WEB BASED PROJECT MANAGEMENT COMPETENCES AND PROJECT PERFORMANCES

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Abstract: This paper explores parallel influence of web based project management competences and project performances. A cross-sectional approach was taken to examine differences among low and high maturity organizations, according to IPMA Delta model for individual, project and organizational maturity assessment in study 1, and differences among low and high experienced project managers using IPMA Competence Baseline 3.0 to evaluate technical competences in study 2. Study 1 consisted of 51, while Study 2 consisted of 53 project portfolio managers from project-oriented international companies in Serbia. Study 1 showed that PMIS fully mediated the positive association between maturity level and project management web based approach. Study 2 showed that PMIS fully mediated the negative association between project portfolio managers' technical competences and experience. Theoretical and practical implications are discussed.

Key words: project web access, competences, performances, maturity

1. INTRODUCTION

IT competence were positively associated with organizational learning, while from the other side there is also a positive correlation between organizational learning and organizational performances (Tippins & Sohi, 2003). Suikki et al.(2006) have developed a project management competence framework, linking organizational learning and knowledge management. Beside the employee competences in organization, in the software solutions implementation, Wang et al.(2008) emphasize the consultants' competences, such as consultant competences during ERP solutions implementation. Bernroider & Ivanov (2011) emphasize stakeholder expectations' valuation in order to create good project proposal.

Case study method is a well-established construct for maturity assessment with respect the relationship characteristics between previous and current situation in organization (Wendler, 2012). Also discrepancies and gaps in software development knowledge and process improvements comes to an inadequate maturity models implementation (Shang & Lin, 2009). Comparing the four largest industries of professional, scientific and technical services; information; finance and insurance; and manufacturing.Grant & Pennypacker (2006) found that there are no differences in project management maturity levels. Cost assessment disparity is not noticeable at early maturity assessment stages, switching from CMMI level 1 to level 2 (Kulk et al, 2009).

Liou (2011) highlights maturity models certification method and the lack of best practices for organizations that are at the higher maturity levels as a key issues in software industry, and therefore Jin et al. (2014) categorized success factors into four process management categories in new service development: strategy management processes, process formalization, knowledge management, and customer involvement. Vezzetti et al. (2013) emphasize product lifecycle management maturity assessment, in order to take all parameters into account in maturity assessment and resolve problems that are typical for maturity models - retrievability and reusability.

High level maturity organizations in software industry achieve process improvement through reduction of expected software outcomes (Agrawal & Chari, 2007). User perception of software providers indicates a high level of expectation in terms of technical

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solutions and project integration (dos Santos, de Oliveira, & da Silva, 2008), and therefore the project managers' technical competences gain an increasing importance.

Information systems development usually has been perceived from project managers' perspective according to relevant methodologies, whether it's traditional or agile, and less from end users'perspective, in order to achieve project objectives, aligning IT strategies with a process-based approach (Jenkin & Chan, 2009). Therefore, Rondeau et al. (2006) proposed end users inclusion in the project first phase, while Davis et al. (2009) highlight "joint IT competences" between IT department and end users as a key drivers of successful information system implementation.

Agile methods in software development projects provide quick response to customer requirements and just-in-time processes. Analyzing scrum practices for CMMI level 2 and level 3, Łukasiewicz & Miler (2012)point out that agile methods and maturity models added about 60% of new practices in software development. Research that was conducted between nearly 200 practitioners in 13 software companies indicates that software developers, managers and project managers don't see themselves entirely as the person responsible for software development, even though they are directly involved in the development processes (Baddoo & Hall, 2002). A large number of software development process' explorations completely ignore human factor. Ply et al. (2012) report significantly lower professional efficacy and lower job satisfaction on the third CMM level, where the dominant point is behavioral control.

