

5-26-2012

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Recommended Citation

Huang, Shu-Hsing and Yang, Jiann-Min, "A Study on the Productivity Review for Management of Performance Using Bibliometric Methodology" (2012). *Eleventh Wuhan International Conference on e-Business*. 4.
<http://aisel.aisnet.org/whiceb2011/4>

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A Study on the Productivity Review for Management of Performance Using Bibliometric Methodology

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Abstract:

This study aimed at investigating the author productivity of performance management related to literature in SSCI database within the year of 1976 to 2011 in order to explore the development of this management. The samples from SSCI database include 922 articles for carry out analysis. Furthermore, this study performed the calculation and verification with the author productivity distribution by Lotka's Law, Price's Square Root Law and 80/20 law separately. We believe our research findings will be referred to industries, government and academia for reference.

The results of this study are summarized as follows: 1. The literature of productivity in performance management has begun to show negative growth from 1976 to 2011; 2. Performance management related researches and publications are dominated by United States and United Kingdom; 3. English is the language prevailing in the literature of performance management; 4. The major type of disciplines in performance management domain is business economy; 5. The value of n parameter and c parameter were -3.7232, 0.8963 respectively in Lotka's Law. Plus, this study also proved that Lotka's law applies to the explanation of the developing trend of literature in performance management by Kolmogorov - Smirnov Test; 6. Further, our research has found that Author productivity could not be explained by Price's Square Root Law or 80/20 Law.

Keywords: Performance Management, Author Productivity, Lotka's Law, Price's Square Root Law, 80/20 Law

1. INTRODUCTION

With the rapid development of information technology and the change of industry type, it is more and more competitive among companies. To gain profit in the market and to have talented people on selection, many corporations get competitive stage by performance management model, especially in hi-tech industry and foreign companies. In recent years, there are many articles of competition strategy、management model、implication for practice specifically for performance management.

Bibliometrics focuses its research target on the specific data, and investigates the increase of literatures by statistical methods. From bibliometrics' viewpoint, the number of literatures will not endlessly increase, but will be saturated and then decayed in a limit point. The data produced by bibliometric research can show the development and tendency of a specific subject or field. Consequently, we are able to conclude that bibliometrics is a reliable and effective enough as a research method. ^[1]

In this paper, we use 922 research papers on performance management from 1976 to 2011 in the SSCI database. We try to search for the productivity of literature in the field of performance management; and meanwhile verify these researches by the distribution law of author productivity in bibliometrics.

The following are the practical research topics and purposes:

What is the number of author publication? Can this number be interpreted as the author productivity-in the performance management field? Whether the author productivity of literature follows the Lotka's Law, Price's Square Root Law, or the 80/20 Law? What fields and institutions does the authors belong to? How's the growth of the number of literatures in performance management? What will the future of the performance management be?

Through the research analysis of productivity, we help researches to understand the distribution of the

literatures in performance management. Moreover, we apply the Lotka's Law to examine the distribution of author productivity, and thus verify the applicability of the important legal provisions to bibliometrics.

2. LITERATURE REVIEW

Performance management mainly focuses on achieving the corporate vision. It could help the corporate managers to figure out the operating results and improve the weaknesses to successfully implement the strategy objectives of the corporate. Also, the corporate is required to offer appropriate feedbacks to the employees to make them be loyal to the corporate, and thus exerts the greatest effect of performance management. Yung-Fu Ho and Kuo-An Yang (1996) pointed out that performance management is a process through measurement, assessment and feedback, and it helps a corporate to allocate its employees appropriately and give each employee appropriate objectives to achieve the greatest effect and lead the corporate to its strategy objectives. Bentley (2006) ^[2] considered that the performance management evaluates personal performance, and gives feedbacks to lead his/her direction of future performance; it has three circulating processes: setting objective, performance assessment, and feedback. Houldsworth (2007) explained performance management by aspect of strategy, composite and claimed that performance management rises personal performance by strategy and integration to improve organizational performance; therefore, in organizational operation, it is a general case to set up an expected target, and evaluate its result number as a practical performance measurement indicator to determine whether the target is achieved or not; this would make the organizational performance value as an integration of the output value. In other words, performance management includes (1) what is the organizational performance to achieve, and (2) how to rise up the organizational performance. ^[3]

