Business Process Modelling Through the Knowledge Management Perspective

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Short Biographies

Dr Brane Kalpič graduated from the University of Maribor in mechanical engineering and holds a PhD in Enterprise Integration from the same University. For a last decade Brane Kalpič has been working in the manufacturing industry at different top-level management positions and also as an independent consultant where he is faced daily with strategy and change management issues. His areas of interest and expertise are focused on Strategic Management, Change Management, Business Process Reengineering and Organisation Design.

Dr Peter Bernus, Associate Professor, Griffith University, Australia (P.Bernus@griffith.edu.au). Since 1976 Dr Bernus worked internationally on various aspects of enterprise integration as researcher, consultant and project leader for Industry, Government and Defence (ADF). Together with Günter Schmidt, Jacek Blazevicz and Michael Schaw he is series editor for the International Handbooks on Information Systems and is member of the editorial boards of several international journals. His special interests is in enterprise architecture, including inter- and intra-organisational management, global enterprise networks, and dynamic project enterprises. Dr Bernus has published over sixty refereed papers and book chapters, several edited books, serves as programme committee member for numerous conferences in the area, and served as IPC chair for the International Conference on Enterprise Integration and Modelling Technology (ICEIMT'04) and the IFIP Working Conference on Modelling and Methodologies for Enterprise Integration (EI95). Peter Bernus is the past chair of the IFIP-IFAC Task Force on Architectures for Enterprise Integration which developed GERAM, the Generalised Enterprise Reference Architecture and Methodology (the basis of ISO 15704:2000) and foundation chair of Working Group 5.12 on Enterprise Integration of the International Federation of Information Processing (IFIP).

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Article Type

Research paper

Purpose

As economies move into the information age and post-industrial era, information and knowledge become important resources to organisations. The article discusses the role and contribution of Business Process Modelling (BPM) in the Knowledge Management initiative and in the management of company specific knowledge.

Approach

The authors consider BPM as a tool for Knowledge Management that allows the transformation of informal knowledge into formal knowledge and facilitates its externalisation and sharing.

The article starts with the brief introduction of the theoretical background of business process modelling and its basic concepts;, and also presents definitions and concepts of major knowledge categories, knowledge processes and knowledge resources, as have been given by different authors in the KM domain. These definitions are used as a basis for the knowledge category model and knowledge process model proposed by the authors.

Findings

The article presents findings of the mapping process of the BPM concepts into the knowledge life-cycle model, proposed by Nonaka and Takeuchi and knowledge categories defined by different authors. During mapping, the authors experienced a lack of explicit and widely accepted definitions of knowledge categories and knowledge processes in respect of all knowledge features.

Originality/value

The article emphasises an important differentiation between various categories of knowledge, identified in the BPM process, as a basis for the business process related knowledge categorisation and identification of key knowledge processes. The article also presents the theoretical framework, which gives an account of how and when business process models capture and allow the sharing of knowledge. The framework identifies key a) knowledge categories, b) stages in knowledge transformation and c) activities in this process.

Business Process Modelling Through the Knowledge Management Perspective

As economies move into the information age and post-industrial era, information and knowledge become important, if not the most important, resources to organisations. Knowledge is widely recognised as being the key asset of enterprises. The article discusses the role and contribution of Business Process Modelling in the Knowledge Management initiative and in the management of company specific knowledge. Business Process Modelling is an important tool for Knowledge Management that allows the transformation of informal knowledge into formal knowledge and facilitates its externalisation and sharing. The article emphasises an important differentiation between various categories of knowledge, identified in the BPM process, as a basis for the business process related knowledge categorisation and identification of key knowledge processes. The article also presents the theoretical framework, which gives an account of how business process models capture and allow the sharing of the knowledge. The framework identifies key a) knowledge categories, b) stages in knowledge transformation and c) activities in this process.

Keywords: Business process modelling, knowledge category, knowledge process, knowledge framework

Introduction

Knowledge Management (KM) with no doubt could be considered as one of the hottest research topics of the past decade. However, the question emerge about the interest in KM, while the basic techniques of KM, which help people to capture and share their knowledge, experience and expertise, have been known and applied for a long-time?

The authors believe that the great interest in KM is being conditioned by several driving forces. *First*, the birth of KM, which occurred in the early 1990s, grew from recognition of how difficult it is to deal with complexity in an environment of ever increasing competition spurred by technology and the demands of sophisticated customers (Bennet and Bennet, 2002).

Second, the idea of KM has created considerable interest because it gives a deeper explanation to managers' interest in core competencies, their communication, leverage and possible transfer. It also creates awareness of knowledge as an important economic asset, and of the special problems of managing such assets (Spender, 2002).

The awareness of the importance of company knowledge (in the form of the company's core capabilities and resources), has also been reflected, recognised and investigated in the strategic management field. E.g., the Resource-Based View (RBV) regards knowledge as a basic source of competitive advantage. It is argued that a company's competitive strength is derived form the uniqueness of its internally accumulated capabilities (Conner and Prahald, 1996; Schultze, 2002). The RBV approach therefore implies that not all knowledge is equally valuable for the company. Knowledge that can freely be accessed or traded in the market has limited ability to serve as a source of competitive advantage; however, this knowledge could improve the organisation competitiveness.

Third, many companies have a world-wide distributed organisation, and the dissemination of company knowledge requires suitable techniques of knowledge management (such as knowledge acquisition and sharing). This situation is made even more difficult in organisations that operate in culturally diverse environments.

