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Abstract:
Educational growth is a fundamental infrastructure factor required to achieve sustainable development. Therefore, evaluation and measurement of educational growth are essential for establishing a development road map. Because of this, there are many organizations and databases that work to capture academic trends and provide the general view of institute achievements. Web of Science and SCImago (cover Scopus indexed journals) are the two most popular and scientific databases. In this paper, we define the important effective factors in educational growth and discuss them; we then compare these defined factors across four different developing countries: Brazil, Iran, Malaysia, and Turkey. As well as the comparisons, this paper uses the Pearson product moment correlation coefficient method to analyze the factors and the strong or weak relationships between the factors are discussed. Through this research, the reader, especially the decision maker will find the effect of the institute and research income to publication as well as other educational growth.

Keywords: *Educational growth; Developing countries; Publication; Impact factor; Web of Science; Scopus*

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1   Introduction

Nowadays, one of the most important factors used to measure a country's level of development is its educational growth. In order to measure the educational growth of organizations or governments, many significant elements need to be considered. These factors, which measure the level of educational growth, are of particular interest to universities. Because, they are also the fundamental criteria to rank universities. Factors such as number of publications [1-3], citation number [4, 5], international collaboration [6, 7], the number of postgraduate students and researchers [8, 9], number of academic staff [10, 11] are the most important ones. In this regard, Web of Science (WoS) and SCImago are the most popular databases used to capture and measure the number and quality of academic publications and provide strong databases to support this information [12-14]. For a long time now, bibliometric studies have been widely applied to evaluate research papers [15]. The field of bibliometrics is concerned with the analysis of citation indices in order to identify highly cited authors, publications and the most productive countries as well as institutions. This information is crucial because it highlights those who drive the trend in a research field and provides information on what is topical [16, 17]. Bibliometric studies have been widely applied in a variety of other research areas and provided valuable insights [16-18].

In this paper authors provide a comprehensive comparison of the different academic variables of educational growth in four different developing countries. Brazil, Iran, Turkey, and Malaysia are selected as four different developing countries and all the variables of these countries are compared together and the correlation coefficients among the variables are discussed in detail. Moreover, by applying bibliometrics analysis, the paper tried to overlook to the world average scholar output and compare to for developing countries in order to give a guideline to decision makers.

Below, we discuss academic variables and explain these significant elements one by one.

1.1   Number of Publications

The number of existing documents in the academic databases is a quantitative criterion for measuring universities' or countries' activities in knowledge production. Here, we compare the total number of documents in the WoS from 1990 until 2012 and existing documents in Scopus from 1996 to 2011 for the four abovementioned different developing countries.

1.2   Number of Citations

Number of citations (of any date) received by the documents published during the source year, --i.e. citations in years X, X+1, X+2, X+3 etc to documents published during year X. When referred to the period 1996-2012, all published documents during this period are considered **[19]**.

1.3   Impact Factor

The Journal Citation Ranking (JCR) provides quantitative tools for ranking, evaluating, categorizing, and comparing journals, organizations, or countries. The impact factor is one of these; it is a measure of the frequency with which the "average article" in a journal, organization, or country has been cited in a particular year or period. The annual JCR impact factor is a ratio between citations and recent citable items published. Thus, the impact factor of a journal, organization, or country is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years (see Figure 1) [20].

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A= total cites in 1992
B= 1992 cites to articles published in 1990-91 (this is a subset of A)
C= number of articles published in 1990-91
D= B/C = 1992 impact factor
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Figure 1. Calculation for journal impact factor.

The impact factor is useful in clarifying the significance of absolute (or total) citation frequencies. It eliminates some of the bias of counts that favor large journals over small ones, or frequently issued journals over less frequently issued ones, and of older journals over newer ones. Particularly in the latter case such journals have a larger citable body of literature than smaller or younger journals. All things being equal, the larger the number of previously published articles, the more often a journal will be cited.

1.4   *h*-index

The *h*-index is a country's number of articles (*h*) that have received at least *h* citations. It quantifies both country scientific productivity and scientific impact and it is also applicable to scientists, journals, etc [19].

1.5   Number of Doctoral Degrees

The number of PhD students can have a significant influence on the amount of research activities and innovations in universities. PhD candidates are involved in research and contribute to the development of ideas and innovation those results in an increase in publication and citations. Researchers need postgraduate students to carry out academic projects; hence this element is important for increasing the institute's income and developing the university's ranking.

1.6   Number of Academic and Research Staff

Human resource is an essential capital for any organization. As with PhD candidates, academic and research staff are the big capital for universities due to all the publications, developments, and innovations they carry out. Therefore it is important to consider the number of academic and research staff when evaluating universities.

1.7   Institute Income and Research Income

Institute income and the amount of financial support for universities plays an important role in motivating research development. Increase in the institute income results in the employment of more researchers and research students, therefore causing a growth in educational productions and more research outputs.

1.8   International Collaboration

In this study international collaboration applies to the document ratio whose affiliation includes more than one country address. International collaboration refers to the exchange and sharing of knowledge among different universities and institutes around the world. Researchers can reach the cutting edge in all fields of science by collaborating with other institutes and exchanging their knowledge and technologies.

