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APPLICATION OF KNOWLEDGE AND BEST PRACTICES IN CONFIGURATION OF PROJECT MANAGEMENT INFORMATION SYSTEMS

Summary of Doctoral Thesis

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DECLARATION

I hereby confirm that I have developed this thesis submitted for the doctoral degree at Riga Technical University. This thesis has not been submitted for the doctoral degree at any other university.

Solvita Bērziša ……………………………….
signature

Date: ……………………………….

The doctoral thesis is written in Latvian. It consists of introduction, 5 sections, conclusions, bibliography and 13 appendixes. It includes 47 figures and 27 tables. The thesis is printed on 196 pages. The bibliography comprises 142 entries.

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GENERAL DESCRIPTION OF THE THESIS

Introduction

Project management is application of project execution knowledge, skills, tools and technology to meet project requirements within the constraints of scope, time, quality and cost. Project management is a complex process where information gathering, processing and exchange play an essential role.

Project management information system (PMIS) is an information system consisting of tools and techniques used to gather, integrate, and disseminate outputs of the project management processes. PMIS is one of the most often used project management tools.

PMIS provides a number of functions: 1) generation and evaluation of ideas; 2) planning, controlling and closing of portfolio, program and project; 3) preparation of project reports and collection of knowledge; 4) system administration and configuration. Utilization of these various functions depends upon a particular PMIS application case.

PMIS consists of one or more project management applications (PMA). PMA is an enterprise software application that is designed for automation of project management processes. PMA is yet to be tailored to the needs of specific project or enterprise.

PMA usually provide options of customisation and modification. Modification of PMA using a set of options provided by a software vendor without making modifications at the code level is called application configuration.

The project or enterprise specific PMIS is established by configuring the selected PMA. The configuration process is assisted by using appropriate project management knowledge and PMIS configuration best practices. Project management knowledge is gained through experience, education, observation, or investigation, it is an understanding of processes, practices, techniques or tools usage. Sources of project management knowledge are methodologies and standards as well as empirical experiences from previous projects. Best practices are a combination of techniques, methods, processes or incentives known to be effective in providing a certain outcome.

Research motivation

PMIS is one of enterprise information system, and it is one of prerequisites for successful project management directly affecting the project results [104]. Information quality, usability, functionality, technical and services quality are factors affecting usability and user satisfaction what in turns influences the information system's benefits for individuals, groups and organisations [73]. In the case of project management, the empirical evidence shows that these factors significantly influence user acceptance and perceived usefulness of PMIS [9]. Similarly, information availability and quality in PMIS directly influences project management decision making and decision-making effectiveness [75].

Usability, information quality and functionality are three factors, which can be controlled by: 1) choosing appropriate PMA; and 2) configuring the PMA selected according to the needs of particular projects and enterprises. Methods and models for definition of PMIS functional requirements and selection of appropriate PMA have been actively researched [6], [84].

However, the problem of implementation and configuration of PMIS has received only limited attention in literature. PMA vendors offer guidance for implementation and configuration of their systems, for example, SAP Project Management module or Microsoft

SharePoint based PMIS. The methodology and PMA specific configuration templates are also available, for example, in Team Foundation Server (TFS). TFS has three default configurations: MSF for agile software development, MSF CMMI and Scrum. These configuration templates are developed for one particular PMA without tailoring to a particular project. The existing research and industry developments do not provide a common solution for configuration of PMIS according to requirements of particular projects and enterprises what limits flexibility of the PMIS usage. This shortcoming is emphasized in a study, which conceptually proposes a smart PMIS [70].

Thus, configuration is a powerful and underexplored method for influencing usability and information quality of PMIS. That in turns allows improving project management efficiency, PMIS usage frequency, user acceptance and decision-making quality. In order to configure PMIS efficiently, a number of challenges should be addressed:

1) Each project is unique and has its own requirements that must be supported by PMIS. These requirements can change during the project lifecycle;
2) Configuration of PMIS is done in an ad hoc manner because they are often perceived just as supporting systems;
3) There is no a common approach for describing PMIS configuration;
4) Users of PMIS do not always have sufficient knowledge about configuration options (including knowledge about project management theory, methodologies and best practices, PMA functionality, technical options and configuration details);
5) Configuration of PMIS is a time-consuming process.

To resolve these problems, an approach for configuration of PMIS according to the project requirements is developed in the thesis.

Goal and tasks

The goal of the thesis is to develop the approach for configuration of PMIS that allows to identify the appropriate system configuration for the particular situation and the organisation's methodological requirements and automates the PMIS configuration process. The configuration approach includes:

- The standardized definition of the PMIS configuration requirements;
- Application of best practices and project management knowledge during identification of the appropriate PMIS configuration;
- Automated configuration of PMA.

The following research tasks are defined:

1) To develop a schema for standardized definition of the PMIS configuration requirements;
2) To develop an architecture and methods supporting acquisition and utilisation of project management best practice and knowledge in configuration of PMIS;
3) To analyse automation of the configuration process for selected PMA;
4) To evaluate completeness and efficiency of the PMIS configuration approach.

Research object

The research object is the PMIS configuration process. The research subject is the approach for configuration of PMIS that is based on the standardized definition of the configuration requirements and is assisted by utilization of project management knowledge.

Research methods

The research method is based on theory about implementation of packaged enterprise applications or commercial off-the-shelf software in enterprises. This theory is based on fit-gap analysis between the enterprise needs and capabilities of packaged applications [109]. In the case of gaps the enterprise should change its processes or the packaged application should be modified.

The new artefact 'Approach for PMIS configuration' is developed as the research result of the thesis. Development of the new artefact is carried out according to principles of design research [122]. The need of the configuration approach is justified and development and multi-stage evaluation of the artefact has been carried out in the thesis.

The configuration approach developed could be used for configuration of various enterprise software applications, but a standardized description of the requirements is specific for the project management domain. The thesis is based on an assumption that the project management domain is relatively closed and well-defined, and it is possible to develop the comprehensive conceptual model.

All phases of the traditional information system implementation [61] are covered in the approach. Definition of the initial project management requirements correspond to the requirement elicitation phase. Preparation of the standardized configuration file corresponds to the design phase. Loading of the configuration file in the selected PMA corresponds to the implementation phase. Testing and maintenance phases are not explicitly investigated in the thesis

Knowledge and best practices are used in configuration of PMIS implying that successful experience of the project execution could be reused for successful realisation of the future projects. Case-based reasoning is used for knowledge processing in the thesis.

The schema integration approach is used for development of the comprehensive conceptual model of the project management domain. The schema integration ensures merging of the existing models of the project management domain. For configuration purposes the conceptual model is transformed to the XML schema. The XML based process definition standard XPDL is used to define processes in the XML configuration file.

Empirical and experimental approaches are used for evaluation of the configuration approach. Possibilities of automated PMA configuration are evaluated experimentally. The empirical approach is used for evaluation of completeness of the configuration file and evaluation of effectiveness of the PMIS configuration approach.

Scientific novelty

The scientific novelty of the thesis is:

- A new approach for configuration of PMIS that covers the configuration process from definition of project specific configuration requirements to working PMIS. The approach can be generalized for configuration of other enterprise applications intended for a limited application domain;
- A comprehensive project management conceptual model integrating the existing specialized conceptual models of the project management domain;
- XML schema for Configuration of Project Management information systems (XCPM) that ensures the standardized and structured definition of the PMIS configuration requirements;

- Integration of XPDL with XCPM to ensure definition of dynamic project management elements;
- Architecture supporting project management knowledge acquisition and utilisation for configuration purposes;
- Application of case-based reasoning for generation of PMIS configuration best practice that can be generalized as a generic method for formal elaboration of best practices.

Practical value

The practical contribution of the approach is:

- Decrease of effort needed for PMIS configuration because the approach provides the standardized requirements definition and automated configuration of PMIS;
- Methods for generating knowledge based recommendations for PMIS configuration that help to create an appropriate configuration for the particular project and improve quality of the configuration;
- The configuration approach allows using the same configuration in various PMA that facilitates collaboration between various enterprise working on a single project;
- The configuration approach allows enforcing the same project management practices across organizations required to comply with common rules and allows individual organizations to save efforts needed to set-up their PMIS. An organization, which determines the project management practices to be used, can distribute these in the form of XCPM. Configuration of PMIS according to requirements for funding European Structural Funds projects is an example to this kind of application.
- Repository containing data about empirical information technology projects in Latvia what can be used in other investigations on project management practices.

