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The most influential researchers in information behaviour: An integrative view on influence indicators

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Abstract

Purpose – The purpose of this paper is to identify the top researchers in information behaviour (IB) based on ideational and social influence indicators.

Design/methodology/approach – The population included papers on IB indexed in the Web of Science from 1980 to 2015. UCINET and Bibexcel were the tools used for measuring the ideational and social influence indicators. The correlations among the study variables were measured by applying SPSS and LISREL.

Findings – There was a significant relationship between IB researchers' productivity and performance, and between ideational influence and social influence. The structural equation modelling showed that a researcher with top placement in his/her co-authorship network can gain higher ideational influence. In total, it seems that the single and traditional criteria are increasingly replacing new and integrative ones in measuring researchers' scientific influence in fields including IB studies. Results have shown that based on total scores of the studied indicators, Spink, A., Nicholas, D., Ford, N., Huntington, P., Wilson, T.D., and Jamali, H.R. gained the high scores.

Originality/value – The current study used an integrative method based on influence indicators to identify the influential researchers in IB studies. None of the few studies done using bibliometric methods in the realm of IB has investigated the ideational and social influence indicators altogether.

Keywords Bibliometrics, Social influence, Co-authorship, H-family indices, Ideational influence, Information behaviour

Paper type Research paper

Introduction

As information and communication technologies develop increasingly and new procedures and instruments are used for searching information, human information behaviour and information needs change, too. Investigating the different aspects of Information Behaviour (IB) has been one of the main research concerns in information science. According to Wilson (1999), IB research is a "general term for a series of nested fields, including the sub-field of information seeking behaviour, which is particularly concerned with the variety of methods people employ to discover and gain access to information resources" (González-Teruel *et al.*, 2015). As a broader term, IB includes other aspects such as information need, information seeking behaviour, information searching behaviour, and information use behaviour (Wilson, 2013).

Research on IB dates back to more than half a century. Different theories have been propounded, and many papers have been published in the field. As a result, IB is considered one of the main subject categories in the field of library and information science, as highlighted in some research (e.g. Sugimoto *et al.*, 2011). For this, Fisher and Julien (2009) concluded that research on IB is developing increasingly.

Considering the above-mentioned points and gradual development of IB studies, it is needed to depict a comprehensive and inclusive picture of the ideational and social influence of top researchers in the field. The use of the notion of "influence" for evaluating research output has the advantage of having powerful theoretical foundations and supportive indicators (Egghe, 2006; Hirsch, 2005; Cuellar *et al.*, 2016). Cuellar *et al.* (2016) identified the

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ideational influence as a researcher's ability to expand his/her thoughts in other researcher's works or the rate of a researcher's influence on his/her research field. Of main discussions in the scientific influence are the ideational influence (Who will use your research?) and the social influence (Who do you collaborate with for conducting your research?). In other words, the rate of citations a researcher receives in a field determines his/her ideational influence, and his/her procedures in co-authorship with other researchers determine his/her social influence.

For measuring the ideational influence, h-index family indicators are often used, including primary h-index, g-index, and contemporary h-index or hc-index (Takeda, 2011; Truex *et al.*, 2011). As a tool for measuring a scientist's scientific influence in a certain field and cumulative influence of scientific output, h-index was introduced by George Hirsch (2005). In spite of its special advantages (Vinkler, 2017), h-index has some shortcomings, and several complementary indices have been added to it for removing its disadvantages. Two of these complementary indices are the contemporary h-index (Sidiropoulos *et al.*, 2007) and g-index (Egghe, 2006). While the former gives more weight to citations to recently published papers, the latter gives more weight to the highly cited papers. A recent research result published in the JASIST (the *Journal of American Society for Information Science and Technology*) has shown that g-index has the most discriminating power among h-index family indicators (Vinkler, 2017). Comparing the square of paper number to citation number, this index highlights highly cited papers. G-index always is more than h-index and is, therefore, more suitable for discriminating researchers' performances (Rosenstreich and Wooliscroft, 2009). One or more highly cited papers influence g-index and results in justly considering the authors' performance (Sahel, 2011). By integrative use of these indicators, a scientific influence profile can be formed for comparing researchers' relative influence in a certain area.

In addition, a researcher's influence is not limited to his/her citations. The manner of interacting with other researchers in the field is at work in his/her scientific influence in a scientific network. Here, we can consider the social influence that discusses the social influence by a researcher through social interaction processes (Truex *et al.*, 2011). Some researchers have the power of attracting other researchers and influencing their thoughts by their strategic placement in the social network of a scientific field.

