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Multi Agents Support Knowledge Management

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ABSTRACT

The paper presents ways for multi agents to support knowledge management in business processes. The support requires knowledge about how to manage collaborative processes to achieve common goals. There are two kinds of knowledge process. One is the knowledge of how to capture and convert knowledge into a form useful within business processes. This includes the definition of knowledge objects and knowledge creation activities. The second is how to integrate the knowledge activities into the business processes. The paper proposes multi agent architecture to implement software agent to facilitate the knowledge management process.

INTRODUCTION

Successful knowledge management requires two kinds of process knowledge. One is knowledge about processes to be followed to collect, interpret and consolidate knowledge. We call this process the evolving knowledge process (EKP) in this paper. The EKP process includes activities that create new knowledge within the business. The second is how to integrate the EKP into business processes. Next step is successful integration requires that selected knowledge management activities be initiated at appropriate points of the business process. The paper describe a way to integrate these two kinds of processes. Organization can use alternate strategies for such integration. They can centralize the knowledge process (KP) activities, distribute them, or have a mix or both. The paper calls this the knowledge management process defines a process similar to *Knowledge Chain Model* (Holsapple,2003) but based on Nonaka's theory of knowledge creation (Nonaka,1995). It describes how to integrate this knowledge management process into business processes. It defines a conceptual model for describing ranges of information process and integrates knowledge management activities as part of the conceptual model.

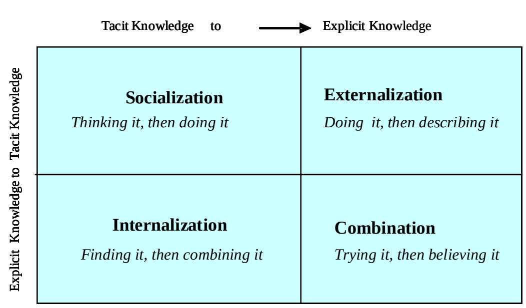
This paper proposes multi agents architecture, which possess process knowledge, to provide such support. The agents will contain the necessary knowledge to identify points in the process where knowledge should be processed and provide the tools to carry out the necessary knowledge management function.

BACKGROUND THEORY

KNOWLEDGE MODEL (1): MICHAEL POLANYI'S MODEL

Polanyi's (1962) concept of knowledge is based on three main these:- (1) True discovery cannot be accounted for by a set of articulated rules or algorithms. (2) Knowledge is public and also to a very great extend personal (i.e., it is constructed by humans and therefore contains emotions, or "passion"). (3) The knowledge that underlines the explicit knowledge is more fundamental; all knowledge is either tacit or rooted in tacit knowledge.

Figure 1 - Nonaka's knowledge creation process



KNOWLEDGE MODEL (2): NONAKA'S KNOWLEDGE CREATION PROCESS

Nonaka and Takeuchi, (Nonaka, 1995) theory of knowledge creation is based largely on their analysis of innovative Japanese companies. They draw on Michael Polanyi's (Polanyi,1962) distinction between *tacit knowledge* and *explicit knowledge*. Tacit knowledge is personal, context-specific, and therefore hard to formalize and communicate. Explicit or "codified" knowledge, on the other hand, refers to knowledge that is transmittable in formal, systematic language. Their theory of knowledge conversion has four modes: from tacit to tacit (socialization), tacit to explicit (externalization), explicit to explicit (combination) and explicit to tacit (internalization).

Nonaka (1995) defines knowledge creation as a spiralling process of interactions between explicit and tacit knowledge. The interactions between these kinds of knowledge lead to the creation of new knowledge. Figure 1 shows the characteristics of the four steps in the knowledge creation process:- from tacit knowledge to tacit knowledge through a process of socialization, from tacit knowledge to explicit knowledge through externalization, from explicit knowledge to explicit knowledge through combination, and from explicit knowledge to tacit knowledge through internalization.

Socialization is a process of acquiring tacit knowledge through sharing experiences. *Externalization* is a process of converting tacit knowledge into explicit concepts through the use of metaphors, analogies, or models. *Externalization* is triggered by dialogue or collective reflection. *Combination* is a process of creating explicit knowledge bringing together explicit knowledge from a number of sources. *Internalization* is a process of embodying explicit knowledge into tacit knowledge, internalizing the experiences gained through the other modes of knowledge creation into individuals' tacit knowledge bases in the form of shared metal models or work practices.

