USEFULNESS OF SCIENTIFIC CONTRIBUTIONS

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Abstract: *The prevailing role of counting citations over the added scientific value evaluating distorts the scientific society. As result, the scientific work becomes a kind of business, for instance, to obtain as more citations as possible. It is important to counterbalance the role of counting citations by using additional qualitative criteria. The aim of this survey is to discuss an approach based on measure of “usefulness of scientific contribution” called “usc-index” and published in [Markov et al, 2013]. It is grounded on theory of Knowledge Market. In accordance with this, we remember main elements of this theory. After that we recall some information about Bibliometrics, Scientometrics, Informetrics and Webometrics as well as some critical analyses of journals’ metrics and quantity measures. Finally, we outline the approach for evaluation usefulness of the scientific contributions.*

Keywords*: Information Market, Knowledge Market, Usefulness of the Scientific Contributions*

ACM Classification Keywords*: A.1 Introductory and Survey*

Introduction

The main goal of this paper is to continue the investigation of Knowledge Markets started in [Ivanova et al, 2001; Markov et al, 2002; Markov et al., 2006; Ivanova et al, 2006].

Now, our attention will be paid to the *Usefulness of the Scientific Contributions (USC)*.

What is “scientific contribution”? May be the most popular understanding is:

(1) The *added scientific value* of the published researcher’s results;

(2) Its impact on obtaining new scientific results registered by corresponded *citations*.

It is very difficult to measure the added scientific value.

Because of this, in recent years, it became very popular to measure the second part – the citations.

There are a number of ways to analyze the impact of publications of a particular researcher. A longtime favorite has been ISI’s (Social) Science Citation Index, which has come to the web as Web of Science. The web has introduced a number of other tools for assessing the impact of a specific researcher or publication. Some of these are Google Scholar, Scopus, SciFinder Scholar, and MathSciNet among many others. In addition, Publish or Perish uses data from Google Scholar, but it automatically does analysis on the citation patterns for specific authors. After searching for an author one can select the papers to analyze and to get metrics such as total citations, cites per year, h-index, g-index, etc. [Peper, 2009]. In the same time, a negative tendency appears.

The prevailing role of counting citations over the added value evaluating distorts the scientific society.

As result, the scientific work becomes *a kind of business*, for instance, to obtain as more citations as possible.

For examples see [Harzing, 2012].

It is important to counterbalance the role of counting citations by using additional qualitative criteria [DORA, 2012; ISE, 2012].

In an early work (1964) Garfield suggested 15 different reasons for why authors cite other publications (reprinted in [Garfield, 1977]). Among these were: paying homage to pioneers; giving credit for related work; identifying methodology; providing background reading; correcting a work; criticizing previous work; substantiating claims; alerts to a forthcoming work; providing leads to poorly disseminated work; authenticating data and classes of fact – physical constants, etc.; identifying original publications in which an idea or concept was discussed; identifying original publication or other work describing an eponymic concept; disclaiming works of others and disputing priority claims.

Similarly, the textual function of citations may be very different. In a scientific article some of the references will represent works that are crucial or significant antecedents to the present work; others may represent more general background literature. For example, reviewing the literature published on this topic during 1965–1980, Henry Small identified *five distinctions*: a cited work may be

1) *Refuted;*
2) *Noted only;*
3) *Reviewed;*
4) *Applied;*
5) *Supported by the citing work*.

These categories were respectively characterized as [Small, 1982]:

1) ***Negative***;
2) ***Perfunctory***;
3) ***Compared***;
4) ***Used***;
5) ***Substantiated***.

Thus, the different functions that citations may have in a text are much more complex than merely providing documentation and support for particular statements [Aksnes, 2005].

The aim of this survey is to discuss an approach for evaluating the "usefulness of scientific contribution" called "***usc-methodology***" [Markov et al, 2013]. It is grounded on theory of Knowledge Market. In accordance with this, the next chapter remembers main elements of this theory. After that we recall some information about Bibliometrics, Scientometrics, Informetrics and Webometrics as well as some critical analyses of journals' metrics and quantity measures. Finally, we outline the approach for evaluation usefulness of scientific contributions. In more details, the chapters of the paper concern:

- Basic concepts of Knowledge Markets' Theory;
- Structure of the Knowledge Market;
- Science, Publishing, and Knowledge Market;
- National and International Knowledge Markets;
- Bibliometrics, Scientometrics, Informetrics and Webometrics;
- Citation tracking and Evaluation of Research;
- Journal metrics;
- Quantity measures;
- Disadvantages of journal metrics and quantitative measures;
- Evaluation of Scientific Contributions;

Basic concepts of Knowledge Markets' Theory

Information society

At the stage of social growth, called "information society", the information and information activities get decisive value for existence of the separate individuals or social teams. Certainly, at earlier stages of development of mankind, the information had important value too. But never, in all known history, other means for existence have been so dominated by the information means as it is in the information society [Markov et al., 2006].

From the origin, human society has been "information" one, but levels of information service differ in different periods of existence of societies. It is possible to allocate following levels of information society:

- *Primitive* (people having knowledge, letters on stones etc.);
- *Paper based* (books, libraries, post pigeons, usual mail etc.);
- *Technological* (telephone, telegraph, radio, TV, audio- and video-libraries etc.);
- *High-Technological* (computer systems of information service, local information networks etc.);
- *Global* (global systems for information service, opportunity for everybody to use the information service with help of some global network etc.).

The information society does not assume compulsory usage of the information services by a part or all inhabitants of given territory. One very important feature thus is emphasized: for everyone will be necessary diverse and qualitative (from his point of view) information, but also everyone cannot receive all necessary information. *The enterprising experts will accumulate certain kinds of information* and will provide existence through favorable to them information exchange with the members of the society. Thus, in one or other form, they will carry out **payable information service (carrying out information services for some income)** [Ivanova et al, 2001]. This is the background of ***Information Market***.

Knowledge Information Objects

The usual understanding of the verb "**to know**" is: "*to have in the mind as the result of experience or of being informed, or because one has learned*"; "to *have personal experience of something*" etc. The concept "**knowledge**" usually is connected to concepts "understanding" and "familiarity gained by experience; range of information" [Hornby et al, 1987] or "organized body of information" [Hawkins, 1982].

V.P. Gladun correctly remarks that the concept "*knowledge*" does not have common meaning, especially after beginning of it's using in technical lexicon in 70-ies years of the last century. Usually, when we talk about the human knowledge we envisage all information one has in his mind.

Another understanding sets the "knowledge" against the "data". We talk about data when we are solving any problem or are making logical inference. Usually the concrete values of given quantities are used both as data and descriptions of objects and interconnections between objects, situations, events, etc.

During decision making or logical inference we operate with data involving some other information like descriptions of the solving methods, rules for inference of corollaries, models of actions from which the decision plan is formed, strategies for creating decision plans, and general characteristics of objects, situations, and events.

In accordance with this understanding, the "knowledge" is information about processes of decision making, logical inference, regularities, etc., which, applied to the data, creates any new information [Gladun, 1994].

The knowledge is a structured or organized body of information models, i.e. the knowledge is information model, which concerns a set of information models and interconnections between them.

Let remember, in general, the information model is a set of reflections, which are structured by Subject and, from his point of view, represents any entity [Markov et al, 2001].

The information objects, which contain information models, are called ***“knowledge information objects”***.

Knowledge Market

The growth of societies shows that the knowledge information objects become important and necessary articles of trade. The open social environment and market attitudes of society lead to arising of *knowledge customers* and *knowledge sellers*, which step-by-step form "Knowledge Markets" [Markov et al, 2002].

As the other markets, the ***Knowledge Market*** *is organized aggregate of participants, who operate following common rules and principles*. The knowledge market structure is formed by a combination of mutually-connected elements with simultaneously shared joint resources.

Staple commodities of knowledge market are knowledge information objects.

The knowledge information bases and tools for processing the knowledge information objects, such as tools for collecting, storing, distributing, etc., form the knowledge market environment. The network information technologies enable to construct uniform *global knowledge market environment*. It is very important, it to be friendly for all knowledge market participants and open for all layers of the population without dependence from a nationality, social status, language of dialogue, place of residing. The decision of this task becomes a crucial step of humanization of all world commonwealths.

In the global information society, on the basis of modern electronics, the construction of the global knowledge market, adapted to the purposes, tasks and individual needs of the knowledge market participants is quite feasible, but the achievement of this purpose is connected to the decision of a number of scientific, organizational and financial problems. For instance, the usual talk is that *at the Knowledge Market one can buy knowledge*. But, from our point of view, *this is not so correct*.

In global information society, the e-commerce becomes fundamental for the Knowledge Market. The advantages of e-commerce are obvious. In the same time there exist many risks for beginners at this kind of market. From this point of view, the society needs to provide many tasks for training the citizens to use properly opportunities of the new environment [Markov, 1999]. Let consider an example.

When an architect develops any constructive plan for future building, he creates a concrete “*information object*”. Of course, he will sell this plan. This is a transaction in area of the *Information Market*.

Another question is: from where does architect have received the skills to prepare such plans? It is easy to answer – he has studied hardly for many years and received knowledge is the base for his business. Textbooks and scientific articles are not concrete information for building concrete house, but they contain the knowledge needed for creating such plans.

The scientific books and papers written by the researchers (lecturers) in the architectural academy are special kind of “information objects” which contain special generalized information models. They are “*knowledge information objects*” which have been sold to students and architects.

Here we have a kind of transactions at the “*Knowledge Market*”.

We have to take into consideration the *difference between responsibility* of architect and lecturer (researcher).

If the building collapses, the first who will be responsible is architect, *but never lecturer!*

In beginning of the XX-th century, the great Bulgarian poet Pencho Slaveikov wrote:

"The speaker doesn't deliver his thought to listener, but his sounds and performances provoke thought of the listener. Between them, a process performs like lighting the candle, where the flame of the first candle is not transmitted to another flame, but only cause it."

If one buys a candle what does he really buy – "wax" or "light" of candle? The light is not for sale in the store… But one really may see the example how the candle works and how it may be used. Based on this he/she may decide whether to buy the candle or not.

We came to the main problem we need to point – t*he authors and publishers are not responsible for what they sold to the customers*. Pros and Cons of (electronic) Publishing are discussed many times (see for instance [NLC, 2004]). From customers' point of view, it is difficult to discover what really we will receive if we will buy one (electronic) publication. The title and announcement of the publications are not their content. The customers could not claim damage if the content is not what it is needed. To regulate this process we need specialized rules and standards for knowledge markets as well as corresponded laws for *authors' and publishers' responsibility*.

The scientific work usually is reported as series of publications in scientific journals. The practice is to delegate social rights to editors and reviewers to evaluate the quality of reported results.

And here we see serious problem – *is their evaluation enough? Of course,* ***it isn't!***

Because of this, counting of citations became important. But, the citations may be of different types including negative ones. We need methodology for evaluating *Usefulness of the Scientific Contributions (USC).*

Structure of the Knowledge Market

The Structure of the Knowledge Market was presented in [Markov et al, 2002]. The updated scheme of the basic structure of Knowledge Market is outlined on Figure 1 below.

Let's remember basic elements of the knowledge market.