Approbation

The results of the thesis have been presented at 8 international scientific conferences:

1. RTU 52th International Scientific Conference, Section "Information Technology and Management Science", Riga, Latvia, October 12th–16th, 2011
2. The 15th IEEE International Conference on Intelligent Engineering Systems 2011 (INES 2011). Poprad, Slovakia. June 23th–25th, 2011
3. The 1st International Workshop on Project and Knowledge Management Trends (PKMT 2011). Torre Canne (Br), Italy. June 20th, 2011
4. The 17th International Conference on Information and Software Technologies 2011 (IT 2011). Kaunas, Lithuania. April 27th–29th, 2011
5. The 9th Conference on Databases and Information Systems 2010 (DB&IS 2010). Riga, Latvia. July 5th–7th, 2010
6. RTU 50th International Scientific Conference, Section "Information Technology and Management Science", Riga, Latvia, October 12th–16th, 2009
7. The 13th East-European Conference on Advances in Databases and Information Systems (ADBIS 2009). Riga, Latvia. September 7th–10th, 2009
8. 7th International Scientific and Practical Conference "Environment. Technology. Resources". Rezekne, Latvia. June 25th–27th, 2009

The research results have been published in 11 scientific papers:

1. Bērziša S., Grabis J. Evaluation of Similarity and Reuse of Project Management processes // Scientific Journal of Riga Technical University. – 2011. – Vol.5 – No. 49 – pp. 59–65. (*Versita, EBSCO, ProQuest, VINITI*)
2. Bērziša S., Grabis J. Combining Project Requirements and Knowledge in Configuration of Project Management Information Systems // Second Proceedings: Short Papers, Doctoral Symposium and Workshops of the 12-th International Conference of Product Focused Software Development and Process Improvement, PROFES 2011, Torre Canne, Italy, June 20th–22th, 2011. / Caivano D., Baldassarre M.T., Garcia F.O. et al. – New York, USA: ACM, 2011. – pp. 89–95. (*ACM Digital Library*)
3. Bērziša S., Grabis J. Knowledge Reuse in Configuration of Project Management Information Systems: A Change Management Case Study // Proceedings of the 15th IEEE International Conference on Intelligent Engineering Systems, INES 2011, Poprad, Slovakia, June 23th – 25th, 2011. – Poprad, Slovakia: IEEE, 2011. – pp. 51–56. (*IEEE Xplore, Scopus*)
4. Bērziša S. Project Management Knowledge Retrieval: Project Classification // Environment. Technology. Resources: Proceedings of the 8-th International Scientific and Practical Conference, Volume II. Rezekne, Latvia, June 20th – 22th, 2011. – Rezekne: Rezekne Higher Education Institution, 2011. – pp.10–18.
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6. Bērziša S. XML-based Specification of the Project Management Domain and Its Application // Databases and Information Systems VI. Frontiers in Artificial Intelligence and Applications, Volume 224: [Selected Papers from the 9th International Baltic Conference, DB&IS 2010, Riga, Latvia, July 5th–7th, 2010] / Barzdins J., Kirikova M. – Amsterdam: IOS Press, 2011, – pp. 213 –226. (*ACM Digital Library*).
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8. Bērziša S. The Baseline Configuration of Project Management Information System // Scientific Journal of Riga Technical University. – 2009. – Vol.5 – No. 40 – pp. 59-65. (*Versita, EBSCO, ProQuest, VINITI*)
9. Bērziša S. Towards an XML Scheme for Configuration of Project Management Information Systems: Conceptual Modelling // Advances in Databases and Information Systems Associated Workshops and Doctoral Consortium of the 13th East European Conference, ADBIS 2009, Riga, Latvia, September 7–10, 2009. LNCS vol. 5968. / Grundspenkis J., Kirikova M., Manopoulos Y., Novickis L. – New York: Springer, 2009 – pp. 229-237. (*ACM Digital Library, Scopus, ACM Digital Library*).
10. Bērziša S. Definition and Formal Representation of the Project Management Processes // Environment. Technology. Resources: Proceedings of the 8-th

International Scientific and Practical Conference, Volume II, Rezekne, Latvia, June 25th–27th, 2009. – Rezekne: Rezekne Higher Education Institution, 2009. – pp. 154–161.
11. Bērziša S., Grabis J. An Approach for Implementation of Project Management Information Systems // Information Systems Development: Towards a Service Provision Society: [Proceedings of the 17th International Conference on Information Systems Development (ISD2008), Paphos, Cyprus, 25-27 August 2008] / Papodopoulos G.A., Wojtkowski G., Wojtkowski W. et al.. – New York: Springer, 2009. – pp. 423–431. (*SpringerLink, Scopus*)

The results of the thesis have been used in the following research projects:
1. IZM-RTU scientific project R. 7392 „Development of Solutions for Dynamic Adjustment of Enterprise Applications" (2008).
2. Latvian Council of Science research grant No. 09.1564 „Simulation and computational intelligence methods for logistics and e-business optimization" (2010-2012).

Structure of the thesis

The doctoral thesis consists of introduction, 5 chapters, results and conclusions, bibliography and 13 appendixes. The doctoral thesis is written in Latvian.

Introduction explains PMIS concept and research motivation, formulates the research aim and tasks, defines the research object and subject, describes research methods, explains scientific novelty, practical importance and approbation.

Chapter 1 "Approach for configuration of project management information systems" discusses problems of PMIS configuration, presents the approach for configuration of PMIS developed in the thesis and describes usage scenarios. It also discusses the related research.

Chapter 2 "Schema for definition of configuration requirements" elaborates the XML schema for definition of requirements for PMIS configuration (XCPM) and presents the detailed schema elaboration process. This process includes elaboration of the project management conceptual model and its use in creation of the schema.

Chapter 3 "Application of knowledge in configuration of PMIS" presents conceptual system architecture supporting utilization of knowledge and best practices in configuring of PMIS. This architecture supports knowledge acquisition, retrieval and processing activities.

Chapter 4 "Configuration of PMIS" demonstrates and evaluates use of the XCPM schema in automated configuration of different PMA.

Chapter 5 "Evaluation of the configuration approach" describes the process and results of evaluation of the PMIS configuration approach. The evaluation process is performed in two phases. The quality of the standardised definition of configuration requirements is evaluated in the first phase by defining the configuration requirements of the real-life projects. Impact of knowledge utilization on quality of the configuration is evaluated in the second phase by comparing efficiency of the knowledge based configuration with efficiency of configurations used in real-life projects.

Results, conclusions and further research directions are discussed in last chapter.

The bibliography comprises 142 entries, and there are 13 appendixes.

1. APPROACH FOR CONFIGURATION OF PROJECT MANAGEMENT INFORMATION SYSTEMS

Description of the approach

In order to solve the configuration problems, an approach for configuration of PMIS is developed in the thesis (author publication [23]). It includes an end-to-end PMIS configuration process from definition of the project specific requirements for PMIS to the working PMIS as well as methods and tools supporting the process. Main activities of the configuration process are shown in Figure 1.1. The process starts with definition of requirements R_j for project j. These requirements are informal and include description of project environment, methodologies, standards and other information. Analysis, supplementation and transformation of these requirements are performed during the configuration process. The result is an executable PMIS configuration I_j^k, where k refers to the particular PMA selected for implementation of PMIS. The configuration process includes two main transformations:

1) Transformation T_1 transforms initial informal requirements R_j in the standardized form according to data schema S. The result is a standardized configuration file C_j:
$$C_j = T_1(R_j, S)$$
This transformation is performed manually using the configuration client and information from the knowledge repository. The configuration client provides a user interface for definition of the requirements according to data schema S and representation of knowledge. Data schema S provides the structure for definition of the PMIS requirements that includes both data and processes.
2) Transformation T_2^k transforms configuration file C_j in PMIS configuration I_j^k:
$$I_j^k = T_2^k(C_j)$$
Each PMA k has its own transformation T_2^k. One configuration file C_j can be transformed to the various PMIS configurations I_j^k by using different transformations T_2^k.

