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THE QUALITY MANAGEMENT METAMODEL IN THE ENTERPRISE ARCHITECTURE

Summary – The paper presents the methodology for determining, management, simulation and optimization of the quality of an enterprise architecture based on defined by the author of two metamodels: classes and processes for quality management of this architecture. The second of them (the process metamodel) of quality management developed in BPMN has undergone simulation and optimization using ARIS Business Process Simulator. The results of this simulation and optimization are presented in the article. The presented research method developed by the author, and the results are related to and are a creative extension of the following ISO standards: • Software Engineering - a metamodel for Development Methodologies - ISO / IEC 24744 [1]; • Systems and Software Engineering - Software Life Cycle Processes - ISO / IEC 12207 [2]; • Systems and software engineering - Architecture description - the ISO / IEC 42010 [3]; and the well-known methodologies: [ZACHMAN FRAMEWORK] A Framework for Information Systems Architecture. - Zachman, J. A, and [TOGAF] The Open Group Architecture Framework.

1 Initial information

What is Quality ?

The quality concept in this article for the development process of the enterprise architecture is understood as a set of measurable and immeasurable characteristics of the product required by the customer (customer, product). Product quality is monitored at all stages of its manufacture, especially in the so-called. checkpoints. Control points in the software development are the points where we get the different stages of the manufacturing cycle of products (e.g. documentation, analysis, design, source code). Detailed information concerning modeling and building of quality system in the software development was published by the author in [5] and [9].

Area of interest (research)

The International (Software Life Cycle Processes - ISO / IEC 12207) [2] groups the activities that may be performed during the life cycle of software system into eight process groups. Each of the life cycle

processes within those groups is described in terms of its purpose and desired outcomes and list activities and tasks which need to be performed to achieve those outcomes. These life cycle process groups are depicted in Figure 1.

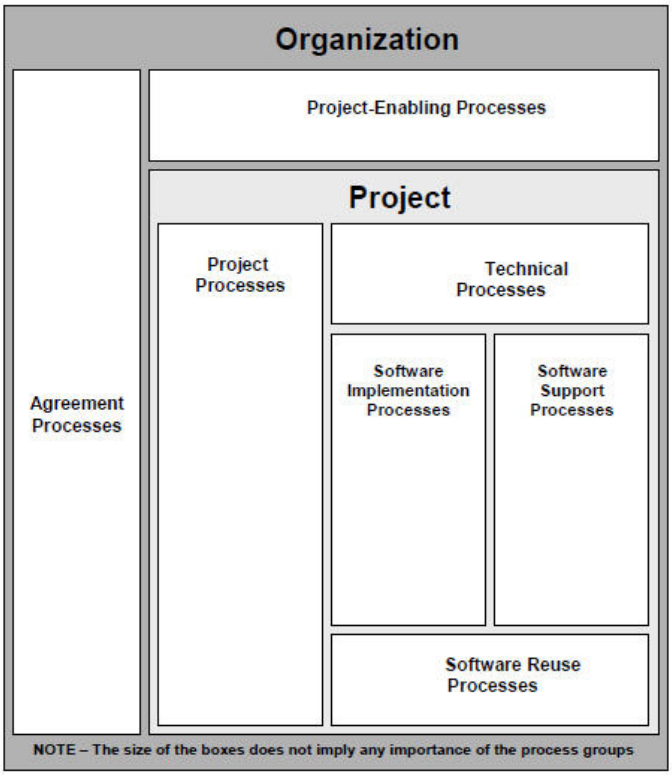

Fig. 1. Life Cycle Process Groups (Source: Systems and Software Engineering - Software Life Cycle Processes - ISO / IEC 12207)

The object of the study (modeling and ptimization) is the area: Software Support processes.

According to the standard ISO / IEC 12207 [2], this area consists of the following subprocesses:

- Software Documentation Management Process
- Software Configuration Management Process
- Software Quality Assurance
- Software Verification Process
- Software Validation Process
- Software Review Process
- Software Audit Process
- Software Problem Resolution Process

The subject of optimization the integrated model of these processes with the exception of process B and H do not belonging to the area of quality management.

