Discussions on Semantic-Based in Decision Support Systems

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Abstract: - This paper outlines some present researches in describing decision-making context by information systems, and especially Decision Support Systems (DSS). We present the results of an empirical study that had the main propose to demonstrate the idea that describing context decision-making in an incorrect manner may lead to an inaccurate decision-making process. We discuss therefore some possible solutions. The paper ends with conclusions drawn from our research.

Key-Words: - context decision-making, DSS, information systems, ontology, semantic technologies

1 Introduction

If decision-makers were asked for defining current information systems, they would probable answer: connected and massive. This issue has been pointed out in the literature with the name of "information overload" [7] and is a frequent cause of Knowledge Management failure.

Though it has not been so widely studied, information overload is important in decision-making, because this fact raises the uncertainty and not actually reduces it. There are few possible causes:

- Either the decision-making context is not well described; so the result is that this context is inappropriate in order to improve decision-making;
- Either information is not integrated; so the result consists in actually informed decisions;
- Either information is described differently but it means the same thing; so the result consists in contradictory information.

Context has been treated by various researchers [16], [2], [4].

Information systems and information technology are, by definition, closely related with knowledge. The manipulation of information is often considered as an equivalent to knowledge management. The benefits from using information systems are well known: computational speed for processing information, procedural and declarative components for capturing information in the form of knowledge. However, the manipulation of information, alone, is not knowledge. Many parameters need to be finally adjusted in order to encourage knowledge elicitation. The main impact of information systems in the knowledge framework is the combination of inference engines with information access and networking facilities, all of which are accessible via user interfaces. Interfaces are a key feature that makes a difference between success and failure. Providing decision-makers with access to key information is- in essence- the main feature of a decision support system.

In contemporary organizations, one finds three levels of information systems. In the first level one finds data management and transaction processing systems (Electronic Data processing, Electronic Data Interchange). At the next level there are inference-based systems, which traditionally include MIS, DSS, and EIS. Finally, at the third level, contemporary IS, in the form of Data Warehouses, Data Marts, and other enterprise-wide information systems implementations provide a hybrid platform for networking and codification. These relationships are summarized in table 1.

Data needed in decision-making process comes from: Business Intelligence applications, Customer Relationships Management applications, Supply Chain Management applications, Enterprise Resource Planning application, collaborative systems, knowledge-based systems, web sources. Decision makers seek information in a logical order for solving the decision problems [12]. The decision-maker may address questions as: "how much", "when", "who" whose answers mean extracting information. In answering to "how" and "why" there is a need to have an already explicit knowledge, priory formalized.

Decisions support systems are more a philosophy and not actually a single technology. Their role is to

assist decision-maker in order to solve the structured part of the decisions' problems. DSS are problem oriented and uses: analytical models, databases, decision-making reasoning and interactive functionalities in order to assist solving semi-structured decisions. For the moment, DSS have tools for analyzing big data sets, performance management, dashboards, and scorecards.

In a recent McKinsey Quarterly survey of 2,207 executives, only 28 percent said that the quality of strategic decisions in their companies was generally good, 60 percent thought that bad decisions were about as frequent as good ones, and the remaining 12 percent thought good decisions were altogether infrequent. [19]

Traditional approach in modeling decision-making process supposes that knowledge to be available and that decisional context to be stable. In computer-based implementations every decision alternative hides knowledge priori specified by those who developed the computer-based model.

2 Problem Formulation

Business decision-making process derives information presented in reports which means usual aggregated data. Financial accounting works with standardized reports. Internal management accounting doesn't work with standardized reports. Every manager needs information according to his/her needs. Every decision-maker knows how to use information. The correlation problem between the actual management's information expectancies and the decision-making process has found standard form of reports in planning, budgets, dashboards or scorecards. The key element in managing is the actual ability of decision-maker in intelligently aggregation of data and by that identifying decision problem. Decision-makers want tools that help in eliciting knowledge, in applying knowledge. They do not need knowledge automation.

