Bibliometric Analysis of Information Security Research

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***Abstract*— Bibliometric analysis of information security area was carried out using information about publications from Scopus. The most productive journals, countries and authors were determined. The most frequently cited article and its citation history was described. Also bibliometric map based on citation network among countries was constructed.**

Keywords*— *information security; computer security; cyber security; bibliometric analysis; bibliometric map

I. INTRODUCTION

For scientific researchers determining of research trends and progress of the area of their interest is very important. The field of library and information science is concerned with the classification and organization of information. Bibliometric analysis, the extraction of statistics on published scientific papers and the research fields they discuss, comprises some of the tools used in library science [1]. Different disciplines were analyzed using bibliometric methods [2, 3].

Information Security (InfoSec) has been growing in importance in the last few years. InfoSec plays a prime role in helping creating the environment needs to set the ground for implementing successful national ICT plans, e-Government or e-Commerce activities, as well as sectoral projects, such as, for example in the areas of education, health or finance [4]. In information security area were carried out bibliometric analysis by some researchers: were determined trends in computer crime and cybercrime research from 1974 to 2006 using ISI Web of Science, the Science Citation Index (SCI), and the Social Science Citation Index (SSCI) [5], was carried out bibliometric analysis of the IEEE Symposium on Security and Privacy (IEEE-SP) based on the statistics between 1992 and 2004, was analyzed inter-sector collaboration by examining the co-authorship between at least two of the four sectors: government, university, industry [6]. In this paper were analyzed publications in information security area using data from Scopus database.

II. TOPICS OF INFORMATION SECURITY RESEARCH

We offer following classification of information security research:

- ISecPol (information security policy; information security strategy; information security program);
- ISecMan (information security management; information security risk; information security risk management; information security decision making;information security economy; information security managemant system; information security system; security monitoring);
- ISecCAT (information security culture; information security awareness; information security trust);
- ISecGen (information security; Cyber security; computer security; information systems security; communication security; network security; software security);
- ISecAD (intrusion detection; intrusion detection system; DDoS attack; cyber-attack; cyber-attack detection; information security safeguards);
- ISecWare (malware; computer virus; malware propagation; malware detection);
- ISecEvent (information security event; information security event management; information security incident; information security incident management);
- ISecMetr (information security metrics; information security evaluation; information security assurance; information security threat; information security vulnerability);
- ISecIdM (access control; identity management; biometric).

III. RESULTS AND DISCUSSION

Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings [7]. To identify publications on information security area following query was used:

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KEY ( ( information security ) OR ( cybersecurity ) OR ( computer security ) OR ( information systems security ) OR ( communication security ) OR ( network security ) OR ( software security ) OR ( information security policy ) OR ( information security strategy ) OR ( information security system ) OR ( information security management ) OR ( information security risk ) OR ( information security risk management ) OR ( information security economy ) OR ( information security culture ) OR ( information security awareness ) OR ( information security trust ) OR ( intrusion detection ) OR ( intrusion detection system ) OR ( ddos attack ) OR ( malware ) OR ( malware detection ) OR ( security resilience ) OR ( cyber attack ) OR ( cyber attack detection ) OR ( information security safeguards ) OR ( information security event ) OR ( information security event management ) OR ( information security incident )
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OR ( information security incident management )
OR ( information security metrics ) OR (
information security evaluation ) OR (
information security assurance ) OR ( information
security threat ) OR (information security decision
making) OR (information security monitoring) OR
(computer virus) OR (malware propagation) OR
(information security vulnerability) OR (access
control) OR (identity management) OR (biometric))
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A. Type of document

The queries result consists of 218704 documents: conference papers comprise 55.2 % of the total production (120680 documents), followed by articles – 36.4 % (79601 documents). Other types of documents – review (4.14 % - 9060 documents), conference review (0.55 % - 1220 documents), notes (0.7% - 1551 documents, editorial materials (0.7% - 1561 documents), book chapters (0.21 % - 456 documents), letters (0.73% - 1588 documents), books (0.07% - 142 documents), reports (0.01% - 43 documents) showed much-lesser significance than conference papers and articles.

B. Publication output

Analyzed documents cover period from 1960 to 2015. Cumulative number of publications in each year graphically illustrated on figure 1. Pearson correlation coefficient between yearly cumulative number of documents and the year was 0.76.

