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The Ontology-based Business Architecture Engineering Framework

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Abstract. Business architecture became a well-known tool for business transformations. According to a recent study by Forrester, 50 percent of the companies polled claimed to have an active business architecture initiative, whereas 20 percent were planning to engage in business architecture work in the near future. However, despite the high interest in BA, there is not yet a common understanding of the main concepts. There is a lack for the business architecture framework which provides a complete metamodel, suggests methodology for business architecture development and enables tool support for it. The ORG-Master framework is designed to solve this problem using the ontology as a core of the metamodel. This paper describes the ORG-Master framework, its implementation and dissemination.

Keywords. business architecture, enterprise architecture framework, enterprise modeling, ontology, enterprise engineering.

Introduction

Today's enterprises have to be agile, quickly respond to environment, market and technology changes, meet internal and external legal and regulatory requirements. This agility and responsiveness is enabled through continuous business transformations. A business transformation implies integrated changes not only in business processes and information systems, but also in organizational structure, business policies, balanced scorecards, and procedures. Such complex changes require integrated methods and tools for business process management, corporate performance management, value chain management and organizational design. Business Architecture (BA) together with relevant methods and tools make enterprises agile and help them successfully cope with business transformations.

"A BA is a formal blueprint of governance structures, business semantics and value streams across the extended enterprise. It articulates the structure of an enterprise in terms of its capabilities, governance structure, business processes, and business information. The business capability is "what" the organization does, the business processes, are "how" the organization executes its capabilities. In articulating the governance and information." … "In defining the structure of the enterprise, BA considers customers, finances, and the ever-changing market to align strategic goals and objectives with decisions regarding products and services; partners and suppliers; organization; capabilities; and key initiatives." [1]

Business Architecture framework is based on the foundational enterprise architecture work - the Generalized Enterprise Reference Architecture and Methodology (GERAM) developed by IFIP-IFAC Task Force [2]. The framework consists basically of four dimensions:

1. The BA Metamodel, also referred to as conceptual model or modeling language, offers constructs that cover, fully or partially, the business domains of an enterprise.

2. The BA Methodology describes the development process of BA models and more importantly, the techniques that are used in the specific context in which BA is applied. In a process model or a structured procedure, the methodology explains the responsibilities to be defined, the activities to be executed and the principles to be considered.

3. The BA software tools support the above metamodels and methodologies and support the engineering of the BA models in the enterprise. They should provide the functionality to develop, visualize, analyze, and eventually simulate aspects of the BA.

4. BA models are descriptions of the company's current and future states, created using the BA metamodel, methodology and tool. These models illustrate the company-specific business concerns. The gap between the current and target states reveals the areas that need further improvement, and thus will guide the design of the final solution under considerations of the company's requirements designed for execution [3]. Thus, business transformation activities in an organization are highly assisted by using BA frameworks.

The two main problems in the BA discipline are directly related to BA metamodels and methodologies, but result in ineffective BA tools. According to its nature, these two problems can be called "metamodel problem" and "methodology problem".

Metamodel problem:

As BA gain popularity, the following transformations are taking place: BA modeling purposes and concerns are multiplying, the number of BA stakeholders is increasing and the object of modeling is expanding and now includes not only business processes, but also goals, measures, organization structure, etc. This results in the growth of the number of BA metamodels. Some of them include a lot of modeling constructs and cover many areas of business, but they are often immature and are specified insufficiently. The others are well specified, but they are more focused and support one or two business concerns. Managers have to combine several BA metamodels, but this leads to incoherence in models. This situation brings to mind the recent problem of the multitude of business process modeling languages (IDEF, EPC, BPMN et al) resembling the Tower of Babel [4]. In order to integrate the information created by applying various business process modeling languages, a unified language [4] and a business process ontology [5] are used. The similar approach seems to be fruitful for BA modeling. Unfortunately, there is no satisfactory unified integrating language/ontology for BA.

Methodology problem is defined by the following:

- There is no integrated or consistent methodology for BA development.
- Some methodologies explicitly manifest the development task for BA (e.g. TOGAF), but they do not provide any specific methods and models for doing this.
- Some methodologies are elaborated, but they typically work with partial components of the whole BA.

The ORG-Master tool-supported technology for ontology-based BA engineering was created to resolve these two problems. The scope of this paper includes the

solution description mostly for the first problem. The methodology of ORG-Master is provided with a concise overview.

1. Related work

The overview of currently available BA frameworks is based on the IBM report [6], which is extended with a description of the ontology-based SUPER project framework and DEMO. The overview refers to the 3 components of the BA framework: BA metamodel, methodology and tool. In order to compare the BA frameworks, we differentiate between the following BA domains defined by [7].

1. Strategy & Structure defines the meaning and direction of an enterprise, governing its actions and structure.

2. The Business Network describes the enterprise's interaction with its partners, as well as the partners' impact on the enterprise.

3. Operations refer to the ongoing recurring activities, which consume resources and capabilities in order to produce the output of the enterprise.

4. The Performance and Revenue Model is concerned with the financial and performance aspects of enterprises.

In recent years, various techniques that cover different Business Architecture Frameworks have been developed. A sub-set of twelve BA frameworks was selected to be included in the overview as they stood out due to their awareness levels, contributions to the BA community, application, maturity of the conceptual models, methodologies or supporting tools, as well as promising planned enhancements.

ArchiMate

Originally maintained by the ArchiMate Foundation, in February 2009 ArchiMate(R) Version 1.0 was formally approved as technical standard by the Board of The Open Group. Today, consulting firms and tool vendors are engaged in its support, as well as the development of version 2.0. ArchiMate is an EA language that can be applied to formally describe business and IT concerns of enterprise operations (i.e., resources, process architecture, and offerings). It is used to identify requirements and to reason about the current and future structure and behavior of business and IT systems. ArchiMate is not however particularly designed to model the strategic, business network, financial, or performance aspects of an enterprise. The application of ArchiMate is published in various sources [8; 9; 10; 11; 12].

