

# Using Social Network Analysis Method to Visualize Library & Information Science Research

Mohammadamin Erfanmanesh

Department of Information Science, Shahid Beheshti University, Tehran, Iran

Email: amin.erfanmanesh@gmail.com

Elaheh Hosseini

Department of Information Science, Alzahra University, Tehran, Iran

Email: Elahehosseini65@gmail.com

**Abstract**—This paper studies the role of world countries in Library and Information Science research during 1963 to 2012 using scientometric and social network analysis (SNA) approaches. A total of 58757 papers which published by 83 Information Science and Library Science journals in JCR 2013 and indexed in the Web of Science were selected as the sample of the study. In this paper, the overall structure and evolution of the collaboration network of countries were investigated using macro-level SNA metrics. UCINET and VOSVIEWER software were utilized for data analysis and visualization. Findings of the study show that the co-authorship network of countries in LIS research contains 151 vertices which connected together through 3121 links (co-authorships). The collaboration network of countries seems to exhibit “scale-free” and “small world” network properties and the famous notion of “six degrees of separation” is valid in this network. The co-authorship network of countries consists of 15 components, the largest of which contains 137 vertices, yielded a ratio of 90% of the whole network. Moreover, the results of clustering analysis show that this network comprises 39 clusters. Amongst them, the eleventh and ninth clusters which contain US and UK, have the highest density.

**Index Terms**—library and information science, scientometrics, social network analysis, countries collaboration network

## I. INTRODUCTION

Scientific collaboration among individuals, research organizations and countries has been increased over the past decades. Sharing of knowledge, expertise, equipment, resources and funds, obtaining prestige and visibility as well as providing intellectual companionship are potential factors which motivate research collaboration [1]. Several studies have reported that collaboration results in greater productivity [2]. Moreover, associations between scientific collaboration and citation impact have been widely examined; the results generally suggest that the higher the number of authors, the higher the citation

impact [3]. Multiple authorship or co-authored publication has been used as the most visible and accessible indicator to measure scientific collaborative activities. Katz and Martin [1] discussed that accessibility of data, the ease of measurement and stability during the time are as advantages of co-authorship. According to Crane [4] the co-authorship of papers creates a social network which can be studied in order to understand the characteristics of a particular field and its ‘invisible colleges’. A co-authorship network is a social network consisting of a collection of researchers each of whom is connected to one or more other researchers if they have co-authored one or more papers. In a co-authorship network authors are connected together if they have co-authored at least one publication. Such a network can be represented as a set of nodes denoting co-authors joined by links denoting co-authorship.

Co-authorship network analysis have been conducted in a number of fields, such as tourism and hospitality [5], medicine [6], health care [7], energy [8], computer science and information systems [9], sociology [10] and economics [11]. This method is also widely used in library and information science [12] [13]. Although a few previous studies have attempted to analyze co-authorship network of LIS researchers using social network analysis, these studies were limited in their sample size, time span, targeted regions and the studied metrics. Additionally, no previous study analyzes the collaboration network of countries in LIS research. Therefore, intensive and comprehensive studies are required to understand the characteristics and structure of co-authorship networks in LIS. This study utilize Social Network Analysis (SNA) to depict scientific collaboration among countries based on 58757 papers which published during 1963- 2012 by 83 Information Science and Library Science journals in JCR 2013 and indexed in the Web of Science. This paper aims to deploy the network analysis methods to identify the key features of the co-authorship network of countries in LIS research. We not only analyze this network with macro-level methods which capture the global features of

the networks, but also illustrate the local features of countries in the networks using micro-level metrics.

