

Information Security from a Scientometric Perspective

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Abstract

During recent years, Information societies are continually confronted with security threats and information vulnerabilities. Literature analysis of major disciplines is one of the key tools available to policymakers of research institutions and organizations. Scientometrics is the field of study which concerns itself with measuring and analyzing scientific literature. The purpose of the present study was to evaluate the research trends of information security in the Middle-East and the world from a scientometric perspective. Descriptive and analytical statistics were used in this study. The Scopus citation database was used to collect the publication data, as the largest abstract and citation database of peer-reviewed literature. Therefore, all documents related to "information security" were retrieved and analyzed. The results showed that the majority of scientific publications in the field of information security were produced in the United States of America and China. Among the Middle-Eastern countries, Iran ranked the first in terms of scientific publications in the field of information security while ranked 23th among the countries of the world. It is apparent that paying special attention to the field of information and data security in terms of international scientific collaborations, using knowledge and experiences of the leading, and supporting research and development in this field can improve the quality and quantity of scientific publications in this field. The expertise gathered during the process will prove invaluable and effective in confronting the security threats and vulnerabilities posed to information societies.

Keywords

Information security; Cyber security; Research assessment; Literature analysis; Bibliometric; Scientometric

Introduction

Scientific publications in each country reflect its development, and sustainable advancement of each country is determined by the specific capabilities of that nation-state. With today's rapid global change, a country having the capacity to innovate and produce science will win in the global competition. Information is one of the most important assets of each country and plays a vital role in national development. In fact, the creation, storage, access, communication, sharing, dissemination and utilization of scientific information plays a significant role in the economic and technological development of countries (Riahi & Sohbatih, 2015).

Scientometrics indicators are frequently used to measure the quality and quantity of published articles and research outputs of organizations (Aminpour, 2011). Numerous studies have been carried out to assess scientific publications of countries, universities and research centers worldwide (Aminpour, Kabiri, & Heydari, 2009; Gupta & Bala, 2011; Karamourzov, 2012;

Mahbuba, Rousseau, & Srivastava, 2010; Parvin, Panahi, & Velmurugan, 2019; Pouris & Pouris, 2009). Dissemination of the information in different fields of human knowledge is considered to be the most important factor in improving progress and development in different areas. In recent years, Iranian researchers have conducted many studies to measure scientific publications in the field of medicine (Djalalinia et al., 2017; Dwivedi, Garg, & Prasad, 2017; Fricke, Uibel, Klingelhofer, & Groneberg, 2013; Groneberg-Kloft, Klingelhofer, Zitnik, & Scutaru, 2013; Karpagam, 2014; Konur, 2012; Mahbuba et al., 2010) as well as in other medical sub-specialties including nursing (Ghazimirsaeid, RastegariMehr, Kolbadinejad, Banisaffar, & Mohammadi, 2015), traditional medicine (Hodhodinezhad, Zahedi-Anaraki, & Ashrafi-Rizi, 2012), immunology (Yousefi et al., 2012), orthopedics (Janmohammadi, Yaminfirooz, Nooshinfard, & AWT_TAG, 2012), dentistry (Zeraatkar, Vara, & GhaziMirsaeid, 2012), and AIDS (Mardani, Mardani & Moghadam, 2011).

Several studies have also confirmed the growth of research in Iran in other fields such as engineering and social sciences as well (Heradio et al., 2016; Lazzarini & Pérez-Foguet, 2018; Patriarca, Bergström, Di Gravio, & Costantino, 2018; Pollack & Adler, 2015). The fundamental transformation of information and knowledge in recent years, especially with the focus on the increasing use of information and communication technology, has brought about many consequences. Information and communication technologies facilitate and improve people's lives. These tools have not only led to the emergence of new products, but also to better and more efficient ways of doing things.