The approach for configuration of PMIS is used for various purposes from simple configuration of stand-alone PMIS to imposing standardized PMIS configurations across enterprises. The approach is primarily used for set-up of the new project environment or implementation of PMA but it also can be used for modification or extension of the existing PMIS configuration.

Related research

Related investigations are reviewed and analysed to establish foundations for development of the configuration approach. These investigations have been used, evaluated or extended to achieve the thesis's objectives.

Implementation and configuration of PMIS is similar to configuration of other enterprise systems or COTS systems. PMIS is mostly related to workflow systems, but it is specifically tailored to the project management domain while general purpose workflow systems are domain independent. Two approaches frequently used in configuration of enterprise and workflow systems are: business process model based configuration and XML files based configuration. The XML files based configuration is used for PMIS.

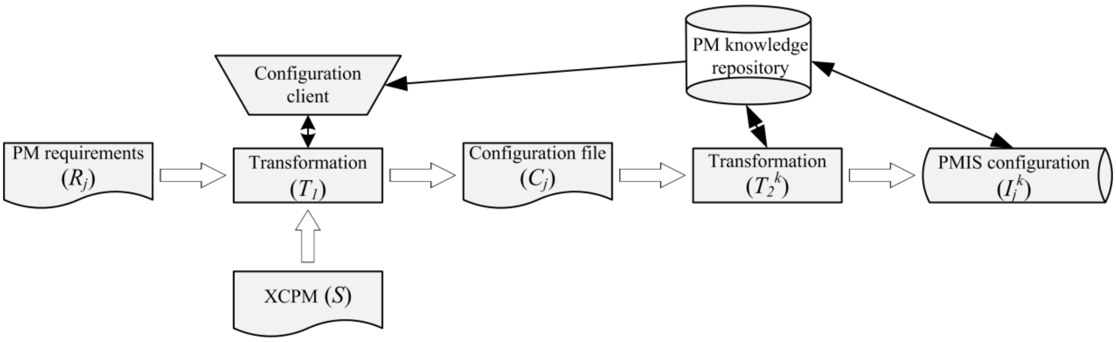

Figure 1.1. PMIS configuration approach

Definition of the PMIS requirements in the existing investigations has been addressed from the perspective of system development. For these purposes, a reference model Ref-Mod^{PM} and a requirement analysis method have been developed. Ref-Mod^{PM} describes functionality of PMIS, but the requirements analysis method formalizes the process of requirement definition. To the best of our knowledge, there are no previous studies on configuration or adaption of PMIS to needs of the particular project. The setup and configuration problem has been studied only in the technical documentation of particular PMA.

Existing conceptualisations and descriptions of the project management domain have been used in elaboration of the data schema S for defining the configuration requirements. These include ontologies, methodologies and standards and XML schemas. The ontologies used in the project management domain are PROMONT, PMO, project metric ontology, building project team ontology, scientific program project plan ontology, scientific project ontology and business project management ontology (BProjM). The project management methodologies are general (PMBOK, PRINCE2 and Scrum) and domain-specific (RUP and MSF). PMA used XML schemas for project data exchange are PMXML and MS Project XML.

An important part of the configuration approach is usage of knowledge / best practice. That is enabled by utilizing knowledge-based system, knowledge repository and case-based reasoning as an interference engine. In the context of project management, knowledge management also has been extensively used in a number of related investigations. However, these investigations primarily focus on project planning and effort estimation tasks. In order to identify similar cases for the case-based reasoning, existing process similarity evaluation methods are adopted.

2. SCHEMA FOR DEFINITION OF CONFIGURATION REQUIREMENTS

The approach for configuration of PMIS is based on the data schema S for standardized definition of requirements. The schema is defined as an XML schema and is referred as to XCPM (XML schema for Configuration of Project Management information systems). The XCPM schema should be comprehensive enough so that requirements of various projects and project management situation can be specified. To ensure that, the XCPM schema is elaborated according to the comprehensive project management conceptual model (PMCM). This conceptual model is obtained by integration of various existing conceptualisation of the project management domain. The process of XCPM schema elaboration is shown in Figure 2.1.

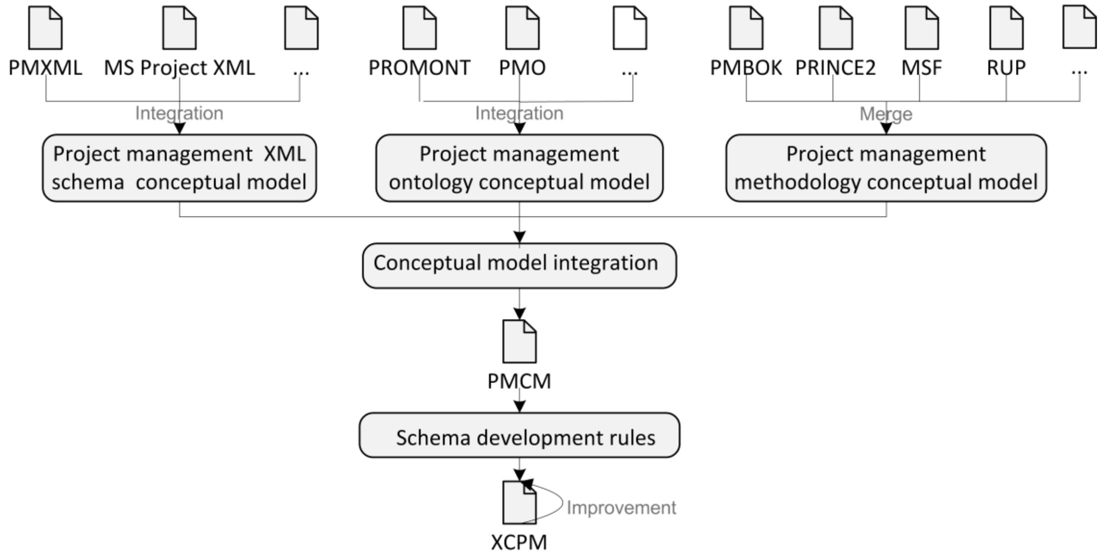

Figure 2.1. XCPM elaboration process

Project management conceptual model

PMCM [30] describes concepts and their relations defining the project management domain. Principles of data base and XML schema integration are used to obtain PMCM. Pairs of the existing or intermediate conceptual models are integrated together as described in Table 2.1. The general models integration procedure consists of four phases: pre-integration, conforming, merging and restructuring (Figure 2.2).

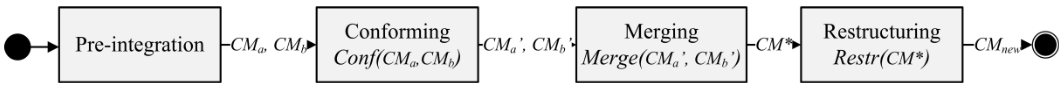

Figure 2.2. Conceptual model integration algorithm

During the pre-integration phase, the exiting conceptual models (*CM*) are analysed. These models are transformed to one chosen notation and, the order of integration is defined.

Conflict detection and resolution between models CM_a and CM_b are performed in the conforming phase. Two conformed models CM_a' and CM_b' are obtained as the result:

$$Conf(CM_a, CM_b) \rightarrow CM_a', CM_b'$$

The conflict between two models occurs if the same real-life situations are represented differently in each of the models. Common types of the conflicts are naming and semantic.