2   Research Questions

Bibliometrics is a statistical analysis of written publications, such as books or articles. Bibliometric methods are frequently used to evaluate the researchers output within scholars/instructions/countries. Bibliometric analysis is a power full tool to compare the trend of educational growth within different countries. So, the current study aims to investigate the critical affecting factors, consists of the number of publications, citations, citations per document, the number of doctoral degrees, the number of academic staff, and international collaboration on the educational growth of the developing countries based on the bibliometrics study. The study also evaluates the correlation coefficient of the investigated factors. These factors assist the decision makers to evaluate their researchers/institutions and find the best investing area in order to get high impacts of research. Therefore, the main research questions are:

Q1- What are the key affecting factors to the educational growth based on the number of publications?

Q2- In what extent, the investigated factors are correlated to the educational growth?

3   Data Collection

In this study all data are captured from two popular academic databases, Web of Science (InCites) and SCImago Journal and Country rank. In Web of Science we apply a longer period of time from 1990 to 2012, while in SCImago we only use the span of 1996 to 2010.

InCites is a research evaluator and objective analyzer of people, programs, and peers that is owned by the Thomson Reuters company. All data in InCites are reported by institutes.

The SCImago Journal & Country Rank is a portal that includes the journals and country scientific indicators developed from the information contained in the Scopus database (Elsevier B.V.). These indicators can be used to assess and analyze scientific domains.

As we already discussed, there are lots of important elements that have an effect on the educational growth of countries and institutes. Some important elements were explained in the last section. To have a comprehensive comparison of the impact of these elements we selected four different countries from developing countries: Brazil in South America, Iran in the Middle East, Turkey in Europe, and Malaysia in Asia. Figure 2 presents a general overview of the position and performance of the selected countries.
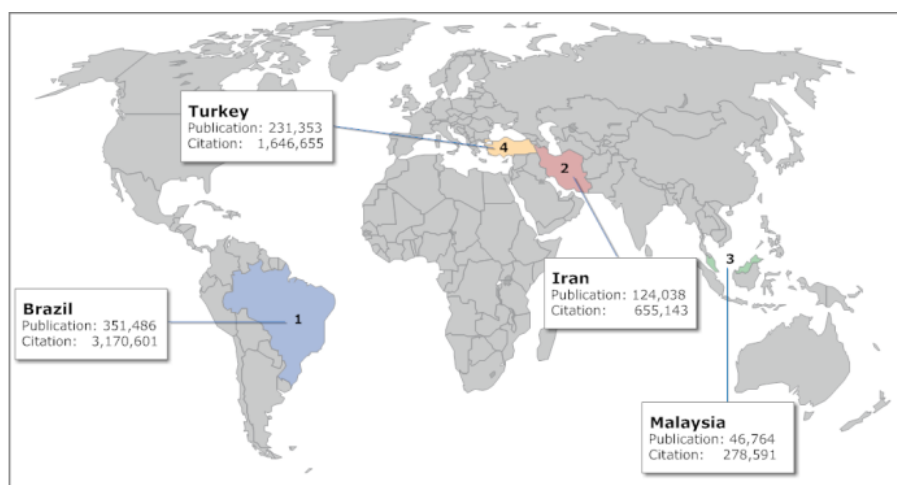

Figure 2. General overview of the position and performance of the selected countries.

4   Methodology

The researcher selected four different developing countries from South America, the Middle East, Asia, and Europe. For each country we gathered some important academic elements from two well-known databases: Web of Science (InCites) and Scopus (SCImago). These academic elements include: the number of publications, citations, citations per document, the number of doctoral degrees, the number of academic staff, international collaboration, and so on. All the gathered data are comprehensively compared and discussed together and also compared to the elements' world average.

In addition, we apply the Pearson product moment correlation coefficient method, to show that these collected data are correlated.

The quantity r, called the linear correlation coefficient, measures the strength and the direction of a linear relationship between two variables. The linear correlation coefficient is sometimes referred to as the Pearson product moment correlation coefficient in honor of its developer Karl Pearson.

The mathematical formula for computing r is:

$$r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}}$$

where n is the number of pairs of data.

The value of r is such that -1 < r < +1. The + and – signs are used for positive linear correlations and negative linear correlations, respectively. If x and y have a strong positive linear correlation, r is close to +1. An r value of exactly +1 indicates a perfect positive fit. Positive values indicate a relationship between x and a y variable such that as values for x increase, values for y also increase. If x and y have a strong negative linear correlation, r is close to -1. An r value of exactly -1 indicates a perfect negative fit. Negative values indicate a relationship between x and y such that as values for x increase, values for y decrease, and finally if there is no linear correlation or a weak linear correlation, r is close to 0. A value near zero means that there is a random, nonlinear relationship between the two variables Note that r is a dimensionless quantity; that is, it does not depend on the units employed.

A perfect correlation of ± 1 occurs only when the data points all lie exactly on a straight line. If r = +1, the slope of this line is positive. If r = -1, the slope of this line is negative. A correlation greater than 0.8 is generally described as strong, whereas a correlation less than 0.5 is generally described as weak. These values can vary based upon the "type" of data being examined.