2 Architecture quality management metamodel

What is metamodel ?

According to ISO standard ISO / IEC 24744 (A metamodel for Development Methodologies) [1] a metamodel is the specification of the concepts, relationships and rules that are used to define a methodology. A methodology is defined as the specification of the process to follow together with the work products to be used and generated, plus the consideration of the people and tools involved, during an development effort. A methodology specifies the process to be executed, usually as a set of related activities, tasks and/or techniques, together with what work products must be manipulated (created, used or changed) at each moment and by whom, possibly including models, documents and other inputs and outputs. In turn, specifying the models that must be dealt with implies defining the basic building blocks that should be used to construct these models. Any metamodel consists from elements. An element is a simple component of a methodology. Usually, methodology elements include the specification of what tasks, activities, techniques, models, documents, languages and/or notations can or must be used when applying the methodology. Methodology elements are related to each other, comprising a network of abstract concepts. Typical methodology elements are Capture Requirements, Write Code for Methods (kinds of tasks), Requirements Engineering, High-Level Modelling (kinds of activities), Pseudo-code, Dependency Graphs (notations), Class, Attribute (kinds of model building blocks), Class Model, Class Diagram, Requirements Specification (kind of work products), etc.

Class metamodel for the Quality Management in the Enterprise Architecture Development Process

This model is shown below in Figure 2. Meaning of various class concepts are explained in Table 1. The class objects in Figure 2 are grouped into four different groups, showing the four business areas (views) of quality topic, namely:

- Organization Structure Submodel
- Generic Enterprise Architecture Submodel
- QM Related Model
- Quality Products Submodel

Table. 1. Definition of classes for the topic “Architecture Quality Management”

Seq. nr	Object name	Definition
Organization Structure Submodel		
1	Analyst	Person(s) responsible for the definitions of the model architecture and its components.
2	Quality manager	Person responsible for the definitions of the quality requirements and and quality control
3	Project manager	Person responsible for the quality requirements and the quality management
4	Stakeholder	Abstract project stakeholder
5	Steering Committee	Group of stakeholders responsible for the strategic management of the project.
Generic Enterprise Architecture Submodel		
6	Architecture Model	Object representing architecture model equivalent to the architecture repository.
7	AD Element	Architecture Description Element - any type of UML/BPMN Element. It builds Architecture Model.
8	AD Link	Architecture Description Link - any kind of link between AD Elements.
9	AD Attribute	Architecture Description Attribute-any type of AD Element Attribute.
QM Related Models		
10	Quality Management Process Model	BPMN submodel of Management Process Model concerning the quality area
11	Architecture Quality Assessment Model	Contains all QM related elements
12	Management Process Model	BPMN general model for the Project Management
13	Correspondence	Defines correspondence between AD Elements and Quality Patterns
14	Quality Requirement Pattern	Definition of Quality Requirements Algorithms
15	Product Pattern	Organizes report from parts
Quality Products Submodel		
16	Report used by Steering Committee	Report used by Steering Committee
17	Product	Quality Management Process Product

