# Knowledge Management and Conceptual Modelling Towards Better Business Results

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## Abstract

A short review on the idea of a synergy of knowledge management and conceptual modelling methods is given in this paper. Innovative systems fostering knowledge management in modern businesses are necessary for safe and efficient knowledge management and are a welcome addition to slowly changing business models in a turbulent socio-economic environment of the modern world. The goal of this paper is to present a short discussion on various methods of knowledge management and how they are related to conceptual modelling. Furthermore, motivation for using conceptual modelling in knowledge management is argued using various references to already published research. The reasoning is steered towards the conclusions in favour of conceptual modelling in knowledge management, but not without providing strong arguments both in favour and against the starting presumption of usefulness of conceptual modelling in knowledge management.

**Keywords:** conceptual modelling; knowledge management; databases; organisational knowledge; metamodel
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## Introduction

Knowledge management is one of the business-related domains of information technologies that is rooted in practice older than emerging technological advancements (Dell'Acqua, 2016), although the rise of information and communication technologies certainly gave it a boost in the context of enhanced user experience, temporal appropriateness, and storage performance, to name a few. The benefits of knowledge management in the business domain are well known and documented (Von Krogh et al., 2000; Smith et al., 2005; King, 2009; Nonaka et al., 2009; Zaied et al., 2015), creating thus many arguments in favour of researching various forms of knowledge management.

The main tasks of knowledge management are enhanced using the developing information technologies for the purpose of gathering, storing, connecting, and using information and knowledge. These five main tasks include knowledge discovery, knowledge elicitation, knowledge storage, knowledge sharing, and finally knowledge application.

All the above stated tasks of knowledge management have one particular thing of interest in common – alternating between tacit and explicit knowledge – one of the key goals of the process of knowledge management which fosters knowledge creation and the ability to act upon it through four important processes: socialisation, externalisation, combination, and internalisation (Nonaka et al., 2009).

Having the above concepts related to knowledge management in mind, the objective of this paper is to provide the reader with a short discussion on various methods of knowledge management and how they are related to conceptual modelling. Such a discussion is deemed as welcome by the authors since innovative systems fostering knowledge management in modern businesses are necessary for safe and efficient knowledge management and are a welcome addition to slowly changing business models in a turbulent socio-economic environment of the modern world.

The paper is therefore structured as follows: Second section describes in short the idea of conceptual modelling, followed by selected examples of modelling in knowledge management in the third section, referenced to by the discussion in the fourth section. The paper ends with some conclusions in the fifth section.

## Conceptual Modelling

For the general purpose of defining models comprising knowledge shared in an organisation, conceptual modelling is a comprehensive solution that can help bridge the gap between real and artificial agents.

Modelling is a process of creating models – abstract representation of a real domain. Elements of the model are concepts that are constrained by some of the properties of real-life concepts (Embley et al., 2011), thus having three main descriptors: intension, extension, and symbol. The process of applying concept to objects of the real domain, i.e. the process of populating the extension of a given concept, is called classification.

The idea of classification is herein beneficial for two main reasons (Olivé, 2007, pp. 39): it helps in structuring knowledge using concepts and their respective real-life objects, and it fosters the reasoning process based on the available knowledge thus making it unnecessary to define all the possible properties of every concept, since some of them can be inferred based on those with defined values.

The reason conceptual modelling is useful in the context of knowledge management and relationship between real and artificial agents is that it can be used to model unstructured data (e.g. textual documents) as structured data that is comprehensible to a computer, while being more available and easier to share.

A good model is thus characterised by four key elements (Embley et al., 2011): origin, its concepts, its representation in the model view, and its comprehension by the intended users.

Models are described using a modelling language accompanied by the constraints of the given language. A language in this context is a set of artefacts that fulfil the needs and purpose of the given model and its users, constrained by the given language's syntax, semantics, and pragmatics. The process of modelling the modelling language is called metamodelling – the elements of a metamodel are concepts with extension comprising concepts (Olivé, 2007, pp. 384). The practice of developing domain-specific models is beneficial inasmuch as the developed models are customised to be used for modelling the respective specific domain, thus containing all the necessary and interesting properties of the real-life objects pertaining to the given real-life domain. A vast number of such models exist, some of which are described in (Karagiannis et al., 2016).

# Modelling in Knowledge Management

In its essence, every model is its author's knowledge model of the modelled domain, regardless of how specific or general it is. When modelling is concerned though, the context used for further discussion in this paper is that of modelling towards knowledge management in organisations.