5   Results and Discussion

5.1   Analysis on Countries' Publication

As we mentioned before, one of the most important elements to evaluate the knowledge growth of any country is the number of documents it produces and publishes. Figure 3 and Figure 4 illustrate the number of existing documents in WoS from 1990 to 2012 and the number of documents in Scopes during 1996-2011. As shown in Figure 3 Brazil has more publications and Malaysia is in the last rank.
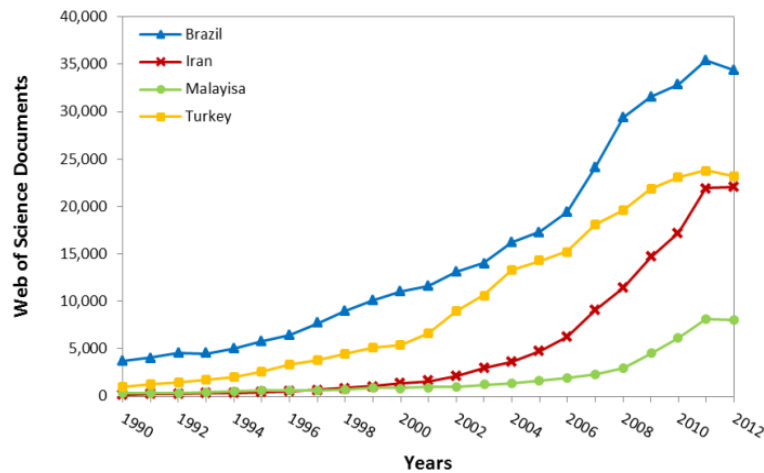
Figure 3. Web of Science number of documents from 1990 to 2012.

Figure 4 not only demonstrates a comparison among four different countries, but shows the average SCImago publications in the world (all countries' average publications). As shown in Figure 4, all four selected countries have a higher number of publications in comparison with the average. As with the figures from the WoS database, Brazil is found in the top rank and Malaysia is last. The difference in these two databases is Iran, which is located at the second rank in SCImago but at the third in WoS. Based on the Figure 4, Iran has the higher ratio of growth in the number of publications among these selected countries.
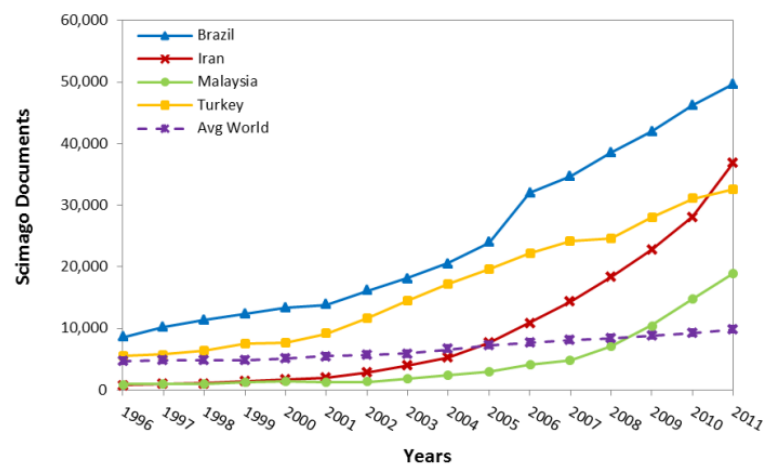

Figure 4. Existing documents in SCImago from 1996 to 2011.

Figure 5 presents the total number of Web of Science publications from 1990 to 2012. As shown in Figure 5, Brazil is located in the first rank for total number of publications with a high degree of difference among the other countries. The number of Malaysian publications is almost seven times smaller than Brazil''s.
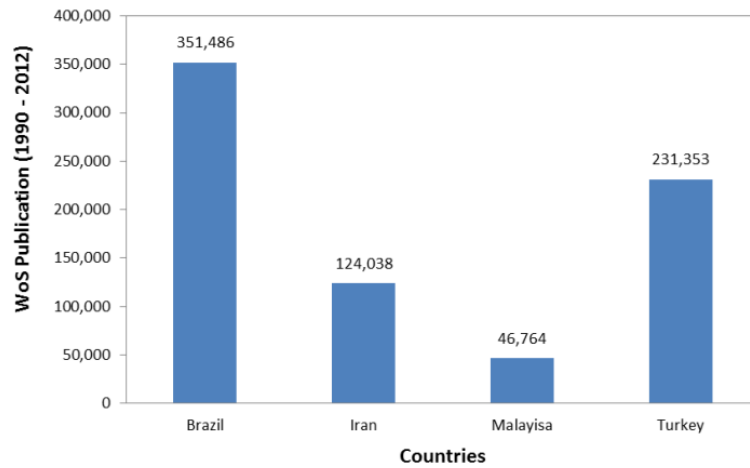
Figure 5. Total number of Web of Science publications from 1990 to 2012.

