Analysis of Performance in Release of Non-metallic Minerals’ Pollutants in Iran by Non-parametric Directional Distance Output Function Model

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Author’s contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

In this study, the environmental aspects of nonmetallic mineral industries have been evaluated and the amount of pollutants and greenhouse gases from energy sources consumption has been calculated in all the subfields. The results demonstrate that the cement, lime and plaster having the utmost share of the spread of the carbon dioxide (CO₂), involve the maximum share of the social costs. In this research, the technical performance of the mentioned industries has been calculated applying Slacks Based Measure (SBM) approach and the competent industries are specified. However the Directional Distance Output Function reveals that none of them are competent.

Keywords: Environmental evaluation; nonmetallic minerals; directional distance output function.

1. INTRODUCTION

At present, the environmental conservation is one of the most important global challenges, and the economic growth and developments are not reliable unless this subject is considered as a priority. Scientists estimate that more than three to four of the greenhouse gases

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which cause this phenomenon emanate from fossil fuels. Evaluation of the social costs caused by the environmental degradation is of a great importance in order to identify remedial methods which can curtail excessive energy consumption in the country. Total social costs of the resources which are related to energy consumption in Iran have been estimated at 92,195 billion Rials. (base year 2002), of which 13.82% was spent by the industry sector. In the year 2011, this figure was in the vicinity of 16%. The increasing energy consumption in the country resulted in increasing emissions of fuel gases. According to the hydro carbon balance report sheets of the past years, the formation of Carbon dioxide was the highest greenhouse gas, which increased from 4.9 tons per person in 2001 to 6.6 tons per person in 2011.

Predicated on the statistics published by the Central Administration of Statistics of Iran, nonmetal mineral industries as well as the regimental metal industries consume more than a moiety of the industrial fuel, and are the most energy consuming industries in the country. This group of industries dominates the highest share of the production costs for energy carriers and plays an important part in the emission of greenhouse gases, thus incurring high costs to the society to a very great extent. According to International Standard Industrial Classification (code ISIC), this group includes manufacturers of non-structural non-refractory ceramic ware (ISIC 2691); refractory ceramic products (ISIC 2692); manufacturers of cement, lime and plaster (2696); manufacturers of bricks (2697); construction fire proof ceramic industries (2698); and manufacturers of other non-metal mineral products (2699).

Considering the fact that during the past years the emission of greenhouse gases in the industrial sector has escalated and the rate of the energy consumption and as a result environmental susceptibility in the non-metal mineral industries is saliently conspicuous, this demands a felicitous orchestrating in order to reduce emissions of the pollutants. In this study, the calculations of the rate of the pollutants in non-metal mineral industries using Directional Distance Output Function are conducted. That is divided into two parts. The first part entails the measurement of the technical efficiency by slacks based measure (SBM) approach, the second part entails the measurement of environmental efficiency using.

2. MATERIALS AND METHODS

After Pittman (1983) who has described undesirable output for the first time there have been prodigious and perplexed models and studies to evaluate the inefficiency of engenderment due to the ease of undesirable output and to estimate the shadow price by economists of environment [1-8]. One of the basic solutions to evaluate environmental inefficiency was Data Envelopment Analysis (DEA) that had been noticed at first. However there was an abundance of challenges to calculate inefficiency by this method because of the behavior of the pollutant in the production function. In the year 1995, Farc et al. illustrated exchange of the environment quality and the economic development via non-parametric distance functions. Then Chambers et al. taking the idea of benefit function in consumer’s function and defect function in producer’s function, they provided a competent additive technical calculation method. DDOF model (Directional Distance Output Function) was employed to increase the amount of outputs and decrease the amount of inputs [4]. By increasing the desirable output the author could decrease the undesirable output in this method. This approach has been used in many studies to measure environmental efficiency. The most important foreign and domestic studies done are as follows:

Kwon and Yun by Distance Output Function and with its dyad during 1990 to 1995 estimated environmental efficiency and the total cost of decreasing pollution of heavy fuel (crude oil) and coal power stations in South Korea and they indicated that the average cost of decreasing Sox pollutants is 310.6 thousand Wons per ton and in decreasing each ton of NOx it is approximately 146.7 thousand Wons and for each ton of TSP (Total Suspended Particles) it is approximately 1548.3 thousand Wons and for each ton of CO2 it is 3.8 thousand Wons.

