The Presence of Iran, India, South Korea and China in science arena during 1999 and 2009

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Abstract

Since it is essential for the research policy makers to acquire knowledge about the global ranks of their countries in different subject areas, scientometrics experts have been always ranking and analyzing countries on the basis of 'total number of papers', 'total number of citations' and 'citations per paper', etc. In this paper, the data in Essential Science Indicators (ESI) has been used to analyze and evaluate the global ranks of Iran, China, South Korea and India. These countries had a similar growth trend in many indicators of science and technology in the past; however, they achieved different international ranks in different subject areas in the last decade. This article mainly deals with the extent of presence of these countries in different subject areas, their international global ranks and comparing them with each other.

Key Words:

Institute for Scientific Information (ISI), Essential Science Indicators (ESI), Iran, China, South Korea, India, Ranking, Papers, Citations, and Citations per Paper

1. Introduction

Islamic Republic of Iran, as another Asian country which had faced imposed war up to late 1980s, initiated its development programs in different scientific, cultural, economic and political aspects. Moreover, India, one of the most important countries of Asia, has undergone numerous developments during the last two decades considering the expansion of its indicators of sciences and technology. Other countries such as South Korea and China have had such improvements in various indicators of sciences and technology that have attracted many communities of science and technology as well as global markets to their products and services. The development programs in each of these countries have had different influences in their scientific, cultural, economic and social aspects. The extent of participation and the global place of each of these countries in the production of science have been always considered as the most important

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indicators of science and technology. Therefore, it is possible to evaluate the quality of performance of these countries with the above-mentioned information and merging them with the results of separate studies which are carried out on the situation of each country through other indicators of science and technology. It is essential to emphasize that it is impractical to judge about their scientific developments in all aspects only on the basis of the information retrieved from these indicators. Therefore, this information makes it only possible to evaluate and compare the scientific outputs of these countries. The evaluation of ideality of their performance requires another independent research which would be conducted to identify the extent of input which was required to produce such output (Noroozi Chakoli, Nourmohammadi, 2007, p. 53-55).

Essential Science Indicators (ESI) is one of the most important bases of ISI which can be used to analyze the international places of countries regarding their production of science. This database also makes it possible to analyze the quality of scientific improvements during an approximately 5, 10 or 11 year span in 22 various subject areas. Besides, it offers data for ranking scientists, institutions, countries, and journals in the world on the basis of these indicators: "number of papers", "total number of citations", and "citations per paper". Furthermore, ESI introduces "Hot Papers" and "Highly Cited Papers" in each subject area (Research Service Group, 2010). Since ESI covers a major portion of journals in the world, it makes it possible to compare the global places and the extent of focus of countries in various subject areas; therefore, scientometrics experts and science and research policy makers have always paid great attention to it.

In this article, the global places of Islamic Republic of Iran, India, South Korea and China are compared and evaluated according to the data retrieved from ESI.

2. *Methodology*

This study was conducted through library method and the data was analyzed via comparative method. The data in this account was collected from ESI during March 25 to April 5, 2010. The data in ESI covers papers during the eleven years between January 1, 1999 and December 31, 2009. This data has been updated by ESI on March 1, 2010. The 22 subject areas in this research have been chosen on the basis of categories of ESI.

3. *Purpose of the Study*

The most important purpose of this research is the study and comparison of the situation of papers of each of the mentioned countries published in international journals during the eleven years between January 1, 1999 and December 31, 2010 by 22 subject areas. It was also tended to analyze the global ranks of each country according to "number of papers", "total number of citations", and "citations per paper". Moreover, the analysis and comparison of this situation by each subject area is also considered as one of the objectives of this research.

4. *Significance of the Study*

A comparative study of the situation of Iranian papers with the situation of other countries in the Asia can be influential in leading the major research plans of Iran to achieve its regional goals and outpace the countries in the region; however, it must be taken into consideration that useful information can also be obtained from the study of this situation in the countries which have had considerable growth according to many indicators of research and development. Some of the most important benefits of this study are: to recognize the priority of subject areas in each

country, to see which subject areas have been paid less attention to, to recognize the growth rate of papers of these countries in order to use them in later researches which would deal with scientific developments of these countries and to evaluate and compare the extent of growth of papers of these countries with their growth considering other indicators of science and technology.