Employer (Er) is the initial component of the Knowledge Market whose investments support providing the scientific research. The concept of Employer means men or enterprise, which need to buy manpower for the purposes of the given business. A special case is the government of the state which may be assumed as representative of the society as Employer. In addition, different scientific or not scientific foundations, social organizations, etc., may invest in scientific activities and this way to become Employers.

The concept of the ***Employee (Ee)*** means a man who is already taken as a worker in the given business or is potentially to be taken in it. The main interest of the employee is to sell his received knowledge and skills. The main goal of the Employee is to receive maximal financial or other effects from already received knowledge and skills. This means that the Employee is not internally motivated to extend them if this knowledge and skills are enough for chosen work activity. From other point of view the Employee motivation closely depends to future expectations for his social status. The Employee became as converter of the learned knowledge and skills into real results of his workplace. Let remark, that scientific organizations, institutes, groups, etc. may be employed to fulfill some scientific projects and to be in the role of Employee at the KM.

In other words, *Employer* hires *Employees*. During the work processes, the knowledge and skills of Employees are transformed in real products or services. This process is served by the Manpower Market. Employees, even owning a high education level, need additional knowledge to solve new tasks of the Employers. Still, they are **customers of new knowledge**, who arouse necessity of the Knowledge Market, which should rapidly react to the customers' requests. In other words, the Manpower's Market causes activity of the Knowledge Market (KM). These two members of KM are main its components – *the knowledge customers*.

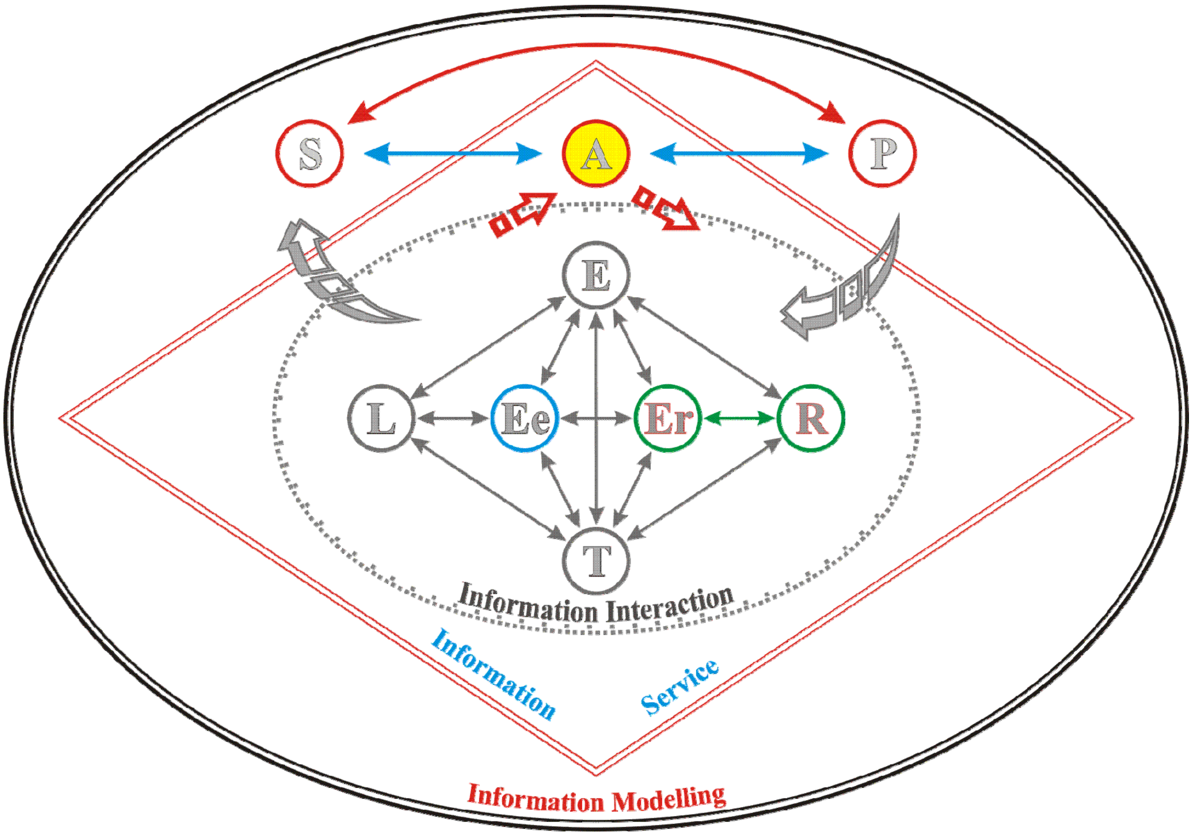


Figure 1. Structure of the Knowledge Market

It is clear that the business needs the high-skilled workers. The employer buys the final result of the cycle in the Knowledge Market - the educated and skilled workers. The continuous changing of technological and social status of the society leads to appearance of new category – industrial **Researchers (R)** – peoples/organizations, who have two main tasks:

- To invent and/or promote new technologies to Employers in convenient way to implement them in practice;
- To determine the educational methods for training the staff for using the new technologies.

The educational process is carried out by the **Lecturers (L)**, who transforms new scientific knowledge into pedagogical grounded lessons and exercises. During realizing concrete educational process, Lecturers are assisted by **Tutors (T)** who organize the educational process and supports the Employees to receive the new knowledge and to master theirs skills. At the end of the educational process, a new participant of KM appears – **Examiners (E)** – who test results of education and answer to the question "have the necessary knowledge and skills been received".

These six components of the Knowledge Market, which contact each other via global information network, form the first knowledge market level called **"*information interaction*"**. As far as these components are too much and distributed in the world space, the organization and co-ordination of theirs information interaction needs adequate **"*information service*"**. It is provided by a new component called **Administrators (A)**. Usually the Administrators are Internet and/or Intranet providers or organizations. They ***collect, advertize and sell knowledge objects, sometimes without understanding what really they content.***

The rising activity of knowledge market creates need of developing new general or specific knowledge as well as modern tools for the information service in frame of the global information network. This causes the appearance of high knowledge market level, which allows observing processes, as well as inventing, developing and implementing new knowledge and corresponded systems for information service. This is the **“*information modeling*”** level. It consists of two important components – the academic researchers called here **Scientists (S)** and the **Publishers (P)**. In this paper we will discuss more deeply characteristics and activities of both of them.

Of course, the Knowledge Market as a kind of Market follows rules and laws given by social environment. The interrelation between government, social structures, and Knowledge Market need to be studied in separate investigation. In several papers we have already investigate different problems of the Knowledge Market [Ivanova et al, 2001; Markov et al, 2002; Ivanova et al, 2003; Markov et al, 2003].

For years we have seen that the Knowledge Market is very important for growth of science and in the same time it is important scientific area and need to be investigated.

Science, Publishing, and Knowledge Market

Preparing this survey, we have collected more than hundred definitions of terms “*science*” and “*scientific methodology*”. Analyzing them we chose the one of the Britain's Science Council, which has spent a year working out a new definition of the word “science”. The Science Council is a membership organization that brings together learned societies and professional bodies across science and its applications. It was established under Royal Charter in October 2003 and was registered as a charity with the Charity Commission in September 2009. The principal activity of Science Council is to promote advancement and dissemination of knowledge and education in science, pure and applied, for public benefit [BSC, 2013].

The Science Council definition focuses on the pursuit of knowledge rather than established knowledge. It may be the first "official definition of science" ever published. Here's what they've come up with:

> ***"Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence"*** [BSC, 2013].

It defines science as a pursuit, an activity, related to the creation of new knowledge, rather than established knowledge itself. Science is seen as a species of research.

Scientific methodology includes the following [BSC, 2013]:

- Objective observation: measurement and data (possibly although not necessarily using mathematics as a tool);
- Evidence;
- Experiment and/or observation as benchmarks for testing hypotheses;
- Induction: reasoning to establish general rules or conclusions drawn from facts or examples;
- Repetition;
- Critical analysis;
- Verification and testing: critical exposure to scrutiny, peer review and assessment.

The last point is closely connected to publishing activities which are the main way to provide critical exposure to scrutiny, peer review and assessment. In addition, previous published research results have to be taken in account and current results have to be compared and evaluated in accordance to them.

Due to very great number of results to be published, *scientific publishing activities became an industrial branch*. Nowadays, the scientific publishing companies (Publishers "**P"** on Figure 1) compete with others at the knowledge markets in two main areas:

- Collecting original scientific results to be published;
- Market shares where the publications may be sold.

The basic difference between knowledge markets and other kinds of markets consists in the following.

To publish the results of their research is an obligation that professional scientists are compelled to fulfill [Merton, 1957b]. New knowledge, updated by researchers, has to be transformed into information made available to the scientific community. Not only do scientists have to make their work available to the public at large, but they in turn are supposed to have access to the work of their peers. Research is carried out in a context of "*exchange*". Even so, the fact that the system of scientific publication has survived in modern science is due, paradoxically, to scientists' desire to protect their intellectual property. New scientific knowledge is a researcher's personal creation, and claim to its discovery can be laid only through publication [Merton, 1957a].

The "reward system", based on the recognition of work, merely underscores the importance of publication: the only way to spread the results of research throughout the world is to have them published. Publication therefore has three objectives: *to spread scientific findings, protect intellectual property and gain fame* [Okubo, 1997].

The academic researchers (Scientists "**S**" on Figure 1) who produce the new knowledge (presented by knowledge objects to be published) are, in the same time, ***main clients***. In other words, *the source and target groups partially coincide* but they are distributed all over the world. Because of this, information about the published results is accumulated by knowledge market organizers (Administrators "**A**" on Figure 1) who, using special kinds of data bases, serve the interactions between scientists and publishers as well as between both of them and the rest participants of the knowledge markets.

Due to serious *competition between publishers*, the administrators play an extra role – to *range* those using different criteria and this way *to control the knowledge objects' flows*. This is a play for billions of Dollars, Euros, etc. Let see an example from our practice.

We were invited to write a chapter in a scientific monograph to be published by a leading scientific publishing company [Markov et al, 2013a]. The book was published and it became as a staple commodity at the knowledge market. Depending of the format, its price varies between $195 and $390 [Naidenova & Ignatov, 2013]. We were glad to understand that our chapter was evaluated as a good one to be included in an encyclopedic four volumes comprehensive collection of research on the latest advancements and developments [Markov et al, 2013b]. Again, depending of format, the price of the collection varies between $2050 and $4100 [AIRM, 2013].

Let see what income will be received if we assume that the editions have only 250 exemplars and if the editions have 1000 exemplars sold.

In the case with 250 exemplars sold, the income is:

- min: 195x250 + 2050x250 = 48750 + 512500 = 561250 USD;
- max: 390x250 + 4100x250 = 97500 + 1025000 = 1122500 USD.

In the case with 1000 exemplars sold, the income is:

- min: 195x1000 + 2050x1000 = 195000 + 2050000 = 2245000 USD;
- max: 390x1000 + 4100x1000 = 390000 + 4100000 = 4490000 USD.

