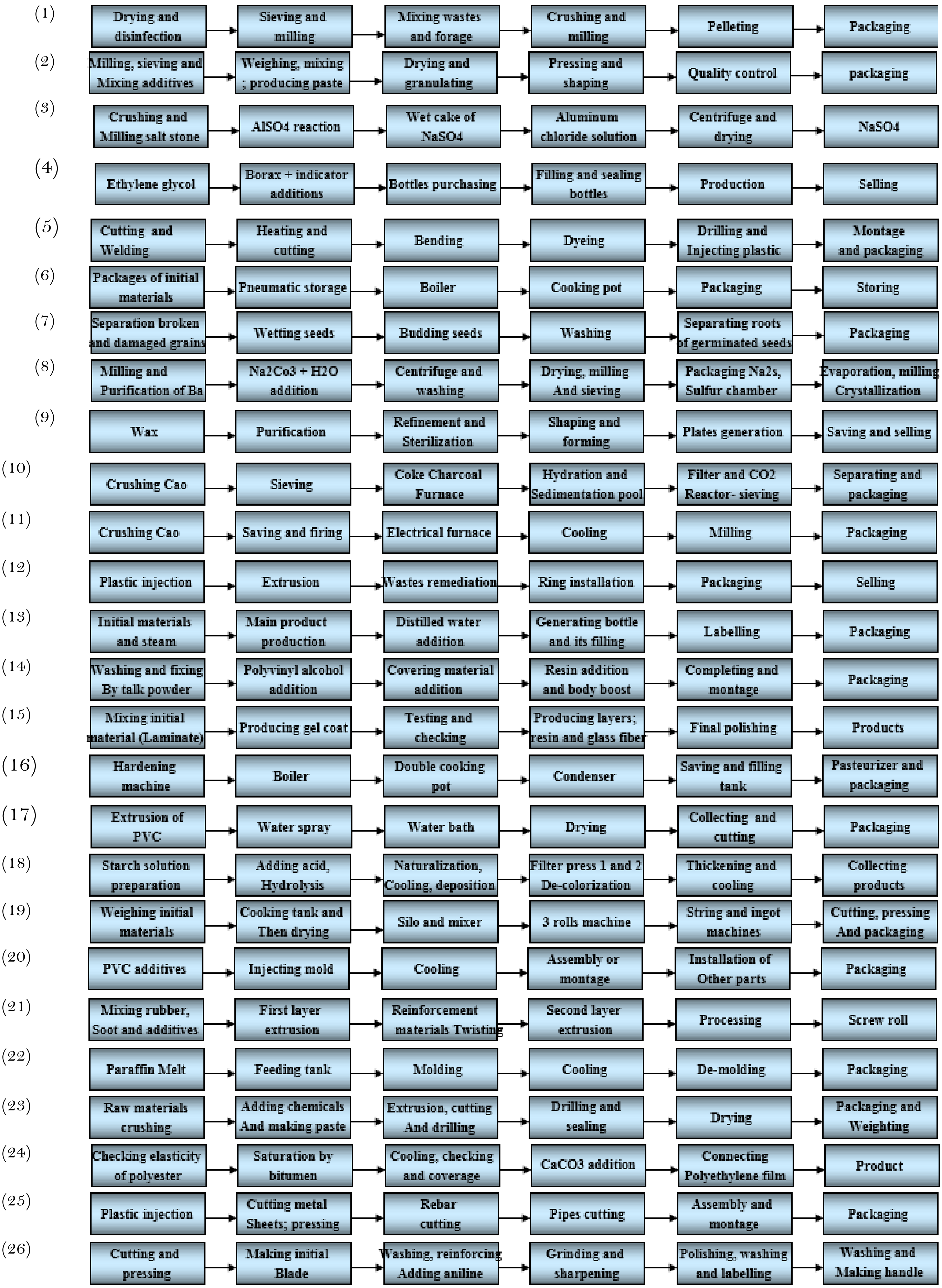
$$Qi = \sum_{j=1}^{n} (Vij - gj) \quad (53)$$

4. RESULTS AND DISCUSSION

4.1. Flow-Diagram of Running Technologies

Most of the technologies that have been transferred to developing countries underwent some appropriate practices through unbalanced processes limited to hardware transfers about technical knowledge, often regardless of sufficient information. Technological performance criteria may change as a result of new information or a change of value and attitude. There are many barriers to technology transfer. The nature and severity of such challenges depend on things like the prevailing environmental conditions, the diversity of technology, its specific uses, and the characteristics of the provider and receiver of technology such as lack of adequate resource allocation for technology, environmental barriers to optimal technology performance, inadequate and unreliable information and various requirements in choosing the right technology, needs must be defined, recorded and understood. Hereby, Figure 2 displays the ICI and their running technologies extracted from the report released by both IIO and IEPA in the national language.

