Intelligent Information Systems for the Information Society

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ON THE VALUE OF INFORMATION FROM THE INFORMATION USER'S POINT OF VIEW

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The paper reviews and analyses the research on the value of information from the information user's point of view. The value concept in philosophy forms the starting point for the analysis. The practical values of different types of information are analysed to study the problems in assessing the use value (or value-in-use) of information. The existing research on the value of information is presented and analysed from this new angle to the economics of information studies. As a result, it is suggested that it is impossible to measure the total value of information; instead only some hints of the value can be given by examples and case-studies. Some aspects of the exchange and use values of information, information products and services can be measured in highly specific contexts.

1. BACKGROUND

What is the value of information, an information product or service? In this paper we focus on the value of information from the information user's point of view. Our approach is based on two principal considerations: The first one is the philosophical value consideration of information, and the second is the classification of information and knowledge needed in a knowledge-work task. By knowledge-work tasks we mean here those tasks where the acquisition, processing, storing and communicating of information plays a major role [1]. Our aim is to develop a framework for analyzing the value of information from the information user's point of view. The framework is briefly tested in the analysis of research already performed in the field.

The paper starts with some reviews on the economics of information and the value concept. Section 2 presents our approach to the value of information and in section 3 the approach is used in the analysis of some of the empirical research already performed in this field.

1.1. On information economics

The economics of information has been an issue among information scientists for more than two decades. There are already many

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reviews on the economics of information available [2],[3], [4],[5],[6]. While studying the empirical research in the area we have found nine main research areas [7]:

- costs of information products and services
- price of information
- evaluation of effectiveness and efficiency of library and information services
- cost-benefit analysis of information transfer
- value of information (case-studies)
- information service as a value-added process
- economics of information retrieval
- macro-economical studies of information and productivity
- economics of information processing.

These groups were derived from about one hundred empirical studies. The list is hardly exhaustive, but reveals the research done so far. Additionally, several other studies as well as most empirical studies present theoretical discussions and expressions of opinion of the problems while measuring information systems and products (e.g. see reviews in [2] and [8]). During the last decade, there has also been a clear shift from cost and effectiveness/efficiency studies towards the value and benefit considerations, which also has meant that the issues now being handled are far more difficult to deal with using classical economic theories.

'Political scientist' Cleveland[9] gives a beautiful list of the characteristics of information as a unique resource among the others:

1. Information is human. It exists only through human perception.
2. Information is expandable. The free flow of information maximizes the use , but in many cases this is against economic thinking of those who know something valuable.
3. Information is compressible. The increasing deluge of information is -at least in principle- possible to control by concentrating, integrating and summarizing it from different points of view needed.
4. Information is substitutable. It may save money by substituting the use of other resources.
5. Information is easily transportable.
6. Information is diffuse. It tends to leak, though we material-minded people try to own it.
7. Information is shareable. By giving away information one does not loose it, which is the case with things.

After seeing this list of special features of information it is not surprising that the analysis of information, information services and products has lately tended to be carried out from the point of view of the use.

1.2. On values and information

Our analysis of the value of information has a philosophical background. We see values as phenomena which make man aim at a certain goal instead of other alternative goals. Values can be divided into two main categories:

- philosophical (or intrinsic) values, and
- practical (or instrumental) values.

The philosophical values have intellectual or emotional meaning to a person, but are very hard to specify - sometimes it is possible only to name them. Information and information products usually have philosophical values, but our 'practical' orientation leaves them almost entirely unexplored.

The practical values can further be divided into
-value-in-use, and
-exchange values.

For us this value analysis is a tool for describing the value of information in situations where information need and use are explained by value-in-use. Information services and products are valued in exchange values.

2. THE INFORMATION USER'S POINT-OF-VIEW OF THE VALUE OF INFORMATION

In this section we demonstrate our value-approach to information and knowledge-work. Our aim is to analyze the valuing process from the point of view of information use. This can be seen as a minor exercise to open the 'black box' of information use, which is often blamed to be insufficiently studied (e.g. [10],[11]).

Our starting point here is the hypothesis that the user of information gives value to the piece of information during the use-process of that information. This takes place in relation to a knowledge-work process (e.g. a research project) so, that the information must first have a potential value-in-use to awaken the interest of the user, who actually decides whether to use the information or not.

