



Research Paper

International scientific collaboration of Semnan university

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Abstract

Background and Objectives: Recent years have seen tremendous growth in international collaboration between researchers around the world. This phenomenon and its benefits are considered by the scientific policymakers. There are many forms of scientific collaboration and co-authorship is one of the most sensible, documented, and standard forms. The purpose of this study was to study and map the scientific cooperation of Semnan University researchers at the international rank.

Methodology: Data was gathered from documents indexed on WoS core collection. The authors were those who mentioned Semnan University as their affiliation. This study covered a period from 1900 to 2018. Thus, 3973 documents were collected. According to the purpose of this study, we only used university to university and country to country coauthor. We also chose documents that were prepared in collaboration with researchers from Semnan University and a researcher from foreign universities. We used VOSviewer, Ucinet and NetDraw software to analyze social networks, extract centrality measures, and map social networks.

Findings: The findings showed that Hanyang, Malaya, Daejin and Gyeongsang Natl universities have the highest number of co-authors with Semnan University (Degree). The universities of Malaya, Texas A&M, King Abdulaziz, Hanyang, and Kebangsaan Malaysia ranked in the top according to ncloseness. The universities of Malaya, King Abdulaziz, Texas A&M, and Hanyang had the highest betweenness. In total, Semnan University has had the largest number of co-authors with universities in the United States, South Korea, Canada, Malaysia, and Poland. A study of the growth of scientific productions of Semnan University researcher's co-author with foreign universities indicates that despite some ups and downs, there is an increasing trend. The highest number of collaborations was done in 2018. A review of scientific journals that published co-authored papers with foreign researchers found that THE JOURNAL OF INEQUALITIES AND APPLICATIONS and JOURNAL OF COMPUTATIONAL ANALYSIS AND APPLICATIONS topped the list. Mathematics and engineering were the most popular topics in international co-authored documents and Gorji was a prominent Semnan University researcher in international co-authorship.

Discussion: This study showed that Semnan University researchers had appropriate co-authorship with researchers from different countries and universities in the fields of engineering and basic sciences, but humanities researchers have not been very active in this regard.

Introduction

The world is evolving into complex day by day. Scientists can no longer work alone to overpower the emerging complications and difficulties of modern life. In general, they are members of a global community that work together to understand the mysteries of nature (Subramaniam, 1983). As Beaver and Rosen point out, from the early 17th to the 18th century, the degree of scientific professionalism began to deepen, to which scientists responded with scientific collaboration. (D. deB Beaver and Rosen, 1978; 1979; D. B. de Beaver and Rosen, 1979). However, some authors (Melin and Persson, 1996) claim that scientific collaboration is a response to the general orientation towards the internationalization of different sections of modern society and is more about the interaction between universities, research institutes, and industries as Builder units in every community. Therefore, as Persson et al. (1997) noted that science is not only commonly used, but also produced in the current global context.

There are various forms of scientific collaboration, including providing general advice, sharing data, ideas, and knowledge, or actually doing parts of a project separately and then integrating the results (Subramanyam, 1983). Another type requires co-authorship, which is one of the most tangible, documented (Glänzel and Schubert 2004) and common forms of scientific collaboration. (Ye et al. 2012). If a scientific document has more than one author, it is considered a co-authorship. According to Persson et al. (1997), statistical indicators are very sensitive to co-authorship, which in turn can reveal the structure and change of collaborative networks among authors. By analyzing co-authorship networks, aspects of scientific collaboration networks can be reliably traced through bibliometric methods (Glänzel and Schubert, 2004).

Co-authorship may occur in many ways. Authors may be from the same or different universities or institutes in the same country, or in a separate country that is considered an international co-author. Many studies show that international collaboration between researchers has been growing over the years. (Narin, 1991; Luukkonen et al., 1992 and 1993; Luukkonen et al., 1993; Miquel & Okubo, 1994; Doré et al., 1996; Georghiou, 1998; Glänzel 2001; Glänzel and De Lange, 2002; Wagner & Leydesdorff, 2005; Gazni et al., 2012; Wagner et al., 2019).