Up to down: Animal Feed from Agricultural Waste (1), Animal drugs (2), Ammonium Chloride (3), Antifreeze (4), Baby carriage (5), Blood Powder (6), Buds of different seeds (7), Barium carbonate (8), Braided wax plates (9), Calcium carbonate (light and active) (10), Calcium carbide (11), Clothes hanger and pin (12), Disinfectants (13), Fiberglass boat (14), Fiberglass pieces (15), Fragrant aromas (16), Glass- strip away (17), Glucose from starch (18), Healthy Soap (19), Helmet (20), High pressure hoses (21), Household Lighting Candles (22), Insecticide coil (23), Isolator (24), Kitchen lighter (25), Knife with injectable handle (26), Adhesive plaster (27), Lining materials and insulating gas pipes (28), Liquid fertilizer (29), Matches (30), Mechanical disposable lighters (31), Medicinal glycerin (32), Melamine dishes (33), Metal flexible hose pipes (34), Nitrobenzene (35), Potassium chloride (36), Printing ink (37), Rubber parts (38), Shoe wax (39), Soft polyurethane foam (40), Starch from wheat (41), Throw-away crockery (42), Tooth brush (43), Detergents (Shampoo, etc) (44), Welding glasses (45), Insecticide spray containing flavoring materials (46), Acetic acid ester (47), Phthalic anodic esters (48), Calcium stearates (49), Boric acid (50), Hydrochloric acid (51), Chromic acid (52), Zinc oxide (53), Oxygen; Ar and N_2 (54), Alcohol from beet molasses (55), Types of gaskets (56), Acid and distilled water (57), Rubber plugs (58), Sprinkler (59), Sodium hypochlorite (60), Recycling silver from film and its solution (61), Industrial Paraffin (62), Raw silk fabrics (63), Pacifier (64), Unsaturated polyester (65), Bleach powder (66), Electrostatic coating (67), Tri-calcium phosphate (68), Hub and rubber ball (69), Synthetic leather of polyurethane (70), Gum stick (71), Wood gum (polyvinyl acetate) (72), Shoe adhesive (73), Medical and sanitary adhesives (74), Toothpastes and health cosmetics (75), Hexagon pen (76), Pen (77), Plugs and screws head (78), Diethyl ether (79), CO_2 (80), Epoxy resin (81), Alkyd resin (82), Bakelite resin (83), Resin; urea formaldehyde gum (84), Dyeing and printing of fabrics (85), Transformer Oil (86), Used motor oil and grease recycling (87), Drying oils (88), Rubber profiles (89), Insecticide spray (90), Rubber glass head (91), Canopy (92), Agricultural liquid pesticides (93), Zinc sulfate (94), Sodium sulfate (95), Alkyl benzene sulphonation (96), Sodium sulfite (97), Sodium sulfide (98), Sodium silicate (99), Drop irrigation system (100), Glasses frames (101), Oil filter recycling (102), Thermos and ice box (103), Industrial and consumable taps (104), Teflon strips (105), Hair comb (106), Glass artifacts (107), Industrial crystals (108), Spectacle glass (109), Chinese insulator (110), Ceramic magnet (111), Tape (for electronic equipment) (112), Fruit concentrate (113), Shuttered windows (114), Hygiene products made of artificial stone (115), Household, industrial and medical gloves (116), Metal octet (117), Refrigerator above zero for crops (118).


(1)
Drying and disinfection
Sieving and milling
Mixing wastes and forage
Crushing and milling
Pelleting
Packaging
(2)
Milling, sieving and Mixing additives
Weighing, mixing ; producing paste
Drying and granulating
Pressing and shaping
Quality control
packaging
(3)
Crushing and Milling salt stone
AlSO4 reaction
Wet cake of NaSO4
Aluminum chloride solution
Centrifuge and drying
NaSO4
(4)
Ethylene glycol
Borax + indicator additions
Bottles purchasing
Filling and sealing bottles
Production
Selling
(5)
Cutting and Welding
Heating and cutting
Bending
Dyeing
Drilling and Injecting plastic
Montage and packaging
(6)
Packages of initial materials
Pneumatic storage
Boiler
Cooking pot
Packaging
Storing
(7)
Separation broken and damaged grains
Wetting seeds
Budding seeds
Washing
Separating roots of germinated seeds
Packaging
(8)
Milling and Purification of Ba
Na2Co3 + H2O addition
Centrifuge and washing
Drying, milling And sieving
Packaging Na2s, Sulfur chamber
Evaporation, milling Crystallization
(9)
Wax
Purification
Refinement and Sterilization
Shaping and forming
Plates generation
Saving and selling
(10)
Crushing Cao
Sieving
Coke Charcoal Furnace
Hydration and Sedimentation pool
Filter and CO2 Reactor- sieving
Separating and packaging
(11)
Crushing Cao
Saving and firing
Electrical furnace
Cooling
Milling
Packaging
(12)
Plastic injection
Extrusion
Wastes remediation
Ring installation
Packaging
Selling
(13)
Initial materials and steam
Main product production
Distilled water addition
Generating bottle and its filling
Labelling
Packaging
(14)
Washing and fixing By talk powder
Polyvinyl alcohol addition
Covering material addition
Resin addition and body boost
Completing and montage
Packaging
(15)
Mixing initial material (Laminate)
Producing gel coat
Testing and checking
Producing layers; resin and glass fiber
Final polishing
Products
(16)
Hardening machine
Boiler
Double cooking pot
Condenser
Saving and filling tank
Pasteurizer and packaging
(17)
Extrusion of PVC
Water spray
Water bath
Drying
Collecting and cutting
Packaging
(18)
Starch solution preparation
Adding acid, Hydrolysis
Naturalization, Cooling, deposition
Filter press 1 and 2 De-colorization
Thickening and cooling
Collecting products
(19)
Weighing initial materials
Cooking tank and Then drying
Silo and mixer
3 rolls machine
String and ingot machines
Cutting, pressing And packaging
(20)
PVC additives
Injecting mold
Cooling
Assembly or montage
Installation of Other parts
Packaging
(21)
Mixing rubber, Soot and additives
First layer extrusion
Reinforcement materials Twisting
Second layer extrusion
Processing
Screw roll
(22)
Paraffin Melt
Feeding tank
Molding
Cooling
De-molding
Packaging
(23)
Raw materials crushing
Adding chemicals And making paste
Extrusion, cutting And drilling
Drilling and sealing
Drying
Packaging and Weighting
(24)
Checking elasticity of polyester
Saturation by bitumen
Cooling, checking and coverage
CaCO3 addition
Connecting Polyethylene film
Product
(25)
Plastic injection
Cutting metal Sheets; pressing
Rebar cutting
Pipes cutting
Assembly and montage
Packaging
(26)
Cutting and pressing
Making initial Blade
Washing, reinforcing Adding aniline
Grinding and sharpening
Polishing, washing and labelling
Washing and Making handle

