Customizing of the Software Organization Maturity Level Assessments Using SCT Based Generator

Melita Kozina, Danijel Radošević, Ivan Magdalenić
Faculty of Organization and Informatics
University of Zagreb
Pavlinska 2, 42000 Varaždin, Croatia
{melita.kozina, danijel.radosevic, ivan.magdalenic}@foi.hr

Abstract. *SPI (Software Process Improvement) is increasingly applied methodology for the improvement of the software development. The practical capability level assessment using CMMI (Capability Maturity Model Integration) is conducted for the business processes within the specific software organization. The overall organization maturity level could be represented in a form of different reports including graphic diagrams. Usage of the SCT based generator enables flexibility in specifying parameters of maturity level assessment as well as producing different forms of customized reports.*

Keywords. SPI, CMMI assessment, SCT generator

1 Introduction

SPI (Software Process Improvement) methodology is increasingly applied for the improvement of the software development by applying standards, methods, models, tools for quality and successful development and management of a software product [7]. The concept of the SPI models is based on the two dimensional reference model for describing processes and process capability (Process Assessment Model (PAM)). The PAM defines a set of the key process areas and their domain, purpose and outcomes. Furthermore, the PAM defines also a measurement framework for evaluating the capability of the key process areas through capability levels

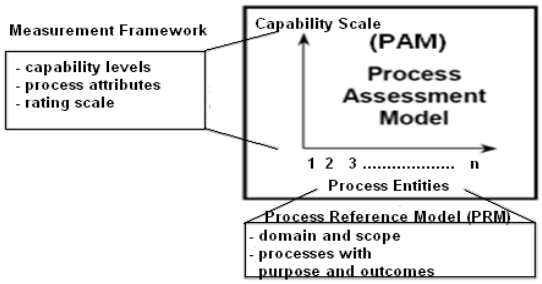


Fig.1 The reference model for the process assessment (PAM)

(*0=incomplete; 1=performed; 2=managed; 3=defined; 4=quantitative managed; 5=optimizing*). This reference model is shown on Fig. 1 [10].

ISO/IEC 15504-5 (SPICE model) as well as Capability Maturity Model Integration (CMMI) are modern SPI models that offer the possibility of integration of the best practice for the software development and approaches for the process capability assessment and the relevant improvements.

The example of the practical capability level assessment for the process area Requirements Management (REQM) within the CMMI framework is described and analyzed in the paper. The results of the assessment indicate a relationship between the target and the actual level of capability for the selected process area. Furthermore, the other process areas organized by maturity level 3, 4 and 5 in the software organization are also assessed and analyzed in the paper.

In this paper is presented a new method of customization of the software organization maturity level assessments by using a SCT based generator. The SCT based generator is originally defined as source code generator with the aim to be used for building of complete applications [8]. The SCT generator consists of three basic components: Specification (S), which describes the application features, Configuration (C), which describes the rules for building applications, and Templates (T), which refer to application building blocks.

Code templates and application features are synthesized according to connection rules defined in Configuration during the process of source code generation. The process of source code generation starts with the initial SCT frame that contains the complete Specification and Configuration and only one template from the set of all Templates. Other SCT frames are produced dynamically for each connection in the template, forming a generation tree (Fig. 2).

The decomposition of source code generator in such way makes it highly configurable and applicable in many different areas.

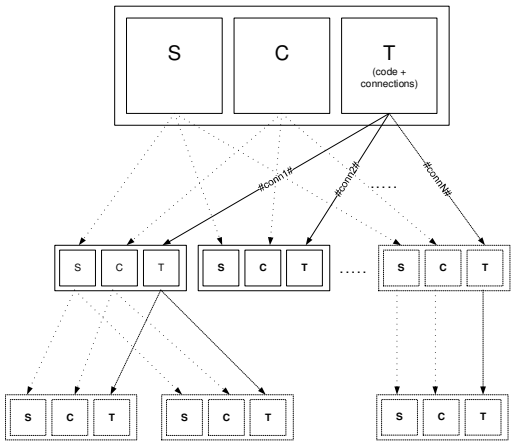


Fig. 2. Generation tree

It should be noted here, that usage of SCT model has sense when more similar applications have to be build. These applications differentiate one from each other only by some minor features and these features are defined in each application specification.

We have recognize the potential of usage of SCT model in software organization maturity level assessments and we have built a tool where parameters of maturity level assessment are defined as specification in SCT based generator. The main feature of these tools is presentation of overall organization maturity level in a form of different reports including graphic diagrams.