Figure 6 presents the world percentage of Web of Science publications from 1990 to 2012 among Brazil, Iran, Malaysia, and Turkey. As shown in this figure, the highest percentage of 2.37% belongs to Brazil and the lowest one to Malaysia (0.23%). Based on Figure 6, Iran and Malaysia have contributed less than 1% to the total world publication record in this specific duration of time.
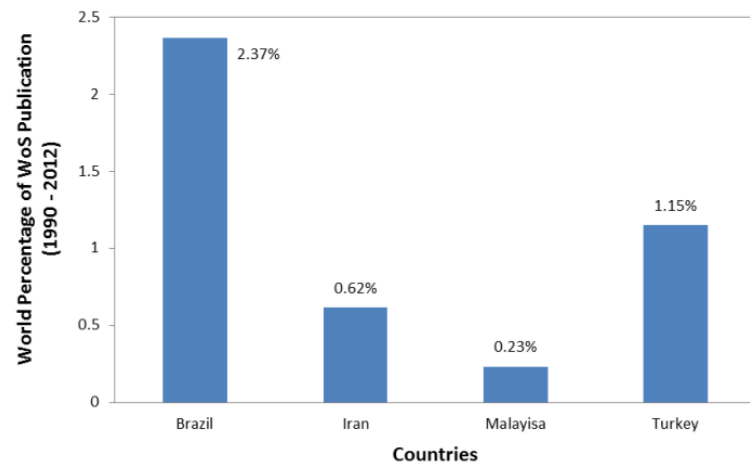

Figure 6. Total world percent of Web of Science publications from 1990 to 2012.

Number of publications is a way to quantitatively measure the academic activity of any organization or country. To evaluate the quality of academic productions and publications, citation has an important role. Citation shows other researchers' interest in the particular publication, therefore it is a helpful measurement of the quality and usability of publications.

Figure 7 illustrates the Web of Science citations of all publications from 1990 to 2012. In keeping with the number of publications, Brazil is at the top for number of citations. Except Malaysia which has a smooth trend, all three other countries see a sharp increase in the number of citations during this time.
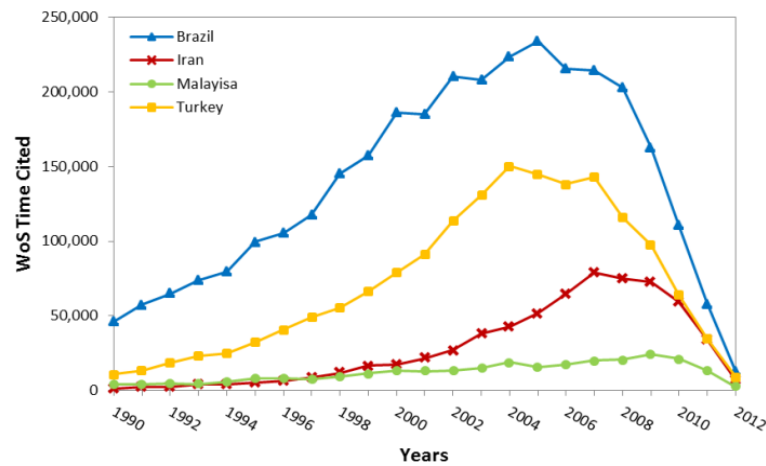
Figure 7. Web of Science times cited from 1990 to 2012.

Figure 8 presents the same trend in the SCImago database from 1996 to 2011. In comparison with the world average citation numbers, Malaysia has a lower ranking than average, while Iran touches the average level in 2006 and prefers the higher than average after that. Based on Figure 8, the quality of the Iran and Malaysia publications is lower than the average quality of the world publications; this is something they need to consider if they aim to reach the international academic standards.
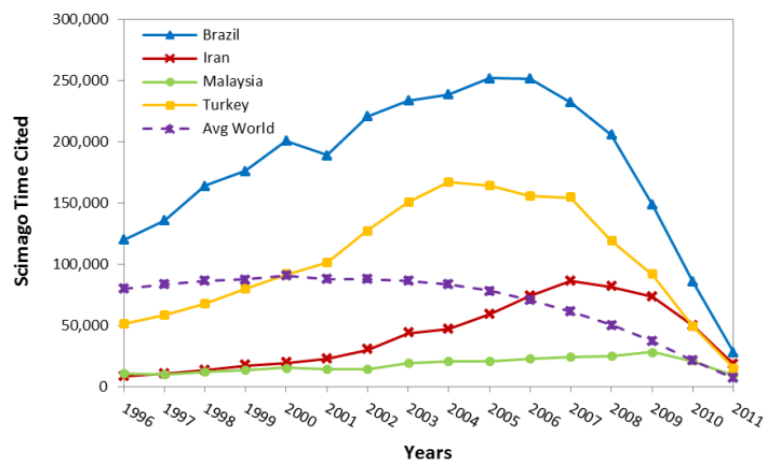

Figure 8. SCImago times cited from 1996 to 2011.

Total Web of Science citations from 1990 to 2012 for Brazil, Iran, Malaysia, and Turkey is demonstrated in Figure 9. As with the other elements, in total citation Brazil again achieved first ranking, followed by Turkey in second position, and Iran third. Based on the Web of Science information, Malaysia has the lowest number of citations in total during these years.
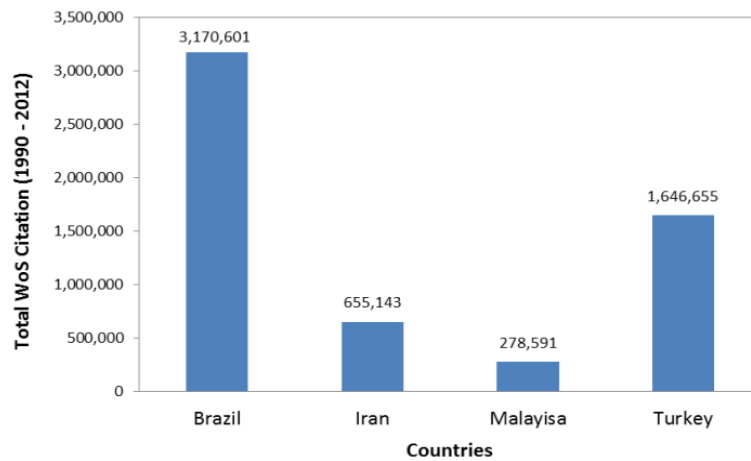
Figure 9. Total Web of Science citation from 1990 to 2012.

