Towards a Holistic Knowledge Leveraging Infrastructure: The KNOWNET Approach

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Abstract

The approaches followed in real-world industrial efforts to develop knowledge management programmes adopt either an information technology based perspective or an organisation management perspective. However, successful knowledge management should be a truly holistic, multi-disciplinary venture. The present paper presents the KNOWNET project, a pan European research effort which aims to define, develop and test a holistic knowledge leveraging infrastructure. In order to develop a consistent framework for KNOWNET the paper defines the knowledge management related business processes as well as the associated information and communication technology requirements using the framework of Nonaka and Takeuchi and outlines the basic architecture and objectives of the KNOWNET project.

1 Introduction

To stay competitive in the increasingly competitive world markets, enterprises know that they must develop better techniques to manage knowledge, which is increasingly becoming their greatest asset. To successfully respond to pressures that require companies to react flexibly to diversified and changing structures of market demand, the "learning ability" of enterprises is often seen as the most important factor in re-organising structures and processes, where flexibility and quality are the benchmarks. In addition, increased innovation and renewal of companies puts a lot of emphasis on the management of knowledge. Knowledge in the form of corporate policies, market competition analyses, products, technologies and especially the skills, know-how and expertise of employees, is considered the source of innovation and growth.

The usual approaches followed in real-world industrial efforts to develop knowledge management programmes adopt either an Information and Communication Technology (ICT) based perspective, with an emphasis on the design and use of related tools, or an organisation management perspective, putting emphasis on the structural and cultural issues of managing knowledge.

However, successful knowledge management should be a truly holistic, multi-disciplinary venture, requiring expertise in strategy development, business process design, change management or people issues as well as technology expertise; the need for each of these four areas. A knowledge management solution needs to be linked to and support an organisation's strategic objectives as well as have its own strategic objectives. It must support key business processes as well as have its own clearly defined knowledge processes for facilitating the creation, acquisition, synthesis, sharing, and use of information and insights. Knowledge management should involve the identification, collection, retention and distribution of knowledge assets, the development of new and the sharing of existing knowledge, as well as the establishment of the appropriate corporate culture, value and reward systems that measure and reward the application of intellectual capital to achieve remarkable performance.

Aiming to define, develop and test a holistic knowledge leveraging infrastructure, the present paper presents the KNOWNET project[1], a pan European research effort,

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[1] The KNOWNET consortium comprises the following companies: PLANET, the leading Greek management consultancy company; KNOWLEGDE ASSOCIATES, a UK-based international company that has attained a very high reputation for knowledge management education, consulting, and systems development; DFKI, the German Research Center for Artificial Intelligence, the leading industry-geared research institute in the field of innovative software technology in Germany; INSEAD's Centre for Advanced Learning Technologies, one of Europe's leading R&D initiative in the domain of advanced learning technologies for management education and knowledge management; Gooch Webster (UK), a top twenty UK Chartered Surveyors firm; the Greek Institute Of Communication & Computer Systems, a research institute active in the area of collaborative technologies; FHBB, an academic institution doing research and development in IT-based applied

partly funded by the ESPRIT (European Scientific Programme of Research in Information Technology) programme of the European Commission and by the participating companies. The KNOWNET project aims to develop a multi-disciplinary framework for knowledge management that will include both the necessary ICT tools and systems, as well as the related organisation management methods. KNOWNET also involves the concrete application of the systems, tools and methods to three knowledge-intensive organisations.

In order to develop a consistent framework for the knowledge leveraging infrastructure of KNOWNET, the paper begins by defining the knowledge management related business processes as well as the associated information and communication technology requirements. Based on the work of Nonaka and Takeuchi (1995) we attempt to translate the types and modes of knowledge conversion into a framework for the development of technological architectures that exploit knowledge leveraging. The framework is explicit in the sense that it contains clearly defined ICT services in support of the knowledge management processes. In addition we outline the basic architecture and objectives of the KNOWNET project.

