"Knowledge Principles and Knowledge Networking"

Strategic Knowledge Management (SKM) Building Blocks

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Knowledge is defined as re-usable information in a specific context.
Knowledge Networking is defined as the interconnection and co-ordination of knowledge through context models.

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1. Introduction

This paper considers fundamental **knowledge principles,** which address the requirements for designing and building strategic knowledge management solutions.
These principles satisfy the following main requirements:

- Support for the specification of knowledge value systems pertaining to sustainable competitive advantage;
- Support for the development of knowledge-centric solutions;
- Support for knowledge networking solutions.

In the first part of this paper an overview of key knowledge principles and concepts is provided. Firstly, we consider the way knowledge has been defined in literature to establish a clear understanding of the difference between data, information and knowledge. Knowledge hierarchies, knowledge development approaches, and knowledge assets are then briefly reviewed.

In the second part of the paper, the kBOS knowledge principles are outlined as the basic building blocks for designing and developing strategic knowledge management solutions. Knowledge is defined by context, information and actions. Knowledge is differentiated by the type of actions supported. Taking this a step further, context is presented as the mechanism for knowledge networking.

2. Defining Knowledge

2.1 Distinction between data, information and knowledge

The distinction between the three terms– data, information and knowledge is important in establishing a common understanding of terms and concepts used in knowledge management.

Data is a sequence of quantified or quantifiable symbols. Numbers, letters and characters, text, pictures, figures, recorded sounds are all examples of data. Data may be totally described through structural, formal representations. Being quantified or quantifiable, data can be stored and processed by computers and are normally linked to form "data structures". Data processing provides manipulations of the data structures. Examples of manipulations in the case of texts are their formatting, sorting, comparing with other texts, statistics of words appearing in the text, etc.

Information is data related to a particular **context**, which creates **meaning.** In other words, "Information is data that has been given meaning by way of relational connection". This "meaning" can be useful, but does not have to be."[1] In computer terms, a relational database creates information from the data stored within it.

[1] Ackoff, R. L., "From Data to Wisdom", Journal of Applies Systems Analysis, Volume 16, 1989

In summary, **data represent facts and becomes information when embedded in a context of relevance to a recipient**. To clarify this statement, *5%* is data as it has no meaning to anybody; *5% basic interest rate is information* for prospective borrowers in the UK (recipients) who interpret the information that they have to pay around 5% interest if they take a loan. Here the context that creates meaning is *basic interest rate*. If the recipient is a customer of a specific Bank A, typical information is 'interest rate charged by Bank A is 5.5%'. In this example, the context is Bank A. Looking at another example, 'price' or '90p a litre' are data. Information is '90p per litre of petrol in BP garages' for motorists (recipients) wishing to purchase petrol in BP garages (context).

Information meaning depends on the understanding of the recipient receiving the data. In our bank interest example, the extent of understanding/meaning (sometimes also termed perception) of the 'interest rate' data is dependent on the associations the bank customer is able to generate between interest rates and their effect on what he does. These associations represent his experience or in other words his knowledge.

In contrast to data that can be characterised as a property of *objects (e.g. bank_interest data, petrol_price)*, knowledge is a property of *agents* (people or computer systems) predisposing them to act in particular way in circumstances defined by the context.
In the bank interest example, the customer of Bank A will use the bank rate information to interpret the implications of a loan. If he then becomes interested to obtain a loan he will need to use his knowledge on loans (types, interest rates. etc) and knowledge about the process of applying for a loan in order to obtain the best possible loan. In this example, therefore interest rate data is just some information associated with 'loans'.
There is an important distinction here between knowledge on loans which is the main object of the exercise and knowledge of the process in obtaining a loan. The former we term **object knowledge** (sometimes also refer to as focal knowledge) and the later **process knowledge**.

It is useful to continue our example with the case that a person needing a loan will want to find the bank offering the best interest rates. For this, the required information is not just the rate offered by Bank A rather a **comparison** of rates offered by UK banks. Therefore, the information is a comparison table of banks and their rates. If this comparison tabled highlighted Bank A in the ranking order, the information will match better the Bank A customer information requirements.
It would be also useful to have these data for different types of loan (fixed term, variable, etc), different loan categories (house repairs, travelling, etc) and their histories.
This example illustrates that information has many **dimensions** (e.g. banks rates, loan types, categories, etc.) Further more the described information must be complete, accurate, easily understood and updated **(information quality attributes)** otherwise it is of little value to the recipient. For example if the information on bank loans is not complete and a bank with lowest

rate is not on the list, if a particular rate is wrong or if rates shown are not up to date their use will lead to wrong decisions.