In the context of knowledge management, the idea of innovation is quite a researched concept, featured for example in the knowledge-based theory (KBT) (Leal Rodríguez et al., 2013; Byukusenge et al., 2017) which supports the idea that effective knowledge management can lead to development of specific capabilities that increase the probability of business performance improvement by the means of innovation (Smith et al., 2005).

## *Temporal Databases and Narratives*

One of the many knowledge storage methods in an organisation, that allow the knowledge worker to follow its development through time as well, are temporal databases. Data stored in temporal databases can have temporal annotations, thus making such data relevant to certain periods of time. Such a feature allows knowledge workers to follow evolution of data and the given organisation, yet it is nowhere stated explicitly what were the actions that caused the observed changes in data in a temporal database.

A possible solution to the stated problem is presented (Furtado, 1999) in the form of additional content that is to be written when data are changed. This additional content contains information about the operations performed over the given data in a given moment in time (a log entry).

Even though narratives can be expressed using natural language, it is best to describe them using predicates and facts, similar to how the world is described using first-order logic, with respect to human and artificial agent cooperation. Furthermore, database facts can be described using predicates as well.

The mechanism of narratives thus enhances temporal databases in the form of providing explicit entries on which actions caused the observed transitions between states of data in the given temporal database, i.e. descriptions of the world portrayed by the data of the given temporal database at the given point in time.

The approach to knowledge storage using the narrative enhancement of temporal databases makes it possible for the system to observe agent intentions based on the detected behaviour of the given agent, i.e. executed operations, and the set of predefined plans identified as possible in the given domain, and act accordingly if the agent is found struggling or if it encounters problems.

## *Integration of Semi-Structured Documents with Modelling*

Even with the ongoing rise of digitisation, documents are an integral part of every organisation, in their various forms and formats. It is vital therefore to be wary of the way these documents are stored, i.e. how is it possible to analyse them and gather information stored in them automatically, or simply retrieve the right document for any given situation at any given instant.

Documents, in the context of organisational documents including letters, reports, and similar, are usually regarded as unstructured wherefore the following is deemed beneficial (Gardarin et al., 1999): metamodel for semi-structured data representation, query language suitable for the given data, and a storage and query strategy. Three accompanying steps are recognised by Gardarin et al. (1999):

conceptual modelling of document attributes, generating mapping rules, and extraction of relevant features.

### *Organisational Knowledge Metamodel*

One of the main tasks of modelling organisational knowledge is to simplify the process of organisational knowledge sharing, especially when such knowledge is domain-specific and in the form of best practices (Loucopoulos et al., 1999). Various techniques of conceptual modelling are therefore used in modelling organisational knowledge for describing organisational structure, processes, mission, and goals. Loucopoulos et al. (1999) thus define organisational knowledge as a set of conceptual models that describe various features of an organisation.

Furthermore, Loucopoulos et al. define an organisational knowledge metamodel containing three main elements (submodels): one for modelling goals, another for modelling organisational processes, and one for modelling information system of an organisation. Organisational processes submodel is the most influential in the context of organisational knowledge, and is further constructed using four submodels, each dealing with either roles of the given organisation, activities, objects used in organisational processes, or rules detailing organisational processes.

An interesting aspect is proposed in the details of the goals submodel – goals are mainly generated, and analysed and decomposed, as a response mechanism to problems, challenges, and opportunities faced by the given organisation. Such an approach opens the possibility of goal re-use, in the context of defining several possible more or less complex processes that can lead to fulfilling a certain goal.

## Discussion

Even though the examples described above are not a part of the state-of-the-art research, they pose very good basis for development of good practice examples and a place where from modern methods can be applied towards a modern take on the concept of knowledge management in organisations, in the wake of interactions of agents of both real and artificial origins.

Temporal databases enhanced **using narratives** pose an interesting take on solving the problem of missing data when historical data changes are observed within an organisation. Nowadays paperwork still usually follows changes in features of an organisation, potentially slowing the changes down and increasing dependence on human availability and other characteristics of human beings. Saving information on the context of a change of data in the form of narrative content makes it easier for human and artificial agents alike to navigate through the available historical data and fosters their comprehension of the organisational operations that led to specific organisational changes. Such an approach allows agents to infer organisational operations based on the available historical data, therefore reducing the necessity for educating each agent on the possibilities of an organisation and available operations within an organisation. This is especially applicable to the modern notion of intelligent artificial agents that are implemented as software agents and can either serve on their own, or as support mechanisms for human agents. When an artificial agent is created, it can analyse all the narratives in an organisational database and infer the optimal set of organisational operations, and their optimal use in the context of the given organisation. Furthermore, since knowledge management has organisational knowledge retention in its numerous tasks, along with faster introduction of newcomers to the ways of the given organisation, clearly defined transitions between various states of a database