Kouwenhoven believed that the industry section plays an important part in air pollution and a mass of the air pollutants considered as hazardous or undesirable output (including Sulfur Dioxide, Nitrogen Oxides, suspended particles, Carbon Monoxide and Hydrocarbons) are emitted from it. The author believes that the costs of the emission of each ton of Sulfur, Nitrogen Oxide, suspended particles in air and
Carbon Dioxide vary according to environmental layout and the present rules are not sufficient diminishing costs.

Murty, Kumar and Paul [8,9] evaluated the Distance Input function assuming the substitution of low to high inputs in sugar industry of India and they obtained the shadow price of a variety of water pollutants and the proper and standard tax rate of the pollutants emission and calculated the rate of efficiency and green productivity by Malmquist Productivity Index.

Murty et al. [8,9] investigated the environmental efficiency and the shadow price of undesirable outputs and the elasticity of replacement between desirable and undesirable outputs of production of coal in a province of India by Directional Distance Output Function 1996-2004. The results of this study indicate that the environmental inefficiency of Andhra Pradesh province power station equals 0.06 that shows this power station can improve its electricity production with decreasing % of production.

3. THEORETICAL FRAMEWORK

3.1 Measurement of Technical Efficiency by SBM Approach

The SBM methodology apperceived by "Measurement Free" or "Units Invariant". This methodology has the accompanying qualities:

1. Units Invariant Posit: In this model, inputs and outputs are invariant to the vicissitude of units.
2. Monotone Postulation: Values decrease monotonically for any overabundance inputs and shortage of yields.

The partial nonlinear model of eq. (1) is proposed to measure the proficiency of undertakings by SBM approach.

\[ \rho = \frac{1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^*}{x_{io}}}{1 + \frac{1}{s} \sum_{r} \frac{s_r^*}{y_{ro}}} \]

\( (SMB) \text{ Min} \)

\( s.t. \)

\[ x_o = X^\lambda + s^- \]

\[ y_o = Y^\lambda + s^+ \]

\[ \lambda \geq 0, s^- \geq 0, s^+ \geq 0 \]

In this model, \( X \geq 0 \) if \( x_{io} = 0 \) then we remove \( S_i^- \) from the goal function. In the event that \( y_{ro} \leq 0 \) then we supplant it with a little positive \( S_i^- \) figure. So \( y_{ro} \) is a punishment in the objective capacity. In this model an undertaking is productive if just its objective capacity is equivalent to one (\( \rho = 1 \)); therefore abundance and deficiency of inputs and yields are zero.

3.2 Measurement of Environmental Efficiency by Directional Distance Output Function Approach

The function \( P(x) \) with \( x \) input has the domain \( x \in R^N_+ \). In addition the input \( x \) is a source of a collection of undesirable outputs with the range of \( u \in R^K_+ \) and desirable outputs with the range of \( v \in R^M_+ \). In order to measure the environmental efficiency via Distance Function introduced by Shephard. We should have some assumptions. The assumptions are as follows:

1. \( (u, v) \in P(x) \) if \( 0 \leq \theta \leq 1 \) then \( (\theta v, \theta u) \in P(x) \). In this case the outputs are slightly separable and controllable.
2. It is possible that zero output be produced: \( 0 \in P(x) \forall x \in R^N_+ \)
3. \( (u, v) \in P(x) \) if \( u = 0 \) then \( v = 0 \) desirable and undesirable output vectors are continuous in source.
4. Inputs are controllable and the producer has no constraints in decreasing and increasing the inputs.