2. LITERATURE REVIEW

Initially, project management web access (PMWA) first encounter with the grid technologies for wide-area distributed computing (Baker et al, 2002), where computer resources are allocated, more heterogeneous and dynamic, rather than localized. During the time the main web-based environment features create a document management system (Chan & Leung, 2004) that provides to participants not only central data visibility, but also the expansion of the knowledge base system in company (Molenaar & Songer, 2001).

Nitithamyong & Skibniewski (2004) emphasize cost and outsourcing benefits, and a higher level of IT professionals' competency as a key PMWA benefits, as well as difficulties in costs and benefits quantification, reliability and system security, legal restrictions, the lack of software interoperability and adaptability to the given software solutions to specific organizational projects. On the other hand Bygstad & Lanestedt (2009) point out that innovation in ICT services are not associated with the standard project constraints (time, cost, quality) or with professional project managers, but there is correlation between organizational integration that provides services and external users.

Stewart & Mohamed (2004) emphasize performance measurement IT perspectives during PWMA evaluation in the construction industry: operational perspective, benefits perspective, user orientation perspective, strategic competitiveness perspective and technology/system perspective. Also, Cheung et al. (2004) highlight the following performance measurement categories for PMWA: People, Cost, Time, Quality, Safety and Health, Environment, Client Satisfaction, and Communication.

User satisfaction has the highest influence in the PMWA application in construction industry, which is the satisfaction cause related to the quality of information that customers receive (S.-K. Lee & Yu, 2012). Ryoo et al. (2010) proposed Web-based construction specification system - project specifications were based on 15 standard specifications, 13 specialty specifications, national design guidelines, technical standards, the standard drawings, over 45,000 construction materials, and more than 600 lists of manufacturers, while in the project plan preparation Cheng et al. (2009) proposed Web-based conceptual cost estimates for construction projects using Evolutionary Fuzzy Neural Inference Model in order to increase reliability in costs assessment.

An increasing number of open source project management software's (OSS), which usually small and medium sized companies apply, creates new system for PMWA assessment. In small and medium-sized enterprises projects are often run by people that project management is not their first discipline, that can be observed as "management by amateur" (Turner et al, 2012). In this cases organizations decided primarily for open source software solutions (Pereira et al, 2013). Key capacities in predicting OSS project performance are defect removal and functionality-enhancement (Ghapanchi & Aurum, 2012). OSS are simplified versions of the project management tools, which require a lower level of technical competence, but must be taken into account according to cost analysis for these solutions. S. H. Lee et al. (2006) introduced the methodology of dynamic planning and control in PMWA in order to integrate strategic and operational project management directions, while Silva & Costa (2013) suggest dynamic programming method, as well as advanced techniques in resource allocation in software development projects.

In some countries such as Japan and US high-tech intensive economy appears resistance to the PMWA implementation, where the most common cause are lessons learned by others who have successfully implemented these systems (Dossick & Sakagami, 2008). A cross-cultural comparison conducted by Niazi et al. (2010) compares the barriers in software process improvement in Vietnam and Australia, and points out that in Vietnam the barriers associated with project management, resource management and sponsorships, while in Australia associated with organizational policies and lack of support.

Skibniewski & Vecino (2012) highlight the following modules in web-based framework for managing dredging projects: project management module, reporting module, project control module and document management module.

3. IMPLEMENTATION OF THE STUDY

General model has been prepared in order to evaluate maturity and project portfolio managers' technical competences in web-based environment, based on IPMA Delta model and IPMA Competence Baseline 3.0 (Figure 1). Two studies were conducted to describe general model. The first study is related with PMWA and organizational, project and individual characteristics, while the second study shows relationship between project portfolio managers' technical competences, their personal characteristics and PMWA. Study 1 includes web-based approach and a localized approach to projects and different modules, while study 2 includes only web-based approach.