Concluding this hypothetical accounting we may say that expected income may vary between **500 thousands** and **4.5 millions** of Dollars. Because of this, it is very important to be a "leading" publisher who publishes new and useful results which can be sold. *Unfortunately our income from these editions was **0 (zero) cents**.*

National and International Knowledge Markets

One may remark that for our scientific work we had received salaries, society spend resources for supporting our research via buildings, service workers, etc. Yes, it is truth. But let analyze the situation according the scheme on Figure 1. Two variants of knowledge markets are shown on Figure 2 and Figure 3. The first one is "*national*" KM and second – "*international*" KM. Let analyze them step by step.

The ***National knowledge market*** (Figure 2) is included in the clear boundaries and all processes are connected.

1. The society, via government subsidies and/or concrete national projects, provides financial and organizational support of the scientists and their work.
2. The received results are published and indexed again on the base of financial and organizational support of government subsidies and concrete national projects.
3. Selling the results as printed publications and implementations in practical realizations as well as via the tax mechanism, the society receives some income which in some degree covers the initial expenses.

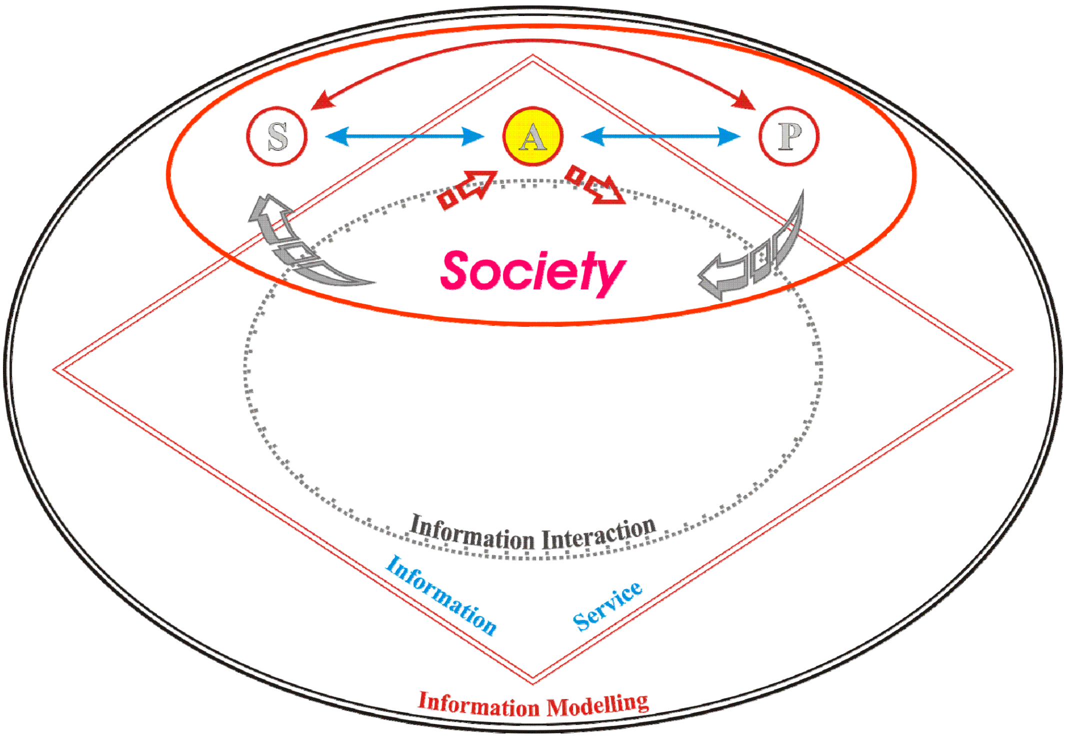


Figure 2. National Knowledge Market

The ***International knowledge market*** (Figure 3) is distributed in the boundaries of separated societies and all processes are financially disconnected.

1. The Society 1, via government subsidies and/or concrete national or international projects, provides financial and organizational support of the scientists and their work.
2. The received results are published in Society 3 and indexed in Society 2 on the base of financial and organizational support of government subsidies and concrete national or international projects.
3. Selling the results as printed publications and implementations in practical realizations as well as via the tax mechanism, the Society 3 receives some income which covers its initial expenses and realizes some profit.

4. Selling informational services based on indexed publications, Society 2 covers its initial expenses and realizes some profit.
5. Only Society 1 has *no profit* but some losses because it spends resources for supporting its scientists but the *surplus value* of their work is accumulated in Society 2 and Society 3.
6. Finally, Society 1 became poor and slowly perishes, but Society 2 and Society 3 became rich and grow.

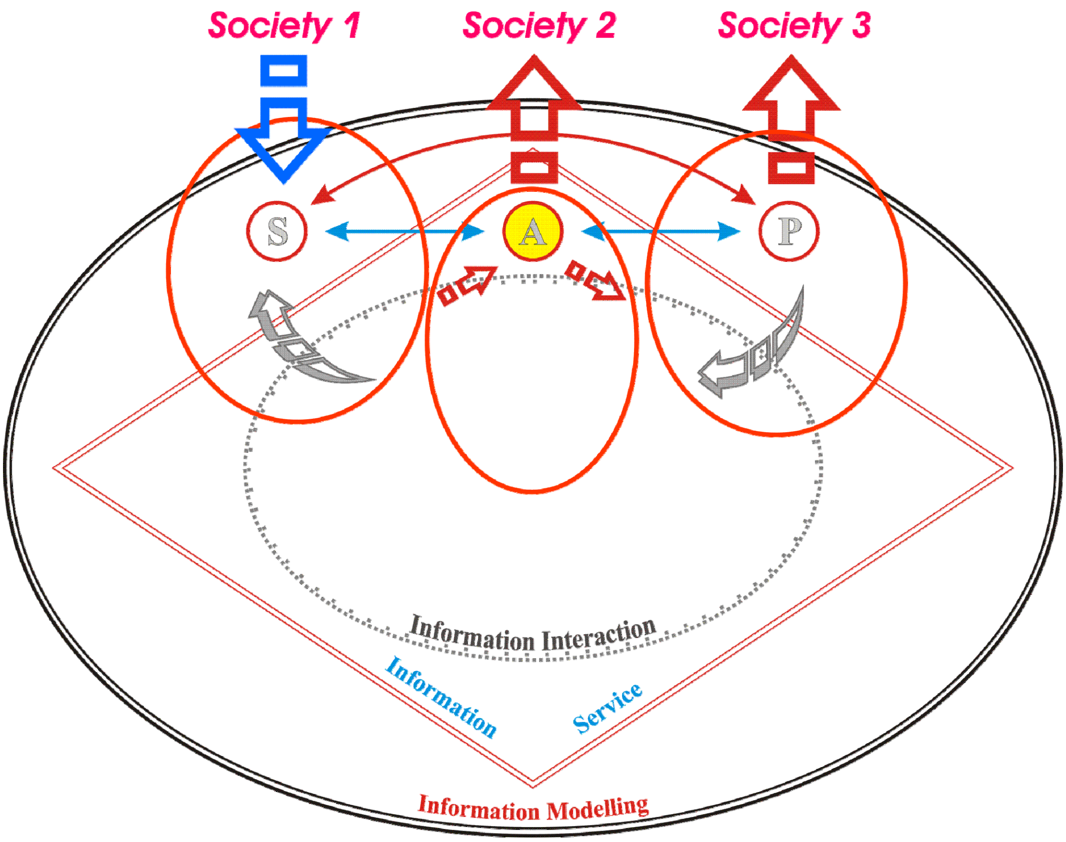


Figure 3. International Knowledge Market

It is important to comment the role of ***international scientific projects***. They give some financial support to the Society 1 but in the same time they orientate scientists towards interests of sponsoring society, usually it is Society 2 or Society 3, both two societies together or one and the same society which plays both roles. As result, the national knowledge market of Society 1 will be *destroyed* and its rebuilding becomes impossible. In opposite, the national knowledge markets of other societies will grow.

Now the main question is "*How to influence to the Society 1 to participate in such unequal battle?*"

The answer is: *By using the power of*

- *Developed national knowledge markets;*
- *Advertising, mainly indirect.*

The best influence is ***the developed national knowledge market*** with participants who are high level specialists in their area. This generates the willingness to join, to be part of them. As more people are involved so great is the influence to other societies. Opening the national knowledge market is very important step. Possibility to be published on such authoritative level is a possible dream. And the result is total influence. In addition, opening the manpower market for specialists from abroad make this dream reality and many scientists start working following the rules of this national knowledge market to ensure possibility for immigration. Finally, they influence on developing the own national knowledge markets to be organized in the same manner and rules as of the prototype one *without taking in account the national specifics and interests*.

The ***advertizing*** (mainly – indirect) of developed national knowledge markets increase their influence. *Advertising* was originated from a Latin term ― “*advertire”*, which means ― “***to turn to***”. The American Marketing Association (AMA) has defined *Advertising* as ― the placement of announcements and persuasive messages in time or space purchased in any of the mass media by business firms, nonprofit organizations, government agencies, and individuals who seek to inform and/or persuade members of a particular target market or audience about their products, services, organizations, or ideas [AMA, 2013].

Indirect advertising is a form of marketing that does not use the formal everyday methods such as newspapers and magazines. This type of advertising uses: a product in a television show**;** giving a product away for free**;** sponsoring of events or activities (= paying for them)**;** etc. [Jeeves, 2013; CBED, 2013].

*“**Audience reach measures**” have been used to determine how many people see the advertising and how often.* Measurement systems exist across the globe that determine how many people in total read certain magazines and newspapers, watch TV programs, listen to radio stations, etc.

For instance, in the US, Roy Morgan Single Source shows that, in year 2005, television is still the most widely used medium (see Figure 4). However, magazines, as a group, reach as many people as ‘free to air’ TV, and more people than newspapers or the Internet. Of course, specific magazines or genres of magazines often outperform specific television ‘shows’ [Levine et al, 2005].