\( P(x) \subseteq P(x'), \text{if } x' \geq x \)

5. The desirable output is controllable.

\( (v, u) \in P(x) \text{ and } v' \leq v \Rightarrow (v', u) \in P(x) \)

6. Null Jointness: Under the following constraint desirable and undesirable outputs can be slightly separable.

\[ \sum_{j=1}^{J} u_{ij} > 0, j = 1, ..., J, \]

\[ \sum_{j=1}^{J} u_{ij} > 0, j = 1, ..., K. \]
Separability assumption indicates that via the dearth of undesirable outputs we will face costs. It implies that the decrementing so as to diminish of undesirable yield is just conceivable attractive yield. Withal proposition number 3 signifies that undesirable yield is a by-result of the alluring yield in the engenderment process. In order to measure the efficiency we can use Data Envelopment Analysis as follows:

If we assume the number of the observations (number of the enterprises) \( k = 1, 2, \ldots, K \)

Environmental inputs can be formulated in eq. 2.

\[
P(x) = \left\{ (v, u) : \sum_{m=1}^{M} \omega_{m} v_{m} \geq v_{n}, m = 1, 2, \ldots, M, \right. \\
\sum_{j=1}^{J} u_{j} = u, j = 1, \ldots, J, \\
\sum_{n=1}^{N} \omega_{n} x_{n} \leq x_{n}, n = 1, \ldots, N, \\
\omega_{k} \geq 0, k = 1, \ldots, K \}
\]

(2)

The equation no. 3 can be solved by a linear programming model in eq. 4.

\[
D(x^{k}, v^{k}, u^{k}, g) = \max \beta \\
\text{s.t.} \left\{ v_{m}^{k} + \beta g_{v}^{k} \geq v_{m}, m = 1, \ldots, M, \\
\sum_{j=1}^{J} u_{j} = u, j = 1, \ldots, J, \\
\sum_{n=1}^{N} x_{n} \leq x_{n}, n = 1, \ldots, N, \\
\omega_{k} = 1, k = 1, \ldots, K \right\}
\]

(3)

In the above equation \( \omega_{k}, k = 1, \ldots, K \) denotes the non-negative variables and steady return regarding the scale. Also the constraint of imbalance of desirable output and equality of undesirable output restricts us to separate and control the outputs slightly (see [10-12]).

According the mentioned assumption Chung and et al. [4], introduced model called Directional Distance Output Function. This approach is able to increase desirable output by decreasing undesirable output. Directional vector is indicated by \( g = (g_{v}, -g_{u}) \) and in this vector we have \( g_{v} = 1 \) and \( g_{u} = 1 \). Therefore, the environmental efficiency of the enterprise \( k^{'}, k \) by the eq. NO. 2.

\[
D(x^{k'}, v^{k'}, u^{k'}, g) = \max \beta \\
\text{s.t.}(v^{k'} + \beta g_{v}, u^{k'} - \beta g_{u}) \in P(x)
\]

(4)

\[\text{Fig. 1. Environmental efficiency by directional distance output function}\]
If $D(x^k, v^k, u^k; g) = 0$ then the enterprise has been working efficiently; otherwise it has been environmentally inefficient. In fact we use the environmental efficiency of the second stage. This was obtained by Shephard’s Distance Output Function, but as Chung et al. [4] said Shephard’s Distance Output Function is a special form of Directional Distance Function and the standard value of environmental efficiency is obtained as eq. 5.

$$D(x, v, u) = \frac{1}{1 + D(x^*, v^*, u^*; v^k, u^k)}$$  

(5)

In eq. 5 if $D(x^k, v^k, u^k; g) = 1$ then the enterprise is efficient; otherwise we have $D(x^k, v^k, u^k; g) < 1$ and it is environmentally inefficient.