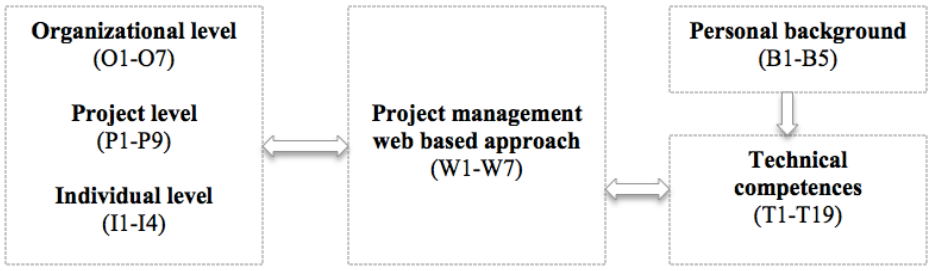

Figure 1: General model for maturity evaluation and project portfolio managers' technical competence assessment in web based environment

3.1 Study 1

Sample and procedure. Participants were 51 project portfolio managers in 51 companies in Serbia, involved in project management software development and implementations in their companies. The sample was composed of 56.9% of male and 43.1% of female respondents. Table 2 shows the characteristics of the project portfolio managers and organizations involved in research.

Table 2: Demographic characteristics of project portfolio managers and organizations – first study

Characteristics	n (%)
Sector	
Profit	23 (45.1)
Public	28 (54.9)
Enterprise (business) type	
Small and micro	18 (35.3)
Medium	13 (25.5)
Large	20 (39.2)
Number of projects (yearly basis) - organizations	
<5	16 (31.4)
5-15	14 (27.5)
>15	21 (41.2)
Web based approach - organizations	
Yes	27 (52.9)
No	24 (47.1)

Questionnaire (in online and regular paperback form) is used for gathering data about project portfolio managers and PMWA in their companies. All variables are categorized according to four groups of factors: 1) individual level – components that influence on personal satisfaction and leadership styles; 2) project level – components that are related with project and portfolio alignment and with project deliverables; 3) organizational level – components that are related with organizational commitment and communication 4) PMIS module usage in accordance with applications that support web based approach usage – project management web access (PMWA).

Measures. Individual, project and organizational elements, and PMIS modules usage respondents ranked on the Likert scale: "1 - very dissatisfied," "2 - dissatisfied "," 3 - moderately satisfied "," 4 - satisfied, "" 5 - very satisfied. The PMIS modules have the following responses: "1 - not used", "2 - low usage level", "3 - medium usage level", "4 - high usage level", "5 - very high usage level". Cronbach's alpha coefficient for project management information system modules' scale is 0.89, indicating a high degree of internal consistency.

Table 3. Confusion matrix for decision tree

	True No	True Yes	Class precision
Pred. No	15	10	60.00%
Pred. Yes	9	17	65.38%
Class recall	62.5%	62.96%	