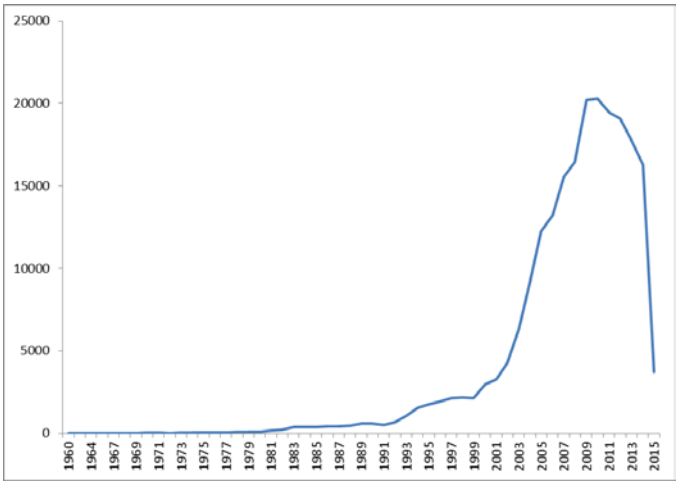

Figure 1. Cumulative number of publications by year

Polynomial and exponential fitting curves for formation security research are C = 13.8Y^2-416.85Y+2088 and C=2.94exp (0.18Y), respectively, where C is the cumulative number of publications and Y is the year.

For all Scopus publications in analyzed area were used 36 languages. Documents in English were obtained 95% of all publications (207735 documents), publications in Chinese was 3.3%, in German 0.34 %, in French 0.29%, in Spanish 0.24 %, in Japanese 0.07 %, in Italian 0.05 % of all Scopus publications. Documents in other languages together obtained 0.35% of all published materials. For determining the trends in information security research were changed keywords on Scopus search dialog box and InfoSecGen was revealed as the most productive topic.

Analyzed materials were from 160 countries. Most articles were published by researchers from USA (25 % - 54732 documents), China (18% - 38672 documents) and UK (6% - 12757). The 7 most highly developed countries (Canada, France, Germany, Italy, Japan, UK and USA) were in the top of most productive countries. Azerbaijan was in the 95th rank with 37 documents, 57 % of them were published by researchers from Institute of Information Technologies Azerbaijan National Academy of Sciences. 51 % (19 documents) of all documents from Azerbaijan were journal articles, 45.9 % (17 documents) were conference papers.

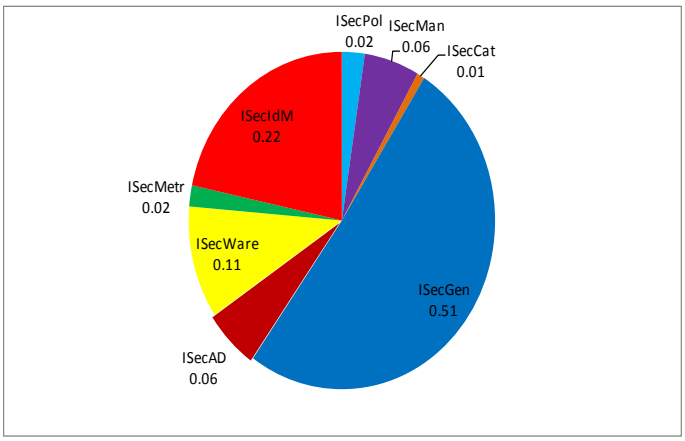

Figure 2. Distribution of publications on research topics

In total 79601 articles were published in 159 journals listed in the Scopus. Figure 3 describes relationship between the numbers of journals and articles. 10 most-productive journals with their impact factors (IF) calculated by Thomson Scientific and numbers of articles published in them were shown in Table 1.

TABLE I. TEN MOST PRODUCTIVE JOURNALS FROM ISI

N	*Journals*	*Number of publications*	*IF*
1	Computer Communications	616	1.352
2	IEEE Transactions on Wireless Communications	575	2.762
3	IEICE Transactions on Communications	568	0.326
4	IEEE Transactions on Vehicular Technology	539	2.642
5	Computer Networks	527	1.282
6	IEEE Journal on Selected Areas in Communications	616	1.352
7	IEEE Security and Privacy	481	4.138
8	Security and Communication Networks	455	0.721
9	Wireless Personal Communications	421	0.433
10	Plos One	419	0.979

C. *Distribution in subject areas*

All documents were published in 28 Scopus subject areas. There were 123653 (57 %) documents published in *Computer Sciences* and 84993 (39%) documents in *Engineering* area. Table 2 shows the other 10 Scopus subject areas with the most number of publications, the number of documents in each area and percentage of subject areas from all publications.

