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A Pluralistic Approach to Information Valuation

Research-in-Progress

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Abstract

Valuing information depends on multiple interpretations, purposes, and requirements, which makes it a wicked problem. This research aims to address the problem from a pluralistic perspective. Our approach is structured in two steps. In the first step, we seek to understand the different viewpoints regarding information valuation that have so far been developed in the related literature. Then, we suggest a model that frames information valuation from a pluralistic perspective.

Keywords: Information value, information valuation, information valuation model

Introduction

Firms are drowning in information flows while thirsting for insights. (Higson & Waltho, 2009). To handle a conundrum, firms need to possess a capability to determine the value of information and turn valuable information into insights. The understanding of the real value of information is a key issue, as suggested by a recent survey of 1,300 CEOs (KPMG). However, the complex nature of information makes it difficult to measure its value (Hubbard, 2014; Ragab & Arisha, 2013a).

Information valuation has been in the interest of scholars for more than two decades already (Y. Chen, 2005; Foster & Clough, 2018; Ragab & Arisha, 2013b; Rao & Keong, 2016; Wilson & Stenson, 2008). During these years, there have been numerous efforts to develop effective methods (Bawden, 1990; Bontis, 2004; Edvinsson & Malone, 1997; Robinson & Kleiner, 1996; Yates-Mercer & Bawden, 2002), however, without significant traction in industry (Bolisani, 2016; Bolisani & Oltramari, 2009, 2012; Viscusi & Batini, 2014). Furthermore, a rational and far-reaching method to address the problem is still missing (Bolisani & Oltramari, 2012; Williams & Johnson, 2015), even though this is crucial for research and practice. The issue is not the lack of methods, but that they do not address the wicked nature of information:

- Even though information is considered to be one of the firm's most important assets and a key originator of value, it is an intangible asset, which makes it particularly difficult to assess it in an objective way (Redlich & Nemzow, 2010).

- It may be difficult, if not controversial, to describe what an information asset is. An example is given by tacit knowledge, which is often distributed, shared and invisible (Nonaka, 1994).
- There are multiple competing viewpoints on how information can be valued (Lagrost, Martin, Dubois, & Quazzotti, 2010; Osinski, Selig, Matos, & Roman, 2017; Ragab & Arisha, 2013a). For example, the adoption of either quantitative or qualitative methodology highlights different assumptions, levels of analysis, contexts, and types of data under scrutiny.
- Some valuation approaches reduce information to a financial dimension, as an asset like financial deposits, when information actually can have value beyond the economic view, e.g. agility, customer loyalty, innovation, trust, and security (Villanueva, 2011).
- Information is often regarded in a static dimension (Andriessen, 2004), while often value is related to its dynamics: the information flows (Chun, Kim, & Dey, 2017; Hubbard, 2014).

In the light of those mentioned above, our research is focused on finding the value of information by integrating multiple perspectives. The main methods applied are the literature review of prior research on information valuation, and then the analysis, synthesis, and generalization of approaches using a conceptual model. In the next section, we describe the literature review. Then we propose a multiview model for information valuation. Finally, we highlight the current status of this research and discuss further steps.

Literature Review

Our review of prior information valuation approaches is based on a narrative review (Green, Johnson, & Adams, 2006) of scholarly papers published in quality-controlled outlets using a set of keywords. The selected outlets were: IEEE, Web of Science, Springer, Science Direct, Emerald Insight, and Scopus. Table 1 summarizes the keywords used in the literature search and selected papers.

Table 1 Search keywords and results

Selection of keywords	Papers	Selection of keywords	Papers
"valuation metrics"	19	"measure value" information	28
valuation AND metrics	18	value AND operational level AND information	25
"measurement metrics"	32	information AND value AND organizational level	31
"metrics for measurement"	11	"measure value"	18
"information value"	23	"measurement of value"	20
"information value" AND metrics	36	"knowledge measurement"	27
"how to measure" AND metrics	32	"information measurement" AND metrics	4
"information assessment"	7	"intellectual capital" AND value metrics	37
Total from keyword searches: 368			
Backward and forward searches: 67			
Total: 435			

After searching the different outlets, we removed duplicated and redundant papers (i.e. describing the same research). We then conducted a manual review of the papers' abstracts and applied exclusion criteria to eliminate papers that did not concern the value of information and papers that did not consider the value of information in the business domain. For instance, we eliminated papers related to communications (e.g. entropy and probability of error), computer science (e.g. complexity) and bibliometrics (Eppler & Mengis, 2004). We considered papers discussing information value in management, marketing, accounting, information systems, and knowledge management. After applying the exclusion criteria, we had a narrowed selection of 368 articles.