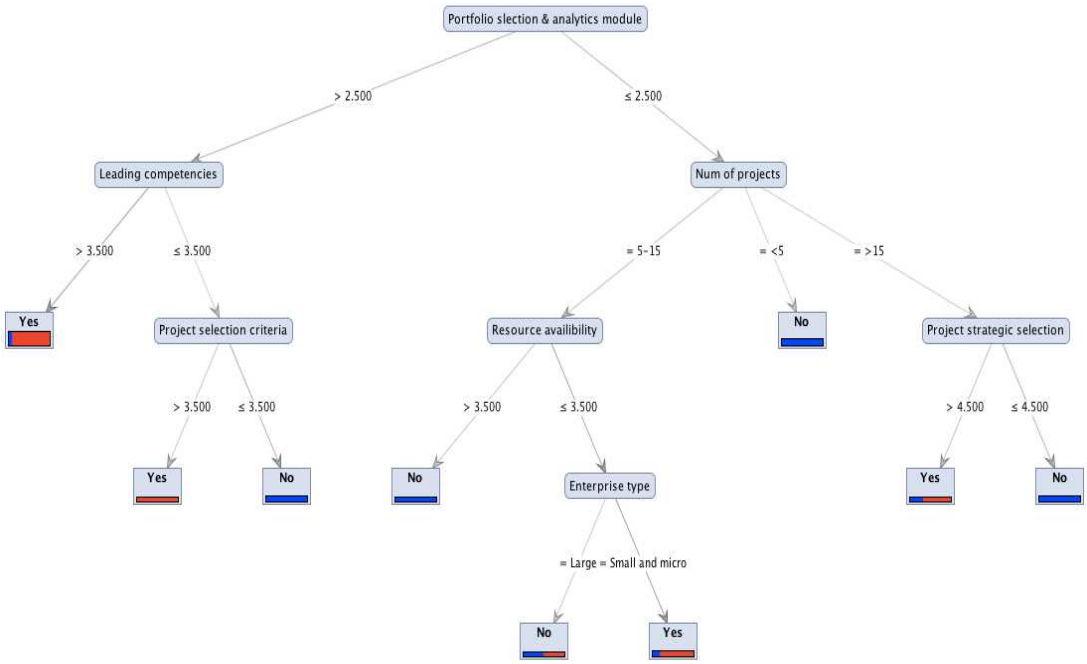

Figure 2: PMWA decision tree

Portfolio selection and analytics module has been perceived as a dominant decision-making point. If the respondents evaluate given module with over 2.5, and perceived leading competences with over 3.5, 90% were likely to use PMWA. If they evaluated leading competences less than 3.5 and project selection criteria has evaluated over 3.5, with 100% they will use PMWA. In the first part of the branch, which was previously described, PMWA has been initiated by project and individual factors.

If respondents have evaluated portfolio selection and analytics module with less than 2.5, the next decision point is number of projects on yearly basis for their organizations. PMWA is not used in 100% of cases if the number of projects is less than 5. If the number of projects is 5-15, branching criterion is the resource availability. Respondents, who have evaluated over 3.5 resources availablity in 100% of cases, don't use PMWA, and while those who have evaluated with less than 3.5 branching continues through the enterprise type criteria. Large company is 50% likely to use PMWA, while on the other hand small and micro enterprises 80% are likely to use the PMWA. Respondents, who work in organizations that implement more than 15 projects per year, electing to use PMWA, based on project strategic selection criteria. If the score is less than 4.5 in 100% of cases PMWA hasn't been used.

In the second branch, it's noticeable that organizations in a very small extent use portfolio selection and analytics module. This indicates a number of projects that organizations realize on a yearly basis. Usually it's less than 5, and there isn't necessary to use such tools. On the other hand, there is predominantly that companies use PMWA if the resource availability evaluated with less than 3.5 and if they belong to small and micro businesses. These companies often justify PMWA tools usage as a "necessary innovation" to improve performances.

Table 4: Clusters' characteristics for PMIS modules and maturity components

Attribute		Cluster 0 (n=23)	Cluster 1 (n=19)	Cluster 2 (n=9)
Gender	Male	70.0%	60.0%	27.3%
	Female	30.0%	40.0%	72.7%
Enterprise type	Large	50.0%	40.0%	18.2%
	Small and micro	30.0%	25.0%	63.6%
	Medium	20.0%	35.0%	18.2%
Num of projects	Num of projects = >15	40.0%	55.0%	18.2%
	Num of projects = 5-15	25.0%	15.0%	54.5%
	Num of projects = <5	35.0%	30.0%	27.3%
Sector	Profit	60.0%	35.0%	36.4%
	Public	40.0%	65.0%	63.6%