The most important social relation among the researchers in a scientific field appears in the form of "co-authorship", as the most documented, tangible, and formal manifestation of scientific collaboration among the authors in producing scientific output (Glanzel and Schubert, 2001). Therefore, a collection of collaborations in a subject field can form the co-authorship network of a scientific field. In fact, by analysing researchers' co-authorship relations in a certain subject field, one can determine top researchers in the field concerning their social influence and social activities. For analysing co-authorship relations, social network analysis can be used and one of the results of this analysis is the "centrality" analysis proposed by Freeman (1979). The centrality represents the kinds and numbers of relations a member of a network has with other members of the network. While investigating the centrality indicators concerning a researcher in a scientific network and creating a related author profile, his/her social influence can be measured (Cuellar *et al.*, 2016). These centrality indicators include, among others degree centrality, betweenness centrality, closeness centrality, eigenvector centrality, beta centrality, and information centrality. Considering the effectiveness of these complementary indicators, the social influence of the researchers in IB studies was analysed in this study by applying the degree centrality, betweenness centrality, and closeness centrality.

Scientific activity is a multilayered activity, and there is no distinct all-encompassed scientific indicator for evaluating research performance. As a result, it can be argued that applying only one indicator is not sufficient to evaluate the influence of researchers.

On the other hand, despite the existence of many scientific indicators, few depict the distinct aspects of researchers' scientific performance, and it is better to use a few relatively comprehensive and integrated ones to identify active and highly influential authors in a certain field rather than using some dispersed ones. Using integrated and relatively comprehensive indicators can result in identifying top active researchers in different fields and disciplines. By this way, researchers can identify their placements by comparison with others and know the newest subjects in their interested fields considered by top researchers. Besides, they communicate and consult with top researchers also. The use of such expertise indicators helps science policy-makers to use a scientific objective tool for ranking researchers and to make just decisions on their employment and promotion and granting them. Therefore, the use of some balanced indicators results in the accurate estimation of an author's scientific influence. This study is aimed at measuring the indicators involved in the social influence and the ideational influence, and identifying most influential researchers in IB as well as investigating the possible relationship between ideational influence and social influence.

Literature review

Evaluation of the performance of scientists has traditionally been done by peer review in the form of evaluations from a handful of experts, which was limited by its subjective nature. Its limitations have driven institutions and agencies to seek scientometric indicators, which are more quantitative measures and can complement and, sometimes, extend thorough evaluation by peers (Kreiman and Maunsell, 2011).

Based on Vinkler's (2017) explanation, there are two generations of scientometric indicators. The first generation of scientometric indicators for evaluation applies data referring to the whole set studied, such as gross indices: total number of journal papers, total number of citations; specific indices: citation rate; productivity: publications/scientist; or relative indicators: relative citation rate, relative subfield citedness, etc. The second is derived from a relatively small part of the total, which can be obtained by different statistics: h-statistics, g-statistics, percentage statistics, or π-statistics and πv-statistics. Through the mentioned statistics, the following indicators can be calculated: h-index (Hirsch, 2005), g-index (Egghe, 2006), π-index (Vinkler, 2009), πv-index (Vinkler, 2010), etc.

There are several scientometric studies, which have been conducted within IB literature. One of the earliest studies was by Julien (1997), who studied the papers published on information needs and used them from 1990 to 1994 from different aspects, including the publishing journal, authoring researcher, and published paper. In a similar vein, Julien and Duggan (2000) compared the related papers on the information needs and uses in two time spans of 1984-1989 and 1995-1998. In another study, Julien *et al.* (2011) studied 749 papers in IB in the time span of 1999-2008 as to author, article, journal, methodology, and similar types. Therefore, Julien has conducted the studies on IB for about 24 years in the form of content analysis. IB research has been considered in other studies (Pettigrew and McKechnie, 2001; McKechnie *et al.*, 2001, 2005, 2006, 2008; Case, 2006; Vakkari, 2008; Fisher and Julien, 2009; Chang, 2011).

In a bibliometric study, Li-Ping (2010) studied 1889 records on IB indexed in LISA regarding co-authorship relations and identified seven top key authors in the field: Spink, A., Savolainen, R., Nicolas, D., Wilson, T.D., Ellis, D., Kuhlthau, G.C., and Marchionini, G. For depicting the scientific map of IB theories, Jamali (2013) extracted the bibliographic information of 51 theories in IB from the Web of Science (WoS) and analysed them using some related software packages. Soheili and Khasseh (2015) studied the historical origins of IB with applying reference publication years spectrography and found that this field encountered three and six major mutations in nineteenth and twentieth centuries, respectively. They argued that IB has been influenced by psychology as well as other works in

quantitative and qualitative methodologies (such as the grounded theory and the critical incident technique).

In a more recent research in IB, González-Teruel *et al.* (2015) used the co-citation analysis in the field. Their research population included 2,386 articles, reviews, and/or conference proceeding papers indexed in the WoS. The papers that received at least 20 citations were included in creating the co-citation network and forming subject clusters. Only 193 papers satisfied the research inclusion criteria. The results of hierarchical cluster analysis of the papers led to the formation of seven subject clusters: the basic and theoretical foundations, users' interaction with information retrieval systems, web-based search, relevance, qualitative methodologies, medical IB, and users' information technology acceptance. They found that theoretical works are dominant in the field and most IB studies focus on users' interaction with information retrieval systems and medical IB.