India, China and South Korea have been chosen in this study because they had similar situations to Iran in the early 1990s, considering many of the global indicators of science and technology; however, all these countries have had quite different situations during the recent years. These countries have enjoyed considerable improvements considering various indicators of sciences and technology and have attracted the attention of many countries.

5. Global Place of All Iranian Papers vs. Other Countries under the Study

A comparison of the countries under the study on the basis of the data at ESI shows that during the 11 years between January 1, 1999 and December 31, 2010, Iran, India, China and South Korea were respectively in the 35th, 12th, 5th and 13th places in the world considering the number of papers in all subject areas. Thus, China outpaced other counties under the study during the mentioned 11 years. Table 1 demonstrates details of the situation of each country considering "number of papers", "total number of citations", and "citations per paper".

Table 1 also shows that some of these countries were placed in almost the same order considering both "total number of citations" and "number of papers". China and South Korea were respectively placed in the 5th and 13th ranks considering "total number of papers" and in the 8th and 15th rank regarding "total number of citations". Thus, China and South Korea had higher ranks than Iran and India regarding "total number of citations". Another important point is that although "total number of citations" of these countries was more than their "number of papers", their global ranks on the basis of "total number of citations" were times lower than their rank on the basis of "number of papers" (Thomson Scientific, 2010).

Table 1. A Comparison of the Global Ranks of Countries in ESI in All Subject Areas

Number of Citations per Paper	Total Number of Citations	Number of Papers	Country	Rank in all Subject Areas on the basis of Number of Papers	Rank in all Subject Areas on the basis of Total Number of Citations	Rank in all Subject Areas on the basis of number of citations per paper
3,92	207349	52928	Iran	35	40	136
5,35	1399497	261598	India	12	18	113
5,56	3740358	673182	China	5	8	112
6,70	1642719	245099	South Korea	13	15	86

Furthermore, table 1 shows that these countries had a different situation considering "citations per paper"; because it did not match with their "number of papers" and "total number of citations" to their papers and did not increase accordingly. "Citations per paper" is considered as one of the most important indicators which shows the average number of citations to each paper. According to table 1, South Korea had a better situation than the 3 other countries regarding this indicator; because, in average, it had the highest number of citations to each paper. However, it must be taken into account that none of the countries under the study had a suitable global rank in this regard. Even China which achieved the 5th and 8th places respectively regarding "number of

papers" and "total number of citations" did not have a high rank considering "citations per paper" and gained the 112th place in the world. As observed in table 1, Iran had the lowest rank among these countries in this regard.

6. *Global Place of Iran VS Other Countries in ESI considering "Total Number of Papers", by 22 Subject Areas*

As mentioned earlier, the situation of papers of each country can be compared and evaluated according to the subject areas in ESI. Therefore, the countries under the study are evaluated according to the 22 subject areas which are mentioned in table 2. As observed in table 2, these countries had different ranks in each subject area. For instance, in 'chemistry', 'Materials Science', 'engineering', and 'pharmacology and toxicology', China, South Korea, Iran and India had respectively more papers in comparison with each other; however, their situation differed in 'Molecular Biology & Genetics', 'agricultural sciences', 'plant and animal science' and 'Economics and Business', i.e. China, South Korea, India and Iran had respectively higher global ranks, considering their number of papers. In general, considering the global ranks of these countries in different subject areas, there is a relationship between the rank of each country in one subject area with its rank in other subject areas. Each country had the possibility to be placed in a range of 1 to 149; but, Iran's rank fluctuated between 13 and 56 in most subject areas, regarding the number of its papers. On the same basis, global rank of China varied between 1 and 16, South Korea between 5 and 29 and India between 2 and 32.

Table 2. Global Ranks of these Countries in ESI Considering "Total Number of Papers", by Subject Areas

