Architecture for Knowledge-Based Enterprise Management System: a Control View

Saulius GUDAS
Informatics department of Kaunas Faculty of Humanities, Vilnius University
Kaunas, Muitines 8, LT-44280, Lithuania

ABSTRACT

The paper presents the framework of Knowledge-Based Enterprise (KBE) architecture. The KBE model is process-oriented model and it refines two different layers of enterprise management hierarchy: the Knowledge management domain (K) and Business domain (B).The Knowledge-Based Enterprise architecture is represented as multilevel management and control structure. Interactions amongst the levels of knowledge management hierarchy are formally defined using the concept of Elementary Management Cycle (EMC).

Keywords: Knowledge-Based Enterprise (KBE), control view, knowledge management hierarchy, Knowledge management domain, Business domain, Elementary Management Cycle (EMC).

1. INTRODUCTION

There are various knowledge management definitions presented by R. Maier [1]. In spite of the variety of knowledge management models and tools, there is some gap between these theoretical enterprise, which is able to gain the synergetic combination (integration) of IT, knowledge management and business strategy [2, 3].

2. MANAGEMENT LAYERS OF KNOWLEDGE BASED ENTERPRISE

An Enterprise Management System is multilevel hierarchical structure. Management layers of traditional Enterprise are as follows: strategic management, managerial, operational management [9]. In case of Knowledge-Based Enterprise (KBE) semantics of Enterprise knowledge and management levels depends on the purpose of modeling and modeling point of view (see Table 1). Semantics of the enterprise Knowledge management layers in the different frameworks and models depends on the on the definite purpose (intention) of modeling as well as on the requirements of business control process and IT related requirements for enterprise management systems.

models and the practical implementation of knowledge management systems in organizations [17].

Integration of knowledge management technologies in business processes is illustrated by using Business and IT Strategic Alignment Model (SAM) [4, 5]. The integrated enterprise knowledge base is concerned as a tool for solving a range of business problems: business transformation into the knowledge-based business, business and IT alignment, and the support of computerization of business management tasks.

The most IT-based enterprises today are data–driven: enterprise management activities are based on the DBMS support, functional IS are implemented. IT-based enterprise became knowledge-driven (knowledge-based enterprise) when Knowledge Base is developed and knowledge management system is implemented.

For instance, the vision of the most adaptive and responsive enterprise, based on IT is the Real Time Enterprise (RTE). The RTE is the kind of the

For instance the Enterprise model aimed for business and IT strategic alignment includes only two layers: strategy layers (business strategy and IT strategy) and infrastructure layer (business infrastructure and IT infrastructure) [7]. The management system of the IT-based enterprise includes layers as follows: strategic management, knowledge management, managerial, operational management layer [9]. The Enterprise Management Network is divided into six layers: Network Layer, Data Layer, Information Layer, Organization Layer, Coordination Layer, and Market Layer [16].

The paper presents the framework of Knowledge-based Enterprise (KBE) architecture. The developed KBE model is based on the management control view [11], interactions of the Management System layers and levels are formally defined using the concept of Elementary Management Cycle (EMC). In brief, the concept EMC is formalized description of the Enterprise management control as interaction

of *Process* and *Function* – as two core components of enterprise from the control point of view [11, 12]. The interaction between the core elements *Process* and *Function* is formally assumed as a *Control Process* [11] with the *Feedback Loop* between *Process P(j)* and *Function F(i)*. This *Function-Process* interaction is the key component of the formalized model of the organizational system (an Enterprise Management Model) described in [11, 12].

The Knowledge-Based Enterprise framework (Figure 1), developed in [4, 5, 6], includes the KBE management layers and their interactions as follows:

- ➤ Level 1 .Enterprise strategic management (Business and IT strategic alignment activities).
- ➤ Level 2. Enterprise meta-knowledge management (Enterprise meta-modeling activities).
- ➤ Level 3. Enterprise knowledge management (Enterprise knowledge for BP management).
- ➤ Level 4. Enterprise management (BP knowledge management: acquisition of knowledge for BP management, required by Enterprise strategy, defined at level 1).
- ➤ Level 5. Business process management (managerial activities: implementation of management functions, directing and controlling manufacturing Process).
- ➤ Level 6. Manufacturing process management and control (manufacturing control activities).