Along with all the advances in technology, the ability for misusing technology has increased during recent years as well. Modern organizations depend heavily on the Internet for their business operations and, as a result, have led to e-commerce that has changed business processes. This dependency on electronic business requires information security in all entities including virtual organizations. Information security means protecting information and systems from unauthorized access, disclosure, disruption, alteration, manipulation, or destruction of data in an unauthorized manner, with the aim of ensuring integrity, confidentiality and secure access to information (Kissel, 2011). Information societies are continually confronted with security threats and information vulnerabilities during recent years. Obviously, it is important to keep pace with the growing trend of scientific publications in the area of information security, assessment and evaluation of scientific publications in this field. Many studies confirmed the importance of information security in organizations all over the world (Line, Tøndel & Jaatun, 2016; Bojanc & Jerman-Blažič, 2008; Sohrabi Safa et al., 2015; Tsohou, Karyda, Kokolakis, & Kiountouzis, 2015; Von Solms & Van Niekerk, 2013). The present study evaluates the research which has been done in the field of information security with focus on Iran in comparison to the same literature in the Middle-East and the world.

Materials and Methods

Total documents indexed in Scopus in the field of information security up to 2018 were completely retrieved and reviewed. The Scopus database serves as an interdisciplinary database covering a wide range of topics in various fields. Such a wide coverage of the study was necessary since information security has been analyzed and studied by researchers of various scientific disciplines such as humanities, law, politics, science and technology, computers, engineering, etc. Therefore, all related documents were retrieved using related keywords as below:

“Information Security”
“Information Assurance”
“Cyber Security”
“Computer Security”
“Network Security”
“Security of Data”

Also, research strategy in stage 1 was (“Information Security” OR “Information Assurance” OR “Cyber Security” OR “Computer Security” OR “Network Security” OR “Security of Data”) which was filtered by the year and the data was saved for the entire world. In stage two, subsequently, the search was narrowed by the Middle Eastern countries. In stage three this data was further stratified which yielded documents and data specific to Iran. Table 1 shows data from every stage.

Table 1. Frequency of results in three stages

Stage	1	2	3
Frequency	158,283	6,407	1,351

Microsoft Excel was used to analyze the data. The results are presented in the form of tables and Figures.

Results

The findings showed that 158,283 subject-related documents indexed in Scopus by the end of 2018. Based on Figure 2, the trend of global scientific publications in the field of information security shows a slow rise from 1944 to 1992. The number of subject-related documents was raised from 598 in 1993 to 14,831 in 2018.

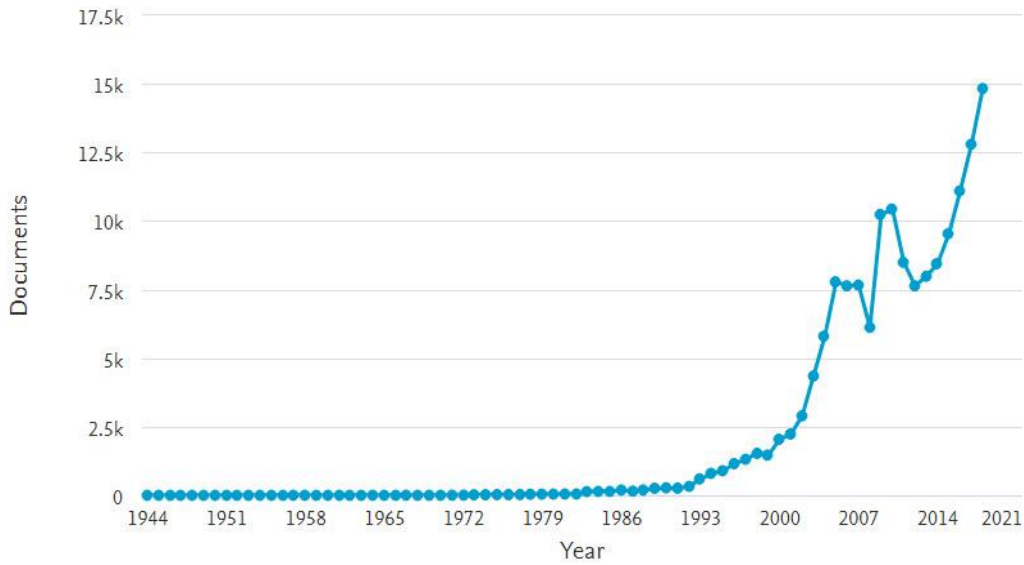


Figure 2. Global trend of scientific publications in the field of Information Security