Tools. The visualization of the ArchiMate-specific symbols is supported by various modeling tools, including BiZZdesign Architect by BiZZdesign, ARIS ArchiMate Modeler by IDS Scheer, Metis by Troux, Corporate Modeler by Casewise, and System Architect by IBM. Additionally, ArchiMate stencils to be used in MS Visio are available.

Business Architecture Working Group

In 2007, the Business Architecture Working Group (BAWG) was founded as part of the Object Management Group (OMG). The BAWG aims at establishing industry standards, supporting the creation, and alignment of business blueprints. In this context, it is planned to develop a Business Architecture, connecting OMG's existing and proposed business standards. The current status of the work is published in whitepapers and on the group's wiki [13; 1; 14]. BAWG's BA ecosystem is planned to cover all business domains on an abstract and detailed level (i.e., strategy & structure, business

networks, operations, and revenue & performance model). As the BAWG's BA is still in its infancy, it has not yet become a standard in BA.

Tools. The current unfinished state of the BA cannot be supported by any tool.

Business Motivation Model

In 2005, the Business Motivation Model (BMM) became a standard of the OMG (Object Management Group). The BMM is used for establishing, communicating, and managing business plans. As such, it defines the factors that motivate a business plan, the elements and the relationships of a business plan. The BMM is designed to model the strategy, governance and the business network of a company. The business operations are not addressed by this model [15; 16].

Tools. Being a well-defined conceptual model, BMM can be modeled with any entity relationship modeling software. IBM Rational RequisitePro in combination with IBM Rational® Software Modeler also provide a BMM template which assigns to every definition a unique symbol.

Business Process Modeling Notation

In 2004, OMG released the Business Modeling Notation BPMN 1.0 Specification. BPMN is based on prior efforts by the BPMI Notation Working Group. BPMN aims at linking business process model design and process implementation. As such, it shall be understandable from business analysts, to the technical developers, as well as the people involved in the management and control of the processes. BPMN can be used to describe business operations on a detail, as well as on a high-level. Thereby, it addresses in particular aspects of the process architecture, and only marginally resource and capability aspects. BPMN is a well accepted standard for process modeling [17; 18].

Tools. BPMN is supported by various SW vendor, as well as open source tools. Examples are System Architect from IBM, Lombardi Teamworks from Lombardi Software, or the BPMN modeler for Eclipse. The usage of these tools assures that the company-specific models are compliant with the BPMN syntax.

Business Concepts

In 1996, McDavid introduced the business concepts as a business language that provides a technique to model common business concerns relevant for the development of information system [19; 20]. They describe a generic Business Architecture, addressing on a high-level aspects of enterprise modeling, such as strategy, structure, business network, and operations. Against this, no particular focus is laid on the revenue and performance models of an enterprise. The BA concepts by McDavid represent a seminal introductory work in BA. As such, it has been laid the foundation for various BA concepts and practices. However, McDavid's business concepts needs to be further specified if they are used in practice.

Tools. In order to support McDavid's business concepts with an entity relationship modeling tool the syntax of the model needs further specification.

Component Business Model

The component-based Business Architecture (CBM) has been developed by IBM and is actively applied in the consulting activities by IBM Global Business Services (GBS). CBM is used for business transformation, by prioritizing strategic targets and their linkage to solutions through traditional packaged applications or SOA solutions [21]. CBM covers aspects of the operations and organizations such as a company's strategy, governance, operations, as well as revenue and performance models. Business network aspects are currently less prominent in CBM [22].

Tools. Core tools support the above conceptual model, including IBM's publicly available WebSphere Business Modeler, as well as a CBM-specific tool.

Enterprise Business Architecture

Developed by Gartner, the Enterprise Business Architecture (EBA) is an integral part of an enterprise architecture. As such, its objective is to optimize business components along with information and technology in order to support the business strategy. EBA is a descriptive BA, which can be used as introduction to the BA topic. It covers in particular the structure and the operations of a company. Aspects, such as the business network and the performance models are less emphasized in the EBA. Publications on the EBA are available from 2008, e.g., [23; 24].

Tools. In order to support Gartner's EBA model with an entity relationship modeling tool the syntax of the model needs further specification.

Event-Driven Process Chain

As part of ARIS ('Architecture of Information Systems'), the Event Driven Process Chain (EPC) was originally developed within a research initiative lead by Prof. A. W. Scheer. EPC is a mature conceptual model, which is widely used for the documentation, and analysis of enterprise operations. The outcomes of these activities serve as foundation for the design of information systems. In particular, in the configuration and customization projects of the enterprise solution SAP, ARIS provides the standard modeling environment (e.g., [25; 26; 27]).

Tools. ARIS is supported by the ARIS Software platform, which is composed of the numerous tools of the strategy platform, design platform, implementation platform, and control platform. Thereby, the tools of the ARIS design platform provide the capabilities to model and manage the EPC business models. All tools of the ARIS platform are based on one data model repository, thus allowing the re-use of information from any tool. For instance, key performance indicators created in the balanced scorecard tool can be accessed in the ARIS Tool and connected to business process models.

Enterprise Business Motivation Model

The Enterprise Business Motivation was developed by Microsoft's enterprise architect Nick Malik. It was first published in his blog, later also in Microsoft's The Architect Journal [28; 29]. The BA model aims at illustrating how the actions of a company are aligned with its objectives. It covers numerous aspects of enterprise modeling. A particular focus is thereby laid on the modeling of business models. As the EBMM was first published in 2009, little is known about the EBMM's actual application in companies, nor can it be today defined as a standard for BA.

Tools. The EBMM can be supported by any tool that provides ER modeling features.

TOGAF Business Architecture

TOGAF (The Open Group Architecture Framework) is developed and maintained by the members of The Open Group working in the Architecture Forum [30]. TOGAF Version 1 was originally published in 1995 with a strong focus on IT architecture. In recent years, Business Architecture has become an essential part of TOGAF. In particular version 9.0, published in February 2009, shows various enhancements regarding conceptual model and guidelines for the creation of Business Architectures. Thereby, the Business Architecture in TOGAF addresses on a high level the organizational aspects strategy, structure, and operations. The business network, performance and revenue models are less covered in TOGAF. However, the maturity

between the Business Architecture and other enterprise architectures still differs significantly.