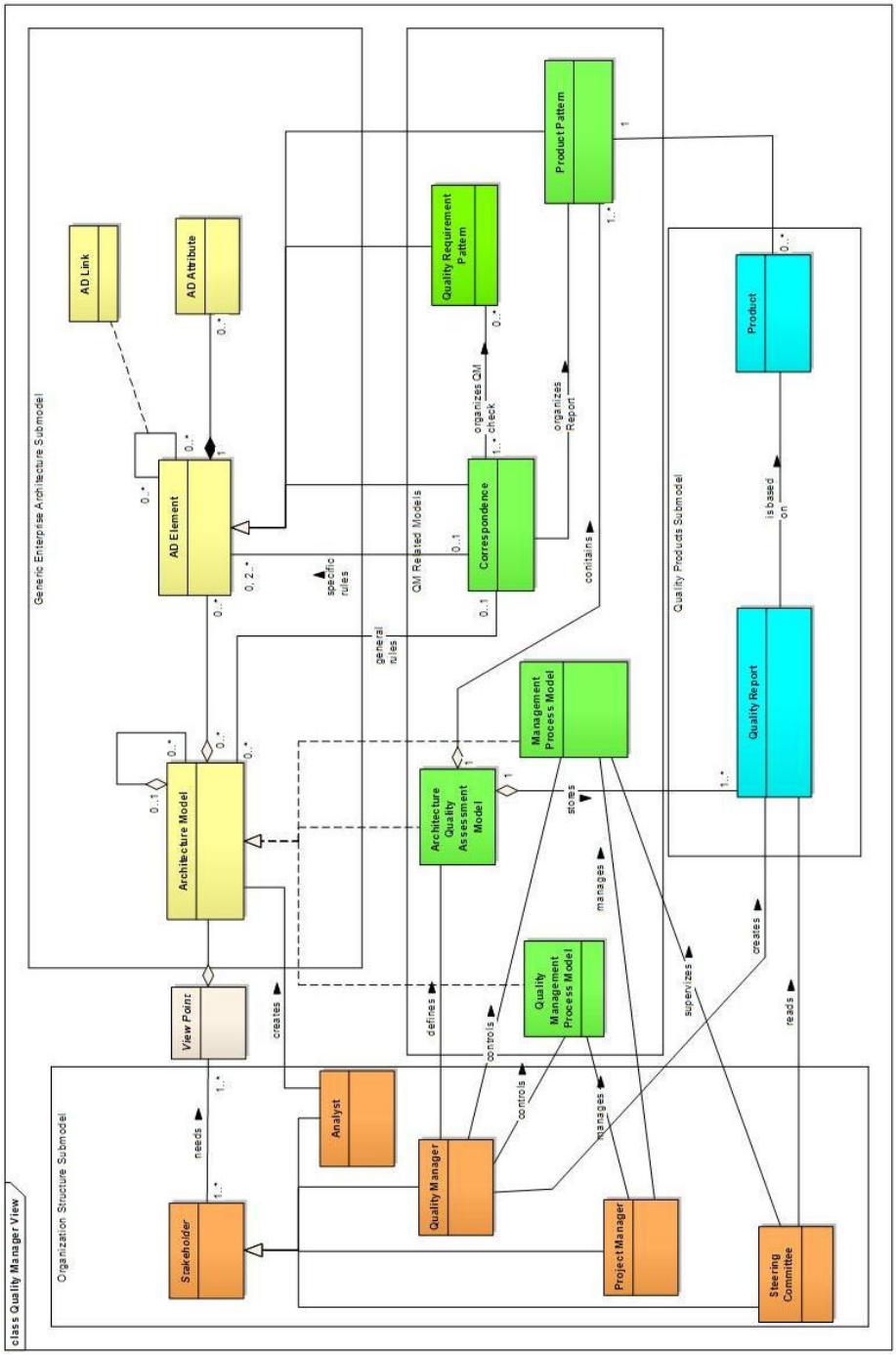

Fig. 2. Metamodel of classes for the topic “Architecture quality management”.

Preliminary process metamodel for the Quality Management in the Enterprise Architecture Development Process

This process model presented as the BPMN model is shown below in Figure 3. Meaning of various processes concepts are explained in Table 2. According to the BPMN modeling methodology the process objects in Figure 3 are placed grouped into four different "LINES" that are groups, showing the organizational units responsible for these processes.

Table. 2. Definition of the processes for the topid "Architecture Quality Management"

Seq. nr	**Process name**	**Definition**
1	Define Quality Requirements	Defines all initial Quality Requirements for the products
2	Define Quality Process & Product Patterns	In this process the pattern for each product of architecture development is defined.
3	Iteration Management	The process of the responsibility of the Project Manager, involving coordination of architectural production process and quality control of its products.
4	Define Correspondence - AD Model to Product Report Patterns	The process of checking the quality requirements which involves checking architecture models with the product standards.
5	Create AD Elements	All kind of operations on AD Elements
6	Quality Validation	Creates QM recommendation for iteration and product revision.
7	Iteration Acceptance	Product acceptance by the Steering Committee.
8	Create Final Report	Preparing report concerning the project closing

