Chapter XX

Towards Constructionist Organizational Data Mining (ODM): Changing the Focus from Technology to Social Construction of Knowledge

Isabel Ramos
Universidade do Minho, Portugal

João Álvaro Carvalho
Universidade do Minho, Portugal

ABSTRACT

This chapter addresses the definition of organizational data mining (ODM) practices that leverage knowledge creation in organizations. It argues that knowledge resides in human minds and it is created by the continuous action and interaction happening in specific social contexts. Knowledge has a rational and an emotional foundation. When represented, knowledge becomes information that shapes the action and interaction by which individuals and communities create their specific knowledge. The purpose of this chapter is to highlight the advantages of adopting a constructionist approach and to present some constructionist guidelines to assist the definition of ODM practices that leverage knowledge creation in organizations.

INTRODUCTION

The creation of scientific and organizational knowledge is guided by the assumptions its creator holds about the nature of the studied reality, the validity of knowledge and the methods and techniques to be used to assist the process.

Traditionally, it has been assumed that an organization and the business in which it is engaged have an objective existence that can be known from an independent and neutral viewpoint. Knowledge is created to assist the decision-making, the definition of strategies and the organizational change. Nevertheless, organizations can also be understood as socially constructed realities. They are, then, seen as subjective in nature, since they do not exist apart from their members and other stakeholders.

Attached to these ontological perspectives on organizations are specific epistemological and methodological assumptions that provide different ways of creating knowledge about organizational phenomena. The next section explores two perspectives on knowledge creation, presenting the advantages and drawbacks of adopting either one of them.

Whatever the paradigm used to guide the creation of knowledge, the process unfolds at two levels: individual and social. At the individual level, the intending knower, through processes such as cognition, action, interaction and emotion, actively creates knowledge. At the social level, people develop shared knowledge, when they are actively involved in the construction of something external and sharable. This chapter details these two levels of knowledge creation.

In the last two sections of the chapter, the constructionist perspective on knowledge creation is used to highlight some problems associated with the current practices in ODM, and some constructionist guidelines to assist the definition of ODM practices that leverage knowledge creation in organizations are presented.

The chapter is structured with the aim of challenging the much advanced idea that knowledge can be elicited from organizational actors and stored in repositories, assuming an independent existence from those who create it. This idea, true or false, is assumed by most existing frameworks for software and requirements engineering (Finkelstein, 2000).

In this chapter, we argue that knowledge resides in human minds, and it is created by the continuous action and interaction happening in specific social contexts. Knowledge has a rational and an emotional foundation. It has an inherently tacit nature and is made explicit in language, through the myriad of linguistic artifacts at the disposal of organizational actors. When represented, knowledge becomes information that shapes the action and interaction by which individuals and communities create their specific knowledge. We also argue that ODM can be designed to assist the social construction of knowledge.

THE PROCESS OF
KNOWLEDGE CREATION

Scientific or organizational knowledge creation has been addressed from different perspectives along the history of science and, in particular, of social sciences. The process is guided by the set of values, beliefs and norms shared by the members of the

community to which the creator of this knowledge belongs, that is, it is guided by the adopted paradigm (Lincoln & Guba, 2000). The adopted paradigm determines how the nature of the studied reality is understood, the criteria that will be used to assess the validity of the created knowledge and the construction and selection of methods and techniques to structure and support the creation of knowledge. This set of ontological, epistemological and methodological assumptions that characterize the paradigm one implicitly or explicitly uses to make sense of the surrounding reality is the cultural root of the intellectual enterprises. Those assumptions constrain the accomplishment of activities, such as construction of theories, definition of inquiry strategies, interpretation of perceived phenomena and dissemination of knowledge (Schwandt, 2000).

The Objective Reality

Traditionally, social realities have been assumed to have an objective nature. Assuming this viewpoint, the knowledge we possess about things, processes or events that occur regularly under definite circumstances should be an adequate representation of them. Knowledge is the result of a meticulous, quantitative and objective study of the phenomenon of interest. Its aim is to understand the phenomenon in order to be able to anticipate its occurrence and to control it.

In this sense, knowledge is discovered and developed by successive testing of new hypotheses. Truth is a matter of verifying or refuting the hypotheses, adequately applying the right method to guide the study of things, processes or events. Thus, developed knowledge is independent of the knower. When developed explanations are empirically tested, and, if they prove effective in predicting the occurrence of phenomena in other settings, they can be generalized to all situations in which the phenomenon occurs under similar circumstances.

The above paragraphs summarize the core assumptions guiding the discovery of scientific knowledge in the last four centuries of human history and Western culture. The creation and management of organizational and business knowledge is also strongly influenced by this paradigm.

The expressions "knowledge discovery" and "knowledge capture" are often used in the literature addressing the issues relevant to organizational knowledge management. These expressions are rooted in the assumption that an organization and the business in which it is engaged have an objective existence that can be known from an independent and neutral standing point. In order to understand organizations and businesses, the intending knower creates models of processes, resources, events and their interconnections. These models are empirically tested, and, then, they are used to support the decision-making, the definition of strategies and the organizational change. Facts, models, best practices and the results of decisions, strategies and social change can be stored for future use, informing new decisions, plans and changes (Sekaran, 1992; Palmer & Hardy, 2000).

All this means that knowledge is viewed as independent of the knower and of the organizational or business reality that it represents. It is understood as an invaluable organizational resource that can be extracted from the knower and made available to others. It provides strategic advantage, when it is delivered in time to people that need it. Another aspect that emerges from this perspective is that knowledge is understood as fairly stable and consensual, so it can be stored to be used later on by different organizational actors in different situations.

Based on these assumptions, information technologies have been used to develop knowledge management tools that should support effective creation, capture, storage and delivery of knowledge (Nemati, Steiger, Iyer & Herschel, 2002).