Solving complex problems and promoting various political, economic, and social issues are among the most important potentials of international cooperation (Sonnenwald, 2007). There are many reasons for research collaboration such as access to special equipment, skills, unique material, visibility, recognition; efficiency in the use of time and labor; gaining experience; training researchers; multiplying proficiencies; spatial propinquity, etc. (D. deB Beaver and Rosen 1978). Also, Osareh and Wilson (2002) mention other benefits for such collaborations such as fruitful exchange of ideas, research techniques, methods, and knowledge that can be potentially beneficial for all partners. Another benefit of international cooperation is increased productivity and greater citation. Many studies have shown a high level of correlation between collaboration and research productivity (D. B. de Beaver & Rosen, 1979; Pao, 1982; Subramanyam, 1983) and receive more citations. (Smart and Bayer, 1986; Narin, Stevens, and Whitlow, 1991; Glänzel and Schubert, 2001; Glänzel and De Lange 2002; Olle Persson, Glänzel, and Danell, 2004; He, 2009; Adams 2012; Gazni, Sugimoto, and Didegah, 2012; Wagner, Whetsell, and Leydesdorff, 2017; Sabah et al., 2019; Wagner, Whetsell, and Mukherjee, 2019).

Hence, research collaboration has become a major issue from the perspective of scientific policy and therefore it can be considered as one of the tools of science politics (Mellin and Person, 1996). Scientific policymakers are aware of the importance and benefits of research collaboration

(Corley, Boardman, and Bozeman 2006) and prefer to promote international research collaboration (O. Persson et al., 1997).

Given the above, it can be seen that scientific cooperation, especially at the international level, has many benefits, so science policymakers in universities and institutions should pay special attention to it. Therefore, the purpose of this study was to analyze and map the scientific cooperation map of Semnan University at the international level. Semnan University is one of the central universities in Iran, which in recent years has had a good promotion in various scientometric indicators, which in turn has improved the university ranking based on many university ranking systems.

Social network analysis (SNA)

A social network is defined by Newman as a collection of individuals, groups, or entities that are related to each other. In social network theory, individuals, groups, or entities are called actors, and the relationship between them is called ties (Newman, 2001). Ye et al Note that collaboration can be thought of as a typical social interaction involving several actors and the relationships between them. The actor and the connection between them can be shown with nodes and edges, respectively (Ye, Song, and Li, 2012). According to the above points, scientific collaboration and consequently writing can be considered a social network that can be analyzed by social network analysis (SNA). Social network analysis is the main tool for examining patterns of collaboration in various scientific fields (Krichel and Bakkalbasi, 2006). It examines the network structure and analyzes the relationships between nodes using graph theory based on statistical techniques (Bozdogan and Akbilgic, 2013).

One of the criteria used in social media analysis is centrality. Degree centrality, proximity centrality, and betweenness centrality are the most important centrality measures (Otte and Rousseau, 2002).

Degree centrality Is the number of links that a node has (Otte and Rousseau, 2002). A node that has many links to other nodes plays a key role in the communication and transmission of information between different nodes in a network (Ye, Song, and Li, 2012). Logically, in social networks, people with more communication are more influential, have more information at their disposal, or have a higher status than members with less communication (Newman, 2010). An actor's degree centrality in the co-author diagram is considered to be the number of authors with whom at least one article has been written (Otte and Rousseau, 2002).

Closeness centrality refers to the total distance of a particular node from other nodes (Otte and Rousseau, 2002). In general, in a social network, a person with a lower average distance may convey his/her opinions to others faster than people with a higher average (Newman, 2010).