To use the information described above a person will use his knowledge. Knowledge involves the mental processes of comprehension, understanding and **involves interaction of individuals (or more generally agents) with their environment**. Knowledge is fundamentally dynamic in the sense that people increase constantly their knowledge through different learning mechanisms. Similarly, computer systems could use learning mechanisms to develop the knowledge, which is embedded in their applications.
Going back to the loan example, the 'loan seeker' will use his previous experience and will develop new knowledge in analysing and comparing information, asking advice, etc. **It is only by observing the actions of the agent (e.g. the loan seeker) that existence and qualification of knowledge can be inferred.** In other words by observing the actions during a loan application and the outcome, (i.e. loan conditions achieved and possibly how long it took to get the loan approval) it can be inferred that the 'loan seeker' has knowledge on loans and on the loan application process.

Better results imply 'better' knowledge. To secure the optimum loan conditions would require a **high level** of knowledge, which is termed sometimes **wisdom or expertise or competence**. To explain this point better, let us assume that the loan seeker is a professional who advises individuals on what is the best loan option. In this case, the 'expert' will look at the information tables described earlier and is likely to recognise a **pattern** in related data and information that represents the best option for his client **profile** which is part of the context. Pattern recognition is an important instrument of using knowledge and therefore good pattern recognition abilities are associated with **intelligent** people or systems.

In summary, information is data endowed with relevance and purpose and knowledge is information endowed with application (Ken Davenport 2002).
Sveiby (1994, 1997) defines knowledge as a *capacity-to act*, (which may or may not be conscious)[2]. The emphasis of this definition is on the action element: *A capacity-to-act can only be shown in action.* Knowledge must therefore involve an agent, who uses knowledge to perform actions necessary to reach a goal. The knowledge of the agent can be evaluated by the resulting decisions or actions (Davenport and Pruzak 1998).

Data, Information, Knowledge and Wisdom form a hierarchical continuum with associated characteristics being "know-nothing", "know-what", "know-how" and "know-why" respectively[3].

[2] See also (Polanyi,1958) and (Wittgenstein,1995),

[3] Zeleny 1987, Ackoff 1989

2.2 Explicit and tacit knowledge

Knowledge is often categorised as explicit or tacit. **Explicit knowledge** consists of anything that can be documented, archived and codified (e.g., knowledge held by designs, manuals, etc.). Explicit knowledge is formal and systematic and therefore can be easily communicated and shared.

Much harder to manage is **tacit knowledge**, or implicit knowledge representing the personal knowledge which cannot be described and is primarily manifested through the results of actions. Tacit knowledge resides with individuals and in their relationships. In an organisational context tacit knowledge is affected by the organisational culture and structure.

In traditional perceptions of the role of knowledge in business organizations, *tacit knowledge* is often viewed as the real key to getting things done and creating new value. Thus, we often encounter an emphasis on the "learning organization" and other approaches that stress learning by doing and generation of new knowledge through managed interactions.

2.3 Knowledge hierarchies

The basic knowledge hierarchy is data- information- knowledge- wisdom described earlier. However, there are a number of interesting perspectives on knowledge hierarchies due to their relevance in knowledge measurement and development and in creating knowledge based capabilities for competitive advantage.

2.3.1 From Associations to rules

According to Robert Gagné (1985), a knowledge hierarchy is a ranked list of all knowledge which progresses from the simplest to the most complex. The simplest knowledge is **associations and chains**, which are prerequisites for discriminations. Associations are prerequisites for **concepts,** which are prerequisites for **rules and generalizations**, which are prerequisites for **higher-order rules.**

2.3.2 From Skills to Expertise

A hierarchy of knowing based on how the rules are followed is given below[4]:

Skill is the ability to act according to rules, which depend on feedback from a non-social environment. Skills might be the ability to chop wood or type on a typewriter. The actor him/herself is able to judge whether the action has been successful or not.

Know-how includes skill and is the ability to act in social contexts. Other actors, like a professional institution or the tradition, establish the rules. Know-how implies problem solving and is acquired by people while doing specific tasks. It is therefore the result of learning by analogy, experimentation, on the job training, etc.