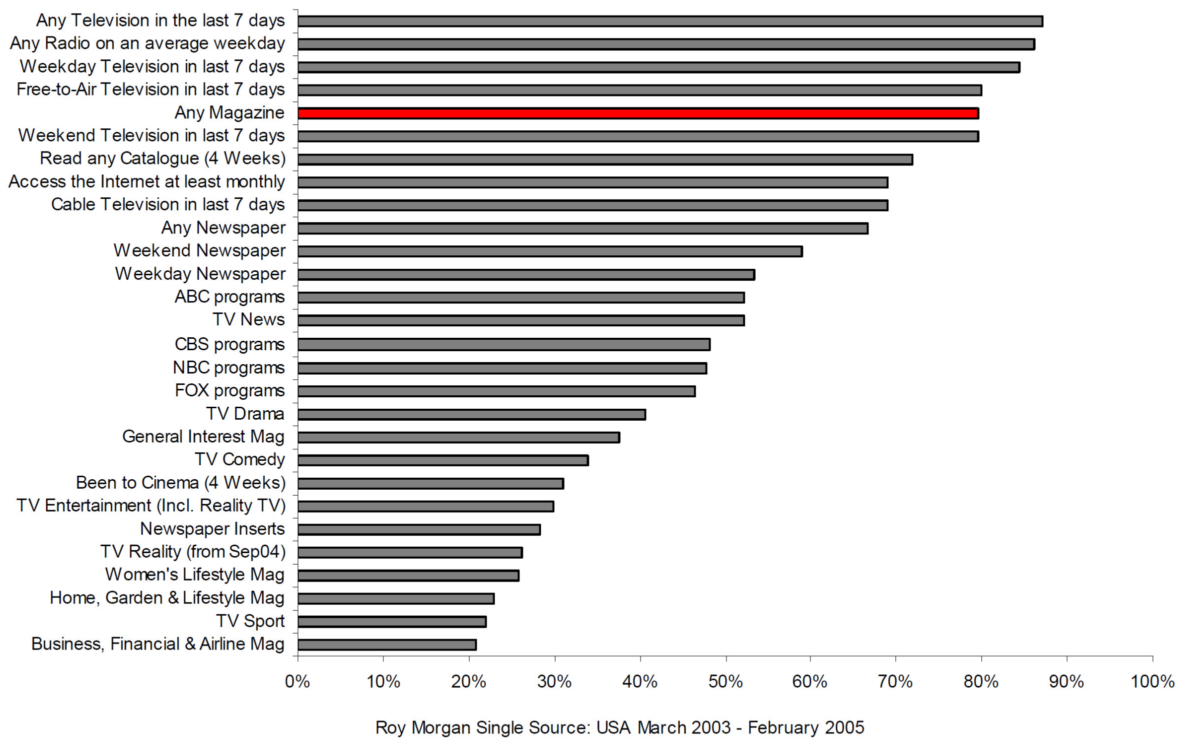


Figure 4. Media Usage in USA for year 2005

One of the movements happening on the internet is that of indirect marketing and advertising. Publishers and manufactures are catching on to what customers want, which is proof that they must invest having a business. Indirect advertising and marketing is often a technique to obtain this, as in most circumstances it supplies something of worth upfront *for totally free*. You are going to see this with no cost eBooks, blogs, and videos all dedicated to helping the visitor.

If the content delivers enough enable, the visitor may just check out the rest of the site and sign up for membership region or buy their premium book. Indirect marketing makes use of a funnel pointing toward the location where the business can make money. Another instance is often observed with no cost apps tied to movies. By downloading the app, you might just want to go see or obtain the movie [EzineMark, 2013].

In order to determine how to create an effective advertising campaign decision makers in the industry use a range of ***measures*** to try to predict the outcome of the campaign. Those who make decisions each year about where to place billions of dollars in advertising have focused in the past primarily on audience or "opportunity-to-see" measures – the task being to create chance that target audience will see advertisement with assumption that everything else will run its course.

Bibliometrics, Scientometrics, Informetrics and Webometrics

The advertisers need to know their audience and ***to measure results achieved – shifts in sales or shifts in attitude*** among the intended audience. Today all marketing and advertising people are judged by the overall performance of their company, each quarter of every year. Research and information is not a substitute for ingenuity. But ignoring intelligent and reliable research and information altogether is a luxury nobody can afford! [Levine et al, 2005]. At the knowledge markets there are two main kinds of indirect advertizing:

- *Ranging selected journals* and this way to raise the income of publishers of these journals and Society 3;
- *Counting citations and computing scientific indexes* based only on digital libraries of collected papers from selected journals and this way to raise income of administrators of these libraries and Society 2.

Measuring science has become an "industry". Governments and their statistical offices have conducted regular surveys of resources devoted to research and development (R&D) since the 1950s. A new science had raised – *Scientometrics*.

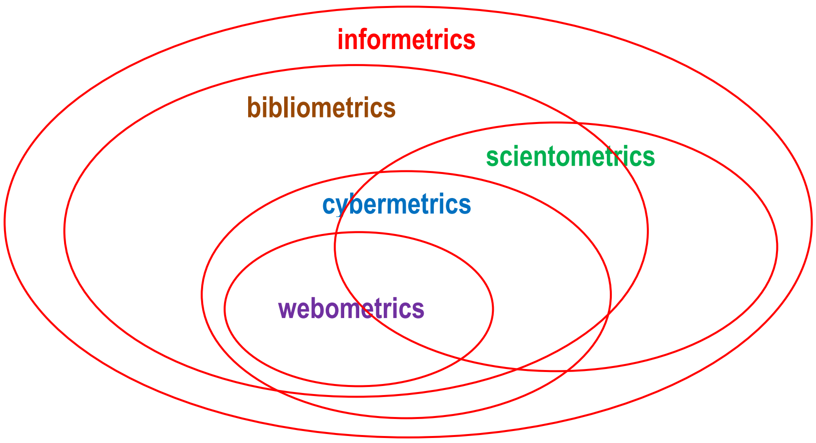
"Scientometrics" is the English translation of the title word of Nalimov's classic monograph "**Naukometriya**" in 1969, which was relatively unknown to western scholars even after it was translated into English. Without access to the internet and limited distribution, it was rarely cited. However, the term became better known once the journal "Scientometrics" appeared in 1978 [Garfield, 2007] and term has grown in popularity and is used to describe the study of science: growth, structure, interrelationships and productivity [Mooghali et al, 2011].

Scientometrics is related to and has overlapping interests with Bibliometrics and Informetrics. The terms Bibliometrics, Scientometrics, and Informetrics refer to component fields related to the study of the dynamics of disciplines as reflected in the production of their literature [Hood & Wilson, 2001]. A whole community of researchers concerned with counting papers and citations called themselves bibliometricians [Godin, 2005].

Among the many statistical analyses of scientific publications, bibliometrics holds a privileged place for counting scientific papers. Bibliometrics is one of the sub-fields concerned with measuring the output of scientific publications. Bibliometrics owes its systematic development mainly to the works of its founders V.V. Naliv, D.J. D. Price and Eugene Garfield in the 1950s. Since 1958 Bibliometrics has evolved as a field, taught in library and information science schools and it emerged as a tool for scientific evaluation for a number research groups around the world. This process was made possible by the work of Eugene Garfield and his "Science Citation Index". Castell, an American psychologist, was credited with the launching of Scientometrics, when he produced statistics on a number of scientists and their geographical distribution, and ranked the scientists according to their performance. He introduced two dimensions into the measurements of science, namely, *quantity* and *quality*. The term informetrics was introduced by Blackert, Siegel and Nacke in 1979, but gained popularity by the launch of the international informertics conferences in 1987. A recent development in informetrics called the webometrics/cybermetrics, has become a part of the main stream library and information science research area. The term webometrics refers to the quantitative studies of the nature of scientific communication over the internet and its impact on diffusion of ideas and information. The inter-relations between Infor-, biblio-, sciento-, cyber-, and webometrics are illustrated on Figure 5 [Thelwall, 2006].

Dirk Tunger gave the next definitions [Tunger, 2007]:

- ***Bibliometrics*** is a study or measurement of formal aspects of texts, documents, books and information;
- ***Scientometrics*** analyses the quantitative aspects of the production, dissemination and use of scientific information with the aim of achieving a better understanding of the mechanisms of scientific research as a social activity;
- ***Informetrics*** is a sub-discipline of information sciences and is defined as the application of mathematical methods to the content of information science;
- ***Webometrics*** is the application of informetrical methods to the World Wide Web (WWW).



Firure 5. Infor-, biblio-, sciento-, cyber-, and webometrics**.**
The sizes of the overlapping ellipses are made for sake of clarity only. [Thelwall, 2006]

Citation tracking and Evaluation of Research

Citation tracking is very important. It allows for tracking of authors own influence, and therefore the influence of organization. It allows tracking the development of a technology, which may be the basis for progress undreamt of when a paper is written. Citation tracking provides information on other organizations and authors who are doing similar work, potentially for collaboration, and identifies publications that cover similar topics. Finally, tracking back in time can find the seminal works in a field [Fingerman, 2006].

The use of scientometric indicators in ***research evaluation*** emerged in the 1960s and 1970s, first in the United States and then also in various European countries. Before that time, research evaluation had not been formalized other than through the peer review system, on the one hand, and through economic indicators which could only be used at the macro-level of a national system, on the other.

The ***economic indicators*** (e.g., percentage of GDP spent on R&D) have internationally been developed by the Organization of Economic Co-operation and Development (OECD) in Paris. For example, the Frascati Manual for the Measurement of Scientific and Technical Activities form 1963 (or its new edition [Frascati Manual, 2002]) can be considered as response to the increased economic importance of science and technology which had become visible in economic statistics during the 1950s.

The idea that scientific knowledge can be organized deliberately and controlled from a mission perspective (for example, for military purposes) was a result of World War II. Before that time the intellectual organization of knowledge had largely been left to the internal mechanisms of discipline formation and specialist communications. The military impact of science and technology through knowledge-based development and mission-oriented research during World War II (e.g., the Manhattan project) made it necessary in 1945 to formulate a new science and technology policy under peacetime conditions.

In 1945, Vannevar Bush’s report to the U.S. President entitled The Endless Frontier contained a plea for a return to a liberal organization of science. ***Quality control should be left to the internal mechanisms of the scientific elite, for example, through the peer review system.*** The model of the U.S. National Science Foundation from 1947 was followed by other Western countries. For example, the Netherlands created its foundation for Fundamental Scientific Research (ZWO) in 1950. With hindsight, one can consider this period as the institutional phase of science policies: the main policy instrument was the support of science with institutions to control its funding [Okubo, 1997].

The attention for the measurement of scientific communication originated from *an interest other than research evaluation*. During the 1950s and 1960s, the scientific community itself had become increasingly aware of the seemingly uncontrolled expansion of scientific information and literature during the postwar period. In addition to its use in information retrieval, the Science Citation Index produced by Eugene Garfield’s Institute of Scientific Information came soon to be recognized as a means to objectify standards [Price, 1963; Elkana et al, 1978]. The gradual introduction of output indicators (e.g., numbers of publications and citations) could be legitimated both at the level of society - because it enables policy makers and science administrators to use arguments of economic efficiency - and internally, because quality control across disciplinary frameworks becomes difficult to legitimate unless objectified standards can be made available in addition to the peer review process [Leydesdorff, 2005].

In 1976 Francis Narin’s pioneering study “Evaluative Bibliometrics” [Narin, 1976] was published under the auspices (not incidentally) of the U.S. National Science Foundation. In 1973 Henry Small had proposed a method for mapping the sciences based on the co-citations of scientific articles. While Small’s approach tried to agglomerate specialties into disciplinary structures, Narin focused on hierarchical structures that operate top-down [Carpenter & Narin, 1973; Pinski & Narin, 1976]. This program appealed to funding agencies like the N.S.F. and N.I.H. that faced difficult decisions in allocating budgets across disciplinary frameworks [Leydesdorff, 2005].

Recent years have seen quantitative bibliometric indicators being increasingly used as a central element in the assessment of the performance of scientists, either individually or as groups, and as an important factor in evaluating and scoring research proposals.

These indicators are varied (see [bibliometric, 2012]), and include e.g.:

- Citation counts of individual papers published by researchers;
- Journal metrics (the impact factors of the journals);
- Measures that quantify personal research contributions over an extended period.