## II. METHODOLOGY

The present research is conducted using Social Network Analysis (SNA) method. We select 83 Information science and library science journals from the JCR 2013 with the time span of 50 years (1963-2012) as the sample of study. During the studied period, there were 58757 research articles published in IS & LS journals from 151 countries. First, bibliometric data of aforementioned articles were retrieved from the Thomson-Reuters' Web of Science® (WoS) database. Then the dataset was converted into a recognized format of SNA software using a C# application. UCINET and VOSVIEWER software were utilized for data analysis and visualization. The co-authorship network of countries in LIS research was analyzed using macro-level metrics. Macro-level metrics concentrates on the global characteristics of a social network as a whole with the aim to capture the overall structure of a network [12]. In this study we will focus on the following metrics:

**Density:** Network density is defined as the total number of observed ties in a network, divided by the total number of possible ties in the same network [5].

**Clustering Coefficient:** Clustering coefficient indicates the probability that nodes with the same neighbor tend to cluster together [14].

**Component:** A component is a set of vertices that can be reached by paths running along links of the network [14].

**Giant Component:** Giant component represent the largest group of nodes who are connected to each other either directly or indirectly [14].

**Mean distance:** Mean distance is the mean length of the shortest path between two vertices in a network [12].

**Diameter:** The diameter of a network is the length (edges) of the longest path between any two nodes [14].

## III. FINDINGS

The co-authorship network of countries in LIS research consists of nodes and links: nodes represent countries, while links connect countries in the form of co-authorships. There is a link between two countries if their researchers have co-authored at least one paper. The size of a node is proportional to the number of co-authorships that a given country has in the network. The size of the total network in 50 years' time span denotes by the number of unique countries (151) with 3121 international co-authorships (Fig. 1).

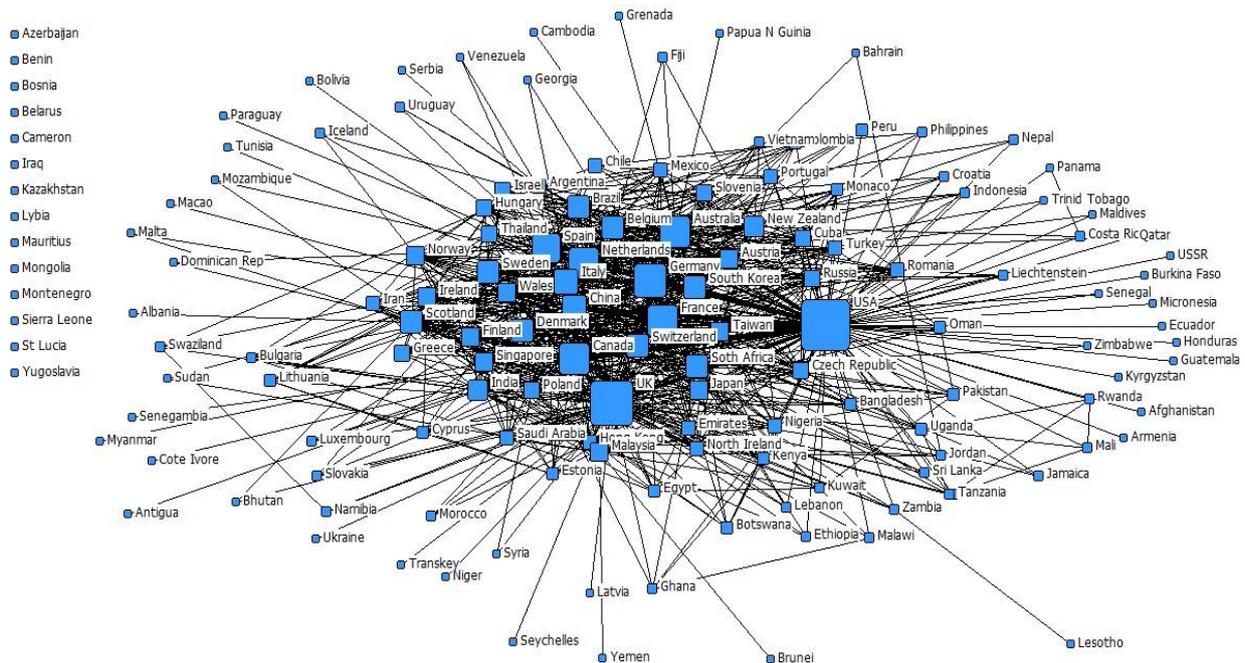


Figure 1. The co-authorship network of countries in LIS during 1963-2012

In this study we focus five key elements of the network: density, clustering coefficient, components, mean distance and diameter. Network density represents the relationship between the numbers of actual links against all possible linkages. The density of the co-authorship network of countries in LIS research is 0.082, which indicates only 8.2% of all possible links being present. Another network topology attribute, the clustering coefficient, indicates the extent to which nodes in a network tend to cluster together (Newman, 2003). It