(27)	Weighting materials	Milling and extruding	Hot steam roller	Separator roller	Cutting edges and Rolling film	Printing and laying
(28)	Weighting bitumen	Bitumen boiler	Resin and filler addition	Mixing	Base bitumen	Blown or primer
(29)	Phosphoric acid deposition unit	Heating and Removing impurities	Re-sedimentation	Acid phosphoric 68%	Base solution producing reactor	Cool mixing tank; mixing additives
(30)	Pollen	Sheeting of timber and sieving	Hot air blow and Making match boxes	Cutting and sieving	Adding Sulfur and Phosphorous	Packing clusters
(31)	Plastic materials	Injection molding ; nozzle assembly	Installation metal sheet	Attaching lever, Gas tap	Cutting and making Metal cap	Packing
(32)	Preparation and press	Filter press and Storage tank	Multi-stage vacuum evaporation	Centrifuge unit and Releasing soap	Raw glycerin and Vacuum evaporator	Evaporation, waste Removal and filter
(33)	Melamine powder and formaldehyde	Three steps press	Polishing	Grading	Packing in films polyethylene	Packing in carton
(34)	Extrusion of Granule PVC	Forming, shaping And cooling	Polishing	Twisting pipes	Packing	Export
(35)	Mixing HNO3 and H2SO4	Reactor of Benzene	Separator	Washing	Distillation	Packaging
(36)	Mine stone	Dissolving	Filtration	Vacuum crystallization	Drying	Product
(37)	Mineral oil and Flaxseed oil	Mixing then pumping	filtration	Mixing tank of Soot and fillers	Three roller mills	Filter
(38)	Weighting and Cutting materials	Mixing	Rolling	Pressing	Separating	Packaging
(39)	Weighting wax and Additives petroleum	Mixing mineral and petroleum solvents	Pumping and Filling cans	Freezing tunnel	Sealing	Packaging
(40)	Raw material to Foam machine	Cutting and Crushing foam	Fillers, plates and Toys of foam	Producing quilts Texture and mattress	Shoe, glove, bag and suitcase	Packaging
(41)	Silo, wetting and Washing wheat	Milling wheat	Separating the shell of wheat	Sedimentation Tank of starch	Washing then Centrifuge starch	Drying and Packaging
(42)	Sheet production machine	Heating to prepare sheets	Shaping and forming	Strip production and cutting	Cutting	Packaging and printing
(43)	Nylon fiber injection unit	Cutting fibers	Molding	Shaping	Forming	Packaging
(44)	Mixing Initial materials	Mixing salt (Nacl)	Mixing additives	Filtration	Sedimentation tank For 24 hour	Packaging
(45)	Drying poly amid	Plastic injection	Plastic of ethyl Meta acrylate	Brass pin	Montage	Packaging
(46)	Solvent addition + synergist	Flavoring materials +insecticide	Pressing and shaping	Filling and cleaning bottles	Weighing, sealing Printing and pressing	Packaging
(47)	Catalyst and acetic acid	Esterification reactor	Preliminary distillation	Naturalization and Washing; separation	Secondary distillation	Packaging
(48)	H2So4 reactor Anhydride alcohol	Other alcohols and Distillation tower	Condenser and Separator	Discharge and naturalization	Purification and treatment	Dewatering and Filter press
(49)	Weighting initial materials	Melting and mixing reactor	Adding lime and Stearic acid	Freezing and Common milling	Silo for storing materials	Packaging
(50)	Reaction between H2SO4 + Borax	Filtration and Thickening	Saturation and Crystal separation	Drying crystals of acid boric; drying	Milling, sieving and packaging	Thickening and Saturation NaSO4
(51)	Reactor of H2SO4 + Na CL	Along with Molten NaSO4	Packed tower 1 and 2 of water	Naturalization	Storing	Packaging
(52)	Sodium Dichromate+H2SO4	Sodium hydrogen sulfate	Heating at mixing reactor	Waste separator	Packaging	Product
(53)	Zinc concentrate sulfuric acid	Additives, H2O and Centrifuge unit	Adding H2SO4 and Zinc powder	Centrifuge + warm treatment	Centrifuge; reactor ZnCO3 generation	Centrifuge, furnace and packaging

(54) Introducing air And filtration → Molecular sieving; thermal convertor → Expansion and Distillation column → Producing N_2 And O_2 → Purification → Charging Argon

(55) Yeast of molasses Diluent → Storing and final fermentation → Initial distillation → Alcohol tank and Final distillation → Storing tank and Filling bottles → Sealing, labeling and packaging

(56) Cutting and Weighting rubber → Mixing and laminating → Temporary storing and second mixing → Cutting sheets, Adding powder → Keeping sheets and Re-lamination → Molding and Packaging

(57) Tanks of H_2O; H_2SO_4 + water → Filtration H_2O by Resin media → Quality control → Labelling → Packaging → Products: H_2O and Distilled water

(58) Weighting rubber materials → Formulation → Weighting → Mixing, molding and curing → Pressure molding → Rubber parts

(59) Cutting pipes and wires → Bending and perforating → Montage → Casting scrap Metals, drilling → Fat removing and dyeing → Packaging

(60) Tank of water and salt → Salt water treatment → Main electrolysis solution → Reactor → Packaging → Filling bottles

(61) Collect dissolved effluent → Washing film by Acid and water → Electrolysis → Precipitation Ag on Cathode; discharge → Melting Ag and Producing bullion → Filtration residual Ag in effluent