Journal metrics

Journal metrics measure the performance and/or impact of ***scholarly journals***. Each metric has its own particular features, but in general, *they all follow the theories and practices of advertizing and aim to provide rankings* and insight into journal performance *based on citation analysis* (very similar to “audience reach measures” and rankings).

They start from the basic premise that a citation to a paper is a form of endorsement, and the most basic analysis can be done by simply counting the number of citations that a particular paper attracts: more citations to a specific paper means that more people consider that paper to be important.

Citations to journals (via the papers they publish) can also be counted, thus indicating how important a particular journal is to its community, and in comparison to other journals. Different journal metrics use different methodologies and data sources, thus offering different perspectives on the scholarly publishing landscape, and bibliometricians use different metrics depending on what features they wish to study [Elsevier, 2011].

For example, let remember four metrics:

- Journal Impact Factor (IF);
- SCImago Journal Rank (SJR);
- Eigenfactor;
- Source-Normalized Impact per Paper (SNIP).

Journal ***Impact Factor***; is a measure of a journal's average citations per article. The impact factor was computed by dividing the number of citations by the number of articles contained in the journal. This made it possible to eliminate any bias stemming from a journal's size, rendering citation proportional to the number of articles.

The Impact Factor (IF) is the brainchild of Dr. Eugene Garfield, who devised a system of quantifying the number of times a manuscript is referenced in the literature [Teixeira da Silva & Van, 2013]. As indicated by Thomson Reuters (http://thomsonreuters.com/products_services/science/free/essays/impact_factor/), the IF is calculated as an extremely simple equation:

Year impact factor ***IF = C/N***, where ***C*** = Cites to articles published in two previous years (Year-1) and (Year-2) (this is a subset of total cites in current Year); ***N*** = number (sum) of articles published in Year-1 and Year-2.

Developed by Professor Félix de Moya, ***SCImago Journal Rank*** (SJR) [SCI, 2013] is a prestige metric based on the idea that "*all citations are not created equal*". With SJR, the subject field, quality, and reputation of the journal have a direct impact on the value of a citation. This means that a citation from a source with a relatively high SJR is worth more than a citation from a source with a lower SJR.

The essential idea underlying the application of these arguments to the evaluation of scholarly journals is to assign weights to bibliographic citations based on the importance of the journals that issued them, so that citations issued by more important journals will be more valuable than those issued by less important ones. This "importance" will be computed recursively, i.e., the important journals will be those which in turn receive many citations from other important journals [González-Pereira et al, 2009].

SJR assigns relative scores to all of the sources in a citation network. Its methodology is inspired by the Google PageRank algorithm, in that not all citations are equal. A source transfers its own 'prestige', or status, to another source through the act of citing it. A citation from a source with a relatively high SJR is worth more than a citation from a source with a lower SJR. A source's prestige for a particular year is shared equally over all the citations that it makes in that year; this is important because it corrects for the fact that typical citation counts vary widely between subject fields. The SJR of a source in a field with a high likelihood of citing is shared over a lot of citations, so each citation is worth relatively little. The SJR of a source in a field with a low likelihood if citing is shared over few citations, so each citation is worth relatively much. The result is to even out the differences in citation practice between subject fields, and facilitate direct comparisons of sources. SJR emphasizes those sources that are used by prestigious titles [Elsevier, 2011].

The ***Eigenfactor® score*** of a journal is an estimate of the percentage of time that library users spend with that journal. The Eigenfactor algorithm corresponds to a simple model of research in which readers follow chains of citations as they move from journal to journal. Imagine that a researcher goes to the library and selects a journal article at random. After reading the article, the researcher selects at random one of the citations from the article. She then proceeds to the journal that was cited, reads a random article there, and selects a citation to direct her to her next journal volume. The researcher does this *ad infinitum*.

The amount of time that the researcher spends with each journal gives us a measure of that journal's importance within network of academic citations. Moreover, if real researchers find a sizable fraction of the articles that they read by following citation chains, the amount of time that our random researcher spends with each journal gives us an estimate of the amount of time that real researchers spend with each journal. While we cannot carry out this experiment in practice, we can use mathematics to simulate this process [Bergstrom, 2007].

Source-Normalized Impact per Paper (SNIP) corrects for differences in the frequency of citation across research fields. SNIP measures a source's contextual citation impact. It takes into account characteristics of the source's subject field, especially the frequency at which authors cite other papers in their reference lists, the speed at which citation impact matures, and the extent to which the database used in the assessment covers the field's literature. SNIP is the ratio of a source's average citation count per paper, and the 'citation potential' of its subject field. It aims to allow direct comparison of sources in different subject fields.

A source's subject field is the set of documents citing that source. The citation potential of a source's subject field is the average number of references per document citing that source. It represents the likelihood of being cited for documents in a particular field. A source in a field with a high citation potential will tend to have a high impact per paper.

Citation potential is important because it accounts for the fact that typical citation counts vary widely between research disciplines – they tend to be higher in Life Sciences than in Mathematics or Social Sciences, for example. If papers in one subject field contain on average 40 cited references while those in another contain on average 10, then the former field has a citation potential that is four times higher than that of the latter. Citation potential also varies between subject fields within a discipline. For instance, basic journals tend to show higher citation potentials than applied or clinical journals, and journals covering emerging topics tend to have higher citation potentials than periodicals in well established areas.

For sources in subject fields in which the citation potential is equal to the average of the whole database, SNIP has the same value as the 'standard' impact per paper. But in fields with a higher citation potential – for instance, a topical field well covered in the database – SNIP is lower than the impact per paper. In fields in which the citation potential is lower – for instance, more classical fields, or those with moderate database coverage – SNIP tends to be higher than the impact per paper. In this way, SNIP allows you to rank your own customized set of sources, regardless of their subject fields [Elsevier, 2011].

Concluding this chapter we have to remember that a metric in business is a measure used to gauge some quantifiable component of an organization's performance, such as return on investment (ROI), or revenues. Metrics are part of the broad area of business intelligence used to help business leaders make more informed decisions. Organizations often use metrics to develop a systematic approach to transform an organization's mission statement and strategy into quantifiable goals, and to monitor the organization's performance in terms of meeting those goals [GPM, 2010]. At the knowledge market, the journal metrics are aimed for quantitative evaluation the popularity and importance of the journals as well as their impact. These metrics have to be used carefully. They are useful for publishers, librarians and administrators, but are not applicable for evaluating of personal scientific contributions. At first, the quantity personal measures were introduced to achieve this goal.

Quantity measures

Quantity measures that quantify personal research contributions over an extended period are based mainly on the idea of [Hirsch, 2005]. Several papers related to research indices were proposed to assess the quality of the academic research publications. Each one of those indices has its own strengths and weaknesses. The idea of having research indices started when J. Hirsh proposed the H-index [Hirsch, 2005].

Although the H-index has many limitations and seems biased or unfair in many cases, the other proposed indices such as: G-, H(2)-, HG-, Q^2 -, AR-, M-quotient, M-, W-, H_w- ,E-, A-, R- , W-, J-index, etc. considered H-index as a suitable base to produce those other indices with some behavioral enhancements in order to overcome its limitations. In fact, all the other indices are calculated based on the number of citations (originally proposed in H-index) which the authors' papers received. The differences between those indices can be shown through how the index deals with the citations number, as in H-index, G-index, W-index, or in adding new attributes such as time, average…etc as in Contemporary H-index, M-quotient, and AR- index [Maabreh & Alsmadi, 2012]. A review focused in h-Index variants, computation and standardization for different scientific fields is given in [Alonso et al, 2009]. Following [Bornmann et al, 2008] in Table 1 below we remember some definitions of popular indexes.

Table 1. Definitions of the h index and its variants [Bornmann et al, 2008]

Index	Definition
N/yr	Total number of publications (N) divided by years of publishing (yr)
N_{pr}/yr	Number of peer-reviewed publications (N_{pr}) divided by years of publishing (yr)
Cit	Total number of citations (Cit) received by an author
Cit/N	Citations per publication
H index [Hirsch, 2005]	A scientist has index *h* if *h* of his or her N_p published papers have at least *h* citations each and the other (N_p - *h*) papers have fewer than ≤ *h* citations each"
M quotient [Hirsch, 2005]	$\frac{h}{y}$ where *h* = *h* index, *y* = number of years since publishing the first paper
G index [Egghe, 2006]	"The highest number *g* of papers that together received g^2 or more citations"
H(2) index [Kosmulski, 2006]	"A scientist's *h*(2) index is defined as the highest natural number such that his *h*(2) most-cited papers received each at least $[h(2)]^2$ citations"
A index [Jin, 2006]	$\frac{1}{h}\sum_{j=1}^{h} cit_j$ where *h* = *h* index, *cit* = citation counts
M index [Bornmann et al, 2008]	The median number of citations received by papers in the Hirsch core (this is the papers ranking smaller than or equal to *h*)
R index [Jin et al, 2007]	$\sqrt{\sum_{j=1}^{h} cit_j}$ where *h* = *h* index, *cit* = citation counts
AR index [Jin et al, 2007]	$\sqrt{\sum_{j=1}^{h} \frac{cit_j}{a_j}}$ where *h* = *h* index, *cit* = citation counts, *a* = number of years since publishing
H_w index [Egghe & Rousseau, 2008]	$\sqrt{\sum_{j=1}^{r_o} cit_j}$ where *cit* = citation counts, r_o = the largest row index *j* such that $r_w(j) \le cit_j$
Creativity index (C_a) [Soler, 2007]	$\sum_{i=1}^{N_p} \frac{c(n_i, m_i)}{a_i}$ where: N_p=Number of published papers; n_i=Number of references for paper "i"; m_i=Number of citations for paper "i"; a_i=Number of authors for paper "i"; c=not clearly defined in reference

Disadvantages of journal metrics and quantitative measures

At the first glance, the variety of scientific measures seems to be very great and with great differences.

Really, they all are based on counting the citations and similar formulas based or not on additional criteria like prestige of the journals, time periods, number of authors, etc.

The indexes for quantifying personal research contributions are based on same idea of the Hirsh with modifications.

The subject of limitations in research indices is still evolving and with all proposed indices, there are still limitations and weaknesses. Moreover, the large number of available indices may lead to the dispersion of the evaluation, and therefore produce differences in values among research communities or even countries [Maabreh & Alsmadi, 2012].

References may also be negative. An author may be cited for research of a controversial nature or for an error of methodology. Here too, citation does not always measure the quality of research but rather the impact of a particular piece of work or of an individual scientist [Okubo, 1997].

At the end, if an academic shows good citation metrics, it is very likely that he or she has made a significant impact on the field. However, the reverse is not necessarily true. If an academic shows weak citation metrics, this may be caused a lack of impact on the field. However, it may also be caused by: working in a small field; publishing in a language other than English (LOTE); or publishing mainly (in) books [Harzing, 2008].

Sites and tools that are interested in the evaluation of researchers and research publications may have to calculate and display all the indices, and this may cause two issues [Maabreh & Alsmadi, 2012]:

- Large number of indices, if used, may clutter pages and make them unreadable;
- Since most likely values will be different among those indices, and in some cases they may even contradict with each other, such information will be misleading to the reader rather than being helpful or informative.