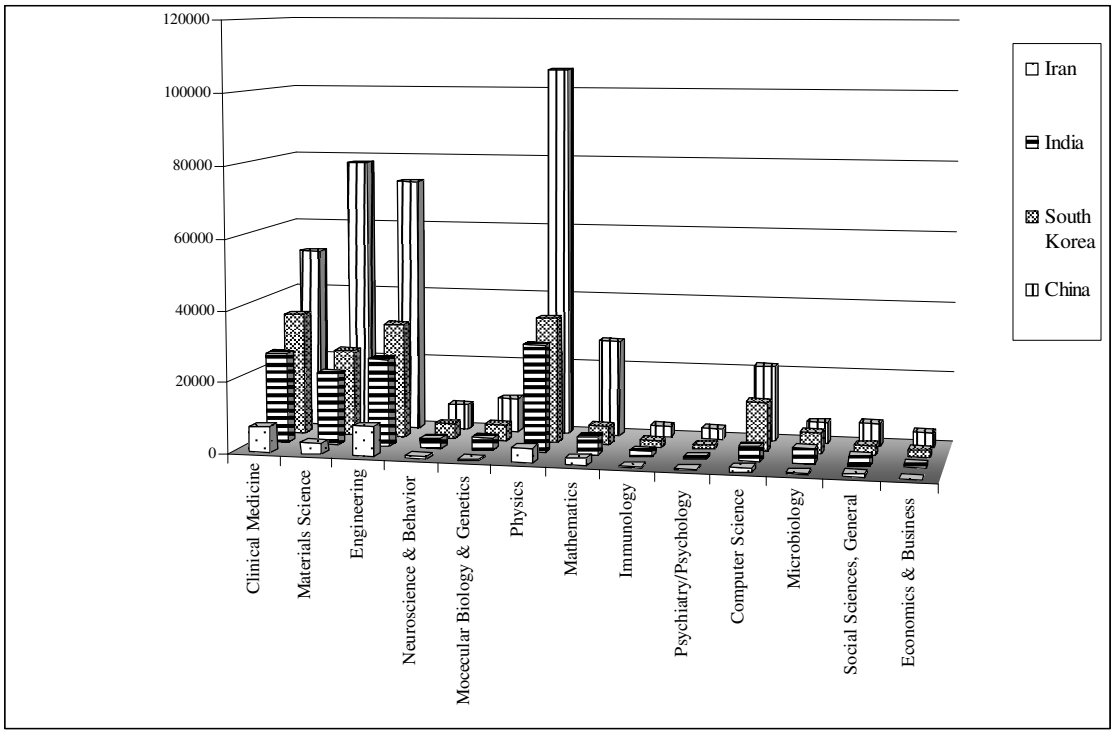
Subject Areas	China	South Korea	India	Iran
CHEMISTRY	2	11	7	20
PHYSICS	3	9	10	36
ENGINEERING	2	9	11	24
CLINICAL MEDICINE	11	15	21	36
PHARMACOLOGY & TOXICOLOGY	5	9	8	26
MATERIALS SCIENCE	1	5	8	29
PLANT & ANIMAL SCIENCE	8	24	11	36
BIOLOGY & BIOCHEMISTRY	7	12	11	42
AGRICULTURAL SCIENCES	12	15	5	35
NEUROSCIENCE & BEHAVIOR	12	16	23	38
GEOSCIENCES	5	26	11	38
MATHEMATICS	2	13	15	32
ENVIRONMENT/ECOLOGY	5	24	13	39
MOLECULAR BIOLOGY & GENETICS	8	16	20	41
IMMUNOLOGY	13	17	19	42
PSYCHIATRY/PSYCHOLOGY	16	29	32	41
COMPUTER SCIENCE	2	7	15	33
MICROBIOLOGY	8	9	14	43
SPACE SCIENCE	9	25	14	44
SOCIAL SCIENCES, GENERAL	9	25	28	39
ECONOMICS & BUSINESS	9	16	28	56
MULTIDISCIPLINARY	3	23	2	13
All Subject Areas	5	13	12	35

However, China had more outstanding ranks in some subject areas in comparison with the global rank of other countries under the study. Among the 149 ranked countries, China achieved the 1st place in 'materials sciences', 2nd place in the four of 'chemistry', 'engineering', 'mathematics

and 'computer science', the 3rd place in both ‘physics’ and ‘multidisciplinary’ and the 5th place in ‘Pharmacology and Toxicology’ and ‘Geosciences’. In contrary, it had the 16th place in ‘psychology and psychiatry’, the 13th place in 'immunology' and the 12th place in ‘agricultural sciences’ and ‘neuroscience and behavior’. Thus, it can be claimed that China had lower ranks in the latter 4 subject areas in comparison with other subject areas. While Iran, with the 13th place in the world, had a more desirable situation in ‘multidisciplinary’, it had the lowest rank in ‘economics and business’ in comparison with its ranks in other subject areas. The same kind of differences can be observed in the global ranks of South Korea and India as well. These differences show that these countries did not pay equal attention to all subject areas which resulted in having different global ranks. On the other hand, the similarity of their ranks in some subject areas can indicate that these countries paid equal attention to them.