DIFFERENCES BETWEEN POLANYI'S MODEL AND NONAKA'S MODEL

There are differences between two knowledge models:

(a) Polanyi's Model
(1) How human beings acquire and use knowledge it is action oriented and about the process of knowing.
(2) He does not discuss his concept for particular industry, organization or department.

(b) Nonaka's Model
(1) Draw on Polanyi's distinction between tacit and explicit knowledge
(2) Based largely on the analysis of innovative Japanese companies
(3) Four kinds of knowledge conversions (socialization, externalization, Combination, internalization)
(4) Knowledge creation happens within places

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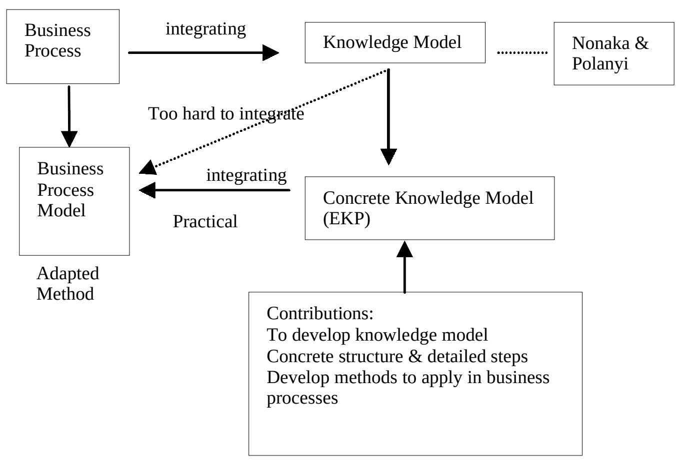
Figure 2 - Research Contribution



We choose Nonaka's model because it is more practical and has many case studies in Japanese companies. This model is abstract and doesn't show detailed steps in knowledge creation process. So we need to develop concrete structured model.

The ideas behinds such integration are illustrated in Figure 2. The ideas of Nonaka and Polanyi (1962) are the basis for the knowledge management process, but we reduce it into more detail. The more detailed process is called Evolving Knowledge Process (EKP) model in this paper, which is concrete knowledge model with concrete structure and detailed steps in the process. The activities of the EKP model are then integrated into business processes using a modified rich picture descriptions.

A KNOWLEDGE MANAGEMENT PROCESS (EKP MODEL)

The Evolving Knowledge Process (EKP) model has been described earlier (Maung, 2003a) but uses Nonaka's idea as the underlying structure. It is similar to (Holsapple,2003) and (Soo,1999) but differs in the way that knowledge management activities are integrated into business processes. . The Evolving Knowledge Process (EKP) model is a detailed elaboration of Nonaka's knowledge creation process. It describes how to capture tacit and explicit knowledge in knowledge creation process and integrate into business process using adapted method, Maung (2003a). In this model, we define a sequence of activities and resources in the knowledge creation process. The challenge here is to understand capturing tacit knowledge and explicit knowledge and to structure this knowledge in forms suitable for further use.