The philosophical values may have the role of an umbrella: they provide a framework for a knowledge-work task, though they seldom have direct connections to it. In practical situations these value considerations are seldom conscious, but they often have some 'background role' in human reasoning. And finally, exchange values usually deal with results of knowledge-work. Only if there are clear practical alternatives available in information-seeking may one consider the situation in terms of the exchange values. But even then it is merely a question of information products, services or channels to choose from, where the information content is more or less the same.

We argue that the analysis of the value of information has not so far really reached value-in-use. This is true partly because the different aspects of values have not been analyzed clearly enough. Another issue is that it is necessary to analyze more deeply the knowledge-work situations and the use of information in them before one is able to analyze the value of information to its user. Previous research is analysed in the section 3, below.

A typical knowledge-work situation is a problem solving task. One can find five kinds of knowledge and information (that part of knowledge which can be transferred to other people) which are needed and processed during a problem solving or handling task [11]:

1. Task knowledge; knowledge that determines the problems and

tasks in the domain.

2. Domain knowledge; earlier produced and organized information about the facts and relations which contribute to the problem.

3. Problem knowledge about the conditions of the problem at hand.

4. Problem solving knowledge; methodological know-how needed.

5. Outcome knowledge; to become partly output information .

There are several other classifications of information [12], but for our purposes this analysis is sufficient. Because this classification links information to the environment where it is used, it can already be used to destroy the illusion that the value of information could be defined outside the knowledge-work process.

As stated before knowledge-work is done by individuals and this raises differing subjective information needs. These needs are influenced by the professional environment where and for which the work is done, and this environment forms the normative information requirements for knowledge-work. For the knowledge-work itself there are requirements which must be fulfilled in order to get the work done: we call these objective information requirements [11].

The objective requirements should form the basis for determining the value of information, but the problem is that one seldom can attain these requirements. Though they are not achievable, approaching them is possible and even desirable - in philosophy this attitude towards the truth as the task of science is known as 'critical scientific realism'. In information science (or studies), e.g. Derr [13] has emphasized this kind of thoughts while rejecting the idea of the information need as a psychological state.

The normative requirements are a result of interaction between people in the community who are involved in that particular knowledge-work process,and these requirements also create the general framework for exchange values. At the community level the value of information or rather information products and services can only be realized through exchange values in 'the information markets'. And finally, subjective information needs and information seeking, as a realization of those needs associated with knowledge work, form the basis for determining the value-in use.

So, the definition of the value of information should take place in those three requirement-levels. This means that measuring of the total value of information is beyond our possibilities, because we cannot achieve the objective values. At a community level we can only measure exchange values of information products and services. The value-in-use of information which can only be determined by individuals (or a group) is needed, because it is a basis of value considerations through the actual knowledge-work processes.

In practice the earlier mentioned five different types of information have varying roles for a knowledge-work task. Task knowledge is given or 'found' for a knowledge-work task to be

done, and valuing of it would require objective information requirements to be known. Domain, problem and problem-solving knowledge and information can be valued by the knowledge worker.

Outcome or output knowledge is the new knowledge that is produced during the knowledge-work task. Outcome knowledge must be formulated into output information in order to determine its exchange value. Output information is a medium for a person communicating with other people in the community and this is how a person can give exchange values to information. So, the exchange values can be identified and measured at the community level via markets, but in practice the indefinite markets of information make precise valuation difficult.

3. SOME COMMENTS ON THE RESEARCH OF THE VALUE OF INFORMATION

In this section we review some studies on the value of information [14],[8]. Certain remarks are made to show how superficial the analysis of information use have been in these studies. Our argument is that though these studies have contributed useful descriptive information they have only scratched the surface of the value of information understood in the sense we presented in section 2. We concentrate here on those studies which include also some empirical analysis, because we consider them still the most interesting ones.

We divide the studies into four separate groups:

1. Studies using statistical or mathematical models.
2. Studies using economic approach.
3. Surveys on willingness to pay and time savings.
4. Studies using examples.