During the merging phase, both conformed models (CM_a' and CM_b') are merged into one model:

$$Merge\ (CM_a', CM_b') \rightarrow CM^*$$

The merged model (CM^*) is improved in the restructuring phase. The new integrated and improved model (CM_{new}) is obtained:

$$Restr\ (CM^*) \rightarrow CM_{new}$$

Table 2.1

Process of PMCM elaboration

Stage	Input	Activities	Output
1.	CM_{PMXML} CM_{MS_Proj}	Step 1.: Conforming $Conf(CM_{PMXML}, CM_{MS\_Proj}) \rightarrow CM'_{PMXML}, CM'_{MS\_Proj}$ Step 2.: Merging $Merge\ (CM'_{PMXML}, CM'_{MS\_Proj}) \rightarrow \mathbf{CM_{PM\_XML\_Schema}}$	$CM_{PM\_XML\_Schema}$
2.	$CM_{PROMONT}$ CM_{PMO} CM_{Pr_metric} CM_{Pr_kom} CM_{Plan_ont} CM_{Sc_proj} CM_{BProjM}	Step 1.: Conforming $Conf(CM_{PROMONT}, CM_{PMO}) \rightarrow CM'_{PROMONT}, CM'_{PMO}$ Step 2.: Merging $Merge\ (CM'_{PROMONT}, CM'_{PMO}) \rightarrow CM_1$ Step 3.: Conforming $Conf(CM_1, CM_{Pr\_metric}) \rightarrow CM'_1, CM'_{Pr\_metric}$ Step 4.: Merging $Merge\ (CM'_1, CM'_{Pr\_metric}) \rightarrow CM_2$ Step 5.: Conforming $Conf(CM_2, CM_{Pr\_kom}) \rightarrow CM'_2, CM'_{Pr\_kom}$ Step 6.: Merging $Merge\ (CM'_2, CM'_{Pr\_kom}) \rightarrow CM_3$ Step 7.: Conforming $Conf(CM_3, CM_{Plan\_ont}) \rightarrow CM'_3, CM'_{Plan\_ont}$ Step 8.: Merging $Merge\ (CM'_3, CM'_{Plan\_ont}) \rightarrow CM_4$ Step 9.: Conforming $Conf(CM_4, CM_{Sc\_proj}) \rightarrow CM'_4, CM'_{Sc\_proj}$ Step 10.: Merging $Merge\ (CM'_4, CM'_{Sc\_proj}) \rightarrow CM_5$ Step 11.: Conforming $Conf(CM_5, CM_{BProjM}) \rightarrow CM'_5, CM'_{BProjM}$ Step 12.: Merging $Merge\ (CM'_5, CM'_{BProjM}) \rightarrow \mathbf{CM_{PM\_Ontology}}$	$CM_{PM\_Ontology}$
3.	PMBOK PRINCE2 RUP MSF Scrum	Step 1.: Summarize the concepts defined in the dictionaries of various metodologies Step 2.: Resolve naming conflicts Step 3.: Identify the relationships between these concepts Step 4.:Elaborate $\mathbf{CM_{PM\_Methodology}}$	$CM_{PM\_Methodology}$
4.	$CM_{PM\_XML\_Schema}$ $CM_{PM\_Ontology}$ $CM_{PM\_Methodology}$	Step 1.: Conforming $Conf(CM_{PM\_XML\_Schema}, CM_{PM\_Ontology}) \rightarrow CM'_{PM\_XML\_Schema}, CM'_{PM\_Ontology}$ Step 2.: Merging $Merge\ (CM'_{PM\_XML\_Schema}, CM'_{PM\_Ontology}) \rightarrow CM_A$ Step 3.: Conforming $Conf(CM_A, CM_{PM\_Methodology}) \rightarrow CM'_A, CM'_{PM\_Methodology}$ Step 4.:Merging $Merge\ \left(CM'_A, CM'_{PM_{Methodology}}\right) \rightarrow CM_B$ Step 5.: Technical restructuring $Restr^T\ (CM_B) \rightarrow CM_C$ Step 6.: Knowledge based restructuring $Restr^K\ (CM_C) \rightarrow \mathbf{CM_{PMCM}}$	CM_{PMCM}

Restructuring includes both technical restructuring ($Restr^T$) through the restructuring transformation, and knowledge-based restructuring ($Restr^K$) by using expert knowledge about the domain.

The resulting conceptual model CM_{PMCM} simply referred as to PMCM includes main concepts and relations from the project management domain. This model consists of 116 entities/concepts and 276 relationships. The concepts in PMCM are grouped in 29 groups, and they describe either data or processes. The central entity of the model is "*Project*" and other entities are directly or transitionally related with "*Project*".

XML schema for configuration of PMIS

XCPM [32] is developed using information that have been collected in PMCM. The XML schema is defined using XML schema definition language XSD. Data entities in PMCM are represented by XML schema elements. Definition of the configuration requirements must include the following information:

1) Data entities used in project;
2) Attributes of each data entity;
3) Processes related to the data entities.

The first version of the XCPM schema is developed using information in PMCM and development rules and then the schema is improved iteratively (Figure 2.3).

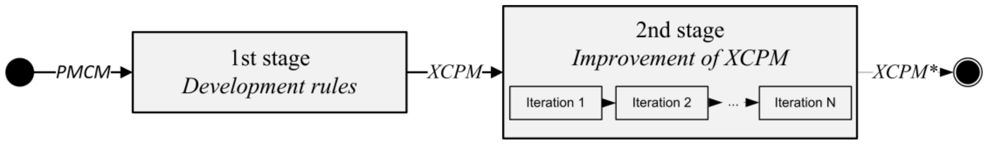

Figure 2.3. Stages of XCPM schema development

The following development rules are used in the first stage:

- XCPM schema main element is „*Project*" and top-level elements are entities in PMCM, which are directly related to the „*Project*" entity;
- Relations between elements are organised either as links or sub-elements;
- Definition of the abstract element must be supported;
- Entities having the similar type can be described with one element;
- Processes and their relations with data items are described with elements „*Process*" and „*ProjectLifeCycle*";
- An XCPM based XML document must support storage of both configuration and data.

Activities of improvement and supplementation in the second stage are performed based on followings conditions:

- Shortcomings in the schema elements or organisation are detected in experiments;
- New elements for the definition of the PMIS configuration are required;
- Schema optimisation is required.

The result of the improvement activities is a better structured XML schema.

The final version of the XCPM schema after the development stage and two iterations is given in Figure 2.4. The figure shows the main elements of the schema. The structure of the XCPM schema ensures definition of the various data entities both the predefined and custom („*OtherElement"*). Only a few default attributes and parameters are defined in the schema, other attributes and parameters can be defined for the specific configuration case using „*AttributeList”* attribute.

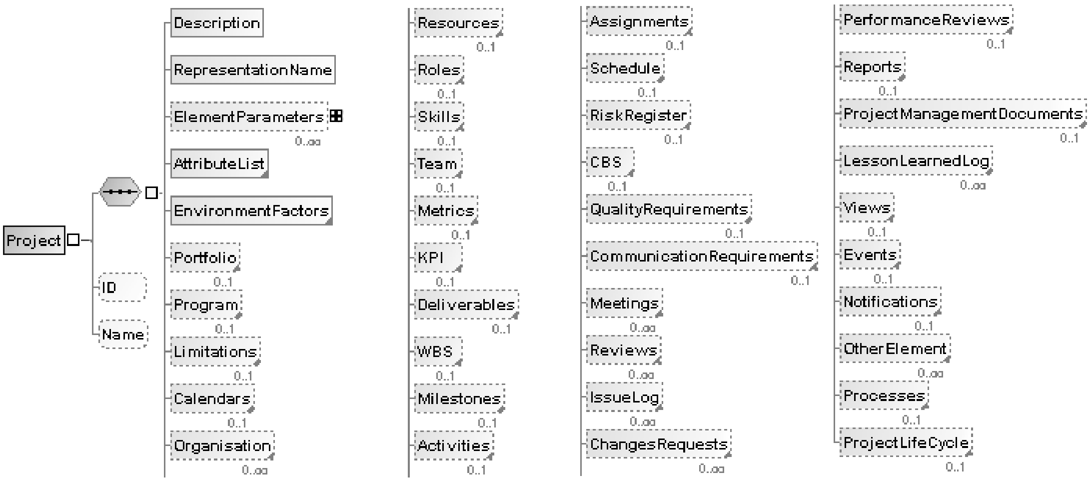

Figure 2.4. Main elements of XCPM schema

Structure of data items is described and data are stored using the descriptive elements. Each element includes the set of sub-elements describing the data entities used in the project (Figure 2.5). These sub-elements are representation name, description, other parameters („*ElementParameters”*), attributes of element records („*Attribute”*) and the set of sub-elements for data storage (*„Records”*).