Figure 3 - Evolving Knowledge Process (EKP) Model

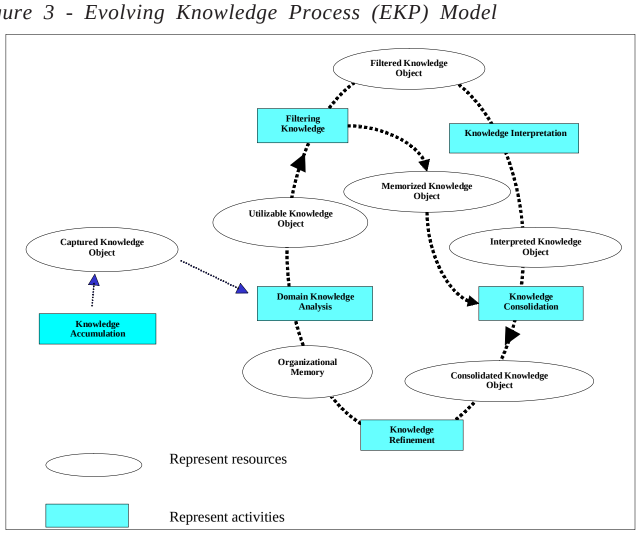


Table 1 – EKP activities and descriptions
EKP Activities

EKP Activities	Description
Knowledge Accumulation	Collecting, gathering and recording (time & space, environment) useful information, data and knowledge and retains them as captured knowledge objects.
Domain Knowledge Analysis	Identifying, classifying, categorising and organizing captured knowledge objects, and recording them as utilizable knowledge objects.
Filtering Knowledge	Determining whether utilisable knowledge objects are relevant to achieving a particular goal, and then either retaining it, if it is relevant. If it is not currently needed then memorize it until it is needed. (Godbout, 1996)
Knowledge Interpretation	Determines the value provided by the filtered knowledge objects. (It is a dynamic human process of justifying personal belief toward the "truth".) (Nonaka, 1995)
Knowledge Consolidation	Classifying interpretative knowledge objects which are events relating to the categories and main interested objects.
Knowledge Refinement	Modifying, updating knowledge which is stored in organisational memory.

The theoretical framework of the EKP model has a sequence of knowledge activities that create and capture knowledge in a business context. The model is finally defined and consist six activities: knowledge accumulation, domain knowledge analysis, filtering knowledge, knowledge transition, knowledge consolidation and knowledge refinement. Knowledge resources are: captured knowledge, filtered knowledge object, transitioned knowledge object, consolidated knowledge object and organisational memory.

MODELING BUSINESS PROCESSES

Our next objective is to integrate the knowledge management activities into a business process. To do this we use a previously reported model (Hawryszkiewycz, 2000) that includes concepts that can be used to model a variety of processes.

The main concepts are:

Role - defines responsibilities in system
Participant – a specific person assigned to a role
Group – a collection of participants
Artifact - data objects such as documents
View – a collection of artifacts
Activity - produces a well defined outputs and usually require many work-items, actions and interactions to do so (eg. Produce a planning document)
Workspace – an interface that supports an activity
Work-item - a set of actions and interactions needed to produce intermediate outcomes that eventually produce an activity output (eg. Review part of a planning document - which may include a number of actions). Can be:
Action - a specific unit of work carried out by a role (eg. Change an artifact, send an artifact)
Interaction - the basic exchanges between people when they collaborate in the activities. An interaction may not produce an explicit output although it may change people's knowledge
Event type – the completion of some action in a workspace
Event rule – defines relationships between events,
Workflow – a set of event rules

Some details are:

- The metamodel centers on activities, which can be made up of a number of sub-activities as indicated by the looping arrow.
- A person, here called a participant, 'is-in' group, which can evolve independently, and contain subgroups. Workgroups sup-

Table 2 – EKP resources and descriptions
EKP Resources

EKP Resources	Description
Captured Knowledge Object	Knowledge which is acquired with the goal of applying it is a particular activity in the workspace.7
Utilisable Knowledge Object	Knowledge which is classified as possible way for a particular use.
Filtered Knowledge Object	Knowledge which that may be immediately useful to a person or organisation to achieve a goal.
Memorized Knowledge Object	Knowledge which is memorized for later use.
Interpreted Knowledge Object	Knowledge which include possible ways that to be applied in making decision in current ongoing organisation.
Consolidated Knowledge Object	Knowledge which is verified, validated and comprehended interpretative knowledge for intended purpose. It includes identified in categories and interested objects.
Organizational Memory	Knowledge which is stored for short-term or long-term memory.

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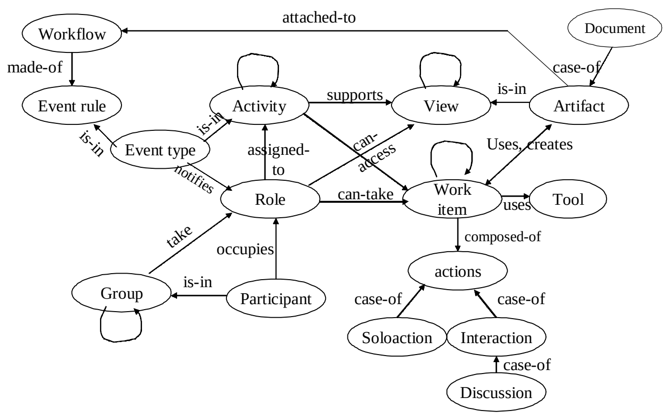
Figure 4 - Collaborative Metamodel



port scalability as independent workgroups can exist in the same system but gradually merge or intersect if needed.

