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Research Output of Academics in the Science and Engineering Faculties of Federal Universities in Southern Nigeria

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Abstract

This paper analysed the research output of academics in the science and engineering faculties of Federal Government-owned universities in Nigeria. It explored their level of research output during 1997-2006 in terms of the publication of journal articles and linked research and publication trends with place of publication and journal title. The stratified random sampling technique was used to select six out of the 13 Federal universities in southern Nigeria. Data on research output were collected through a questionnaire survey of the academics. In all, 435 copies of questionnaire were distributed to the academics, out which 353 copies were returned and only 291 were found usable for the analyses. The study revealed that 30.6% of the academics published between 0-4 journal articles; that only 2.7% of them published 30 or more journal articles during the period; and that as many as 42.1% did not have any article in overseas journals. The study recommends that Nigerian governments, university administrators and other stakeholders in scientific and technological research should improve the research environment in the universities by providing essential research resources. The National University Commission should establish a database of research publications by Nigerian academics to facilitate access to and analysis of data on research productivity.

Keywords

Research output, academics, science, engineering, universities, Lotka's law

Introduction

Scientific and technological discoveries have become an index for measuring the social, political and economic well-being of a nation (Teferra, 2004). Sabo (as cited in Chiemeke et al., 2009) had observed that knowledge accumulation places the advanced countries at the top in terms of the control of social and human capital formation for economic development and for improving living conditions. Research entails the application of intellectual effort in the investigation of matter of either natural or human origin. The aim of research is discovery and development of methods and systems for advancement of human knowledge. The generation, dissemination and applications of research outputs and findings are the basis for industrial innovations and improved productivity and competitiveness at the organisational, societal and national levels. Research output is a means by which academics contribute new knowledge to the existing body of knowledge. This can be in form of journal articles, technical reports, books or chapters of book. Ochai and Nedosa

(1998) stated that in universities the world over, recognition and advancement of academic staff rest largely on the quantity and quality of their research outputs. The publishing of research findings is also an act of information transfer between producers and consumers of information and knowledge.

Bibliometrics is the study of the attributes of and trends in publications, and most bibliometric studies are often done on scientific publications. Ashoor and Chaudry (as cited in Okafor, 2008) emphasised that bibliometric studies are useful for ascertaining indicators of scientific productivity trends and emphasis among researchers in different subject fields, local or overseas publication outlets, and so on. According to Hertzel (2003), bibliometrics also enables comparison of the production of literature in different fields and subfields, periods and countries. In some countries, bibliometric findings are used in deciding on the funding of research in different fields, areas or among persons. Bibliometric findings have also been found useful for collection planning and development in libraries.

The quantity of research could be measured, according to Jacobs (1998) and Popoola (2002), by counting the number of books published, or journal articles produced over a period. Chiemeke et al. (2009) had however emphasised that measurements of research productivity have nearly been the exclusive preserve of developed countries. They also observed that the criteria for determining world class universities are not so much the sizes of students' population or the quality of community services, but the scientific research outputs. It is in this context that there is need in Nigeria for bibliometric studies that investigate periodically the patterns and trends of scientific research outputs, particularly in the science and engineering fields.

This study aimed to contribute to knowledge on the scientific research output and productivity of Nigeria's universities, with specific focus on journal publications by academics in the Federal Government-owned universities in Southern Nigeria.

Research Questions

The following questions guided the data collection:

1. What was the level of research outputs of academics in southern Nigerian universities from 1997-2006?
2. What was the proportion of academic publications in local and overseas journals from 1997-2006?
3. In which local and overseas journals did these academics publish?

Literature Review

Hertzel (2003) described bibliometrics as a quantitative science comprising two main aspects – descriptive and evaluative. The productivity count, which is descriptive, involves countries, time periods and disciplines or subjects, while literature usage count, which is evaluative, involves references and citations. Nisonger (1996) divided bibliometric studies into two categories – journal-based studies, which focus on the characteristics of authors in one journal or in a group of related journals, and individual-based studies, which focus on the publication habits of a defined population. Both types of studies could be based on the counting of research output or citation analysis. The quantity of research output could be observed, according to Narin and Oliviastro (1994), Jacobs (1998) and Popoola (2002) by counting the number of books published and papers produced over a period.