International Level

Figure 2 indicates that the United States with 38,134 documents in the field of information security ranked first followed by China (31,764 articles) and India (10,587 articles). It is worth noting that Iran ranked 23th in the world with 1,351 documents in the field of information security (Figure 2).

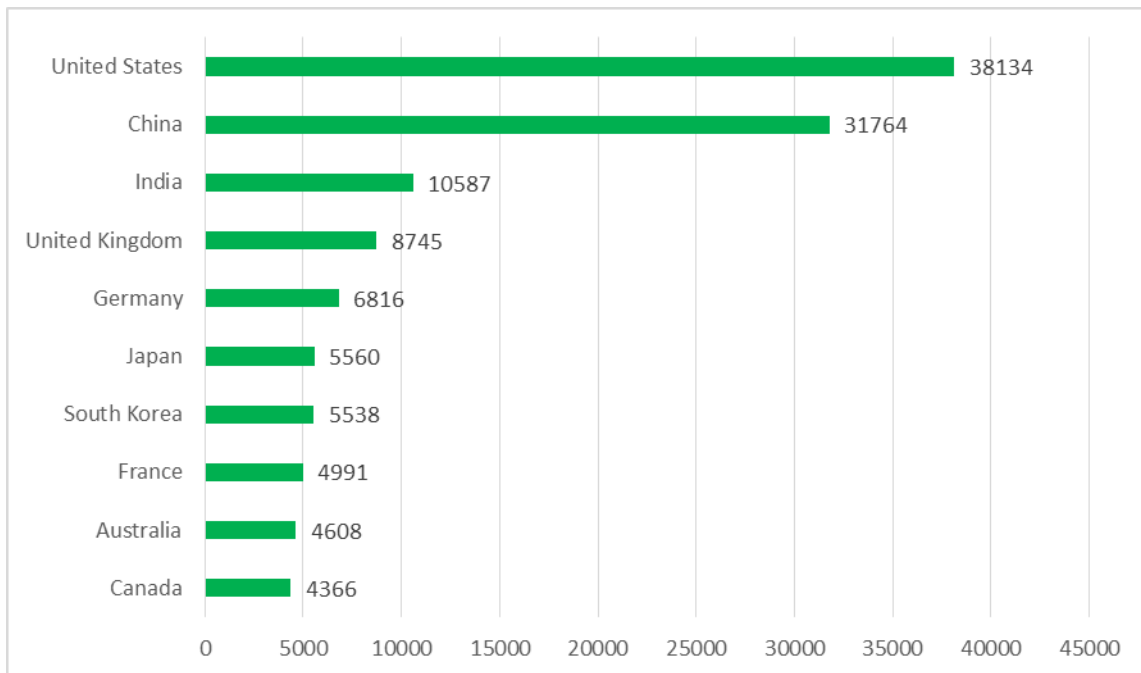


Figure 3. Top 10 countries with the highest scientific publications in the field of information security

Regional Level

The contribution of the Middle-Eastern countries to the global literature in the field of information security was 6,407 from the total 158,283 documents (4.04%), while Iran's contribution to the documents related to the Middle-Eastern countries' was 1,351 (21.08%). Figure 3 ranks the Middle-Eastern countries in terms of scientific publications in the field of information security. The comparison of the Middle-Eastern countries in terms of scientific publications in the field of information security indicates that Iran published 1,351 articles, which is equivalent to 21.08 percent of total Middle-Eastern papers in this field and was ranked first. Saudi Arabia with 1088 documents (16.98%) ranked second, followed by Israel, with 1014 documents (15.82%). Figure 4 illustrates the trend of Iranian scientific publications in the field of information security by the end of 2018.