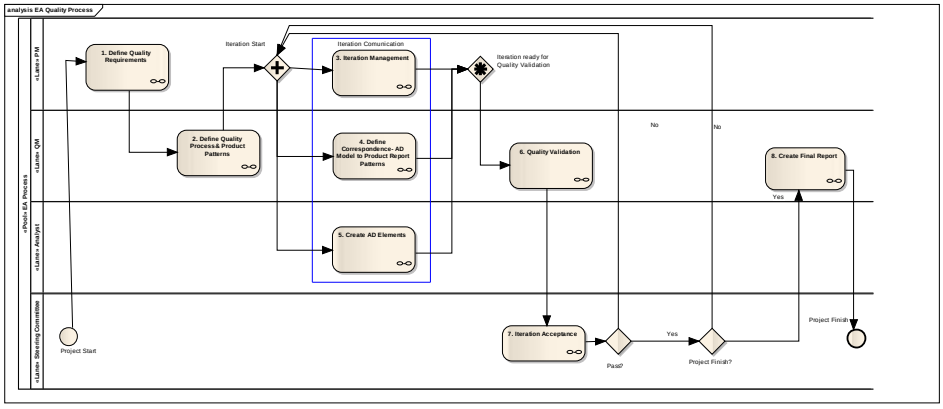

Fig. 3. Preliminary metamodel of processes for the topic "Architecture quality management".

Verifying the completeness and redundancy of the model classes in relation (versus) to the process model.

Comparison and verification is performed using the technique of "relationship matrix".

Table. 3. Relationship matrix processes versus clasees

	Analyst	Create Final Report	CRUD AD Elements	Define Corespondence - AD	Define Quality Process &	Define Quality Requirements	EA Process	Iteration Acceptance	Iteration Management	Iteration ready for Quality	Iteration Start	Message1	Pass?	PM	Project Finish	Project Finish?	Project Start	QM	Quality Validation	Steering Commetee
AD Attribute	X																		X	
AD Element	X																		X	
AD Link	X																		X	
Analyst	X		X																	
Architecture Model																				
Architecture Quality Assesment Model																		X	X	
Correspondence																		X	X	
High Level Quality Report								X										X		
Management Proces Model														X						
Project Manager									X		X			X						
Quality Management Process Model					X													X		
Quality Manager		X		X	X	X		X		X			X					X	X	
Quality Report																		X	X	
Quality Report Pattern					X													X		
Quality Requirement Pattern					X													X		
Stakeholder																				
Steering Committee		X						X		X			X		X	X	X			X
View Point																				

The relevant dimensions of this matrix is the "list classes" created from the class metamodel and "list process" created from the processes metamodel. The process of being in relationship with the class is marked by "X".

3 Simulation and optimization of the quality management process metamodel

Simulation assumptions and input data

Simulation and optimization was performed by using the tool "Aris Business Process Simulator" available in the "ARIS Business Architect". Fig. 3 shows the preliminary model preliminary. Model is due to the requirements of simulation tools have to be transformed.

Because of size and usefulness during interpretation of simulation results, completed BPMN diagram is shown on Figure 5. Based on BPMN model and process parameters, 10 process executions have been performed. On-line observed process simulation (animation) provides numerical results of the current simulation status. Every function from business process model parses process instances and dynamically provides information about current status of simulation. Figure 4 shows ARIS way of presentation progress of simulation. Every function is surrounded by numbers, presenting simulation results, as described on fig. 4.