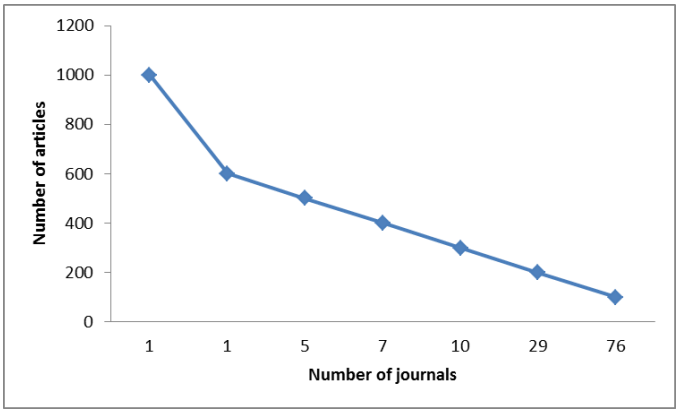

Figure 3. Relationship between journals and articles published in them

Table 3 shows top 10 of most-productive authors in information security area with their affiliations, h-indexes and number of published materials in analyzed area.

TABLE II. TEN SCOPUS SUBJECT AREAS WITH THE MOST PUBLICATIONS

N	*Subject areas*	*Number of publications*	*Percentage*
1	Medicine	27655	12.6%
2	Mathematics	25434	11.6%
3	Social Sciences	12475	5.7%
4	Biochemistry, Genetics and Molecular Biology	12359	5.7%
5	Physics and Astronomy	7598	3.5%
6	Decision Sciences	5026	2.3%
7	Business, Management and Accounting	4469	2.0%
8	Materials Science	4392	2.0%
9	Immunology and Microbiology	3804	1.7%
10	Energy	3239	1.5%

D. *Most-frequently cited article*

Although, the number of citations does not absolutely indicate the quality of an article, it is a measure of its impact and prestige. The most-frequently cited article about information security was “Wireless sensor networks: A survey” by Akyildiz et al (2002) was published in 2002 in Computer Networks journal with an IF of 1.282 and was cited 7549 times from publishing since 2015. Article life and cited times was illustrated in figure 4.

TABLE III. TOP 10 MOST PRODUCTIVE AUTHORS

N	*Author*	*Affiliation*	*h-index*	*Number of papers*
1	Bertino Elisa	Purdue University, Department of Computer Science, West Lafayette, United States	39	303
2	Ma Jianfeng	University of Science and Technology Beijing, Dongling School of Economics and Management, Beijing, China	16	287
3	Feng Dengguo	Institute of Software Chinese Academy of Sciences, Trusted Computing and Information Assurance Laboratory, Beijing, China	18	214
4	Shen X Xuemin	University of Waterloo, Department of Electrical & Computer Engineering, Waterloo, Canada	45	208
5	Jajodia Sushil	George Mason University, Fairfax, United States	42	187
6	Yang Yixian	Beijing University of Posts and Telecommunications, National Engineering Laboratory for Disaster Backup and Recovery, Beijing, China	19	170
7	Susilo Willy	University of Wollongong, School of Computer Science and Software Engineering, Wollo ngong, Australia	26	161
8	Xiao Yang	University of Alabama, Department of Computer Science, Tuscaloosa, United States	42	149
9	Li. Weí	George Washington University, Department of Computer Science, Washington, United States	116	140
10	Varadharajan Vijay	Macquarie University, Department of Computing, North Ryde, Australia	14	140

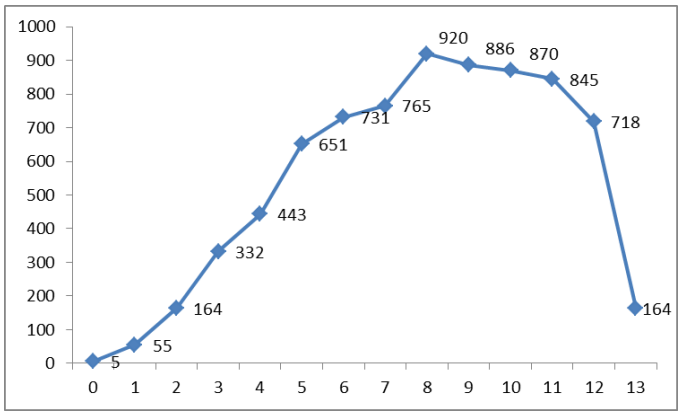

Figure 4. Citation history of the most cited article

CONCLUSIONS

In information Security research were determined dominant countries, languages and authors. Also the most cited article, the most productive journals and information security topics were revealed. Polynomial and exponential fitting curves for cumulative number of publications in information security area and publication year were identified. For determining the information security research distribution in the world created bibliometric map using vosviewer mapping software from citations network (Figure 5).