- An activity 'is-in' a group, 'has' any number of roles and 'contains' any number of views, which can be made up of other artifacts or define groups of artifacts. An activity 'is-in' a group.
- The roles define access abilities to artifacts and 'can-take' the actions.
- Each role is 'occupied' by participants, who have the role abilities.
- Actions 'use or create' artifacts. They can be solo actions, which are taken by individuals, or interactions, such as discussions, which can include more than one participant. Actions 'use' tools.
- An activity can include a number of event types, which are assigned to roles. Event instances of particular types lead to message being sent to other activities. (Hawryszkiewycz, 2000)

The paper now describes how to use these semantics to model collaborative applications and implement the models. Integration into business processes requires ways to show how knowledge actions are placed into activities and then allocating the action to a person responsible for the action. To do this, we use a notation to describe the semantic concept.

Figure 5 illustrates the notations are used in Figure 6, Supply Chain Management.

Figure 5 illustrates the supply chain management consists of supplier, warehouses and distribution centres, and customers at the role of KM as described in (Simchi-Levi, 2000). Every facility in supply chain management can impact on cost and plays a role in making the product conform to customer requirements; from suppliers through warehouses and distribution centre to retailers. The objective of supply chain management is to be efficient and cost-effective across the entire systems and minimised the cost as low as possible.

Figure 5 shows main ***activities*** and ***roles*** in supply chain management,

- ***order processing activity***, where the ***Order Manager*** makes arrangement with ***Suppliers***. This procedure is a set of contracts and guidelines on preferred suppliers to the ***Order Clerks*** who arrange orders which are requested by ***Customers***

Figure 5 - Notations

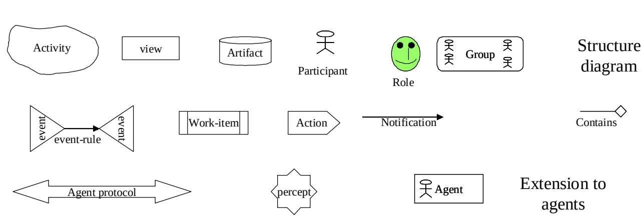
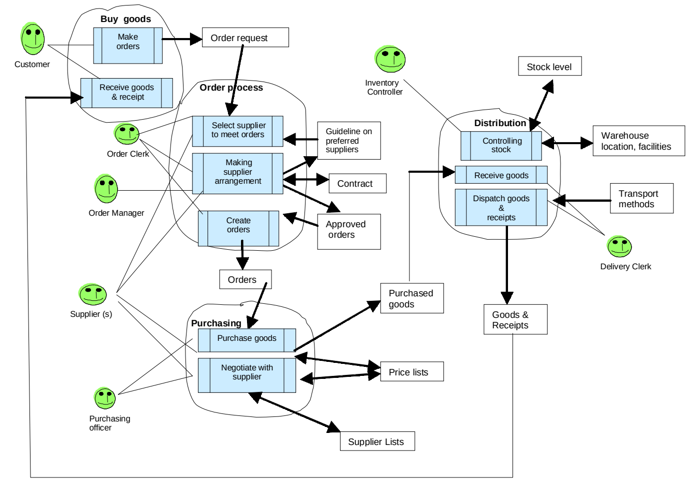


Figure 6 Supply chain management – top level diagram



- ***purchasing activity***, where the ***Purchasing Officer*** negotiates with the suppliers to discuss goods and prices
- ***distribution activity***, where warehouse facilities (such as storage cost, storage time, location, stock in store and distance) are provided the ***Inventory Controller*** to control stock levels and warehouse locations, and the ***Delivery Clerk*** uses facilities to receive goods and dispatches goods with receipts to ***Customer***
- ***buy goods activity***, where the customer places orders.