Developing integrated systems leaded to possibility to use big data sets in analyses undertaken by decision-makers. It remains one problem: semantics. The decision-maker is not concerned with the actual name of data structures, he/she seeks some information and although this information is available this integrated and all performed systems are not capable to provide it because of interoperability problems.

The systemic approach in organizing business lead to developing tools for business processes implementation. All systems satisfy a certain information need and seek to offer access to real information. The semantics' problem belongs to end-user. The actual meaning of information depends on knowledge detained by user, either being an expert, a decision-maker or an apprentice. Decisions problems are information problems. The interest in modeling decisions concerns acquiring knowledge and know-how in making decisions. Finally, modeling decisions it is not so important. Information quality is much more important. Solving business decisions is different from groups to other groups so the automation of business decision-making is not convenient.

The decision-makers come from different business area, different countries, different government policies, different management approaches. So…from the informatics point of view which is the actual problem that needs a solution? It seems that the actual problem remains integration not of the systems but of information. So…we might say that semantic web efforts must concern business software developers. We discuss in the following the solution proposed by the present article in improving decision-making process.

Actually the knowledge of using information belongs to decision-maker and it can be formalized only by eliciting the decision-making rules. The way of interacting with the decision-makers might be by simply offering the solution to the decision-problem or by interacting with decision-makers through questions/answers. The decision-making models are, in this case, priory formalized. In this way the model is very static; they cannot adapt and often end by not being useful.

Using decision-rules have proved to be useless for decision-maker because they offered knowledge from the model to the decision-maker. If knowledge is not appropriate the model is not valid.

The principal problem derives from to basic situations:

1) information needed in the business decision-making process comes from various data sources

2) the context of using information differs according to the decision-making problem.

Schematically, data becomes information following its day-to-day collection and further analysis or processing. Information evolves to knowledge after repeated application of models. Knowledge and information are used in decision-making.

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3 Problem Solution

There have been many studies on the relationships between IT and KM [6], [14], [15]. Most of all previous works focused on success factors of information systems including KM systems [5], [11]. There are few studies on barriers and limitations to information systems [3].

Hume's Chasm (www.intelligententerprise.com)

Although you may empirically demonstrate that $2 million were spent on DW-DSS project and that $6 million in additional revenues were recorded, these numbers do not prove that the spending on the DW-DSS project caused the increase in revenues.

The only way to prove that changes to an information system caused some measurable change to the organization's critical metrics is through a twofold approach: link changes in measurable attributes of the information supplied with changes in decisions made, and link changes in decisions made with changes in the organization's metrics.

In our study, we focus on analyzing the technological limitations, rather than social and cultural limitations. We propose a research model by referring to DeLone and McLean's IS success model. They proposed system quality and information quality as important factors that affect user satisfaction and organizational performance.

We derived research questions from the research model.

Q1: On a scale of 1 to 10 how digitized is information needed in your decision-making processes?

Q2: In case you use a DSS, what are its functionalities? (Multi-choices)

Q3: On a scale of 1 to 10 how much you consider that your DSS is helping you in making decisions?

Q4: In case you don't use a DSS how much you consider that your current computer-based applications are helping you in making decisions?

We realized a questionnaire that has been addresses to 40 decision-makers present in a conference meeting held in October 2010. We intend to continue our study on a bigger scale.

We concentrate on a single dependant variable (decision quality measured by user satisfaction in using their DSS) and on an independent variable (digitization – how much from the information used in the decision-making processes is actually properly digitized).

The findings of the empirical analysis presented in the previous section suggested that there are limitation factors in DSS quality that relates to context describing. In this section we discuss how ontologies and semantic technologies support decision-making processes and how a DSS based on semantic technologies offers an opportunity to overcome limitations of the current DSS.

Ontology-driven semantic integration is one of the solutions for the semantic integration problem [17], [13], [9]. The approach of using a global ontology in communication of a vocabulary and common semantics is hard to get in our days [17]. Local ontologies for an independent system represent the context of action of the system and its users' point of view. Guarino states that "every (symbolic) information system has its own ontology, since it ascribes meaning to the symbols used according to a particular view of the world" [8].