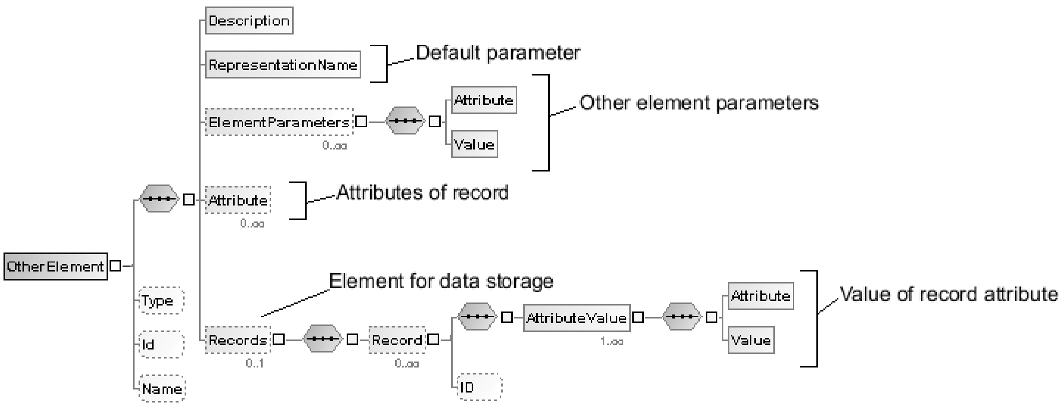

Figure 2.5. Main sub-elements of the data entity in XCPM schema

The elements „*Processes”* and „*ProjectLifeCycle”* define the project management processes. All processes are described in the „*Processes”* element that includes the process description according the XPDL 2.1 structure. Interactions among individual processes are defined with the project lifecycle „*ProjectLifeCycle*” element.

3. APPLICATION OF KNOWLEDGE IN CONFIGURATION OF PMIS

In order to obtain a good PMIS configuration, knowledge and best practices gathered from previous similar projects are used. In order to support knowledge retrieval, acquisition and utilization, the conceptual architecture of the knowledge-based PMIS configuration system is elaborated in the thesis (Figure 3.1) [27]. This system is based on principles of case-based reasoning. The cases in the configuration of PMIS are 1) configuration files, which previously have been used for configuration of PMIS (C_j, $j=1,\dots, m$) and 2) theoretical knowledge, which is contained in project management methodologies, standards and best practices (H_i, $i=1,\dots, p$). The cases are stored in the project management knowledge repository.

Access to knowledge is provided by the configuration client consisting of three modules:

1. The new case description module is used to input project attributes A_{j+1} categorizing new case $j+1$.
2. The information retrieval module ensures retrieval of similar cases according to the specified search knowledge area M_s and descriptions of case similarity L_k. The search returns the sets of similar theoretical cases $\mathbf{H_{j+1,s}}$' and empirical cases $\mathbf{C_{j+1,s}}$' .
3. The information processing and display module processed the similar cases retrieved and displays knowledge to configuration specialist.

A new case is added to the knowledge repository once the new configuration file C_{j+1} has been used for configuration of PMIS.

The architecture supports two main knowledge management sub-processes: 1) knowledge acquisition; and 2) knowledge utilization.

Knowledge acquisition

The knowledge repository consists of the library and the case register. The library collects data about previous cases, which are defined as XCPM files. It contains theoretical cases, empirical cases as well as unstructured knowledge $\mathbf{D} = \{D_l | l=1,\dots, s\}$. Unstructured knowledge is in various formats e.g. diagrams, templates, documents and other information.

The case register collects information that is needed for knowledge organisation, search and retrieval. It stores:

- Project classification characteristics and their values: $A_j = (a_1, \dots, a_n)$. The characteristics are project type, product, size, organisation and others;
- Case descriptions $\mathbf{P^H} = \{P_t^H | t=1,\dots, x\}$ and $\mathbf{P^C} = \{P_t^C | t=1,\dots, y\}$, which are a tuple of project classification characteristics and the associated case stored in the library, i.e., $P_t^H=(A_i, H_i')$ and $P_t^C=(A_j, C_j')$ for theoretical and empirical cases, respectively;
- Descriptions of case similarity $\mathbf{L} = \{L_k | k=1,\dots, z\}$, where $L_k=(M_k, B_k, X_k)$, $k=1,\dots,n$. The similarity measurements $X_k=(x_1, \dots, x_n)$ identifies the project classification characteristics, which will be used for the case search in a particular situation. More specifically $x_i=1$ if the characteristic is relevant in the particular PMIS configuration situation, and $x_i=0$ if the characteristic is not relevant. The use of the similarity measurements depends of two parameters. The first is the knowledge search area M_k, specifying a project management knowledge sub-area of interest, e.g. risk register, change management, documents etc. The second is knowledge type B_k, that distinguishes between theoretical and empirical knowledge.

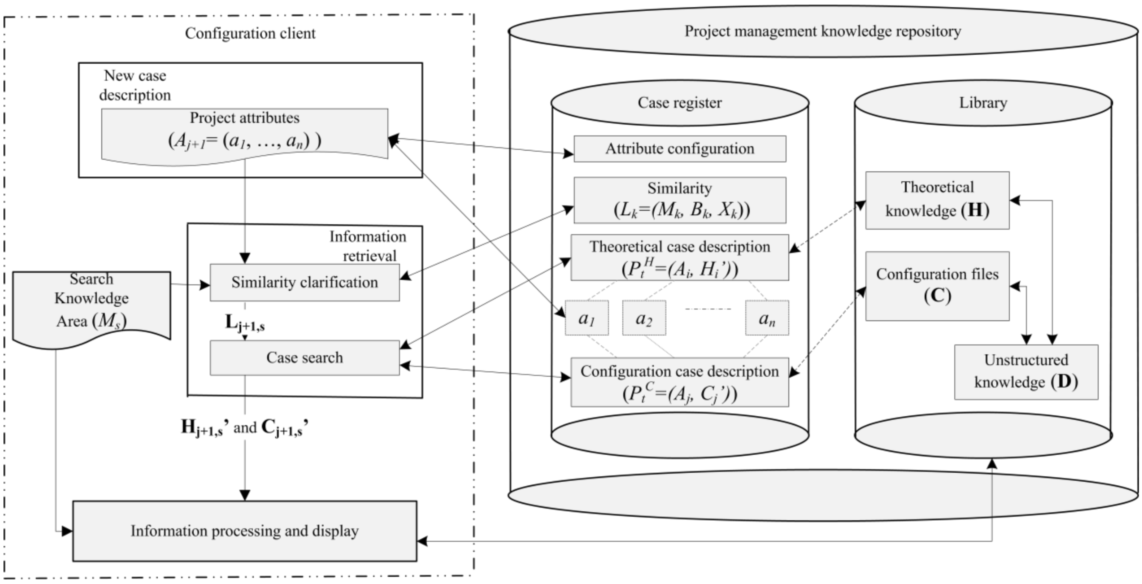

Figure 3.1. Knowledge based PMIS configuration architecture

The knowledge repository is populated following the knowledge acquisitions process as shown in Figure 3.2.

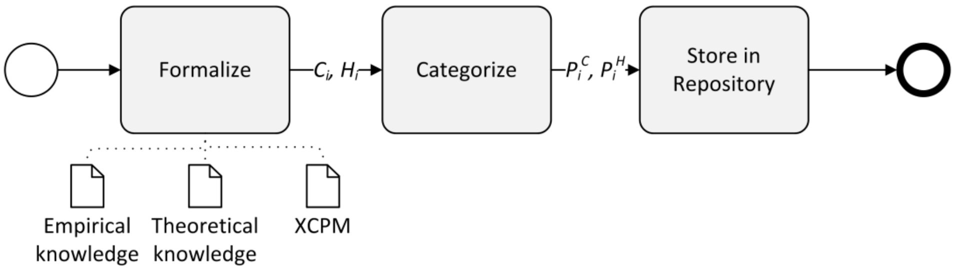

Figure 3.2. Knowledge acquisition process

Knowledge utilisation

The result of knowledge utilisation is recommendations and best practice for configuring PMIS for the particular project. These recommendations and best practices are derived by analysing similar cases stored in the repository.