Fourth, the pace of adoption of the Internet technology, especially the establishment of Intranets, Extranets, Web portals, etc., has created a networking potential that drives all of society and corporations to work faster, create and manage more interdependencies, and operate on global markets (Bennet and Bennet, 2002).

Finally, as a *fifth driver*, in the 1990s companies became aware of the threat and risk of losing valuable key organisational knowledge, that is often present only in employees' heads (knowledge which is not explicit, externalised or formalised and is consequently not available for use by other individuals). At the same time, the demand for quicker growth of knowledge (competence) of employees has become a new driver to manage organisational knowledge.

Even though the concept of KM has emerged only recently, there are a number of initiatives that organisations have already adopted and that have become useful components for KM implementation. The result of the learning organisation, business process re-engineering, business process modelling, quality management and business intelligence movements can be used as a foundation for a comprehensive adoption of KM and the building of knowledge-based companies.

This article a) discusses the role of Business Process Modelling (BPM), which has recently been receiving increasing attention from the business and research community, through the perspective of Knowledge Management and b) raises the issues regarding the management of company specific knowledge. The authors

believe that BPM is an important tool for KM that allows the transformation of informal knowledge into formal knowledge and facilitates its externalisation (in the form of knowledge artefacts), sharing and subsequent internalisation.

The article presents findings of the mapping process of the BPM concepts into the knowledge life-cycle model, proposed by Nonaka and Takeuchi (1995) and knowledge categories defined by different authors (Polanyi, Skryme and Amidon, Bejierse). During mapping, the authors experienced a lack of explicit and widely accepted definitions of knowledge categories and knowledge processes in respect of all knowledge features. The mapping process has also shown important differentiation between various categories of knowledge (identified in the BPM process) as a basis for a *new* knowledge categorisation and definition of key knowledge processes, presented by the knowledge category model and the knowledge process model.

Beside the definition of knowledge categories, the article discusses a theoretical framework which presents an account of how enterprise models capture and allow the sharing of the knowledge of business processes – whether they are possessed by individuals or groups of individuals in the company.

The article starts with the brief introduction of the theoretical background of business process modelling and its basic concepts. The second section of the article gives a definition of 'business process' and 'business process model'; it also defines main categories of process models and process types.

The third section presents definitions and concepts of major knowledge categories, knowledge processes and knowledge resources, as have been given by different authors in the KM domain. The presented definitions are used as a basis for the knowledge category model and knowledge process model proposed by the authors.

The final section of the article discusses issues, which consider the application of contemporary Knowledge Management Systems and the role and value of BPM in the process of knowledge externalisation, formalisation and sharing. This section also presents the knowledge life-cycle model as the mapping of BPM concepts into the field of KM. The presented framework describes, in detail, the knowledge categories and associated knowledge processes in the process of business process model development.

Business processes and business process modelling

Business process

The Oxford English Dictionary (1999) defines 'process' as a series of actions or operations conducing to an end, or as a set of gradual changes that lead toward a particular result. Business processes (*i.e.* processes performed by the 'physical system'[1]) are a set of activities intended to transform system inputs into desired (or necessary) system outputs by the application of system resources.

It is customary to enrich this definition with characteristic properties that stress the business nature of a process. According to Davenport (1993) and the ISO9000:2000 family of standards (2000) a 'business process' is a structured and measured, managed and controlled set of interrelated and interacting activities that uses resources to transform inputs into specified outputs (goods or services) for a particular customer or market. Davenport also proposes a *differentia specifica* of business processes: every process relevant to the creation of an added value is a business process.

Business process model

A model[2] is a set of facts about an entity captured in some structured and documented form. Thus a simple list of facts about an entity *A* is not necessarily a model of *A*. The set of facts becomes a model only if *all* relevant facts are captured. In simple terms: "Model M models entity A, if M answers all relevant questions about A". Depending on the types of questions that the model is supposed to answer (the 'relevant' questions) many types of models can be developed, each representing and aspect, or view, of the same entity.

For every *type* of model there is a set of inference rules, therefore in practice the developer of the model does not have to include these with the model.

A model is a set of facts captured in some structured and documented form therefore modelling is an abstraction (and a mapping) process of the real world into a formal representation, where the relevant facts[3] are expressed in terms of some formalism (called a *modelling language*[4]). There is always a difference between the real world and model. Only a real world system is a perfect representation of itself; models are only approximations of the real world entity. The difference between a system and its model may be considered as a form of *semantic gap*.

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[1] The structural and behavioural characteristics of artificial systems can be studied using a simple cybernetic model proposed by Chen and Doumeingts (1996). The cybernetic model of an artificial system consists of three main components: physical system, management & control system and management information system.

[2] In many engineering disciplines, the word 'model' is the equivalent to what mathematical logic calls a 'theory'. The definition above uses this engineering terminology.

[3] To the reader familiar with mathematical logic: the word 'fact' is used here in its everyday meaning, covering propositions, constraints, rules, etc.

[4] **Modelling language** may be defined as a set of modelling constructs and rules that govern how they can be combined to form a valid model.

Business Process Models, as a specialised category of enterprise models, focus on the description of business process features and characteristics. For example, business process models are used for the definition of the functionality and structure of a process (sub-processes, activities and operations), the sequence of activities and their relationships, the cost and resource usage characteristics, etc.

Business process models, may be used to achieve (Vernadat, 1996):

- reduction (or better understanding) of process complexity
- improved transparency of the system's behaviour and through it better management of business processes
- better understanding and uniform representation of the entity in question
- capitalisation of acquired business knowledge and improvement of its reusability
- process improvement (to improve the characteristics of business processes).