Expertise is 'know-how plus the ability of reflection'. Expertise or competence implies the ability of know-how within a certain domain and the ability not only to submit to the rules but also by reflection

[4] Bertil Rolf Profession, Tradition och Tyst Kunskap (1991)

influence the rules of the domain or the tradition. **Expertise is thus not a property but a relation between individual actors and a social system of rules.**

2.3.3 Competences and Capabilities

Knowledge assets can be categorised in terms of technologies, competences and capabilities[5]. Technology is defined as a socio-physical system configured to produce specific types of physical outputs. Competence denotes the organisational and technical skills involved in achieving a certain level of performance in the production of such outputs. Capability is interpreted as a 'strategic skill' in the application and integration of competences.

2.4 Knowledge Development

2.4.1 Nonaka's spiral of knowledge creation

According to Nonaka there are four basic patterns for knowledge creation in an organisation[6]:

- **Socialisation:** Sharing of tacit knowledge between individuals. In this pattern, tacit knowledge is increased but does not become explicit and cannot easily be used by the organisation as a whole.
- **Articulation:** An individual succeeds in formulating the fundaments of his/her own tacit knowledge in a way that can be communicated to others. This process of making tacit knowledge explicit allows sharing within the organisation.
- **Synthesis:** An individual can combine several pieces of explicit knowledge into a new whole. Knowledge changes from explicit to explicit, but does not really extend the 'total' knowledge of the organisation.
- **Externalisation:** Individuals use explicit knowledge to broaden, extend and reframe their own tacit knowledge.

In a knowledge-based organisation, these four patterns are assumed to exist in dynamic interaction, a kind of spiral of knowledge, moving into higher and higher levels.

2.4.2 Knowledge networks

Organisations store in computers (in the form of processes, instructions and data bases) only a small fraction of the knowledge needed to run an enterprise. A figure of 10%-30% is the estimated range. The rest is the tacit knowledge in people's heads which is the key to an organisation's ability to innovate and respond in a flexible and timely manner to dynamic challenges.

The role of **knowledge networks** is traditionally associated with support for **tacit knowledge growth**. A knowledge network connects people inside and outside a company using a variety of approaches to facilitate knowledge development by sharing experiences and through collaboration.

[5] Boisit 1998

[6] Nonaka, 1991

The structure of knowledge networks and techniques used determine their efficiency in knowledge development. A key feature of a knowledge network is **the 'capacity for knowledge absorption'** by the members of the knowledge network. Knowledge diffusion works better if the knowledge level of sender and receiver of knowledge is similar.
The second important factor in knowledge diffusion is the knowledge base associated with a specific industrial sector. Spatial clustering generates high knowledge growth rates in industries characterised by tacit knowledge and high potential for technological innovation. The opposite is true in industries where codified knowledge is important and in such cases, special knowledge clustering could have a negative effect.

Knowledge networking IT systems provide the means of combining individuals' knowledge in the pursuit of personal and organizational objectives. In the simplest form knowledge networking supports person-to-person communications resulting in the development of new knowledge. More advanced computer conferences (forums, bulletin boards, reviews) can create a level and quality of debate not normally achievable within the conventional work environment.

2.5 Knowledge assets

2.5.1 Defining knowledge assets

Knowledge assets are the knowledge a business owns and uses to obtain business value or needs to develop as part of its strategic plan. Knowledge assets are fundamental strategic levers in order to manage business performance and continuous innovation in a company (Marr and Schiuma, 2001; Mouritsen et al., 2002; Quinn, 1992; Boisot, 1998).

Knowledge assets also referred to as **intellectual capital,** include organisational or **structural capital** (the knowledge that is embedded in its organisational design, relations, processes and IT applications), **human capital** (the human resources within the organisation and its suppliers) and **customer capital** (company's ongoing relationships with the people or organisations to which it sells). [See also kBOS white paper "Strategic Knowledge Management Solutions"]

2.5.2 Measuring and accounting for knowledge assets

In accountancy terms, an asset is a stock from which services flow. Accordingly, knowledge assets are defined as "stocks of knowledge from which services are expected to flow for a period of time that may be hard to specify in advance" [Boisot 1998]

Intangibles[7] are receiving increasing attention, which has triggered the emergence of ideas for knowledge accounting, based on investment in people's training and experience, employees learning capacity and knowledge management capabilities.