### 3.3 Statically Analysis

In order to measure the social costs to compensate for the vulnerability of the pollutants emission and greenhouse gases we should quantify the effects of emission in the environment (human and nature). Environmental social costs of NOx, SO$_2$, CO$_2$, CO, CH$_4$ and SPM in the country are shown in the following table.

After adjustment of social costs mentioned in Table 1 by CPI index, and after calculating the pollutant emissions of each unit of energy resources of industries in Table 2, emissions produced by each industrial unit is calculated, then total social costs for NOx, SO$_2$, CO$_2$, CO, CH$_4$ and SPM are calculated for evaluating Environmental Efficiency of each industry and is shown in Table 3.

The above table shows the gregarious costs of non-metal mineral industries of each of the energy resources. By comparing the last column of the table for each non-metal mineral group, it can be concluded that cement, lime and plaster industries (Code 2694) have the highest share of convivial costs among the total costs of non-mineral industry pollutants.

According the above figure cement, lime and plaster industry (Code 2694) share of the total social costs of pollutants of non-metal mineral industries is %61. Manufacture of bricks has the second rank by %33 share of the total social costs of energy resources pollutants.

In perpetuate the pollutant emissions of energy resources in non-metal minerals which have not been categorized in other places (Code 269), have been discussed.

The above tables show the amount of pollutants and greenhouse gases emission by consumption of energy resources of each of the non-metal mineral industries. The comparison of the columns of the tables indicates that the Carbon Dioxide has the most pollutant emission in consumption of energy resources in non-metal mineral groups. It is prominent that the distinguishing proof of key elements in the outflow of Carbon Dioxide is extremely weighty to assess arrangements and techniques of decrement of atmosphere impacts.

### 4. RESULTS OF THE MODEL

In this section the specialized productivity and the ecological proficiency of the non-metal engenderment commercial ventures, which have not been classified in different spots (Code 269), have been considered. In assessing the specialized effectiveness SPM methodology has been used. This nonlinear model can be figured by GAMS programming. Information was collected from modern workshops with 10 representatives or more. Data and results for technical efficiency were obtained from Table 10.

The data of the last column of Table 10 indicate that manufacture of non-structural non-refractory ceramic ware (2691), manufacture of ceramic, lime and plaster (2694), manufacture of articles of concrete cement and plaster (2695), cutting, shaping and finishing of stone (2696) and manufacture of bricks (2697) are efficient industries.

After measurement of technical efficiency, this study proceeds to calculate environmental efficiency. An integration of the above data, data of convivial costs of energy sector by gas emission and for the amount of emission of industrial sector obtained from the energy balance sheet for energy and the environment were additionally used to evaluate environmental efficiency. In quantifying environmental efficiency Directional Distance Function (DDF) was utilized. Data and results are shown in Table 11.
By comparing the last column of the Tables 10 and 11 it can be concluded that the industries 2691, 2694, 2696, 2697 that are technically efficient are not environmentally efficient, and the decrement of their emission is the only way of reaching the efficient level. For instance, if industry 2691 decreases 39% of its pollutants, it can increase its desirable production by 36% and achieve the efficient level.

![Pie chart showing non-metal mineral industries share of the total social costs of energy resources pollutants.](image)

**Fig. 2.** Non-metal mineral industries share of the total social costs of energy resources pollutants

*Source: study achievements*

**Table 1. Social costs of consumption of energy resources: Pollutants/greenhouse gases (thousand Rials per ton)**

| Type of gas | N₂O | CH₄ | CO₂ | SPM | CO  | SO₃ | SO₂ | NOₓ |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Cost        | 1680| 80  | 34400| 1500| N   | 14600| 4800|     |

*Source: Energy Balance Sheet according to the study of the world bank and the Environmental Protection Agency*