Tools. The TOGAF is supported by various tools, such as IBM System Architect, MDG Technology by Sparx Systems, or Metastorm Provision. Thereby, most tools support the modeling of conceptual EA models referenced by TOGAF. Furthermore, they provide a structure to organize the created company-specific models.

SUPER Project framework

The SUPER Project [31; 32] utilizes semantic technologies for business process management and automation. This project delivered ontology-based language, method and tool-support for business-process modeling, redesign, automation and analysis. But the other areas of BA (Value-added chain, Balanced scorecard development and Organizational Design) must be elaborated. SUPER project deliverables include organizational ontologies, which can contribute to balanced scorecard development [33] and organizational design [40], but they are insufficient. These ontologies are used in business process design and analysis, but should be more fine-grained and integrated with methods of strategic management and organizational design. Otherwise it will be hard to answer the following questions:

- What set of business processes does this enterprise need?
- What department should own a particular business process?

Besides SUPER project does not include methods for complete BA development.

DEMO

DEMO [34] is a methodology for the design, engineering, and implementation of organizations and networks of organizations. The entering into and complying with commitments is the operational principle for each organization. These commitments are established in the communication between social individuals, i.e. human beings. DEMO focuses on the productional essence of enterprises by providing an implementation independent way of describing the essence of the way the enterprise produce its results. This description provides mechanisms for construction enterprise synthesis. Limitations of the methodology: absence of explicit links with motivation model and goals prevents the possibility of any prioritization work and performance management.

Table 1. Comparison of the currently available Business Architecture frameworks

Select Business Architecture (July 2009)	Archi-Mate	BAWG	BMM	BPMN	Business Concepts	CBM	EBA	EPC	EBMM	TOGAF BA	SUPER	DEMO
1. Metamodel												
• scope												
- strategy & structure	◑	◑	✔	○	◔	◑	◑	◑	◕	◑	◔	◕
- business network	◔	◑	◕	○	◑	◔	◔	◔	◕	○	◔	◔
- operations	◕	◑	◔	◕	◑	◕	◕	◕	◑	◑	◕	◑
- revenue model & performance	○	◑	◑	○	○	◑	◔	◑	◔	◑	◔	◔
• integration with other architectures	✔	✔	◔	✔	◑	◑	○	✔	○	◑	◕	◑

Select Business Architecture (July 2009)	Archi-Mate	BAWG	BMM	BPMN	Business Concepts	CBM	EBA	EPC	EBMM	TOGAF BA	SUPER	DEMO
• maturity	◕	◔	✓	✓	◑	◕	◔	✓	◑	◔	◑	✓
2. Methodology												
• scope												
- development of BA model	◑	○	◑	✓	○	◑	○	◕	◔	◔	✓	✓
- management BA initiatives	○	○	○	○	◔	✓	✓	◑	◔	✓	○	◔
• structured procedure model	○	○	◑	◑	◔	✓	✓	○	○	✓	✓	○
• use case scenarios	○	◕	○	◔	○	✓	◔	◑	◔	○	✓	◑
• best practices / reference models	◑	○	◑	◕	○	✓	◑	✓	◔	◔	✓	✓
• maturity	◔	○	◑	◔	◔	◑	◔	◔	◔	◕	◑	◕
3. Tool Support												
• available tools	✓	○	✓	✓	○	✓	○	✓	✓	✓	✓	✓

Legend: circle filling level is defined by qualitative evaluations based on the following questions:
Does the framework suggest relevant elements?
What is the elaboration level of the suggested elements (do they have definitions, properties, examples…)?
If the framework doesn't suggest relevant elements than the circle is blank. If it suggests relevant elements and describes them thoroughly, than the circle includes check mark. All the other fillings corresponds to intermediate levels.

The more mature BA approaches address only selected subareas of the four business domains 'Strategy & Structure', 'Business Network', 'Operations' and 'Performance and Revenue Model'. In general, these BAs represent silos which provide only limited guidance for the integration with other BAs. On the other hand, BA approaches addressing a broader spectrum of business concerns currently lack the depth required for BA modeling in a practical context.
There is a lack for the framework, which:

- Covers all the domains of business architecture (completeness of metamodel),
- Provides methodology for BA development
- Provides tool support for metamodel and methodology.

2. Ontology-based business architecture engineering concept

The ontology-based approach for BA engineering was suggested to solve the above problems.

Ontology is a formal, explicit specification of a shared conceptualization [35]. A 'conceptualization' refers to an abstract model of some phenomenon in the world by having identified the relevant concepts of that phenomenon. 'Explicit' means that the

type of concepts used, and the constraints on their use are explicitly defined. For example, in medical domains, the concepts are diseases and symptoms, the relations between them are causal and a constraint is that a disease cannot cause itself. 'Formal' refers to the fact that the ontology should be machine readable, which excludes natural language. 'Shared' reflects the notion that ontology captures consensual knowledge, which is not private to some individual, but accepted by a group. Ontologies and corresponding semantic technologies are actively used for information integration, knowledge management, e-commerce, education and semantic web [36; 37; 38, 39]. Ontologies are also used for enterprise modeling [33; 5; 40; 31], but these applications are geared towards business process modeling/management and data integration. Ontologies for BA engineering are not yet applied.

It is suggested to use enterprise ontology as a metamodel for BA models. A populated enterprise ontology is equal to a BA model. All the necessary stakeholders' concerns are satisfied using ontology-based views. These views can be either document-oriented (text, table) or visual (diagram). The contents and the form of these views are defined using specifications (or viewpoints). Figure 1 represents the transition from the collection of independent enterprise modeling languages to the mapping between the domain specific visual notations and the enterprise ontology. This mapping provides the translation of ontology-based BA model into the partial views.