2 Background of the Research

There are more CMMI frameworks: CMMI-DEV 1.2, CMMI-ACQ 1.2, CMMI-SVC 1.2, P-CMM, etc. There are more also SPI methods: SCAMPI A v1.2, SCAMPI B v1.1, SCAMPI C v1.1, etc. Target capability level (CL) can be from 0 to 5.

CMMI-DEV 1.2 contains 22 process areas. Each process area has its defined purpose. In addition, the goal (specific/generic) is achieved by implementing effective practices (specific/generic) [1]. The practice describes the activities that are important for the implementation of the objectives (goals). The specific goals and practices are the process dimension of the PAM while the generic goals and practices are the capability dimension of the PAM. Accordingly, the assessors can analyze the purpose of the particular process area and the process capability how to achieve its purpose.

The work products are the results of the specific practice (typical work products) as well as the results of the generic practice. The work products are the important indicators for the assessment of the practice implementation and achieving the goals.

Rating scale for the practice implementation: fully implemented (80-100%); largely implemented (50-80%); partially implemented (20-50%); not implemented (0-20%); not yet (0%). Rating scale for the goal satisfaction: satisfied, unsatisfied. Rating scale for the process area satisfaction: not applicable, unsatisfied, and satisfied. Rating scale for the process area capability level (CL): CL0 (incomplete), CL1 (performed), CL2 (managed), CL3 (defined), CL4 (quantitative managed), CL5 (optimizing).

The main aspiration of Generative programming as a discipline within Automatic programming is to use generators to facilitate the process of application development [5]. In this research is used the SCT model, which is an example of Feature Oriented Software Development. The term feature refers to a property of a system relevant to some stakeholder that is used to capture variability or discriminate among products in the same family [4].

In our case, the features are presented as descriptions of processes in form of higher level of abstraction in application specification of SCT based generator. The detail description of features is given in section 4. The separation of features into application specification enables customization of our tool to specific process properties used in overall software organization maturity level assessments.

The SCT model is oriented to working with code-fragment-sized components similar to approach presented in XVCL [3]. The great flexibility of the SCT model and its orientation to working with code-fragment-sized component enables its application in many different areas like building of web applications [9], web service [6], e-business applications [5] and now tool for software organization maturity level assessments.

3 Practical capability assessment for the software organization processes using CMMI

CMMI-DEV 1.2 framework/SCAMPI A v1.2 method and Appraisal Assistant tool were selected and used for the practical capability assessment for the processes within the software organization. The detailed procedure of the assessment is described only for the process area REQM in the paper. The same assessment procedure was applied on the all processes in the organization in order to generate the overall organizational maturity level. The initial target capability level for the REQM was CL=2.The research method is mainly based on the interviews with the process owners and their documentation (work products as the main assessment indicators).

First, the assessment was conducted on the implementation specific practices of REQM based on the specific work products as the assessment indicators according to the rating scale: fully implemented (80-100%); largely implemented (50-80%); partially implemented (20-50%); not

implemented (0-20%); not yet (0%).These assessment indicators are shown in the Fig.3.

	Specific practice	Evidence of the work products
SP1.1	Obtain an Understanding of Requirements	- Lists of criteria for distinguishing appropriate requirements providers - Criteria for evaluation and acceptance of Requirements
SP1.2	Obtain Commitment to Requirements	- Documented commitments to requirements and requirements changes
SP1.3	Manage Requirements Changes	- Requirements status - Requirements database - Requirements decision database
SP1.4	Maintain Bidirectional Traceability of Requirements	- Requirements traceability matrix- - Requirements tracking system
SP1.5	Identify Inconsistencies Between the Project Work and Requirements	- Documentation of inconsistencies including sources, conditions, and rationale - Corrective actions

Fig. 3: Specific Practice Implementation Indicators (CMMI-DEV standard)

The results of this assessment are shown in the Fig.4. The specific goal SG1 (Manage Requirements) for selected process area REQM is satisfied.

In addition, the assessment was conducted on the implementation generic practices of the REQM based on the generic work products as the assessment indicators. The results of this assessment are shown in the Fig.5. The generic goal GG2 for selected process area REQM is unsatisfied.

Same assessment procedure, (target CL=2), was conducted for the other process areas organized by maturity level 2, 3, 4 and 5 within the software organization.