The total citation of these four countries as a percentage of the world total citation is illustrated in Figure 10. Based on this figure, the percentage of total citation for Brazil, Turkey, Iran, and Malaysia is approximately around 0.95%, 0.49%, 0.20%, and 0.08% respectively.
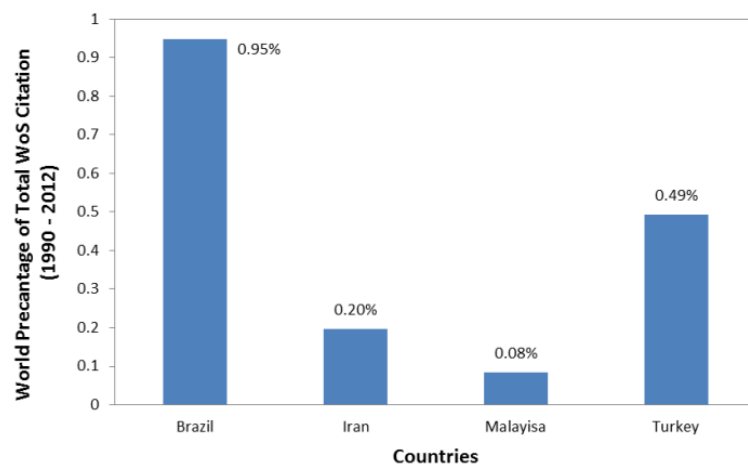

Figure 10. World percentage of total citation from 1990 to 2012.

Web of Science and SCImago citations per document are presented in Figure 11 and Figure 12 respectively. Both Web of Science and SCImago show almost the same trend of average citation per documents. A comprehensive comparison of the four selected countries and the world average is illustrated in Figure 12. Based on this figure, these countries achieve an acceptable number of citations, but all of them are under the world average for number of citations.
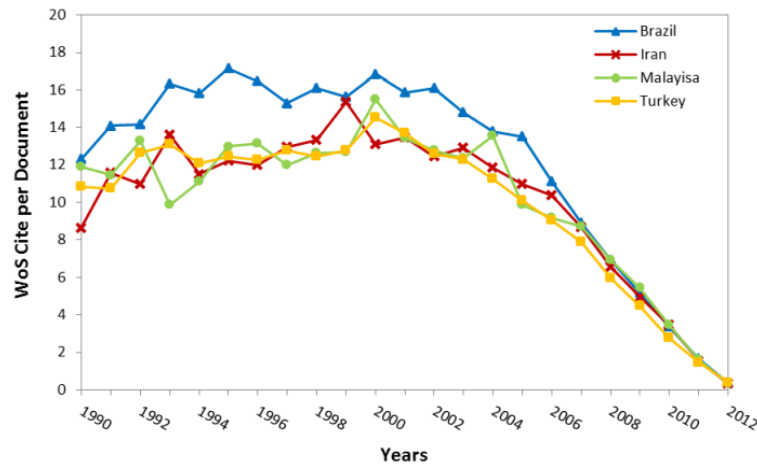
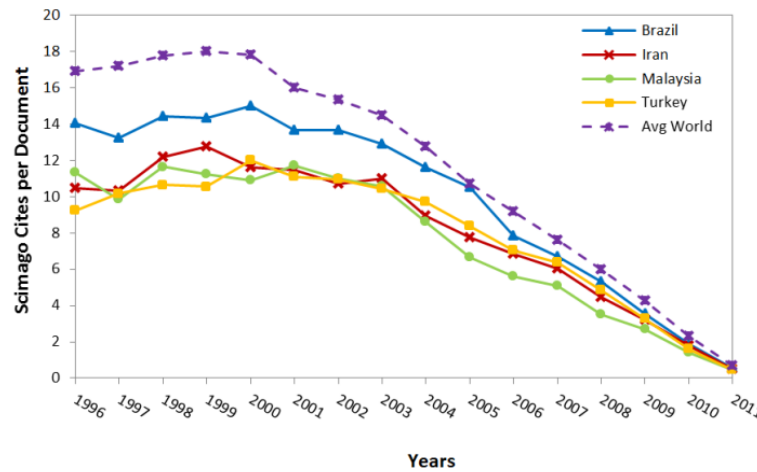Figure 11. Web of Science citations per document from 1990 to 2012.

Figure 12. SCImago citations per document from 1996 to 2011.