INTEGRATING EKP ACTIVITIES INTO THE BUSINESS PROCESS

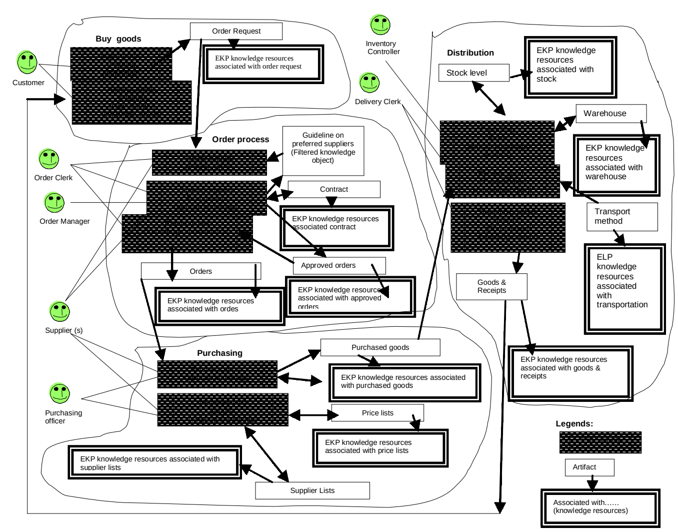
The next step is to add the EKP activities to those shown in Figure 6. The way this is done depends on the chosen knowledge management strategy. Figure 7 illustrates the alternative where EKP activities are distributed through the different business activities. Each EKP activity becomes a work-item. Figure 7 shows the EKP activities as shaded work-items. The model also defines specific roles responsible for the work-items.

In Figure 7, we associate knowledge resources with the actual data object, then implementing a distributed knowledge policy. An alternate would be to centrelise the EKP activities.

In that case there will need to be a separated high level activities of knowledge management with information sent to it from other activities for knowledge processing.

We describe how EKP activities in "**Order process**" allocate the responsible person for the action in Figure 7.

Figure 7 – Integrating EKP activities into the business process



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For example, when the ***Order Manager*** makes arrangement (Shaded work-item; *Domain Knowledge Analysis*) with ***Suppliers***, she produces a set of contracts and also adds to guidelines on preferred suppliers. These guidelines are the filtered knowledge objects.

In purchasing activity and distribution activity has its own agent to coordinate with other EKP activities and other work-items.

AGENT STRUCTURE

Each of the agents must be defined. The description of agents in detail is beyond the scope of the paper our approach is based on the well-know **BDI** (Belief, Desire, Intention) architecture (Anand, 1991). The agent components that make up these structures.

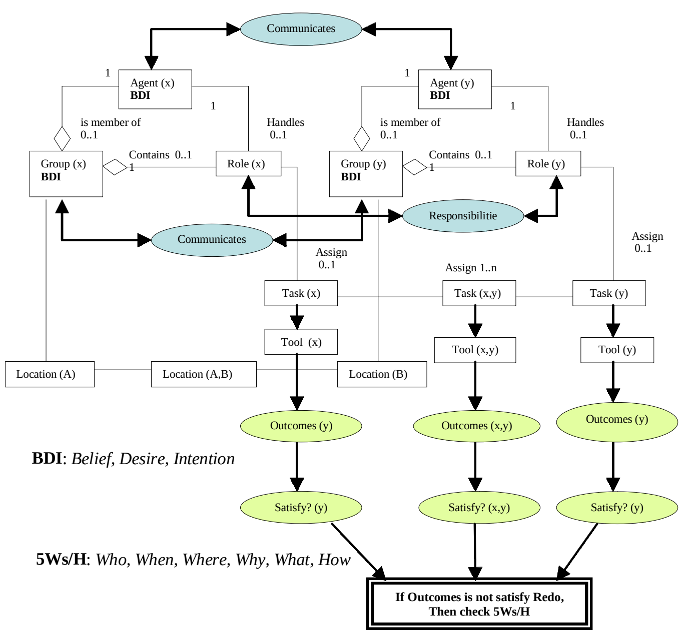
Desire: what the agent sees as its ultimate although abstractly defined achievement,
Belief: the information that an agent has about its environment. It includes local beliefs that are private to an agent or they can be social beliefs that are shared by a group of agents.
Intention: a currently chosen course of action to realize the goal
Precept: what the agent observes in its external environment
Goal: what needs to be done to react to the event
Plan: a set of actions to carry out an intention
Multi Agent Architecture
Agent architecture defines the structure of an individual agent.
A **multi agent architecture** defines how individual agents are combined and how the communicate.
Agent interaction algorithms are the algorithms used in agent interaction.