The keyword searches were complemented with backward and forward searches on individual papers to identify important missing papers (Castelfranchi, 2016; Tatar & Karabacak, 2012; Viscusi & Batini,

2014; Wijnhoven, Amrit, & Dietz, 2014). Through this process we added 67 papers, resulting in a total of 435 papers to work with.

Content analysis and classification were then conducted on each paper to understand the directions that the research was taking. We extensively reviewed and analyzed elements related to information, information valuation, and measurement techniques. We then shortlisted the papers that were most relevant to our research using two criteria: pertinence to business context, and prior validation. Finally, we clustered the papers according to their affinity in terms of how they measure information. As the result of this process, the five clusters described in Table 2 emerged as distinct viewpoints on how information is regarded and how it has been valued.

Table 2 Summary of findings from the literature review

	Viewpoints	**Eval. elements**	**Conceptualization**	**Examples**
Intellectual Capital (IC)	Information as an intangible **asset**	Information **objects** (e.g. database, system, list of clients)	Valuation of **static** information assets	▪ The value explorer ▪ The Intangible Asset Monitor ▪ Balanced Scorecard ▪ Skandia Navigator
Knowledge Management (KM)	Information as **value in use**	**Actors'** capabilities (e.g. generating and sharing)	Valuation of knowledge as **action**	▪ Intellectual bandwidth
Supply Chain Management (SCM)	Information as a **commodity**	Delivery **process**	Mathematical models emphasizing **estimation**	▪ Capacity planning of production
Business Process Management (BPM)	Information as **business transformation**	Relationship between **actors** through **processes**	Valuation of **dynamic** business **execution**	▪ Information lifecycle management
Decision Support Systems (DSS)	Information as **decision support**	**Objects** as part of decision-making support	Value contribution to decisions made by **actors** and **autonomous** objects	▪ Bayesian networks

Research on Intellectual Capital (IC) seeks to determine the economic value of intangible assets owned by firms (Miller et al., 1999). A diversity of constructs have been developed in this category assessing, e.g., annual turnover of staff (used by Skandia Navigator (Edvinsson & Malone, 1997)), extent of database queries meeting the user's need (used by Technology Broker (Brooking, 1996)), and number of customer complaints (a metric used by OECD (Development, 1996)). A complete list of existing constructs is beyond the scope of this paper. It suffices to say they cover multiple dimensions of the firm including engineering, management and accounting, while addressing different aspects of value such as usability, relevance and trust (Chun et al., 2017; Y. Zhao, et al. 2008; Y. Y. Zhao, et al. 2007). We note, however, that this cluster essentially regards information assets from a static perspective, considering ownership but not actual use.

The Knowledge Management (KM) cluster is more centered on the dynamic value of information. That is, the value is generated via exchange and use. Creating knowledge is an especially important element of the firm influencing this view. Information is seen as relevant to knowing and acting, and also to generating and using. People take the central stage in KM, supported by technology and making use of information. The intellectual bandwidth construct, for instance, highlights the importance of the human-technology relationship in knowledge creation (Alavi & Leidner, 2001; Bach, Belardo, & Faerman, 2004). Organizations possessing high intellectual bandwidth have people who apply existing and new

information to build knowledge and wisdom. They capitalize on knowledge management systems and collaboration tools to help people move up the data, information, knowledge, and wisdom ladder.

In this cluster, information is an ingredient and a by-product of KM. Therefore, information per se is rarely assessed. Instead, value is accrued when one takes action to create knowledge and uses it. Considering the dynamic nature of KM, researchers focus on evaluating the actors' capacity to generate and use knowledge. For instance, the construct of knowledge management capability evaluates the firm's ability to create, transfer, integrate and leverage knowledge across business units (Tanriverdi, 2005). Another construct suggests that value is a function of tasks, workers' competency, knowledge depreciation, and other associated costs (A. N. Chen & Edgington, 2005).

The third cluster we identified is Supply Chain Management (SCM). Nowadays many firms are forced to offer a wide variety of products while competing in niche markets. Retailers are also placing smaller orders and exploring more flexible and lean retailing practices. In such context, estimating demand, forecasting production, and synchronizing orders based on accurate and timely information are major endeavors (Pereira, 2009). Information is crucial to make strategic and operational decisions on the supply chain. Delayed or incorrect information can cause serious consequences in the supply chain, such as the bullwhip effect, which occurs when orders sent to suppliers have larger variance than sales to customers (Forrester, 1968). Such variance can disrupt the smoothness of the supply chain (F. Chen, Drezner, Ryan, & Simchi-Levi, 2000; Lee, Padmanabhan, & Whang, 1997). Information itself is considered as a commodity in this school of thought. As claimed by the founder of FedEx three decades ago, "the information about the package is just as important as the package itself." Therefore, firms can generate value by exchanging information with supply chain partners (Hawkins, 2012). Constructs such as yield information, lead time, and resource information for SCM, used in combination with mathematical models of the supply chain, have been developed in this cluster to assign value to information (Y. Y. Zhao et al., 2007).