The total Web of Science citations per document from 1990 to 2012 is presented in Figure 13. As already shown in Figure 5, the total number of published documents in Web of Science, from 1990 till 2012, is 351486 (Brazil), 124038 (Iran), 46764 (Malaysia), and 231353 (Turkey). Figure 9 and Figure 5 present the total number of citations in the same duration of time: 3170601 (Brazil), 655143 (Iran), 278591 (Malaysia), and 1646655 (Turkey). Based on this information, Figure 13, generated by Figure 5 and Figure 9, presents the average number of citations per document from 1990 to 2012. As Figure 13 makes clear, there is a big gap between the average numbers of citations for documents from the selected countries in comparison with the world average number of citations per document.
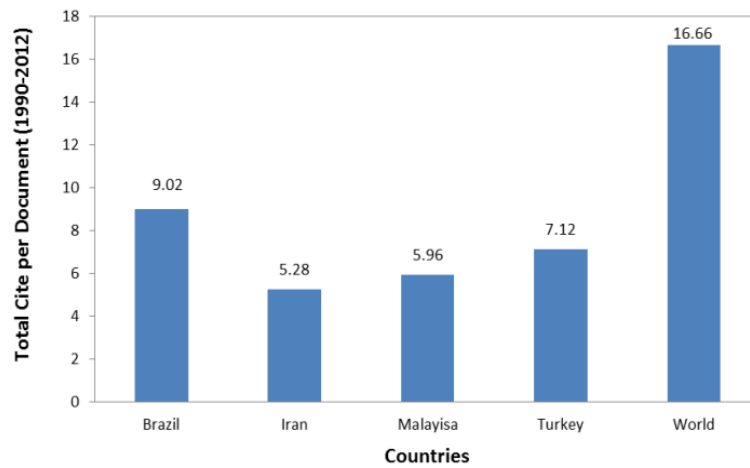
Figure 13. Total citations per document of four selected countries in comparison with world impact factor.

As previously defined, *h*-index is an important index that identifies the quality measurement of published documents in an organization or country. Based on this definition and as seen in Figure 14, Brazil, Iran, Malaysia, and Turkey's *h*-indexes are 350, 135, 125, and 210 respectively. This means, in the case of Brazil for example, that there are 350 papers published by Brazil that achieve at last 350 citations. As with quantity, in the qualification ranking Brazil is again located in the top rank, followed by Turkey, Iran, and Malaysia respectively.
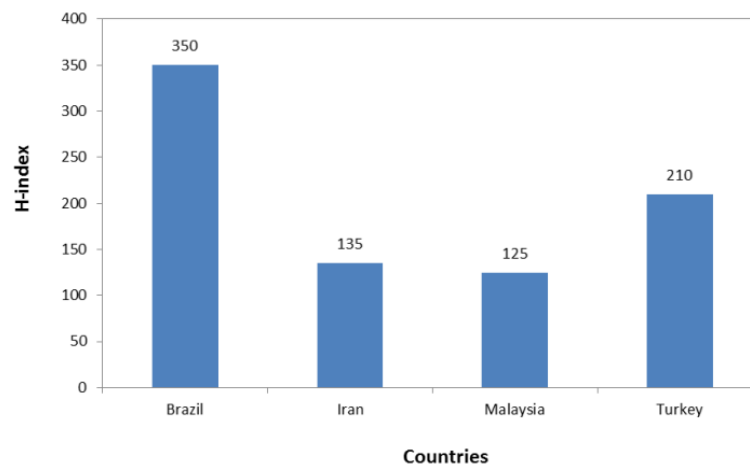

Figure 14. *h*-index of four different selected countries.

5.2   Analysis on Countries Academic Capabilities

The last twelve figures all relate to publications, which is the most important element used to evaluate the academic ranking. Elements such as number of publications, citations, citations per documents, impact factor, *h*-index and so on all relate to publication and they evaluate publications both quantitatively and qualitatively. As already discussed in the introduction, there are other important elements that help us evaluate the academic level of organizations or countries, such as the number of doctoral degrees, the number of academic staff, institute income, research income, and international collaboration by that organization or country. In this section we discuss these issues in detail.

The number of doctoral degrees and the number of academic staff (those who do research and other academic activities), is an important indicator that can be used to rank universities and countries. Figure 15

presents the average number of doctoral degrees in Brazil, Iran, Malaysia, and Turkey's universities in comparison with the world average. Based on these figures Brazil, with around 972 doctoral degrees per university is located in the top rank, with Iran placed second. Malaysia and Turkey, with around 293 and 202 doctoral degrees are in a lower place compared with the world average.
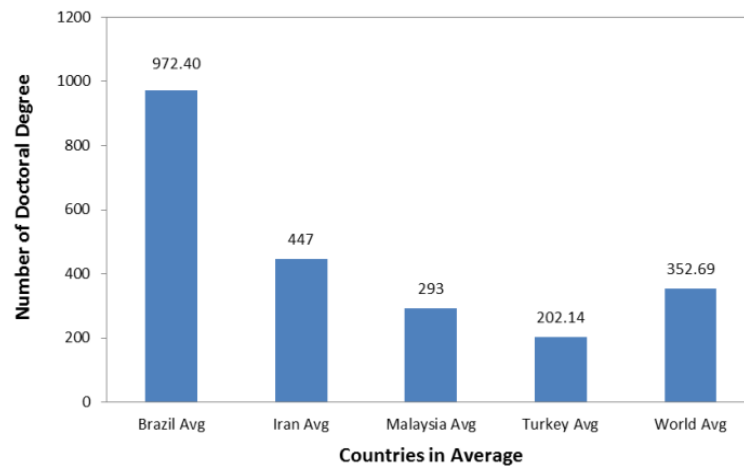

Figure 15. Average number of doctoral degree in different countries in comparison with world average.