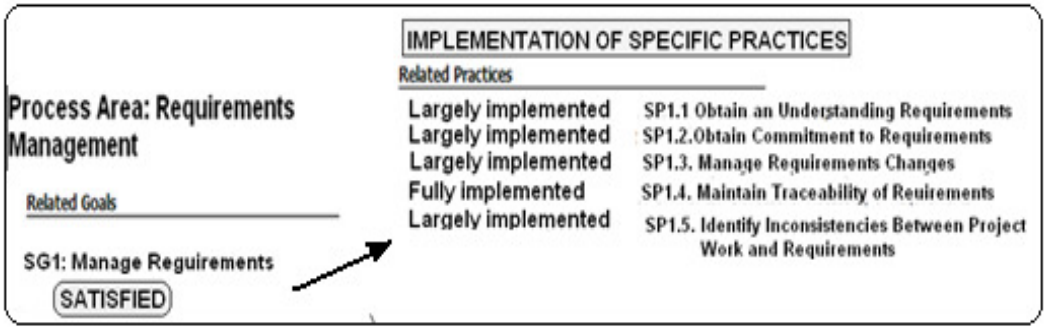


Fig. 4: Practical capability level assessment for REQM – specific dimension

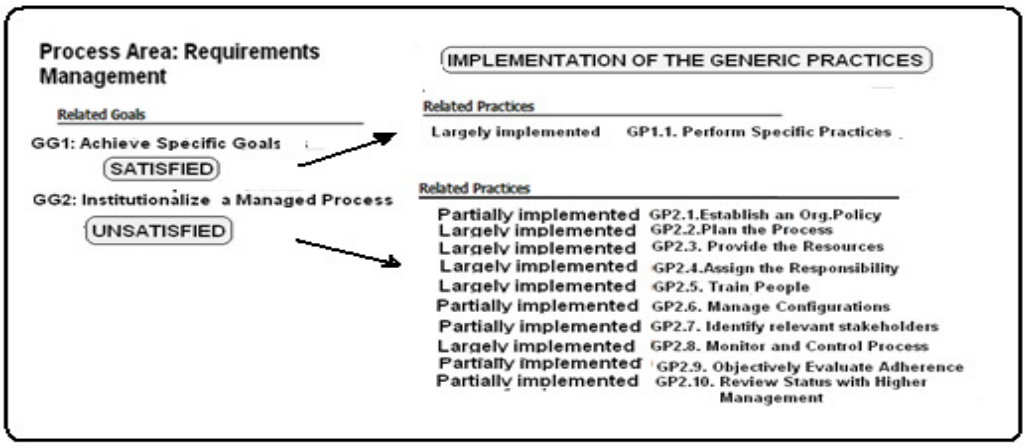
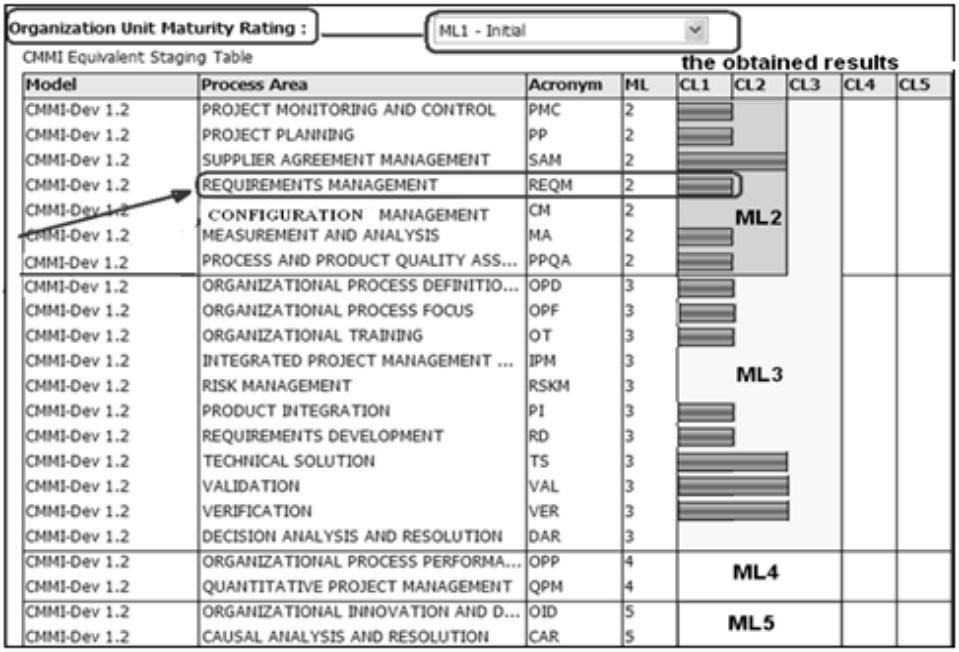


Fig.5: Practical capability level assessment for REQM – generic dimension

Some of them has the capability level 0, i.e. incomplete process area (for example, configuration management, integrated project management, risk management, decision analysis and resolution and the processes of the ML4/ML5).