The information retrieval module identifies similar cases according to the new project characteristics A_{j+1} and knowledge search area M_s, $s = 1,...,v$. That yields two sets of the similar cases $\mathbf{H_{j+1,s}}$' and $\mathbf{C_{j+1,s}}$'. The information retrieval process consists of two steps:

1. *step:* Similarity clarification. Appropriate descriptions of case similarity L_k are searched in set $\mathbf{L}$ according to the knowledge search area M_s:

$$\mathbf{L_{j+1,s}} = \{L_k | \, L_k \in L \text{ and } M_k = M_s \text{ and } k = 1, \dots, n\}$$

2. *step:* Search of similar cases. Using the similarity measurements X_k from the subset $\mathbf{L_{j+1,s}}$, similar cases are searched in case descriptions $\mathbf{P^H}$ and $\mathbf{P^C}$. The case search is performed in two stages:

2.1. Search in the set of the theoretical case $\mathbf{P^H}$ is performed according to each $L_k \in L_{j+1,s}$, where $B_k = H$. The set of case identifier $\mathbf{H_{j+1,s}}$'=$\{H'_z | H'_z \in P_z^H\}$ is retrieved, where attribute values a_{iz} are equal to new case attribute values a_{ij+1} of those attributes that similarity measurement x_i=1: $\sum_{i=1}^{n}(x_i | x_i \in$ *Xk* and *Xk∈Lk*= *i=1n(xixi∈Xk* and *Xk∈Lk* ∗ *(1* if *∃((aiz|aiz∈Az* and $A_z \in P_z^H) = (a_{ij+1} | a_{ij+1} \in A_{j+1}))$;

2.2. Search in the set of the empirical case $\mathbf{P^C}$ is performed according to each $L_k \in L_{j+1,s}$, where $B_k = C$. The set of case identifier $\mathbf{C_{j+1,s}}$'=$\{C'_z | C'_z \in P_z^C\}$ is retrieved, where attribute values a_{iz} are equal to new case attribute values a_{ij+1} of those attributes that similarity measurement x_i=1: $\sum_{i=1}^{n}(x_i | x_i \in X_k$ and $X_k \in L_k)$ = $\sum_{i=1}^{n}(x_i | x_i \in X_k$ and $X_k \in L_k)$ ∗ (1 if $\exists((a_{iz} | a_{iz} \in A_z$ and $A_z \in P_z^C) = (a_{ij+1} | a_{ij+1} \in A_{j+1}$

If the knowledge search area M_s is changed, the information retrieval must be repeated from the beginning because the similarity measurement could be changed.

The information processing and display module processes the retrieved similar cases and displays the processing results in the form of PMIS configuration recommendations. The information retrieved for processing includes data describing both data entities and processes. This information is processed in four stages:

1. stage: identification and processing of data entities used in the knowledge search area M_s. A simple data analysis method is used for this purpose;
2. stage: identification and processing of attributes of the data entities using the simple data analysis method;
3. stage: identification and processing of processes associated with the selected data entity. A process data analysis method is used for this purpose;
4. stage: analysis of data content of the selected data entity using the simple data analysis method.

The result of each stage is displayed to a configuration specialist in a form of recommendations suggesting which data entities, attributes and associated processes to include in PMIS configuration. The configuration specialist chooses items deemed appropriate for the particular project. The number of choices is narrowed from stage to stage (e.g., if the data entity is not selected for inclusion in the PMIS configuration, all associated processes are also excluded).

The simple data analysis method processes an input set of records $\mathbf{R} = \{r_i, i=1..d\}$ (Figure 3.3) where records are names of data entities, attributes, statuses or other information elements.

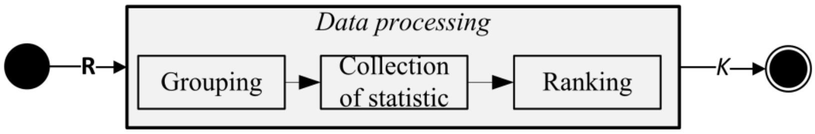

Figure 3.3. Algorithm of the simple data analysis method

The groups of identical records are created during the grouping. The records are assumed to be identical if one of the following conditions is satisfied:

- Two records have the same name ($r_a = r_b$, where $r_a, r_b \in \mathbf{R}$);

- Records names are synonymous ($syn(r_a, r_b) = 1$, where $r_a, r_b \in \mathbf{R}$). Synonyms are stored in the synonym dictionary, and they are classified according to their type (e.g., data entity, attribute, process status).

Collection of statistics determines size of each group in the set of records **R**. Ranking sorts the identified groups in a descending order and assigns a rank starting with the largest group. The highest ranked groups refer to the most appropriate configuration elements.

The process data analysis method [25] ensures processing of the input set of processes **Pr** = $\{pr_i,\ i=1...e\}$ (processes are defined with XPDL). The method algorithm consists of three stages (Figure 3.4).

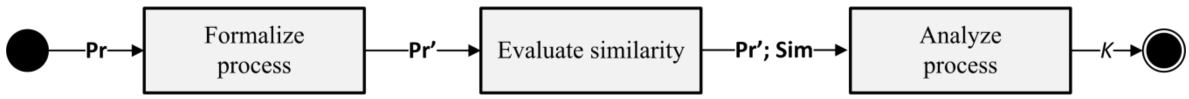

Figure 3.4. Algorithm of the process data analysis method

The processes initially are represented as either activity-centric or object-centric. Similarity evaluation is performed with object-centric process representations. Therefore, process representation formalization **Pr'**=*F*(**Pr**) transforms all activity-centric processes to object-centric processes.

The process similarity evaluation identifies processes that can be considered to be similar, i.e., their similarity score is greater than or equal to a specified similarity threshold sim_{lim}. The semantic similarity metric is used to measure process similarity. The similarity score for two processes $sim(pr_i, pr_k)$ (where pr_i, $pr_k \in$ **Pr'**) is calculated using Formula 3.1. Calculations depends on the activity similarity $sim(a_{i,s}, a_{k,t})$ that is calculated with Formula 3.2.

$$sim(pr_i, pr_k) = \frac{\sum_{s=1}^{x} max\left(\forall_{t=1}^{y}\ a_{k,t} | sem(a_{i,s}, a_{k,t})\right)}{N}, \quad (3.1.)$$

where

x is the count of activities in pr_i;
y is the count of activities in pr_k;
$sem(a_{i,s}, a_{k,t})$ is similarity of activities (Formula 3.2.);
$N = max(x,y)$.

$$sem(a_{i,s}, a_{k,t}) = \begin{cases} 1, ja\ a_{i,s} = a_{k,t} \\ 1, ja\ syn(a_{i,s}, a_{k,t}) = 1 \\ \frac{|(a_{i,s} \cap a_{k,t})| + \sum_{\substack{c \in a_{i,s}/a_{k,t} \\ b \in a_{k,t}/a_{i,s}}} syn(c,b)}{max(|a_{i,s}|, |a_{k,t}|)} \end{cases}, \quad (3.2)$$

where

$a_{i,s} \in pr_i$ (i process s activity);
$a_{k,t} \in pr_j$ (k process t activity);
$syn(c,b) = \begin{cases} 1, if\ c \text{ and } b \text{ is synonym} \\ 0, if\ c \text{ and } b \text{ is not synonym} \end{cases}$.

The similarity evaluation is performed for each pair of processes in **Pr'.** The result is a two-dimensional matrix ***M****[z,z]* with the process similarity scores, where z is the number of process in **Pr'**. The similar process group consists of the processes whose mutual similarity is greater than or equal to sim_{lim}. The set **Sim** consists of identified subsets of the similar processes.

The process analysis is performed in the each similar process subset from **Sim** using the simple data analysis method that collects information about activities and transaction used in the processes. The result of process data analysis is subsets of similar processes and information about processes' statuses and transactions.