We propose multi agent architecture in Figure 9 is based on AALAADIN architecture proposed by Ferber and Gutnecht (1998). Their model, expressed as a UML class diagram. It involves agent, role and group:

- An *agent* is an active communicating activity.
- A *group* is a set of agents.
- A *role* is an abstract representation of an agent's function, service, or identification with a group.

Agent's BDI: Agent's Belief, Desire and Intention
Group's BDI: Group's Belief, Desire and Intention

Figure 8 - Multi Agent Architecture



DISCUSSION

We explain how multi agent architecture works in Figure 6 (Supply Chain Management) top level diagrams.

[*Manager*(*x*)] in marketing department assigns [*Task*(*x*)]; finding suppliers and products for [*Group*(*x*)] uses ;[*Tool*(*x*)]; supplier lists database.

[*Manager*(*y*)] in distribution department assigns [*Task*(*y*)]; checking warehouse facilities, stock control, transportation, Just In Time delivery for [*Group*(*y*)] uses ;[*Tool*(*y*)]; distribution information.

Manager(*x*) and *Manager*(*y*) has responsibilities on the *Group*(*x*) and *Group*(*y*) and they communicate each other. *Group*(*x*) and *Group*(*y*) exchange information and report to *Manager*(*x*) and *Manager* (*y*) in individual department.

Outcomes of each department need to be checked satisfactory results *Outcome*(*x*), *Outcome*(*y*) and *Outcome*(*x,y*). If each outcome meets satisfied level, *Manager*(*x*), *Manager*(*y*) and *Manager*(*x,y*) can accept, otherwise task has to be redone again.

If task has to be redone it, we must have check 5Ws/H Couger (1996) in each group or department who makes mistake. until satisfactory condition is met.

(5Ws/H: What, Who, When, Where, Why, How) (Couger, 1996).

In the next section, we describe how to implement multi agent architecture using LiveNet interface at University of Technology Sydney, Australia.

IMPLEMENTATION OF THE MODEL

We are using a system known as LiveNet which has been developed at the Cooperative Systems Laboratory, University of Technology, Sydney (UTS) to implement the models. Each of the activities in the model becomes a workspace in the implementation. User can create different folders in the workspace and each folder contains the elements that contain the various knowledge object of the EKP process. They can also create as work-items and sub-workspaces. An authorized user can select documents, backgrounds and get information about the various roles and participants in the workspace.

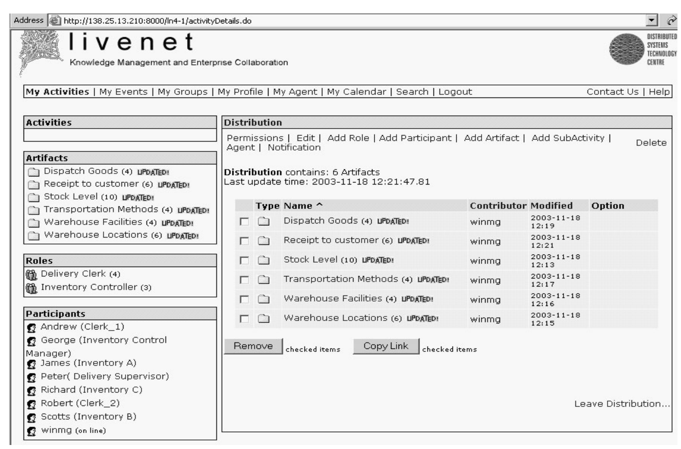
In Figure 9 illustrates the "Distribution" activity. The concept illustrated in Figure 6 appears in the interface.