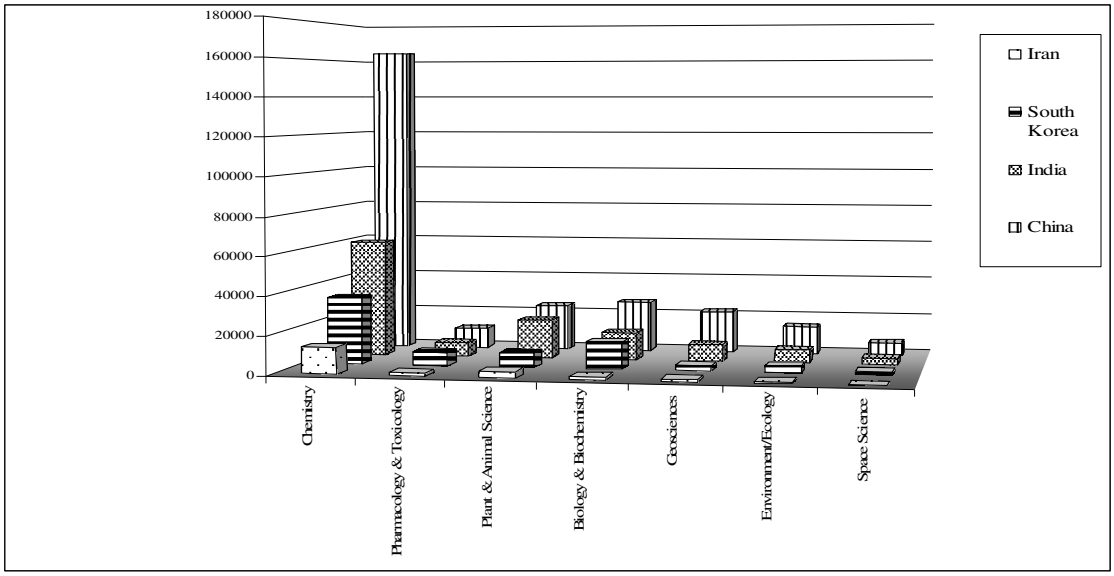
Table 2 shows that China had higher ranks in 20 subject areas in comparison with other countries under the study and was placed after India in 'agricultural sciences' and 'multidisciplinary' subject areas. A comparison of the ranks of South Korea, India and Iran in other subject areas shows that South Korea had higher ranks than India in 13 subject areas, while India had a better rank than South Korea in only 9 subject areas. On the other hand, the global rank of Iran was higher than South Korea in ‘multidisciplinary’, but it wasn't in a higher global rank than India and China in none of subject areas. As shown in graph 1, it can be claimed that China, South Korea, India and Iran had respectively better ranks in comparison with each other in the 13 subject areas of ‘clinical medicine’, ‘materials science’, ‘engineering’, ‘neuroscience & behavior’, ‘molecular biology and genetics’, ‘physics’, 'mathematics', 'immunology', 'psychiatry/psychology', ‘computer sciences’, 'microbiology, 'social sciences, general', and economics & business'.

Fig. 1: Comparison of Global Ranks of Countries in 13 Subject Areas



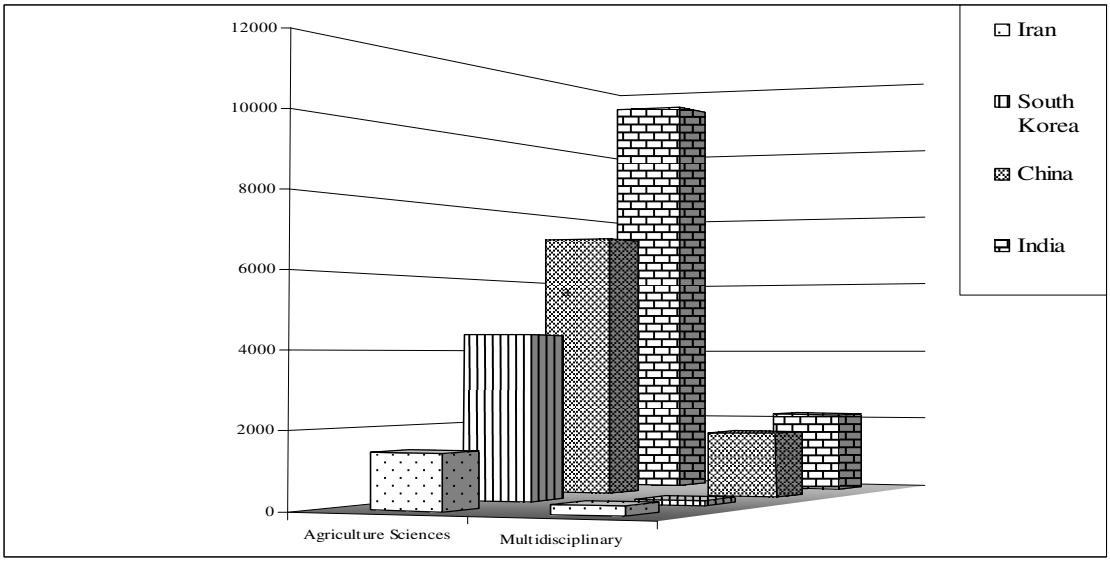
On the other hand, as graph 2 demonstrates, China, India, South Korea and Iran had respectively higher ranks in comparison with each other in the 7 subject areas of ‘chemistry’, ‘pharmacology & toxicology’, ‘plant and animal science’, ‘biology & biochemistry’, ‘geosciences’, ‘environment/ecology’ and ‘space sciences’.