containing organisational data can foster human and artificial agents' comprehension of the organisational operations and expectations they are faced with. Furthermore, since narratives describe past actions, learning potential can also be identified, in the context of the proverb about one learning on one's mistakes. Since all the changes in data are followed by narratives, no operation that deals with data can go unrecorded, and is therefore a potential lesson to learn, based on the outcome and how it affects various organisational features of the given organisation, that can be applied or avoided in similar future situations, thus exercising various tasks of the knowledge management process, from knowledge capture, to its reuse. Periodical scanning of past practices in the form of used organisational operations for data modification can be used to adjust or refine the existing set of available operations, so as to steer the organisation in the right direction market- and success-wise, and to remove operations that proved to be bad practice.

History-oriented learning can pose a threat as well though, since key organisational features, such as organisational culture, can change in time, rendering past operations, potentially including knowledge and experience, obsolete. Therefore, it is vital to address organisational changes with care regarding the knowledge management processes.

**Document-oriented** organisational knowledge extraction can be a tedious job since high quality results are hard to achieve using automated extraction processes. To prepare the organisation for knowledge extraction from unstructured data formats such as documents that are extensively used in organisations, a thorough preparation is necessary, in the context of document analyses, and planning of organisation knowledge management based on both the available and future generated documents. A great advantage, although a potential obstruction as well, is the sheer volume of documents available in an organisation, and the information contained within. Using natural language processing (NLP) methods and other modern technologies can foster the process of document analysis with the goal of information retrieval and storage, as well as sharing with both human and artificial agents, even though only on the level of semi-automated analysis (Dill et al., 2003; Kiyavitskaya et al., 2006; Tang et al., 2012), thus still demanding human interaction and intervention. Although NLP approach can be used for analysing what the documents contain, document metadata can be applied and used with the goal of creating an environment and repository of easy to retrieve documents that have their metadata values defined at the time and during the process of their creation, thus removing the need for additional modifications of the given documents. This approach requires thorough planning of organisational processes though and integration of the knowledge management process as an integral horizontal part of the given organisation, i.e. a concept fused throughout the organisation. Another benefit that annotation of organisation related documents brings is their readability for artificial agents, thus opening a host of possibilities in the context of organisational process automation, and organisation-wide implementation of artificial agents that recognise and understand document contents. Furthermore, structured and semi-structured information is easier to use in further analyses.

Temporal focus of document-oriented approach to knowledge management on the past has similar repercussions as the earlier discussed model using the concept of narratives. Historical data can and should be used for future reference, but the organisation must be aware of the risks such an approach entails.

Every knowledge management venture must provide its users with clear understanding of the used content, without ambiguous definitions or references.

Therefore, an **organisational knowledge metamodel** is a welcome addition to any serious organisation-wide knowledge management process. Unambiguous and clear definitions of various concepts and object classification can be provided by using a clear model of the involved concepts. Modelling such concepts should therefore be used along with other knowledge management techniques and methods of choice (Abecker et al., 2004; Brandt et al., 2008). Significance of such a modelling approach is notable in the context of organisations featuring human and artificial organisational units alike, where humans may have a certain notion of specific concepts, yet artificial agents are not accustomed to such knowledge. Furthermore, even when discussing knowledge management in human-only populated organisations, standardised dictionary of terms is a necessity, since varying past experience of such agents may induce various notions of a specific concept.

# Conclusion

Even though it is useful to acknowledge the hardship one may encounter when trying to change a business system, it is necessary therefore to discuss modern technologies that make up for the time and effort put into changing such business systems, since successfully implemented and used knowledge management systems foster existing infrastructure and make it more responsive and resilient in the turbulent environments of the modern world.

It is natural that knowledge as a driving force of organisational success is recognised as a crucial resource to be kept safe in organisations and utilised. It is to no surprise therefore that modern research suggests knowledge management activities to be introduced as regular activities of organisations of all sizes, thus aiming to raise success achievement rates and market survival in general.

With the rise of artificial intelligence and artificial agents, it is more important than ever to model knowledge in a formalised way. When thinking about modelling knowledge, many aspects of it come to mind, but this paper argues the point that conceptual modelling is necessarily employed as a sort of a buffer between the real world (and real agents, i.e. people), and the artificial world (including artificial agents). An approach using conceptual modelling to bridge the gap between real and artificial agents is arguably welcome in many ways, some of which are covered in this paper.

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