**Table 2. Emission of pollutant and greenhouse gases of industry sector by energy resources (ton)**

| Type of fuel | N₂O | CH₄ | CO₂     | SPM | CO  | SO₃ | SO₂     | NOₓ |
|--------------|-----|-----|---------|-----|-----|-----|---------|-----|
| Gasoline     | 1   | 5   | 126783  | 69  | 18652| -   | 80      | 719 |
| Kerosene     | 2   | 10  | 249955  | -   | 75  | -   | 230     | 48  |
| Gas oil      | 71  | 354 | 8742882 | 4654| 621 | 621 | 48715   | 15514|
| Fuel oil     | 157 | 784 | 20229656| 6265| 23  | 4492| 294034  | 62647|
| LPG          | 1   | 13  | 816787  | -   | 354 | -   | 2       | 534 |
| Normal gas   | 86  | 862 | 48383622| 6443| 3043| -   | 157     | 76603|

*Source: The total energy balance of the country*
Table 3. Complete social expense of outflow of non-metal mineral commercial ventures by vital assets

| The type of fuel industry code | Natural gas | LPG   | Fuel oil | Gas oil | Kerosene | Gasoline | The total social cost of emission for each industry (Rials) |
|------------------------------|-------------|-------|----------|---------|----------|----------|-----------------------------------------------------------|
| 2691                         | 72120581    | 3589502 | 5609631  | 9661132 | 55026    | 1354043  | 92389915                                                  |
| 2692                         | 12701124    | 88450 | 4369293  | 4134125 | 53346    | 321839   | 21668177                                                  |
| 2694                         | 1160370623  | 4008872 | 318200000 | 56997314 | 2789958 | 6631042  | 4413025433                                                |
| 2695                         | 10951360    | 439172 | 11328186 | 70930678 | 691819   | 6393287  | 100734501                                                 |
| 2696                         | 6943281     | 597150 | 987351   | 10963154 | 1789824  | 6106241  | 27387002                                                  |
| 2697                         | 299398194   | 3304789 | 1937000000 | 122000000 | 1788144 | 8562075  | 2371843726                                                 |
| 2698                         | 142990825   | 57326426 | 29797978 | 18491804 | 1068602 | 3783782  | 253459416                                                  |
| 2699                         | 17273529    | 591870 | 174910494 | 155000000 | 719122   | 5313242  | 353387269                                                  |

Source: study achievements

Table 4. Pollutants and green house gases of gasoline consumption (kg)

| Industry code | CH4 | CO2    | SPM | CO     | SO2 | NOx |
|---------------|-----|--------|-----|--------|-----|-----|
| 2691          | 88  | 2222301 | 1209 | 326939 | 1402 | 12603 |
| 2692          | 21  | 528213  | 287  | 77709  | 333  | 2996  |
| 2694          | 429 | 10883090 | 5923 | 1601093 | 6867 | 61719 |
| 2695          | 414 | 10492878 | 5711 | 1543686 | 6621 | 59506 |
| 2696          | 395 | 10021770 | 5454 | 1474378 | 6324 | 56835 |
| 2697          | 554 | 14052367 | 7648 | 2067349 | 8867 | 79692 |
| 2698          | 245 | 6210071  | 3380 | 913610  | 3919 | 35218 |
| 2699          | 344 | 8720272  | 4746 | 1282905 | 5502 | 49454 |

Source: study achievement
Table 5. Pollutants and greenhouse gases of Kerosene consumption (kg)

| Industry code | CH₄  | CO₂  | SPM | CO  | SO₂  | NOx |
|---------------|------|------|-----|-----|------|-----|
| 2691          | 14   | 34113| 0   | 102 | 314  | 19  |
| 2692          | 13   | 33071| 0   | 99  | 304  | 19  |
| 2694          | 692  | 17296104 | 0 | 5190 | 15915 | 969 |
| 2695          | 172  | 4288871 | 0 | 1287 | 3946  | 240 |
| 2696          | 444  | 11095889 | 0 | 3329 | 10210 | 621 |
| 2697          | 443  | 11085443 | 0 | 3326 | 10200 | 621 |
| 2698          | 265  | 6624705  | 0 | 1988 | 6096  | 371 |
| 2699          | 178  | 4458135  | 0 | 1338 | 4102  | 250 |

