Research methods: Bibliometrics as an example of LIS methods

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Why it is important to know about different research methods?

- To be able to read and understand the research results in your field (passive research).
- To be able to both design and implement your research (active research).
The most common error made in reading (passive) and conducting (active) research is overlooking the methodology, and concentrating on the conclusions. Yet if the methodology isn’t sound and clear, the research results are hard to prove and use.
Methodology

The underlying theory and analysis of how research is or should be proceed, influenced by scientific discipline paradigm.
Paradigm

Scientific paradigm is:
- what is to be researched,
- conceptual, theoretical and methodological nucleus,
- how the research results should be interpreted.
Methods

Methods are:

- Different techniques for gathering data and other evidence.
- The various ways of proceeding in analysing data and gathering information from it.
An overview of research methods

Qualitative measures:
1. Descriptive,
2. Numbers are not the primary focus,
3. Interpretive, ethnographic, naturalistic.

Quantitative measures:
1. Quantifiable,
2. Numbers are primary focus,
Assessing methods

Research question is the key.
Methods must answer the research question.
Methodology guides application of methods.
Theory guides analysis.
All must include rigor/strictness.
Qualitative methods

- Observe Things
- Report Things
- Interact with people about Things
**Strengths**

1. Observational field work done in the actual context being studied;

2. Focus on how individuals interrelate in their own environment (and the influence of this environment);

3. Helps identify and fill gaps in current knowledge re: perceptions, attitudes, feelings, etc;

4. Helps in understanding of context, production, audience, and text.
Limitations

1. Difficult to interpret/analyze \( \text{(Categories are often fluid)} \);
2. Subjective analysis;
3. Time consuming/expensive;
4. Can influence subject behavior;
5. Can be superficial;
6. Not necessarily representative.
Quantitative methods

- Compare Things
- Count Things
- Survey People About Things
Strenghts

1. An efficient means of gathering large amounts of data;
2. Can be anonymous and inexpensive
   Isolates systematically the most important variables and quantify and interrelate them;
3. Possible to collect large amounts of data;
4. Not as disruptive;
5. Biases not as likely.
Limitations

1. Feedback often incomplete;
2. Wording of instrument can bias feedback;
3. Details often left out;
4. Data restricted to information available, often not well understood.
Quantitative and qualitative

- Qualitative research methods aims at understanding. It answers primarily to how? – questions.
- Quantitative research methods aims at (causal) explanation. It answers primarily to why? – questions.
- Both qualitative and quantitative research methods can aim at description of social reality.
- Complementary - not contradictory
Example

- Bibliometrics and its’ methods.
- Quantitative and qualitative.
What is bibliometrics?

It is the quantitative evaluation of publication and citation data, is used in research performance evaluation in universities and other research institutions, by policymakers, research directors and administrators, information specialists and librarians, and researchers themselves.
Use of bibliometrics

Bibliometrics is often used in applicative context.

Beside research evaluation, bibliometric methods and models can be applied in a large number of context, for example science studies tracing trends and development, research evaluation, knowledge management, Information retrieval, and optimizing library and information resources.
Why bibliometrics?

Nearly all writings about science start with the statement that it is a driving force of our modern society and a starting point for breakthroughs in our knowledge of the world. The funding of science is an important part of investment in the world’s future.
Evaluation

As science became more important, the evaluation of scientific research proved to be crucial.

Bibliometric methods are based on measurable units/publications of scientific results.
Research results (measurable)

- Articles (research results publications in peer-reviewed journals),
- Books (research results publications in books, also peer-reviewed),
  - Chapters in books,
  - Papers in congress publications;
B Lectures in important congresses;
C Research projects;
D Citation (all scientific publications contain references),
E Patents, mentorship etc.
Methods in bibliometrics

Bibliometric methods are designed to study the production, the flow, the organization and the use of information in research settings.

Bibliometric methods are:

- Different techniques for gathering data and other evidence
- The various ways of proceeding in analysing data and gathering information.
Use of methods

These are research methods based on the use of advanced information technology.

They are used also for monitoring and analysis of information resources and for the management of knowledge in social and organisational contexts.
Science = information activity

Science may be understood as information activity (gathering, production and dissemination of information). Basically science was always based on information, although this was not as visible, as it became in modern times.
Theories/ paradigm

Theory of bibliometrics covers general theories dealing with important phenomena of regularities found in scientific communication and information processes.
Quantitative vs. qualitative

Generally there are two ways to evaluate scientific research:

An assessment or review by colleagues, equals, or peers is applied to judge research proposals, the evaluation of research groups, and appointments and promotion of research staff.
Peer review

Peer review is regarded as the qualitative assessment of research performance and is older than its quantitative counterpart, bibliometric indicators.
Subjective vs. objective

The opinions of experts are linked to subjectivity and may have conflict of interest elements or be the result of unrelated factors and negative or positive biases.

But quantitative elements are always present in peer review, and even citations (often used as bibliometric indicators) given to research work can be seen as the judgments or “votes” of colleague-scientists in favor of the work cited.
Sources of data

It is important to understand the use of readily available software, modularly integrated to facilitate full automation of the data gathering and analysis processes, as well as to obtain bibliometric indicators.
Bibliometrical indicators

They are based on different citation databases.