3.1. Studies using statistical or mathematical models

The studies using statistical models base their analysis on the idea of the multidimensional value of information; such attributes as relevance, usefulness and informativness are often used among sometimes tens of other attributes to describe the phenomenon more thoroughly. Multidimensional models on valuing information are presented in several studies [14]: McKendry et al. try to solve the problem of counting the value of information by splitting the sources of information and Yovits and Abilock count probabilities for different courses of action in decision making.

Morehead et al. [15] have also done interesting work which uses the multidimensional value concept. They have used man's value structure as a framework for evaluating online searching: the multidimensionality is in their fiction retrieval -case described by the subject matter, frame (time, place,setting), author's intention and accessibility. The problems in identifying and rating specific components of the value function without examining each information searching situation individually, were also documented in this study. Still, one has to say that these kinds of approaches using subjective value statements and opinions of more or less carefully chosen variables for 'the multidimensional formula' can make value analysis look good (and 'scientific'), but this does not guarantee practical usefulness of them. These analyses try to measure the value-in-use of information, but the values are asked from users without any

deeper consideration to the actual use situation.

3.2. Studies using economic approach

A pure economic modeling approach is sometimes used in valuing information services. Mason and Sassone [16] developed a framework for understanding observations about the demand for scientific and technical information and integrating these observations with fundamental economic principles (demand and supply curves, rational behaviour of users of the services by saving money, private and social costs and benefits). An example is given of an information centre economic model that provides "a lower bound on benefits" in money-terms. Braunstein [3] used similar approach while analyzing costs and benefits of library services to the user.

The economic models like these may be useful in a rough evaluation of information services and products (exchange values), but they do not tell us much of the value of information the services and products transmit to the users of those services (values-in-use).

3.3. Surveys on willingness to pay and time savings

The most used ways to study the value of information are surveys on the users of information or merely information services and products. There are more or less careful inquiries done on willingness to pay and time savings (for reviews, see e.g. [8], [2]).

Perhaps the most interesting surveys on value assessments are performed by King Research Inc. ; the study on the energy data base (EDB) of the United States Department of Energy [17] is perhaps the most suitable to look at in this context. In this study the extent of use of EDB and other identification methods of needed information and the resultant readings were analyzed by a broad set of questionnaires. The apparent value was measured in terms of willingness to pay, both for the searches performed and for articles and reports read. The consequential value was measured in terms of effect, for searching, the cost of reading which resulted, and for reading, the savings which resulted from application of the information obtained in reading. The resulting estimates are said to reflect the value to the searchers, the readers, and the reader's organization or funding sources.

In the report of the study, the problems experienced in these kinds of measurements are discussed broadly, and it is explicitly said that the measurements only 'reflect' the value of information (or should one say here pieces of information, domain information especially), information services and products. It is important to notice that in this study there was an effort to bridge the gap between an information product or service and the information itself: willingness to pay deals with information products and services, and with the knowledge-work process; and finally the effects of obtaining information deal directly with the information content (the measurement used examples in this study).

From our point of view the problems arise when starting to summarize these different values for total value estimates. These impressive sums (billions of dollars) are perhaps important in

showing the politicians how important it is even for a big research organization to utilize the research done elsewhere; and revealing the shares of information seeking, identification, access and reading per an article or a report. So, the sums have value in descriptive sense, but according to our approach they are misleading while neglecting the distinction of value-in-use and exchange values: one cannot bridge the gap between the value-in-use and the exchange values solely by explaining the use values in money terms derived from examples.

3.4. Studies using examples

The easiest way to explain the value of information is to use examples: my apartment is worth $ 80,000 (exchange value), my lego-house is twice as valuable as your doll (emotional value), or that air-raid shelter takes 80 people (value-in-use). And if you ask an information specialist about the value of information, he presumably starts recalling examples like the damage caused by a chemical accident due to lack of information during the rescue operation, or the great success he or his friend had once when finding quickly an important piece of information for the boss.

In the information science literature there are surprisingly few studies collecting information about examples of value of information, though it seems to be the only way to measure the benefits gained from the use of information. Still, e.g. King Research Inc. has done it in their studies [17],[18] and also Ljungberg [19] lists such examples in his study. The lack of information is studied, e.g. by Brittain [20].