A support of the model development process is usually necessary on two accounts: 1) *Reference models*[5] should be available so that models do not need to be build from scratch; 2) Enterprise *modelling tools*[6] should be used that support the creation, analysis, maintenance and distribution of these models.

Categories of business process models and business process types

Categories of business process models

The purpose of modelling determines what features/properties of business processes need to be represented. There are two major categories of business process models: activity models and behavioural models.

Activity models concern the functionality of the business process i.e. the 'things to be done' or 'tasks' (activities and operations performed within the process). Activity models are primarily concerned with the ways in which business activities are defined and connected through their products and resources. Therefore, activity models characterise a process by describing a) its structure (sub-processes and activities) b) required inputs and delivered outputs for each sub-process or activity, c) control relationships, and d) resources needed for activity/process execution and highlight the roles that objects play in them.

Behavioural models capture the flow of control within a process – the rules of the sequence in which activities are (or must be) performed. This can be done explicitly (describing a procedure), or implicitly (describing rules of transition, also called behavioural rules). Behavioural models do not necessarily define the objects and resources used or produced by the process – the need to do so depends on the reason for developing the model. These models are particularly well suited for the design or analysis of business processes in which the timing and/or sequencing of the events is critical (for example, the in the development of simulation models). Behavioural models are executable representations of a process (similar to a computer program), thus they can also be used for process control (or process tracking); in this case the objects exchanged and resources used have to be well defined by business process model.

Business process types

Manufacturing and other business processes (e.g. engineering, design, production, etc.), performed in the physical system, can be described by activity or behavioural models.

While activity models can always be developed, behavioural models are feasible only for processes that follow known procedures or known rules or transition, and are therefore called *structured processes* (Vernadat, 1998).

Unstructured processes can only be described as an activity model, i.e. defining functions by their inputs, outputs and mechanisms and circumscribing the contents of the function (using an explanation suited to the mechanism at hand).

Ill-structured processes can only be described by their desired outputs, and noting the range of inputs that might be necessary, as well as circumscribing the task in a way that is suitable for the mechanism (which in case of ill-structured processes is invariably human). Typically, the inputs and outputs to unstructured and ill-structured processes can only be defined as policies, objectives, goals and constraints rather then mechanistically provided 'control signals'.

[5] A **Reference model** enhances the modelling process making it faster and improving the quality of the outcome. There are three types of reference models: a) generic models (capturing the common aspects of a type of enterprise), b) paradigmatic models (where a typical, particular case is captured in model form and that model is subsequently modified to suite the new situation) (Bernus et al, 1996), and c) building block models (a set of elementary model fragments that can be freely combined as components to form a complete model).

[6] For the efficient development and implementation of business process models modelling languages must be supported by adequate **modelling tools**. Modelling tools should a) support the entire life of these models and b) provide user guidance through the modelling process and support model analysis.

The nature of knowledge and its sharing

What is knowledge?

In the literature, several different definitions of knowledge can be found. The Oxford English dictionary (1999) defines knowledge as the "facts, feelings, or experiences known by a person or group of people".

According to Baker *et al* (1997), knowledge is present in ideas, judgements, talents, root causes, relationships, perspectives and concepts. Knowledge can be related to customers, products, processes, culture, skills, experiences and know-how.

Bender and Fish (2000) consider that knowledge originates in the head of an individual (the mental state of having ideas, facts, concepts, data and techniques, as recorded in an individual's memory) and builds on information that is transformed and enriched by personal experience, beliefs and values with decision and action-relevant meaning. Knowledge formed by an individual could differ from knowledge possessed by another person receiving the same information.

Similarly to the above definition Baker *et al* (1997) define knowledge in the form of a simple formula:

Knowledge = Information + [Skills + Experience + Personal Capability]

This simple equation must be interpreted to give knowledge a deeper meaning: knowledge is created from data which becomes information as interpreted and remembered by a person with given skills, experience, personal capabilities and previously developed mental models. Knowledge gives a person the ability to use information to guide the actions of the person in a manner that is appropriate to the situation. It is noteworthy that this does not imply that the person is *aware* of this knowledge or that he/she can *explain* (externalise) it. These distinctions are important to consider when planning to discover what knowledge is available, or intending to establish knowledge transfer/sharing.

Knowledge categories

KM literature defines two main knowledge categories: explicit and tacit.

Polanyi (1966) defines tacit knowledge as knowledge, which is implied, but is not actually documented, nevertheless the individual 'knows' it from experience, from other people, or from a combination of sources. Explicit knowledge is externally visible; it is documented tacit knowledge (Junnarkar and Brown, 1997).

Skryme and Amidon (1997) define explicit knowledge as formal, systematic and objective, and it is generally codified in words or numbers. Explicit knowledge can be acquired from a number of sources including company-internal data, business processes, records of policies and procedures as well as from external sources such as through intelligence gathering. Tacit knowledge is more intangible. It resides in an individual's brain and forms the basis on which individuals make decisions and take action, but is not externalised in any form.

Polanyi (1958) also gives another detailed and substantial definition of knowledge categories. He sees tacit knowledge as a personal form of knowledge, which individuals can only obtain from direct experience in a given domain. Tacit knowledge is held in a non-verbal form, and therefore, the holder cannot provide a useful verbal explanation to another individual. Instead, tacit knowledge typically becomes embedded in, for example, routines and cultures. As opposed to this, explicit knowledge can be expressed in symbols and communicated to other individuals by use of these symbols.