Although researchers have increasingly studied IB by scientometric methods and its literature from different perspectives, "there is little research that has analysed the international literature published in IB using bibliometrics and network analysis" (González-Teruel *et al.*, 2015). A gap can be seen in a deep and special view on the researchers in IB and their scientific influence. Therefore, this paper aims at answering the following questions:

RQ1. Who are the top researchers in IB concerning the number of papers and received citations?

RQ2. Is there any significant relationship between productivity (published papers) and performance (received citations)?

RQ3. Who are the top IB researchers based on the ideational influence indicators?

RQ4. Is there any significant relationship between the h-index family indicators?

RQ5. Who are the top IB researchers based on the social influence indicators?

RQ6. Is there any significant relationship between the productivity (papers published) and the centrality indicators (social influence)?

RQ7. Is there any significant relationship between the performance (received citations) and centrality indicators (social influence)?

RQ8. Based on individual author profiles, who are the most influential researchers in IB concerning all ideational and social influence indicators?

RQ9. Is there any significant relationship between the ideational influence indicators and those of the social influence?

Methodology

Using the bibliometric approach as well as social network analysis, this study is aimed at investigating the ideational influence and social influence of top researchers active in IB. Truex, Cuellar, Takeda, and Vidgen started to dedicate their research focus to the scientific influence and scholarly capital. The scholarly influence research began in 2008 with the Southern Association for Information Systems, Americas Conference on Information Systems, and International Conference on Information Systems papers, punctuated by Truex *et al.* (2009), which showed how influence could be measured by means of the Hirsch family indices (ideational influence). Then social influence (connectedness) was added as published in Truex *et al.* (2011) and Takeda *et al.* (2012).

The research population included IB papers indexed in the WoS between 1980 and 2015. It seems that this time span would be enough for depicting the network of researchers active

in the field. Normally, a researcher needs a long time to form a competent international research team and to conduct influential studies within a field. This research attempts to present a proper image of the situation of IB researchers in the course of time. In fact, all researchers of the past three and a half decades who entered this field have been assessed. This course of time includes most young and retired researchers who have had effective impacts in this field.

The following search strategy was applied for retrieving the papers:

TOPIC: ("information behavio*") OR TOPIC: ("information need*") OR TOPIC: ("information seek*") OR TOPIC: ("information us*") OR TOPIC: ("information search* behavio*") OR TOPIC: ("information shari* behavio*").

This search strategy was applied in both Social Science Citation Index and Conference Proceedings Citation Index-Social Science & Humanities. Out of the document types, original research papers, review papers, and conference proceedings were retrieved and those in the category of library and information science in English were included in the study. This strategy resulted in retrieving 3,493 records. It is worth noting that this search strategy has been previously used in other studies (i.e. González-Teruel *et al.*, 2015; Soheili and Khasseh, 2015).

Following that, the data file was amended and revised to consider name variations. Then, the researchers with at least three papers in the field were identified (481 individual authors). They authored 2,782 papers in the field. A profile was constructed for an individual author including the rate of his/her centrality indicators and those of h-index family. UCINET was used for measuring the centrality indicators and Bibexcel tool for measuring h-index. For measuring other indices such as g-index and hc-index, these tools did not have any means of calculating and the primary data were entered in Microsoft Excel. These indices were calculated by formulating them. It is worth noting that since publish or perish can calculate these indices only for the first author, this tool was not applied for measuring them. The needed correlational tests and structured model were done in SPSS and LISREL.

Data analyses

RQ1. Who are the top researchers in IB concerning the number of papers and received citations?

The analysis of 3,493 papers retrieved in the field and authored by 7,767 authors has shown that the most highly productive researchers in the field included Nicholas, D. and Spink, A. (each with 58 papers) and Savolainen, R. (with 39 papers), respectively. These 3,493 papers received 38,907 citations in total. As shown in Table I, Wilson, T.D. (with 1,287 received citations), Spink, A. (with 1,151 received citations), and Savolainen, R. (with 949 received citations) were the most highly cited researchers in the field, respectively. Out of 15 most highly productive researchers, eight researchers highlighted in bold were most highly cited:

RQ2. Is there any significant relationship between productivity (published papers) and performance (received citations)?

The results of correlating researchers' productivity and performance showed that there was a significantly positive relation between the two variables ($r = 0.700$, $p \leqslant 0.01$). In other words, the more the published papers were, the more the received citations were. Therefore, it can be concluded that IB researchers considered both productivity (the number of papers) and performance (the number of citations) in their studies simultaneously:

RQ3. Who are the top IB researchers based on the ideational influence indicators?