(62) Slack wax No 39 → Plus H_2SO_4 → Molding; Sweating to remove oil → Further treatment by soil → Filtration, molding → Packaging

(63) Silk yarns and fibers → Twisting yarn → Weaving → Yarn measurement → Twisting → Packaging

(64) Poly ethylene and silicon → Plastic injection → Rubber curing the Pacifier head → Preparing pieces → Assembly → Packaging

(65) Esterification Using chemicals → Additives → Adding monomers → CO-polymerization → Filling → Packaging

(66) Cao + H_2O → Introducing Cl_2 → Producing lime paste → Milling → Sieving → Packaging

(67) Washing and fat removal → Cooling and diving Piece in chemicals → Improvement Corrosion resistance → Washing and coating → Curing, cooling → Check and final inspection

(68) Milling and sieving ore → Powdering and Dust cyclone → Rotary kiln and cooler → Calcium collector reservoir → Clinker mill → Silo and Packaging

(69) Cutting and pasting rubber → Mixing, rolling and powdering → Punching, installing Valve and pressing → Baking, cutting and pasting rubber → Hot press → Hub products

Cutting and mixing raw rubber → Rolling, powdering and cutting → Adding compound Valve installation → Pressing, baking and blowing hubs → Twisting and pressing → adding needle

(70) Drying fibers or Cotton yarn texture → Diving at poly--urethane; coating → Coagulation, Washing and drying → Rolling and Covering by paper → Cooling; laminating drying → Packaging

(71) Polyethylene → Plastic injection machine → Plastic partition assembling → Gum producer machine → Using wood and Additives; filling → Packaging

(72) Dissolving N_2 + Vinyl acetate with → Potassium per-Sulfate + plasticizer → Sodium Bicarbonate and Oxidized Starch → Polymerization Reactor + N_2 → Storing poly vinyl acetate; formulation → Preparation, Dissolving + saving

(73) Chemical and Polymeric additives → Weighting, mixing and granulation → Drying; adding organic solvents → Homogenization → Filling barrels or tubes → Keeping in warehouse

(74) PVC, cotton and additives → Mixing, plating and rolling and cooling → Cutting, laminating Gas bands → Mingling with drug and drying → Cutting, rolling and packing bands → Keeping in warehouse

(75) Weighting and raw material → Mixing tank → Hydraulic turbo mixer → Aromatic and oily Materials addition → Pumping to tank and storing → Filling and Packaging cosmetic

Weighting and raw material → Mixing tank → Hydraulic turbo mixer → Storing → Filling → Packaging toothpastes

(76) Extruding poly propylene → Cutting and Shaping body → Filling by ink → Joining partitions → Adding cap → Packaging

(77) Extruding poly propylene → Montage → Casting machine and centrifuge → Air suction and Adding cap → Making cap by Plastic injection → Packaging

(78) Coupling nut screw and cap → Protector and contactor → Making screw → Joining light and Pressure molding → Polishing and assembling parts → Packaging screw heads

(79) Alcohol storage → Modular reservoir → Shell and tube heat exchanger → Acid-resistant and double-glazed reactor → Washing and Distillation towers → Ether tank

(80) Fuel burning, Wash and cool → CO and CO_2 Absorption → Retrieve and cooling → Water and Sox removal → Rising pressure H_2O, dust removal → Liquefaction; CO to CO_2 conversion

(81) Steam + resin → Reaction reactor and polymer storage → Vacuum separation → Na OH + H_2O+ N_2 Treatment reaction → Effluent storage and naturalization → Methyl isobutyl Ketone recovery

(82) Additives and Initial materials → Hot oil kiln and reactor → Solvent reservoirs → Filter → Filling barrels → Product

(83) Weighing and Charging materials → Mixing step and Proportion checking → Baking resin and Complete process → De-watering and naturalization → Discharge to dry → Milling and Producing resin

(84) Urea, Na OH (4%) + Formaldehyde → Plus acid formic in reaction reactor → H_2O + Catalyst + fillers → Reservoir tank → Packaging → Products

(85) Cotton and poly Ester fibers → Adding enzyme, wetting and washing → Baking, filtering and Pressure dewatering → Drying machine Dyeing and printing → Hot air fixing, washing; dewatering → Setting and sizing machine

(86) H_2SO_4 treatment → Sedimentation and naturalization → Heating 60-80°C → Adsorption and filtration → Storing and filtration → Products

(87) Pre-heating tank of used oil → Preliminary Distillation; cooling → H_2SO_4 addition and clay filter → Second preliminary Distillation → Filter press and Grease baking → Producing oil base 10,40 and grease

(88) Oily seeds preparation → Heating, baking and pressing seeds → Waste and shell Removal of seeds → Naturalization and producing soap → Washing, centrifuge and clay filter → Curing by steam; Final curing

(89) Cutting rubber materials → Weighting and mixing → Rolling → Storing and extruding → Autoclave → Keeping at warehouse

(90) Mixing insecticide and synergist → Filtration, storing Filling bottles → Perforating vent and filling motivator → Sealing and printing → final checking and adding pressure → Packaging

(91) Preparation and Mixing materials → Milling and crushing → Cutting → Shaping by press → Baking → Packaging

(92) Galvanized sheet → Flattening → Press punching → Stretching and shaping → Producing grid sheets → Products

(93) Technical Toxins, Solvents → Plus emulsifiers; Mixer → Filtration → Storage tank → Air pressure → Packaging

(94) H_2O + Bleach + Fe → $AlSO_4$ + $ZnSO_4$ → Mixing and centrifuging → Thickening boiler → Crystalline tray and drying → Milling and packaging

(95) Mixing initial materials → Concentrating; Sedimentation tank → Thickening kiln, Mixing tank → Filtration, storage tank; crystallization → Sedimentation tank, centrifuge → Rotary dryer