Source: study achievements

Table 6. Pollutants and greenhouse gases of gasoline consumption (kg)

| Industry code | CH₄  | CO₂  | SPM | CO  | SO₂  | NOx |
|---------------|------|------|-----|-----|------|-----|
| 2691          | 1213 | 29960454 | 15949 | 2128 | 166938 | 53164 |
| 2692          | 519  | 12820471 | 6825  | 911  | 71435  | 22750 |
| 2694          | 7157 | 176756253 | 94091 | 12555 | 984879 | 313649 |
| 2695          | 8906 | 219965466 | 117092 | 15624 | 1225639 | 390323 |
| 2696          | 1377 | 33998198 | 18098  | 2415 | 189437 | 60329 |
| 2697          | 15262 | 376930294 | 200647 | 26773 | 2100241 | 668852 |
| 2698          | 2322 | 57345543 | 30526  | 4073 | 319527 | 101758 |
| 2699          | 19410 | 479370082 | 255178 | 34049 | 2671032 | 850629 |

Source: study achievements

Table 7. Pollutants and greenhouse gases of fuel oil consumption

| Industry code | CH₄  | CO₂  | SPM | CO  | SO₂  | NOx |
|---------------|------|------|-----|-----|------|-----|
| 2691          | 400  | 10310655 | 3193 | 12  | 149863 | 31930 |
| 2692          | 311  | 8030879  | 2487 | 9  | 116727 | 24870 |
| 2694          | 226679 | 5849021527 | 1811406 | 6650 | 85014357 | 18113192 |
| 2695          | 807  | 20821516 | 6448  | 24  | 302637 | 64480 |
| 2696          | 70   | 1814779  | 562   | 2  | 26377  | 5620 |
| 2697          | 137995 | 3560708503 | 1102730 | 4048 | 51754185 | 11026767 |
| 2698          | 2123 | 54769499 | 16962 | 62  | 796064 | 169610 |
| 2699          | 12459 | 321490278 | 99564 | 366 | 4672797 | 995588 |

Source: study achievements
| Industry code | CH₄  | CO₂    | SPM | CO    | SO₂  | NOx |
|---------------|------|--------|-----|-------|------|-----|
| 2691          | 398  | 25004810 | 0   | 10837 | 61   | 16348 |
| 2692          | 10   | 616154  | 0   | 267   | 2    | 403  |
| 2694          | 444  | 27926176 | 0   | 12103 | 68   | 18258 |
| 2695          | 49   | 3059311 | 0   | 1326  | 7    | 2000 |
| 2696          | 66   | 4159805 | 0   | 1803  | 10   | 2720 |
| 2697          | 366  | 23021469 | 0  | 9978  | 56   | 15051 |
| 2698          | 6356 | 399341250 | 0  | 173077 | 978  | 261082 |
| 2699          | 66   | 4123019  | 0 | 1787  | 10   | 2696 |

Source: study achievements

| Industry code | CH₄   | CO₂      | SPM | CO   | SO₂  | NOx |
|---------------|-------|----------|-----|------|------|-----|
| 2691          | 8127  | 456151144 | 60743 | 28689 | 1480 | 722198 |
| 2692          | 1431  | 80332578  | 10697 | 5052  | 261  | 127186 |
| 2694          | 130754 | 7339158633 | 977318 | 461583 | 23815 | 11619667 |
| 2695          | 1234  | 69265603  | 9224  | 4356  | 225  | 109664 |
| 2696          | 782   | 43915142  | 5848  | 2762  | 143  | 69528  |
| 2697          | 33737 | 1893645698 | 252167 | 119097 | 6145  | 2998100 |
| 2698          | 16113 | 904394100  | 120434 | 56880  | 2935  | 1431875 |
| 2699          | 1946  | 109252306 | 14549 | 6871  | 355  | 172973  |