As shown in Table II depicting the values of h-index family measures of 15 top IB researchers, Spink, A., Savolanien, R., and Nicolas, D. gained the highest ranked positions in

Table I.
15 prolific and highly-cited authors in IB studies

Ranking by no. of articles (productivity)						Ranking by total citations (performance)					
Rank	Name	No. of articles	Total citations	Average citation per paper	Median	Rank	Name	No. of articles	Total citations	Average citation per paper	Median
1	**Spink, A.**	58	1,151	19.84	51	1	**Wilson, T.D.**	21	1,287	61.28	68
2	**Nicholas, D.**	58	708	12.20	20	2	**Spink, A.**	58	1,151	19.84	51
3	**Savolainen, R.**	39	949	24.33	60	3	**Savolainen, R.**	39	949	24.33	60
4	Huntington, P.	32	537	16.78	28	4	Kuhlthau, C.C.	9	814	90.44	542
5	Fourie, I.	30	56	1.86	9	5	**Nicholas, D.**	58	708	12.2	20
6	Jamali, H.R.	28	432	15.42	24	6	Ellis, D.	12	671	55.91	100
7	Cole, C.	28	352	12.57	14	7	**Ford, N.**	25	653	26.12	39
8	**Ford, N.**	25	653	26.12	39	8	**Fisher, K.E.**	18	650	36.11	91
9	**Wilson, T.D.**	21	1,287	61.28	68	9	**Marchionini, G.**	20	542	27.1	8
10	**Marchionini, G.**	20	542	27.1	68	10	**Huntington, P.**	32	537	16.78	28
11	Julien, H.	20	287	14.35	30	11	Dervin, B.	4	531	132.75	412
12	Large, A.	19	328	17.26	59	12	Saracevic, T.	8	525	65.625	179
13	Beheshti, J.	19	311	16.36	59	13	Kantor, P.	10	522	52.2	179
14	Marcella, R.	19	98	5.15	9	14	Yoon, K.	4	473	118.25	236
15	**Fisher, K.E.**	18	650	36.11	91	15	Nilan, M.S.	6	453	80.98	412
16	Williams, P.	18	250	13.88	299						
17	Shenton, A.K.	18	119	6.61	17						
18	Westbrook, L.	18	114	6.333	13						

Rank	Ranking by hc-index Name	hc-index	Rank	Ranking by g-index Name	g-index	Rank	Ranking by h-index Name	h-index
1	**Spink, A.**	11	1	**Spink, A.**	33	1	**Spink, A.**	19
2	**Savolainen, R.**	10	2	**Savolainen, R.**	30	2	**Savolainen, R.**	16
3	**Nicholas, D.**	9	3	**Nicholas, D.**	26	3	**Nicholas, D.**	15
4	**Huntington, P.**	9	4	**Ford, N.**	25	4	**Huntington, P.**	14
5	**Ford, N.**	8	5	**Huntington, P.**	23	5	**Ford, N.**	14
6	**Wilson, T.D.**	8	6	**Wilson, T.D.**	21	6	**Jamali, H.R.**	13
7	**Jamali, H.R.**	8	7	**Jamali, H.R.**	20	7	**Wilson, T.D.**	12
8	**Fisher, K.E.**	8	8	**Marchionini, G.**	20	8	*Cole C*	11
9	**Julien, H.**	8	9	*Cole, C.*	18	9	**Marchionini, G.**	11
10	*Rowlands, I.*	8	10	**Fisher, K.E.**	18	10	**Fisher, K.E.**	11
11	Jansen, B.J.	8	11	Large, A.	18	11	**Tenopir, C.**	11
12	*Ellis, D.*	8	12	Beheshti, J.	17	12	**Julien, H.**	10
13	**Marchionini, G.**	7	13	*Vakkari, P.*	17	13	*Rowlands, I.*	10
14	**Tenopir, C.**	7	14	**Tenopir, C.**	16	14	*Ellis, D.*	9
15	Foster, A.	7	15	**Julien, H.**	16	15	*Vakkari, P.*	8

Table II.
Top IB researchers based on the ideational influence indicators

all three h, g, and hc indices, respectively. The results showed that these authors were of top researchers in the ideational influence in the field. For more details, the researchers common in all three columns were highlighted in bold, and those common in two columns were highlighted in italic.

As Table II shows, Vakkari, P. and Cole, C. were among 15 top researchers concerning their h and g indices, but not so in their hc indices (these authors were ranked 17th and 24th, respectively). It can be said that the recently published papers by these authors have not received more citations in comparison with their previously published papers. However, the papers recently published by researchers such as Jansen, B.J. and Foster, A. received more citations:

RQ4. Is there any significant relationship between the h-index family indicators?

The h-index is an author-level metric that attempts to measure both productivity and citation impact of the publications of a scientist or scholar. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other publications (Hirsch, 2005). The g-index is an index for quantifying scientific productivity based on publication record (an author-level metric). It was suggested by Egghe (2006). The index is calculated based on the distribution of citations received by a given researcher's publications. This is such that given a set of articles ranked in decreasing order of the number of citations that they received, the g-index is the unique largest number such that the top g articles received together at least g^2 citations (Egghe, 2006). The contemporary h-index was proposed by Antonis Sidiropoulos, Dimitrios Katsaros, and Yannis Manolopoulos in 2006. It adds an age-related weighting to each cited article, giving (by default; this depends on the parametrisation) less weight to older articles. The weighting is parametrised; the publish or perish implementation uses $\gamma = 4$ and $\delta = 1$, like the authors did for their experiments. This means that for an article published during the current year, its citations count four times. For an article published four years ago, its citations count only once (4/4). For an article published six years ago, its citations count 4/6 times, and so on.