Fig. 2: Comparison of Global Ranks of Countries in 7 Subject Areas



India, China, South Korea and Iran had respectively better ranks in comparison with each other in ‘agricultural science’, and India, China, Iran and South Korea had respectively better ranks in comparison with each other in 'multidisciplinary'. Thus, although China had better ranks than other countries under the study in most subject areas, its rank was lower than India in ‘agricultural science’ and 'multidisciplinary'. In addition, Iran had a better rank than South Korea in 'multidisciplinary' (graph 3). Therefore, the only subject area in which Iran achieved a higher rank than South Korea was ‘multidisciplinary’; however, India and China had a better rank than Iran in this subject area.

Fig. 3: Comparison of Global Ranks of Countries in 2 Subject Areas



Not only table 2 and graph 1 make it possible to compare the situation of the countries under the study with each other in regard to their number of papers in these 22 subject areas, it also reveals the situation and rank of these subject areas in each country. In other words, study of the global ranks of each country in different subject areas can indicate the extent of attention of that country to these areas. Therefore, considering the fact that Iran had higher ranks in ‘multidisciplinary’, ‘chemistry’ and ‘engineering’ in comparison with its ranks in other subject areas, it can be

concluded that Iranian scientists paid more attention to these three subject areas during the 11 years between January 1999 and December 2009. However, China had a different situation; it can be stated that China had an outstanding presence in most subject areas, particularly to 'engineering', 'chemistry', 'materials sciences', 'mathematics', 'computer sciences', 'physics', 'environment/ecology' and 'geosciences'. The study of papers of South Korea shows that it focused more on 'pharmacology and toxicology', 'materials sciences', 'engineering', 'physics' and 'computer sciences' and 'microbiology'. India paid more attention to 'multidisciplinary', 'agricultural sciences', 'chemistry', 'geosciences', 'ecology and environment', 'plant & animal science', 'biology & biochemistry' and 'space science'.

However, it must be taken into account that publishing scientific articles is relevant to the number of researchers of a country. Thus, if it is planned to gain information about the scientific capabilities of research communities of a country in different subject areas in order to compare its situation with other countries, the judgment should be basically based on the rank and number of papers of that country, not the number of its researchers or the investments of that country on special subject areas. But if we require information about the performance of each country in different subject areas, we need other indicators such as "papers per expenditure" or "number of papers per researcher" in order to have a proper judgment about performance of that country. In simple words, the only way to evaluate research performance of a country is through comparison of the number of its papers with other indicators of science and technology such as expenditure ratio or number of researchers. As mentioned earlier, these indicators can also be useful if it is aimed to study the number of papers of each country, without considering its research performance. However, this comparison should take place between the countries with similar situations in political, social, economic, cultural and scientific areas in order to come to a reasonable conclusion. Of course, a comparison of their situation with the target countries can provide research policy makers with useful information about the distance between the subject areas in the countries under the study and the situation of leading countries and can lead them to improve this situation. Therefore, one of the best procedures for a comparative study of the performance of different scientific areas is to compare the situation of each subject area in one country with the situation of that area in other countries. Having more papers in one subject area does not necessarily indicate the success or superiority of scientific activities of scientists in that subject area in comparison with scientists in other subject areas; because it might be resulted from differences between scientific nature of various fields. Considering these facts, it is essential to categorize and analyze the data retrieved from scientometrics studies on the basis of objectives in consideration.