Limitations of Objectivism

This objectivist view of knowledge and its creation has some limitations:

a)   It assumes that when presented with facts, organizational actors will reach consensual interpretations and views. However, it may very well be that "…we can only see what fits into our mental space, and all description includes interpretations as well as sensory reporting" (Gould, 1998, p. 72). This accounts well for the difficulty in reaching consensus in organizations, even when confronted with the same information about events or processes (Sparrow, 1998). Our mental spaces are constructed and reconstructed along stages of socialization that occur in childhood, in learning role-specific knowledge and the professional language associated with it and in interactions with others. Our mental constructs define what we see as reality. Because individuals have different life experiences, it is not surprising that different organizational actors see different realities. When a common view of the reality is developed, this may not be related with some intrinsic meaning of the available information, but because individuals who interact for some time and extensively in similar social contexts, as is the case of people working in the same organization, develop similar mental constructs and end up seeing similar things. However, this is not true for situations such as when new organizational members interpret the stored information, when people subjected to recent or restricted learning interpret the information or when the stored information is interpreted in the ever-changing contexts of some organizations.

b)   It assumes that knowledge has a stable nature. However, stable knowledge creates stable ways of understanding realities, and stable, unchanging understanding could be highly problematic for organizations operating in turbulent environments. In order to implement concepts, such as flexibility, creativity and continuous learning, organizational actors must value the challenge of established knowledge and foster pluralism of perspectives in assessing complex realities and problems.

c)   It assumes that organizational actors understand the value of sharing knowledge and are motivated to contribute with their own knowledge. However, knowledge is power in organizations. Individuals compete for access to resources, promotion, wages, etc. Knowledge helps to make informed decisions, to be more effective and to be creative. These are aspects for which organizational actors get rewarded. In order to promote knowledge sharing, a balance between competition and collaboration must be cultivated for each organization and trust must be built upon ethical concerns about human action and interaction (Parker & Wall, 1998).

d)   It assumes that a complete account of specialized knowledge is possible. However, even if we feel motivated to externalize our specialized knowledge, a complete account of it is impossible. All knowledge we possess about a concept, thing, process, event or behavior is inherently tacit. It can be expressed in order to become explicit. However, no matter how much we try and how good are the tools we use to externalize our knowledge, there is always a part that we cannot express. Tacit knowledge includes the knowledge that is related with personal emotions involved

in knowing, the practice we gained manipulating and experimenting with the object of interest but we are not able to verbalize and the unconscious processes involved in knowing.

e)   It assumes that the knowledge of managers and for management is the most important, when approaching knowledge management in organizations. This approach is founded on bureaucratic (Weber, 1947) and Tayloristic (Taylor, 1911) views of organizations, which propose a clear distinction between management and operation. Managers are seen as the elite that hold the responsibility of guiding the organization through the path that leads to its success. The employees have the obligation to comply with work rules and procedures. However, this perspective does not fit the internal and external complexity and uncertainty faced by current organizations. Moreover, information technologies enable decisions to be made closer to operations, thus empowering employees, flattening the organizational structure and rendering the resolution of problems and the reformulation of work practices more effective.

The Socially Constructed Reality

Organizations can instead be understood as socially constructed realities. As such, they are subjective in nature, since they do not exist apart from the organizational actors and other stakeholders. The stable patterns of action and interaction occurring internally, with the exterior of the organization responsible for the impression of an objective existence.

The paradigm behind this view of the organization is called constructivism (Piaget, 1954) and, in a later development, called constructionism (Papert, 1990). Constructivism refers to the theory that defines human beings as active constructors of their own learning and development. Constructionism refers to the theory that adds to constructivism the idea that learning and development of human knowledge happen more effectively when individuals are involved in the construction of something external, something that can be shared or both. In the rest of this chapter, we refer to the constructionist paradigm, since it integrates the theory we find useful in supporting the ideas presented here.

Viewing reality as socially constructed implies several epistemological and methodological assumptions, including (Schwandt, 2000; Arbnor & Bjerke, 1997):

1.   Reality is constructed through purposeful human action and interaction.
2.   The aim of knowledge creation is to understand the individual and shared meanings that define the purpose of human action.
3.   Knowledge creation is informed by a variety of social, intellectual and theoretical explorations. Tools and techniques used to support this activity should foster such explorations.
4.   Valid knowledge arises from the interactions between the members of some stakeholder community. Agreements on validity may be the subject of community negotiations regarding what will be accepted as truth.
5.   To make our experience of the world meaningful, we invent concepts, models and schemes, and we continually test and modify these constructions in the light of new experience. This construction is historically and socio-culturally informed.
6.   Our interpretations of phenomena are constructed upon shared understandings, practices and language.

7.   The meaning of knowledge representations is intimately connected with the authors' and the readers' historical and social contexts.

8.   Representations are useful if they emerge out of the process of questioning the status quo, in order to create a genuinely new way of thinking and acting.

The social construction of reality emerges from four main social processes: subjectification, externalization, objectification and internalization (Arbnor & Bjerke, 1997).

Subjectification is the process by which an individual creates her own experiences. How an individual interprets what is happening is related to the reality she perceives. This reality is shaped by her subjective conceptual structures of meaning.

Externalization is the process by which people communicate their subjectifications to others, through a common language. By making something externally available, we enable others to react to our previously subjective experiences and thoughts. By means of this communication, humans may transform the original content of a thought and formulate another that is new, refined, changed or developed. The mutual relation with others is dialectical and leads to continuous reinterpretation and change of meanings. Surrounding reality is created by externalization.

Objectification is the process by which an externalized human act might attain the characteristic of objectivity. Objectification happens after several reflections, reinterpretations and changes in the original subjective thoughts, when the environment has generally started to accept the externalization as meaningful. This process can be divided into two phases: institutionalization and legitimization.

Internalization is the process by which humans become members of the society. It is a dialectic process that enables humans to take over the world in which others already live. Internalization is achieved through socialization occurring during childhood, and in learning role-specific knowledge and the professional language associated with it.

This way of understanding and assisting human action in organizations holds some important advantages. By viewing organizations as social constructions, their members and external entities interested in them can assume the responsibility for their own decisions, for the visions they create for the organization and for the work performed there. The defined goals, objectives, strategies and plans emerge, then, as mechanisms to structure human action for as long as internal and external circumstances keep stable. The organization assumes a contextual objective nature, i.e., concerns about its identity are matched with constant assessment of historical and socio-cultural circumstances that justify keeping that identity or demand its reconstruction.