Table III shows that there is a relatively powerful relationship between h-index variants ($r = 0.941$ in the case of the relationship between h and g indices; $r = 0.905$ in the case of the relationship between g and h-c indices; and $r = 0.856$ in the case of the relationship between h and g indices, $p \leqslant 0.01$):

RQ5. Who are the top IB researchers based on the social indicators?

As shown in Table IV depicting the rates of the social influence indicators, Cool, C., Bystrom, K., and Vakkari, P. gained the highest ranked positions in the closeness centrality, respectively, and Cool, C., Bilal, D., and Jarvelin, K. gained the highest ranked positions in the betweenness centrality, respectively. The results have shown that these authors were top researchers based on the social influence indicators that in turn shows their authority in co-authorship network of IB:

RQ6. Is there any significant relationship between the productivity (papers published) and the centrality indicators (social influence)?

Degree centrality is defined as the number of links incident upon a node (i.e. the number of ties that a node has). The degree can be interpreted regarding the immediate risk of a node for catching whatever is flowing through the network (Freeman, 1979). On the other hand, betweenness centrality quantifies the number of times a node acts as a bridge along the shortest path between two other nodes. It was introduced as a measure for quantifying the control of a human on the communication between other humans in a social network by Linton Freeman. In his conception, vertices that have a high probability to occur on a randomly chosen shortest path between two randomly chosen vertices have a high betweenness (Freeman, 1977). Closeness centrality (or closeness) of a node is the average length of the shortest path between the node and all other nodes in the graph. Thus, the more central a node is, the closer it is to all other nodes (Freeman, 1979).

Regression analysis was used to answering the question on the relationship between the productivity and the centrality indicators. Table V shows the results of ANOVA related to the variables "productivity" and "social influence". As can be seen, 55 per cent of the variance of productivity was predicted by social influence ($R^2 = 0.552, F = 173.744, p \leqslant 0.01$). Considering the significance of the regression of variables, the coefficients of the regression equation is shown in Table VI.

Table III.
Correlation matrix among h-index variants ($n = 481$)

Dependent variable	Independent variable	Correlation coefficient	Sig.
h-index	g-index	0.941	0.01
	hc-index	0.905	0.01
g-index	hc-index	0.856	0.01

Table IV.
Top IB researchers based on the social influence

Ranking by betweenness centrality			Ranking by closeness centrality			Ranking by degree centrality		
Rank	Name	Betweenness	Rank	Name	Closeness	Rank	Name	Degree
1	*Cool, C.*	2.439805	1	*Cool, C.*	0.2654559	1	Nicholas, D.	0.5637255
2	*Bilal, D.*	2.1538506	2	*Bystrom, K.*	0.2654456	2	Huntington, P.	0.5392157
3	*Jarvelin, K.*	2.1320460	3	*Vakkari, P.*	0.2654324	3	Jamali, H.R.	0.3799020
4	*Wilson, T.D.*	2.1285665	4	*Bilal, D.*	0.2654295	4	Williams, P.	0.3186274
5	*Bystrom, K.*	1.6945025	5	*Jarvelin, K.*	0.2654001	5	*Spink, A.*	0.3063726
6	*Zhang, Y.*	1.4132742	6	White, M.D.	0.2653796	6	*Ford, N.*	0.3063726
7	*Ford, N.*	1.2856646	7	Saracevic, T.	0.2653781	7	Rowlands, I.	0.2818627
8	*Nahl, D.*	1.2556541	8	*Zhang, Y.*	0.2653752	8	*Tenopir, C.*	0.2328431
9	*Tenopir, C.*	1.0858946	9	Belkin, N.J.	0.2653678	9	Cole, C.	0.2205882
10	*Vakkari, P.*	0.9829506	10	*Nahl, D.*	0.2653532	10	Baruchsonarbib, S.	0.1960784
11	*Spink, A.*	0.8842206	11	*Wilson, T.D.*	0.2653473	11	*Foster, A.*	0.1838235
12	Fiszman, M.	0.8263744	12	Hansen, P.	0.2653458	12	Large, A.	0.1838235
13	Delfiol, G.	0.7585247	13	Zhang, X.M.	0.2653282	13	Beheshti, J.	0.1838235
14	*Foster, A.*	0.6854558	14	Erdelez, S.	0.2653194	14	Barilan, J.	0.1715686
15	Marchionini, G.	0.6123869	15	Druin, A.	0.2653194	15	Blandford, A.	0.1470588