describes the probability that two of a scientist's collaborators have themselves co-authored a paper. Considering all vertices of the network, the total clustering coefficient is 0.427, which indicates that the network is clustered. Similar to many other social networks, the co-authorship network of countries in LIS research is composed of one large component (known as giant component) and many small components. This network consists of 15 components, the largest of which is consisting of 137 vertices, yielded a ratio of 90.7% of



network, number of vertices in the neighborhood and the importance of the neighboring vertices. This color is somewhere in between red and blue. The larger the number of items in the neighborhood of a point and the higher the weights of the neighboring items, the closer the color of the point is to red. Moreover, nodes are located closer if they have more co-authorship. Fig. 4 shows that U.S.A and the U.K. (red ones) as well as Canada, China, Netherlands, Australia and German (yellow ones) have the highest density in the network. Additionally, cluster analysis shows that the network is formed from 39 different clusters, most of which are fairly small.

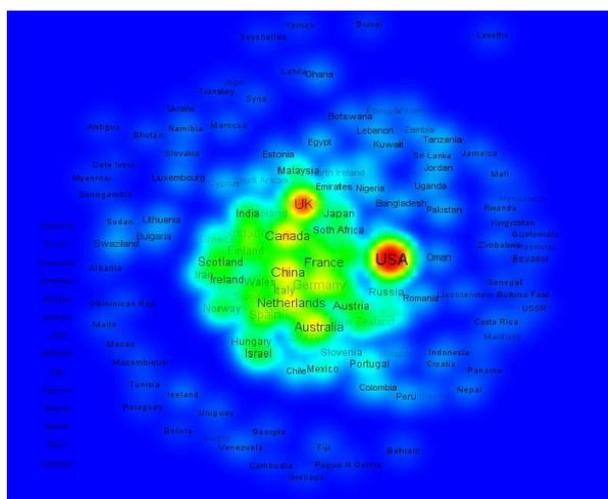


Figure 4. Cluster density map of countries collaboration network in LIS during 1963-2012

#### IV. CONCLUSION

This study investigates the performance of world countries in library and information science research over a 50-years period. Using the data from 58757 papers, we construct the co-authorship network of countries. The key findings of the study are:

a) The collaboration network of countries is a “small world network” by demonstrating its short mean distance and scale free properties. A “small world” is a network in which any two nodes are only a few steps apart, regardless of network size.

b) The mean geodesic distance of the network is 2.178, suggesting that there are less than six degree of separation between most countries in the network. In other words, the famous notion of “six degree of separation” can be valid in this network.

c) Through degree distribution analysis, we find that this network also possesses the characteristics of “scale-free networks” in which quite a few countries collaborate widely while others collaborate with limited number of countries.

d) Two measures (density and clustering coefficient) which have been used to investigate the cohesion of the network indicate relatively loose structure of the countries collaboration network.

e) The co-authorship network of countries in LIS research appears to be quite connected, with a giant component which contains 90.7% of the nodes.

f) Prolific countries like US, UK, Australia, Canada, Germany, Netherlands, Spain and China have a critical role in LIS research. They are also strategically positioned in the network due to their centrality.

g) The results indicate that LIS has experienced the same trends of increasing co-authorship as other disciplines.