7. *Global Place of Iran VS Other Countries in ESI considering "Total Number of Citations", by 22 Subject Areas*

Ranking countries according to "total number of citations" can be considered as one of the qualitative indicators of papers which show their impact and usage.

According to table 3, there are, in a few cases, some differences between the ranks of countries considering "total number of citations" and "total number of papers"; however, in most cases, there is a relation between their ranks regarding these two indicators. In general, there is a certain relationship between the extent of citations to the papers of a country in different subject areas. According to table 3, for instance, Iran's global rank regarding "total number of citations" fluctuated between 27 and 65 during the eleven years between 1999 and 2009; however, in most subject areas such as 'chemistry', 'engineering', 'materials sciences' and 'mathematics', Iran had higher ranks in comparison with other countries under the study regarding both "total number of papers", and "total number of citations". On the other hand, Iran was situated in a low place in

subject areas such as 'microbiology' and 'economics and business' considering both "total number of papers" and "total number of citations". Although there might be slight differences between some subject areas in Iran, the greatest difference is seen in 'multidisciplinary'; because Iran achieved the 13th place considering "total number of papers", but in the 65th place regarding "total number of citations". Therefore, it can be stated that global rank of Iran regarding "total number of citations" had greater fluctuation than its rank considering "total number of papers".

Table 3 shows that there is a similar situation in other countries under the study. For instance, South Korea gained higher ranks in subject areas such as 'materials sciences, 'engineering', 'chemistry' and 'physics', in comparison with other countries under the study, considering both "total number of papers" and "total number of citations".

Table 3. Global Ranks of Countries in ESI Considering "Total Number of Citations", by Subject Areas

Subject Areas	China	South Korea	India	Iran
CHEMISTRY	4	12	10	27
PHYSICS	6	12	14	43
ENGINEERING	2	10	13	29
CLINICAL MEDICINE	17	21	21	47
PHARMACOLOGY & TOXICOLOGY	8	13	15	37
MATERIALS SCIENCE	3	7	8	37
PLANT & ANIMAL SCIENCE	11	24	20	47
BIOLOGY & BIOCHEMISTRY	13	16	19	47
AGRICULTURAL SCIENCES	11	22	12	42
NEUROSCIENCE & BEHAVIOR	17	21	32	42
GEOSCIENCES	8	29	18	43
MATHEMATICS	4	16	23	41
ENVIRONMENT/ECOLOGY	10	25	21	63
MOLECULAR BIOLOGY & GENETICS	16	20	26	55
IMMUNOLOGY	20	21	25	59
PSYCHIATRY/PSYCHOLOGY	19	25	31	41
COMPUTER SCIENCE	6	14	19	38
MICROBIOLOGY	15	17	13	61
SPACE SCIENCE	15	27	23	56
SOCIAL SCIENCES, GENERAL	10	25	28	48
ECONOMICS & BUSINESS	8	18	29	60
MULTIDISCIPLINARY	6	20	8	65
All Subject Areas	8	15	18	40

In general, it can be stated that China, South Korea, India and Iran had respectively the most number of citations in 'physics', 'engineering', 'pharmacology & toxicology', 'materials science', 'biology & biochemistry', 'neuroscience & behavior', 'mathematics', 'molecular biology & genetics', 'immunology', 'psychiatry/psychology', 'computer science', 'social sciences, general' and 'economics & business' in comparison with each other. Thus, it shows that China and South Korea had better ranks than India and Iran in this regard in 13 subject areas. However, this situation differed in 8 other subject areas, i.e. China, India, South Korea and Iran gained respectively higher ranks in comparison with each other in 'chemistry', 'plant and animal sciences', 'agricultural sciences', 'geosciences', 'environment and ecology', 'microbiology', 'space science' and 'multidisciplinary'. Therefore, Iran's ranks were lower than China, India and South Korea in these 8 subject areas.

On the other hand, the most number of citations among these four countries in 'chemistry', 'plant & animal science', 'agricultural sciences', 'geosciences', 'environment and ecology', 'microbiology', 'space science' and 'multidisciplinary' belonged respectively to China, India,

South Korea and Iran. So, India gained better ranks than South Korea in the above-mentioned subject areas. This is while India achieved the highest rank in comparison with the other 3 countries in 'microbiology'. In other words, the subject area is the only one in which India achieved higher rank than China. In addition, India and South Korea's global ranks are similar to each other in 'clinical medicine' in this regard.