The regression coefficients of all three predicting variables have shown that they can significantly predict the variance of the dependent variable (the productivity) ($p \leqslant 0.01$). The effect coefficient of the degree centrality ($B = 0.714$) showed that this centrality can significantly predict the variance of the variable productivity. The positive significance showed that one-unit increase in the degree centrality can increase 0.714 score in productivity. Further, the effect coefficient of the betweenness centrality ($B = 0.126$) has shown that this centrality can significantly predict the variance of the variable productivity. The positive significance showed that one-unit increase in the betweenness centrality can increase 0.216 score in the variable productivity. The effect coefficient of the closeness centrality ($B = -0.01$) has shown that this centrality can significantly predict the variance of the variable productivity. The negative significance showed that one-unit increase in the closeness centrality can decrease 0.01 score in the variable productivity:

RQ7. Is there any significant relationship between the performance (received citations) and centrality indicators (social influence)?

Regression analysis was again used for answering the question on the relationship between the performance and centrality indicators. Table VII shows the results of ANOVA related to the variables' "performance" and "social influence". As can be seen, 33 per cent of variance of the performance was predicted by social influence ($R^2 = 0.331$, $F = 78.760$, $p < 0.01$). Considering the significance of the regression of the variables, the coefficients of the regression equation is shown in Table VIII.

Source	Sum of squares	df	Mean Square	F	Sig.	R	R^2	SE	Durbin-Watson
Regression	7566.81	3	2522.271	173.744	0.01	0.723	0.552	3.801	2.059
Residual	6924.7	477	14.517						
Total	14491.514	480							

Table V. ANOVA of regression between productivity and social influence

Model	B	SE	β	t	Sig.
Constant	4.089	0.32		12.775	0.01
Degree	0.847	0.042	0.714	19.868	0.01
Betweenness	0.002	0.001	0.126	3.775	0.01
Closeness	−5.22	1.837	−0.01	−2.845	0.005

Table VI. The coefficients of regression equation of productivity and social influence

Source	Sum of squares	df	Mean square	F	Sig.	R	R^2	SE	Durbin-Watson
Regression	3290504.93	3	1096834.79	78.76	0.01	0.576	0.331	118.008	2.022
Residual	6642598.44	477	13925.783						
Total	9933103.37	480							

Table VII. ANOVA of regression between performance and social influence

Model	B	SE	β	t	Sig.
Constant	52.11	9.91		5.25	0.01
Degree	12.97	1.31	0.419	9.86	0.01
Betweeness	0.151	0.019	0.319	8.08	0.01
Closeness	−77.86	56.88	−0.057	−1.36	0.172

Table VIII. The coefficients of the regression equation of performance and social influence

The regression coefficients of the predicting variables showed that the degree centrality and the betweenness centrality can significantly predict the variance of the dependent variable (the performance) ($p \leqslant 0.01$). The effect coefficient of the degree centrality ($B = 0.419$) showed that this centrality can significantly predict the variance of the variable performance. Furthermore, the positive significance showed that one-unit increase in the degree centrality can increase 0.419 score in the performance. The effect coefficient of the betweenness centrality ($B = 0.319$) showed that this centrality can significantly predict the variance of the variable performance, and the positive significance showed again that one-unit increase in the betweenness centrality can increase 0.319 score in the performance:

RQ8. Based on individual author profiles, who are the most influential researchers in IB concerning all ideational and social influence indicators?

On the basis of the sum of all six indicators (h-index, g-index, hc-index, degree centrality, betweenness centrality, and closeness centrality), a better depiction of top researchers in IB can be gained. At first, all of the indicators were scores from 0 to 100. In that the score of the researcher with the highest rate in a certain indicator was assumed 100 and the scores of other researchers were assigned relatively based on their placement and taking this maximum score into account. Ideally, a researcher with the highest score in each of these indicators would gain 600 scores in total.

The result showed that Spink A had the highest rank and was the most influential author in the field. The ranks from second to fifth belonged to Nicholas, D., Ford, N., Huntington, P., and Wilson, T.D., respectively (Table IX). Only five researchers have been able to gain more than 400 points:

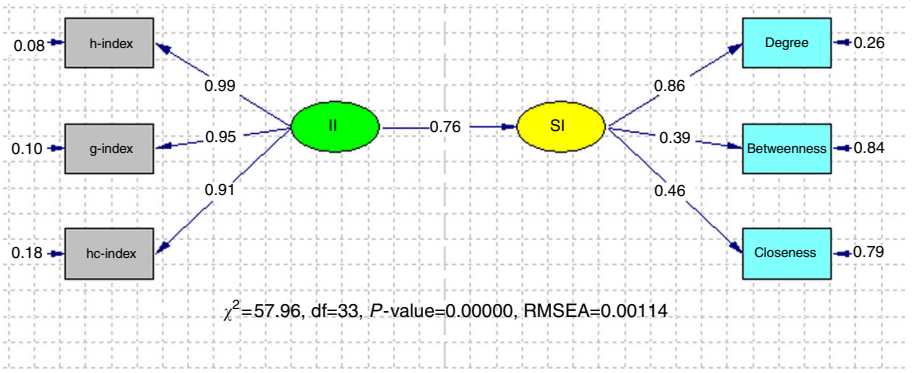
RQ9. Is there any significant relationship between the ideational influence indicators and those of the social influence?