Betweenness centrality generally refers to the number of frequencies that a node may need a particular node to reach another. In other words, it is equal to the number of shortest paths passing through a particular node (Otte and Rousseau, 2002), which indicates the occupancy rate of a node in the paths (Newman 2010). Betweenness measures the facilitation of flow in a network by a node (Otte and Rousseau, 2002). The high betweenness of an author refers to his/her vital role in the interactions between different members of society (Yin et al., 2006).

Data and Method

Data of the study were collected from documents indexed on Web of Science core collection (8 citation indexes). The authors were those who mentioned Semnan University as their affiliation. The study covered a time from 1900 to 2018. In this way, 3973 documents (all kinds) were collected.

After that, the data were added to VOSviewer software (Van Eck and Waltman, 2010), which is designed to construct and visualize bibliometric maps such as co-authorship networks. This software makes it possible to consider co-authorship at the author, university, or country levels. According to the aim of this study, we just used university to university and country to country co-authorship. Also, we selected the documents which were co-authored by scholars from Semnan University and a researcher from foreign universities. This means that we deleted solo author documents or documents authored completely by Iranians. For social network analysis, extracting centrality measures, and drawing social networks, we used Ucinet (Borgatti, Everett, and Freeman, 2002) and NetDraw software (Borgatti, 2002).

Results

Data analysis showed that researchers at Semnan University published 3973 documents indexed by WoS. After separating the documents that had at least one author from Semnan University and at least one author from a country other than Iran, 740 degrees were chosen.

Co-authorship network

To examine the relationship between Semnan University and foreign universities in terms of co-authorship, these relationships were drawn according to Figure 1 by VOSviewer software. The threshold was set at 5, so 52 universities are shown on the map.

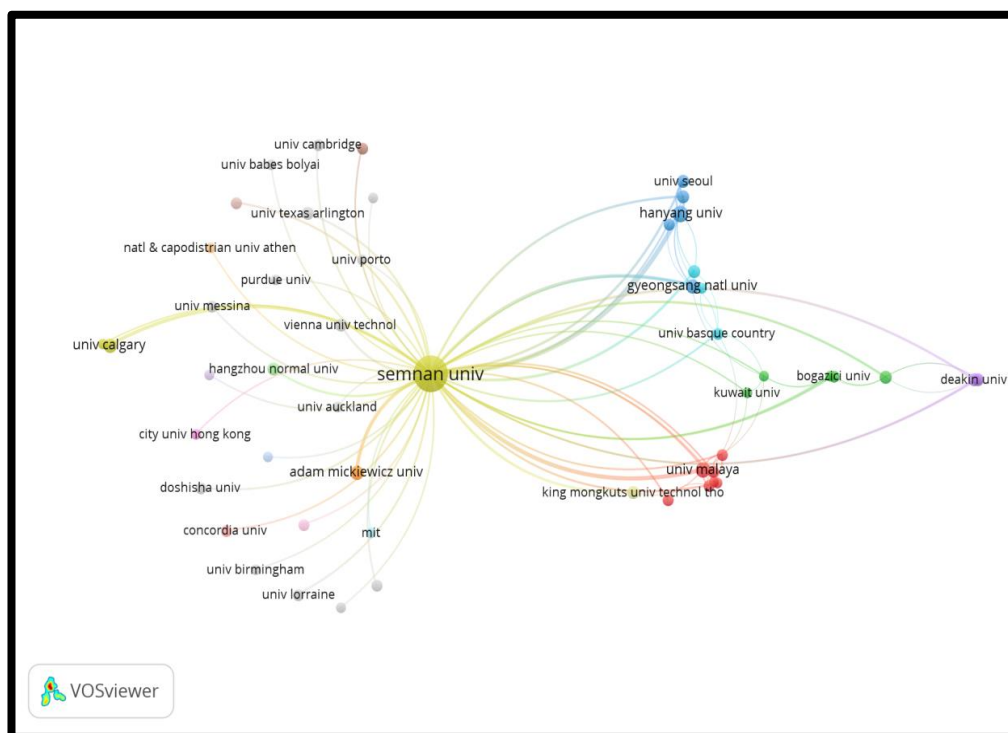


Figure1. International Co-authorship map of Semnan University

Social network Analysis

To better understand the relationship and identify important universities in this network, the criteria of centrality were extracted by Ucinet software. The international co-authorship network of Semnan University with foreign universities is shown in Figure 2 according to the degree.