2 Role and Types of Knowledge

According to Webster's Dictionary, knowledge is ”the fact or condition of knowing something with familiarity gained through experience or association”. Knowledge may be recorded in an individual brain or stored in organizational processes, products, facilities, systems and documents. In reality, though, there exist many possible, equally plausible definitions of knowledge.

Nonaka and Takeuchi (1995) are distinguishing two types of knowledge: explicit and tacit. *Explicit knowledge* is formal and systematic and thus, easy to communicate and share; it is knowledge that is transmittable in a formal language and can be stored in databases, libraries, etc. *Tacit knowledge* is personal knowledge that is hard to transmit; it consists of mental models, beliefs and perspectives that can not be easily articulated and shared. It is the movement between these two forms of knowledge that forms the process of creating new knowledge. Four types of interactions can occur: from tacit to tacit (Socialisation); from explicit to explicit (Combination); from tacit to explicit (Externalisation); and from explicit to tacit (Internalisation).

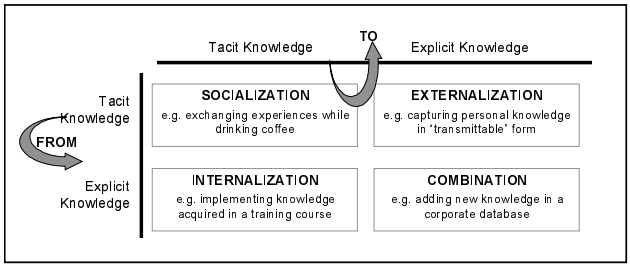

Figure 1: Modes of Knowledge Conversion

The basic characteristics of the four modes of knowledge conversion are as follows; see also Figure 1. *Knowledge socialisation* generates new tacit knowledge by sharing and exchanging know-how and past experiences. *Knowledge internalisation* maps explicit knowledge into internal knowledge. Internalisation happens when individuals, exposed to other's people knowledge, make it their own. People internalise knowledge by doing, but also by looking at what other people have done in a similar context and by example. *Knowledge externalisation* involves structuring knowledge and make it available to other users, while *knowledge combination* generates new knowledge by combining pre-existing explicit knowledge and bringing it together to produce new insight.

3 Information & Communication Technology Requirements

There is an ongoing lively debate about the role that Information and Communication Technology (ICT) can play for knowledge management (Borghoff and Pareschi, 1997). On the one hand, ICT is used pervasively in organisations, and thus qualifies as a natural medium for the flow of knowledge. At the other end of the spectrum, leading knowledge management theorists have warned about the attitude that drives management towards strong investments in ICT, possibly at the expense of investments in human capital; see for instance Sveiby (1997).

We believe that ICT should aim at the development, identification and application of the appropriate technological approaches for building, using and managing IT-supported learning and equip employees with all the knowledge required to successfully perform their engagements. ICT support should be viewed as the mechanism to augment and interconnect resources so that information can be distributed, consonant with the organisation's requirements for team-based management, responsiveness to change, etc.

Based on the knowledge life-cycle as depicted in the Figure 1 (Modes of Knowledge Conversion) we attempt a classification of current ICT support according to the four modes of knowledge conversion; see Table 1.

organisational learning; and the Union Bank of Switzerland, which has been in the forefront of applying knowledge management concepts in the banking sector.

Table 1: ICT Support and Example of Tools for Each Mode of Knowledge Conversion

Mode	Support required for	Examples of tools
Socialisation	informal communication on-line discussions during work question raising information discovery	e-mail discussion lists bulletin boards collaborative hypermedia multimedia conferencing brainstorming applications
Internalisation	search for methods & lessons-learned process documentation knowledge sharing knowledge interpretation	lessons-learned databases information retrieval process history tracking hypermedia CBT data warehouses data mining
Externalisation	concept mapping tacit knowledge: categorisation / representation organisational memory creation personalised pathways	semantic networks knowledge ontologies network publishing push technologies agent technologies issue-based argumentation data warehousing
Combination	knowledge sharing decision co-ordination	computer-mediated comm. Searching and filtering document management workflow systems Group DSS