The KBE model is process-oriented model and it refines two different layers (Figure 1) of enterprise management hierarchy. The *Knowledge management domain* (*K*) is aimed to control activities of the component *Business domain* (B). The *Business domain* (B) includes management and control of manufacturing activities (the component *Processes* (*P*).

The interactions of the different levels (including levels 1 – 6) of the KBEM are considered as control loops (informational feedback) formally described in [11, 12] as *EMC* (the *Elementary Management Cycle*). The semantics of identified management transactions *EMCp* and *EMCz* are different, and are defined as follows:

- – Process management cycle *EMCp* implements a set of *Process* management functions. The *EMCp* is responsible for control of the component *Processes* (*P*) – primary activities of enterprise (development of products and services in the proper way (Quality, Time schedule, etc));
- – Knowledge management cycle *EMCz* is a higher level EMC, it's component *Knowledge management functions* is responsible for the adequate activities of the *KBEM* component *Process management functions* (*F*). The *EMCz* is focused on the alignment of *Business process (B)* with the Enterprise strategic goals.

As the Process management cycle *EMCp* is extensively discussed in [12] and analysis of Business process management cycle (*EMCz4*) is presented in the [6], next the particularities of the component Enterprise Knowledge management and the Knowledge management cycle *EMCz3* are described in brief (see Fig. 2 and Fig. 3).

3. THE ENTERPRISE KNOWLEDGE MANAGEMENT LEVEL

The component *K3 "Enterprise Knowledge Management" (*KM level 3 - *Enterprise Knowledge Management Level*) is aimed to complement knowledge of the component *K4 „BP Knowledge Management" by* required knowledge, stored in Enterprise Knowledge base (KB) using interface *S3*. The component *K3* is related with the next knowledge management level 4 by feedback loop *EMCz3* (related with component K4).

The component *Enterprise Knowledge Management (*K3) is interrelated with other knowledge management system components as follows:

- ➤ *EMCz2* – the Enterprise Knowledge (content) Management Cycle; based on the Enterprise meta-knowledge (Ontology) stored at the EKB (supported by the interface S2);
- ➤ The interface *S2* – service to component K2 for using meta-knowledge, stored in Enterprise Knowledge base (KB);
- ➤ *EMCz3* – the Business Process Knowledge (content) Management Cycle; based on the Enterprise knowledge stored at the Enterprise Knowledge Base EKB (supported by the interface S3);
- ➤ The interface *S3* – service to component K3 for using knowledge, stored at the Enterprise Knowledge Base (EKB).

The overview of Enterprise knowledge and management levels   Table 1

| Meta-modeling approach	Modeling purpose, intention	Abstraction levels or views
GERAM [15]	Enterprise architecture model development	Generic; Partial; Particular
Meta-modeling approach to adaptive knowledge management [18]	Knowledge management	Abstract meta-model Application specific model Domain-specific models Hypermedia information space Real world
The Knowledge Factory [19]	Knowledge management	Knowledge; Information; Data
A.Liew [20]	Understanding Data, Information, Knowledge	Wisdom Knowledge; Information; Data
A Multi-Layer Architecture for Knowledge Management Systems [13]	Architecture for Knowledge Management Systems	Views of a Knowledge Management System: Strategy view; Organizational view; Information System view. Abstraction levels: Generic knowledge; Specific knowledge.
Meta-Object Facility (MOF) [14]	Object-oriented language description	Meta-meta model; Meta-model; Model; Information
Knowledge-Based Enterprise framework [5, 6, 8]	Architecture for Knowledge-Based Enterprise Management Systems	Enterprise strategic management Enterprise meta-knowledge management Enterprise knowledge management Enterprise management Business process management Manufacturing process management and control
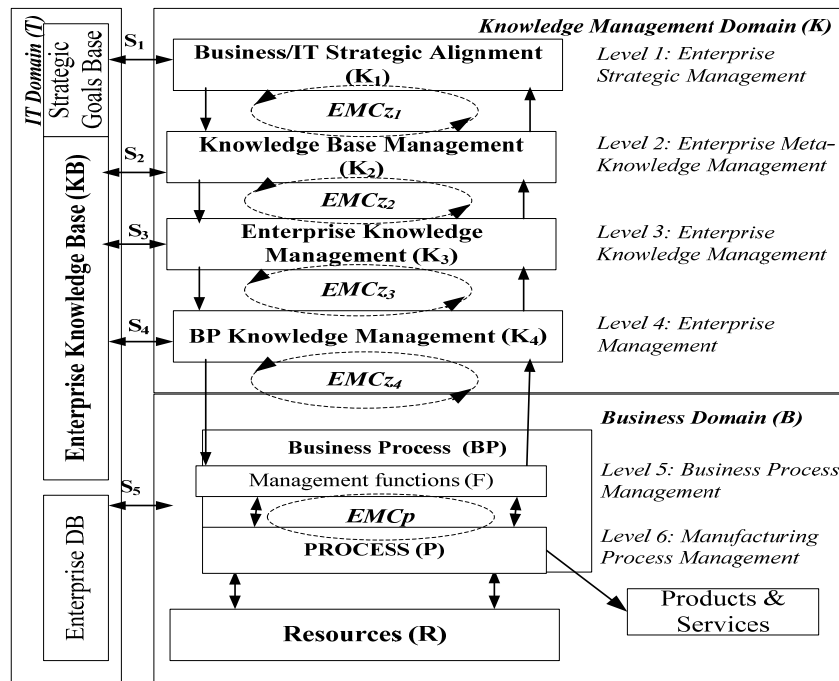
Fig. 1. The Knowledge-Based Enterprise management framework