For answering the question, the structural equation modelling (SEM) was used and the results are depicted in Figures 1 and 2 and are shown in Tables X and XI.

As results show, the model has acceptable goodness of fit ($X^2 = 57.96$, $p > 0.05$). Considering the acceptable correspondence between the structural model and experimental data (RMSE = 0.00114, GFI = 0.92), the model is suitable for the ideational influence. Therefore, this model is an appropriate model for ideational influence and social influence.

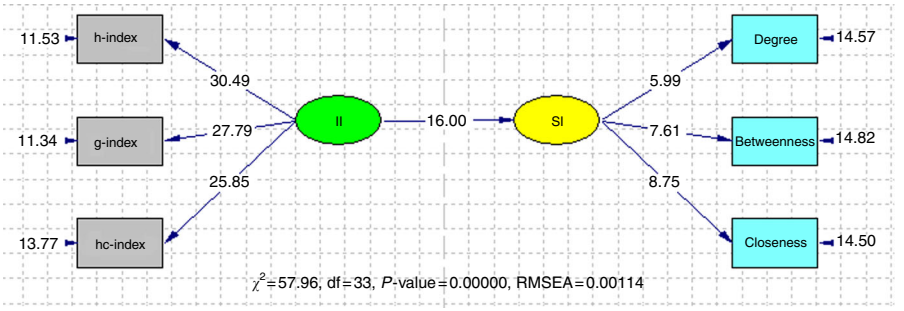
Table IX.
The most influential researchers in IB based on all ideational and social influence indicators

Rank	Name	h-score	g-score	hc-score	DC-score	BC-score	CC-score	Sum of scores
1	Spink, A.	100	100	100	54.34779	36.24144553	99.928689	490.5179203
2	Nicholas, D.	78.94737	78.78788	81.81818	100	7.49907882	99.890038	446.9424574
3	Ford, N.	73.68421	75.75758	72.72727	54.34779	52.69538344	99.931439	429.1436672
4	Huntington, P.	73.68421	69.69697	81.81818	95.65209	3.858890362	99.890038	424.6003805
5	Wilson, T.D.	63.15789	63.63636	72.72727	17.39129	87.24330428	99.959052	404.1151728
6	Jamali, H.R.	68.42105	60.60606	72.72727	67.39125	3.166621923	99.890038	372.2022965
7	Tenopir, C.	57.89474	48.48485	63.63636	41.3043	44.507434	99.940819	355.7685056
8	Savolainen, R.	84.21053	90.90909	90.90909	6.521732	0.320878103	79.306024	352.1773428
9	Bilal, D.	42.10526	36.36364	45.45455	17.39129	88.27962071	99.990017	329.5843687
10	Marchionini, G.	57.89474	60.60606	63.63636	19.5652	25.0998297	99.919836	326.7220234
11	Rowlands, I.	52.63158	42.42424	72.72727	49.99995	2.627328823	99.889473	320.2998429
12	Jarvelin, K.	36.84211	33.33333	45.45455	10.86955	87.38591814	99.978942	313.8643977
13	Vakkari, P.	42.10526	51.51515	54.54545	15.21738	40.2880804	99.99111	303.6624344
14	Foster, A.	36.84211	33.33333	63.63636	32.60866	28.09469609	99.888381	294.40354
15	Fisher, K.E.	57.89474	54.54545	72.72727	19.5652	6.381915768	82.415353	293.5299297



Notes: SI, social influence; II, ideational influence

Figure 1.
The standard structural modelling



Notes: SI, social influence; II, ideational influence

Figure 2.
The significances of coefficients

G.Par.	SRViL	VoMr
χ^2	The difference between observed frequency and expected frequency	57.96
df	$\geqslant 0$	33
χ^2/df	$0 \leqslant \chi^2/df \leqslant 2$	1.76
RFI	$\geqslant 0.9$	94%
CFI	$\geqslant 0.9$	97%
NNFI	$\geqslant 0.9$	95%
NFI	$\geqslant 0.9$	97%
RMSR	$\leqslant 0.05$	4%

Notes: G.Par, goodness of fit index parameters; SRViL, standard recommended value in literature; VoMR, value of model's reliability

Table X.
The indicators of model's goodness of fit

	Direct effects			Indirect effects			Total effects		
Relations	β	t	Sig.	β	t	Sig.	β	t	Sig.
SI↓II	0.76	16	Significance	–	–	–	0.76	16	Significance

Table XI.
The direct, indirect, and total effects of variables on each other

As other indicators in the model, including among others RFI and CFI, are more than 0.90 and RMSR is less than 0.5, the model has expected goodness of fit (Table XI).