The clear division between managerial activities and operational activities loses its meaning. The organization is all its members. There is no privileged knowledge, since organizational knowledge is constructed upon the shared experiences of its members, plus all tacit knowledge held by all of them. Managerial and operational activities are interconnected. Thinking and doing are emerging at all levels of the organization as a result of human action and interaction.

Thus, the organization appears as a flexible, albeit complex, social construct where learning occurs spontaneously from the social processes of transformation happening continuously. It does not mean that the learning processes should not be intentionally designed in order to increase their effectiveness. This can be done by understanding how knowledge is socially constructed, fostering the challenge of the status quo and taking care that the means exist to create genuinely new ways of thinking and acting.

Limitations of Constructionism

Nevertheless, the constructionist perspective contains some risks associated with extreme interpretations of some of its assumptions. It may sound like organizational actors have free choice relating to the future of the organization and the design of work environments. In fact, they are inserted in contexts that are made stable by the action of wider communities of practice. This action is founded in common values and beliefs, historically and socio-culturally rooted. These values and beliefs are responsible for patterns of action that constrain the choices of organizational actors.

Another aspect that should be considered is the consequences of extreme pluralism. Although pluralism of perspectives and practices is important to keep the organization flexible and able to learn from experience, it must be balanced with the need for cohesion, shared goals and common interests (Wallace, 2000). For this reason, processes of negotiation, power, sense making and socialization interact to keep individual and group freedom inside of certain boundaries (Buchanan & Badham, 1999).

Since the constructionist perspective endorses the idea that all social constructions are based on specific historical or socio-cultural circumstances, it seems that there is no basis to judge these constructions unfair as long as the community making the assessment believed the criteria of judgment fair. The fact is that the constructionist perspective alerts us to this possibility. By understanding our reality as objective and stable, we may lose the capacity to critically analyze the values, beliefs and emotions upon which the reality is based. The community whose interaction gives rise to a social construction, such as an organization, must continuously question and negotiate the ethical and moral foundations for the criteria that are used to judge the validity of its practices.

THE RATIONAL AND EMOTIONAL NATURE OF PERSONAL KNOWLEDGE

Knowledge is not simply transmitted from a knower to a learner. It is actively constructed by the mind of the learner (Kafai & Resnick, 1996).

We make ideas instead of simply getting them from an external source. Idea making happens more effectively when the learner is engaged in designing and constructing an external artifact, which is meaningful for the learner, and she can reflect upon it and share it with others. From this constructionist description of the learning process, we can emphasize several elements associated with the creation of knowledge, namely, cognition, introspection, action, interaction and emotion.

Through cognitive processes, humans construct mental representations of their external realities. Human cognitive functions, such as language, memory, reasoning and attention, interact to produce and sustain symbols, schemas, images, ideas and other forms of mental representation (Damásio, 1999; Wallace, 2000). Cognitive knowledge is the result of the use and interconnection of these objects of knowledge, i.e., mental constructs, to make sense of the world and our action in it.

Introspection is a specific type of cognition that permits the personal inquiry into subjective mental phenomena, such as sensory experiences, feelings, emotions and mental images. Through introspection, we can see ourselves in action and observe the dialectic relations we establish with the external objects.

Through action and interaction, we create the experiences of the world we live in. These experiences construct or reconstruct our mental constructs, which in turn are responsible for a new understanding of the external reality. In this way, knowledge and experience are inseparable and influence each other.

The effective construction of personal knowledge requires the building of relationships between concepts and other mental constructs, in profoundly meaningful experiences (Shaw, 1996). All human experience is mediated by emotions, which drive our attention and concentration in order to help us process external stimuli and communicate with others. According to Damásio (1999), there are three types of emotions: primary emotions, background emotions and social emotions. Primary emotions include joy, sadness, fear, anger, surprise and aversion. Background emotions include the sensations of well-being and malaise, calmness and tension, pain and pleasure, and enthusiasm and depression. The social emotions include shame, jealousy, guilt and pride.

All knowledge and actions are associated with experiences that trigger negative and positive emotions. Specific kinds of objects or events tend to be more systematically associated with specific kinds of emotion than others. This creates consistent patterns of emotion, either at the level of the individual or the group sharing the same socio-cultural antecedents.

In accordance with the previous paragraphs, we can define meaningful experiences as those in which positive primary, background and social emotions flow easily, either as drivers or consequences of the experiences. In this sense, knowledge construction is more than cognition and action, it is also affection towards the ideas we construct and the actions we perform (Kafai & Resnick, 1996).

In the learning of new skills, concepts or practices needed to adapt to new organizational situations, emotions, such as calmness, trust, enthusiasm, pleasure, pride and self-esteem, play an important role. Because our mental constructs define the reality we see and the understanding of our place in the world, to reformulate them means to navigate for a while in ambiguity, uncertainty and risk. Those circumstances inherent to organizational change bring about emotional responses. These may be positive or negative responses. Positive emotions connect us to the new knowledge and favor its stabilization; negative emotions may lead to rejecting the new mental constructs or the process of constructing them. Thus, in effective learning environments, emotions cannot be ignored, but must be taken care of in environments that foster mutual trust.

THE HISTORICAL AND SOCIO-CULTURAL CONTEXT OF KNOWLEDGE

A social reality is a construction in continuous reformulation that occurs whenever social actors develop social constructions that are external and sharable. Those actors are active constructors of:

1.   Social relationships, such as friendships, familial relationships, partnerships, and all other associations that people actively develop and maintain in their social setting;
2.   Social events, which are activities that happen because people come together under some organized manner; they have a well-defined duration and may happen regularly;

3. Shared physical artifacts, such as things and physical spaces that people build, or maintain through their own efforts and expense;
4. Shared social goals and projects, which are those goals upon which the community agreed upon and is motivated to achieve, and which are those projects in which members of the community actively participate in order to achieve the social goals;
5. Shared cultural norms and traditions, which are things, such as shared dialects, music, styles of interacting and dressing, identity and organizational processes, with which people are comfortable (Shaw, 1996, p. 181).

Social constructors need materials for their constructions. It is the surrounding culture that provides those materials. If these materials exist in abundance, constructive learning is facilitated. If these materials are scarce, learning becomes difficult. Yet, in some situations, the surrounding culture may provide the materials in abundance but block their use. This latter situation may happen, for example, in social settings marked by fractured or limited social activity, in situations where conflicts are kept too high or are suppressed, when people do not have at their disposal enough time to experiment with new concepts, practices, etc.