(96) O_2 + SO_2 → SO_3 Reactor → Heat exchanger → Adding Alkyl benzene → Distilled water + Na OH → Product

(97) Melting initial materials → Gas production kiln and absorption tower → Reactor and evaporator → Centrifuge and rotary dryer → Milling and sieving → Product

(98) H_2O + Na OH 40% → Dilution tank → Absorption tower and reactor → Evaporator → Crystallization → Packaging

(99) Weighting initial materials → Autoclave and Sedimentation tank → Filtration and clarification → Concentration tank boiler and drying → Packaging → Keeping at warehouse

(100) Polyethylene sheets → Extrusion, fixation and cooling → Stretching → Cutting and twisting → Plastic injection → Assembling and montage

(101) Cutting and uniting Cellulose sheets → Perforating and polishing → Bending and assembling → Making blocks and molding → Dimension check Up and control → Packaging

(102) Sorting initial materials → Implementation as mechanical → and pneumatic filters → Crushing and slicing components → Re-operating → Products

(103) Poly ethylene Poly styrene → Plastic injection → Heating by steam → Molding, cooling And shaping → Assembling and Installing parts → Packaging

(104) Filament yarn warehouse → Wetting yarns by Steam and water → Loom and design → Twisting yarns → Distribution and Packaging → Save at warehouse

(105) Poly tetra fluoride ethylene → Sieving and mixing → Pressing, shaping and extruder → Strip production and cutting → Twisting → Packaging

(106) Heavy and light Poly ethylene → Plastic injection → Molding → Products → Packaging → Selling

(107) Weighting and mixing → Silo and melting → Shaping and cooling → Discharging and checking → Sending back to silo or packing → Keep in warehouse

The project identification step assessed by both IIO and IEPA has calculated the amount of energy consumed, including water, electricity and fuel demands for each industry was individual. By the way, an assessment is done once before the construction of each industry and all the requirements for the construction of the industry are estimated using the right equations. In addition to energy requirements, the number of employees and the land area needed for the construction of industries is also calculated. Table 1 includes the main criteria of ICI, their energy consumption and land area applied based on Nominal Capacity (NC). The NC reported as the ton, number (No), L (length), meter, square meter (m^2), cubic meter (m^3), pair and, etc.

Table-1. ICI, their energy consumptions and land area applied based on NC.

Industry	NC	Employees	Power (kw)	Water (m^3)	Fuel (GJ)	Land (m^2)
(1)	10000t	23	399	10	6	9900
(2)	500t+50000 No	20	102	5	3	3300
(3)	3500t	50	181	58	53	4500
(4)	960 m^3	15	22	3	3	2300
(5)	25000 No	41	152	11	6	5300
(6)	500t	19	122	10	67	2200
(7)	150t	8	25	3	4	3400
(8)	4187t	43	145	45	147	5000
(9)	130t	18	52	8	19	2700
(10)	19200t	120	775	27	29	15800
(11)	1350t	31	1510	12	3	2500
(12)	504000 No	9	55	6	3	2100
(13)	900000 L	16	160	4	4	2600
(14)	5000 No	55	153	15	8	8200
(15)	100t	20	273	6	3	2300
(16)	130t	24	106	35	67	4400
(17)	650t	33	78	19	5	4000
(18)	2160t	29	199	26	67	4600
(19)	1090t	20	221	18	53	5300
(20)	65000 No	12	178	14	5	1300
(21)	240t	56	227	17	6	7700
(22)	7560 No	10	46	3	2	1400

(23)	50000 No	9	130	5	5	3900
(24)	2000000 m^2	27	296	15	5	8600
(25)	100000 No	23	46	4	3	1900
(26)	800000 No	26	161	10	5	2700
(27)	1700t	68	229	26	31	7000
(28)	3500t	14	113	9	13	2600
(29)	1250t	16	184	10	17	3100
(30)	7776000 No	41	330	9	48	5100
(31)	5000000 No	59	321	17	21	10700
(32)	1500t	41	331	10	125	4700
(33)	1000t	109	411	21	7	5000
(34)	309t	49	105	12	4	2100
(35)	1620t	14	127	5	35	2500
(36)	400t	19	179	19	104	2400
(37)	500000t	16	229	9	3	3300
(38)	25t	20	273	6	3	2300
(39)	3750000 No	10	77	5	20	1900
(40)	6000t	13	162	5	9	4500
(41)	1580t	50	175	11	19	5300
(42)	962.35t	51	137	26	4	4400
(43)	5000000 No	26	247	6	15	4000
(44)	1080t	36	55	12	18	4300
(45)	50000 No	16	44	5	2	1300
(46)	2700 No	20	128	5	5	3300
(47)	1200t	24	76	13	54	5800
(48)	970t	28	145	13	341	5700
(49)	2592t	30	150	19	47	5900
(50)	6300t	45	311	24	100	5100
(51)	3000t	26	133	18	52	3900
(52)	270t	15	61	6	3	2700
(53)	1377.5t	29	266	32	161	5000
(54)	3643.2 m^3	32	542	310	13	8800
(55)	1500000 No	41	132	50	241	7100
(56)	200t	52	193	12	5	4900
(57)	1725 m^3	15	32	7	19	1900
(58)	25t	19	208	4	3	2200
(59)	81000 No	23	52	6	8	2100
(60)	217.88 m^3	29	529	15	3	4700
(61)	40.40t	7	41	3	2	1100
(62)	3000t	29	56	11	11	7200
(63)	330000 m	25	100	8	10	6100
(64)	300000 No	16	83	4	4	2100
(65)	1000t	30	131	14	51	6200
(66)	2700t	26	137	10	3	2200
(67)	81000 m^2	16	173	18	4	2200
(68)	15000t	65	547	19	210	15100
(69)	360000 No	28	147	5	34	1900
(70)	12000 m^2	59	371	17	24	12600
(71)	200000 No	14	61	6	2	1400
(72)	7000t	46	335	31	41	7300
(73)	1800t	46	267	9	6	3300
(74)	45600 No	13	59	3	2	1300
(75)	800t	23	58	8	20	2200
(76)	24000000 No	70	164	18	5	3500
(77)	2000000 No	36	116	8	4	2200
(78)	800000 No	29	84	5	3	1900
(79)	100t	13	131	8	38	3500
(80)	1800t	18	161	65	134	2500
(81)	5475t	28	243	7	102	5300
(82)	2500t	27	163	15	3	2300