The obtained results show that the software organization has maturity level 1 (Initial) and achieves its business goals based on the processes that are not well managed. The management should decide about the improvements related to the processes of maturity level 2 (ML2) as well as the other process areas. Overall results are shown in Fig. 6. The authors used the continuous CMMI model for the assessment and mapped the obtained the results through the staged CMMI model (CMMI Equivalent Staging) [2].



Model	Process Area	Acronym	ML	CL1	CL2	CL3	CL4	CL5
CMMI-Dev 1.2	PROJECT MONITORING AND CONTROL	PMC	2					
CMMI-Dev 1.2	PROJECT PLANNING	PP	2					
CMMI-Dev 1.2	SUPPLIER AGREEMENT MANAGEMENT	SAM	2					
CMMI-Dev 1.2	REQUIREMENTS MANAGEMENT	REQM	2					
CMMI-Dev 1.2	CONFIGURATION MANAGEMENT	CM	2					
CMMI-Dev 1.2	MEASUREMENT AND ANALYSIS	MA	2					
CMMI-Dev 1.2	PROCESS AND PRODUCT QUALITY ASS...	PPQA	2					
CMMI-Dev 1.2	ORGANIZATIONAL PROCESS DEFINITIO...	OPD	3					
CMMI-Dev 1.2	ORGANIZATIONAL PROCESS FOCUS	OPF	3					
CMMI-Dev 1.2	ORGANIZATIONAL TRAINING	OT	3					
CMMI-Dev 1.2	INTEGRATED PROJECT MANAGEMENT ...	IPM	3					
CMMI-Dev 1.2	RISK MANAGEMENT	RSKM	3					
CMMI-Dev 1.2	PRODUCT INTEGRATION	PI	3					
CMMI-Dev 1.2	REQUIREMENTS DEVELOPMENT	RD	3					
CMMI-Dev 1.2	TECHNICAL SOLUTION	TS	3					
CMMI-Dev 1.2	VALIDATION	VAL	3					
CMMI-Dev 1.2	VERIFICATION	VER	3					
CMMI-Dev 1.2	DECISION ANALYSIS AND RESOLUTION	DAR	3					
CMMI-Dev 1.2	ORGANIZATIONAL PROCESS PERFORMA...	OPP	4					
CMMI-Dev 1.2	QUANTITATIVE PROJECT MANAGEMENT	QPM	4					
CMMI-Dev 1.2	ORGANIZATIONAL INNOVATION AND D...	OID	5					
CMMI-Dev 1.2	CAUSAL ANALYSIS AND RESOLUTION	CAR	5					

Fig. 6: Overall results of the organizational maturity level (Appraisal Assistant)

4 Customizing of the Software Organization Maturity Level Assessments Using SCT Based Generator

An example[1] of software organization maturity level assessment was conducted using SCT based generator. The generator uses Specification to define parameters that are necessary for maturity level assessment. These parameters can be defined on different levels, e.g. process CL could be specified directly, or calculated from specific goals and generic goals of the process. Also, particular goals could be specified as satisfied/unsatisfied, or calculated from specific practices and generic practices.

The Specification of the example starts with some "technical" data:

```
//output type
OUTPUT:out1

//report file for generation
out1:output/cmmi_report.html

//ascending values used in table //creation
iterator_Cell:0,1
```

Project common parameters are specified next:

```
project_name:Overall results of the
  organizational maturity level(SCT
  generator)
framework:CMMI-DEV 1.2
method:SCAMPI A
```

[1] Available at http://gpml.foi.hr/cmmi/

The rest of the Specification contains process data. Specific processes belong to different maturity level assessments (ML2-ML5) that is visible in generated report. Each process has its target capability level (CL) and actual CL. It's important that actual CL can be specified directly, as previously calculated value, as well as a set of satisfied/unsatisfied goals (both specific and generic goals). Also, particular goal can be specified as a set specific/generic practices, as well as a previously calculated value.