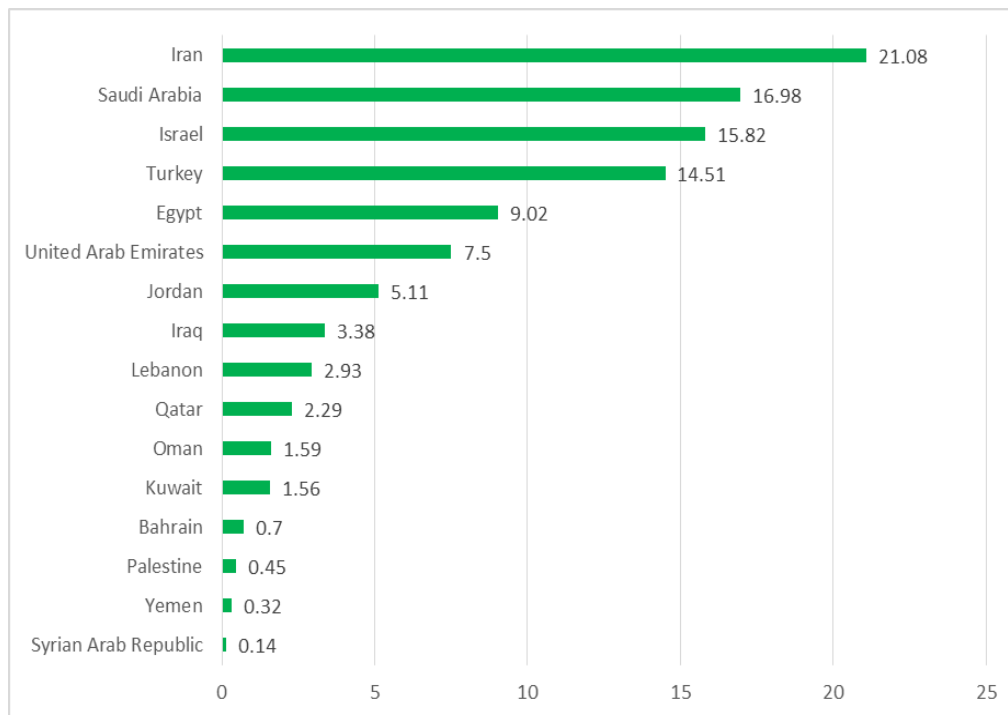


Figure 4. Ranking of the Middle-Eastern countries in scientific publications in the field of information security

On the other hand, the first five countries (Iran, Saudi Arabia, Israel, Turkey, and Egypt) accounted for approximately 80 percent of the total scientific output of the subject area of information security.

National Level

Iran's trend of scientific literature in the field of Information Security is shown in Figure 4. According to the results, the growth of related literature published by Iranian researchers was remarkable since 2005.