Other bibliometric studies focus on either or both of two important aspects of evaluation research, namely: performance output, and impact. For instance, Shastree (2000) reported that the evaluation strategies at the Technical University of Denmark had focused on estimation of research activity and productivity covering research projects, number of publications, and the relevance of the projects and publications to teaching activities, to international research, and to society.

Russel and Galina (1998) have stated however that, in developing countries, the problem of quality and impact analysis using citations is complicated by the fact that applied research of a local nature is rarely cited, even when published in the mainstream journals. It then means that only a small proportion of research in developing countries would be considered if one has to do citation analysis using the well-known citation indexes. A recent report on research in the third world published in the *Scientific American* addressed this question and referred to the large amount of research that is carried out in developing countries that is practically invisible to the

global scientific community. For instance, Jacob (1998) in his study of publication patterns of South African scientists tried to search through the Science Citation Index (SCI), but found it difficult and disappointing because most of the South African publications were not cited in the SCI. Thus, a complete list of all the journal articles, conference papers and technical reports published by the scientists had to be obtained through correspondence with them individually.

Popoola (2002) used a questionnaire to find out the research output of social scientists in Nigerian universities. To determine the research output of the respondents, they were asked to state the number of their publications that appeared in refereed publication outlets in the preceding three years by types of publication. Publication types were books, chapters in books, journal articles, conference proceedings and technical reports. Journal articles topped the list of research output of respondents in the three years (1999-2001) with a mean of 12.0. On the whole, the social scientists in the Nigerian university system produced an average of 7.0 publications from (1999-2001) with an average of approximately two publications per year. In another study, Oduwole and Ikhizama (2007) used survey method and questionnaire to find out the research output of librarians in Nigerian agricultural research institutes. They found out that the librarians' research output, although generally low, was related to their work experience.

Ashoor and Chaudhry (as cited in Okafor, 2008) found out that the 1,082 papers covered in their study of Saudi scientists were published in 29 different countries. The study also found that although the scientists published in 442 different journals, only 37 of the journals carried the bulk of the papers, constituting the core scientific journals for Saudi libraries. The data shows that Saudi researchers preferred to publish their papers in the USA, which had 546 of the papers (52.9%) while the UK had 252 (23.3%). However, the study was based on the Science Citation Index (SCI). So, all those journals not indexed by SCI were excluded, in addition to articles not published in English.

Aina and Mooko (1999), using library and information science researchers, found out that the researchers published in many countries in most continents of the world, with the United Kingdom having 40.5%, South Africa 19.4%, USA 14.6% and Nigeria 6.8%. A total of 73 journals were used for publishing research findings, out of which 15 published five or more papers. The 15 journals also accounted for about 65.4% of all the journal articles published by the top researchers in the study. In order to publish internationally, some scientists preferred journals published in the USA and UK.

Mehnotra and Lancaster (as cited in Ashoor and Chaudhry, 1993) found out that about half of the Indian scientists published in overseas journals, mostly in journals published in the United States. Lancaster (as cited in Ashoor and Chaudhry, 1993), in his study on the publishing patterns of Brazilian scientists, highlighted that many scientists in developing countries preferred to publish in overseas journals rather than in native journals for the sake of prestige and recognition.

Faria (2008) explored the productivity rankings of economic departments and economists in Brazil. The results showed that only nine out of 506 economists managed to publish at least one paper in top journals of economics, and 52 economists published at least one paper in a wide list of international journals. The areas in which Brazilian research was most internationally successful were development economics, mathematical economics and Post Keynesian economics. However, there were remarkable differences in the academic quality of the departments, with the performance of departments strongly depending on the individual excellence of a very small number of people. The findings suggested that academic productivity in Brazil was low when evaluated by international criteria.

Chiemeke et al. (2009) investigated the research outputs of Nigerian tertiary institutions using nine journals randomly selected from African Journals Online (AJOL). They found that the research papers from Nigeria in the journals accounted for 39.1% of the total number of publications in the journals during 1999-2005. The limitation of the study, however, was that it did not focus on any specific subject area.

The comparatively lower research output of researchers in Nigeria and other developing countries compared to their counterparts in advanced countries reported by some studies may be due to lack of access to adequate information sources. Olukoju (2004) emphasised that due to economic crises, libraries in Nigeria could no longer subscribe to current journals.