Knowledge socialisation can receive direct IT support from technologies that make users communicate without imposing any particular structure on their interaction. A more structured approach, like workflow management can also powerfully support knowledge management by enabling the interaction between communities associated with different functional domains of the organisation. The ICT element in *knowledge internalisation* can focus on recording explicit knowledge and making it available to potentials users as well as enabling them to re-experience what other people have done in similar situations, help them familiarise themselves with analogous situations, etc. In *knowledge externalisation* the major issue is the creation of organisational memories. An organisational memory is an enterprise-internal, application-independent information and assistant system that aims at supporting knowledge preservation, knowledge capitalisation and knowledge creation. Finally, in order to aid *knowledge combination* various knowledge sharing and decision co-ordination systems can be used aiming to combine pre-existing explicit knowledge and bring it together to produce new insights.

4 Towards a Holistic Knowledge Leveraging Infrastructure

In an effort to develop a framework that guarantees the support of all four modes of knowledge conversion we define the ***core services*** that need to be offered for systematic knowledge management rather, than examine the technologies available. This way a knowledge leveraging infrastructure will have a focus on problem solving rather than on output and transactions, it will be open and flexible, it will be tailored to the ways communities of practice communicate, learn and evolve. The services should span the whole knowledge life-cycle, from knowledge creation to knowledge disposal and should address in a ”holistic” manner all four modes of knowledge conversion.

The knowledge management processes begin with knowledge acquisition, i.e. when an organisation acquires knowledge. Acquisition of declarative knowledge or facts and information is achieved by monitoring the environment, using information systems to store, manage, and retrieve information. Learning occurs not only due to knowledge acquisition from outside the organisation but also due to the rearrangement of existing knowledge, the revision of previous knowledge structures, and the building and revision of theories. In summary, *services to acquire knowledge from internal and external sources* are required.

Knowledge distribution refers to the process by which an organisation shares information among its units and members, thereby promoting learning and producing new knowledge or understanding. Knowledge in the form of tacit know-how, letters, memos, informal conversations, and reports can be captured and distributed. Very often, learning in an organisation takes place by members sharing stories or anecdotes of actual work practice as opposed to what is mentioned in formal job descriptions or procedure manuals. Distribution, publication and collaboration services are required to support knowledge distribution.

In order for information to be shared, such information must be interpreted. Information interpretation is the process by which distributed information is given one or more commonly understood meanings; see Huber (1991).

Organisational memory, i.e. the repository where knowledge is stored for future use [also called "corporate knowledge" or "corporate genetics" by Prahalad and Hamel (1990)] includes not only hard data or information but also "soft" information, that is, information with meaning. This soft or interpreted information can be in the form of tacit know-how, expertise, biases, experiences, lists of contacts, anecdotes, etc. Indexing, mapping, classification and metadata processing services are required for the purposes of these last two knowledge management processes; see Kühn and Abecker (1997).

Table 2 lists the ICT services required for leveraging knowledge at the organisational level. These services need to also support *integration* with the existing tools and systems such as: relational DBMSs; legacy applications; process automation and workflow management products; third-party tools; and current business applications.

Table 2: ICT Services for the Knowledge Leveraging Infrastructure

Services	Description
search, retrieval and navigation	Search and retrieval services should provide transparent access to multi-platform, heterogeneous sources, including Internet/ WWW / intranet sites, file servers/ databases, popular proprietary formats, legacy IS. Various types of search services should be accommodated, i.e. hierarchical (e.g. traversing hyperlinks), attribute (query-type searching), and content (e.g. crawler-type searching of popular WWW search engines).
indexing, mapping and classification	A information map defines the channels available for use by individual employees or the enterprise at large and describes the mechanisms available for information processing and knowledge formulation. When put to work, the information map will provide a representation of available knowledge (knowledge bases, topics, sources, narrative summaries, higher-level descriptions, etc). This will help ensure that employees know "what they know". Automated indexing routines can be facilitated in order to ensure complete synchronisation of indices and data sources and thereby ensure that employees know "where is what they want".
storage, analysis and metadata processing	This is a core service, traditionally served by expert systems and artificial intelligence (AI), that aims at transforming information into valuable knowledge, by providing intelligent assistance to users and accompanying the execution of tasks. Storage and metadata services should define and insert new knowledge elements into the different layers of the corporate knowledge management system.
distribution and publication	Distribution and publication services can include: subscription-based approaches on internal (such as bulletin boards) and external (such as WWW sites) information sources; and push and ”smart-pull” approaches coupled with intelligent, selective mechanisms of content relevance assessment that will provide useful knowledge while preventing information overload.
collaboration	This is a group of services offered by technologies providing rich, shared, virtual workspaces in which interactions occur between people who share a common goal. Indicative collaboration services include email, messaging, on-line discussions, electronic scheduling and meeting, video and audio conferencing, virtual workshops, just-in-time workgroup alerting, etc.