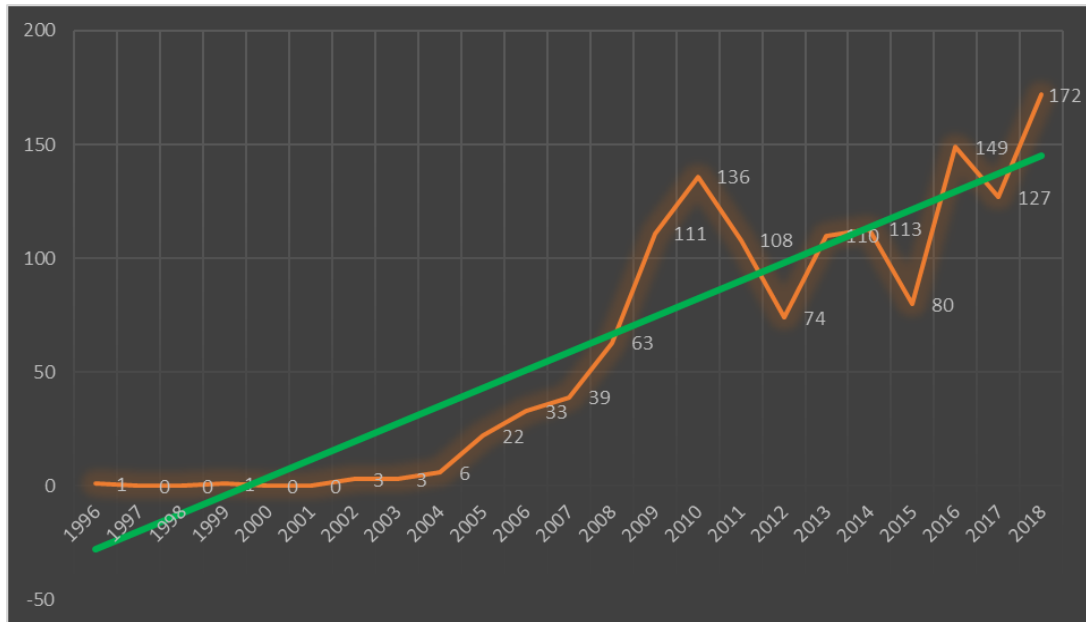


Figure 5. Iran's trend in scientific publications in the field of Information Security

Figure 5 ranks the top 10 Iranian universities in the field of information security research. Based on these findings, “Sharif University of Technology” with 228 articles followed by “Iran University of Science and Technology” (150 articles) and “Amirkabir University of Technology” (109 articles) are among the most prolific universities in Iran in this area.

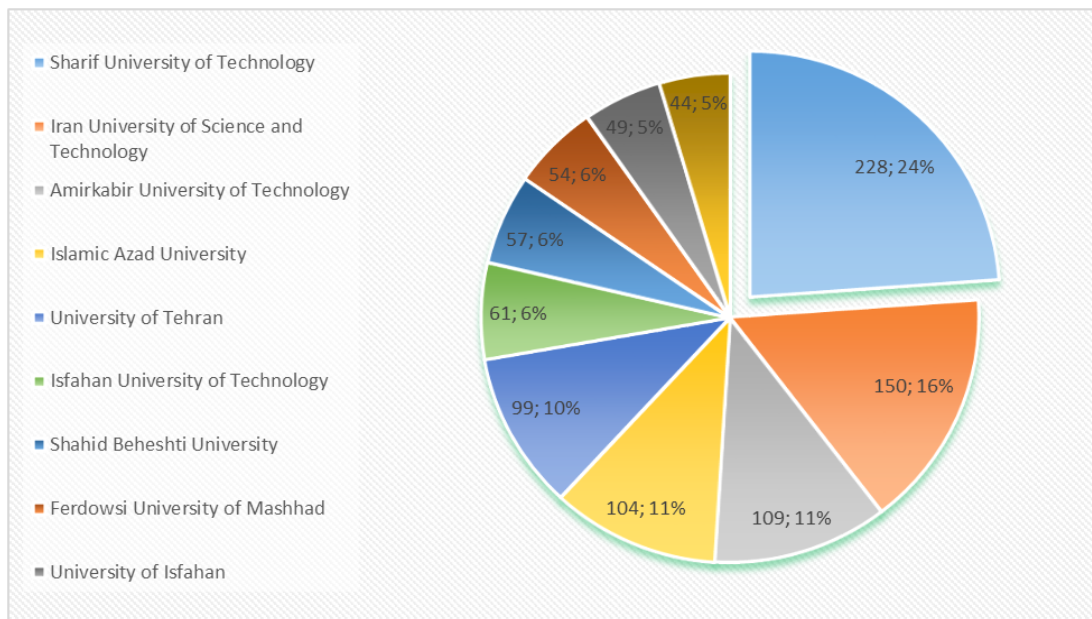


Figure 6. Iran's leading universities in the field of information security research