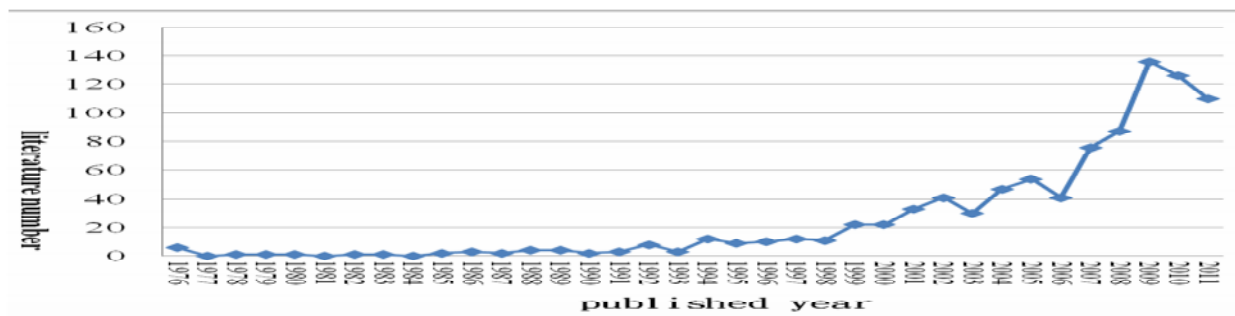
Performance management can improve the organization and increase productivity and value. It is a comprehensive process, including setting objective, performance evaluation system, reward and punishment system, training and developing project, feedback of communication, and the effective assessment on tutoring, career planning, and performance management. Therefore, performance management has been an indispensable element in nowadays corporates. However, performance management is not a new field, but it has developed for more than twenty years. It is questionable that whether this field has already been saturated, or there are still opportunity for research. Under such circumstances, we try to figure out the application of performance management in social science fields in this paper, and analyze its characteristics. We mainly use the Lotka's Law, one of the three great laws in bibliometrics, to investigate the author productivity in the fields related to performance management, and effectively understand the growth of the research literature in performance management.

3. ANALYSIS OF THE DEVELOPMENT IN PERFORMANCE MANAGEMENT

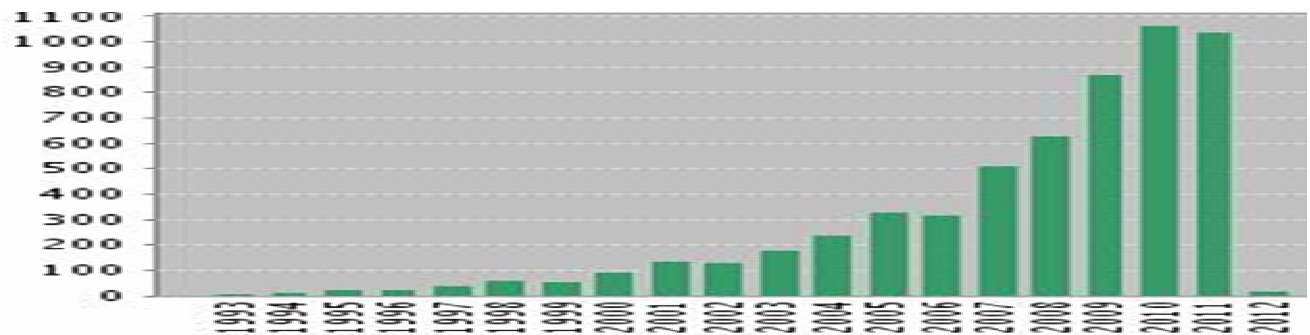
In this paper, we investigate the literatures under the performance management topic in ISI Web Knowledge during the past 36 years (1976-2011). In this database, there are about 6700 scientific technology journals, covering nearly 150 topics, and 2000 journals of social science, covering approximately 50 topics. We search the database mainly by the "Topic" section, with the search method of Title="PERFORMANCE MANAGEMENT" as a restriction, and receive 922 literatures publishing during 1976-2011. The increase of the number of literatures in performance management is shown in graph 1. Also, the number of citations of the literatures is shown in graph 2, which has the same tendency as graph 1. Both of the two increase by year, which shows that although the performance management field has developed for a long time, there are still

multiple issues can be extended.