SUMMARY

In this paper, we described background theory of knowledge management to develop (EKP) Model, modelling business process using supply chain management as an example. Then paper presented integrating EKP activities into business processes and using sequence diagram for interaction in the process.

The paper described multi agent architecture and implementation of LiveNet interface at University of Technology Sydney, Australia.

Figure 9 LiveNet interface for Supply Chain Management (Distribution Activity)



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REFERENCES

Aizhong, Lin. (2000):"Multi-agent Business Process Management". Proceedings of ISA'2000,

International ICSC Congress on INTELLIGENT SYSTEMS AND APPLICATIONS on December 11-

15, 2000, University of Wollongong, NSW, Australia

Anand S. Rao and Michael P. Georgeff (1991)" Modeling rational Agents within a a BDI-architecture.

Proceedings of the Second International Conference on Principles of Knowledge Representation and

Reasoning, KR'91,473-484, Cambridge, MA, 1991.

Bauer, B. (2001): "UML Class Diagrams: Revisited in the Context of Agent-Based Systems"

Proceedings of Agent Oriented Software Engineering, Agents, 2001, Montreal, pp. 1-8.

Bauer, B., Muller, J.P. and Odell, J. (2001): "Agent UML: A Formalism for Specifying Multiagent

interaction" in Agent-Oriented Software Engineering, Ciancarini, P., and Wooldrifge, M. (eds),

Springer, Berlin, pp. 91-103.

Couger .D (1996) "Creativity & Innovation in Information Systems Organizations", Boyd & Fraser publishing company.

Godbout.M (1999) " Filtering Knowledge", Changing Information into Knowledge Assets, Journal of

Systematic Knowledge Management, January, 1999.

Knolmayer.G, Zeir.H (2002) Supply Chain management Based on SAP Systems, Springer Verlag, NY

Hawryszkiewycz, I. T. (2000): "Knowledge Networks in Administrative System", Proceedings of the

Working Conference on Advances in Electronic Government, Zarazoga, Spain, February 200, pp. 59

76.

Hawryszkiewyczm I.T (2003) "Providing Personalized Learning Services" Proceeding of the ISATED

Conference on Computer Assisted Technologies for Education, Rhodes.

Hawryszkiewyczm I.T (2002) " Designing Learning Activities from Learning Objects" ASCILITE, Auckland, December 2002.

Holsapple. C and Jones.K (2003) "Toward and Elaboration of the Knowledge Chain Model", Ninthe

Americas Conference on Information Systems, Tempa, Florida August 2003, USA.

Kuczmarski, T. (1997): "Innovation: Leadership Strategies for the Competitive Edge" NTC Business

Books, Chicago, Illinois.

J.Ferber and O.Gutknecht (1998) " A Meta-Model for the Analysis and Design of Organizations in Mulit-Agent Systems". In Proceedings of Second International Conference on Multi-Agent Systems (ICMAS-96), pages 72-79,1996.

LiveNet at University of Technology Sydney, Australia:http://138.25.13.210:8000/ln4-1/index.jsp

Maung, W (2003a) "Capturing tacit and Explicit Knowledge in evolving Knowledge Process", The

Knowledge Management Aston Conference 2003, KMAC 2003, The OR Society, Birmingham, UK,

14-15 July 2003, pp 375-385.

Maung, W (2003b) " Filtering Knowledge in Software Design" ISOneWorld Conference 2003, Las

Vegas USA April 23-25, 2003.

Nonaka .I (1995) "Knowledge Creation Company", Oxford university press.

Parunak, H., Odell, J. ((2001): "Representing Social Structures" Proceedings of Agent Oriented

Software Engineering, Agents, 2001, Montreal, pp. 17-31.

Rao, A.S. and Georgeff, M.P.(1991) " Modeling rational agents within a BDI-architecture. In

Proceedings of the Second International Conference on Principles of Knowledge Representation

and Reasoning, KR '91, 473-484, Cambridge, MA, 1991.

Polyani, M (1962) "Personal Knowledge, Towards A Post –Critical Philosophy", New York, Harper.

Soo, C.W, et al (1999) "The Process of Knowledge Creation in Organization", Working Paper Series, AGSM, UNSW, Sydney, Australia. Spring 1999, 00125-145.

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