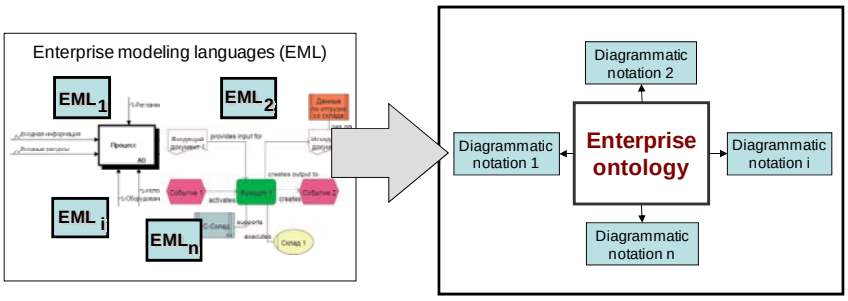

Figure 1. The transition towards the ontology-based BA modeling

The ontology-based approach provides agility, seamless information integration ("integratability"), easy change management, reasoning and deduction of the implicit knowledge. It helps satisfy the information needs of various stakeholders and guarantees consistency of information at the same time.

3. ORG-Master business architecture engineering framework

3.1. Overview of the framework

Figure 2 represents components of ORG-Master framework and their interactions. We will use bottom-up explanation approach. Enterprise modeling is the core of business architecture development within ORG-Master framework. Business architect and analysts create an enterprise model. Output views satisfying the concerns of

different stakeholders, are generated from the enterprise model. Input views, which populate the enterprise model, are an optional mechanism that support knowledge acquisition process. These input/output views take the form of text or table documents and graphical diagrams.

The structure of an enterprise model is defined by enterprise ontology while the structure and the form of input/output views are defined by corresponding specifications. Technically, these specifications define the contents through queries to the model or mapping between the elements of enterprise ontology and input/output graphical notations. The BA development process is defined within the methodology for enterprise model creation and use. This process can automatically guide novice-users. The metamodel and methodology can be customized for the specific enterprise and situation using the customizing method based on ontology mapping and merging [41]. This meta-modeling level integrates all the methodological work and requires relevant competencies. In practice, the results of meta-modeling level can take the form of enterprise standards.

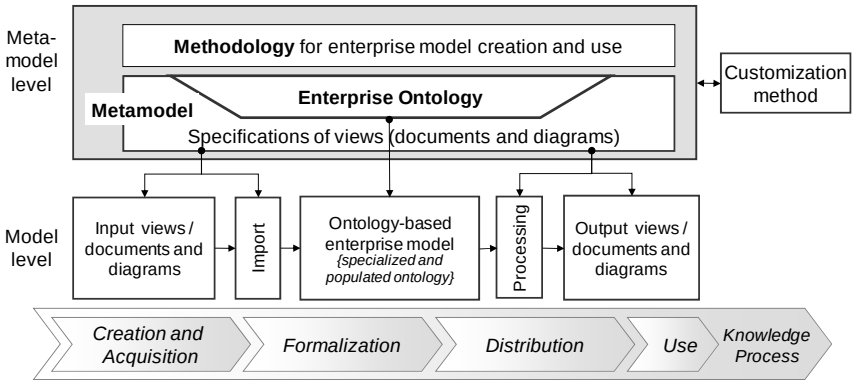

Figure 2. Components of ORG-Master architecture framework

3.2. The ontology-based metamodel

Ontology-based metamodel consists of 2 components: enterprise ontology and views' specifications (viewpoints).

Enterprise ontology of the ORG-Master framework spans 12 domains: activities, production, performance management, norms, business concept, environment, information resources, material resources, financial resources, human resources, organizational structure and infrastructure (Figure 3).

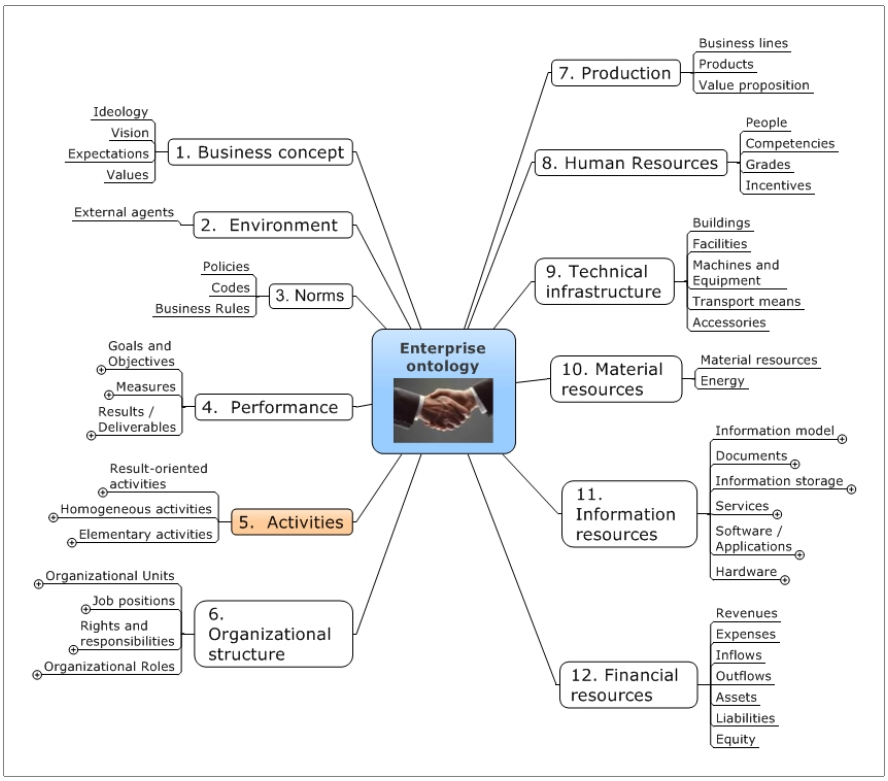

Figure 3. Overview of the ORG-Master enterprise ontology

Fig.4 shows a fragment of the ORG-Master enterprise ontology for the Activities domain:

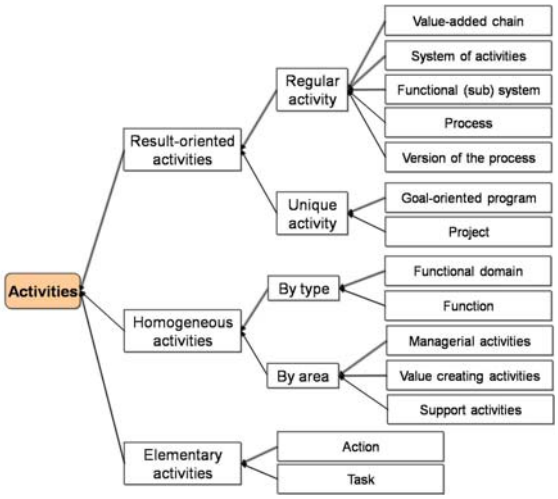

Figure 4. Fragment of the ORG-Master enterprise ontology

Views (documents and diagrams) specifications. The complexity of implementing an enterprise's strategy is likely to be immense because many processes, departments and information systems are involved. When using business architecture as a planning and steering instrument, this instrument should reflect this complexity. As a result, it is almost undoable to make one single univocal and comprehensive set of models that can be used for all the people concerned, therefore, several views are needed which focus on specific stakeholders and their concerns [10; 42, 43, 44]. Different views based on the stakeholders concerns are an important communication means to obtain the cooperation of stakeholders. A view is a representation of a whole system from the perspective of a related set of concerns [44].

The structure and the form of input/output views are defined by corresponding specifications. Specifications are created based on the analysis of concerns and of information needs of stakeholders [43; 45]. Technically these specifications define the contents by the means of either queries towards the model, or mapping between the elements of enterprise ontology and input/output graphical notations. The technology of queries and mapping is detailed in [41].

3.3. The Methodology (Business architecture development method)

BA development method starts from the top-level concepts and policies and ends with the organization structure of an enterprise. Goal-driven approach is one of the main ideas of the method, which is based on business architecture "triangle", see Fig. 5. It is necessary to define purpose and decompose it into goals of the future system, then define the necessary functional structure and, finally, define the responsible actor and his goals. It is necessary to balance goals of actors from organizational structure with the goals of the functional systems in his responsibility.

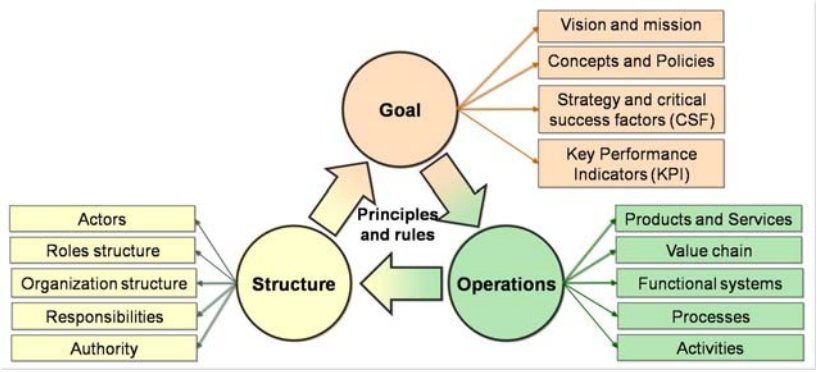

Figure 5. Business architecture "triangle"

This cycle repeats for every goal and, gradually, at every level of decomposition.

The main tasks within BA development method and their interrelations are represented in Fig. 6. Pentagons are tasks, rectangles – are deliverables, arrows – transfer of deliverables. Tasks and deliverables from the upper-left triangle-area corresponds to "goals corner" (see Fig. 5), from the low-right triangle-area – to "organization corner", from in-between area – to "functional corner".

Principles and rules within the cycle imply that all the tasks within BA development have corresponding principles and rules. For example, the task "Identify

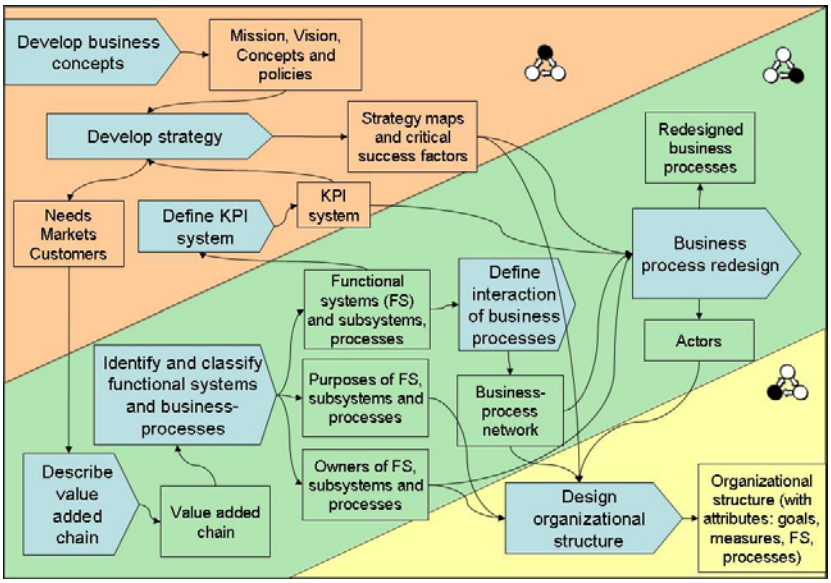

Figure 6. Business architecture development method

and classify functional systems" is guided by identification and classification principles and rules, while "design organizational structure" will have its own rules and principles and some of them will be similar to the ones from [46].

Every task implies "as is" and "to be" models.