5 Overview of the KNOWNET Project

The KNOWNET project is a pan-European applied research effort, partly funded by the ESPRIT (European Scientific Programme of Research in Information Technology) programme of the European Commission and by the participating companies. The project aims to address the knowledge management needs of business entities by developing, applying, testing and evaluating an advanced multi-disciplinary holistic knowledge leveraging infrastructure.

The project opts for a holistic approach in the sense that the knowledge leveraging infrastructure to be developed explicitly includes:

- the development of information and communication technology systems and tools; within KNOWNET an intranet-based knowledge platform will be developed, which will include collaborative tools supporting communities of practice and an individually adaptable tool.
- the development of organisation and management solutions and methods; i.e. business strategies, processes and organisational structures that enhance and facilitate organisation-wide knowledge leveraging and methods for explicitly measuring and evaluating the quality and business value of intangible assets.

In order to verify and validate the applicability and usability of the knowledge leveraging infrastructure, KNOWNET will use as test-beds organisations that exhibit the most complex environment for installing knowledge management strategies, tools and methods: knowledge-intensive organisations of the services sector.

For the purposes of the KNOWNET project, we focus upon the following definition of knowledge: *The ideas or understandings which an entity possesses that are used to take effective action to achieve the entity's goal(s)*. Within KNOWNET we focus on the following entity types: individuals, teams and organisations. KNOWNET treats *knowledge management as the ways to create, retain, share, account for, and leverage knowledge - at all levels, from the personal level, to the team level, the organisational level, the inter-organisational level, and the global level*.

KNOWNET tackles the fact that knowledge management should be implemented as a business activity with two primary aspects:

- Treating the knowledge component of business activities as an explicit concern of business reflected in strategy, policy, and practice at all levels of the organisation.
- Making a direct connection between an organisation’s intellectual assets - both explicit [recorded] and tacit [personal know-how] — and positive business results.

KNOWNET intends to generate industrial impact within the business context outlined by Peter Drucker, who argues that ”the performance of an individual, an organisation, an industry or a country in acquiring and applying knowledge will increasingly become the key competitive factor for career and earnings opportunities of individuals; for the performance, if not the survival of the individual organisation; or of an industry, and for a country” (see Drucker 1994). It is within this context that KNOWNET intends to generate industrial impact at European level by developing an integrated toolset of methods and systems and demonstrating real-life

applications of companies that produce business value by leveraging knowledge assets.

KNOWNET's primary target for industrial impact includes the Knowledge Intensive Organisations (KIOs) of the service sector. Examples of such companies include, but are not limited to: advertising; management consulting; financial or legal advice; specialist nursing care; software programming and systems design; etc.

Within KNOWNET the emphasis on KIOs is evident in the participation of three user companies that are indicative examples of knowledge-intensive organisations: the Greek management consultancy company PLANET which strives to manage its knowledge assets in order to satisfy client expectations; the UK chartered surveyors company GW, which has critical knowledge management requirements for enhancing its property valuation processes; and the Union Bank of Switzerland which requires extensive knowledge sharing support for its corporate credit control processes. For the KNOWNET user partners not to manage knowledge would be equivalent to an automotive company not managing production.