The problem of obtaining information in the context of using ontologies doesn't solve entirely the decision-making problem. Every decision-maker has its own way of solving decision-problems, its own perception of risk, and its own business environment.

Actually the semantic heterogeneity is a problem of debate as the decision-making context is [17]. The context depends on local meaning of information and is offered by the decision-maker. Adapting information to context will mean developing intelligent decision support systems in an interactive way that have knowledge bases interactively developed by their own users.

The inference engines implements a meta-model necessary in specifying a problem solving reasoning.

Inferring rules must produce a change in the represented knowledge and the final purpose must be rising information quality. Inferring is related to learning. In order to be retrieved information must exist on a physical device or obtain due to some inference.

In order to be integrated an inference engine must access a general domain ontology. Data schema of each source data must be ontology of which concepts to be semantically mapped with concepts from the general domain ontology. Between inference engine and sources' data the following mediations must be realized: the mappings between data schema and ontology; the mappings between ontology and inference engine's primitives.

In computer science and information science, ontology is a formal representation of knowledge as a set of concepts within a domain, and the

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relationships between those concepts. It is used to reason about the entities within that domain, and may be used to describe the domain.

The Web Ontology Language (OWL) is a family of knowledge representation languages for authoring ontologies. The languages are characterized by formal semantics and RDF/XML-based serializations for the Semantic Web. OWL is endorsed by the World Wide Web Consortium (W3C) and has attracted academic, medical and commercial interest.

Ontologies have been developed by artificial intelligence researchers to improve knowledge sharing and reuse. The reason is that ontologies are studied intensively because they would promise: to ensure shared common meaning in a domain that can be communicated between people and systems.

Current interest in modeling is motivated by the Semantic Web metadata. Semantic Web is not a decision-modeling technology to improve decision but perhaps more a possibility of integrating data.

Each data source and each application that uses the data source must have either a schema (SQL / DDL or XSD) or an informal structure that can be formalized as a schema. Due to changes in economic environment inherent business schemes change over time.

Currently, Google is funding a project called KnowItAll in which members and students of the University of Washington are participating. Yahoo! semantic technologies used to develop search engine for food. Citigroup is investing now in semantic technologies to organize and correlate the content of different sources of financial data to help identify investment market stock exchanges. Oracle has incorporated Seamark Navigator system to find relevant information through semantic search. HP offers open source environments to develop semantic web applications. Metaweb Technologies is developing a database (type Wikipedia) called Freebase with semantic technologies. RadarNetworks is developing a semantic search engine. Massachusetts General Hospital and Harvard University have initiated a pilot project for the labeling of clinical data using semantic technologies. Doug Lenat of Cycorp develops an intelligent system using semantic technologies which claims that could answer questions in natural language.

Currently there are several research projects at EU level in engineering semantic web services: DIP, SECT, Knowledge Web, SeCSE, ASG, Sodium, Infrawebs, WS2.

Ontologies can be incorporated at the level of an organization, the use of portal-type applications in client-server architecture with sharing of information described by the model ontology.

In a client / server architecture with a database server, server domain ontology, ontology applications and an inference engine, editing the meta-model (specialized knowledge extraction) is performed by the user, and inference engine executes the rules and "enriches" semantically the existing ontology. The user must have a custom application with ontology of concepts which will overlap with the domain ontology. In this there is a possibility to retrieve information coming from different sources.

Information retrieval is done using a query language. The proposed solution is SPARQL language with which the user can make SELECT sentences and get so-called conceptual responses (responses that contain an intensional part). Providing response can be regarded as intelligent information system based on answers enriched semantic properties of concepts (classes) performed by inference engine.

Opportunities for integrating numerical and qualitative factors, numeric and symbolic variables in applications developed should be guided by the degree of structure and context-sensitive issues. When the factors are qualitative and depend on their assessment and decision-context, problem-solving model must allow inferences on the ontology specification of qualitative factors.

Hyperlink technology is a valuable human-computer interaction too, that allows humans to follow their mental processes, and not the other way around.