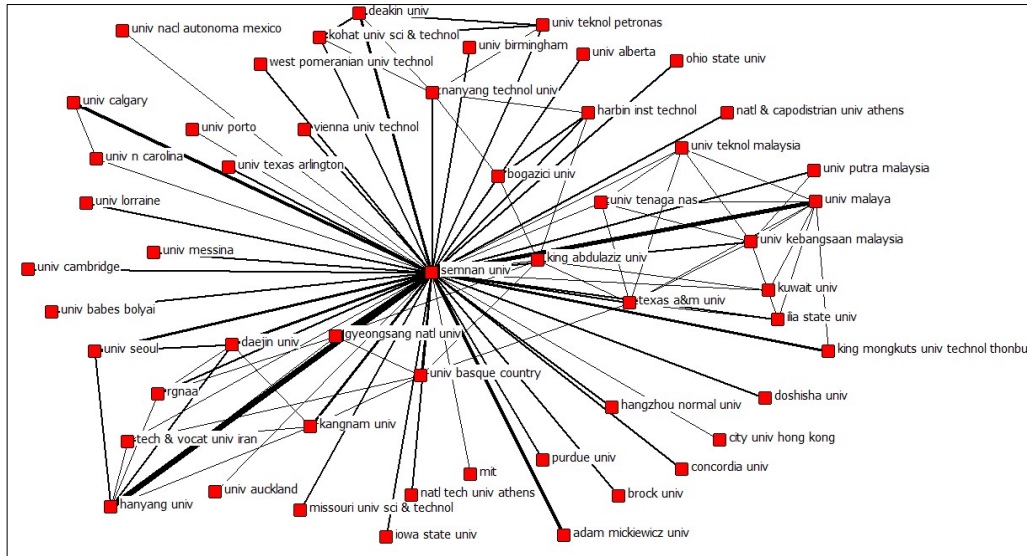


Figure 2. International co-author network of Semnan University

As shown in the map, Hanyang University and Malaya University have the highest degree of co-authorship with Semnan University. The top five universities in terms of degrees are shown in Table 1. As mentioned before, this means that these universities have the maximum level of co-authorship relations with Semnan University in this network. Most of these universities are from South Korea.

Table1. Universities with the highest degree in co-authorship network with Semnan University

| Rank | University | Degree | Country |
|------|----------------------|--------|-------------|
| 1 | Semnan Univ | 524 | Iran |
| 2 | Hanyang Univ | 75 | South Korea |
| 3 | Univ Malaya | 56 | Malaysia |
| 4 | Daejin Univ | 32 | South Korea |
| 5 | Gyeongsang Natl Univ | 32 | South Korea |
| | Univ Seoul | 30 | South Korea |

Data analysis based on proximity was obtained as another measure of centrality, Table 2. In this table, Univ. The University of Malaya and Texas a&m has the highest degree of closeness after Semnan University. According to the definition of closeness, these universities can be considered as universities that are available for connection and hence for cooperation. They can have a special effect on the network.

“Closeness is the inverse measure of centrality in that the larger value represents the central actor less, while the smaller value represents the more central actor. For this reason, "the standardized approach is defined and again makes it a direct measure of centrality" (Otte and Rousseau, 2002). The results showed different values for the centrality of universities. For example, Texas a & m, King Abdulaziz, and Kebangsaan Malaysia are on the top of the list but do not rank first in terms of the degree of centrality. This means that despite the reduction in co-authorship, they create connections between nodes (universities).