Based on the results in Table XI, the direct effect of the social influence variable on the ideational influence variable was 0.76 and in significant level ($t = 16.00$).

Discussion and conclusions

Bibliometric analysis is a useful tool for collecting information on the researchers' states in different scientific fields as well as for evaluating their research output (Zyoud *et al.*, 2014). There has not been any standard yet for identifying the core researchers in a certain field. Lutka and Price identified top researchers based on their published papers and Garfield identified them based on their received citations. The authors recently argue that it is needed to include both papers and citations for identifying top researchers in a certain field (Wang *et al.*, 2012).

The results of this study have shown that researchers such as Spink, A., Savolainen, R., and Nicolas, D. had the highest ideational influence in the IB field. Cool, C., Nicolas, D., and Ford, N. had high authorities and were highly ranked in the social influence in the field. The results have shown that all three centrality indicators (degree, betweenness, and closeness) can predict the variance of productivity. Glanzel and Schubert (2001) found similar results. Stringer (2009) found that the authors with a more central role in the co-authorship network have better research performance (especially research productivity). After identifying prolific and highly cited authors in IB, regression analysis showed a significant relationship between productivity and performance. This part of finding is in line with that of Rumsey-Wairepo (2006) who found a positive relation between productivity and performance. However, this finding is not accorded with that of Abrizah *et al.* (2014) who found that highly productive authors are not necessarily the highly cited ones.

Considering the individual author profiles created concerning all ideational and social influence indicators (the sum of scores in six indicators: h-index, g-index, hc-index, degree centrality, betweenness centrality, and closeness centrality), it was found that Spink, A. was the most influential researcher in IB who gained the highest sum score in these indicators. This author gained the first rank in the paper count or second rank in citation count when considering the primary indicators such as the number of published papers and received citations, with 58 published papers and 1,151 received citations.

On the basis of individual profiles created for individual authors and measuring their h-index variants and ideational and social influence indicators, it appeared that out of three researchers in the field (Figure 3), Spink, A. had a good state in h-index variants and

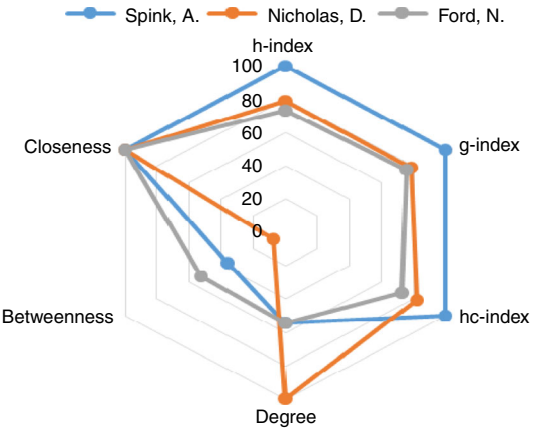


Figure 3.
Top three researchers in IB studies

closeness centrality indicator, but not in degree and betweenness centrality indicators. Nicolas, D. was weak in the betweenness centrality, and Ford, N. was in a relatively similar state.

Several LIS top authors identified by Walters and Wilder (2015) and Li *et al.* (2010) were among IB top researchers revealed in the current study (e.g. Spink, A. Nicholas, D., Savolainen, R., Huntington, P., Jamali, H.R., Ford, N., and Wilson, T.D.). Moreover, most researchers identified as top researchers in the study by Li-Ping (2010), including among others Spink, A., Savalonien, R., Nicolas, D., Wilson, T.D., and Marchionini, D., were top researchers in our study as well.

One of the cases frequently raised in the scientometric studies is that for the evaluation of the effectiveness of a researcher, a series of complementary indicators are to be regarded (Bornmann *et al.*, 2008; Mingers *et al.*, 2012). Many previous studies used the productivity (the number of published papers) as a criterion for evaluating a researcher's scientific influence. Citation-based indicators such as h-index have been applied for measuring a researcher's scientific influence. However, this study applied some integrated indicators for measuring the scientific influence of researchers active in a certain scientific field. The SEM showed some relationship between social influence and ideational influence. In other words, a researcher with top placement in his/her co-authorship network can gain higher ideational influence. In total, it seems that the single and traditional criteria (e.g. number of publications and number of citations) are increasingly replacing new and integrative ones (e.g. social influence and ideational influence) in measuring researchers' scientific influence in scientific fields, including IB studies. It can be, thus, concluded that the use of balanced and compound bibliometric indicators has the capability to provide a relatively fair and clear insight on researchers' influence in a specific field. In this way, it is possible to create individual profiles for all researchers in that field so that the result could be used for important decisions such as tenure and promotion committees, granting research projects, and the like.

The use of appropriate indicators and the coherent combination can lead to the identification of prominent and active researchers in the fields or tend to be the subject. In this way, other researchers will be able to compare their situation with top researchers and be also informed through study and research topics conducted by top researchers. Additionally, they can become familiar with the latest issues in their field. Of course, scientific communication, consultation, and consultation with top researchers are the subsequent works needed.

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