- ISI Web of Knowledge (Thomson Reuters)
- Scopus (Elsevier)
- Google Scholar.
Sources of citation analysis

- Cited References: association of one author to another

- Citation Indexes: were the approach to control the scientific publications and to connect them.
Citations

Main principle:

The more complete and accurate is a reference list, the more guarantee of an article’s content and subsequent review exists.

Authors cite all relevant sources, used in their research.
Citation index

Eugene Garfield, the father of Citation index.

1955 published the article in Science “Citation indexes for science: A new dimension in documentation through association of ideas”

- 1960 established Institute for Scientific Information (ISI),
- 1961 National Institutes of Health ordered first Citation Index.
- 1963 is known under name Science citation Index.
- 1973 Social Science Citation Index
- 1978 Arts&Humanities Citation Index
- Until recently, Web of Science, standard for research evaluation used around the world.
Scopus

New powerfull player, as it is supported by biggest publishing house in the world – Elsevier.

It covers more journals then ISI (18.000 tw. 11.000)
Google Scholar

Freely accessible web search engine, part of a Google, that indexes scientific publications from all disciplines, across the WWW.
Indicators

Are very important addition to databases and search engines:

Examples:

- Impact Factor (IF),
- h-index,
- SNIP and SJR,
- Eigenfactor.
Advantages

- Easy to access, understand, and to use;
- Universal and mathematical (=objective) nature;
- Establish benchmarks;
- Consistent and repeatable.
Obstacles

Important!

- Citation behavior is very different for different research fields.

- Examples:
  - Life Sciences = many articles, lot of references, highly cited, quickly tail off.
  - Mathematics = low citations, continue to be cited for many years.
Important problems

- Self-citations.
- Multi-authorship.
Peer-reviews and bibliometrical methods: Two sides of the same coin?

Based on the article "Scientometric indicators: peer-review, bibliometric methods and conflict of interests."
Project origin

**Target research programmes** represent a system created in 2001 for inter-sectoral cooperation in planning and implementing networked R&D projects for specific areas of public interest.

Slovenian research agency financed it.
Two ways how to evaluate scientific research

Assessment or review by colleagues “equals” or "peers« is applied to judge research proposals, evaluation of research groups, appointments and promotion of research staff. Peer review is regarded as a qualitative assessment of research performance and is older as the quantitative counterpart, bibliometric indicators.
Interrelationship

Bibliometric indicators → Peer reviews → Quality of research

Applied Statistics 2009, Bibliometrics
Research policy

Research evaluation has become a large part of the business of science and technology management. Often this is part of grants decisions process and funds allocation as a part of broader research policy.
Research problem

How the peer assessments and bibliometric methods for research performance assessment are used in practice, support each other, and how can they be compared.
Three Calls for research projects proposals in Slovenia

2002 (2003) with a domestic peer review system designed in such a way that conflict of interest is not avoided efficiently,
2005 with a sound international peer review system with minimised conflict of interest influence, but limited number of reviewers and
2007 (2008) with a combination of bibliometric and a sound international peer review with minimised conflict of interest influence.
Research model

Bibliometric data for all applicants for all calls for proposals are available in Slovenia Research Agency and calculated on the basis of SICRIS. So three different peer review system were used and compared with same set of bibliometric indicators. All three Calls for research projects follow basically the same procedure. Any researcher in Slovenia can write her or his proposal and ask for a grant. It can be either basic or applicative project, the maximum length of three years.
Reviewers

Reviewers have three elements to evaluate:

- B1 research qualification of grant seeker,
- B2 quality of the project and
- B3 social relevance (from 1 to 5).
Results

Results of expert system ARRS, successful applicants

Peer reviews

Bibliometric indicators
Bibliometric indicators

There were two pure bibliometric indicators:
- A1 number of publications;
- A2 number of citations;
- A3 projects (in FTE) that grant seeker had already received from other sources (non-Agency).

All data were normalised to give each indicator value from 0 to 5.
Simulation

Simulation was done based on the presumption, that all proposals would be decided solely on the basis of two bibliometric indicators (A1, A2) and of one scientometrics indicator A3.

The results of this simulation were then compared with actual decision done on the basis of peer reviews.
Simulation results by years 2002, 2005 in 2007