Bejierse (1999) states that explicit knowledge is characterised by its ability to be expressed as a word or number, in the form of hard data, scientific formulas, manuals, computer files, documents, patents and standardised procedures or universal works of reference that can easily be transferred and spread. Implicit (tacit) knowledge, on the other hand, is mainly people-bound and difficult to formalise and therefore difficult to transfer or spread. It is mainly located in people's 'hearts and heads'.

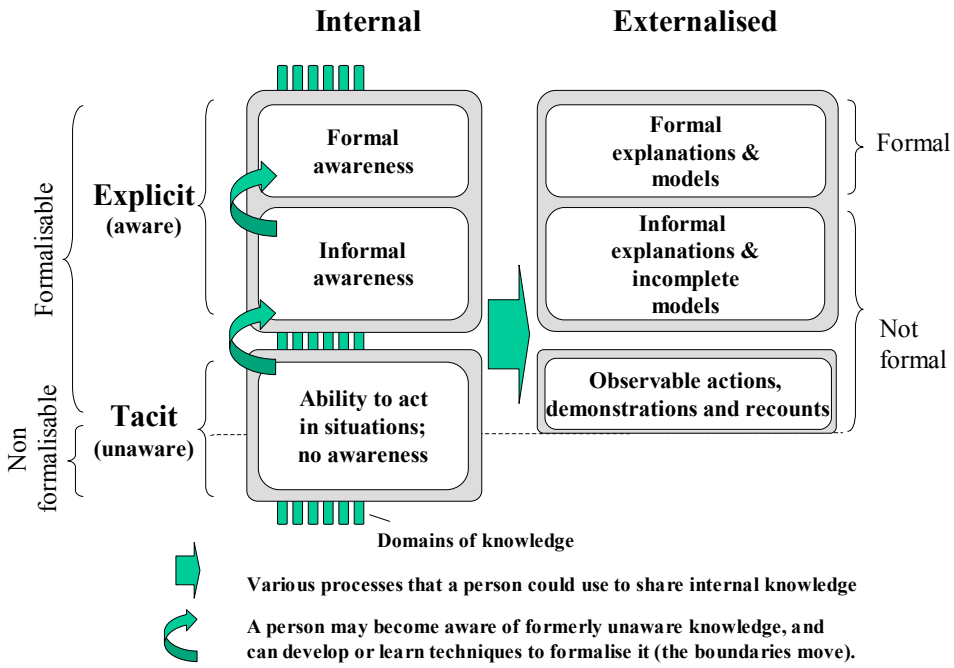

Figure 1. Knowledge categories

Considering the aforementioned definitions, the authors define explicit knowledge as knowledge, which can be articulated and written down. Therefore, such knowledge can (or could) be externalised and consequently shared and spread. Tacit knowledge is developed and derives from the practical environment; it is highly pragmatic and specific to situations in which it has been developed. Tacit knowledge is subconscious, it is understood and used but it is not identified in a reflective, or aware, way. Although tacit knowledge is not directly externalisable, it is sometimes possible to create externalisations[7] that may help someone else to acquire the same tacit knowledge. Tacit knowledge could be made up of insights, judgement, know-how, mental models, intuition and beliefs, and may be shared through direct conversation, telling of stories and sharing common experiences.

The above definitions give rise to a categorisation that can be used to make practically important differentiations between various categories of knowledge. The authors propose to divide knowledge into categories according to the following criteria (see Figure 1):

- Is there awareness of this knowledge (explicit/tacit)? Awareness means here that the person identifies this knowledge as something he/she is in the possession of and which could potentially be shared with others. In other words, the person not only can use the knowledge to act adequately in situations, but also conceptualises this knowledge (this awareness may be expressed by statements as "I can tell you what to do", "I can explain how to do it"). The lack of awareness manifests is statements like "I can not tell you how to do it, but I can show".
- Is the knowledge internalised in a person's head or has it been externalised (internal/externalised)? In other words, have there been any external records made (in form of written text, drawings, models, presentations, demonstrations, etc.)?
- Does the externalisation have a formalised representation or not (formal/not-formal)? Formalisation here means that the external representation of the knowledge is in a consistent and complete mathematical/logical form (or equivalent).

Note that each domain of knowledge may contain a mixture of tacit and explicit constituents.

Beside the division of knowledge into aware and unaware categories, additional categorisation of knowledge, according to whether the knowledge is able to be externalised, into the category of formalisable and non-formalisable, has to be added. While explicit knowledge can always be externalised (applying different processes, mechanisms and approaches) tacit knowledge could not be fully externalised, except for the formalisable part of the tacit knowledge. The formalisable part could be externalised by a) indirect externalisation through conversation, telling of stories, sharing common experiences and other similar approaches, or b) thought the awareness building process, where the unaware knowledge is transformed into an aware knowledge. More detailed definition of knowledge processes and their relations to the knowledge categories is presented in the third section of the article.

The above presented definitions and categories of knowledge are mainly limited to the individual's knowledge while the organisational knowledge presented in organisation behaviour and individual interactions,

[7] I.e., these externalisations do not contain a record of the knowledge itself, rather they would contain information that another person could (under certain circumstances) use to construct the same knowledge out of his/her already possessed internal knowledge.

is paying less attention. The collective knowledge is presented more in detail in the third section as schema knowledge.

The knowledge process and knowledge resources

A comprehensive survey of the KM literature shows the various knowledge management frameworks and KM activities. Some of frameworks are composed of very low-level activities and in some frameworks seems that elementary activities group into higher-level activities.