Source: study achievements
Table 10. Technical data and efficiency of non-metal mineral industries uncategorized by SBM approach

| Industry code | Production (Million rials) | Capital stock (Million rials) | Energy (Million rials) | Labor | Level of technical efficiency |
|---------------|-----------------------------|------------------------------|------------------------|-------|-------------------------------|
| 2691          | 1891919                     | 2215730                      | 79629                  | 12328 | 1                             |
| 2692          | 1000905                     | 446908                       | 27139                  | 2876  | 0.71                          |
| 2694          | 16274956                    | 21767663                     | 1735999                | 23073 | 1                             |
| 2695          | 6216211                     | 8589560                      | 96686                  | 16760 | 1                             |
| 2696          | 2026767                     | 7985071                      | 130899                 | 12066 | 1                             |
| 2697          | 2832964                     | 14368374                     | 557945                 | 41399 | 1                             |
| 2698          | 8224543                     | 11285677                     | 308451                 | 22077 | 0.88                          |
| 2699          | 4879750                     | 8432004                      | 154928                 | 13382 | 0.99                          |

Source: study achievements

Table 11. Data and environmental efficiency of non-metal mineral industries by DDOF approach

| Industry code | Production (Million Rials) | Emission of pollutants (Million Rials) | Capital stock (Million rials) | Energy (Million rials) | Labor | Level of environmental efficiency |
|---------------|----------------------------|---------------------------------------|------------------------------|------------------------|-------|----------------------------------|
| 2691          | 1891919                    | 92                                    | 2215730                      | 79629                  | 12328 | 0.59                             |
| 2692          | 1000905                    | 22                                    | 446908                       | 27139                  | 2876  | 0.726                            |
| 2694          | 16274956                   | 4413                                  | 21767663                    | 1735999                | 23073 | 0.52                             |
| 2695          | 6216211                    | 101                                   | 8589560                      | 96686                  | 16760 | 0.87                             |
| 2696          | 2026767                    | 27                                    | 7985071                      | 130899                 | 12066 | 0.82                             |
| 2697          | 2832964                    | 2372                                  | 14368374                    | 557945                 | 41399 | 0.51                             |
| 2698          | 8224543                    | 253                                   | 11285677                    | 308451                 | 22077 | 0.64                             |
| 2699          | 4879750                    | 353                                   | 8432004                      | 154928                 | 13382 | 0.57                             |

Source: study achievements
6. CONCLUSION

Development and growth process of countries is not acceptable and they do not reach a vast development unless considering environmental concerns. Today this topic is the controversial and its importance is emphasized every day. Considering the fact that the fossil fuels emit the most environmental vulnerability especially in emission of pollutants and greenhouse gases. Recognizing its resources and presenting solutions suitable for decreasing the emissions is of great importance. As the industry sector in our country has remarkable share of the emission of pollutants, improving the technical efficiency and the environmental issues is of great importance. In this paper by choosing non-metal minerals as sub-group of industries the technical and environmental efficiency has been investigated. The results indicate that among the industries of this group, cement, lime and plaster have the most shares of the social costs of the pollutants of each unit. By exploring the measure of poison outflows of every industry, it was found that CO2 as a nursery gas has the most divide of the toxins. Assessment of specialized productivity of every industry by SBM methodology betokens that some of non-metal mineral businesses are proficient. However none of them are environmentally efficient by DDF approach.

Since cement plays the most consequential role in engenderment of CO2 between non-metal mineral industries, policy points for decrement of emissions in this industry include: Improvement of industrial units, using substitute fuels, using technologies suitable for decrement of emission of CO2 and encouraging industries to invent an economical method to decrease the emission of CO2.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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