In the following example, the process area CL (0) is specified as previously calculated value:

```
process:
+process_area:CONFIGURATION MANAGEMENT
+acronym:CM
+target_CL:2
+process_area_purpose:To establish and
  maintain the integrity of work products
// CL as previously calculated value
+process_area_CL:0
```

This example calculates process area CL from a set of specific goals and generic goals:

```
process:ML2
+process_area:PROJECT MONITORING AND
 CONTROL
+acronym:PMC
+target_CL:2
+process_area_purpose:To provide
  understanding the project progress
// CL calculated from specific and
// calculated values
+sg:1
++status:satisfied
+sg:2
++status:satisfied
+gg:1
++status:satisfied
+gg:2
++status:unsatisfied
```

Some of specific/generic goals could be specified as set specific/generic practices, as shown in the following example:

```
process:
+process_area:REQUIREMENT MANAGEMENT
+acronym:REQM
+target_CL:2
+process_area_purpose:To manage the
 requirements of the projects products
+sg:1
// specific goal calculated from
// specific practices
++sp:largely_implemented
++sp:largely_implemented
++sp:largely_implemented
++sp:fully_implemented
++sp:largely_implemented
+gg:1
++gp:largely_implemented
+gg:2
// generic goal calculated from
// specific practices
++gp:partially_implemented
++gp:largely_implemented
++gp:largely_implemented
++gp:largely_implemented
++gp:largely_implemented
++gp:partially_implemented
++gp:partially_implemented
++gp:largely_implemented
++gp:partially_implemented
++gp:partially_implemented
```

This Specification is connected with set of HTML/Javascript code templates by Configuration (set of connection rules according to SCT generator model). The Configuration of the example looks as follows:

```
// main template file - connected to
// out1
#1#,,main.template
// project common parameters
// project name
#project_name#,project_name
//framework name
#framework#,framework
// method name
#method#,method
// process area name
#process_area#,process_area
#process_area_purpose#,process_area_purpose
// calculated/entered CL
#process_area_CL#,process_area_CL
// target CL
#target_CL#,target_CL
// particular row in table
#rows_in_table#,process,row_in_table.template
// acronym
#acronym#,acronym
// assignements rules
#assignments#,process,assignment.template
// set of specific goals
#specific_goals#,sg,specific_goals.template
// set of generic goals
#generic_goals#,gg,generic_goals.template
//status of spec./gen. goal
#status#,status
// value of specific goal
#sg#,sg
// value of generic goal
#gg#,gg
// set of specific practices
#specific_praxis#,sp,specific_praxis.template
// value of specific practice
#sp#,sp
// set of generic practices
#generic_praxis#,gp,generic_praxis.template
// value of generic practice
#gp#,gp
// process level (ML2 - ML5)
#process#,process
```

Given result is in form of HTML document, as shown in Fig. 7.

Overall results of the organizational maturity level (SCT generator)

Framework: CMMI-DEV 1.2

Organization Unit Maturity Rating: 1

CMMI Equivalent Staging Table

Process area purpose	Process Area	Acronym	CL	CL1	CL2	CL3	CL4	CL5
ML2								
To provide understanding the project progress	PROJECT MONITORING AND CONTROL	PMC	1					
To establish and maintain plans that define project activities	PROJECT PLANNING	PP	1					
To manage the acquisition of products from suppliers	SUPPLIER AGREEMENT MANAGEMENT	SAM	2					
To manage the requirements of the projects products	REQUIREMENT MANAGEMENT	REQM	1					
To establish and maintain the integrity of work products	CONFIGURATION MANAGEMENT	CM	0					
To develop and sustain a measurement capability that is used to support management information needs.	MEASUREMENT AND ANALYSIS	MA	1					
To provide staff and management with objective insight into processes and associated work products	PROCESS AND PRODUCT QUALITY ASSURANCE	PPQA	1					
ML3								
To establish and maintain a usable set of organizational process assets and work environment standards.	ORGANIZATIONAL PROCESS DEFINITION + IPPD	OPD	1					
To plan, implement, and deploy organizational process improvements	ORGANIZATIONAL PROCESS FOCUS	OPF	1					
To develop the skills and knowledge of people so they can perform their roles effectively and efficiently.	ORGANIZATIONAL TRAINING	OT	1					
To establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.	INTEGRATED PROJECT MANAGEMENT + IPPD	IPM	0					
To identify potential problems before they occur so that risk-handling activities can be planned and invoked as needed across the life of the product or project	RISK MANAGEMENT	RSKM	0					
To assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product	PRODUCT INTEGRATION	PI	1					
To produce and analyze customer, product and product component requirements	REQUIREMENTS DEVELOPMENT	RD	1					
To design, develop and implement solutions to requirements	TECHNICAL SOLUTION	TS	2					
To demonstrate that a product or product component fulfills its intended use when placed in its intended environment	VALIDATION	VAL	2					
To ensure that selected work products meet their specified requirements	VERIFICATION	VER	2					
To analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria	DECISION ANALYSIS AND RESOLUTION	DAR	0					
ML4								
To establish and maintain quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives	ORGANIZATIONAL PROCESS PERFORMANCE	OPP	0					
To quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives	QUANTITATIVE PROJECT MANAGEMENT	QPM	0					
ML5								
To select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies.	ORGANIZATIONAL INNOVATION AND DEPLOYMENT	OID	0					
To identify causes of defects and other problems and take action to prevent them from occurring in the future	CAUSAL ANALYSIS AND RESOLUTION	CAR	0					