Nonaka and Takeuchi (1995) defines four processes:

- *Internalisation* is the process in which an individual internalises explicit knowledge to create tacit knowledge. In Fig.1 this corresponds to turning externalised knowledge into internalised – Nonaka does not differentiate between formal and not-formal awareness.
- *Externalisation* is the process in which the person turns their tacit knowledge into explicit knowledge through documentation, verbalisation, etc. In Fig. 1 this process corresponds to turning internalised, formalisable knowledge into externalised knowledge and subsequently communicating it (internal → externalised).
- *Combination* is the process where new explicit knowledge is created through the combination of other explicit knowledge.
- *Socialisation* is the process of transferring tacit knowledge between individuals through observations and working with a mentor or a more skilled / knowledgeable individual. In Fig. 1 this corresponds to tacit knowledge → observable actions, etc.

Devenport and Prusak (1998) identify four knowledge processes: knowledge generation (creation and knowledge acquisition), knowledge codification (storing), knowledge transfer (sharing), and knowledge application (these processes can be represented as various transitions between knowledge categories in Figure 1).

Alavi and Marwick (1997) define six KM activities: a) acquisition, b) indexing, c) filtering, d) classification, cataloguing, and integrating, e) distributing, and f) application or knowledge usage, while Holsapple and Whinston (1987) identify more comprehensive KM process, composed of the following activities: a) procure, b) organise, c) store, d) maintain, e) analyse, f) create, g) present, h) distribute and i) apply. (Again, these processes can be represented as various transitions between knowledge categories in Figure 1.)

Holsapple and Joshi (2002) present four major categories of knowledge manipulation activities:

- *acquiring* activity, which identifies knowledge in the external environment (form external sources) and transforms it into a representation that can be internalised and used;
- *selecting* activity identifying needed knowledge within an organisation's existing resources; this activity is analogous to acquisition, except that it manipulates resources already available in the organisation;
- *internalising* involves incorporating or making the knowledge part of the organisation, and
- *using*, which represents an umbrella phrase for a) generation of new knowledge by processing of existing knowledge and b) externalising knowledge that makes knowledge available to the outside of the organisation.

These four processes are applicable to the organisation as an entity, rather then addressing knowledge processes from the point of view of an individual.

As a conclusion: organisations should be aware of the complete process of knowledge flow, looking at the flow between the organisation and the external world and the flow among individuals within (and outside) the organisation. This latter is an important case, because in many professional organisations individuals belong to various *communities*, and their links to these communities is equally important to them as the link to their own organisation.

Knowledge resources

Knowledge manipulation activities operate on knowledge resources (KR) to create value for an organisation. On the one hand, value generation depends on the availability and quality of knowledge resource, as well productive use of KR depends on the application of knowledge manipulation skills to execute knowledge manipulation activities.

Holsapple and Joshi (2002) developed a taxonomy of KR, categorising them into schematic and content resources. The taxonomy identifies four *schematic* resources and two *content* resources appearing in the form of participant's knowledge and artefacts. Both schema and content are essential parts of an organisation's knowledge resources.

Content knowledge is embodied in usable representations. The primary distinction between participant's knowledge and artefacts lies in the presence or absence of knowledge processing abilities. Participants have knowledge manipulation skills that allow them to process their own repositories of knowledge; artefacts have no such skills. An organisation's participant knowledge is affected by the arrival and departure of participants and by participant learning. As opposed to this, a knowledge artefact does not depend on a participant for its existence. Representing knowledge as an artefact involves embodiment of that knowledge in an object, thus positively affecting its ability to be transferred, shared, and preserved (in Figure 1 knowledge artefacts correspond to recorded, externalised knowledge).

Schema knowledge is represented or conveyed in the working of an organisation. It manifests in the organisation's behaviours. Perceptions of schematic knowledge can be captured and embedded in artefacts or in participant's memories, but it exists independent of any participant or artefact. Schematic knowledge resources are interrelated and none can be identified in terms of others. Four schematic knowledge resources could be identified: a) culture (as the basic assumptions and beliefs that are shared by members of an organisation), b) infrastructure (the knowledge about the roles that have been defined for participants), c) purpose (defining an organisation's reason for existence), and d) strategy (defining what to do in order to achieve organisational purpose in an effective manner).

Note, that the above-described content knowledge is also referred to in contemporary management literature and can be named as 'individual knowledge'; while schema knowledge is identified as 'collective or organisational knowledge' and is closely related to the organisation's capability (Baumard, 1999; Grant, 1996).

In addition to its own knowledge resources, an organisation can draw on its environment that holds potential sources of knowledge. Through contacts with its environment, an organisation can replenish its knowledge resources. The environmental sources do not actually belong to an organisation nor are they controlled by the organisation. When knowledge is acquired form an environment source, it becomes an organisational source.

Knowledge process model

Considering the definitions of a) knowledge processes proposed by different authors (like Nonaka and Takeuchi (1995), and Holsapple and Joshi (2002)) and b) knowledge categories defined in the knowledge category model the authors further propose a knowledge process model, which identifies main internal and external knowledge processes and their relationships to knowledge categories.

This model defines two major categories of knowledge process: the knowledge *externalisation* process and the knowledge *internalisation* process.

The knowledge internalisation process, considers the source or environment from where that knowledge derives (originates) and applies two major mechanisms: a) the *selection* process internalises knowledge from inbound KR and b) the *acquisition* process acquires knowledge from external KR. However, a KR could appear in different forms as a) knowledge artefacts in formal or not-formal presentation and b) schema knowledge and knowledge present in data and information which has to be processed (in the form of observation of actions, demonstrations, recount and data and information processing) to be turned into a usable and transferable form of knowledge.