3.4. The BA engineering tool

ORG-Master BA engineering tool includes the following modules: Ontology-based enterprise model editor, Reporting and query module, Diagram editor, Integration wizard, Modeling process wizard:

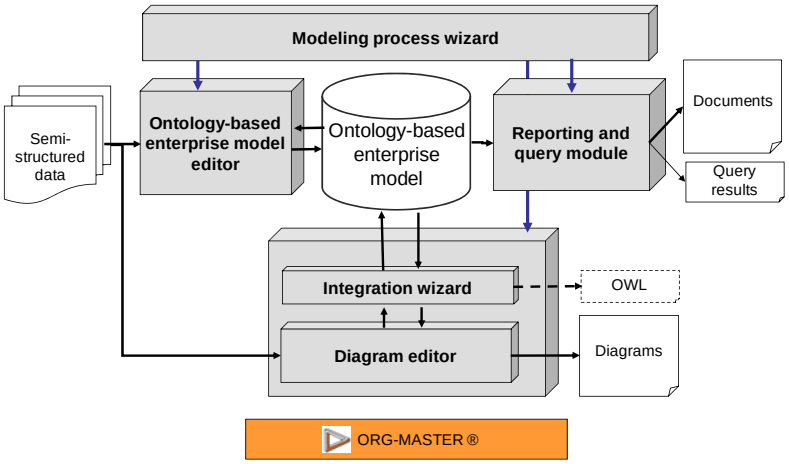

Figure 7. The ORG-Master business architecture engineering tool

Ontology-based BA model and metamodel are represented using special language ORLAN (ORganizational LANguage) within the ORG-Master tool. This language allows to structure, represent and query enterprise model.

ORLAN :: = <TYPES, CL, MX, InferPR, D, TASKS, SPEC >, where:

TYPES – types descriptions, which specify the classes, relationships and properties of enterprise ontology, together with their taxonomies,

CL – classifier, the representation format for entities, hierarhical relationships between them and values for the properties of entities (including ontological types). Hierarchy is the main feature of classifies and the main relationship types are "part-of ", "class-subclass", "be subordinated to" etc.

MX – matrix (or table), the representation format for relationships between entities from classifiers. Example relationship types are "perform", "help achieve" etc.

InferMX – inference matrix, allows to infer implicit knowledge via transitive property of relationships in several matrixes,

D – modeling domains (activities, norms, information resources, etc),

TASKS – enterprise engineering method specification,

SPEC – views specifications.

ORLAN does not require programming skills and allows enterprise modelers to structure knowledge visually and allows specilist in methodology to customize it. ORLAN details are represented in [41].

Table 2. ORLAN-OWL mapping

ORLAN elements	OWL elements
TYPES	
e-type$_i$ + sign	owl:Class + rdfs:label(pictogram)
pt-type$_k$+ sign	owl:DatatypeProperty + `rdfs:label(pictogram)`
rel-type$_j$+ sign	owl:ObjectProperty + `rdfs:label(`pictogram`)`
(«subClassOf», e-type$_{i1}$, e-type$_{i2}$)	rdfs:subClassOf (owl:Class, owl:Class) rdfs:subPropertyOf
CL	
Onto-CL	
type$_{Cli}$	owl:Class OR owl:DatatypeProperty OR owl:ObjectProperty
{(type$_{CLi}$, pt-type$_k$, pt-type$^{VAL}_k$)}	owl:DatatypeProperty (rdfs:domain, rdfs:range)
{(rel-type$_j$, type$_{CLi1}$, type$_{CLi2}$)}	owl:ObjectProperty (rdfs:domain, rdfs:range) *the graph structure must be of the tree type for this property*
Base-CL	
{E$_{Cli}$} – classifier elements	rdf:ID (instances) OR owl:DatatypeProperty OR owl:ObjectProperty
(«type», E$_{CLi}$, e-type$_i$)	`rdf:type(`E$_i$, C$_{0i}$)
(rel-type$_j$, E$_{Ci1}$, E$_{Ci2}$)	owl:ObjectProperty (E$_1$, E$_2$) *the graph structure must be of the tree type for this property*

ORLAN elements	OWL elements
MX	
Onto-MX	
(rel-type$_j$, type$_{CLi1,}$ type$_{CLi2,}$)	owl:ObjectProperty (rdfs:domain, rdfs:range) Seldom: owl:DatatypeProperty (rdfs:domain, rdfs:range)
Base-MX	
(rel-type$_j$, E$_{Ci1,}$ E$_{Ci2,}$)	owl:ObjectProperty (E$_1$, E$_2$) Seldom: owl:DatatypeProperty (E$_1$, E$_2$)

Figure 8, 9 and 10 represents the examples of ORLAN implementation within ORG-Master tool.

ORG-Master is integrated with process and project execution system (TIME-Master) and with strategy and business activity monitoring system (E-Master). These systems allow to realize the complete managerial cycle (analysis, design, execution, monitoring) and can be jointly considered as BPM (Business Process Management) and CPM (Corporate Performance management) systems.