The Business Process Management (BPM) cluster addresses the cooperation of strategy, people, processes, and information technology. Information is considered to be organic (being constantly reused, maintained and updated), computer-mediated (increasing productivity and competitiveness through control and automation) and dynamic (as it is time-sensitive). Information value depends on actual context and use. The use of information, in turn, depends on coordination, collaboration and tools (Al-Fedaghi, 2013; Cleveland Jr, 1999; Engelsman, 2007). BPM takes the SCM viewpoint about information but extends it to the whole set of processes that define a firm, focusing on the overall business performance. One of the information valuation methods developed in the BPM field is the information lifecycle management model. The model is derived from two measurable and observable metrics: usage and time. The model captures how the information value changes over time and the value differences among information (Y. Chen, 2005). Unlike the SCM cluster, which seems to privilege mathematical modeling and forecasting, BPM favors task modeling and execution.

The last cluster is Decision Support Systems (DSS). This cluster concerns making rational business decisions, which require adequate and reliable information structures. Value in decision-making depends on data quality, quality of decision processes, and capacity of decision makers, which may include people and systems. In this context, the value of information is related to the holistic capacity to appreciate the internal and external business environments, and the dynamic events affecting the firm (Citroen, 2011).

A well-known construct in this cluster is the Bayesian belief network, which models uncertainty with probabilities. Assigning a probability to an event gives an indication of how strongly is the belief that the event will occur. Belief networks can then be used to compare situations, to make inferences, and ultimately to make rational decisions. The DSS cluster, therefore, values information according to the positive and negative contributions it brings to decision making (Cooper & Herskovits, 1991, 1992).

Multiview Evaluation Model

The different viewpoints described above use information to achieve different purposes and therefore apply particular constructs critical to information valuation. For instance, IC treats information as a static asset, setting out to capture asset values and manage them financially. As a result, IC emphasizes

static information *objects* that are *owned* by the firm, such as product databases and lists of clients and suppliers.

KM attempts to enhance the *dynamic* usage of information objects by the firm's *actors*. Actors enable the *use* through *action*, and therefore the value of information should consider both actors and objects. DSS is concerned with the value embedded in objects (static or dynamic) in the support to actors making *decisions*. However, it also concerns the decision-making capacity of *autonomous* objects.

Both SCM and BPM emphasize information embedded in *process* models in order to improve operational efficiency, effectiveness, and flexibility. However, SCM stresses the value of information in *estimation* models, while BPM regards the value of process models to *execution* support. In the execution perspective, processes consider the *coordination* of actors.

Based on this conceptualization, we suggest the elements pertaining to the different viewpoints can be brought together into a coherent system, which could then contribute to develop a multiview model for information valuation. Considering the identified knowledge areas, we have determined that three entities should participate in the valuation systems: actor, process, and object. An actor is a person, group, or organization that possesses information and entails activities related to information. Furthermore, actors entail actions, decisions and coordination of activities.

A process refers to a collection of inter-related and coordinated activities within a firm or across firms, which produce and consume information and are managed together. As previously noted, processes can either model execution or estimate production.

An object ties to the information itself. An object can be either static (i.e. a repository such as a sales database and a list of clients), dynamic (e.g. sale to an important client), or autonomous (e.g. tying information with automated functionality, such as business intelligence detection and alerts). An object can also be owned (e.g. a client list), generated (e.g. clients' complaints), and used (e.g. an online store). As shown in Figure 1, the proposed model establishes a collection of relationships among these entities and associates them to different information valuation clusters.