Knowledge externalisation includes the articulation and codification of knowledge in the form of formal or not-formal knowledge. Formal, aware knowledge could be externalised by formal explanations and models, while informal knowledge can be externalised using informal explanations or incomplete models.

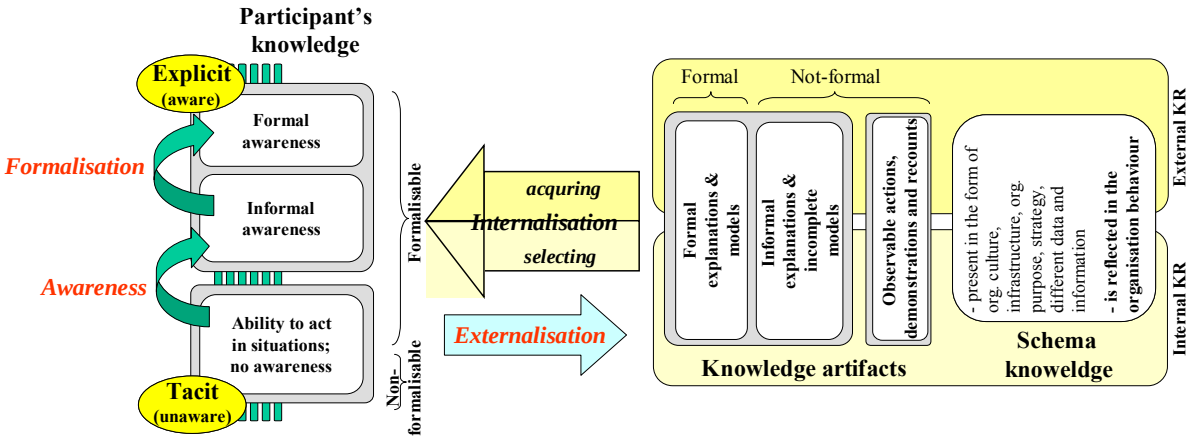

Figure 2. Knowledge process model

Beside the externalisation and internalisation processes, two other important participant-bounded processes can be identified – the awareness process and the formalisation process. The awareness process transforms the formalisable part of unaware knowledge into aware knowledge, while the formalisation process converts already aware knowledge into structured and formal form. Awareness and formalisation knowledge processes are discussed in more detail in the final section, where knowledge processes are instantiated according to BPM concepts.

Business Process Modelling and Knowledge Management

Many knowledge management systems (KMSs) are primarily focused on solutions for the capture, organisation and distribution of knowledge.

Rouggles (1998), for example, found that the four most common KM projects conducted by organisations were creating/implementing an intranet, knowledge repositories, decision support tools, or groupware to support collaboration.

Spender (2002) states that the bulk of KM literature is about computer systems and applications of 'enterprise-wide data collection and collaboration management', which enhance communication volume, timeliness, and precision.

Indeed, current KM approaches focus too much on techniques and tools that make the captured information available and relatively little attention is paid to those tools and techniques that ensure that the captured information is of high quality or that it can be interpreted in the intended way.

Teece (2002) points out a simple but powerful relationship between the codification of knowledge and the costs of its transfer. Simply stated: the more a given item of knowledge or experience has been codified (formalised in the terminology of Figure 1), the more economically it can be transferred.

Uncodified knowledge is slow and costly to transmit. Ambiguities abound and can be overcome only when communication takes place in face-to-face situations. Errors of interpretation can be corrected by a prompt use of personal feedback.

The transmission of codified knowledge, on the other hand, does not necessarily require face-to-face contact and can often be carried out by mainly impersonal means. Messages are better structured and less ambiguous if they can be transferred in codified form.

Based on the presented features of business process modelling (and in the broader sense enterprise modelling) and the issues in knowledge capturing and shearing, BPM is not only important for process engineering but also as an approach that allows the transformation of informal knowledge into formal knowledge, and that facilitates externalisation, sharing and subsequent knowledge internalisation. BPM has the potential to improve the availability and quality of captured knowledge (due to its formal nature), increase reusability, and consequently reduce the costs of knowledge transfer.

BPM and KM are related issues

While the methods for developing enterprise models have become established during the 1990s (both for business process analysis and design) these methods have concentrated on how such models can support analysis and design teams, and the question of how these models can be used for effective and efficient sharing of information among other stakeholders (such as line managers and engineering practitioners) has been given less attention.

If enterprise models, such as business process models, embody process knowledge then it must be better understood to what extent and how existing process knowledge can be externalised as formal models, and under what conditions these models may be effectively communicated among stakeholders. Such analysis may reveal why the same model that is perfectly suitable for a business process analyst or designer may not be appropriate for end users in management and engineering. Thus the authors developed a theoretical framework which can give an account of how enterprise models capture and allow the sharing of the knowledge of processes – whether they are possessed by individuals or groups of individuals in the company. The framework also helps avoid the raising of false expectations regarding the effects of business modelling efforts.

The knowledge life-cycle model

Figure 3 introduces a simple model of knowledge life-cycle, extending (detailing) the models proposed by Nonaka and Takeuchi (1995), and Zack and Serino (1998). Our extension is based on Bernus *et al* (1996), which treat enterprise models as objects for semantic interpretation by participants in a conversation, and establishes the criteria for uniform (common) understanding. Understanding is of course most important in knowledge sharing. After all, if a model of company knowledge that can only be interpreted correctly by the person who produced it, is of limited use for anyone else. Moreover, misinterpretation may not always be apparent, thus through the lack of shared interpretation of enterprise models (and lack of guarantees to this effect) may cause damage. This model (Figure 3) represents relations between different types of knowledge, and will be used as a theoretical framework.