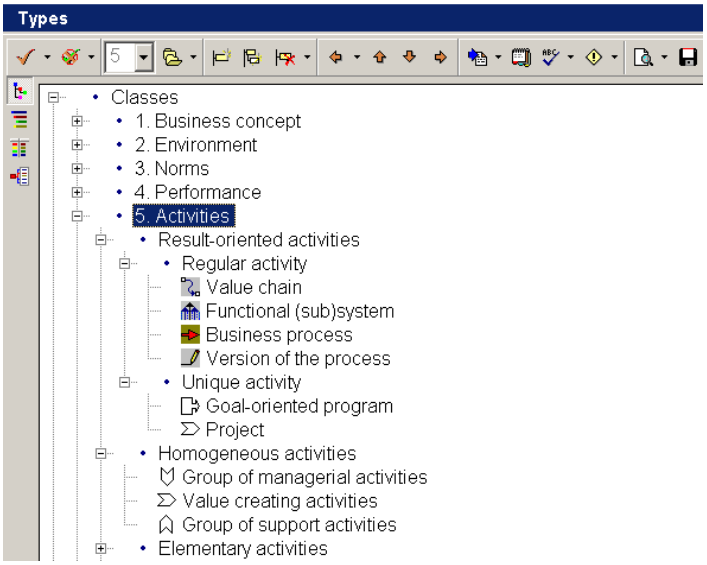

Figure 8. TYPES for the enterprise ontology editing

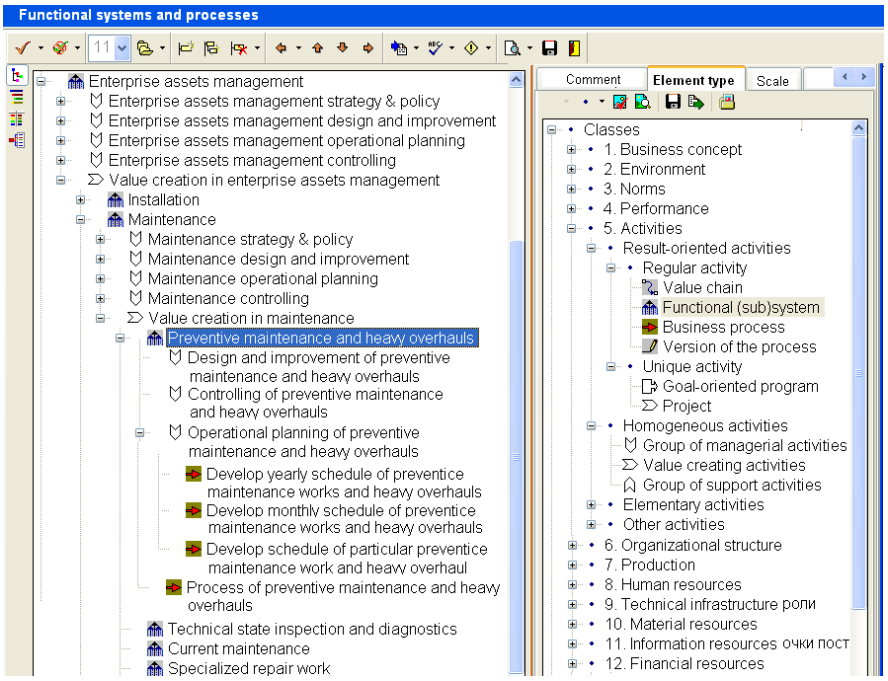

Figure 9. Classifier (CL) for instance-level editing

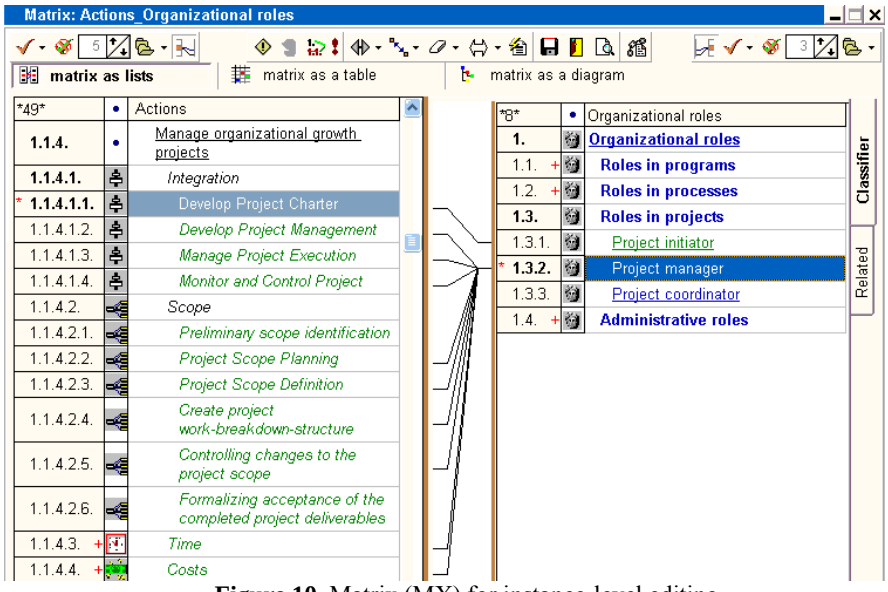

Figure 10. Matrix (MX) for instance-level editing

4. Implementation

4.1. Implementation in business entities

The ORG-Master software tool together with the corresponding models and methods has had a more than 10-year long history of use in organization development and business process improvement projects. The ORG-Master is used in business entities in Russia and the CIS countries, and the scope of client uses varies from small companies to corporations employing as many as 10,000 staff.

More than 10 implemented projects in Russian and CIS companies such as GOTEK Group, Kirishskaya GRES (power station), Ilim Group, Trade House PEKAR, North-Western Shipping Co., Power Machines, Irkutskenergo, Gazapparat, ASTRA, Petrovsky Trade House, OGK-1, Pit-Produkt, Eurosib, etc. All these projects are carried out by specialists of Business Engineering Group (bigc.ru).

GOTEK Group project example:

Goals: Improve and formalize company's group activities management

Objectives: Identify, describe and improve business processes; Divide the processes between the managing company, shared service center and enterprises involved; Group-wide strategy deployment; Develop organization's regulatory and quality management documentation.

Examples of documents (views) generated from the ontology-based model:

Regulatory: Functional System Strategy, Business Process Datasheet, Business Process Regulation Procedure, Employee Working Instructions;

Analytical: Strategic Performance Measure Analysis, Responsibility and Motivation Measures Analysis, Process Description Control Report.

Ilim Group project example:

Ilim Group is one of the leaders of the Russian pulp and paper industry. Its business assets located in the Leningrad, Arkhangelsk and Irkutsk Oblasts are the largest mills in the Russian forest industry accounting for more than 65% of the total pulp production in Russia and for over 25% of the Russian production of board. Ilim Group employs over 20,000 people. Koryazhma Branch of Ilim Group is the former Kotlas Pulp and Paper Mill, one of the largest in Europe. Koryazhma's share in the total amount of Russian-manufactured products is 14% for market pulp, more than 10% for the complete range of board and over 6% for paper. The branch currently employs 3,328 people.