However, more and more industrial firms now routinely describe themselves as being "in the knowledge business". This is because the make-up of today's products and the way in which they are delivered encapsulate an unprecedented amount of knowledge. In the extreme, this takes the form of "smart products" - things that can, for example, diagnose their own maintenance requirements or adapt to a particular owners' preference. More broadly, we are seeing a rise the knowledge-intensity in products, which is also resulting from a trend toward "*mass customisation*", which essentially builds greater knowledge of particular customers' needs into what used to be a standardised product. In addition, as firms increasingly bundle products with service in their pricing, they are increasing the knowledge component of what they sell. It is within this context that KNOWNET will attempt to generate impact on other industries as well.

5.1 KNOWNET's Technical Architecture

The KNOWNET platform (see also Figure 2) is an integrated suite that intelligently collects the information users want, from a number of information sources and presents it in a way so that users can take immediate action. Knowledge users and suppliers comprise the same group of people, continually responding to and building on each individual's addition to the organisational memory. The flow continually loops back from presentation to acquisition. Knowledge evolution is a continuous activity with the users making improvements, updates and suggestions in a manner tightly integrated into their work processes.

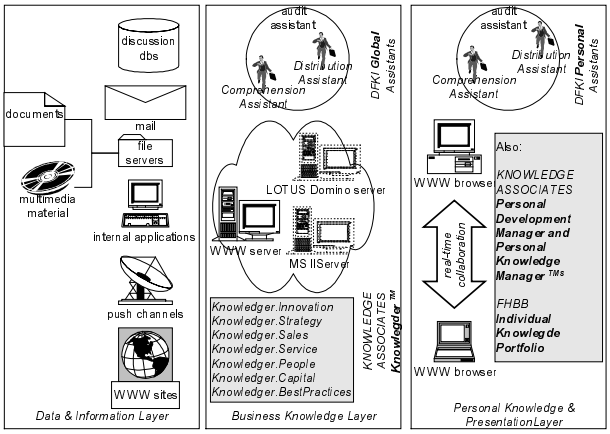

Figure 2: KNOWNET Tool Architectural Layout

The key characteristics of the KNOWNET technical platform will be as follows:

- the system will be *intranet-based* and it will adopt a 3-tier architecture with a thin client. A client is thought of as an environment that enables access to a variety of information/ knowledge and is equipped with the tools that will represent this information and enable the user to feed back responses. It is not an environment with excessive data storage or even processing requirements. This approach will allow users to remotely access their personalised workspaces and ensure that information mapping and indexing is always current. The Knowledge Server, will be managed by a dedicated administrator and will perform the previously described functions, as shown in Figure 3. The client will providing open access to services described above via a standard Java/JavaScript enabled Browser.
- the system will extend the Knowledger™ product (of Knowledge Associates) and the underlying power of Lotus Notes™ in order to provide KNOWNET with stable components for knowledge management at the individual, team and corporate level. Extensions will be implemented using non-proprietary, open Internet languages, publishing formats and collaboration methods in order to provide client platform-independence and scalability.
- Intelligent assistant systems will be developed (by DFKI) for the provision of a number of the aforementioned services. These systems will cooperate with the users providing guidance, verification, executing sub-tasks, etc. In particular we will examine the applicability and further development of: a distribution assistant for knowledge exchange, diffusion, and communication based on documents available in the intranet and the Internet; a comprehension assistant for collecting the most relevant information; and an audit assistant for supporting the generation an distribution of audit-

reports or supporting other user-partner specific processes.

Figure 3 provides a functional layout of the KNOWNET middle layer, the Knowledge Server. Although these services will be carefully designed throughout the project, the figure provides an indicative view of the core KNOWNET Server functionality.