(83)	2000t	24	200	11	35	4500
(84)	1000t	21	69	39	23	6100
(85)	2000 m^2	75	255	223	230	13000
(86)	8100 m^3	18	191	5	36	3900
(87)	10500t	20	194	29	34	3900
(88)	1500t	22	213	15	89	2000
(89)	200t	19	133	13	50	2500
(90)	2700 No	20	128	5	5	3300
(91)	3240 No	12	114	5	2	1600
(92)	1540t	12	100	4	8	3600
(93)	750t	15	87	6	2	3300
(94)	3400t	30	112	29	134	5300
(95)	25000t	63	298	84	11	8900
(96)	5000t	56	503	13	38	4700
(97)	5000t	39	328	65	23	6600
(98)	3000t	33	202	27	4	2700
(99)	3000t	29	90	6	127	3300
(100)	1000 No+383.9t	52	176	17	5	4600
(101)	80000 No	46	206	10	101	4900
(102)	2000t	16	71	4	3	2400
(103)	150000 No	44	343	15	44	7000
(104)	3000 No	22	99	5	9	2600
(105)	12393000 No	55	148	9	4	2200
(106)	1000000 No	14	112	4	4	2100
(107)	1787.5t	38	168	11	207	6200
(108)	1000t	70	276	14	605	4300
(109)	500000 pairs	55	365	0	4	2500
(110)	730t	84	350	21	14	10200
(111)	869565 m	27	78	9	2	1100
(112)	3370000 No	25	137	6	6	3500
(113)	19820t	29	265	39	149	7000
(114)	330000 No	66	296	13	5	4400
(115)	4500t	59	182	17	14	10100
(116)	12600000 pair	75	200	31	127	7800
(117)	1000t	16	137	4	3	3400
(118)	5000t	21	331	19	1	10100

Source: IIO and IEPA.

Current research tried to process the existing raw data of ICI using decision-making models. Therefore, raw data were undergone SPSS software analysis. To compose a special vector of the main criteria in Table 1, the Friedman test was used. Therefore, the special vector obtained had shown values around 2.52, 3.94, 1.6, 1.94 and 5 for the criteria such as employees, power, and water, fuel, and the land area used based on existing data in Table 1. The test statistic (N=118) was presented amounts of about 388.645 and 0.00 for Chi-square and significant difference supported by Friedman test for existing data. One sample Kolmogorov Smirnov Test had proved significant differences around 0.001, 0.002, and 0.012 for the number of employees, power, and land respectively. The distribution was obtained as same according to related samples Friedman's two-way analysis of variance by ranks for them. In the following process, the special vector was applied to the values using Equation 7. Then, Equations of 6 to 53 were employed to find out the rank values by TOPSIS, DEA, ARAS, SAW, CODAS, WASPAS, MARCOS and MABAC, models and final weights for alternatives (industries). Table 2 denotes the obtained values.

Table-2. The values of rank and their weights

Industry	TOPSIS	DEA	ARAS	SAW	CODAS	WASPAS	MARCOS	MABAC
(1)	11	30	23	23	17	14	16	14
(2)	91	58	92	92	94	85	85	83
(3)	37	59	29	29	35	35	36	36
(4)	112	9	113	113	112	109	109	109
(5)	49	99	59	59	56	47	46	46
(6)	90	85	71	71	74	88	88	88
(7)	98	90	110	110	102	102	101	101
(8)	34	56	21	21	24	31	33	33
(9)	101	100	98	98	98	98	97	97
(10)	2	28	3	3	4	1	1	1
(11)	6	86	6	6	5	8	12	9
(12)	111	21	112	112	112	113	113	113
(13)	88	3	91	91	89	92	92	92
(14)	28	117	38	38	32	20	22	20
(15)	61	106	**	**	******	****	*&	*&&&
(16)	58	109	45	45	52	56	56	56
(17)	72	80	68	68	72	64	64	63
(18)	48	64	40	40	41	49	48	48
(19)	43	93	41	41	42	50	47	47
(20)	92	73	96	96	92	107	106	107
(21)	26	104	31	31	31	19	20	19
(22)	117	102	117	117	117	117	117	117
(23)	77	75	88	88	82	83	80	80
(24)	21	10	32	32	30	26	23	23
(25)	109	95	111	111	110	106	107	106
(26)	80	22	79	79	80	76	77	77
(27)	25	72	27	27	29	16	19	18
(28)	97	27	94	94	95	96	96	96
(29)	73	69	75	75	73	73	73	73
(30)	32	18	36	36	36	33	34	34
(31)	9	52	14	14	12	9	7	7
(32)	30	77	24	24	25	30	29	29
(33)	16	87	15	15	14	10	14	13
(34)	75	91	78	78	77	68	72	72
(35)	95	49	84	84	90	95	95	95
(36)	79	97	51	51	54	69	68	69
(37)	66	1	69	69	68	72	69	68
(38)	60	114	**	**	******	****	*&	*&&&
(39)	110	13	105	105	109	110	110	110
(40)	64	23	74	74	70	67	66	66
(41)	41	65	44	44	45	37	38	37
(42)	54	78	53	53	56	46	49	49
(43)	56	11	62	62	60	57	57	57
(44)	70	66	67	67	71	61	61	60
(45)	116	63	115	115	115	115	115	115
(46)	71	*	***	***	*******	*****	*&&	*&&&$
(47)	53	71	57	57	55	54	53	53
(48)	14	94	10	10	7	25	26	26
(49)	42	53	42	42	43	44	42	43
(50)	29	40	22	22	28	28	28	28
(51)	69	46	60	60	63	62	59	59
(52)	102	83	103	103	103	100	100	100
(53)	31	82	18	18	22	32	30	30
(54)	4	16	2	2	2	4	4	4
(55)	17	31	7	7	9	15	17	16
(56)	44	103	46	46	46	39	41	40
(57)	113	42	109	109	111	111	111	111
(58)	74	113	83	83	78	90	89	89