Consequently, scholars could no longer keep pace with developments in their fields, and many academics stopped publishing in international journals. Alemna (1996) also emphasised that it is not always easy for scholars in developing countries to get articles published in foreign journals because many of their papers address local issues and problems, which are unlikely to interest overseas audiences. This accounts partly for the high rejection rate of manuscripts sent abroad for publication.

Methodology

Lotka's law is relevant to this study as it provides the fundamental theoretical base for bibliometric studies that focus on author productivity. Lotka was interested in determining the contributions of researchers of different calibre to the progress of science. Lotka found that on plotting the frequencies of persons having made 1, 2, 3, 4… contributions, against the numbers 1, 2, 3, 4 … of contributors, both variables on logarithmic scale, the points were rather closely scattered about an essentially straight line having a slope of approximately 2. To do this, he first considered the volume of production of papers in chemistry and physics by individual scientists. He checked the chemical index of Chemical Abstracts 1907-1916 and counted the number of names beginning with letter A and B. In the cases examined, it was found that the number of persons making 2 contributions was about one-fourth of those making one contribution. Lotka's law states that the number of authors making n contributions is about $1/n^2$ of those making one, and that the proportion of all contributors that make a single contribution is about sixty per cent (Lotka 's law, as cited in Lawani, 1981). This means that out of all the authors in a given field, sixty per cent would have just one publication, while seven per cent of the authors will have three publications. According to Lotka's law of scientific productivity, only six per cent of the authors in a field will produce more than ten articles each.

Lotka used data extracted from the database of Chemical Abstracts to derive his law. Bibliometric research is usually best done using a database of publications. Such database normally provides objective and accurate data pertaining to journals, years and countries wherein the academics publish and even such details as numbers of authors for each publication, citation patterns, etc. However, such databases are not available in Nigeria, and international databases like the Science Citation Index, Social Science Citation Index do not index Nigerian local journals except the African Journal of Library, Archives and Information Science which is covered by the Social Science Citation Index.

Hence, the data for this study were collected not from a database, but through a questionnaire administered on academics sampled from selected Nigerian universities. The questionnaire was used to elicit from individual academics information on the number of their journal articles published during the period 1997-2006. Jacob (1998), Popoola (2002) and Oduwole and Ikhizama (2007) had also used this method to collect similar data for their own studies. However, a limitation of this approach to data collection is that data provided by questionnaire respondents may contain inaccuracies as actual publications or verified database records of such publications are not available to the researcher for verification purposes. Nevertheless, such data would help ascertain the extent of research output of academics published in both indexed and non-indexed journals.

The questionnaire survey was conducted in southern Nigeria, which comprises three geo-political zones – south-east, south-south and south-west. The population of the study consisted of academics in the science and engineering faculties of the first, second and third generation federal universities in the zones. Stratified random sampling at two levels of stratification – zone and generation of university – was used to select two universities from each zone. The first generation universities are University of Ibadan, Ibadan, University of Lagos, Lagos and Obafemi Awolowo University Ile-Ife (South-West); University of Benin, Benin (South-South); and University of Nigeria, Nsukka (South East). South-East and South-West zones do not have second generation universities. It is only south-south that has second generation universities - University of Calabar, Calabar, and University of Port Harcourt, Port Harcourt. Owing to the fact that Southwest and Southeast do not have second-generation universities, the second and third generation universities were lumped together. Within each zone and each generation, if there were more than one university, a university was selected randomly. Zones like South-

South and South-East have one first generation university each. These were automatically included in the sample. South-west has three first generation universities and, through random sampling, the University of Ibadan was selected. In the group of second and third generation universities, a university was randomly selected from each zone.

Ultimately, the following universities were selected: University of Ibadan (UNIBADAN), because it is the oldest federal university in the zone, and the University of Agriculture, Abeokuta (UNAAB) (South West); the University of Benin (UNIBEN) and the University of Uyo (UNIUYO) (South-South); the University of Nigeria, Nsukka (UNN) and Nnamdi Azikiwe University, Awka (NAU) (South-East). A total of six universities were used out of 13, two from each zone.