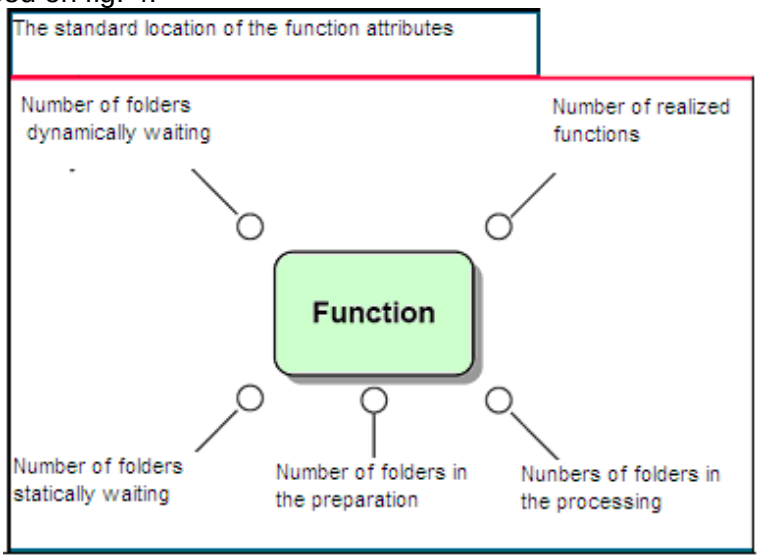

Fig. 4. The meaning of the individual numbers, describing simulation progress

The meaning of the various descriptions in Figure 3 is as follows:

- number of folders dynamically waiting – number of instances of processes, waiting for execution due of human resource absence (eg. in the same time, needed
- resources are busy because of handling other processes),
- number of realized functions – number of instances, which has been carried out and completed,
- number of folders statically waiting – number of instances of processes that can not be done; they are not waiting for resources, but for trigger from decision point XOR or parallel AND flow,
- number of folders in the preparation – number of instances of the process, which are in preparation status (some processes require preparation time to run them),
- number of folders in the processing – number of instances of processes, which are currently in processing status.

Business process simulation and optimization

Business process simulation and optimization has been performed as number of iterations, where the main goal is concerned to select optimal duration time of every step in the process and selecting the optimal value of process time for each processes in such way to perform 10 process instances executions and complete them in just one year (time of the project). Each instance of the process simulation is randomly activated in sequence during the event input. Starting a new instance of the process by the initial event is equivalent to running a quality management process for the new (next) of the product. It follows that the number of instances generated by the event input is equal to the number of products formed during the project.

Table. 4. Input data before and after optimization

	Number of the products instancess/year	10		
Number of the process	**Name of the process instantion**	**Processing time for the optimization (dddd:hhhh :mmm:sec)**	**Processing time after the optimization (dddd:hhhh :mmm:sec)**	**The share (%) of time in the total time**
1	Define Quality Requirements	0010:00:00:00	0006:00:00:00	14,20%
2	Define Quality and product Patterns	0014:00:00:00	0007:00:00:00	16,60%

3	New Product Activation (Preparation time- organizing the team and tools)	0000:05:00:00	0001:00:00:00	2,40%
4	Iteration Management	0002:00:00:00	0001:00:00:00	2,40%
5	Define Correspondence AD Model to Product Report Patterns	0005:00:00:00	0005:00:00:00	11,80%
6	Create AD Elements	0010:00:00:00	0015:00:00:00	35,50%
7	Quality Validation	0010:00:00:00	0006:00:00:00	14,20%
8	Product and Iteration Acceptance	0005:00:00:00	0001:00:00:00	2,40%
9	Create Final Report	0001:00:00:00	0000:05:00:00	0,50%
	TOTAL	**0057:05:00:00**	**0042:05:00:00**	**100,00%**

Simulation and optimization study consists of several steps, some of which are repeated in an iterative cycle. At the beginning, UML activity diagram, obtained with some exploring methods from workflow system database, has been converted to BPMN form. Some additional model parameters, which are also obtained with exploring methods, are placed in to the simulation BPMN model. Then the simulation process has been carried out and first analysis has detected three sources of “bottlenecks”:

- **”bottlenecks" associated with the allocation of resources** – human resources are insufficient; they are invoked by the currently processing instance but resources are busy. Therefore, they can not be used until the end of processing another process execution. As the result, on the simulation model are created process instances called "dynamically waiting" for the execution until the release of resources. The optimization solution is to increase resources in order to eliminate " dynamically waiting” processes.
- **"bottlenecks" associated with function processing time (function execution time)** – exists, if possibility to increase the resources has been already exhausted and the only solution is to reduce the execution time (but according to business possibilities). As the result, on the simulation model are created process instances called "statically waiting". Optimization solution is to reduce the

implementation time of such processes, in order to eliminate "statically waiting" processes.