Table 2. Universities with the maximum ncloseness in co-authorship network with Semnan University

| | University | nCloseness |
|---|--------------------------|-------------------|
| 1 | Semnan Univ | 100 |
| 2 | Univ Malaya | 54.255 |
| | Texas A&M Univ | 54.255 |
| | King Abdulaziz Univ | 53.684 |
| 3 | Hanyang Univ | 53.684 |
| | Univ Kebangsaan Malaysia | 53.684 |
| | Univ Basque Country | 53.125 |
| 4 | Nanyang Technol Univ | 53.125 |
| | Univ Tenaga Nas | 52.577 |
| 5 | Gyeongsang Natl Univ | 52.577 |

Examination of data based on the third criterion of centrality showed that the University of Malaya has the highest insight in the co-author network after Semnan University. King Abdul Aziz University and the University of Texas a&m are next. Therefore, it can be said that these universities have a communication role in the network, and without them, the network will collapse. The top five universities in terms of betweenness are shown in Table 3. King Abdul Aziz University was not among the top universities in terms of degrees.

Table 3. Universities with most betweenness in co-authorship network with Semnan University

| Rank | University | Betweenness |
|-------------|---------------------|--------------------|
| 1 | Semnan Univ | 1192.917 |
| 2 | Univ Malaya | 5.833 |
| 3 | King Abdulaziz Univ | 5.667 |
| 4 | Texas A&M Univ | 5.333 |
| 5 | Hanyang Univ | 3.833 |

Top topics

For achieving the other aims of this study, the subject of co-authored documents with foreign universities was analyzed. The results showed that mathematics, mathematics applied, engineering electrical electronic and materials science multidisciplinary science were the top subjects in Semnan University co-investigated by foreign university scholars. This classification was based on the WoS. The topics are shown in table 4.

Table 4. Top topics of internationally co-authored documents of Semnan University

| Rank | Web of Science Categories | Records | % Of 740 |
|-------------|-------------------------------------|----------------|-----------------|
| 1 | Mathematics | 110 | 14.865 |
| 2 | Mathematics Applied | 99 | 13.378 |
| 3 | Engineering Electrical Electronic | 89 | 12.027 |
| 4 | Materials Science Multidisciplinary | 76 | 10.27 |
| 5 | Mechanics | 57 | 7.703 |

Collaboration Growth

Investigating the growth of scientific production of Semnan University researchers in co-authorship with foreign universities shows that despite some ups and downs, there is an increasing trend overall. The highest number of cooperation was done in 2018. This growing trend is shown in Figure 3. In general, the study of scientific collaboration of Semnan University researchers in different years shows an annual growth rate of 28%.