The respondents sampled from the selected universities were academics ranked Lecturer II or higher. Copies of a questionnaire were given to all the academics on the staff roll of the science and engineering faculties of the sampled universities during data collection in 2006. Out of 435 academics present in the faculties, 353 of them returned their copies, but only 291 were found usable for the data analysis. This represented 66.9% of the academics in the faculties. One of the researchers personally visited the selected universities to administer the questionnaire.

Findings

Research question 1: What is the level of research outputs of academics in southern Nigerian universities?

The level of research output in terms of publications of journal articles is shown in Table 1. A total of 2,769 journal articles were published by the 291 academics. Fifteen of the academics did not have any publication at all, while 17 of them had one publication each. Only one academic published 38 articles. Table 1 also shows that academics with three journal articles were the highest with 8.9%.

Table 1: Numbers of Academics Publishing Numbers of Articles (Local plus Overseas Journals)

Number of journal articles	Number of academics	%	Cumulative %
0	15	5.22	5.22
1	17	5.82	11.04
2	19	6.54	17.58
3	26	8.92	26.50
4	12	4.12	30..62
5	18	6.21	36.83
6	19	6.53	43.36
7	17	5.82	49.18
8	17	5.82	55.00
9	8	2.71	57.71
10	22	7.62	65.33
11	9	3.12	68.45
12	12	4.12	72.57
13	3	1.01	73.58
14	12	4.12	77.70
15	7	2.41	80.11.
16	7	2.41	82.52
17	5	1.71	84.23
18	6	2.12	86.35
19	1	0.33	86.68
20	13	4.52	91.20
21	1	0.33	91.43
22	2	0.70	92.10
23	2	0.70	92.80
24	2	0.70	93.50
25	8	2.71	96.21
26	1	0.33	96.54
27	1	0.33	96.87
28	1	0.33	97.20
30	2	0.70	97.90
31	1	0.33	98.33
32	3	1.01	99.34
33	1	0.33	99.67
38	1	0.33	100.00
Total 2769	291	100.0	

Almost one-third of the academics (30.6%) had 0-4 articles, while only one academic had between

35-39 journal articles.

Research question 2: What is the proportion of academic publication in local and overseas journals?

The articles were categorised into those published in local (Nigerian) and overseas journals, and the frequency distributions are provided in Table 2 and Table 3 respectively. Table 2 shows that 215 academics published 1089 journal articles. Twenty-eight (13%) of the academics did not publish any paper at all in local journals. It also showed that academics with one journal publication had the highest percentage of 12.6 in local journals.

Similarly, Table 3 shows that 214 academics produced 564 articles in overseas journals. Ninety (42.19%) of the academics did not publish at all in overseas journals. The table also shows that 54.7% of the academics published only one journal article. It could be observed from Tables 2 and 3 that articles in local journals outnumbered those in overseas journals by a ratio of about 2:1.

Table 2: Numbers of faculty members publishing numbers of articles in local journals

Number of journal articles	Number of academics	%	Cumulative %
0	28	13.0	13.0
1	27	12.6	25.6
2	24	11.2	36.8
3	23	10.7	47.5
4	15	7.0	54.5
5	20	9.3	63.8
6	19	8.8	72.6
7	14	6.5	79.1
8	8	3.7	82.8
9	6	2.8	85.6
10	5	2.3	87.9
11	4	1.9	89.8
12	7	3.3	93.1
13	1	0.5	93.6
14	2	0.9	94.5
15	1	0.5	95.0
16	1	0.5	95.4
17	1	0.5	95.8
18	2	0.9	96.7
19	1	0.5	97.2
20	2	0.9	98.1
23	3	1.4	99.6
24	1	0.5	100.0
Total 1089	**215**	**100.0**	

Table 3: Numbers of Academics Publishing Numbers of Articles in Overseas Journals

Number of journal articles	Number of Academics	Relative %	Cumulative %
0	90	42.1	42.1
1	27	12.6	54.7
2	20	9.3	64.0
3	18	8.4	72.4
4	15	7.0	79.4
5	12	5.6	85.0
6	6	2.8	87.8
7	7	3.3	91.1
8	3	1.4	92.5
9	3	1.4	93..9
10	3	1.4	95.3
11	1	0.5	95.8
12	3	1.4	97.2
13	1	0.5	97.7
16	2	0.9	98.5
20	1	0.5	99.0
21	1	0.5	99.5
25	1	0.5	100.0
Total 564	214	100.0	

Research question 3: In which local and overseas journals did these academics publish?