In order for employees to be able to execute production, service or decisional processes they must possess some '*working knowledge*' (e.g. about process functionality, required process inputs and delivered outputs, organisation, management, etc.). Working knowledge is constantly developed and updated through receiving information from the internal environment (based on the knowledge *selection* process) and from the external environment (thought the process of knowledge *acquisition*).

Working knowledge (from the perspective of the knowledge holder) is usually tacit. Knowledge holders don't need to use the possessed knowledge in its explicit, formalised form to support their actions. They simply

understand and know what they are doing and how they have to carry out their tasks – having to re-sort to the use of explicit formal knowledge would usually slow down the action.

According to the suitability for formalisation such working knowledge can be divided into two broad groups: *formalisable* and *non-formalisable* knowledge. Such division of knowledge into two broad categories seems to closely correspond to how much the process can be structured, i.e. to be decomposed into a set of interrelated lower level constituent processes. These characteristics can be observed when considering knowledge about different typical business process types.

The formalisation and structural description of innovative and creative processes, such as some management, engineering and design processes (or in general the group of *ad-hoc* processes), is a difficult task, due to the fact that the set of constituent processes is not predefined, nor is the exact nature of their combination well understood by those who have the knowledge. Consequently, knowledge about this type of processes could be considered tacit knowledge (because they are not formalisable unaware processes), i.e. not suitable for formalisation/structuring.

In contrast to the characteristics of the group of *ad-hoc* processes the group of ill-structured and structured (repetitive or algorithmic) processes can be formalised and structured at least to a degree; consequently the knowledge about these processes may become explicit formal knowledge. Examples of such processes are management, engineering and design on the level of co-ordination between activities as performed by separately acting-individuals or groups, and repetitive business and manufacturing activities.

The formalisable part of knowledge (knowledge about structured and ill-structured processes) is extremely important and valuable for knowledge management, because this may be distributed and thus shared with relative ease. Namely, the process of transformation of the formalisable part of tacit knowledge into formal knowledge (the formal part of explicit/aware knowledge) represents one of the crucial processes in knowledge management. The authors believe that the cost of knowledge management (measured by the level of reuse and return of investment to the enterprise) in case of formal explicit knowledge would be lower than in case of tacit (unaware) – or even in case of unstructured explicit – knowledge, simply because the sharing of the latter is a slow and involved process.

To be able to perform the aforementioned formalisation process we need additional capabilities known as *culturally shared* or *situation* knowledge (e.g. knowledge shared by the community that is expected to uniformly interpret the formal models of the target processes). Culturally shared knowledge plays an essential role in the understanding of the process or entity in question and in its formalisation and structuring. E.g. the definition of an accounting process can only be done by an individual who understands accounting itself, but this formalisation will be interpreted by other individuals who must have an assumed prior culturally shared and situational knowledge that is not part of the formal representation (Bernus *et al*, 1996).

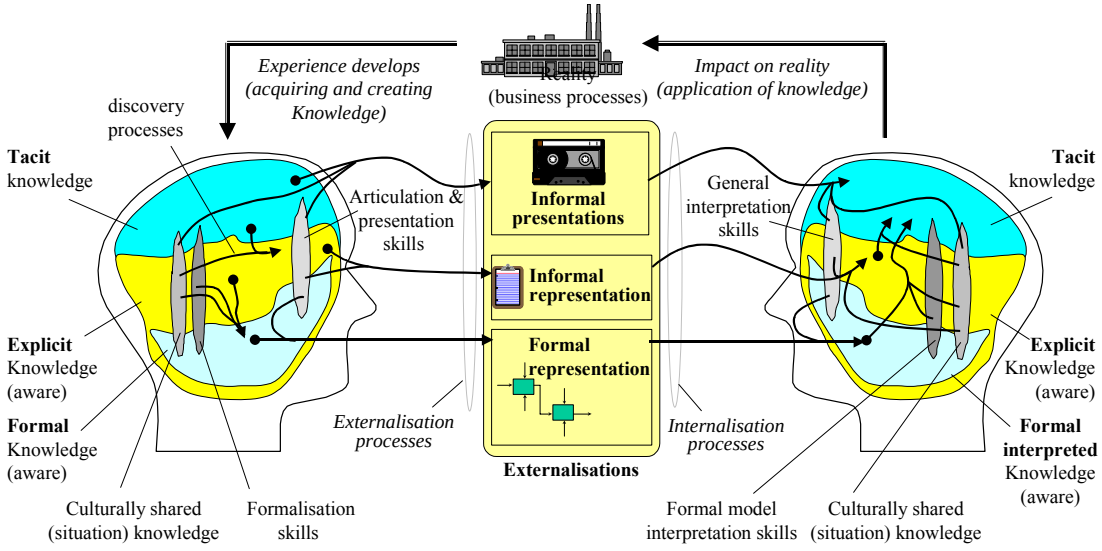

Figure 3. The knowledge life-cycle model

As already mentioned, one of key objectives of KM is the *externalisation* of participants' knowledge. Regarding the type of knowledge (tacit and explicit) different tools and approaches in knowledge capturing may be used:

- Tacit knowledge (whether formalisable or not) can be transferred through live *in situ* demonstrations, face-to-face storytelling, or *captured informal presentations* (e.g. multimedia records, personal accounts of experience, or demonstrations). Note that tacit formalisable knowledge may be *discovered* through a research process (awareness process in the terminology of Figure 2) and thus made explicit. Subsequently such knowledge may be captured as described in the bullet point below.