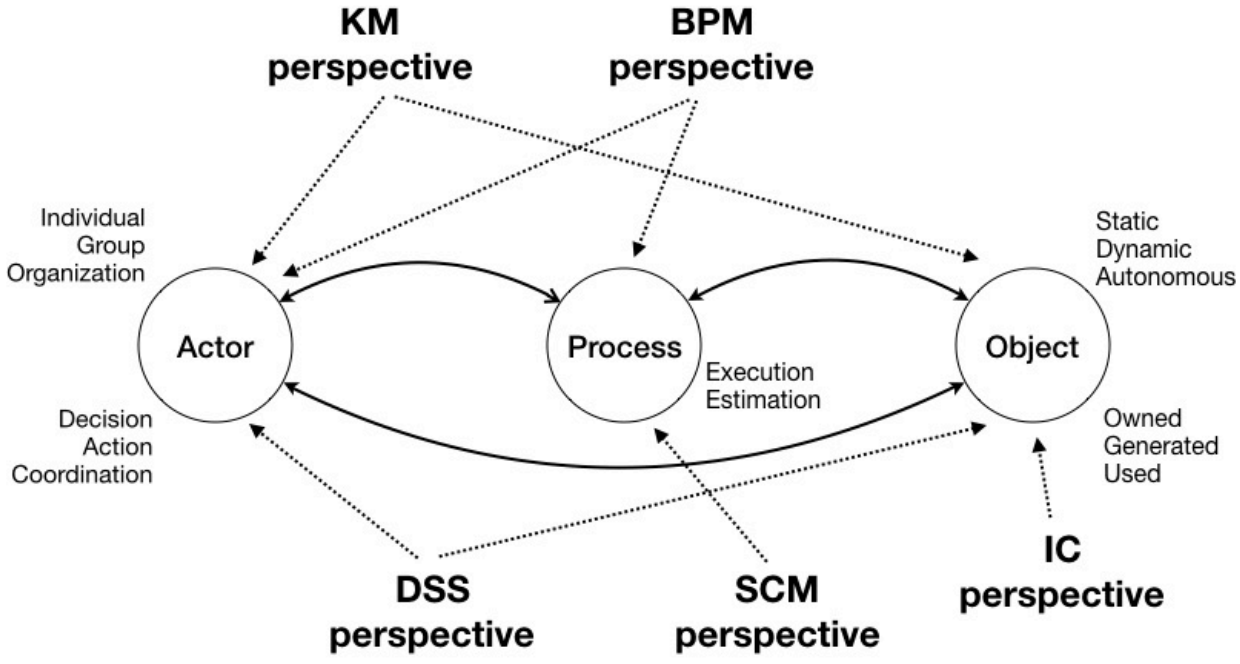

Figure 1 Multiview information valuation model

Having briefly defined the model, we now discuss how it may be applied to scaffold information valuation in a pluralistic way. The first element to note is the diversity of relationships that are established between the three main elements of the model, all contributing to information value in different ways. For instance, actors can interact with static, dynamic or even autonomous objects to exploit and develop the firm's knowledge, and also to make better decisions. Actors may also relate to

processes to improve coordination and estimation. These relationships may happen across multiple actor levels, i.e. individuals, groups, and organizations. Information objects, besides standing for themselves, may relate both to actors and processes in order to improve decision, action and coordination, as well as model-based execution and estimation.

In this landscape, information valuation emerges as the process of assessing (both quantitativelly and qualitatively) the intensity and effectiveness of these relationships. For instance, the high number of accesses to a clients' database, which can be modelled as an actor-object relationship (between individual actors and a static object), may reflect the value brought to the firm of that actor-object relationship. Such value could perhaps be added to the value brought by a quality checking process, which can be modelled as an actor-process-object relationship, measuring, for example, error rates, exceptional events and performance.

All in all, we propose a model that highlights and brings together the fundamental elements, properties, and relationships we find in various information valuation clusters developed in the literature. The model gives an integrative view of information valuation, identifies the phenomena of interest, and creates the possibility for management to quickly get a snapshot of value production in a comprehensive and integrated way.

Discussion and Next Steps

To the best of our knowledge, no current valuation approach takes the pluralistic approach suggested in this paper. However, the approach is still in the early stages of development. We propose a model that takes into consideration different schools of thought on information, and that identifies common characteristics among them. We then establish a collection of elements and relationships that can be used to value information in different ways.

Of course, the model does not eliminate fundamental differences, (e.g., between ownership and use, estimation and execution, or even operating and thinking about a business). Instead, the model highlights commonalities we find in the schools of thought. A consequence of such an approach is that the model may be seen as too abstract. In essence, it identifies three elements, actor, process, and object, and respective relationships. However, we argue the model already starts to reveal the critical features of the elements relevant to evaluation: objects can be static, dynamic and autonomous; they can also be owned, generated and used. Processes relate to execution and estimation. Actors can be individuals, groups, and organizations; and they can also be involved in decision, action and coordination. These concepts and definitions can be used to frame and delimit further theoretical and empirical research in the area.

Furthermore, we reveal distinct relationships between elements pertaining to the different schools of thought. We see these elements, attributes, and relationships as a foundation for further investigating and consolidating information valuation theory.

In the immediate future, we seek to analyze how the model elements relate to existing evaluation criteria, methods, and metrics. We also seek to identify possible gaps in information valuation. Some relations are immediately recognizable and relatable to existing metrics, such as the relationship between actors and processes in measuring execution performance. However, other relationships seem more intriguing and deserve further investigation. For instance, creativity could be a relevant criterion for information evaluation, and could be measured by relating actors and dynamic objects through action.

After identifying a whole set of possible metrics, we then seek to investigate how they can be measured in practice. In this regard, our research goal is to integrate the model and metrics into an existing information modelling tool. Then, the tool will be used to conduct empirical tests to evaluate the feasibility, utility and usability of the proposed information valuation method (Nguyen, et al. 2017).

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