Graph 1 The increase of the number of literatures in performance management



Graph 2 The citations on performance management of literatures



It can be seen from the increasing tendency in Graph 1 that the number of literatures in topics about performance management has been gradually increased since 1993, greatly increased after 1998, and achieve its peak in 2008 with 136 literatures, accounting for 14.75% in total number of literatures. However, the increase has slowed down since 2010. There are only 126 in 2010 and 110 in 2011, decreasing 10 and 26 compared to that in 2009. It shows a negative growth and tends to decline. The distribution by year of performance management literatures is shown in Table 1.

Table 1 the distribution by year of the publications about performance management

Published year	Published number	Percent
Before 1991	31	3.27%
1992	8	0.87%
1993	3	0.33%
1994	12	1.30%
1995	9	0.98%
1996	10	1.08%
1997	12	1.30%
1998	11	1.19%
1999	22	2.39%
2000	22	2.39%
2001	33	3.58%

2002	41	4.45%
2003	30	3.25%
2004	47	5.10%
2005	54	5.86%
2006	41	4.45%
2007	76	8.24%
2008	87	9.44%
2009	136	14.75%
2010	126	13.67%
2011	110	11.93%
2012	1	0.11%
Total	922	100%

For the distribution by country of the publications concerning performance management, we provide the statistics of the top 10 countries, finding out that the USA has published 313 literatures (33.95%), which is the number one publisher of all countries, followed in the order by 210 literatures of United Kingdom (22.78%), and 52 literatures of both Australia and Canada (5.64%). We investigate the top 10 publication institution, figuring out that most of them are in the USA. It represents the conclusion that the USA and United Kingdom are prominent countries in performance management field. The results are Table 2 and Table 3.

Table 2 the distribution by country of the publications about performance management

Published country	Published number	Percentage
USA	313	33.95%
ENGLAND	210	22.78%
AUSTRALIA	52	5.64%
CANADA	52	5.64%
NETHERLANDS	46	4.99%
PEOPLES R CHINA	30	3.25%
SCOTLAND	26	2.82%
GERMANY	22	2.39%
NEW ZEALAND	20	2.17%
SPAIN	20	2.17%
Others	131	14.21%
Total	922	100.00%

Table 3 the distribution by institution of the publications about performance management

Rank	published institutions	Published number	Percent	Country
1	RUTGERS STATE UNIV	12	1.30%	USA
1	WESTERN MICHIGAN UNIV	12	1.30%	USA
3	UNIV MANCHESTER	11	1.19%	UK

3	UNIV STRATHCLYDE	11	1.19%	UK
5	CITY UNIV HONG KONG	10	1.08%	HK
5	EINDHOVEN UNIV TECHNOL	10	1.08%	NL
5	UNIV BIRMINGHAM	10	1.08%	UK
8	UNIV WISCONSIN	10	1.08%	USA
9	UNIV YORK	9	0.98%	UK
10	FLORIDA STATE UNIV	9	0.98%	USA
10	UNIV LANCASTER	9	0.98%	UK
10	UNIV WARWICK	9	0.98%	UK
	Others	799	86.66%	
	Total	922	100.00%	

Most of the performance management literatures are published as articles, totally reaching the number of 820 (85.06%), followed by proceedings papers, totally 42 literatures (4.36%), shown in Table 4. English as the main publishing language, totally accounts for 896 literatures (97.18%), which can be seen in Table 5.

Table 4 the distribution by document type of the publications about performance management

Document Type	Published number	Percent
ARTICLE	820	85.06%
PROCEEDINGS PAPER	42	4.36%
BOOK REVIEW	39	4.05%
EDITORIAL MATERIAL	29	3.01%
REVIEW	23	2.39%
MEETING ABSTRACT	5	0.52%
LETTER	4	0.41%
BIBLIOGRAPHY	1	0.10%
NOTE	1	0.10%
Total	964	100.00%

Table 5 the distribution by language type of the publications about performance management.