(59)	107	61	102	102	105	101	102	102
(60)	22	34	30	30	26	34	31	31
(61)	118	105	118	118	118	118	118	118
(62)	38	39	61	61	49	45	43	42
(63)	51	7	64	64	62	53	52	52
(64)	106	26	106	106	108	105	105	105
(65)	40	76	43	43	44	43	40	39
(66)	93	36	90	90	91	89	90	91
(67)	84	14	82	82	83	94	93	94
(68)	3	35	5	5	6	3	2	2
(69)	87	33	81	81	84	86	87	87
(70)	7	98	8	8	8	5	5	5
(71)	114	29	114	114	114	114	114	114
(72)	19	47	19	19	23	18	18	17
(73)	50	57	55	55	53	52	54	54
(74)	115	62	116	116	116	116	116	116
(75)	103	67	99	99	99	99	99	99
(76)	45	5	48	48	50	38	45	45
(77)	89	19	87	87	88	78	84	84
(78)	99	20	100	100	100	97	98	98
(79)	78	108	76	76	75	77	74	74
(80)	52	84	34	34	33	58	60	61
(81)	35	37	37	37	37	40	37	38
(82)	81	41	80	80	81	81	82	82
(83)	57	54	58	58	58	55	55	55
(84)	46	79	50	50	47	51	50	50
(85)	1	111	1	1	1	2	3	3
(86)	63	4	65	65	65	66	62	64
(87)	59	60	54	54	61	59	58	58
(88)	65	70	56	56	57	71	71	71
(89)	85	118	70	70	76	84	83	85
(90)	83	*	***	***	*******	*****	*&&	*&&&&
(91)	108	110	108	108	107	112	112	112
(92)	86	43	93	93	93	87	86	86
(93)	94	107	97	97	96	91	91	90
(94)	39	55	33	33	34	41	39	41
(95)	10	24	9	9	10	11	13	10
(96)	18	44	20	20	18	23	25	25
(97)	23	51	17	17	19	24	24	24
(98)	68	45	63	63	64	65	67	67
(99)	62	89	52	52	48	63	63	62
(100)	47	96	49	49	51	42	44	44
(101)	55	88	35	35	38	36	35	35
(102)	105	32	104	104	106	103	103	103
(103)	24	74	26	26	27	21	21	21
(104)	96	112	95	95	97	93	94	93
(105)	67	8	66	66	69	60	65	65
(106)	100	15	101	101	101	104	104	104
(107)	27	81	16	16	16	27	27	27
(108)	5	101	4	4	3	6	8	8
(109)	36	17	47	47	40	48	51	51
(110)	8	92	11	11	11	7	6	6
(111)	104	2	107	107	104	108	108	108
(112)	76	12	77	77	79	70	70	70
(113)	20	25	13	13	15	22	15	22
(114)	33	50	39	39	39	29	32	32
(115)	13	48	25	25	21	13	10	12
(116)	15	6	12	12	13	12	9	11
(117)	82	68	89	89	85	82	81	81
(118)	12	38	28	28	20	17	11	15

*Same rank=115, 116 ** Same rank=72, 73 *** Same rank 85, 86 **** Same rank 74, 75	***** Same rank 79, 80 ****** Same rank 66, 67 ******* Same rank 86, 87 *& Same rank 75, 76	*&& Same rank 78, 79 *&&& Same rank 75, 76 *&&&& Same rank 78, 79

4.2. Sensitivity Analysis (SA) - Comparison Methods

In this part of the research, it was conducted a SA among ranking systems of TOPSIS, CODAS, MARCOS, MABAC, WASPAS, ARAS, SAW, and DEA according to Table 3.

Table-3. Correlations Transformed Variables

Criteria	Topsis	Codas	Marcos	Mabac	Waspas	Aras	SAW	DEA
TOPSIS	1.000	.953	.970	.967	.966	.949	.949	.164
CODAS	.953	1.000	.957	.954	.964	.982	.982	.190
MARCOS	.970	.957	1.000	.998	.988	.954	.954	.171
MABAC	.967	.954	.998	1.000	.986	.952	.952	.172
WASPAS	.966	.964	.988	.986	1.000	.957	.957	.180
ARAS	.949	.982	.954	.952	.957	1.000	1.000	.176
SAW	.949	.982	.954	.952	.957	1.000	1.000	.176
DEA	.164	.190	.171	.172	.180	.176	.176	1.000
Dimension	1	2	3	4	5	6	7	8
Eigenvalue	6.834	.963	.119	.043	.025	.014	.002	.000