From the beginning, the quantitative measuring of scientific work has been criticized due to problems raised during evaluation of scientific results. Let point one of the earliest papers "Why the impact factor of journals should not be used for evaluating research" [Seglen, 1997]. Its arguments are still valid:

Problems associated with the use of journal impact factors [Seglen, 1997]

- Journal impact factors are not statistically representative of individual journal articles;
- Journal impact factors correlate poorly with actual citations of individual articles;
- Authors use many criteria other than impact when submitting to journals;
- Citations to "non-citable" items are erroneously included in the database;
- Self citations are not corrected for;
- Review articles are heavily cited and inflate the impact factor of journals;
- Long articles collect many citations and give high journal impact factors;
- Short publication lag allows many short term journal self citations and gives a high journal impact factor;
- Citations in the national language of the journal are preferred by the journal's authors;
- Selective journal self citation: articles tend to preferentially cite other articles in the same journal;
- Coverage of the database is not complete;
- Books are not included in the database as a source for citations;

- Database has an English language bias;
- Database is dominated by American publications;
- Journal set in database may vary from year to year;
- Impact factor is a function of the number of references per article in the research field;
- Research fields with literature that rapidly becomes obsolete are favored;
- Impact factor depends on dynamics (expansion or contraction) of the research field;
- Small research fields tend to lack journals with high impact;
- Relations between fields (clinical v basic research, for example) strongly determine the journal impact factor;
- Citation rate of article determines journal impact, but not vice versa;

Summary points [Seglen, 1997]:

- Use of journal impact factors conceals the difference in article citation rates (articles in the most cited half of articles in a journal are cited 10 times as often as the least cited half);
- Journals' impact factors are determined by technicalities unrelated to the scientific quality of their articles;
- Journal impact factors depend on the research field: high impact factors are likely in journals covering large areas of basic research with a rapidly expanding but short lived literature that use many references per article;
- Article citation rates determine the journal impact factor, not vice versa.

These problems still exist and are object for current discussions. For example, the major disadvantage of the Web of Science is that it may provide a substantial underestimation of an individual academic's actual citation impact. This is true equally for the two functions most generally used to perform citation analyses – for the "general search" and for the Web of Science "cited reference". However, the Web of Science "general search" function performs more poorly in this respect than the "cited reference" function. There are a number of reasons for the underestimation of citation impact by Thomson ISI Web of Science, for instance [Harzing, 2008]:

- Web of Science General Search is limited to ISI-listed journals - In the General Search function Web of Science only includes citations to journal articles published in ISI listed journals [Roediger, 2006]. Citations to books, book chapters, dissertations, theses, working papers, reports, conference papers, and journal articles published in non-ISI journals are not included;
- Web of Science Cited Reference is limited to citations from ISI-listed journals - In the Cited Reference function Web of Science does include citations to non-ISI publications. However, it only includes citations from journals that are ISI-listed.

Both Google Scholar and Thomson ISI Web of Science have problems with academics that have names including either diacritics (e.g. Özbilgin or Olivas-Luján) or apostrophes (e.g. O'Rourke) [Harzing, 2008]:

- In Thomson ISI Web of Science a search with diacritics provides an error message and no results;
- In Google Scholar a search for the name with diacritics will generally not provide any results either.
- For both databases doing a search without the diacritic will generally provide the best result.

The popularity and the wide use of the h-index have raised a lot of criticism.

The most notable and well-documented example of critical view on the h-index (and other "simple" measures of research performance) is the report by the joint Committee on Quantitative Assessment of Research [Adler et al, 2008]. In this report, the authors argue strongly against the use (or misuse) of citation metrics (e.g., the impact factor or the h-index) alone as a tool for assessing quality of research, and encourage the use of more complex methods for judging scientists, journals or disciplines, that combine both citation metrics as well as other criteria such as memberships on editorial boards, awards, invitations or peer reviews. With regard to the h-index (and associated modifications), specifically, [Adler et al, 2008] stress that its simplicity is a reason for failing to capture the complicated citation records of researchers, loosing thus crucial information essential for the assessment of a scientist's research. The lack of mathematical/statistical analysis on the properties and behavior of the h-index is also mentioned. This is in contrast to the rather remarkable focus of many articles to demonstrate correlations of h-index with other publication/citation metrics (i.e. published papers or citations received), a result which according to the authors is self-evident, since all these variables are essentially functions of the same basic phenomenon, i.e. publications [Panaretos & Malesios, 2009].

Besides the above-mentioned works, there are many more articles referring to disadvantages of the h-index. In what follows we list some of the most important disadvantages of the h-index [Panaretos & Malesios, 2009]:

- The h-index is bounded by the total number of publications. This means that scientists with a short career (or at the beginning of their career), are at an inherent disadvantage, regardless of the importance of their discoveries. In other words, it puts newcomers at a disadvantage since both publication output and citation rates will be relatively low for them;
- Some authors have also argued that the h-index is influenced by self-citations. Many self-citations would give a false impression that the scientists' work is widely accepted by the scientific community. Both self-citations and "real" (independent) citations are usually used in the calculation of the h-index. In this context, the emerging problem is that scientists with many co-operating partners may receive many self-citations, in contrast to scientists that publish alone;
- The h-index has slightly less predictive accuracy and precision than the simpler measure of mean citations per paper;
- Another problem is that the h-index puts small but highly-cited scientific outputs at a disadvantage. While the h-index de-emphasizes singular successful publications in favor of sustained productivity, it may do so too strongly. Two scientists may have the same h-index, say, h = 30, i.e., they both have 30 articles with at least 30 citations each. However, one may have 20 of these papers that have been cited more than 1000 times and the other may have all of his/hers h-core papers receiving just above 30 citations each. It is evident that the scientific work of the former scientist is more influential;
- Limitations/differences of the citation data bases may also affect the h-index. Some automated searching processes find citations to papers going back many years, while others find only recent papers or citations;
- Another database related problem often occurring with a significant effect on the correct calculation of the h-index, is that of name similarities between researchers. It is almost impossible to find a scientist with a unique combination of family name and initials while searching the most known citation databases. As a result, in many cases the h-index will be overestimated, since in its calculation the works of more than one researcher are added;
- It seems that the h-index cannot be utilized for comparing scientists working in different scientific fields. It has been observed that average citation numbers differ widely among different fields;

— General problems associated with any bibliometric index, namely the necessity to measure scientific impact by a single number, apply here as well. While the h-index is one 'measure' of scientific productivity, some object to the practice of taking a human activity as complex as the formal acquisition of knowledge and condense it to a single number. Two potential dangers of this have been noted:

(a) Career progression and other aspects of a human's life may be damaged by the use of a simple metric in a decision-making process by someone who has *neither the time nor the intelligence* to consider more appropriate decision metrics;

(b) Scientists may respond to this by maximizing their h-index to the detriment of doing more quality work.

This effect of using simple metrics for making management decisions has often been found to be an unintended consequence of metric-based decision taking; for instance, governments routinely operate policies designed to minimize crime figures and not crime itself.

The disadvantages of the h-index may be seen in the indices which inherit its properties. For instance, some advantages and disadvantages of quantity metrics were outlined by [Thompson, 2009] (see Table 2).

Table 2. Some advantages and disadvantages of quantity metrics [Thompson, 2009]

Metric	Advantages	Disadvantages
N/yr	Measures gross productivity	Definition of "publication" can be arbitrary; No insight into the importance or impact of published works
N_{pr}/yr	Measures gross productivity Eliminates marginal publications	No insight into the importance or impact of published work
Cit	Measures total impact of a body of work	Can be inflated by a small number of papers with high citation counts.
Cit/N	Measures total impact of a body of work normalized by the number of published papers.	Tends to reward low productivity Can penalize high productivity
h-index	Combines quantitative (publication numbers) and impact (citation counts) into a simple whole number. Identifies a set of core, high performance journal articles ("Hirsch core")	Insensitive to highly cited work
M quotient	Allows h-index comparisons between faculty that differ in seniority	Insensitive to highly cited work
G index	Once a paper makes the Hirsh core, additional citations in this group are not counted further; the g index takes these further citations into account	Gives more weight to highly cited papers
H(2) index	Since h(2) index is always smaller then h-index, it is less open to problems of citations accuracy	Possibly overly sensitive to a few highly cited papers

Metric	Advantages	Disadvantages
A index	Calculates the average number of citations in the Hirsch core	Emphasizes more of the impact of the Hirsch core than quantity. Can be very sensitive to a few highly cited papers
M index	Median value may be a better measure of central tendency because of the skewed nature of citation counts	Emphasizes more of the impact of Hirsch core than the quantity.
R index	Involves the Hirsch core but does not “punish” an author for having a high h-index unlike the a-index	Emphasizes more of the impact of the Hirsch core than quantity. Can be very sensitive to a few highly cited papers
AR index	Normalizes the r index by the number of years publishing allowing comparison of younger and more seasoned faculty	Similar to r index
Creativity index (C_a)	Only scholarship metric that proposes to measure creativity	Insufficient data to validate this metric at present. The calculation of the creativity index is not simple, however the author of paper has a free download of a program that will calculate the index

Very important disadvantage of quantitative measures is that they are applicable only to cited papers.

In 1991, David A. Pendlebury of the Philadelphia-based Institute for Scientific Information had published the startling conclusion that

> ***55% of the papers published in journals covered by ISI's citation database did not receive a single citation in the 5 years after they were published*** [Hamilton, 1991].

In his further publication, Pendlebury gave more concrete data. He had written [Pendlebury, 1991]:

“The figures -- 47.4% un-cited for the sciences, 74.7% for the social sciences, and 98.0% for the arts and humanities -- are indeed correct.

These statistics represent every type of article that appears in journals indexed by the Institute for Scientific Information (ISI) in its Science Citation Index, Social Sciences Citation Index, and Arts & Humanities Citation Index. The journals' ISI indexes contain not only articles, reviews, and notes, but also meeting abstracts, editorials, obituaries, letters like this one, and other marginalia, which one might expect to be largely un-cited. In 1984, about 27% of the items indexed in the Science Citation Index were such marginalia. The comparable figures for the social sciences and arts and humanities were 48% and 69%, respectively.

If one analyzes the data more narrowly and examines the extent of un-cited articles alone, the figures shrink, some more than others: **22.4%** of 1984 science articles remained un-cited by the end of 1988, as did **48.0%** of social sciences articles and **93.1%** of articles in arts and humanities journals.

If one restricts the analysis even further and examines the extent of un-cited articles by U.S. authors alone, the numbers are even less "worrisome."

Only 14.7% of 1984 science articles by U.S. authors were left un-cited by the end of 1988.

We estimate the share of un-cited 1984 articles by non-U.S. scientists to be about 28%” [Pendlebury, 1991].

Authors from developing countries

Whatever performance metrics we may use, it appears that ***authors from developing countries*** do face certain constraints in terms of achieving higher performance indices and therefore recognition for themselves and their country. *It is quite possible that authors from advanced countries may tend to cite publications from organizations located in their own countries, leading to a disadvantage for authors working in difficult situations, with less funding opportunities* Since there is a limited page budget and increased competition in many "high-profile" journals, it is *not always possible to publish in these journals*.