Table 2 presents the scientometric indices of Iranian scientific publications in the Scopus database in the field of information security. These indicators include the number of indexed

documents, the number of citations received, and the average number of citations received by each document, frequency and percentage of published document resulting from international cooperation at the end of 2018. This information is compared with similar indicators over a five-year period, from 2014 to 2018. Based on our findings, a total of 1351 Iranian papers were indexed in Scopus in the field of information security. Furthermore, they have received 9242 citations. In the last 5 years of the study, 641 documents have received 3003 citations. In fact, roughly 33 percent of the total citations are received by documents published between 2014 and 2018. The average citation for each document for this time frame is 4.68. The h-index of the total documents up to 2018 is 40 while the h-index of the documents in the last 5 years of the study is 24. Also, 343 documents (25.38%) were related to international institutions in overall and 224 documents (34.94%) from 2014 to 2018. This information is compared with similar indicators over a five-year period, from 2014 to 2018.

Table 1. Iran's scientific publications in the field of information security

Year	Total Documents	Total Citations	Citation per Document	Citation per Year	h-Index	International Collaboration #	International Collaboration %
All Years	1351	9242	6.84	123.22	40	343	25.38
2014-2018	641	3003	4.68	600.6	24	224	34.94

Figure 6 represents the top 10 countries (United States, China, and India, etc.) in which Iran has had the most cooperation in the field of scientific publications in terms of information security. This study provides evidence that Iranian researchers are actively engaged in international collaborative research with at least one non-Iranian author in the area of information security. Based on the results of this study, most of Iran's scientific cooperation in the field of information security has conducted with the United States, Canada, and Australia.

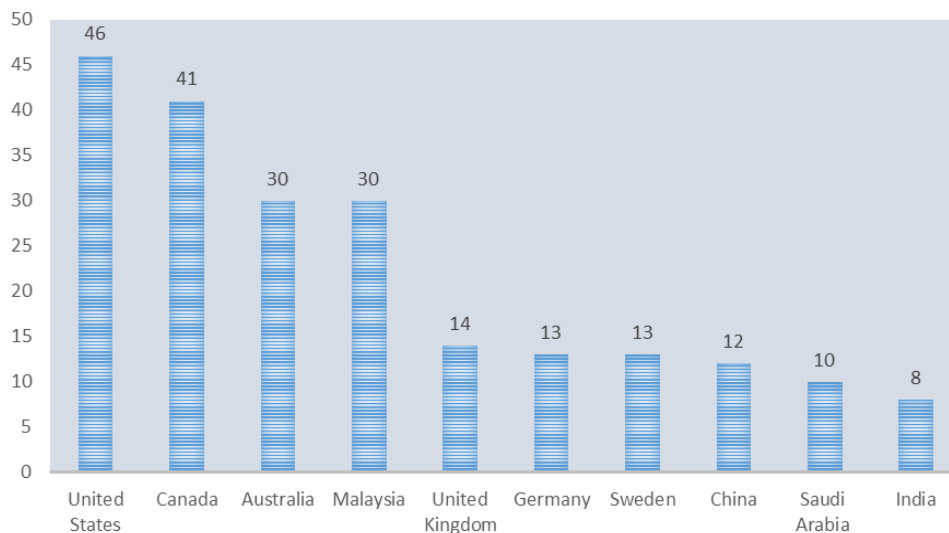


Figure 7. Top 10 countries with the most cooperation with Iran in the field of information security

Figure 7 shows the thematic distribution of Iran's scientific publications in the field of information security. Based on the Scopus' thematic categorization, the field of computer science has the highest rank among other papers (n=1065) in the area of information security, followed by Engineering (n=512), Mathematics (n=212), Social sciences (n=79), Decision sciences (n=71), Energy (n=58), and Medicine (n=55).