- **"bottlenecks" associated with downtime (which means to stop the activation process instance)** – it results as elongation of total duration of the simulation. The solution is optimize “bottlenecks” described above in order to reduce downtime.

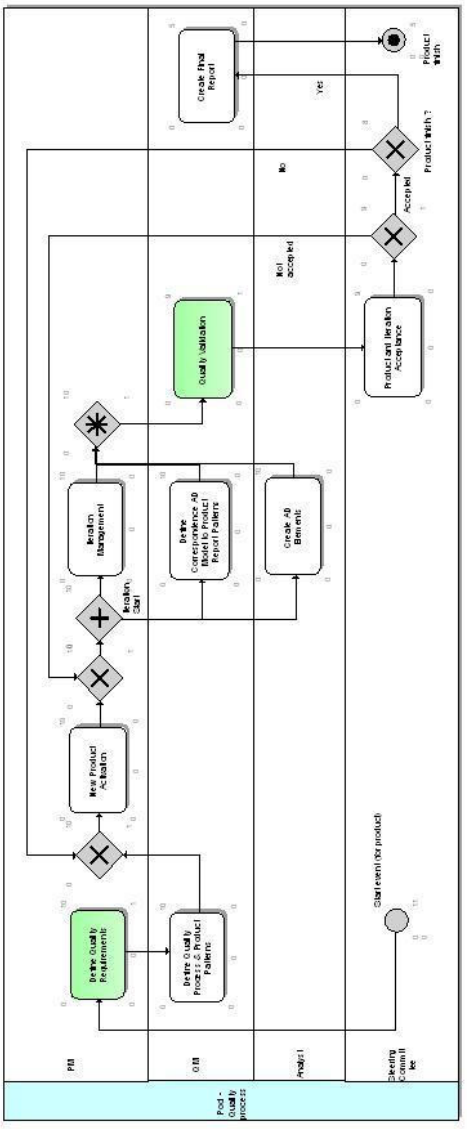

Fig. 5. Final metamodel of processes for the topic "Architecture quality management” for the optimization.

4 Summary

Introduced by the author metamodels for classes and processes concerning quality management in the manufacturing cycle of the software allow you to define the methodology of this process. In this sense it is an extension of ISO standards given in []. The simulation and optimization of the process model can determine the ratio between the duration times of individual elementary processes in the metamodel concerning quality management. Optimal durations of processes eliminates the so-called bottlenecks in the process. The simulation results bring important guidance for managers in the construction process allowing the project plan to build an optimal plan consisting the right proportions between the various stages and between elementary processes in the project and optimal resource allocation. The work is an extension of another author's work [], which involved the construction of a quality management system but without the optimization.

5 Literatura

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METAMODEL ZARZĄDZANIA JAKOŚCIĄ W ARCHITEKTURZE KORPORACYJNEJ

Streszczenie - Artykuł przedstawia metodologię określania, zarządzania, symulacji i optymalizacji jakości architektury korporacyjnej opartą o zdefiniowane przez autora 2 metamodele: klas i procesów w zakresie zarządzania jakością architektury korporacyjnej. Drugi z nich (metamodel procesowy) zarządzania jakością opracowany w BPMN został poddany symulacji i i optymalizacji za pomocą *ARIS Business Proces Simulator.* Wyniki tej symulacji i optymalizacji przedstawiono w artykule. Przedstawiona metoda badawcza opracowana przez autora i jej wyniki wiążą się i są twórczym rozszerzeniem następujących norm ISO:
•Software Engineering — Metamodel for Development Methodologies - ISO/IEC 24744; •Systems and Software Engineering — Software Life Cycle Processes - ISO/IEC 12207; •Systems and software engineering — Architecture description - ISO/IEC 42010; oraz znanych metodologii: [ZACHMAN FRAMEWORK] *A Framework for Information Systems Architecture*. - Zachman, J. A oraz [TOGAF] *The Open Group Architecture Framework*.