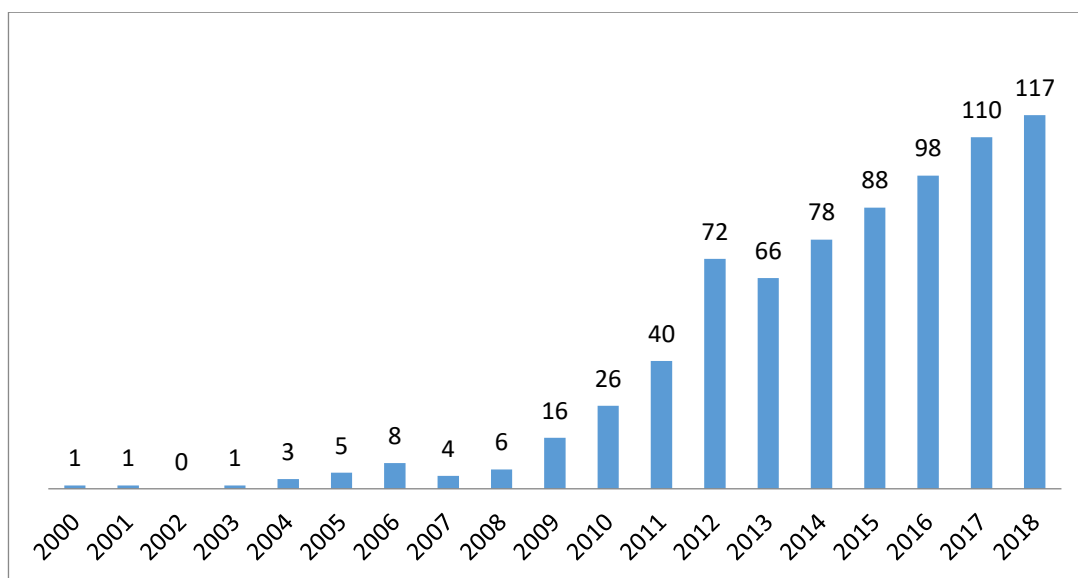


Figure 3. International growth of scientific collaboration of Semnan University researchers

The most productive co-authors

Data analysis to identify the authors with the highest co-authorship levels with non-Iranian (international) authors showed that GORDJI, Amjadi, and Salehi rank first to third, respectively. Table 5 presents the group of authors affiliated with Semnan University who have the most international co-authorship numbers.

Table 5. The most productive co-authors

| Rank | Authors | Records | % of 740 |
|------|-------------|---------|----------|
| 1 | Gordji ME | 120 | 16.216 |
| 2 | Amjady N | 37 | 5 |
| 3 | Salehi M | 30 | 4.054 |
| 4 | Khanesar MA | 26 | 3.514 |
| 5 | Karami H | 21 | 2.838 |

Journals that published co-authored documents

A review of scientific journals which published co-authored documents with foreign researchers showed that *Journal of Inequalities and Applications* and *Journal of Computational Analysis and Applications* topped the list. The high-ranking 5 journals publishing research in collaboration with the foreign authors are shown in Table 6.

Table 6. Journals which published international co-authored documents from Semnan university

| Rank | Source Titles | Records | % of 740 | IF |
|------|--|---------|----------|-------|
| 1 | Journal of Inequalities and Application | 18 | 2.432 | 0.966 |
| 2 | Journal of Computational analysis and applications | 17 | 2.297 | - |
| 3 | IEEE Transactions on Power systems | 14 | 1.892 | 5.255 |
| 4 | Abstract and Applied analysis | 13 | 1.757 | - |
| 5 | Fixed Point Theory and Applications | 11 | 1.486 | 0.971 |

Country most co-authored

Data analysis showed that Semnan University researchers had the maximal co-authorship with the US, Korea, and Canada scholars. Table 7 reveals the countries having the foremost number of co-authorships with the authors from Semnan University.

Table 7. Countries with the largest amount of co-authorship with Semnan University

| Rank | University | Record |
|------|-------------|--------|
| 1 | USA | 129 |
| 2 | South Korea | 109 |
| 3 | Canada | 68 |
| 4 | Malaysia | 60 |
| 5 | Poland | 36 |

Semnan University co-authorship map with Countries

For better understanding, the co-authorship relations of Semnan University were mapped by VOSviewer which is shown in figure 4.