- Explicit knowledge can be captured and presented in *external presentations* (through the process of knowledge capturing also known as knowledge codification). An external presentation may be *formal* or *not formal*. A textual description, like in quality procedure documents (ISO9000) is not formal, while different enterprise models (e.g. functional business process models) are examples of formal external representations of knowledge (knowledge externalisations).

Formal and informal external representations are called *knowledge artefacts*. The advantage of using formal models for process description is the quality of the captured knowledge.

To actually formalise knowledge, *formalisation skills* are needed (in this case business process modelling skills).

The above process of knowledge externalisation has to be complemented by a matching process of knowledge *internalisation* that is necessary for the use of available knowledge resources.

According to the type and form of externalised knowledge, various internalisation processes (and corresponding skills) are necessary. In general, the less formal the presentation / representation, the more prior assumed *situation-specific* knowledge is necessary for correct interpretation. Conversely, more formal representations allow correct interpretation through the use of more generic knowledge and require less situation-specific knowledge. Thus formalisation helps enlarge the community that can share the given knowledge resource.

An informal external presentation of knowledge accompanied with its interpretation (e.g. interpretation of the presented story) can directly build working (tacit) knowledge, however the use of these presentations is only possible in limited situations, and it is difficult to verify that correct interpretation took place as well as the degree of completeness of such knowledge transfer. However, the verification of correct interpretation and completeness is only possible through direct investigation of the understanding of the individuals who internalised this type of knowledge. This is a serious limitation for knowledge sharing through informal means.

A *formal external presentation*, such as a business process model developed in the IDEF0 (ICAM DEFinition) modelling languages (Menzel and Mayer, 1998), must be first interpreted to be of use. To interpret the content, i.e. the information captured in this model, knowledge-processing skills (capabilities) are needed. Formal model interpretation skills are generic and not situation dependent, therefore even culturally distant groups of people can share them. Still, such formal representation must be further interpreted by reference to culturally shared, prior assumed knowledge so that the content of the formal knowledge (information captured in the business process model) can be understood and interpreted in the intended way, and thus integrated into working knowledge (to improve competencies). However, to test for correct interpretability it is possible to test whether the primitive concepts in the model (i.e. those not further explained/decomposed) are commonly understood. If this is the case then the formal nature of the model guarantees uniform interpretability. Completeness can be tested without the direct investigation of the understandings of those individuals who internalise this formal knowledge (i.e. the developer of the formal model can test himself or herself, whether the model is complete – provided the primitive concepts used are uniformly understood [8]).

The reuse of formal externalised knowledge could have an impact on the execution of process in terms of their efficiency, according to the well known fact that formally learnt processes must undergo an internalisation process after which they are not used in a step-by-step manner. Therefore, the transfer of the acquired formal knowledge into tacit knowledge is a 'natural' learning process and is necessary for efficiency. The internalisation of externalised formal knowledge thereby closes the loop of the knowledge life-cycle.

Beside the importance of the formalisation/structuring process of knowledge, easy accessibility and distribution of business process models is one of the key factors for a successful deployment of EM practice in organisations. Organisations can use an information infrastructure and a variety of technologies (usually already available and present in organisations) such as an Intranet, web tools, etc., to support storage, indexing, classification, transfer and sharing activities. Using such a distribution mechanism process models can be made available to all stakeholders, and their access can be made platform (software and hardware) independent.

Conclusion

The great interest in Knowledge Management, as one of the hottest research topics of the past decade, is being conditioned by several driving forces: a) recognition of how difficult it is to deal with complexity in the business environment, b) interest in core competencies, their communication, leverage and possible transfer, c) issues concerning the dissemination of company knowledge in world-wide distributed companies, d) rapid development and adoption of ICT, and e) company awareness of issues concerning individual's knowledge and its externalisation and formalisation.

Companies have already adopted a number of different initiatives, which could become useful components for KM implementation. BPM represents one of these initiatives and a key KM component. BPM as

[8] This test is commonly ignored by developers of formal models, probably because they assume that primitive concepts are all known through the users' formal education.

an important tool for KM allows the transformation of informal knowledge into formal knowledge and facilitates its externalisation and sharing.

Beside supporting the knowledge awareness and formalisation process, BPM has the potential to establish the criteria for uniform understanding and improve the availability and quality of captured knowledge (due to its formal nature), increase reusability, and consequently reduce the costs of knowledge transfer.

The article developed a further differentiation between various types of knowledge and processes and their mutual relationships (relative to existing knowledge categorisations available in the literature). The proposed knowledge categorisation and definition of key knowledge processes represents the authors' attempt and contribution as a basis for more explicit definitions of key notions in the KM domain. However, further research should be done to create a unified and widely accepted Knowledge Management ontology.

Because business process models embody process knowledge, a better understanding of the extent and effective communication of business process models must be achieved. Therefore, by use of the presented theoretical framework this article gave an account of how enterprise models capture and allow the sharing of the knowledge encapsulated in processes. The framework also:

- helps to avoid the raising of unrealistic expectations regarding the effects of business modelling efforts
- presents major knowledge categories, stages in knowledge transformation and activities in this process
- defines the correlation between the formalisable and non-formalisable knowledge categories and process types and
- emphasises the importance of the transformation process on the formalisable part of the knowledge, into its formal presentation as one of the crucial processes in knowledge management.

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