One way to overcome this problem is to encourage and give value to papers published in national journals. There are many scientists from developing countries such as India working in highly developed countries with advanced scientific infrastructure and huge funding. These scientists should seriously consider publishing their work in journals originating from their native countries. This will bring an international flavor to the national journals, attracting more international authors and ultimately making them mainstream international journals. When these journals become more visible and easily accessible through their online versions, there is a chance that papers published in these journals are more often cited [Kumar, 2009].

In other words, *developing national knowledge markets became mission important and considerable*.

Mentoring abilities

In addition, we should measure the ***mentoring abilities*** of a scientist. Scientists do research and also mentor younger colleagues. Good mentoring should be a significant consideration of one's contribution to science. The h-index might measure research productivity, but currently there does not appear to be a "*mentoring index*" [Jeang, 2008]. If the coauthors of a scientist are his or her own trainees or students and if they continue to make a scientific impact after leaving their supervisor, it does point to the quality of the mentoring by the scientist and to the impact made by the scientist, as a result of his/her mentoring abilities, in a given area during a given period. This is a very important but totally neglected aspect of the contribution made by a scientist or an academic.

However, *we do not yet have a well–worked out formula to measure such mentoring abilities* [Kumar, 2009].

Evaluation of Scientific Contributions

The products of science are not objects but ***ideas***, means of communication and reactions to the ideas of others. While it is possible simultaneously to track scientists and money invested, it is far more difficult to measure *science as a body of ideas*, or to grasp its interface with the economic and social system. For now, indicators remain essentially a unit of measure based on observations of science and technology as a system of activities rather than as a body of specific knowledge [National Science Foundation, 1989].

Research papers and publications are important indicators for the ability of an author or an education community to conduct research projects in the different human science fields. In general, the number of publications and the increase in this number is a direct indicator of the size or the volume of research activities for a particular author or university. Nonetheless, the number of publications merely, is showed to be a limited indicator to show the impact of those publications. The number of citations for a particular paper is shown to be more relevant and important in comparison to the number of publications. This is why early citation indices such as H-index and G-index gave more weight and important to the number of citations in comparison to the number of publications [Maabreh & Alsmadi, 2012].

Each indicator has its advantages and its limitations, and care must be taken not to consider them as "absolute" indices [Atanassov & Detcheva, 2012; Atanassov & Detcheva, 2013]. The "convergence" of indicators has to be tested in order to put the information they convey into perspective [Martin & Irvine, 1985]

Usefulness of Scientific Contribution

The Main Phases of the Science are

(1) Creation of a Scientific Result;

(2) Registration of the Scientific Result;

(3) Implementation and Using of the Scientific Result.

The bibliometric indexes analyze the second phase – registration of scientific result as (primary) publications and as (secondary) citations. The first and third phases are out of bibliometric scope. This way the evaluating of scientific work became partial and not significant. Practically, the evaluation of scientific results is closed in the contours of the Knowledge Markets (KM) shown at Figure 2 and/or Figure 3, i.e. without taking in account the main knowledge customers of the KM.

A possible step, to counterbalance and to extend consideration to all KM elements shown at Figure 1, is to analyze the publications and citations from point of view of the third phase – ***implementation and using the scientific results*** *by the members of KM.*

A wide spread understanding is that only high qualified ***academic researchers*** (Scientists (S), Figure 1) can evaluate published ideas. They have knowledge and skills to continue research and developing of proposed ideas and via citations they recognize previous research done by other scientists or by themselves. In accordance to *usefulness of cited ideas*, we may separate academic citations on three main groups:

– ***Substantial citations***, which applied or supported the citing work indicating implementation and using the citied results, including "mentoring impact";

– ***Casual citations***, which noted only or reviewed the citing work;

– ***Refuting citations,*** which indicate that the citing work (possibly) has no scientific added value.

Regarding ***industrial researchers*** (Researchers (R), Figure 1) we may make the similar consideration. They have knowledge and skills to implement the published ideas and to evaluate their usefulness for industrial applications. Here the citations are mainly in two groups:

– *Substantial citations*, which applied or supported the citing work indicating implementation and using the citied results, including "mentoring impact";

– *Refuting citations,* which indicate that the citing work (possibly) has no scientific added value to be implemented.

Further analysis of the KM-scheme concerns the educational cycle done by ***Lecturers*** ((L), Figure 1), ***Tutors*** ((T), Figure 1) and ***Examiners*** ((E), Figure 1). Their main goal is to assist Employees in learning of the published ideas. In this cycle, the citations are in text-books, methodical or other supporting publications, and educational learning materials. All such citations we may classify as:

– *Casual citations*, which noted only or reviewed the citing work.

The ***Employees*** ((Ee), Figure 1) may use the received knowledge in their everyday activities. During educational process they may create some new knowledge information objects with or without new ideas. For instance, they may prepare different theses, surveys, guides, papers, etc. In such case, the types of citations may vary, i.e. it may be:

– *Substantial citations*, which applied or supported the citing work indicating implementation and using the citied results, including "mentoring impact";

– *Casual citations*, which noted only or reviewed the citing work;

– *Refuting citations,* which indicate that the citing work (possibly) has no scientific added value.

The ***Employers*** ((Er), Figure 1) are the most important members of KM. They invest both in developing man power as well as in research activities. In both cases the evaluation of usefulness of scientific results is not by citations in papers but by amount of invested assets. This way their citations may be classified only as

– *Substantial citations*, which applied or supported the citing work indicating implementation and using the citied results, including "mentoring impact"

if the amount of investments is over some normalized limit. Usually the investments are provided by scientific or educational projects and because of this we may assume that one project corresponds to one substantial citation.

At the end we have to pay attention to two main distributors of knowledge ***Publishers*** ((P), Figure 1) and ***Administrators*** ((A), Figure 1). After first publishing of the knowledge information objects (papers, books, etc.), Publishers start selling and corresponded advertizing. Main part of advertizing activities is indexing of published materials by different scientific digital libraries and data bases which are inherent for Administrators. All their citations may be classified as:

– *Casual citations*, which noted only or reviewed the citing work.

Transitive citations

The useful scientific results may cause a chain of publications which further use and develop them. This way, transitive citations will exist. Citation chain has to start from a substantial citation and to continue by same type citations because casual citations could not generate such citation chain.

The influence of the scientific ideas is greatest when citation chains exist. Because of this, the *transitive substantial citations* have to be counted as native characteristic of the scientific publications. It is correct to assume that a transitive substantial citation is equal to direct one.

Temporal dimension

There is also a ***temporal dimension*** to the citation process. An article may first be cited for substantial reasons (e.g., its content has been used). Later when a paper is widely known and has obtained many citations the importance of the other mechanisms will increase (authors citing authoritative papers, the bandwagon effect, etc.). In other words, ***visibility dynamics*** become more important over with time because of the self-intensifying mechanisms that are involved. This explains why the relative differences in citation rates between poorly cited and highly cited papers increase over time. Another temporal effect is the phenomenon termed "obliteration by incorporation", meaning that basic theoretical knowledge is not cited anymore. As a consequence, the most basic and important findings may not be among the most highly cited papers because they have been rapidly incorporated into the common body of accepted knowledge [Aksnes, 2005].

Concluding this short survey we have to draw attention to one very important fact.

A great number of publications have no chance to be viewed and further studied because they are published in media with limited and/or payable access. In this case only well-known authors have chance to be recognized and possibly – cited.

Only what is needed is publications to be included in different digital libraries with open access and *as more such libraries exist* in the world so greatest chance these publications have to become useful. The variety of digital libraries and index data bases with open access to scientific publications and reviews is a crucial factor for further grow of the science. One may say that such practice will destroy the knowledge markets. This is partially true. The societies invest in science by direct or indirect financing and further business with scientific results is not admissible

USC-methodology

Following considerations discussed above, we assume that for evaluating of usefulness of scientific contributions more-less important are:

- ***p*** – Number of the papers;
- ***q*** – Number of monographs;
- ***s*** – Number of the substantial citations;
- ***c*** – Number of the casual citations;
- ***r*** – Number of the refuting citations;
- ***Y*** = $y_e - y_b + 1$ – Length of the interval of publications;
- ***z*** = $y_c - y_b$ – Length of the interval of citations,

where

- y_b – starting year (beginning) of the period of publications;
- y_e – last year (end) of the period of publications;
- y_c – last year (end) of the period of citations.

In this list we have three different types of values which we have to reduce to common measurement unit. We propose to use "paper" as such unit because it may be assumed that *one paper represents a single idea*.

In accordance with this, we propose to use four coefficients of correlation:

- ***m*** – coefficient of the monograph correlation:
  - ⇒ ***m** : **1 monograph*** = ***m papers****;* example: if 1 monograph = 5 papers than m = 5;
- ***a*** – coefficient of the substantial citation correlation:
  - ⇒ ***a : 1 substantial citation*** = ***1/a paper****;* example: if 5 substantial citations = 1 paper than a=5;
- ***b*** – coefficient of the casual citation correlation:
  - ⇒ ***b : 1 casual citation*** = ***1/b paper****;* example: if 10 casual citations = 1 paper than b = 10;
- ***v*** – coefficient of the refuting citation correlation:
  - ⇒ ***v : 1 refuting citation*** = ***1/v paper****;* example: if 10 refuting citation = 1 paper than v = 10.

This way we have the methodological formula for *Usefulness of Scientific Contributions* (***usc-index****)*:

$$usc = \frac{p + mq + z}{Y} + \frac{s}{aY} + \frac{c}{bY} - \frac{r}{vY}$$

This formula is ***only a formal representation*** of the understanding that the ***scientific contributions have to be evaluated completely*** taking in account as more parameters as possible. All types of publications have to be included in the evaluation process as well as mentoring activities, learning materials, and all types of citations including transitive citations, implementations, scientific projects, received funding, etc.

Special comment is needed for ***substantial self-citations***. They are indicator that the scientists provide longtime investigation and step by step publish new results. This is normal cycle of science. Ignoring this means that we expect receiving the results in one "genius" invention. In addition, mentoring students and young researchers lead to publishing of co-authored papers which cause ***substantial citations from co-authors*** in further their independent work and publications. As the received knowledge is more qualitative so more important are the further citations from co-authors. Ignoring this means that we do not acknowledge the high level skills and leading ideas of the advisors.

Example

Results from an experiment with real data taken from DBLP (http://dblp.uni-trier.de/) are presented in Table 3. In the real data there was no data for monographs and refuting citations. Because of this the corresponded columns contain zeroes.