As a general assumption, constructionism proposes that by the mere fact that people interact, influencing each other's mental constructs, social reality is in constant reconstruction. As mentioned before, the processes of subjectification, externalization, objectification and internalization exist in a constant interplay to create and recreate the social reality. In this context, learning of new concepts and practices is happening continuously, either intentionally or unintentionally.

The main conclusion about learning that emerges from what has been said in this section is that learning happens inside specific mental and social spaces, meaning that what a group can learn is influenced by:
1. The concepts, schemata, values, beliefs and other mental constructs shared by the group. What does not fit our mental spaces may never be seen, experienced, internalized or shared. Only what we can understand molds our interactions and helps define our position in relation to the external world that we are able to see.
2. All knowledge we create about external things, events and relationships is based on and constrained by our mental constructs. The richness of our perspective of the world depends on the diversity, complexity, depth and intensity of our own mental constructs, which in turn can be developed only by growing in connection with the reality that surrounds us.
3. The creation of knowledge is founded on the historical and socio-cultural context of its creators, providing a shared basis for the interaction inside a group. The continuous interaction of the group members, happening in a common environment, leads to similar mental constructs, a common interpretation of events and the creation of shared meaning structures and external constructions. These common meaning structures and external constructions are responsible for the stable reality that all members of the group experience. If these meanings are never challenged, they imprison the group in taken-for-granted concepts and practices.
4. There is no viewpoint outside human subjectivity or historical and socio-cultural circumstances from which to study phenomena and to judge the inquiry process and the knowledge produced. Even if we decide to study, for example, how an application of IT is used in an organization other than ours, we will always be

constrained by our mental space, and the broader historical and socio-cultural circumstances that render that use meaningful to the studied organizational actors.

The above considerations highlight the point that there are many truths about social realities, each one derived from specific mental, historical and socio-cultural circumstances. It is not possible to establish definitively that the knowledge that one individual or group creates in a disciplined and honest way is preferable to the knowledge created by another individual or group. Moreover, knowledge created in the past that brought great advantages to a community, often later became inadequate to deal with new social circumstances.

If there is no privileged perspective from which to produce knowledge that is intrinsically true, a pluralistic and multidimensional perspective should be encouraged, whenever a solution must be envisioned, a decision must be made or an intervention must be carried out. The active participation of individuals and groups subjected to different constraints can contribute to the enlargement of each other's mental space and to the enrichment of the knowledge representations and social constructions produced while making a decision or performing a social intervention.

Of course, in reality, human relationships and interests are not as consensual and passive as the above paragraphs may imply. That is why political and symbolic processes are so important in keeping conflicts to acceptable limits, in supporting the negotiation of interests and helping create and use symbols to foster group cohesion and meaning.

Accepting relativism and pluralism as relevant assumptions in reshaping social realities and creating knowledge, the next important step is to determine how knowledge claims should be judged by a community of practice. Constructionist assumptions propose that those claims (Lincoln & Guba, 2000):

- are plausible for those who were involved in the process of creating them,
- can be related to the individual and shared interpretations from which they emerged,
- express the views, perspectives, claims, concerns and voices of all stakeholders,
- raise awareness of one's own and others' mental constructs,
- question the status quo and unfair social arrangements,
- prompt action on the part of people involved in the process of knowledge creation and
- empower that action.

ODM AND KNOWLEDGE CREATION: PROBLEMS AND OPPORTUNITIES

The previous sections offered the context for knowledge creation, viewed as an individual and collective effort to make sense of the social realities that we actively construct and reconstruct. The reasoning developed in the previous sections is applied to the reconstruction of the concepts of knowledge and information. These two concepts are central in applying the constructionist paradigm to discuss current ODM practices and to propose some guidelines to reconstruct the practices in order to enhance their effectiveness.

The facts, events, things, procedures, rules, concepts, models, ideas registered and stored outside a human mind cannot be considered knowledge, since knowledge can reside only in human minds continuously growing in connection with the inner and outer worlds. What we register, store and manipulate with specific tools is some part of the human knowledge that has been expressed in some form of language. In this chapter, we call those externalized items of knowledge, knowledge representations or information. All meaningful information, which fits our mental or social spaces, has the potential of creating new knowledge through the processes of cognition, feeling and interaction.

Based on the notions of information, knowledge, and the process of knowledge creation, we are going now to present and then deconstruct the discourse usually associated with ODM. Table 1 summarizes the discourse to be deconstructed.

ODM (also called Organizational Knowledge Discovery) has been defined as the process of analyzing organizational data from different perspectives and summarizing it into useful information for organizational actors, who will use that information to increase revenues, reduce costs or achieve other relevant organizational goals and objectives (Fayyad, Piatetsky-Shapiro & Smyth, 1996; Matheus, Chan & Piatetsky-Shapiro, 1993).

Data mining is a subprocess of the knowledge discovery. It leads to the finding of models of consumer behavior that can be used to guide the action of organizational actors. The models are built upon the patterns found among data stored in large databases that are backed by statistical correlations among that data. Those patterns are extracted by specific mechanisms called data mining algorithms.

The algorithms integrating the available data mining tools increase the knowledge of organizational actors about consumer behavior or automate part of the decision-making process by defining the models that predict that behavior. Data mining tools analyze relationships and patterns in stored data based on open-ended queries. The relationships sought are of four types (Santos, 2001):

- **Classes.** Data are located in predetermined groups. These classes can then be used to predict the class to which a nonclassified record belongs.
- **Clusters.** Data items are grouped according to specific criteria that define metrics of similarity. The classes emerge from this process and are not predefined.
- **Associations.** The algorithm searches for relationships between data.
- **Sequential patterns.** Temporal relationships are identified in the data. These relationships help to anticipate behavior patterns and trends.