We can distinguish between three aspects of measurement:

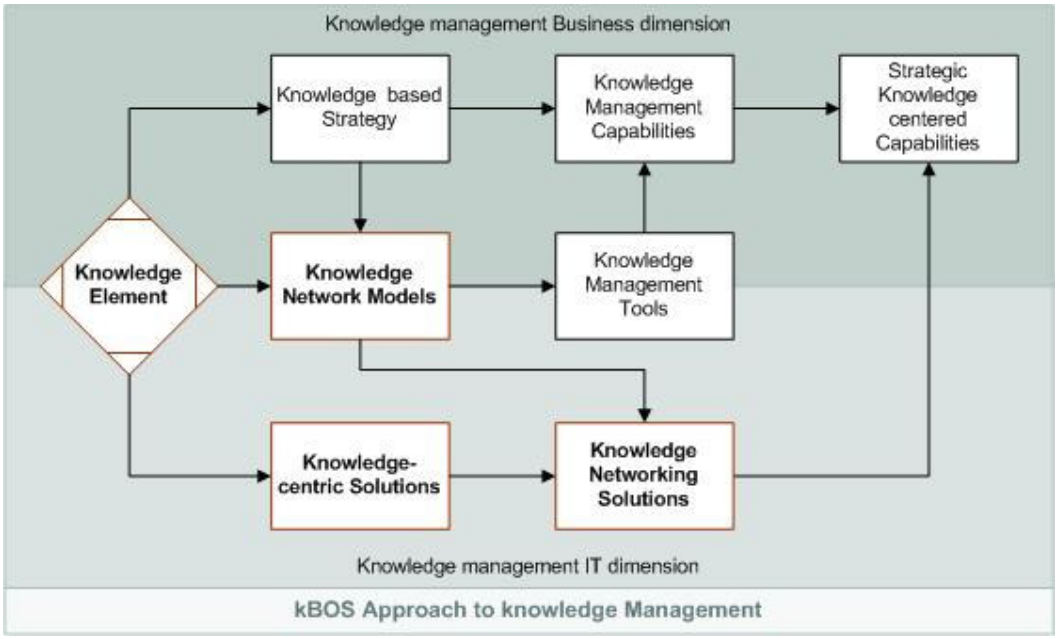
[7] The Knowledge Creating Company, I. Nonaka, Harvard Business Review (Nov/Dec 1991; The Knowledge Creating Company, I. Nonaka and H. Takeuchi, OUP (1995).

1. Measuring company value including intangible assets and specifically intellectual capital
2. Measuring knowledge in terms of its value in supporting business objectives
3. Measuring the effectiveness or maturity of knowledge management capabilities.

3. Strategic Knowledge Management Building blocks

3.1 An overview of SKM Building Blocks

Two fundamental building blocks are proposed, the Knowledge Element and the Knowledge Network Model as shown in the following diagram. These represent the main instruments of the knowledge dynamics identified in the SKM framework (SKM1 white paper). Furthermore, these two instruments provide the design approach for knowledge-centric solutions and knowledge networking solutions, which can then support Strategic Knowledge centred Capabilities (SKM2 white paper).



Knowledge Network models also guide the design of knowledge management tools that support the development of Knowledge Management Capabilities (SKM2 white paper).
The main thrust of this section is to define the knowledge element and the knowledge network models.

3.1 The kBOS knowledge definition

The kBOS knowledge definition given below emphasises consistency and rationalisation of use.
"**Knowledge is re-usable information in a specific context.”** (*P Katsoulakos 1994*).

Our knowledge definition implies that information becomes knowledge when it is re-usable in a specific context through the reasoning/learning capabilities of the agent (person or computer) using the knowledge. In this sense, we can think of knowledge as actionable information with a value associated with the result of that action.

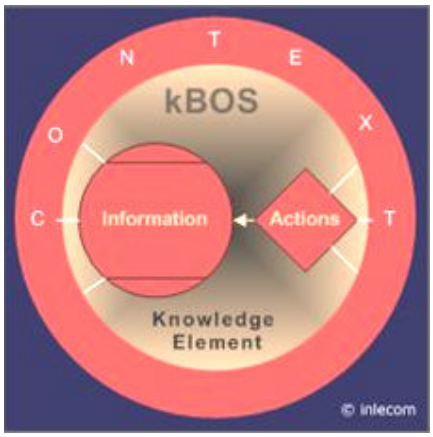
The kBOS definition endorses the view of knowledge as "capacity to act" and provides a handle for developing and managing this capacity. This handle is the **pattern** specified by information and context, which can be used to activate **a fixed set of actions**.
The starting point is some incoming information. When a person receives information that he has to act upon, he first creates associations (context) to help him interpret it in order to decide what to do (actions). What to do is often an orderly sequence of actions, which in a business context reflect the main activities in a process, which we term tasks.
Generally, knowledge enables different type of tasks to be performed by people or computers taking into account factors that influence the way the task should be performed. Therefore, a task triggered by incoming information and the factors affecting its execution generate a pattern. Such 'task patterns' embody both a consistency and completeness of relations and create **context** of variable complexity. This context then activates the fixed set of actions, which demonstrate the use of knowledge.