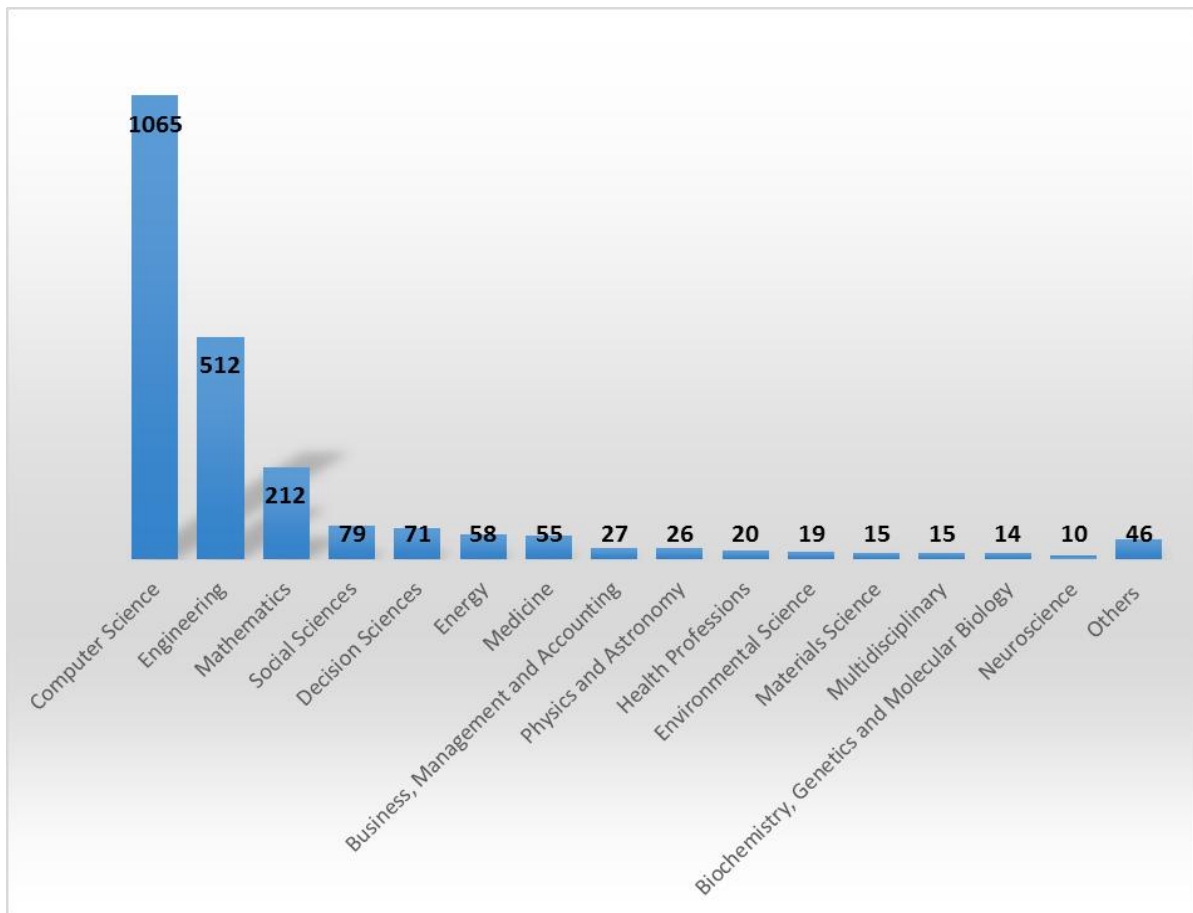


Figure 8. Subject distribution of Iranian scientific publications in the field of information security