Table 1. ODM, Key Elements of a Discourse

Organizational Data Mining		
	Knowledge discovery in data repositories	**Data mining**
Purpose	To analyze organizational data from different perspectives and summarize it into useful information for organizational actors.	To produce statistically valid models of consumer behavior.
Input	Business knowledge and data from organizational repositories.	Selected data from the repository.
Tasks	Data selection and treatment; data mining and interpretation of results.	Classification, clustering, association, and/or sequencing.
Analysis approach	Qualitative/subjective.	Quantitative/objective.
Results	Valid, useful and possibly surprising patterns, correlations and models.	Patterns, correlations, and models with statistic significance.

Data mining tools assist in performing different kinds of technical analysis on the stored data (Rainsford & Roddick, 1996; Adriaans & Zantinge, 1996):

- **Rule induction.** The extraction of statistically significant if-then rules from data. The rules are induced in a top-down or bottom-up process. Using the top-down strategy, the process begins with general concepts that describe the data. These concepts are then refined through a process of specialization. Using the bottom-up strategy, all records of the database are considered as rules, which the algorithm tries to generalize based on the data analyzed. This kind of analysis produces results that are usually considered easy to interpret.

- **Decision trees.** The algorithm produces tree structures that represent sets of decisions. The nodes show the attributes to be classified, the branches describe the values that the attribute can assume and the leaves represent the classes by which the records can be classified. The leaves can also represent a business rule associated with certain values of the attribute.

- **Neuronal networks.** These algorithms generate predictive models whose structure imitates live neuronal tissue built from separate neurons. These models can be made quite sophisticated through training in the execution of a specific task. The model is used to classify new records. The process of creating this structure is very complex and cannot be controlled in order to assure that the obtained model is really relevant.

- **Genetic algorithms.** The process of data analysis is founded on the concepts of genetic mutation and natural selection proposed by the theory of natural evolution of live organisms.

- **Nearest neighbor method.** This process of analysis leads to the forecast of a future situation or to a decision by finding the closest past analogs of the present situation and by choosing the same solutions that were the correct ones in those past situations.

The algorithms determine the statistical significance of the found patterns and correlations. This significance is considered an objective measure of the relevance of the produced models to support the decision-making, resolution of problems or any other management task.

The results of data mining (patterns, correlations and models) are usually referred to as knowledge, which is discovered in the analyzed data repository. This knowledge must then be subject to human interpretation. Organizational actors determine its qualitative significance according to their own knowledge of the business domain.

The interpretation of data mining results is considered the most subjective part of the whole process of knowledge discovery in data repositories. It depends on the individual and shared knowledge of the business, the interests that guide the interpretation, the cognitive and social circumstances that provide the context for that interpretation and the creativity of the interpreter.

Thus, the interpretation of patterns and models of consumer behavior may vary depending on who is the interpreter. That interpretation is qualitative in nature, and makes the interpreter a key element in the knowledge discovery process. This is believed to introduce some ambiguity and lack of rigor and control in the process.

A found pattern or model that does not fit the business expectations of the data mining system user is usually considered potentially very interesting. It is also interesting if it can be used to attain organizational interests. It must be valid when applied to new data.

We want to emphasize that the purpose of the above paragraphs about ODM is not to provide an extensive account of the relevant concepts, practices and tools. We also do not consider the consequences resulting from problems with the data in repositories, such as insufficient and corrupted data, which can lead to invalid data mining results. Our aim is to address the current discourse associated with this organizational process. In the sequel, we deconstruct this discourse by identifying the values, beliefs and meanings that support it.

The concepts of data, information and knowledge are closely linked with ODM. "Data" is often defined as facts, numbers or text that can be processed by the computer. There can be various kinds of data, namely, operational and transactional data, management data and metadata (data dictionary definitions are an example of metadata). Information is defined as the patterns, associations or relationships among the data. Information can be converted into knowledge about historical patterns and future trends of consumer behavior. This categorization seems to reflect the idea of growing sophistication and meaning. Information and knowledge result from computerized data processing.

However, when we analyze these concepts more closely, it emerges that patterns, associations, relationships and historical patterns and future trends could also be considered facts of varying degrees of complexity and certainty. They can also be subject to further computerized processing. Moreover, data, information and knowledge, as they are defined in the above paragraph, have no intrinsic meaning. They become a fact, a number, a pattern, a future trend and so on, only after a human interprets the symbols of a language. So, there is no significant basis for the separate use of the terms data, information and knowledge, other than some interest in separating knowledge representations before they are subjected to the process of computerized processing from the results of such processing.

In this chapter, we argue that the expression "knowledge representation" is better and more accurate than "data, information and knowledge," because:

- it avoids the use of three different terms to refer the same things;
- it avoids confusion with the much more complex concept of knowledge, which is inherently human;
- it links what exists in organizational repositories with the human capital of the organization and the historical, and socio-cultural circumstances that shape the organizational work realities;
- it emphasizes that organizational repositories are human constructions shaped by the shared values, beliefs, feelings and experiences, which were reinforced or reconstructed in the process of constructing and updating those repositories and
- it addresses the importance of these repositories for the construction of individual and shared knowledge, having the potential of serving as support either for developmental activities or as the reinforcement of the status quo.

Attached to the discourse around the data mining tools, there is the idea that in the future, new and more powerful algorithms will be developed that will be able to find more valuable patterns and models, independent of human subjectivities and limitations. If it ever becomes possible to integrate the knowledge of the relevant business domain into the system, the algorithm would be able to decide the usefulness and validity of discovered patterns, correlations and models, as well as to grow in sophistication by integrating these models in its knowledge of the business. The decision-making process would become extensively automated and guided by the objective reasoning of clear and rational rules implemented in a computer-based system.

However, this view has several drawbacks related to the issues already addressed in the previous sections of this chapter, namely:

1. Since all human knowledge has a tacit and nonexpressible dimension, it will never be possible to integrate all relevant business knowledge in a repository to be analyzed by a data-mining algorithm.

2. The diversity of views about the business activities and their context is what allows for the emergence of organizational creativity and development and the challenging of taken-for-granted concepts and practices (Bolman & Deal, 1991; Morgan, 1997; Palmer & Hardy, 2000). The stored knowledge representations are those around which there is some degree of consensus. This is important for the stability of work concepts and practices and to support organizational cohesion. However, they may also trap organizational actors in those concepts and practices, even when evidence shows they are threatening organizational success.