The journals in which the academics published were categorised into local and overseas journals. The top 27 local journals and 27 overseas journals were ranked in terms of articles as shown in tables 4 and 5 respectively. The journal, *Mathematical Society of Nigeria,* was the topmost local journal used by the respondents of this study and had 27 of

the journal articles (Table 4). The *Nigerian Journal of Microbiology* followed with 18 journal articles. It is noteworthy that some of the journals were inter-disciplinary journals in which academics from different departments published. It should also be noted that there were many journals with only one or two articles (not shown in the tables).

Table 4: Top Local Journals where the Academics Published

Rank	Local journal	Number of articles
1	Journal of Mathematics Society of Nigeria	27
2	Nigerian Journal of Microbiology	18
3	Journal of Mining and Geology	13
4	Journal of Nigeria Statistical Association	12
5	African Journal of Biotechnology	11
6	Nigerian Journal of Science	11
7	Nigerian Journal of Mathematical Physics	11
8	Nigerian Journal of Botany	11
9	Journal of Chemical Society of Nigeria	8
10	Nigerian Journal of Applied Science	8
11	Nigerian Journal of Solar Energy	7
12	Bioscience Research Communication	7
13	Journal of Scientific and Industrial Studies	6
14	Nigerian Journal of Physics	6
15	Tropical Freshwater Biology	6
16	Journal of Engineering Development	5
17	African Journal of Non-Linear Analysis	5
15	Nigerian Food Journal	5
16	The Zoologist	5
17	Nigerian Journal of Natural Product and Medicine	5
18	The Nigerian Statistician	5
19	Nigerian Journal of Technology	5
20	Journal of Mathematical Association of Nigeria	5
21	Nigerian Journal of Biotechnology	5
22	The Journal of Applied Science and Environment Management	4
23	African Scientist	4
24	Journal of Aquatic Science	3
25	Plants Products Research Journal	3
26	African Journal of Biomedical Research	3
27	African Journal of Environmental Pollution and Health	3

The *Journal of Bioresearch* and *Global Journal of Mathematical Engineering* were the topmost overseas journals with 14 articles each, followed by *Journal of Science and Technological Research* with 10 articles. The titles of these journals suggest that their scopes cut across disciplines in the sciences and engineering, which may be the reason they are the three top journals in terms of numbers of articles. The table also shows that the academics published most in the USA-based journals, with 8 out of the 27 overseas journals published in that country, followed by South Africa and Netherlands with 5 and 4 journals each respectively. Other

Table 5: Top Overseas Journals where the Academics Published

Rank	Overseas journal	Number of articles	Country of Publication
1	Journal of Bioresearch	14	USA
2	Global Journal of Mathematical Engineering	14	India
3	Journal of Science and Technological Research	10	Zambia
4	Global Journal of Pure and Applied Science	7	South Africa
5	Global Journal of Mathematical Science	7	South Africa
6	Journal of Science, Engineering and Technology	6	Malaysia
7	World Journal of Biotechnology	6	Netherlands
8	Journal of Applied Polymer	6	USA
9	World Journal of Biotechnology and Microbiology	6	Netherlands
10	Journal of Tropical Science	6	USA
11	IEEE Transactions on Nuclear Science	5	USA
12	Animal Research International	5	South Africa
13	African Earth science	5	Egypt
14	African Journal of Science	5	South Africa
15	Science Focus	5	Australia
16	Global Journal of Science	5	Canada
17	Journal of Applied Science	5	Pakistan
18	Environmental Geology	5	Netherlands
19	Africa Journal of Electrical Engineering	4	South Africa
20	The Environmentalist	4	Netherlands
21	European Polymer Journal	4	UK
22	Bioresource Technology	3	USA
23	Pakistan Journal of Science and Industrial Research	3	Pakistan
24	African Geo science Review	3	Paris-France
25	Astrophysical Journal	3	America
26	Biometrics	3	USA
27	ASSET	3	USA

countries were India, Zambia, Malaysia, Egypt, Australia, Canada, Pakistan and France.