Legend:

Actual process area CL
Target process area CL
Out of target area CL

Fig. 7.: Overall results of the organizational maturity level (SCT Generator)

5 Conclusion

The example of the assessment of the software organization maturity using CMMI model was conducted in the paper. The observed organization in the example achieves its business goals based on the actual process capability levels CL0, CL1 and CL2 and the overall maturity level ML1.

The obtained results were based on the assessment of the specific and generic goals for each process area of the CMMI standard. Furthermore, each specific and generic goal was evaluated by the percentage of the specific and generic practice implementation in the software organization. The above assessment components (process area, CL, ML, goals and practices) have enabled the development of the Specification for the customization of the Software Organization Maturity Level Assessments using SCT Based Generator. The Specification can use previously calculated values, as well as sets of parameters (specific/generic goals satisfaction, specific/generic practices implementation level) in calculation of overall software organization maturity level (ML).

This hybrid Specification that is consisted from calculation parameters as well as from previously calculated values could simplify the assessment process, and well as its documentation, in relation to traditional tools.

References

[1] CMMI Product Team. CMMI for Development, Version 1.2, (CMU/SEI-2006-TR-008),Software Engineering Institute Carnegie Mellon University Pittsburgh, PA 15213, August 2006, Available from:http://www.sei.cmu.edu/library/abstracts/reports/06tr008.cfm, Accessed:2013-03-15.

[2] Dennis M. Ahern, Aaron Clouse, Richard Turner .CMMI® Distilled: A Practical Introduction to Integrated Process Improvement, Third Edition, Boston, 2008.

[3] Jarzabek S., Bassett P., Zhang H., Zhang W. XVCL: XML-based variant configuration language. Proc. Int'l Conf. on Software Engineering. Los Alamitos, CA, USA: IEEE Computer Society, 2003, pp. 810–811.

[4] Kang K. C., Cohen S. G., Hess J. A., Novak W. E., and Peterson A. S., Feature-Oriented Domain Analysis (FODA) Feasibility Study, Technical Report, Software Engineering Institute, Carnegie Mellon University, 1990.

[5] Magdalenić I., Radošević D., Orehovački T. Autogenerator: Generation and Execution of Programming Code on Demand. Expert system with applications. 40 (2013), 8; 2845-2857

[6] Magdalenić I., Radošević D., Skočir Z. Dynamic Generation of Web Services for Data Retrieval Using Ontology, Informatika, Volume 20 Issue 3, pp. 397-416, 2009. Available at: http://www.mii.lt/informatica/htm/INFO755.htm

[7] O'Regan, G. (2011). Introduction to Software Process Improvement, Springer-Verlag, ISBN 978-0-85729-171-4, London.

[8] Radošević D., and Magdalenić I. Source Code Generator Based on Dynamic Frames, Journal of Information and Organizational Sciences, vol. 35, no. 2, pp. 73–91, 2011.

[9] Radošević D., Orehovački T., and Stapić Z. Automatic On-line Generation of Student's Exercises in Teaching Programming, In Proceedings of the 21st Central European Conference on Information and Intelligent Systems, Varaždin: FOI, 2010. pp. 87–93.

[10] Sassenburg H. &Kitson, D. (2006).A comparative analysis of CMMI and automotive SPICE, Available from: http://www.se-cure.ch/images/06-ESEPG1.pdf, Accessed:2013-03-30.