3. The relevance of knowledge representations stored in organizational repositories changes according to changes in the socio-cultural circumstances that offer the context for making sense of the representations. Only the organizational actors can understand those contexts and are able to give meaning to knowledge representations.

4. It is still believed that decision-making is or should be an essentially rational process, guided by cognitive processes such as planning, resolution of problems, and creativity (Sparrow, 1998). However, recent experiments in neurobiology show that emotion is an integral part of reasoning and decision-making (Damásio, 1999). Thus, only organizational actors can make decisions. The full automation of the process is not a realistic objective.

Instead of the present focus on the technological side of ODM, it would be interesting to adopt a constructionist approach and to focus on the social process of knowledge construction that makes ODM meaningful. With this new focus on people and the way they create and share knowledge, the main concern would be to mobilize the knowledge of organizational actors so the whole organization can benefit from it. This concern is justified by the awareness that the organization, seen as a community, is more intelligent than each of its members, including any of its leaders.

As described in previous sections, knowledge construction and sharing is more successful, when individuals are involved in the construction of something external and/or something that can be shared. Knowledge representations, organizational repositories and the results of data mining are external and sharable social artifacts. The use of data mining systems supports the building or reinforcement of social relationships, the achievement of shared goals and the accomplishment of shared projects.

All these social constructions help make ideas tangible, support the negotiation of meanings and facilitate the communication between organizational actors. Thus, the whole organization is involved in a developmental cycle each time social constructions are created or reconstructed. For the construction of individual and shared knowledge, as important as the shared artifacts, goals, projects, events, relationships and other constructions is the process of creating them is more important. In the next section, we present some constructionist guidelines to drive the ODM process to the goal of leveraging the social dynamics of knowledge creation in organizations.

DESIGNING THE ODM PROCESS TO LEVERAGE KNOWLEDGE CREATION IN ORGANIZATIONS: SOME CONSTRUCTIONIST GUIDELINES

A precondition to getting people naturally involved in the ongoing production of social constructions is the existence of social cohesion, a sense of belonging to a group and a sense of common purpose (Shaw, 1996). When the group is marked by fragmented and alienating relationships among its members, it will be very difficult for its members to engage in a joint effort to construct anything. In this way, organizational actors lose developmental opportunities.

The sense of common purpose is important to sustain interaction. It motivates organizational actors to come together as concerned parties to address common issues, and actively participate in decision-making and change. When actors get together to jointly construct something sharable, social relationships are established or reinforced. These relationships, along with cultural artifacts, provide the materials for further social construction, which will support new learning and creativity. In the process, the organization, in part or as a whole, is redefined.

With ODM there is a special focus on knowledge about consumer behavior to support decision and action. ODM assists the organization in knowing the preferences of its customers and in anticipating their needs and reactions. The construction of this knowledge must be guided by the specific purposes of the several communities of practice that constitute the organization.

ODM and the knowledge it helps to create are social constructions. Repositories, data mining tools and the resulting patterns, correlations and models are social artifacts that should be used to make ideas tangible, to negotiate meanings and to facilitate communication between organizational actors. As such, they may become catalysts for the development of shared knowledge about consumer behavior, when they are used in the contexts of meaningful projects.

Data mining systems may become empowering tools in the sense that they make viable the analysis of large organizational repositories of knowledge representations. These knowledge representations are social constructions that connect organizational actors to a common view of the business concepts and practices that shape their intentions and interactions. Problems in the performance of organizational tasks or in organizational adaptation to environmental changes may reside in the inappropriateness

of knowledge representations or in the tools used to extract rules and patterns from them. Knowledge representations were created and stored under specific historical and socio-cultural circumstances of which their readers must be aware in order to be able to understand their relevance or inadequacy.

The patterns, correlations and models extracted from knowledge representations stored in organizational repositories become lenses, or assimilation frames, through which actors attribute meaning to others, the business, their action and interaction and the relationships with customers, suppliers and other relevant external entities. They can empower or impoverish an actor's decision-making and task performance. The risk of weakening action increases if organizational actors have no means of testing their interpretations of those patterns, correlation and models in practice, and if they are not given the opportunity of learning from their own mistaken interpretations or the mistakes of others. In order to support insight and creativity, organizational actors need time and opportunities to reflect upon those data mining results, to build mental relationships with their own previous mental objects of knowledge and to externalize their interpretations, i.e., talking about those interpretations and showing them to others allows each actor to influence and be influenced by the views of others.

Another important aspect to consider is that the patterns that are encountered in stored knowledge representations provide the means to reinterpret an actor's past experience and the past experience of others. Good formal and informal communication must exist in order to take advantage of this basis for the discussion of that experience in the light of the context in which it occurred in order to construct shared meanings. Thus, the meaning structures of the past are rearranged into new meaning structures.

Moreover, the rearrangement of meaning structures should be assisted with theoretical tools that critically analyze the old structures. Data mining tools can serve this aim, when they provide surprising patterns of behavior. Theoretical models, case studies and local explanations are examples of other means to support learning and the reconstruction of meaning by providing insights that do not fully overlap, or conflict with, individual and shared conceptual schemas.

In using data mining systems, the knowledge of the business domain assumes particular importance to define a user's goals and objectives, guiding the queries she defines and her interpretations of the results. The user's queries are used by the system to select the knowledge representations that are to be analyzed by data mining algorithms. Usually, this business knowledge is structurally and economically oriented; that is, it is focused on mission, strategy, objectives, tasks, processes, costs, profits, process and product quality, responsibilities, coordination and control of the activities, resources allocation, management levels, decision making, etc. These are assumed as objectively identifiable aspects of work, and, therefore, they can be analyzed and measured.

However, to gain a deeper insight of the organization and its business, in order to better understand knowledge representations, stimulate creative interpretations of data mining results and to structure the ODM process in order to facilitate organizational learning, a diverse range of organizational aspects and of interests that support the use of the data mining system should be explored. Table 2 summarizes some key aspects of a multidimensional analysis of organizations.