Discussion

Lotka's law states that the proportion of contributors that makes only one contribution is about sixty per cent. The analyses show that when articles in local and overseas journals are lumped together, the distribution of articles among the academics did not agree with Lotka's law of author productivity. In Table 1 (local and overseas articles together), the percentage of academics that made one contribution was 11%, while in Table 2 (articles in local journals only) it was 25.6%. However, in Table 3 (articles in overseas journals only), the proportion that had one journal article was 54.7%. This shows that the percentage of articles in the overseas journals was close to Lotka's law.

Lotka's law also stated that seven per cent of the authors would have three publications. Table 1 shows that 8.9% of the academics had three articles overall (local and foreign journal articles taken together), while Table 2 shows that 10.7% had three articles in local journals. However, 8.4% of the academics had three journal articles in overseas journals. The percentage of authors that has three articles in overseas journals and in local plus overseas journals were close to Lotka's prediction, but 1.4% and 1.9% higher respectively.

The study revealed low productivity among the academics, as 30.6% of the academics published 0-4 journal articles. Also revealed is that about two-fifth of the academics (42.1%) did not have any article at all in an overseas journal. This may have to do with the problems involved in publishing in overseas journals. Olukoju (2004) emphasised that due to economic crises, Nigerian libraries could not keep up with their journal subscriptions; as a result, many academics also could not keep abreast with the developments in their fields. This often leads to rejection of their manuscripts that attempted to disseminate outdated ideas and findings. Alemna (1998) had lamented that it is not easy to get articles published in overseas journals because many of the submitted papers address local issues and problems which may not be of interest to overseas journals.

Journals in both local and overseas journals where the respondent academics published their articles were compiled and ranked, as shown in Tables 4 and 5. These journals should constitute part of the scientific journals in the library for academics in science and engineering faculties in Nigeria. Therefore, these journals should be considered in building periodical collections, so that Nigerian researchers can build or improve on research work already done. The *Journal of Mathematical Society of Nigeria* was the top local journal used by the respondents of this study. This may be due to the fact that it is a multi-disciplinary journal where academics from various fields like engineering, statistics, physics, etc. publish. On the other hand, *Journal of Bioresearch, Global Journal of Mathematical Engineering* and *Journal of Science and Technological Research* were the top overseas journals. The titles of these journals suggest that their scopes probably cut across disciplines in science and engineering, which may be the reason for their relative popularity among the academics. These three journals are published in the USA, India and Zambia respectively.

The analysis shows that the respondents published more in the USA-based journals, as 8 of the top 27 overseas journals are from the USA. This finding is similar to that of Ashoor and Chaudhry (as cited in Okafor, 2008) who found out that Saudi researchers preferred to publish their papers in the USA, and Mehnotra and Lancaster (as cited in Ashoor and Chaudhry, 1993) who found out that about half of the Indian scientists published in overseas journals that were mostly USA-based. The country where the respondents published second most was South Africa with five journals. Aina and Mooko (1999) had also found out that library and information science researchers in Africa published in a wide range of countries in most continents of the world, but with the United Kingdom being foremost and South Africa coming second.

Conclusion

The economic wealth and prospects of a country depend to a great extent on the volume and quality of scientific and technological research being carried out in the country. The National Universities Commission (NUC) has emphasised that science and technology in Nigeria can be strengthened through planned scientific research and publications in all the higher education institutions in the country. Bibliometric analyses of the research output of academics in science and engineering institutions in the country can help promote in-depth understanding the changing patterns and trends of scientific and technological research and productivity. The findings of this study provide insight and lessons for librarians, academics, university managers, NUC and government. The results of this study showed that the academics publish more in local journals than in overseas journals. The implication is that the research findings of these academics will only have local visibility and impact. Academic research is not meant for one country alone, but should have impact on other countries. Academics should be encouraged to publish in overseas journals so that their work may be known outside the country.

Recommendations

The following recommendations are based on the findings of this study. Firstly, Nigerian academics should be encouraged to publish more in overseas journals. In line with this, some universities have already started emphasising publication in overseas and/or high impact journals as criteria for the promotion of their academics. Secondly, governments and universities should motivate researchers by giving awards and recognition to top and budding researchers, and providing essential resources for quality research in the universities. Finally, the

National University Commission should establish databases of research publications of Nigerians and in Nigeria to enable easy access to information on research output and productivity, as it has been done in some other countries.

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