8. *Global Place of Iran VS Other Countries in ESI considering "Citations per Paper", by 22 Subject Areas*

"Citations per paper" is one of the indicators which shows the average number of citations per paper in each country. Since it is possible to use this indicator as one of the indicators of relative quality of papers, ranking countries on its basis can also be regarded significant. Table 4 demonstrates the global rank of the countries under the study on the basis of "citations per paper".

Table 4. Global Ranks of Countries in ESI Considering "Citations per Paper",by Subject Areas

Subject Areas	**China**	**South Korea**	**India**	**Iran**
CHEMISTRY	55	32	51	61
PHYSICS	62	45	47	73
ENGINEERING	49	58	57	68
CLINICAL MEDICINE	78	83	97	105
PHARMACOLOGY & TOXICOLOGY	76	59	72	79
MATERIALS SCIENCE	52	34	43	73
PLANT & ANIMAL SCIENCE	64	42	100	106
BIOLOGY & BIOCHEMISTRY	70	44	65	93
AGRICULTURAL SCIENCES	56	52	92	91
NEUROSCIENCE & BEHAVIOR	61	47	73	78
GEOSCIENCES	68	60	90	99
MATHEMATICS	36	51	65	71
ENVIRONMENT/ ECOLOGY	71	66	78	101
MOLECULAR BIOLOGY & GENETICS	78	65	83	89
IMMUNOLOGY	86	69	82	91
PSYCHIATRY/PSYCHOLOGY	38	37	36	70
COMPUTER SCIENCE	56	69	65	65
MICROBIOLOGY	71	76	79	89
SPACE SCIENCE	59	41	55	70
SOCIAL SCIENCES, GENERAL	46	71	77	97
ECONOMICS & BUSINESS	18	37	54	72
MULTIDISCIPLINARY	65	42	69	75
All Subject Areas	112	86	113	136

It shows that Iran's rank fluctuated between 61st and 106th places considering this indicator. It can also be mentioned that Iran's rank in 'Chemistry' was higher than its rank in other subject areas. South Korea, India, China and Iran gained higher ranks in comparison with each other in 'chemistry' regarding their "citations per paper".

One of the important points in this regard is that China had lower ranks than South Korea and India in a lot of subject areas which caused a great difference between China' ranks regarding "total number of papers" and "total number of citations" and its ranks considering "citations per paper".

Table 4 shows that South Korea had generally higher ranks than the other 3 countries regarding "citations per paper". This point can indicate that although "total number of citations" to China

and India's papers outnumbered "total number of citations" to South Korea's papers, they could not achieve higher ranks than South Korea regarding "citations per paper" because their "total number of citations" were far less than their "total number of papers".

9. Conclusion

According to the study, the situation of the countries under the study seemed to be better in some subject areas such as 'chemistry' than their situation in other subject areas; however, this point should be taken into consideration that they did not have an equal presence in all subject areas. As mentioned earlier, considering "total number of papers", Iran's global ranks were higher in subject areas such as 'multidisciplinary', 'chemistry' and 'engineering' than other subject areas. China gained the highest ranks, in comparison with the countries under the study, in all subject areas except 'agricultural science' and 'multidisciplinary'; however, its ranks in 'chemistry', 'physics', 'materials sciences', 'engineering', 'mathematics' and 'computer sciences' were more outstanding than its ranks in other subject areas. South Korea had concentrated more on 'pharmacology and toxicology', 'materials sciences', 'engineering', 'computer sciences', 'microbiology' and 'physics' while India had mainly focused on 'agricultural sciences', 'multidisciplinary', 'plant and animal sciences', 'chemistry', 'pharmacology & Toxicology' and 'materials science' which made their ranks in these subject areas better than other subject areas.

In general, it can be stated that all the 4 countries had higher ranks in 'multidisciplinary', 'chemistry' and 'engineering' than other subject areas. The following reasons can undoubtedly be considered as some of the most important factors affecting this situation and can be studied in separate researches:

- The difference in nature of these sciences as well as the difference in procedures of production of science in these subject areas;
- Greater number of scientists in these subject areas;
- Special attention of government development and research policy and plans for more reinforcement and investment in these subject areas;
- Greater number of journals in these subject areas;
- Wider scope of theses subject areas and greater number of their subfields.

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