Figure 3.5 summarizes the knowledge utilization process. The process starts with a new project case j+1. Environment characteristics are defined and PMIS configuration requirements are formulated for the new project. Similar cases are searched in the knowledge repository by comparing their characteristics with those of the new project. Analysis of the similar cases is performed using both data and process analysis methods. The configuration specialist uses the knowledge and the requirements to prepare the configuration file.

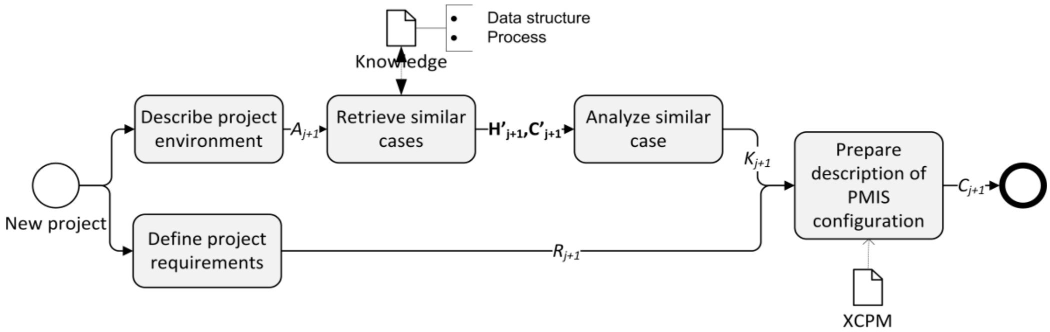

Figure 3.5. Knowledge utilization process

4. CONFIGURATION OF PMIS

PMIS provides functionality supporting different project management uses-cases. These use-cases are: project planning and controlling, resource management, quality management, risk management, change management, communication management, reporting, procurements, configuration management, management documents, project processes, initiation, project knowledge, team collaboration and personal information [29]. All PMA do not have functionality for all this use-cases, and they have different approaches to organisation and processing of information. An application specific transformation T_2^k is defined for every PMA, and implementation details of this transformation depend upon characteristics of PMA

Regardless of PMA selected, transformation T_2^k includes the following activities:

1) Analysis of the elements included in configuration file C_{j+1} to determine whether the selected k PMA provides appropriate functionality;
2) Mapping of C_{j+1} elements to data structures supported by k PMA;
3) Analysis of information already stored in k PMA using the synonym dictionary and evaluation of information reuse in the new configuration;
4) Loading of the configuration in k PMA.

The transformation T_2^k should be defined for every particular PMA and it can be reused every time a new configuration for k PMA is required. Capabilities and limitations of automated configuration are evaluated by implementing the transformations T_2^k for three PMA: MS Project Server, Team Foundation Server (TFS) and JIRA [26].

MS Project Server configuration activities are divided in two groups:

1) MS Project Server configuration (information about projects, its tasks, resources and various reports). Automation of these configuration activities is limited because it impacts all projects.
2) MS Project Server (MS SharePoint) project web site configuration. MS SharePoint site templates and definitions are used for creating a project site in MS Project Server. The site template and definitions are described with the set of XML files located in the file system of MS Project Server. During the automatic configuration the new template is created by performing the transformation T_2^{MPS} between the configuration file and the MS Project Server template XML files.

Lists for storing projects data, their data fields, workflows, permissions, notifications, server parameters, resources, skills and reports can be configured in MS Project Server.

Team Foundation Server (TFS) uses process templates for configuration of the project environment. These templates technically consist of the set of XML files. In order to automate TSF configuration according to the project requirements, transformation T_2^{TFS} between the XCPM configuration file and the process template XML files is implemented.

TFS supports configuration of types of work items, their fields and layout, workflows, classification, queries, reports, work item relations, configuration of SharePoint portal and other parameters.

Project task management system JIRA provides an advanced configuration interface that allows definition of configuration associated with one or many projects. Importing and exporting options of the configuration data are limited and are available only for workflows. In order to automate JIRA configuration, transformation T_2^{JIRA} includes direct modification of its database using data provided by the XCPM configuration file and only processes can be transformed into the JIRA workflow XML schema and imported in JIRA using the workflow importer.

JIRA supports configuration of project information, classifications, types of work items, it fields and layouts in different modes, workflow statuses, transactions and it screen, user roles and permissions, notifications, work item relations, filters and dashboards and other parameters.

Almost all XCPM schema elements can be mapped to structures used in evaluated PMA (in some cases PMA extensions are needed). Data layout, different accesses modes (e.g., read/write) and user permissions, which are usually considered in PMA, are not described in XCPM schema.

5. EVALUATION OF THE CONFIGURATION APPROACH

Evolution of the approach for configuration of PMIS validates:

1) Completeness of the XCPM schema;
2) Efficiency of the knowledge assisted configuration of PMIS;
3) Automation possibilities of configuration of the selected PMA.

The automation possibilities were explored in Chapter 4. Completeness and efficiency are evaluated in this chapter.

Completeness validation

In order to validate completeness of XCPM, 49 cases have been collected and stored in the knowledge repository following the knowledge acquisition process. That implies creating XCPM based configuration files for all of these cases. The cases include 12 theoretical and 37 empirical cases. They are focused on describing the change management area of project management. Theoretical knowledge is acquired from methodologies, best practices and default configurations provided by PMA developers. Empirical knowledge is derived from real-life information technology projects. Given that it was possible to define all these cases using XCPM, it can be concluded that structurally the schema is suitable for defining different configuration requirements.

One of 37 empirical cases referred as to project P2 is defined completely to cover all areas of projects management. The project P2 data and processes are described according to the schema structure. The configuration requirements are collected from the project management plan, project quality assurance plan, existing PMIS (JIRA and Confluence) and best practices.

The configurations file C_2 of the project P2 consists of 38 descriptive elements, where 7 are custom elements specified using the "*OtherElement*" element. Nine knowledge areas are defined in C_2. Elements representing calendars, material resources, key performance indicators ("*KPI"*), contracts ("*CBS"*) and lessons learned are not used to define configuration for P2.

Efficiency evaluation

An empirical outsourcing software development project for the government institution (referenced as P3) is used for analysis and evaluation of benefit from knowledge assisted configuration. This analysis is limited to the change management area. In the project P3, the default configuration of organisation's PMIS I_{eks} is used for task and change management. Five data entities are included in I_{eks} (Figure 5.1). Attributes of the data entities and statuses of the processes are specific for each data entity.

The proposed configuration I_3 for the PMIS change management module is elaborated following the knowledge utilisation process. Relevant data entities, their attributes and associated processes are identified from the similar cases in the knowledge repository.

The following parameters of the knowledge utilisation process are set:

- The data entities and their attributes are included in the PMIS configuration if they occur in at least 30% of similar cases;
- The process similarity threshold is 0,70;
- The process status is included in the PMIS configuration if it occurs in at least 25% of similar cases or the process status is in the similar process group that incorporates 40% of the analysed processes.

The similar cases in the knowledge repository are searched according to the characteristics of project P3. These characteristics are:

- Activity, product and project lifecycle for empirical cases;
- Project lifecycle for theoretical cases.

The search for similar cases for project P3 results in ten similar empirical cases and eight relevant theoretical cases: PMBOK, PRINCE2, MSF-CMMI, RUP, best practices [17] and [36], VSTFS MSF-CMMI and JIRA default configuration.

Data entities used in the project change management are identified from these eighteen similar cases. The most frequently observed data entities are change request (83%), task (67%), problem (56%) and bug (33%). Giving the threshold of 30%, the configuration of project P3 I_3 includes data entities: "*Change request*", "*Task*", "*Issue*" and *"Bug"*.

For each data entity, the list of attributes is created by analysing attributes used for this data entity in the similar cases. New configuration I_3 includes the attributes with occurrence frequency greater than 30%. The resulting lists of the attributes are similar for all four data entities.