It seems that at least in practice examples are the best way to describe the value of information in the empirical research conducted so far. This means difficulties in generalization: while the lack of a suitable theory is obvious, conclusions are often made by rough estimates - possibly supported by the examples. We believe that our approach presented in section 2 could help to clarify the starting point of value considerations by the distinction of value-in-use and exchange values. In addition, the analysis of different types of information can give hints for the fact that the exchange value is possible to measure for information products and services. Information itself and its value-in-use is at best only touched by such measures like time and money savings, and time spent for reading. In order to get any further deeper analysis of the information use situations is certainly needed.

4. CONCLUSIONS

Some general conclusions from the study:

-One should speak of the value of information at the user level only in terms of value-in-use, because the value-giving situation is a need-oriented situation. The talks about use values in money terms makes it easy to mix these values to exchange values.

-The organization, or the community more generally, gives the framework for knowledge work and it operates with exchange values. There is no real meaning for such a concept as the value-in-use of information at the

organizational level - should we only speak of the exchange values of information products, services, systems and channels?

-One should not mix a user's point of view and a community's point of view when determining the value of information, and on the other hand the value of an information service or a product.

-Different kinds of information and knowledge have varying values for an user of information: domain -, problem - and problem solving information are the most interesting ones when determining the value-in-use. Also the information use context has major importance here.

-Specification of the exchange values of information systems and products is an issue entirely different from specification of the value-in-use of information - the exchange values deal with information production via costs and transfer, not with the use.

Some practical conclusions:

-There is no sense in trying to count the total value of information; different viewpoints and observation levels mean different emphasis.

-When an organization measures the value of information in some particular situation, it has to ask the information user's opinion about information needs and study the information-use contexts - here the examples of the use values are the useful tools available. In finding the most cost-effective information products, services, systems and channels one needs exchange value considerations in the information markets.

For future research on the value of information our study suggests more specific -and perhaps also more modest- goal settings, and definitions of what values are actually being measured. The research in this area is certainly needed, but in order to get more reliable results the basic approach has to be more clear. The research on the value of information should remember the words of Ludwig Wittgenstein: "What we cannot speak about, we must pass over in silence."

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STAGE III OF INFORMATION SYSTEMS TECHNOLOGY

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I present this paper today to this audience with some trepidation. The analysis I am presenting is perhaps, it seems to me, rather obvious and straightforward, but it produces what I am convinced are some very useful perceptions about the future of our field, and it is to the best of my knowledge, novel. I take comfort in the fact that after the fact most new insights seem to have been easy and obvious.

The automation of information processing systems can usefully be described as having evolved through two major stages, and as being poised to embark on stage three, a development which will have a major impact upon the configuration and the capabilities of information systems. It is quite common to characterize the development of data and information processing by describing that development as a series of stages. Thus, vacuum tube based machines have been described as first generation computers, discrete solid state transistor machines as second generation, integrated circuit based machines as third generation, very large scale integrated circuit machines as fourth generation (but here the distinction becomes a fuzzy one of degree, rather than one of kind), and the newer parallel processing or inference rather than instruction processing machines now under development as fifth generation. In a different vein, Nolan[1] has characterized the managerial organizational stages of data processing development as those of initiation, contagion, control, integration, data administration, and maturity, representing a transition over time from a hardware orientation to an information content orientation.

It is the thesis of this article that the development of data processing can be equally usefully characterized in terms of a stage hypothesis that derives from two fundamental assumptions. The first assumption is that the most salient operational aspect of electronic information systems or IT, information technology, has been the explosive rate of growth of that technology, best encapsulated in terms of Moore's law, that the number of elements that can be integrated onto one chip is doubling every year or two.[2] The second assumption is that from a systems viewpoint, the capability of information processing systems can be best described and analyzed in terms of three principal parameters or characteristics, their ability to processs data, that is computational capability, their ability to store data, and their ability to transmit and communicate data. Combining those three parameters of systems capability with observations concerning when the Moore's law of exponential growth of technological capabilities has or will reach operational significance leads rather neatly to three distinct stages in the growth of information systems capability. See Figure 1.

Figure 1.

STAGES OF INFORMATION SYSTEMS CAPABILITY (RELEASE ONE)*	
STAGE:	EXPONENTIAL GROWTH OF:
I	1). Computational Capability
II	1). Computational Capability and 2). Storage Capability
III	1). Computational Capability and 2). Storage Capability and 3). Telecommunications Capability
*See Figure 9 for release two	