It is one of the first studies to analyze collaboration in the field of LIS using co-authorships network of countries. The study has included a time span of five decades for the LIS co-authorship network. The positive evolutions of the network coupled with the presence of a number of key players are evidence of the healthy status of the LIS research community. The results allow scholars in the field of LIS to step back and look at international research collaboration patterns over a relatively long period of time. An overview of the field and the connections between countries provides a useful schematic of invisible colleges for new researchers.

#### REFERENCES

- [1] J. S. Katz and B. R. Martin, “What is research collaboration?” *Research Policy*, vol. 26, no. 1, pp. 1-18, 1997.
- [2] F. Barjak and S. Robinson, “International collaboration, mobility and team diversity in the life sciences: Impact on research performance,” *Social Geography Discussions*, no. 3, pp. 121-157, 2007.
- [3] D. Beaver, “Does collaborative research have greater epistemic authority?” *Scientometrics*, vol. 60, no. 3, pp. 399-408, 2004.
- [4] D. Crane, *Invisible Colleges: Diffusion of Knowledge in Scientific Communities*, Chicago: University of Chicago Press, 1972.
- [5] P. Benckendorff, “Exploring the limits of tourism research collaboration: A social network analysis of co-authorship patterns in Australia and New Zealand tourism research,” Paper presented at the Tourism and Hospitality: Challenge the Limits Conference, Tasmania, Australia, February 8-11, 2010.
- [6] O. Yu, H. Shao, and Z. Duan, “The research collaboration in Chinese cardiology and cardiovascular field,” *International Journal of Cardiology*, no. 26, pp. 1-6, 2012.
- [7] J. Godley, G. Barron, and A. M. Sharma, “Using social network analysis to assess collaboration in health research,” *Journal of Healthcare, Science & the Humanities*, vol. 1, no. 2, pp. 99-116, 2011.
- [8] I. Sakata, H. Sasaki, and T. Inoue, “Structure of international research collaboration in wind and solarenergy,” Paper presented at the International Conference on Industrial Engineering & Engineering Management, Singapore, December 6-9, 2011.
- [9] H. Takeda, “A social network analysis of the IS field: A co-authorship network study,” in *Proc. the Southern Association for Information Systems Conference*, Atlanta, USA, March 26-27, 2010.
- [10] J. Moody, “The structure of a social science collaboration network: Disciplinary cohesion from 1963 to 1999,” *American Sociological Review*, vol. 69, no. 2, pp. 213-238, 2004.
- [11] T. Krichel and N. Bakkalbasi, “A social network analysis of research collaboration in the economic community,” Paper presented at the International Conference on Webometrics, Informetrics & Scientometrics, Nancy, France, May 10-12, 2006.
- [12] E. Yan, Y. Ding, and Q. Zhu, “Mapping library and information science in China: A co-authorship network analysis,” *Scientometrics*, vol. 83, no. 1, pp. 115-131, 2010.
- [13] M. Erfanmanesh, V. A. Rohani, and A. Abrizah, “Co-authorship network of scientometrics research collaboration,” *Malaysian Journal of Library & Information Science*, vol. 17, no. 3, pp. 73-93, 2012.

- [14] M. E. J. Newman, "The structure and function of complex networks," *SIAM Review*, no. 45, pp. 167-256, 2003.



**Mohammadamin Erfanmanesh** received bachelor and master degrees in Library & Information Science from Shiraz University, Iran in 2006 and 2008 respectively. He also received a Ph.D. in Information Science from University Malaya, Malaysia in 2012. He is currently an assistant professor at the department of Information Science, Shahid Beheshti University, Iran (National University of Iran). His research interests

include scientometrics, research evaluation, social network analysis and information visualization. Dr. Erfanmanesh is a member of Iranian Library Association.



**Elaheh Hosseini** is currently a PhD. Student in Information Science (information storage and retrieval) at Alzahra university, Tehran, Iran. She also received bachelor and master degrees in Library & Information Science from the same university in 2008 and 2011, respectively. She is a member of young research club in Iran. Her research interests are scientometrics, information retrieval, electronic-resource evaluation and information visualization.