Similarly, processes or workflows of each data entity are identified by analysing process similarity among the similar cases. That allows identification of process statuses and transaction used in similar cases. In the case of project P3, all incoming processes have object-centric representations, and formalisation of the processes is not needed. The synonym status values collected in the synonym dictionary are used during the process comparison. As the results, each data entity has its own associated process with following statuses:

- Change request: *„Closed", „Open", „In progress", „Resolved", „Approval", „Testing", „On hold", „Ready for testing", „Tested"* and *„Clarification"*.;
- Issue*: „Closed", „Open", „In progress", „Resolved", „Testing", „Reopened"* and *„Clarification";*
- Task: *„Closed", „In progress", „Open", „Resolved", „Testing", „Ready for testing", „Tested", „Approval"* and *„Reopened";*
- Bug: *„Closed", „Open", „In progress", „Resolved", „Testing", „Ready for testing", „Reopene*d" and *„Cancelled".*

To evaluate efficiency of the proposed configuration I_3 relative to the existing PMIS configuration I_{eks}, the analysis of data usage in the existing configuration is performed. Information for evaluation is taken from 155 closed work items (i.e., instances of data entities). That includes information about:

1) Data entities used (Figure 5.1);
2) Statistics about frequency of filling data (i.e., how often the attribute is not left empty) (Figure 5.2);
3) Statistics about statuses used during the work item processing. It is aimed at identification of fictitious transactions when statuses are changed without performing any meaningful activities (Figure 5.3).

It is assumed that the configuration is more efficient if there are fewer empty attributes and fictitious transactions. The comparison of the proposed knowledge-based configuration I_3 and existing I_{eks} shows that:

1) The attributes of data entities that are not included in I_3 are left empty in close to 100% of cases;
2) The attributes filling rate increases from 65% to 80% if I_3 is applied (Figure 5.2);
3) The percentage of fictitious transactions is close to zero if I_3 is applied because the number of unnecessary process statuses is reduced (Figure 5.3);
4) The knowledge assisted configuration I_3 still contains data entities, their attributes and process statuses, which are not necessary, and lack some data entities, their attributes and process statuses, which are necessary. Therefore, knowledge based configuration recommendations should be evaluated by a human expert who uses her judgement to make the final decision about definition of the appropriate configuration.

Existing configuration I_{eks}	**Proposed configuration I_3**
New Feature Improvement	Change Request
Bug	Issue Bug
Task	Task
Question	-

Figure 5.1. Data entities used in the existing and proposed configuration

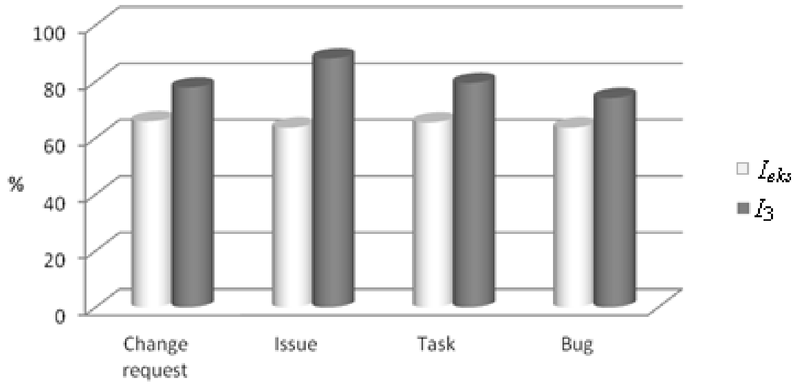

Figure 5.2. Percentage of non-empty attributes

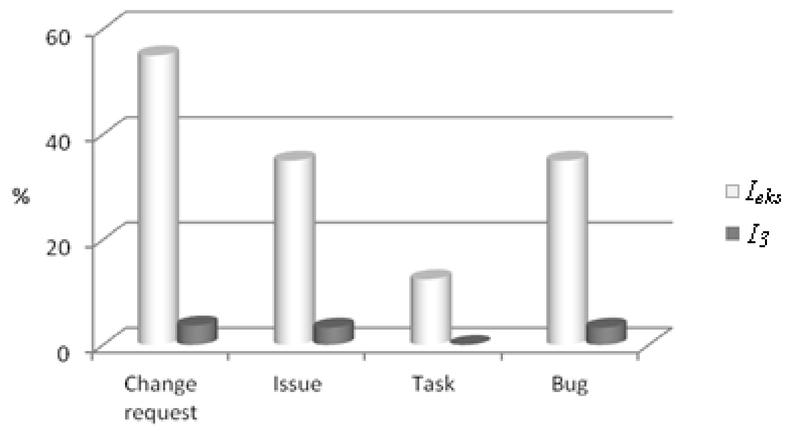

Figure 5.3. Percentage of work items with fictitious transactions

RESULTS AND CONCLUSIONS

The approach for configuration of project management information systems has been developed in the thesis. This approach uses knowledge and best practices to improve the quality of the configuration.

The main results of the thesis are:

- The approach for configuration of PMIS has been elaborated;

- The project management conceptual model PMCM has been developed. It describes all project management concepts and relations. The conceptual model has been obtained by integrating information from various sources including XML schemas, ontologies and methodologies;
- The algorithm for building conceptual models by integration of information from various sources various been developed;
- The standardised definition of PMIS configuration requirements in the form of XCPM schema has been developed on the basis of PMCM. It allows defining the project management data and processes. Processes are defined using XPDL as a part of XCPM;
- The conceptual architecture of the system supporting utilization of project management knowledge and best practices in preparation of the PMIS configuration has been developed. The knowledge repository and the principles of case-based reasoning are used in this conceptual architecture;
- The initial extensible set of the project classification criteria has been developed. This set is used for identification of the relevant cases in the knowledge repository and knowledge retrieval;
- The method for formalized representation of project management processes and evaluation of their similarity has been adapted;
- The automatic configuration of three PMA has been explored, and the transformations for these PMA have been developed. The automatic configuration can be performed for systems providing an open configuration mechanism (such as XML based configuration).
- Configuration of three PMA using a single standard configuration file has been demonstrated;
- The ability of XCPM to fully capture all PMIS configuration requirements is validated by collecting cases in the knowledge repository. Definition of the configuration requirements has been analysed in details for one selected project;
- Knowledge assisted preparation of the PMIS configuration has been demonstrated. The knowledge-based configuration has been compared with the configuration actually used in a real-life project to evaluate efficiency of the configuration approach;
- The comparison of the knowledge based configuration and the actual configuration shows that in the knowledge based configuration the filling of work item attributes has been increased from 65% to 80% and the count of work items with unnecessary transactions has been decreased.

The main conclusions of the thesis are:

- The approach developed ensures systematic configuration of PMIS. It includes standardised definition of the project requirements, utilization of knowledge and best practices to elaborate the most appropriate configuration and automation of the configuration of PMIS.
- The configuration approach enables decreasing configuration time by: 1) using the automated configuration; 2) using existing fragments or templates of the configuration file; 3) using the recommendations and the best practices.

- Using the schema integration principles in the conceptual model integration: 1) ensures that information is not lost during merging of model; 2) extends application domain of the schema integration rules.
- Using PMCM as the basis for XCPM development ensures that XCPM is able to represent all project management concepts.
- XCPM standardizes and formalizes definition of PMIS configuration requirements. XCPM supports definition of custom data entities.
- Using XPDL2.1 for defining processes in the definition of the PMIS configuration file enables complete definition of these processes and compatibility with different process modelling methods.
- The project management knowledge acquisition and utilisation process elaborated supports collection of the PMIS configuration best practices.
- Using knowledge and best practices during the configuration allows reducing amount of redundant data in PMIS. In the example, redundancy has been reduced by 15%. But a good configuration could not be made without involvement of the configuration specialist. Knowledge only facilitates definition of the configuration.
- The configuration approach developed is possible to use in configuration of the other process-oriented enterprise systems operating with data entities. However, that requires elaboration of a comprehensive conceptual domain for the chosen application area and adjustment of the characteristics used for the case identification in the knowledge repository.
- The configuration approach can be used for PMA, which provide a configuration interface It is not intended for desktop PMA (e.g., MS Project) and project management modules of ERP systems (e.g., SAP PS).
- The configuration approach and automated configuration of PMIS cannot add new PMA functions not intended by vendors of PMA.

Main further research directions are:

- Application of project management knowledge from PMIS during project execution;
- Configuration of PMIS according to user-needs during the different project phases;
- Using the standardized definition of the PMIS requirements for choosing PMA.

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