Language Type	Published number	Percent
ENGLISH	896	97.18%
GERMAN	9	0.98%

Observing into the subjects where the performance management literatures are published, we found that 508 pieces are in business economics (55.1%), which is the most and accounting for more than half in the total number. The second one are 178 pieces in public administration (19.31%) and 155 pieces in psychology (16.81%). This result is listed by the order in Table 6. For the literatures related to performance management, in addition to the above three subjects, there are also publications in multiple subjects such as engineering, computer science, administrative education, government law, information system, and health science service. What can be inferred from this phenomenon is that performance management can not only be operated in corporates, but also in schools, hospitals, and any executive bodies. All these institutions can use performance

management to receive record and analyze the performance of their staffs in a past period. Institutions can also improve their subordinates' working performance or even exhume the potential by "assessment" and "feedback". Therefore, all the institutions and group formed by "people" can achieve their objectives by performance management, and thus the subject distribution of performance management literatures will become wider and wider.

Table 6 the distribution by subject areas of the publications about performance management

Rank	Subject Areas	Published number	Percent
1	BUSINESS ECONOMICS	508	55.10%
2	PUBLIC ADMINISTRATION	178	19.31%
3	PSYCHOLOGY	155	16.81%
4	ENGINEERING	48	5.21%
5	HEALTH CARE SCIENCES SERVICES	42	4.51%
6	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	41	4.45%
7	GOVERNMENT LAW	33	3.58%
7	PUBLIC EDUCATIONAL RESEARCH	33	3.58%
9	EDUCATION EDUCATIONAL RESEARCH	32	3.47%
10	COMPUTER SCIENCE	28	3.04%

4. VERIFICATION OF AUTHOR PRODUCTIVITY

4.1 Application and verification of Lotka's Law

There are 1318 authors in 922 literatures from the database. Considering the contribution of each author to be the same, we discover that each author has published 0.69 literatures in average. The detailed distribution is shown in Table 7. In the 1318 authors, four authors have published more than five literatures, with a maximum value 6 and the second highest value 5. Overall speaking, 1314 authors (99%) have published less than five literatures, and 1130 authors (71.93%) have only published one literature, which means that over half of the literatures are published by the authors having only one or two literatures. In other words, most of the authors of performance management literatures are low productivity authors, with only few of them having high productivity.

Table 7 An author distribution and productivity about the publications in performance management.

number	Number of author	Number of author %	Number of author literature	Number of literature%	Number of literature% (accumulated)
1	1130	85.74%	1130	71.93%	71.93%
2	144	10.93%	288	18.33%	90.26%
3	29	2.20%	87	5.54%	95.80%
4	11	0.83%	44	2.80%	98.60%
5	2	0.15%	10	0.64%	99.24%
6	2	0.15%	12	0.76%	100.00%
Total	1318	100.00%	1571	100.00%	

We use Lotka's Law, Price's Square Root Law, and 80/20 Law to verify the author distribution and productivity. For the Lotka's Law, we follow the calculation of least squares difference, and transform the number of literatures and authors to their logarithm value to receive the n and c numbers in Lotka's Law, and

check its satisfaction . The whole process is shown in Table 8.

Table 8 the analysis process by author distribution and productivity situation of the publications about performance management

Number (x)	Number of author (y)	X=ln x	Y=ln y	XY	XX
1	1130	0.0000	3.0531	0.0000	0.0000
2	144	0.3010	2.1584	0.6497	0.0906
3	29	0.4771	1.4624	0.6977	0.2276
4	11	0.6021	1.0414	0.6270	0.3625
5	2	0.6990	0.3010	0.2104	0.4886
6	2	0.7782	0.3010	0.2342	0.6055
Total	1318	2.8573	8.3173	2.4191	1.7748

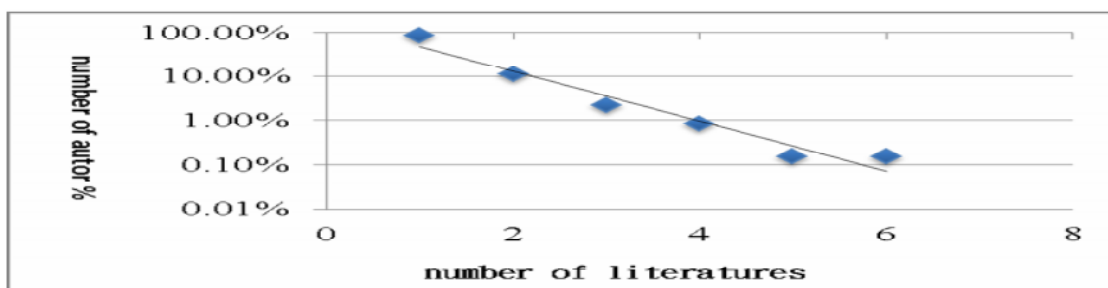
Substituting the calculation results in Table 8 to the following least squares difference equation, we discover that the slope value n is -3.7232, which is also the exponent in Lotka's Law. The equation is

$$n = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2}$$

$$c = \frac{1}{\sum_{x=1}^{p-1} \frac{1}{x^n} + \frac{1}{(n-1)(p^{n-1})} + \frac{1}{2p^n} + \frac{1}{24(p-1)^{n+1}}}$$