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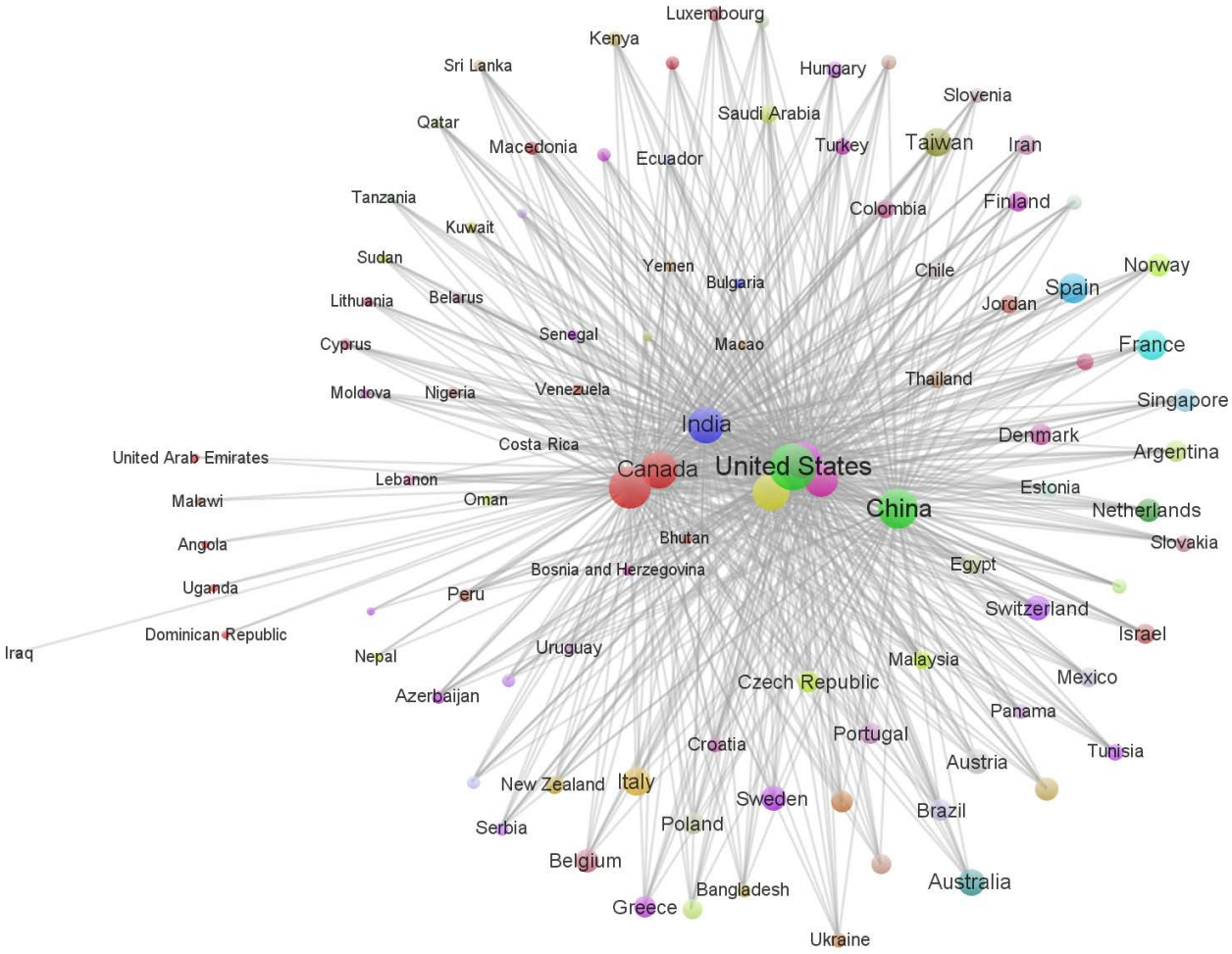

Figure 5. Bibliometric map based on citation network