Discussion

With the progress of business processes, use of information and communication technology in organizations and companies has significantly increased. Information security that goes into the context of information and communication technology between different sections is an important issue because information security threats can cause irreparable damages to the organizations. In recent years, many organizations suffered from multiple successful cyber-attacks. Aside from the cyber-attacks with political goals, another type of cyber-attack popularly known as commercial cyber-attacks has emerged in the recent years. The main goal of commercial cyber-attacks is a

monetary benefit through obtaining sensitive and valuable information from an organization. Many studies confirm the increase in the number of cyber-attacks against organizations and the need for protection against such threats since they can cause significant damages (Brewer, 2014; Clark, Hakim, & Panguluri, 2018; Harries & Yellowlees, 2013; Hentea, 2008). On this matter, in a study of cyber threat defense report North America & Europe published by cyber edge group, over 70 percent of the businesses process have faced with cyber-attack against among their organizations in during the last 12 months (Cyberedge group, 2015).

Many studies indicated that Iran's scientific publications in areas such as nursing, traditional medicine, immunology, orthopedics, dentistry, AIDS and other fields have significantly increased dramatically in the recent years (Ghazimirsaeid et al., 2015; Hodhodinezhad et al., 2012; Janmohammadi et al., 2012; Yousefi et al., 2012; Zeraatkar et al., 2012). The current study confirmed the same development in the field of information security in Iran. Sharif University of Technology, Iran University of Science and Technology and Amirkabir University of Technology has produced the highest number of articles in the field of information security. The findings showed that more than 50 percent of Iran's scientific documents in the field of information security have been published during the five years period 2014-2018. In terms of scientometric quality indicators like total citations, citations per document and h-index, Iran's scientific publications in the field of security is in a relatively favorable position. As a result, 1351 Iranian articles on information security have received 9,242 citations. The average citation for each Iranian article in this area was 4.68 during the five-year period from 2014 to 2018, which is more than the average citation for the total Iranian scientific publications which was 6.84. Also, citation per year index was reported 223.22 in total years and was calculated 600.6 for the last five years. In other words, more citations to Iranian documents in this field have occurred in this period which shows the importance and the huge attention that Iranian researchers have recently given to the field of information security. Brito and Rodríguez-Navarro believe through the country affiliations of the citing authors, it is possible to trace the countries that benefit from the results of the studies produced in a national research system (Brito & Rodríguez-Navarro, 2018).

Changes in the international security situation necessitate organizations to implement knowledge-based information security controls to prevent the occurrence of security risks. More researches and publications in this field can be definitely helpful. Although Iran's global share of the total researches conducted in the field of information security is only 0.85 percent, but compared to other countries in the Middle-East, Iran with a total 1351 papers (21.08%) is standing on top. While, in terms of scientific publications in the field of nursing, Iran ranked second among the Middle-Eastern countries (Ghazimirsaeid et al., 2015).

Abramo and colleagues analyzed the relationship between the different types of collaboration and research productivity. They believe that only collaboration at intramural and domestic level can make a positive effect on research productivity (Abramo, D'Angelo, & Murgia, 2017). In our

study, the rate of international collaboration in the field of information security among Iranian researchers was 25.38 percent. This means that 25.38 percent of researches conducted by Iranian scholars have been the result of scientific collaboration with at least one foreign author. Findings of this study indicated that by the end of 2018, international research collaboration among foreign authors had reached to a greater extent with an initial cooperation with the United States of America followed by Canada, Australia. Also, the rate of international cooperation has increased by almost 10 times in the last five years.

Conclusion

The present study evaluates the research trends of information security in the Middle-East and the world from a scientometric perspective. The results showed that the majority of research publications in the field of information security were conducted by researchers in the United States and China. According to the findings, Iran has a relatively good standing in the field of information security in the world. It is also in a better position in the Middle-East than its competitors countries. Iranian institutions have collaborated in science with leading scientists and foremost experts of the world and perceived in good light and held in high esteem. What is highlighted in this article is the low scientific output specific to information security in the medical field. Given that this area of study is of utmost and paramount importance in terms of human benefit; researchers are expected to increase their attention to this area.

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