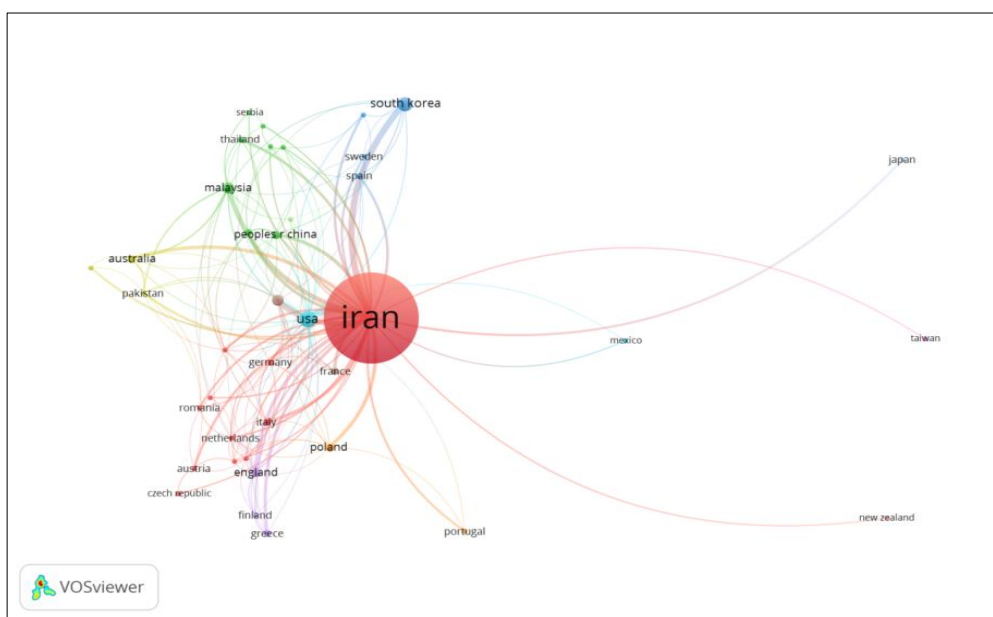


Figure 4. Co-authorship map with other countries

Discussion and conclusion

The importance and benefits of scientific collaboration are evident. This study aimed to investigate the scientific collaboration of Semnan University faculty members with foreign universities on a global scale. The results showed that out of 3973 indexed documents on WoS, 740 are written in collaboration with one or more foreign authors. As co-authorship forms a network that can be considered as a social one, the co-author networks formed by international co-authorship of Semnan University members were analyzed and mapped by social network analysis. The maximum collaborations (i.e., degree) were carried out with universities from South Korea and one university from Malaysia. In closeness and betweenness, Univ. Malaya, Texas a & m Univ. and King Abdulaziz Univ., gained better ratings. But, in terms of the country, the USA was the most collaborated and South Korea and Malaysia ranked two and three, respectively. The findings of most studies conducted on Scientometrics of disciplines in Iranian universities (Asadi et al., 2013; Fahimnia and Fahimifar, 2017; Jafarzadeh and Jalali Dizaji, 2016; Razvan, 2016), showed that the USA is ranked first. But surprisingly, South Korea ranked two. No similar results reported South Korea as a primary collaborator with Iranian authors. Canada or England is usually highly co-authored by Iranian researchers after the USA. Data analysis revealed that most collaborations related to mathematics and electronic engineering. Most of the international co-authorships on mathematics are carried out by professor Gorji (120 documents, 16%). He is a distinguished scholar in mathematics, who has presented the shortest solution to Lieb's mathematical theorem after 41 years. He has also been among the top 100 mathematical scientists in the world in 2013 and is also listed among the top 1 percent of scientists in the world by the ISI-ESI index. Perhaps South Korea came second because of contributions to mathematics by Prof. Gorji. The second most productive international co-author is Professor Amjadi (37 documents, 5%). He is also on the list of the top 1 percent of scientists in the world by ISI-ESI index. At present, he is a Professor in the Electrical Engineering Department.

In line with the results of other research results, this study also showed that Semnan University's scientific collaboration with foreign universities has been on the rise over the years. Most of the documents completed in collaboration were on mathematics and engineering topics. This shows weaknesses in humanities and social sciences. Semnan University researchers in this area should make more collaborate with researchers from other countries.

Another finding concerns the journals which published the co-authored documents of Semnan University researchers. Most of them neither have a top rank nor a high impact factor.

In general, the scientific collaboration between Semnan and the foreign universities is in a favorable situation but it needs more attention from scientific policymakers to improve and continue this growing trend.

Suggestion for future research

This research analyzed the international co-authorship network of faculty members of Semnan University. Further research is needed on the reasons for co-authorship using documents indexed in other databases, such as Scopus.

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