4. THE BUSINESS PROCESS KNOWLEDGE MANAGEMENT CYCLE

The Business Process Knowledge Management Cycle (the management control EMCz3 in Figure 1) is *knowledge adaptation cycle* (Figure 2) aimed to integrate the component "BP knowledge management" (K4) with the actual content of the component "Enterprise Knowledge Base" (KB).

The Enterprise knowledge management cycle EMCz3 is aimed to development (generation) of particular new knowledge for business process management functions, which are depicted as the component K4 ("Business process management") in Figure 2.

The semantics of steps of the Business process knowledge management cycle (EMCz3) are as follows (Figure 2): IN3 – interpretation of facts (characteristics) related with the controlled object – an activity of the component K4, IP3 – processing of interpreted information (data, knowledge) and decision making (aimed to control the component K4), RE3 – realization of decision (management control making, including transferring of manipulated variables (a particular decision) and influencing a controlled object – the component K4.

The constraints on the Business process knowledge management cycle (EMCz3) are output of the component K2 (Knowledge base management) and input of the interface S3 from Knowledge base (KB).

The activity IN3 performs an interpretation of the actual knowledge about the features (state) BP knowledge management functions (F4).

The step IN3 comprises of a set of interpretation rules and procedures for transformation the actual data and knowledge about a state BP knowledge management functions (F4) for the integration with the step IP3. These transformations are aimed to fit the requirements of the IP3 – the next step of the enterprise knowledge management cycle EMCz3.

The step IP3 – knowledge processing activity, aimed to form a set of manipulated variables – decision to implement new features of the BP knowledge management functions. The IP3 is a system of data and knowledge manipulation procedures focused for modification of the content of component K4 with the requirements of the higher level component K2 (these requirements are the output the step RE2 of the higher level management EMCz2) and actual knowledge accessed by interface S3 from the Enterprise knowledge base.
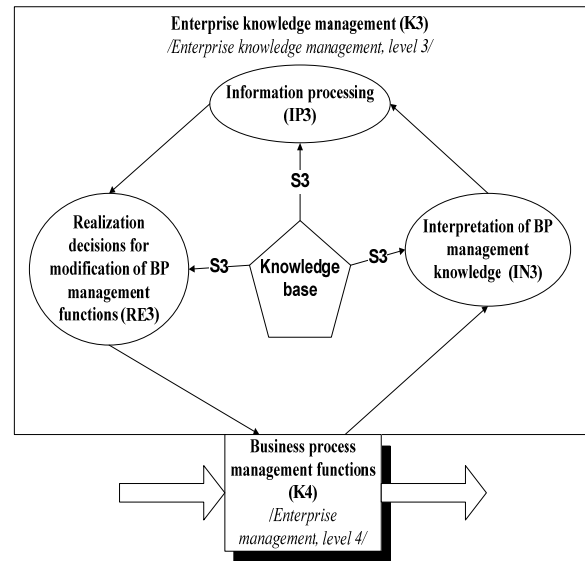

Fig 2. The Business process knowledge management cycle (EMCz3)

The step RE3 – the co-ordination activity, the feedback from higher level Knowledge management component K3 to Business process knowledge management functions (K4). The step RE3 is aimed to transfer manipulated variables (decision) and to influence the component K4, namely to modify Business process knowledge management functions (F4).