4 Conclusion

We focused in this paper on how to overcome the limitations imposed by the way in which the decision-making context is described by actual DSS. Our study has limitations derived from the fact that the domain of study is new, unstructured yet and with very few applications in practice. Therefore, any empirical analysis is limited. What we wanted to underlie is the fact that the decision-making context might be described by using ontology and semantic technologies.

Another important fact that our paper tries to transmit is its importance to business software

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developers. There is equivalence between the degree in which organizations realize their information needs, their needs in context representations and the degree in which business software developers realize what the niche for semantic web technologies is.

Our study addresses all information systems within an organization and is not limited only to DSS. Under the umbrella of DSS we treated any business information system that helps in making business decisions.

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References:

[1] Bloodgood, J.M., Salisbury, D., Understanding the influence of organizational change strategies on information technology and knowledge management strategies, *Decision Support Systems* (31), 2001, pp. 55-69

[2] Chedrawy Z., Abidi S., An Adaptive Personalized Recommendation Strategy Featuring Context Sensitive Content Adaptation", *AH* 2006: 61-70

[3] Chircu, A. M., and Kauffman, R. J., Limits to Value in Electronic Commerce-Related Information Technology Investments, *Journal of Management Information Systems*, 17, 2, 2000, pp. 61-82

[4] Decouchant D., Escalada Imaz G., Martinez Enriquez A. M., Mendoza S., Contextual Awareness Based Communication and Coauthoring Proximity in the Internet, *Expert Systems with Applications,* 2009, vol:36, no. 4, pp:8391-8406

[5] DeLone W. H., McLean E. R., Information Systems Success: The Quest for the Dependent Variable, *Information Systems Research*, 1992, 3(1): 60-95, doi:10.1287/isre.3.1.60

[6] Edwards, D.S., & Collier, P.M., Knowledge management systems: Finding a way with technology, *Journal of Knowledge Management*, 2005, 9(1), 113-125

[7] Eppler, M., & Mengis, J., The concept of information overload: A review of literature from organization science, accounting, marketing, MIS, and related disciplines, *The Information Society*, 2004, 20(5), 325–344

[8] Guarino N., Formal ontology and information systems, in: *Proceedings of FOIS98*, Amsterdam, 1998, IOS Press, pp. 3–15

[9] Hakimpour, F. & Timpf, S., Using ontologies for resolution of semantic heterogeneity in GIS, in *Proceedings 4th AGILE conference on geographic information science*, Brno, Czech Republic, 2001, pp. 385–395

[10] Koutsoukis, N.-P., Mitra, G., *Decision Modelling and Information Systems. The Information Value Chain*, Kluwer Academic Publishers, Boston, 2003, p.84

[11] Kulkarni, U., Ravindran, S., & Freeze, R., A Knowledge management success model: Theoretical development and empirical validation, *Journal of Management Information Systems*, 2007, 23(3), 309-347

[12] Mintzberg, H., Raisinghani, D., & Theoret, A., The structure of "unstructured" decision processes, *Administrative Science Quarterly*, 1976, 21, 246-275.

[13] Segev A., Gal A., Enhancing portability with multilingual ontology-based knowledge management, *Decision Support Systems*, 45 (2008) 567–584

[14] Tanriverdi, H., Information technology relatedness, knowledge management capability, and performance of multibusiness firms, *MIS Quarterly*, 2005, 29(2), 311-334

[15] Tsui, E., The role of IT in KM: Where are now and where are we heading, Journal of Knowledge Management, 2005, 9(1), 3-6

[16] Vieira V., Tedesco P., Salgado A. C., Designing context-sensitive systems: An integrated approach, *Expert Systems with Applications,* 2011, 38:1119–1138

[17] Xue Y., Ghenniwa H. H., Shen W., Instance-based domain ontological view creation towards semantic integration, *Expert Systems with Applications* 38 (2011) 1193–1202

[18] IntelligentEnterprise (-) Hume's Chasm http://intelligent-enterprise.informationweek.com/010613/print/feat1.jhtml

[19] McKinsey, Flaws in strategic decision making: McKinsey Global Survey Results, mckinseyquarterly.com, January 2009