P=5, x=1,2,3,4,5,6

We discover that c = 0.8963, 89.63%, which means there are about 90% of all authors have published only one performance management literature. Our n is equal to -3.7232, different from the estimated value of Lotka's Law -2 by 1.7232, and is more close to the practical observed value 0.8574. We also plot the log-log diagram of author productivity by setting number of published literatures as x-axis and number of authors as y-axis, shown in Graph 3. In this diagram, the straight line extending from upper left to right oblique is the straight line of expectation value, and the points are the distribution of practical observed values. However, the distribution points of the authors of published literatures also deviate from the straight line of expectation value. Therefore, the overall distribution curve is not like the straight line result of Lotka's Law, which means it does not completely obey Lotka's Law.



We then examine that whether the distribution of author productivity satisfy Lotka's Low, and use Kolmogorov-Smirnov Test to verify the appropriation of Lotka's Law in our research. The following is the application process of Kolmogorov-Smirnov Test: .^[4]

List observed values and expectation values by the order, and accumulate each one's percentage. Take the

absolute value of the accumulation of observed value and expectation value.

Calculate the limit value (Kolmogorov-Smirnov statistical value) of the research result by equation 1.63/EMBED Equation.3. If the maximum absolute value (D_{max}) of the difference between observed value and expectation value is less than the threshold value, the observed results of our research satisfy Lotka's Law; otherwise, our research result does not coincide with Lotka's Law.

We substitute the $n=3.7232$ and $c = 0.8963$ into equation $c (1/x$ EMBED Equation.3) and receive the author expectation value by Lotka's Law. The result of Kolmogorov-Smirnov Test is shown in Table 9, which gives D_{max} equals 0.0389 and threshold value equals 0.04489. Because the threshold value is greater ($0.04489 > 0.0389$) than the D_{max} value, its observed value obeys Lotka's Law. In other words, Lotka's Law satisfies the research of author productivity of performance management literature.

Table 9 the distribution by author proportional distribution of the publications about performance management.

Number of published literature	Number of author	Author observation	Accumulation of Author observation	Author expectation	Accumulation of author expectation	Balance between observation and expectation
1	1318	0.8574	0.8574	0.8963	0.8963	0.0389(D_{max})
2	144	0.1093	0.9666	0.0679	0.9642	0.0025
3	29	0.0220	0.9886	0.0150	0.9792	0.0095
4	11	0.0083	0.9970	0.0051	0.9843	0.0127
5	2	0.0015	0.9985	0.0022	0.9865	0.0120
6	2	0.0015	1.0000	0.0011	0.9877	0.0123

4.2 Price's Square Root Law

Price's Square Root Law implies that half of the literatures in a topic are written by a group of authors with high productivity, and the number of the high-productivity authors is roughly equal to the square root of the number of all authors. In our research, there are totally 1318 authors, with square root 36.30. According to the definition of Price's Square Root Law, over half of the literatures should be published by 36 authors. However, we observe Table 7 and find that the accumulative number of literatures is about 87, 4.2% of the total number of literatures, when the accumulative number of authors is 36. This number is far from the 50% of total number of literatures required by Price's Square Root Law. We then know that our research does not satisfy Price's Square Root Law.

4.3 80/20 Law

According to 80/20 Law, the 20% authors with high-productivity would publish 80% of the total number of literatures. We use 80/20 Law to examine the distribution of author productivity in our research, show that 20% of the total number of authors is 264, and they 80% of the literatures should be published. However, according to Table 7, in the first 20% authors (264 people), there are 44 people have published more than three papers and 188 people have more than two, and their publications account for 10%~28% of the total publication. This result shows that the number of published literatures of the top 20% high-productivity authors in performance management field is far from 80% of the total number of published literatures, which means that our research does not obey 80/20 Law.