5. THE ENTERPRISE KNOWLEDGE MANAGEMENT CYCLE

The Enterprise Knowledge Management Cycle (the management control EMCz2 in Figure 1) is a *higher level knowledge adaptation cycle* aimed to modify the component "Enterprise knowledge management" (K3) of Knowledge management (K) domain. The Enterprise knowledge management cycle EMCz2 is aimed to development (generation) of definite knowledge required to adapt a set of Enterprise knowledge Management functions to the new requirements of the Knowledge Base meta-model.

The semantics of steps of the Enterprise knowledge management cycle (EMCz2) are as follows (see Figure 3): IN2 – interpretation of facts (characteristics) related with the controlled object – an activity of the component K3; IP2 – processing of interpreted information (data, knowledge) and decision making (aimed to control an activity of the component K3); RE2 – the step of realization (implementation) of decision aimed to influence a controlled object Enterprise management – the component K3.

The constraints on the Enterprise knowledge management cycle (EMCz2) are output of the component K1 ("Business and IT strategic alignment") and input of the interface S2 of Enterprise Knowledge base (KB).
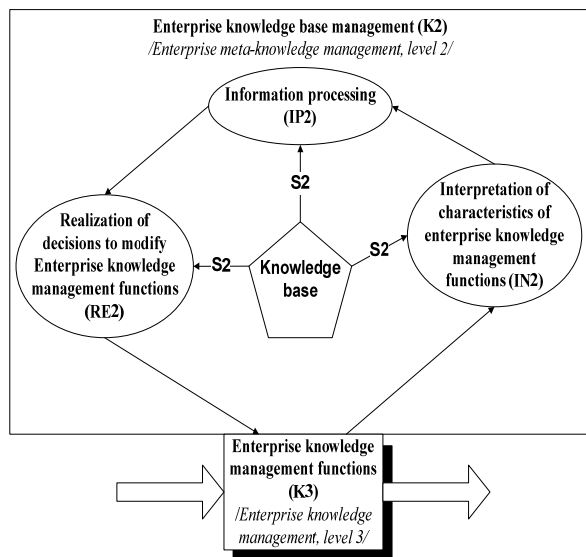

Fig 3. The Enterprise knowledge management cycle (EMCz2)

The activity IN2 performs an interpretation of the actual knowledge about the features (state) Enterprise knowledge management functions (F3). The step IN2 comprises of a set of interpretation rules and procedures for transformation the actual data and knowledge about a state of Enterprise knowledge management functions (F3) for the integration with the step IP2. These transformations are aimed to fit the requirements of the IP2 – the next step of the enterprise knowledge management cycle EMCz2.

The step IP2 – knowledge processing activity, aimed to form a set of manipulated variables – decision to modify the component Enterprise knowledge management (K3). The IP2 is a system of knowledge manipulation procedures focused for alignment of the content of component K3 with the requirements of the higher level component K1 (these requirements are the output the step RE1 of the higher level management EMCz1) and actual knowledge accessed by interface S2 from the Enterprise Knowledge Base.

The step RE2 is the co-ordination activity, the feedback from higher level component Knowledge base management (K2) to the component Enterprise knowledge management (K3). The step RE2 is aimed to transfer manipulated variables (decision) and to influence the component K3, namely to modify Enterprise knowledge management functions (F3).

6. CONCLUSIONS

Developed Knowledge-Based Enterprise (KBE) model refines knowledge management activity in the enterprise more formally and is the basis for the development of the Enterprise knowledge base, which is concerned as the main component of the KBE. The interactions amongst the levels of knowledge management layers is based on the Elementary Management Cycle (EMC) concept. The EMC concept is derived in the [11, 12] from the classical control loop concept as the formal background for description of management information processing in the hierarchical organizational systems.

The interactions between knowledge management layers of KBE are formally described as two semantically different control loops: the Process Management Cycle (*EMCp*) and the Knowledge Management Cycle (*EMCz*).

The presented framework of the Knowledge-based Enterprise Management System architecture is aimed to development of the practical methods for the knowledge-based enterprise modelling and implementation.

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