According to Table 3 the highest correlation among ranking models of TOPSIS, CODAS, MARCOS, MABAC, WASPAS, ARAS and SAW were approached about 0.970 (TOPSIS-MARCOS models), 0.998 (MABAC-MARCOS), 0.998 (MARCOS-MABAC), 0.988 (MARCOS-WASPAS), 0.982 (CODAS-ARAS) and 0.982 (CODAS-SAW). The pair test analysis had shown a significant difference around (p-value ≤0.014) between values of SAW-DEA. The t-test analysis was revealed a significant analysis of (p-value ≤0.003) among values of TOPSIS, CODAS, MARCOS, MABAC, WASPAS, ARAS, SAW, and DEA. While there is no significant difference with recede the values of DEA. The distribution of values for TOPSIS, CODAS, MARCOS, MABAC, WASPAS, SAW, ARAS, and DEA were obtained the same based on related-samples Friedman's two-way analysis of variance by ranks. Therefore, the Null hypothesis was rejected. While the distribution of values for TOPSIS, MARCOS, MABAC, and WASPAS came into view normally based on a one-sample Kolmogorov Smirnov test. That is why it resulted to retain the null hypothesis. Figure 3 shows the object points labeled and discrimination measures for variable principal normalization of above-named models in 2 dimensions.

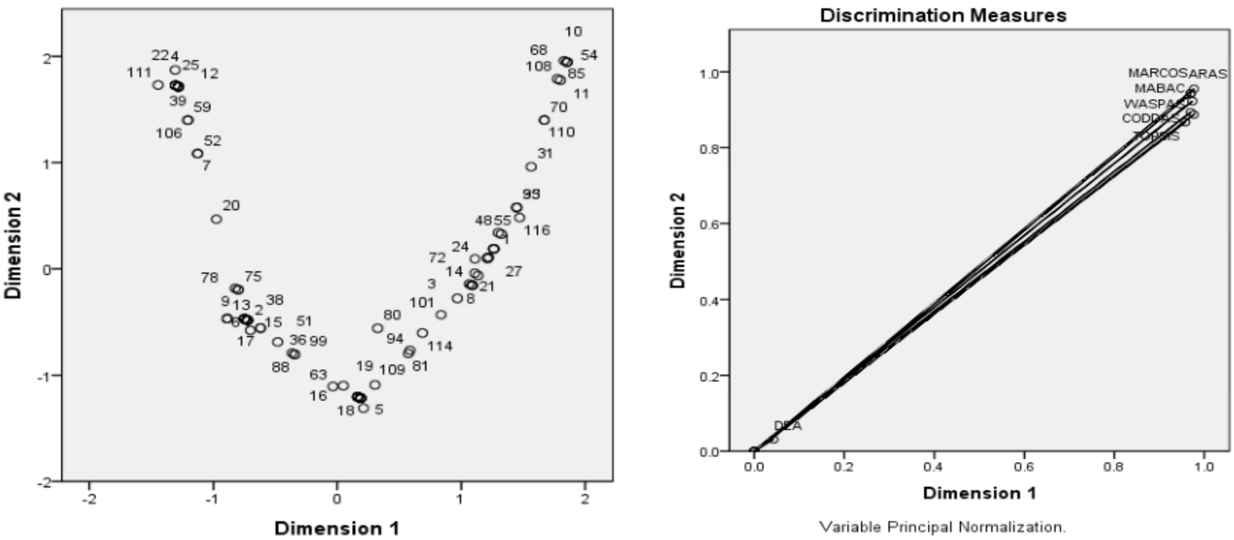


Figure-3. The object points labeled and discrimination measures for variable principal normalization of above-named models in 2 dimensions.

By present study was conducted a DEA based on an additive ratio model to find the efficiency score for ICI. By the way, the data sorted out into output and input sections and the ARAS model assigned to normalize the data along with the weighing vector induced into the matrix. As a result, the division of a weighted average of output to a weighted average of input released an efficiency score for industries individually. Then ICI was classified and ranked based on the existing score. It was found significant differences around 0.036 and 0.093 for the criteria of initial feed (m) and initial feed (L) in the calculation of DEA based on parameters of NC (No), NC (t), NC (m^3), NC (m^2), NC (L), NC (m), NC (pair), Initial feed (m^2), Employee, Power (kW), Water (m^3), Fuel (Gj), Land (m^2), Initial feed (t), Initial feed (L), Initial feed (Pairs), Initial feed (m) and Initial feed (No). Using both Friedman and Kendall's W tests resulted to provide weight values around 8.88, 9.58, 5.87, 5.84, 5.69, 5.79, 5.79, 6.06, 15.3, 17.11, 13.66, 14.09, 13.71, 12.50, 6.85, 5.68, 6.04 and 12.54 for the same parameters respectively. In studies related to industrial ecology, the knowledge of the material inputs injected into the industry cycle contains particular importance.

The ecological science of industries gets back to the study of material and energy streams in industrial ambient. Industrial ecology takes into account various industrial processes and systematically records and censuses the flow of materials including raw materials, energy carriers, main products, sub-products, pollutants, and wastes. By this, the science of industrial ecology provides the opportunity to increase the efficiency of industrial processes and shows which parts of the industrial systems produce more pollutants or are inefficient in the consumption of raw materials or energy carriers. In this way, the purpose of industrial systems should be to circulate the material in a cyclic and renewable environment and avoid generating waste, because the surplus of an industrial sector should be the feed of another industrial sector, like natural ecosystems

5. CONCLUSION

Regarding the high precision of the decision-making methods for ranking purposes, the classification can be used as a reference in this field. SA proved the highest compliance among ranking models and enough confidence for the findings to ensure readers. The quantity of input and output materials entered into the industry cycle has provided useful information for managing the industrial ecology to stakeholders and DEA estimation. Also, the raw data employed to assess ICI can be used as a reliable source for comparing ICI with other nations as well as the benefits in the easiest way towards financial outcomes and performance assessments. Future research orientations will encompass the materials and energy outlay in the performance assessment via DEA and sustainable development aims for ICI.

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