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<tr>
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<tbody>
<tr>
<td></td>
<td>Number of</td>
<td>Bibliometric/Actu-</td>
<td>%</td>
<td>Number of</td>
<td>Bibliometric/Actu-</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>proposals</td>
<td>rally/selected</td>
<td></td>
<td>proposal</td>
<td>rally/selected</td>
<td></td>
</tr>
<tr>
<td>Natural science</td>
<td>60</td>
<td>11/20</td>
<td>55</td>
<td>46</td>
<td>17/24</td>
<td>71</td>
</tr>
<tr>
<td>Engineering</td>
<td>114</td>
<td>15/31</td>
<td>48</td>
<td>114</td>
<td>26/41</td>
<td>63</td>
</tr>
<tr>
<td>Biotechnical sciences</td>
<td>27</td>
<td>1/4</td>
<td>25</td>
<td>39</td>
<td>7/12</td>
<td>58</td>
</tr>
<tr>
<td>Social sciences</td>
<td>54</td>
<td>8/14</td>
<td>57</td>
<td>43</td>
<td>6/10</td>
<td>60</td>
</tr>
<tr>
<td>Humanities</td>
<td>47</td>
<td>4/11</td>
<td>36</td>
<td>33</td>
<td>8/11</td>
<td>73</td>
</tr>
<tr>
<td>All*</td>
<td>302</td>
<td>39/80</td>
<td>49</td>
<td>275</td>
<td>64/98</td>
<td>65</td>
</tr>
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</table>
Simulation results by years 2002, 2005 in 2007 – Natural sciences

<table>
<thead>
<tr>
<th>Natural sciences</th>
<th>2002/2003</th>
<th>2005</th>
<th>2007/2008</th>
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<tbody>
<tr>
<td></td>
<td>Number of proposals</td>
<td>Bibliometric Indicators/Actu. selected</td>
<td>Number of proposals</td>
</tr>
<tr>
<td>Mathematics</td>
<td>8</td>
<td>3/4</td>
<td>1</td>
</tr>
<tr>
<td>Physics</td>
<td>11</td>
<td>0/2</td>
<td>11</td>
</tr>
<tr>
<td>Biology</td>
<td>11</td>
<td>0/2</td>
<td>10</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>2/4</td>
<td>6</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>1</td>
<td>0/1</td>
<td>3</td>
</tr>
<tr>
<td>Geology</td>
<td>5</td>
<td>2/3</td>
<td>2</td>
</tr>
<tr>
<td>Computer intensive methods and applications</td>
<td>1</td>
<td>1/1</td>
<td>2</td>
</tr>
<tr>
<td>Ecology</td>
<td>10</td>
<td>1/1</td>
<td>8</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>5</td>
<td>2/3</td>
<td>3</td>
</tr>
<tr>
<td>All</td>
<td>60</td>
<td>11/20</td>
<td>46</td>
</tr>
</tbody>
</table>
The purpose of the reported statistical analysis was to test the (research or alternative) hypothesis that there is positive association (correlation) between bibliometric scores of research team leaders and peer review selections of research project proposals.
Limitations of analysis

Research project proposals are divided in six research fields and further in about 70 subfields. In many subfields the number of proposals was too small for any statistical analysis. As there is no sense to compare bibliometric scores from different subfields the merging of sparsely populated subfields was not applicable.
Method

- Because the sample sizes were small, Fisher's exact test of significance was used in the analysis of contingency tables 2 x 2.
- In some research subfields, we also applied the Kullback test, and in some the Chi-square test as well.
- Null hypothesis H0: there is no positive association (one-sided test).
- Level of significance: \( \alpha = 0.05 \).
- Fisher's exact test was calculated with the statistical package available on [http://www.langsrud.com/fisher.htm](http://www.langsrud.com/fisher.htm).
Result of statistical analysis for project proposals 2007(2008)

- 270 project proposals (38%) fall in the 15 (21%) subfields where the null hypothesis of no positive association can be significantly rejected (α=0,05).
- For 263 project proposals (37%) in 18 (25%) subfields, the null hypothesis cannot be rejected.
- 178 project proposals (25%) are in 39 (54%) subfields where no significant statistical estimation can be made because of too small population or not enough or too many selected project proposals.
Comparison among three different evaluations (all fields included)

<table>
<thead>
<tr>
<th></th>
<th>2002/03</th>
<th>2005</th>
<th>2007/08</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No. of subfields</td>
<td>No. of proposals</td>
<td>No. of subfields</td>
</tr>
<tr>
<td>H0 rejected</td>
<td>1 (1%)</td>
<td>12 (3%)</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>H0 not rejected</td>
<td>16 (23%)</td>
<td>188 (52%)</td>
<td>15 (21%)</td>
</tr>
<tr>
<td>too scarce</td>
<td>53 (76%)</td>
<td>161 (45%)</td>
<td>53 (76%)</td>
</tr>
<tr>
<td>total</td>
<td>70</td>
<td>361</td>
<td>70</td>
</tr>
<tr>
<td>selected p.</td>
<td>122 (34%)</td>
<td>123 (40%)</td>
<td></td>
</tr>
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</table>
Conclusions

Our results are supporting the conclusions that peer ratings cannot generally be considered as standards to which bibliometric indicators should be expected to correspond. Instead we have found that shortcomings of peer judgements, of the bibliometric indicators, as well as lack of comparability can explain why the correlation was not stronger.
Discussion

We focused on the bibliometric indicators as well as on the peer review side on several specific elements of the assessments, in order to gain more insight into relevant aspects of the evaluation procedures and improve it for the benefit of science policy in Slovenia.
Further research

Peer evaluation and bibliometric assessment showed correlation - the important question is why particular bibliometric indicators correlate more with different peer review systems.