Figure 16 shows the number of academic staff on average per university in our four selected countries in comparison with the world average. Brazil, Malaysia, and Turkey are located at the first, second, and third rank respectively, and only Iran is placed below the world average. Based on Figure 16, on average there are around 1500 academic staff in any of the universities around the world. The average number of active academic staff in Iran is around 34% under the world average.
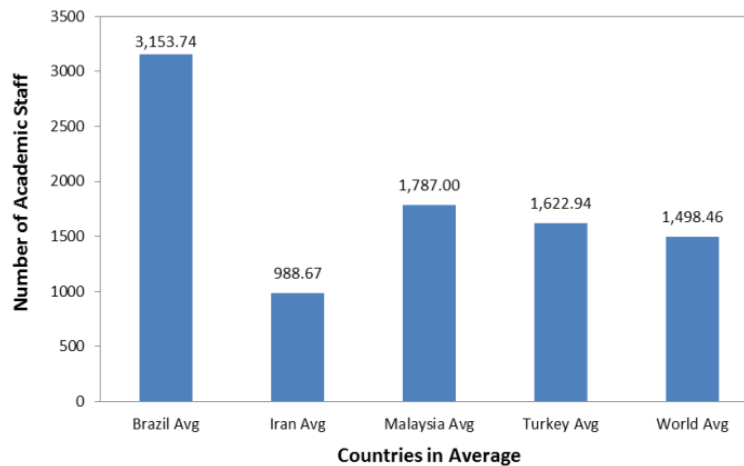

Figure 16. Average number of academic staff in different countries in comparison with world average.

Institute income and research income are an important indicator of industrial and commercial companies' collaborations with universities and research institutes. Figure 17 and Figure 18 show institute income and research income respectively, demonstrating government and private companies' investment in academic research activities. Research income is an important incentive for all institutes and researchers and always plays an essential role in the development of research areas and academic activities.

Based on Figure 17, only Brazil reaches the higher level of institute income in comparison with the world average institute income. After Brazil, Malaysia, followed by Iran are located at the next levels of institute

income. Though Turkey reaches the second ranking in the number of publications and citations, it achieves last position in the institute income.
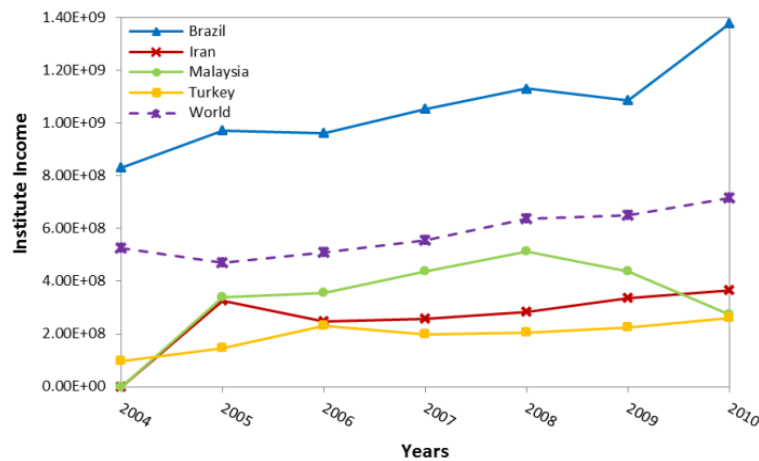
Figure 17. Institute income in different countries from 2004 to 2010.

The research income of our four different countries, from 2004 to 2010, is shown in Figure 18. Based on Figure 18, only Brazil has a higher research income than the world average research income. Brazil has a sharp increase in 2009 and 2010 from 162 million US dollars in 2008 to 457 and 518 US dollars in 2009 and 2010 respectively.

Figure 18. Research income in different universities from 2004 to 2010.

The countries' international collaboration is demonstrated in Figure 19. Malaysia has the highest international collaboration in comparison with the other three selected countries; it is followed by Brazil, then Iran, then Turkey.