Table 3. Experimental data for usc-index

scientist	usc	y_b	y_e	y_c	Y	z	m	a	b	v	p	q	s	c	r
S1	**26.07**	1991	2011	2009	**21**	18	5	5	10	10	405	0	15	1215	0
S2	**13.74**	1983	2011	2011	**29**	28	5	5	10	10	109	0	208	2200	0
S3	**13.52**	1995	2011	2011	**17**	16	5	5	10	10	110	0	32	975	0
S4	**11.66**	1981	2011	2011	**31**	30	5	5	10	10	181	0	50	1406	0
S5	**8.48**	1999	2011	2010	**13**	11	5	5	10	10	44	0	8	537	0
S6	**8.23**	1972	2011	2011	**40**	39	5	5	10	10	98	0	66	1789	0
S7	**6.68**	2000	2011	2007	**12**	7	5	5	10	10	53	0	10	182	0
S8	**5.57**	1985	2011	2011	**27**	26	5	5	10	10	68	0	22	520	0
S9	**4.36**	2007	2011	2010	**5**	3	5	5	10	10	16	0	1	26	0
S10	**3.87**	1991	2010	2010	**20**	19	5	5	10	10	44	0	1	142	0
S11	**3.71**	2003	2011	2008	**9**	5	5	5	10	10	26	0	0	24	0
S12	**3.62**	2004	2009	2011	**6**	7	5	5	10	10	8	0	0	67	0
S13	**3.62**	1983	2009	2011	**27**	28	5	5	10	10	47	0	2	223	0
S14	**3.54**	1973	1986	2008	**14**	35	5	5	10	10	11	0	2	32	0
S15	**3.33**	2009	2011	2010	**3**	1	5	5	10	10	8	0	1	8	0
S16	**3.16**	1995	2009	2011	**15**	16	5	5	10	10	18	0	2	130	0
S17	**2.42**	1986	2011	2006	**26**	20	5	5	10	10	34	0	2	85	0
S18	**2.35**	2008	2011	2011	**4**	3	5	5	10	10	6	0	1	2	0
S19	**1.63**	2001	2011	2008	**11**	7	5	5	10	10	10	0	1	7	0
S20	**0.96**	1991	2006	2001	**16**	10	5	5	10	10	5	0	1	1	0

USC-index reflects the dynamics of scientific development during the analyzed period. For instance, scientist S2 has more long scientific career and more citations than S1 but his usc-index is less than that of S1 due to less number of papers for longer period.

It is important to remark: *periods have different lengths (column Y) and for further analysis it has to be accounted.*

It is complicated to compute usc-index for all scientists of a given organization and many times more complicated to do this for all researchers from given scientific area. Because of this, the computer linguistic analysis of the scientific publications (to obtain values of the main parameters of usc-index) is serious scientific problem which has to be solved. Some preliminary considerations about possibility for solving it may be done. For instance, it is typical that the introduction of a scientific article is structured as a progression from the general to the particular. References have been found to be most frequent in the introductory section of paper. Thus, in the introduction, an article typically refers to more general or basic works within a field. The net effect of many articles referring to the same general works, therefore, is that such contributions get a very large number of citations. References to highly cited publications seemed to occur more in the introduction than anywhere else in the articles. Similarly, since most scientific articles contain a methodology section in which the methods applied in the study are documented, authors typically cite the basic papers describing these methods. This may explain why some papers containing commonly used methods sometimes receive a very large number of citations [Aksnes, 2005].

Conclusion

Starting point of our consideration was the introduction of the "Information Market" as a payable information exchange and based on it information interaction. In addition, special kind of Information Markets - the Knowledge Markets (KM) were outlined. Basic understanding of our work is that we have to evaluate the usefulness of scientific contributions from point of view of those for whom the results are created. This is not simple task because the KM customers are of many kinds.

The identifying of the staple commodities of the knowledge markets was a step of the process of investigation of contemporary situation in the global knowledge environment. Investigation of the staple commodities of the knowledge markets is very difficult but useful task. We have introduced them as kind of information objects, called "knowledge information objects". The main their distinctive characteristic is that they contain information models, which concerns sets of information models and interconnections between them.

We belong to the modern knowledge market and perhaps we shall agree that "à la marché comme à la marché" ("at the market as at the market"). In the world of science, there exist commercial interests that set the trends to redistribute the money given for science by the societies. Unfortunately, for instance, the "impact factor" is just such trend, borrowed from advertising industry, to force scientists to invest in selected retailer chains.

It is not permissible to replace the quality of a scientific publication, with qualities of the media in which it has been published.

In science, the incorrect management decisions lead to a decline in its development. *If a complete scientific "industry" is not developed, the "complete" administrative attitude to science grows, which inevitably will kill it.* Exuberant dependence on single numbers to quantify scientists' contribution and make administrative decisions can affect their career progression or may force people to somehow enhance their h-index instead of focusing on their more legitimate activity, i.e., doing good science. Considering the complex issues associated with the calculation of scientific performance metrics, it is clear that a comprehensive approach should be used to evaluate the research worth of a scientist. We should not rely excessively on a single metric [Kumar, 2009].

Although the use of such quantitative measures may be considered at first glance to introduce objectivity into assessment, the exclusive use of such indicators to measure science "quality" can cause severe bias in the assessment process when applied simplistically and without appropriate benchmarking to the research environment being considered. Funding agencies are aware of this, nevertheless experience shows that the reviewing of both individuals and projects on the national and European level is still relying excessively on the use of these numerical parameters in evaluation. This is a problem of much concern in the scientific community, and there has been extensive debate and discussion worldwide on this topic [bibliometric, 2012].

Since the very first applications of bibliometric indicators in this way, scientists and science organizations have taken strong positions against such purely numerical assessment. Various organizations in Europe have published studies on their potential adverse consequences on the quality of funded scientific research. A prime example is the publication of the Académie des Sciences of the Institut de France that has presented clear recommendations on the correct use of bibliometric indices [IDF, 2011]. Other publications have addressed the role of peer review in the assessment of scientists and research projects e.g. the European Science Foundation Peer Review Guide published in 2011 [ESF, 2011a] with recommendations for good practices in peer review following an extensive European survey on peer review practices [ESF, 2011b]. Other recent examples are a study of peer review in publications by the Scientific and Technology Committee of the House of Commons in the UK [STC, 2011], the peer review guide of the Research Information Network in the UK [RIN, 2010] and the recommendations formulated at a workshop dedicated to quality assessment in peer review of the Swedish Research Council [SRC, 2009].

A common conclusion of these studies is the recognition of the important role of peer review in the quality assessment of research, and the recommendation to apply bibliometric performance indicators with great caution, and only by peers from the particular discipline being reviewed [bibliometric, 2012].

A considerable step toward this goal is ***The San Francisco Declaration on Research Assessment*** (DORA), [DORA, 2012] initiated by the American Society for Cell Biology (ASCB) together with a group of editors and publishers of scholarly journals, who recognize the need to improve the ways in which the outputs of scientific research are evaluated. The group met in December 2012 during the ASCB Annual Meeting in San Francisco and subsequently circulated a draft declaration among various stakeholders. DORA as it now stands has benefited from input by many of the original signers. It is a worldwide initiative covering all scholarly disciplines.

A special press release of *Initiative for Science in Europe (ISE)* called ***“Initiative to put an end to the misuse of the journal impact factor (JIP)”*** has been published [ISE, 2012]. We have kind permission of ISE to reprint text:

> “Major European science organizations have joined the "San Francisco Declaration On Research Assessment" which was released today by the American Society for Cell Biology (ASCB). Signatories in Europe include the European Mathematical Society, EUCheMS, European Sociology Association, European Education Research Association, FEBS, EMBO and other societies and organizations that are organized under the umbrella of the Initiative for Science in Europe (ISE).
>
> The increasing reliance on journal based metrics for research assessment, hiring, promotion or funding decisions has been criticized by experts for a number of years. The "San Francisco Declaration On Research Assessment" for the first time unites researchers, journals, institutions and funders to address the problems of an overreliance on the journal impact factor and to work for change of the current system of research assessment.
>
> The declaration formulates concrete recommendations for different stakeholder groups. It calls publishers to "greatly reduce emphasis on the journal impact factor as a promotional tool", funding agencies and institutions to consider "the value and impact of all research outputs" for purpose of research assessment, "including qualitative indicators of research impact" and researchers to make "decisions about funding, hiring, tenure, or promotion, [..] based on scientific content rather than publication metrics" when involved in assessment committees. It also invites organizations that supply metrics to "[b]e open and transparent by providing data and methods used to calculate all metrics".
>
> The San Francisco Declaration on Research Assessment was drafted by a group of editors and publishers of scholarly journals that met at the Annual Meeting of The American Society for Cell Biology (ASCB) in San Francisco in December 2012. It has since developed into a worldwide initiative welcoming all scientific disciplines including the social sciences and humanities.
>
> Scientists and institutions alike are invited to express their commitment and support for the initiative at http://ascb.org/SFdeclaration.html” [ISE, 2012].

Endorsing DORA, the Association for Computers and the Humanities (ACH) remarked that it is a set of recommendations for applying more nuanced, accurate ways to evaluate research than the Journal Impact Factor

(JIF). DORA makes eighteen recommendations for researchers, funders, research institutions, organizations that provide metrics, and publishers, such as focusing evaluation on the content of a paper, applying article-based rather than journal-based metrics, incorporating research outputs such as datasets and software in evaluating impact, and promoting the reuse of reference lists through the adoption of Creative Commons Public Domain Dedication licenses.

In addition, we have to underline that the variety of digital libraries and index data bases with open access to scientific publications and reviews is a crucial factor for further grow of the science. One may say that such practice will destroy the knowledge markets. This is only partially true because the societies invest in science by direct or indirect financing and further business with scientific results is not admissible

Following the considerations given above, this paper was aimed to present a new *usc-methodology* for evaluating the scientific contribution of a scientist or a scientific group (organization).

It consists in proposing three main groups of citations: ***Substantial citations***, ***Casual citations***, and ***Refuting citations***, which all have *temporal dimensions*.

In addition, due to existence of different types of values (for monographs, papers and citations), a common measurement unit (“idea” or “paper”) and four coefficients (for monographs, substantial, casual, and refuting citations) of correlation to measurement unit (paper) have been proposed.

The problem of automatic linguistic analysis of scientific publications, in accordance with usc-methodology and computing of its ***usc-index*** for different target scientific structures has been outlined.

Finally, we have to underline, that usc-methodology is aimed only to turn process of evaluation of scientific contributions back to human responsibility of authors, reviewers, and publishers. Modern science is distributed all over the world and concentration of any it’s part in one or two monopolies is absolutely inadmissible. To ensure growing of science we are obligated to provide for growing of variety of possibilities for doing science – financial resources, publishing opportunities, scientific indexing systems, and distributing organizations.

In addition to all printed universe we are obligated to take in account the variety of possibilities for direct contact between scientists in a single place like conferences, seminars, and workshops or distributed geographically like tele-conferences, electronic mailing lists, blogs, etc.

Special comment was done for *substantial self-citations*. They are indicator that the scientists provide longtime investigation and step by step publish new results. In addition, mentoring students and young researchers lead to publishing of co-authored papers which cause *substantial citations from co-authors* in further their independent work and publications. As the received knowledge is more qualitative so more important are the further citations from co-authors. Ignoring this means that we do not acknowledge the high level skills and leading ideas of the researchers and advisors.

This *usc-index* is *only a formal representation* of the understanding that the *scientific contributions have to be evaluated completely* taking in account as more parameters as possible. All types of publications as well as mentoring activities, learning materials, and all types of citations including substantial self-citations, substantial citations from co-authors, transitive citations, implementations, scientific projects, received funding, etc. have to be included in the evaluation of usefulness of scientific contributions.

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