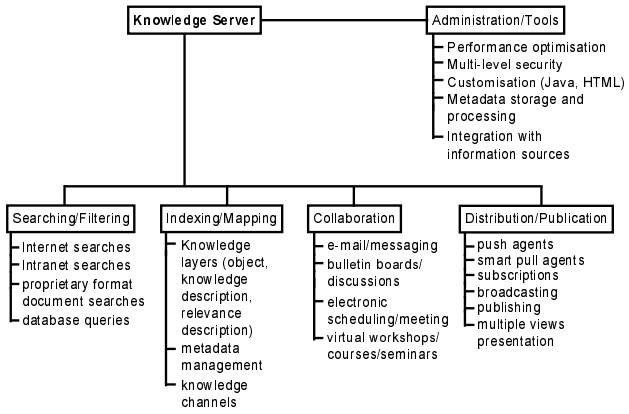

Figure 3: Preliminary Functional Architecture of Knowledge Server

5.2 KNOWNET's Organisation and Management Architecture

The development of the KNOWNET Organisation and Management Architecture (OMA) aims at the definition and development of the OMA for managing, measuring and evaluating the quality and business value of intangible assets. The KNOWNET OMA will include tools and techniques to facilitate and guarantee: the knowledge-related audit of an enterprise; the establishment of knowledge management processes; the definition and establishment of organisational roles for managing knowledge; the definition, development, testing, and evaluation of corporate performance measures that explicitly link learning-related efforts to measures of performance, and develop innovation and renewal indices.

The development of the KNOWNET OMA will involve the evaluation of the organisation's status on eight different areas to ensure that emphasis and progress in each area reflect the organisation's business needs; see Table 3). These areas will be addressed holistically, rather than as isolated initiatives.

Table 3. Focus Areas of KNOWNET's Organisation & Management Architecture

Business and knowledge strategy	people
structure and roles	products and services
internal relationships & partnerships	information and communication technology
business processes	knowledge content

The KNOWNET method for the Organisation and Management Architecture (OMA) will support three important steps toward the creation of a learning organisation: knowledge diagnosis; knowledge transformation; and performance evaluation.

Knowledge Diagnosis: This first step of the KNOWNET method will involve the determination of the most critical areas for information exchange and knowledge capture and creation within the organisation. Understanding what knowledge is used and how in a company's decision-making process is essential. Organising knowledge into key objects areas, such as customers, competitors, competencies and practices, will provide a way to assess its value in decision making.

The diagnosis method will particularly focus on the: critical skills necessary for the organisation's prosperity; priorities within business context; the core processes; and the roles of top performers. The KNOWNET method will also support the diagnosis step by facilitating the identification of the ways the organisation uses knowledge to arrive at decisions. The filters, methods, interactions, and competencies used in arriving at a decision will be analysed. Understanding how knowledge is used, its sources, and its usefulness will also impact in determining how knowledge is "packaged" and stored.

Knowledge Transformation: KNOWNET will support the transformation of companies towards knowledge-based businesses, by tackling such issues as: the mapping of knowledge in order to empower personnel to quickly and accurately locate sources of knowledge applicable to specific business problems; the transformation of business processes through knowledge by shifting the organisation's focus from process flows to core competencies; the establishment of processes for keeping the cycle of knowledge gathering, storing and application active throughout the organisation; the establishment of organisational roles and units related to knowledge management that will guarantee periodic reviews and updates of the knowledge repository; and creation of reward systems that facilitate openness, improvisation, integrity, creativity, team-spirit, trust and ability to change.

Performance Evaluation: The KNOWNET evaluation will include approaches for explicitly measuring and evaluating the quality and business value of intangible

assets and knowledge leveraging, as well as tools for the development of innovation and renewal indices.

The KNOWNET evaluation method will take into account and extend current approaches like: the Intangible Assets Monitor, which has been developed by Sveiby and organises the measurement of intangible assets in indicators of organisational *growth/renewal*, organisational *efficiency*, and organisational *stability*; the Navigator approach of the Swedish firm SKANDIA, which is explained by Edvinsson and Malone (1997) and combines a simple visual map of the company's core assets and an evolving set of around 30 metrics which attempt to measure a broad range of critical factors; the notion of "Tableau de Bord", which French companies have been using for over fifty years [see Epstein and Manzoni (1997)]; and Balanced Scorecard by Kaplan and Norton (1992), which proposes a set of leading and lagging performance indicators grouped into four different perspectives: the financial perspective; the customer perspective; the internal business perspective; and the innovation and learning perspective.