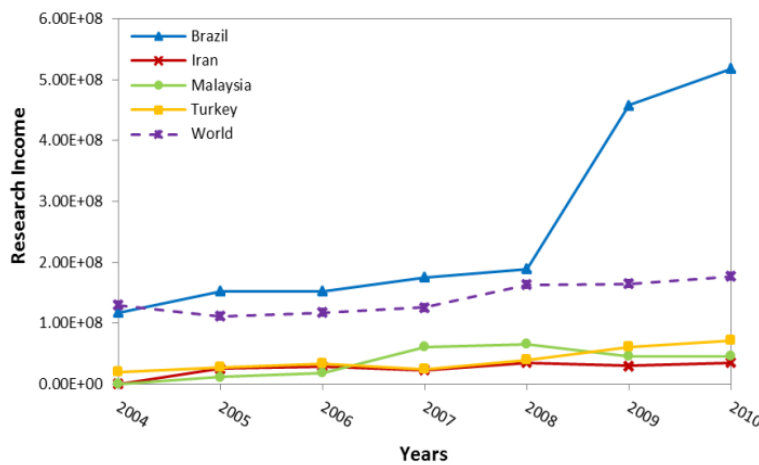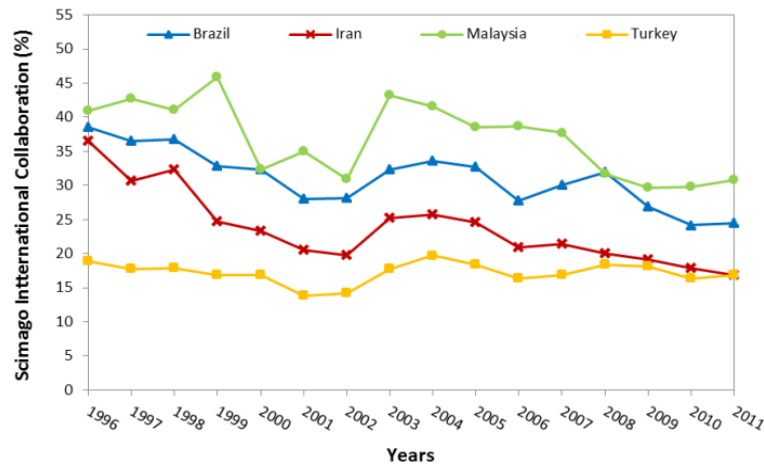Figure 19. International collaboration for different countries from 1996 to 2011.

5.3   Pearson Correlation Coefficient Analysis

As we already mentioned in the methodology, one method of expressing effect sizes is in terms of strength of association. The most well-known example of this approach is the Pearson correlation coefficient, r. Using Pearson r, effect sizes are always less than |1.0|, varying between -1.0 and +1.0 with 0 representing no effect and +1 or -1 the maximum effect.

In the previous figures we compared some academic elements that have an essential impact on academic growth of institutes and countries. Table 1 demonstrates the correlation coefficients of the abovementioned elements. As shown in Table 1, both Web of Science's and SCImago's number of documents have a strong correlation with the number of doctoral degrees.

Institute income and research income both have a strong positive correlation with the number of publications (paper) and their correlations are significant at the 0.01 level. It means that by increasing the number of publications we expect an increase in both research and institute income directly. Based on Table 1, research income has a strong correlation with the institute income and they have a direct relationship with each other. Another strong correlation among the variables exists between the number of academic staff and the number of doctoral degrees with the $r = 0.844$ where their correlation is significant at the 0.01 level.

On the other hand, there are also some poor correlations among the selected variables. For example the level of international collaboration with the number of doctoral degrees and the number of publications (paper) have very weak correlations with the $r = 0.005$ and -0.006 respectively; it means there is almost no relationship between them.

An important interpretation of Table 1 is the poor correlation between the citation number and impact factor on one side and both institute income and the number of academic staff on the other. It means that there is a poor relationship between the institute income and citations. In the same way there is almost no relation between the citations and the number of academic staff and doctoral degrees.

Table 1. Correlation coefficient among variables

	Number of WoS Document	Time Cited	Impact	SCImago Citation	SCImago Cites/Doc	SCImago number of Document	International Collaboration	Institute Income	Research Income	Academic Staff	Citations	Papers
Time Cited	.556**											
Impact	-.614**	.168										
SCImago Citation	.181	.590**	.271*									
SCImago Cites/Doc	-.529**	.181	.981**	.220								
SCImago Document	.986**	.549**	-.667**	.157	-.621**							
International Collaboration	-.365**	-.150	.332**	.546**	.303*	-.373**						
Institute Income	.601**	.557**	.047	.730**	.048	.632**	.433*					
Research Income	.716**	.395*	-.225	.338	-.183	.733**	.143	.848**				
Academic staff	.486*	.497**	-.017	.324	.026	.496**	.193	.574**	.512**			
Citations	.465*	.872**	.434*	.758**	.518**	.462*	.206	.699**	.378	.398*		
Papers	.810**	.646**	-.238	.464*	-.149	.843**	-.006	.880**	.826**	.413*	.667**	
Number of Doctoral Degree	.800**	.744**	-.108	.335	.024	.807**	.005	.735**	.738**	.844**	.600**	.708**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

6   Conclusion

Based on the bibliometrics analysis, for comparing of educational growth within four different developing countries, Brazil is located in the top rank in almost all factors; consists of the number of publications, citations, citations per document, the number of doctoral degrees, and the number of academic staff. In the international collaboration Malaysia take the Brazil place. The Pearson product moment correlation coefficient analysis shows the positive strong relationship between the numbers of publications (academic papers) and both the institute and research income. This means that by increasing the number of publications, the institute and research income could be expected to increase, and vice versa. There is also a weak relationship between the citations per document (impact factor) and both institute income and the number of academic staff, meaning that by increasing the income or the number of academic staff we cannot necessarily expect a significant change in the number of publications. In this research, firstly, the research questions were answered and the key affecting factors to the educational growth based on the number of publications proposed. Next, a comparisons between four developing countries and world average research outcome, carried out. Finally, the decision makers are able to develop a right strategy for their institutions in order to get the best research impact with investing in the proper factors to achieve the higher educational growth. In summary: academic decision makers should invest to increase the number of publications per staff. By increasing the number of academic staff per nonacademic staff alone, we would not be able to achieve the targeted publications. We should consider all factors that effecting to the educational growth and make a balance between them.

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