As mentioned already, tasks patterns are characterised by different levels of complexity. Simple tasks such as following instructions or workflow can be performed using basic know-how and can be automated by computer programs.
Performing complex tasks involves the use of tacit knowledge (mental reasoning process such as association, generalisation, etc.) and generation of new knowledge by applying different learning mechanisms. In these cases the set of actions associated with the tasks are possibly numerous, with sequence alternatives dependent on new knowledge provided by **some third party** or generated by **learning actions.** Third parties can be the existing business partners or some expert that is to be identified on demand. The way links are established to knowledge residing in the extended organisation is part of the **knowledge network model**. The knowledge network model should also address how new knowledge links are dynamically generated.
The case of activating appropriate learning services is also part of knowledge networking. The use of learning services will produce different knowledge with different people and therefore it will be important to check the results of learning by some verification or risk assessment or authorisation action. Activation and management of learning services becomes therefore an important part of the knowledge capability.

3.2 The kBOS Knowledge Element

With reference to the following diagram, the Knowledge element/unit is represented by three entities:

- Information
- Actions
- Context



3.2.1 Knowledge Actions

The knowledge nucleus is represented by information linked to the actions that transform information to knowledge in a specified context. The implication is that in a given context every expert or 'intelligent' system should respond with the same actions to an information input. This implies that actions also represent the available options on how information can be used. People use their knowledge to select and execute an appropriate sequence of actions. In computer systems, knowledge, for example, in the form of rules will be used in exactly the same way to automate the sequence and execution of actions.

From an information systems perspective actions can be regarded as object methods or workflow actions. Typical actions familiar to everyone are edit, delete, save and in a workflow situation the 'send' action will initiate the next activity. Actions can also represent complex algorithmic manipulations such as 'compare', 'plan' or 'design'. Both, the different types of actions and their characteristics will affect the value of the represented knowledge.

3.2.2 Context

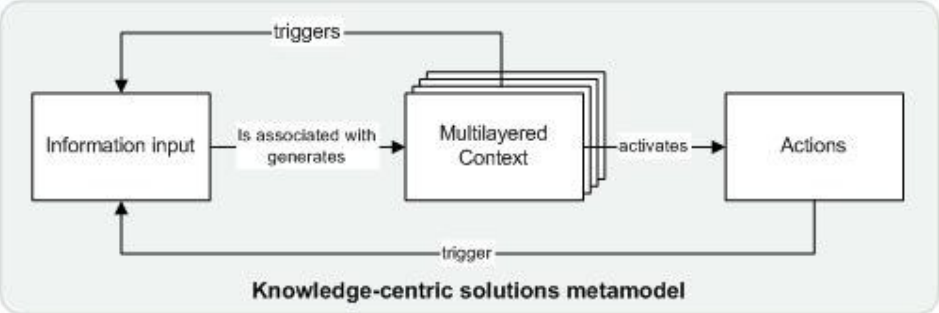
Context and information create a pattern that represents knowledge associated with a set of fixed but possibly different types of actions.

Patterns representing knowledge have a tendency to be more self-contextualizing. That is, the pattern tends to create its own context rather than being context dependent to the same extent that information is. A pattern which represents knowledge provides a high level of predictability as

to how the pattern will evolve over time. Pattern dynamics are therefore a crucial aspect of the way dynamic capabilities can be developed.

3.3 Knowledge-centric systems

Knowledge centric systems are essentially information systems based on a knowledge type meta-model. The kBOS metamodel, reflecting the definition of the knowledge element given above, is shown below.



Knowledge-centric solutions metamodel

It is important to highlight the multilayered nature of the context and the fact that the incoming information is associated with a specific context but can also generate dynamically context that will trigger information that will be associated with new context and related actions. The output from actions will trigger information which will start a new cycle.