In 2008, the Koryazhma Mill faced the problem of equipment reliability drop. Breakdowns happened often and that resulted in unplanned equipment downtime increasing from 367 hours in 2006 to 1271 hours in 2008, that is some 3,5 times as much. This not only caused additional repair costs but also loss of profit. Diagnostics uncovered the following reasons: ineffective organizational structure, unmanageable maintenance-related decision-making, vague responsibility for the equipment reliability, inefficient procedures for interaction between production and maintenance, loss of qualified personnel and inadequate motivation system (repairmen not interested in reliable equipment).

A maintenance system reengineering project was carried out to eliminate the identified problems. It focused on BA elements mostly and included the following tasks:

- Develop maintenance system concept, strategy and measures;

- Redesign organizational structure – equipment maintenance department was reorganized and maintenance board was established,
- Optimize the key business processes in maintenance (planning and control processes, defect reporting);
- Information system improvement;
- Formalize and enhance key maintenance operations;
- Develop organizational documentation (procedures, regulations for departments, job descriptions, work manuals).

All of the above was done using electronic ontology-based BA model. Goals, measures, business process, organizational structure, roles, operations and other entities were entered into the model and related to each other. The organizational documentation was then generated from the model. At the beginning of each task, the ontology was being presented and agreed upon, e. g. an activity-related ontology was agreed upon at the start of the business process optimization.

The ontology included about 60 concepts and some 100 types of the relationships. The instance base included more than 10000 elements.

Project deliverables include Ontology-based BA model, which enable the Koryazhma Mill to generate the following organizational documentation (views): 36 process regulations, 12 functional system standards, more than 400 job descriptions, more than 200 employee performance scorecards, 35 operation instructions.

Overall effects of the maintenance system reengineering project:

- The tendency for the unplanned equipment downtime to keep growing has been reversed for the first time in 4 years. Instead of 1,527 hours of downtime forecasted for 2009, the actual downtime was only 917 hours, a 40 percent decrease;
- All compliance assessments (ISO, etc) successfully completed;
- Increased manageability and performance, personnel reduced, according to leadership's estimates;
- Repair times reduced;
- Increased equipment reliability.

In order to identify the role of the project in this situation it is necessary to evaluate changes in the other equipment reliability (the final effect) factors, namely level of production and equipment usage, maintenance staff competencies, quality of spare parts tools and accessories, environment. All these factors didn't change significantly (e.g. spare parts budget change didn't exceed 10%) and historical dependency analysis doesn't support the idea that slight variance in these factors could lead to 40 percent decrease in the unplanned equipment downtime. So it is possible to deduce that the role of the project is high. Since the project was carried out using the ORG-Master framework, the above case justifies the framework effectiveness. Quantitative comparison between different business architecture frameworks is problematic. Such a comparison will require producing business architecture descriptions of the same enterprise using different metamodels, methodologies and tools at the same moment. Unfortunately this experiment is unrealistic.

4.2. Implementation in government agencies [47]

The GOV-Master is a version of the ORG-Master, which complies with the federal, regional and local authorities modeling methodology developed by the authors of this research as part of R&D [43] and represented as an overview in [47]. The GOV-Master

tool is designed for the Russian government agencies, specifically for those involved in administrative reform including Administrative Regulations, structure and function optimization, performance management.

The three aspects of GOV-Master framework (a version of ORG-Master) implementation include administrative regulations, structure and function optimization, performance management. More than 10 administrative regulations have been developed for the Federal Migration Agency, Federal Registration Agency, Federal Agency for Physical Culture and Sport, etc.

Examples of regulatory documents (views) generated from the ontology-based model include Government Agency Activity Regulation; Administrative Regulations; List of administrative processes supported by a government agency and their delegation to its subdivisions; Graphic descriptions of administrative processes in two formats (one is similar to EPC, another is extended IDEF0); Regulation of subdivision functions.

5. Dissemination of ORG-Master framework

One of the ways to disseminate the framework is to provide training. Business Engineering School is our flagship training instrument. Since 2003, it has been providing a regular one-week training course for managers, organizational development directors, business analysts, business owners. More than 200 people from Russia and CIS completed these trainings. The 16th Business Engineering School took place in May, 2011. ORG-Master framework is also included in the curricula of several institutes and universities in Saint-Petersburg and Moscow: International Banking Institute (Organizational Modeling course for Applied Informatics in Economics), Saint Petersburg State University of Economics and Finance (Business Engineering and Business Process Modeling courses within MBA program since 2010-2011), Higher School of Economics (Public Administration Modeling as a Technology of Administrative Reform course within further training for public officials). More than 200 corporate seminars and tutorials on the management methods based on business engineering have taken place since 1998.

Another way of dissemination is industry-oriented publications. The most detailed representation of ORG-Master framework is contained in the book [48] providing guidelines and examples for BA engineering projects. Some representations of its content, target audience and application area can be found in [49], which explains knowledge navigator for the book. The most recent public explanation of ORG-Master framework methods is contained in the series of articles (about 10) in the Methods of Quality Management journal, one of the leading TQM journals in Russia.

6. Conclusions

Business architecture (BA) became a well-known tool for business transformations. However there is a lack for the business architecture framework which provides an integrated metamodel, methodology and tool support for BA development. The ORG-Master architecture framework is an attempt to solve this problem. The ORG-Master architecture framework first emerged in the late 90s to support organizational development. It suggests using enterprise ontology as a metamodel for BA models.

Populated enterprise ontology is equal to BA model. All the necessary stakeholders' concerns are satisfied using ontology-based views. These views can be either textual, tabular or visual. The contents and the form of these views are defined using specifications (viewpoints). The ORG-Master architecture framework provides the metamodel components (enterprise ontology, view specifications), the methodology (BA development method, typical project tasks specifications, reference models and classifications) and ORG-Master tool. The paper gave an overview for the main components of the ORG-Master architecture framework, implementation case-studies and dissemination.

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