The study of these organizational aspects helps to identify different venues for analyzing the stored knowledge representations by uncovering a diversity of useful

Table 2. Relevant Work Aspects (Adapted from the Work of Bolman & Deal, 1991; Morgan, 1997; Palmer & Hardy, 2000)

Structural Dimension	Social Dimension	Political Dimension	Symbolic Dimension
Definition of tasks; Formal roles; Coordination and control; Formal processes; Objective, environmental and internal factors that determine the organizational structure; Authority; Formal communication channels.	Shared goals and objectives; Performance evaluation; Criteria for the delivering of rewards and punishments; Motivational factors; Informal roles and communication; Professional recognition; Professional training; How well the organizational structure fits human needs and business constraints; Participation in the decision making process.	Individual interests: tasks, career, personal life; Conflict coming from the collision of interests; Hierarchy of authority; Control of the scarce resources; Control of the organizational structure definition; Actors with to restricted access to key knowledge and information; Control of boundaries; Control of core competencies needed to guarantee the quality of the production; Coalitions and their specific interests; Charismatic actors and their exerted influence; Political processes which are responsible for the organizational structure.	Used symbols to reduce the uncertainty and ambiguity of organizational activities; Shared values and beliefs and the way they influence and are influenced y the organizational structure; Common language; Myths, stories, and metaphors; Rituals and ceremonies; Messages to the entities that hold interest in the performed activities; Legitimized way of expressing emotions.

applications of data mining results, which can function as materials for a wider range of social constructions. Patterns and models of consumer behavior can be searched and used:

- to support the achievement of organizational goals and the fulfillment of strategies, in accordance with the structural circumstances that sustain those goals and strategies;
- to develop shared purposes, to define performance criteria, to allow informal discussions of issues of common interest, to train newcomers and to support participation in decision-making processes;
- to further individual interests, to support the discussion and negotiation of interests, to empower the actors' action and to facilitate coalition building;
- to play the role of symbols that help reduce negative emotions triggered by the ambiguity and uncertainty resulting from turbulent markets, to help develop shared values and beliefs, to foster a common business language integrating the relevant concepts and practices and to design attractive messages for customers and public opinion.

Table 3 summarizes the guidelines presented in this section, grouping them in two categories:

1. guidelines that should be considered for the creation of rich learning environments in which data mining systems are used as social artifacts that leverage continuous learning and
2. guidelines that should be considered when using a specific data mining tool.

Table 3. Constructionist Guidelines for ODM

Constructionist guidelines for ODM	
Creating rich learning environments	**Using data mining tools**
Work relationships must be strengthened in order to create the social cohesiveness needed for the ongoing production of shared constructions that engage the organization in developmental cycles.	Data mining results will support insight and creativity when organizational actors have enough time to reflect upon them and the opportunity to externalize and discuss their interpretations.
The construction of knowledge about customers' preferences and their future needs and reactions must be guided by the shared purposes of the specific communities of practice that constitute the organization.	Effective formal and informal communication must be fostered in order to become possible to discuss each other's interpretations of past experience in the light of the context in which it occurred.
Organizational repositories, data mining tools, and the results of data mining are social artifacts that should be used to make ideas tangible, to negotiate meanings, and to facilitate communication between organizational actors.	Theoretical tools, locally or externally developed, should be used to critically analyze the old meaning structures, facilitating the rearrangement of those structures.
Knowledge representations were created and stored under specific historical and socio-cultural circumstances of which their readers must be aware in order to be able to understand relevance or inadequacy of those representations.	The search and interpretation of patterns and models of consumer behavior should be guided by a multi-dimensional knowledge of the business domain, and work concepts and practices.

These guidelines are given from constructionist theories developed and applied in areas, such as psychology, education and organization theory.

An Illustrative Example

The following example is based on the implementation success story of an SAS solution (http://www.sas.com/news/success/parknshop.html). This example serves to illustrate the concerns that would emerge from using the guidelines presented in this section. The set of concerns presented here include some abstract, albeit obvious, concerns since a more exhaustive set could be generated only in a detailed study of the organization, and the circumstances that provide the context and the meaning of the use of the data mining system.

An international supermarket chain has as its mission to provide the freshest food items and the best customer service possible. This supermarket chain has 170 stores spread across the country. The company has introduced a system that collects retail sales data from every cash register in every store, and delivers analyzed sales figures to the head office in time for the next working day. In the morning, store managers and buyers at the head office get up-to-the minute information about daily sales, changes in stock and price change. Vital information relating to the company's performance through the use of critical success factors, traffic lighting and drill-down is displayed. The system helps the store managers order their supplies and helps the buyers to make purchases. With the system, the company's buyers can spot trends and adopt the best long-term buying strategies.

See Table 4 for a list of general concerns developed upon constructionist guidelines to leverage the knowledge creation.

Table 4.

Strengthening work relationships:	**Data mining results in support of insight and creativity:**
What can be done to capitalize on the eventual different interpretations about consumer behavior trends held by store managers and the head office buyers?	Do managers and buyers have opportunities to share their experiences, i.e., failures and successes, in using the system to support their tasks?
Do buyers know the specifics of each store in order to better assess the supply orders and other relevant information? What events and common activities exist to relate the managers' work experiences with the buyers' experiences?	Are the system users able to follow the consequences of their decisions? When needed, do users have time to seek the reasons for positive or negative consequences?
How do friendship and other informal relationships between managers and buyers impact order fulfillment and purchasing decisions?	How is failure to see relevant information in the reports acknowledged and, eventually, punished? Are individual and social factors considered in punishing or rewarding?
The construction of knowledge about customer's preferences and their future needs and reactions:	**Discussion of interpretations of data mining results:**
Do system users know how the system is supposed to support the company mission?	What happens when the intuition of a manager or a buyer goes against the findings of the system?
What common projects, events, and artifacts have been developed by managers and buyers because of the existence of a data warehouse?	Is the data mining system used to control work performance of the company staff, namely, salespeople? How are sudden drops in performance handled?
Making ideas tangible, negotiating meanings, and facilitating the communication:	**Critically analyzing meaning structures:**
Do managers and buyers understand each other's views better now that they use the same pool of information?	Do managers use the database queries to highlight specific problems of the store?
Do users share a meaning for "effective system use"?	What are the feelings towards the system's support?
What inter and intra store power imbalances does the system create?	What steps, if any, are being taken to reduce the impact of the system on the traditional ways of performing the tasks? Why? Can the resistance be stopped? Should it be stopped?
Historical and socio-cultural circumstances surrounding the creation of knowledge representations:	**Multi-dimensional knowledge of the business domain supporting interpretation of the data mining results:**
How are experiences communicated in order to provide the context for the sales figures in terms of product demand, demographic changes, specific characteristics of the store's costumer service, aspects of the organizational structure, specific skills and motivations, local consumer culture, etc.?	With the support of the new system, do managers and buyers feel more confident in the quality of their decisions?
Can managers and buyers save the reasons behind particularly risky decisions? If they can, are they motivated to do this?	How can the systems users be motivated to use the system to its full potential? Are unexpected uses accepted?
	Are external models of management and organizing used to discuss the improvement of sales and customer service?