The context activates actions in response to an information input, which may include the identification of the relevant cognitive system needed for the execution of a specific action, which may be one user, a group, a computer, or some combination.

Actions often represent process activities, as already mentioned, (referred also in kBOS as tasks) which are executed through a sequence of sub activities (actions).

3.4 Knowledge Networking

Essentially all organisations have the potential to be efficient knowledge networks. The basic requirement is to connect the different knowledge sources and control the network behaviour so that it contributes towards the achievement of corporate objectives and strategies.
We defined knowledge networking as the inter connection and co-ordination of knowledge through context models. Knowledge networking is equally applicable to one organisation, to one organisation and its stakeholders or to a business network.

3.4.1 Knowledge networking strategies

Organisational design promoting knowledge networking has broad implications for competitive advantage.
First of all, the direct networking of professionals to each other's knowledge and experience means, as Drucker (1998), Senge (1999) and Quinn, Anderson , and Finkelstein (1996) make clear, that whole layers of management can be cut out of the structure. In non-networked

structures, management roles serve as relays of information and controllers of resources, at times behaving as barriers to effective business process execution. The removal of these non-value-adding activities should reduce bureaucracy and allow the organisation to respond quickly, in a flexible fashion, to client requests and market influences.

Knowledge networking should support strategic knowledge management by:

- Enabling development of a variety of strategic knowledge based capabilities
- Coordination guided by principles of network organization
- Availability of an extended knowledge repository
- Access to additional intellectual property rights

3.4.2 Knowledge Networking models

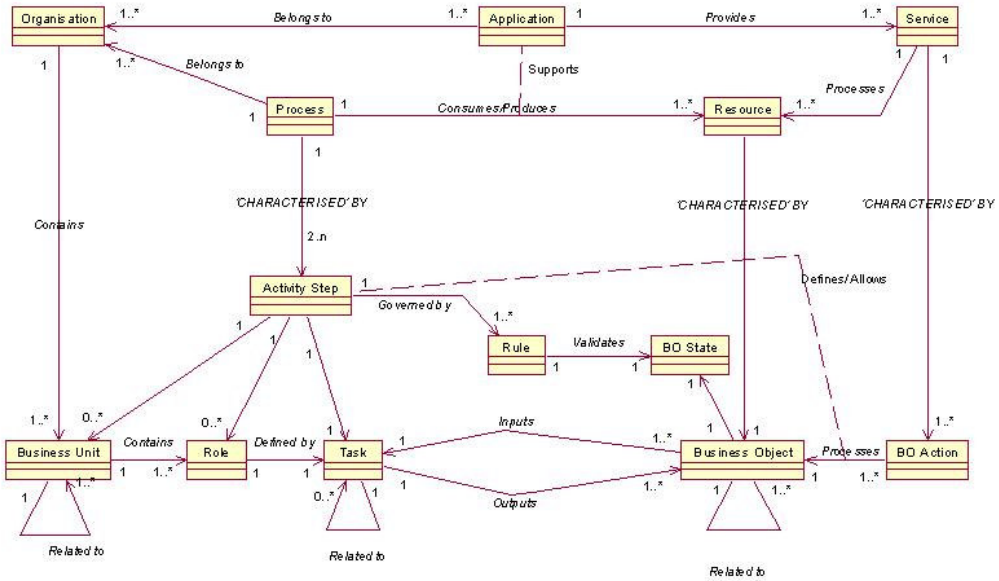
Key knowledge networking (context) models include:

- The Stakeholder model
- The Process model
- The Information model
- The knowledge and learning model
- The measurement and performance management model
- The knowledge service delivery model

The Stakeholder model defines all the organisations and organisational units involved in the knowledge network and their roles, which dictates access rights to information and knowledge.
The Process model defines the flow of information between network nodes and will .include one or more workflows.
The Information model defines the business objects and documents used in the network.
The knowledge and learning model defines knowledge sources in terms of people profiles and learning services.
The measurement and performance management model defines business performance measurements as well as criteria for competencies and capabilities and feedback handling processes.
The service delivery model defines the delivery mechanisms supported for different knowledge services.

3.4.3 An example of a knowledge networking model

An example of a knowledge networking metamodel is shown in the following diagram. The logical point for knowledge networking is that of the *task*.



The goal of such meta-model is to enable:

- Defining the meaning of each organisational data in a precise and unambiguous manner that complies with the semantics of the model.
- Share these meanings in terms of XML based standards and associated technologies