The KNOWNET Evaluation method will provide a total picture of the knowledge created, accumulated, dispersed and used. Easy to define, measure, understood and communicate indicators will be utilised and will serve as management tools. These indicators will serve as the starting point for the development of a complementary accounting taxonomy and way of managing based on awareness and insight into intellectual capital development.

6 Critical Points and Anticipated Results from KNOWNET

The global interest in all aspects of knowledge management continues to grow unabated. It is also becoming increasingly more clear that there is a real danger that excessive and unrealistic expectations could end up discrediting knowledge management. Numerous reports on practical knowledge management engagements have shown that there is a need to follow a multidisciplinary approach that will assure the alignment of the effort to the business environment; see e.g. Ives and Gersting (1998), Davenport (1998) and Davenport and Prusak (1998).

Such an alignment can be facilitated by ensuring that the knowledge management project is linked to:

- *strategy.* Linking knowledge management to strategy implies specifying how knowledge management will support the organisation's business strategy and also which are the specific knowledge domains the organisation will focus, how knowledge links to better business performance, and how the benefits of knowledge management can be measured.
- *organisational structure.* If knowledge is the only sustainable competitive advantage, then it is an important resource to link to organisational structure. Today's organisational structures do not reflect the knowledge flow. Newly established roles, such as the Chief Knowledge Officer and the Knowledge Manager as well as the incorporation of knowledge evaluation criteria in the performance review structures of firms are targeting exactly this point.
- *processes.* It is widely acknowledged that knowledge related activities will not flourish if they are simply added onto existing work processes. Instead, they must be effectively linked to the redesign of core business processes that employees perform regularly and they must be truly embedded within corporate activities.

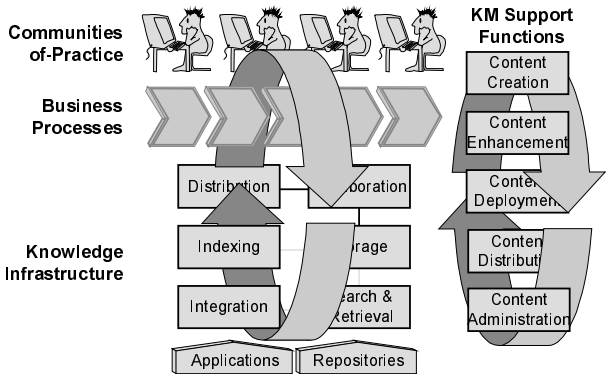

Figure 4: Knowledge Infrastructure Embodied in Business Context

- *technology.* The promise of technologies aiming at knowledge management is that they will help organisations use the knowledge they have more efficiently without changing the tools they currently use to create and process it. Unfortunately, today support is coming only from existing technologies that partially address KM problems and do not provide support for unifying all of an organisation's knowledge.
- *people.* Shifting corporate cultures from knowledge hoarding to knowledge sharing is regularly considered as the hardest aspect of knowledge management; it is extremely difficult to provide techniques that will change such attitudes. Understanding, however, the factors that drive knowledge related behaviours can provide critical insight and possibly enable organisations to remove barriers (e.g. luck of trust or interest) that prevent employees from sharing their knowledge.

The KNOWNET project besides identifying and providing support for those needs has another objective: to be "holistic" in the way it will be introduced in the organisation. The KNOWNET knowledge leveraging infrastructure will focus on specific value-adding activities and on crating empowered, knowledgeable workers arranged in teams (communities of practice). The

infrastructure aims to avoid introducing new costs to the business, but will try to deliver leverage by weaving together and augmenting already existing knowledge assets in the enterprise.

As global competitive pressures continue to increase, organisations that effectively manage their knowledge assets and continuously improve their knowledge transfer processes will gain substantial competitive advantage. We firmly believe that supporting frameworks and infrastructures as the one to be developed by KNOWNET can assist firms in that direction provided they adopt a "holistic" approach that is embodied in the business environment.

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