CONCLUSION

According to the assumptions of the constructionist perspective, ODM should be designed to involve organizational actors in the social construction of something external and sharable. The designing of a marketing campaign, the making of a decision and the transformation of work concepts and practices are examples of social construction processes for which ODM could be viewed as relevant.

As a result of the process, the individual and shared knowledge will become more sophisticated, empowering the action of individuals and groups and facilitating interaction. In this way, organizational actors consciously create cohesive and pluralist work environments, more prone to deal with problems and difficult decisions associated with

consumer behavior. This perspective is more realistic than the traditional view of ODM as a process of making knowledge neutral and independent of the knower and social contexts in which it was created, in order to support decision-making processes idealized as inherently rational.

The tools used to support ODM fundamentally shape and define the process. Lack of appropriate tools impoverishes a social setting and makes social construction difficult. Future research is needed to study if current data mining systems facilitate organizational developmental activities. It will also be important to create practical experiences of designing and implementing the ODM process in specific organizational settings, so that learning from a constructionist perspective can be supported.

We have planned a research project to understand the way Portuguese organizations view and do organizational data mining; to study: in specific cases, to what extent organizational data mining contributes to the organizational efficacy, according to the local definitions of efficacy and the historical, social and cultural circumstances in which that contribution is made and to define a conceptual framework to assist the design of the organizational data mining process.

REFERENCES

Ackermann, E. (1996). Perspective-taking and object construction: Two keys to learning. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice* (pp. 25-36). Lawrence Erlbaum Associates Publishers.

Adriaans, P., & Zantinge, D. (1996*). Data mining*. Edimburgo: Addison Wesley Longman.

Arbnor, I., & Bjerke, B. (1997). *Methodology for creating business knowledge*. SAGE Publications.

Bolman, L. G., & Deal, T. E. (1991). *REFRAMING ORGANIZATIONS: artistry, choice, and leadership*. San Francisco, CA: Jossey-Bass Publishers.

Buchanan, D., & Badham, R. (1999). *Power, politics, and organizational change: Winning the turf game*. SAGE Publications.

Damásio, A. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York: Harcourt Brace.

Fayyad, U., Piatetsky-Shapiro, G., & Smyth, P. (1996). From data mining to knowledge discovery: An overview. In U. M. Fayyad, G. Piatetsky-Shapiro, P. Smyth, & R. Uthurusamy (Eds.), *Advances in knowledge discovery and data dining* (pp. 1-34). MA: The MIT Press.

Finkelstein, E. A. (2000, June). The future of software engineering roadmap. *Proceedings of 22nd International Conference on Software Engineering* (ICSE), Limerick, Ireland.

Gould, S. J. (1998). The sharp-eyed lynx, outfoxed by nature (part two). *Natural History, 107*(23-27), 63-73.

Kafai, Y., & Resnick, M. (Eds.) (1996). *Constructionism in practice: Designing, thinking, and learning in a digital world*. Mahwah, NJ: Lawrence Erlbaum Associates.

Lincoln, Y. S., & Guba, E. G. (2000). Paradigmatic controversies, contradictions, and emerging confluences. In N. K. Denzin & Y. S. Lincoln (Eds.), *Hanbook of qualitative research* (pp. 163-188). SAGE Publications.

Matheus, C. J., Chan, P. K., & Piatetsky-Shapiro, G. (1993). Systems for knowledge

discovery in databases. *IEEE Transactions on Knowledge and Data Engineering, 5*(6), 903-913.

Morgan, G. (1997). *Images of Organization*. SAGE Publications.

Nemati, H. R., Steiger, D.M., Iyer, L. S., & Herschel, R. T. (2002). Knowledge warehouse: An architectural integration of knowledge management, decision support, artificial intelligence and data warehousing. *Decision Support Systems, 33,* 143-161.

Palmer, I., & Hardy, C. (2000). *Thinking about management*. SAGE Publications.

Papert S. (1990). Introduction. In I. Harel (Ed.), *Constructionist learning*. Cambridge, MA: MIT Media Laboratory.

Parker, S., & Wall, T. (1998). *Job and work design: Organizing work to promote well-being and effectiveness*. SAGE Publications.

Piaget, J. (1954). *The construction of reality in the child*. New York: Ballantine Books.

Rainsford, C. P., & Roddick, J. F. (1996). *A survey of issues in data mining*. (Tech. Rep. CIS-96-006). University of South Australia, School of Computer and Information Science.

Santos, M. Y. C. A. (2001). *PADRÃO: um sistema de descoberta de conhecimento em bases de dados geo-referenciadas*. Unpublished thesis, Universidade do Minho, Portugal.

Schwandt, T. A. (2000). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics, and social constructionism. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 189-213). SAGE Publications.

Sekaran, U. (1992). *Research methods for business: A skill-building approach*. John Wiley & Sons Inc.

Shaw, A. (1996). Social constructionism and the inner city: designing environments for social development and urban renewal. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice* (pp. 175-206). Lawrence Erlbaum Associates Publishers.

Sparrow, J. (1998). *Knowledge in organizations: Access to thinking at work*. London: SAGE Publications.

Taylor, F. W. (1911). *Principles of scientific management*. New York: Harper & Row.

Wallace, B. A. (2000). *The taboo of subjectivity: Toward a new science of consciousness*. New York: Oxford University Press.

Weber, M. (1947). *The theory of social and economic organization*. New York: Free Press.