5. Conclusion and discussion

We have analyzed the characteristics of literature development, and thus improve the understanding of the development and future tendency of the subjects. We believe that it is necessary to detect and analyze a large number of literatures to provide the best historical description for the evolution of the subjects.

We inductively collect the results from the comprehensive analysis on the published year, number, institution, and species of the literatures. We investigate the distribution of author productivity in performance management from 1976 to 2011, 36 years totally. According to the developing tendency in this field, we further deeply discuss the factors which may affect the results, and propose the direction of its future development.

The following are the comprehensive description:

5.1 The research result satisfies Lotka's Law

In bibliometrics, there are three Laws: Lotka's Law, Bradford's Law, and Zip's Law. Researches can seek the relationship in literatures by these Laws. Although not all subjects are appropriate to be assessed quantitatively for their ability of research development, we use Lotka's Law to investigate the author productivity distribution in performance management field. We use least squares method to acquire the value of n and constant c , and verify that it satisfies Lotka's Law in our research. In addition, according to the Kolmogorov-Smirnov Test, we further verify that Lotka's Law is appropriate for explaining the developing tendency of performance management literatures.

5.2 The literature of performance management has already been in the mature stage

We investigate the development of performance management field in the past 36 years, from 1976 to 2011. We found that the development was at its peak in 2009, totally published 136 literatures, accounting for 14.75% in the total number, but then the number decreased by 10 to 126 in 2010, declining and showing a negative growth tendency. However, in the new fields of performance management, there are still multiple issues having the potential to be deeply discussed. Generally speaking, the meaning of performance management is just the following steps: the institution decides the performance objectives and indicators and works flexibly to achieve the objectives, and uses the feedback information by evaluating practical performance and report as a basis of making decision. Therefore, this issue has a wide variety of applications. Moreover, in recent years, there are some other extending sub-topics of performance management, such as the c .

These topics are based on the purpose of decreasing the risk from performance by sharing information between the members of the performance. Also, they intend to enhance the connection with the customers and thus achieve the purposes of appearing earlier on the market and reducing the cost. All these would gradually expand the scope of performance management.

5.3 Institutions in the USA and UK dominate the research and literature publication

We investigate the country distribution of the institutions the authors belong to. According to the institution ranking, 9 of the top 10 institutions are in the USA and UK, followed by Hong Kong in Asia as the fifth place. This top 1 institution is the Rutgers, the State University of New Jersey, publishing 12 literatures, and the second one is the City University of Hong Kong by 10. It shows that there is still a gap from Asia to Europe and America in the research of performance management, and there is still a huge space to improve. We propose the academics and industry to investigate how the Asian performance management field is different than in Europe and North America, and thus exhume new research direction in this field.

5.4 English is the main language in the literature of performance management

The 922 literatures in our research are mainly written by two languages. Most of them (896 literatures, 97.18%) are written in English, followed by German as the second most. Currently, performance management

is facing the challenge of globalization, making the performance management not only restricted in domestic phenomena but beyond the country boundaries and developing to a global performance management. Therefore, the global universal language, English, becomes the main language for the discussion between scholars. The other main reason is for the accessibility and effectiveness of academic communication which causes the scholars tend to publish their research results by the international language.

5.5 Performance management field is mainly focus on business economy research

We find that the most literatures in performance management field are about business economy, accounting for 55.10%. This shows that most of the researchers are discussing the proper control of performance management for decreasing reducible waste, thus helping the corporates to be more competitive in global environment. The other researchers are focus on public administration, account for 19.31% as the second most. With rapid corporate change in global environments, the complexity of public affairs increases more and more, therefore, official authorities take the effort on public administration by performance management. This is also one of the critical directions in the research of performance management.

Finally, according to the bibliometrics method applied in our research, one may discuss the productivity distribution in performance management field, and the research results will provide the following applications:

I. In our research, we discuss the productivity distribution in performance management field in our research. Scholars in this field can figure out the currently newest developing tendency of the research in performance field.

II. In our research, we use Lotka's Law to investigate the author productivity, and construct a theoretical pattern for the author productivity distribution of performance management literatures. This can be a reference for the other subjects to evaluate their patterns of author productivity. This pattern can also help researches figure out which research institution has the most publication in performance management field, and thus provide scholars an approach for scholarly exchange and technology collaboration.

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