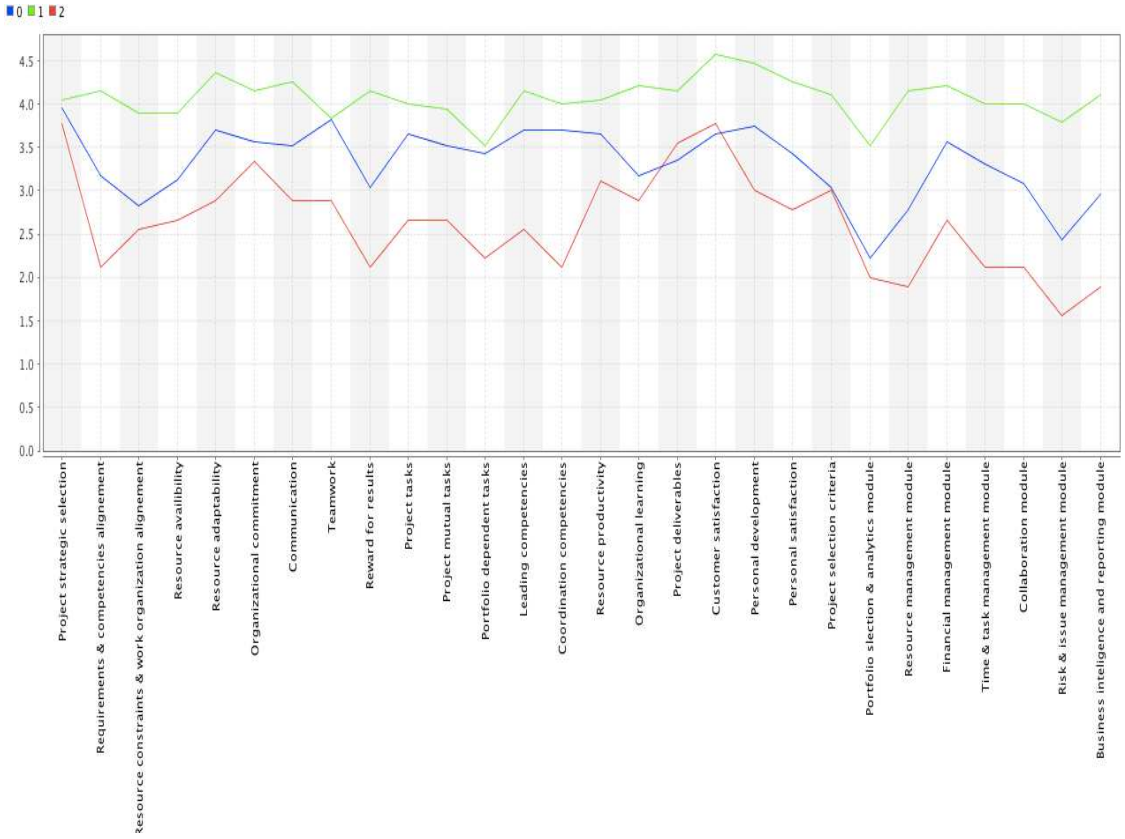

Figure 3: Clusters' centroids for PMIS modules and maturity components

The last step in the first study was to observe three clusters in order to determine PMWA organizational characteristics. Cluster 1 (19 items) is superior in all parametars comparing with cluster 0 (23 items) and cluster 2 (9 items). Cluster 2 expressed low scores in most of the project, organizational, and individual segments and predominantly has been composed of PMIS modules with a low intensity of usage (portfolio selection and analytics, risk and issue management, business intelligence and reporting modules). Comparing with cluster 0, perception of achieving project results and customer satisfaction have better evaluated in cluster 2, while the biggest differencies have been pereceived in individual and organizational aspects. Cluster 0 with a medium level of PMIS modules' usage exemplifies a significant improvement within the individual

segments - personal satisfaction and personal development. Also slightly more has pronounced business intelligence and reporting module usage. Most of the individual, project and organizational segments are within cluster 2 closer to cluster 1 than to cluster 0.

3.2 Study 2

Sample and procedure. Participants were 53 project portfolio managers in 53 companies in Serbia, involved in project management software development and PMWA implementations in their companies. The sample was composed of 60.4% of male and 39.6% of female respondents. All respondents were PMWA users.

Questionnaire (in online and regular paperback form) is used for gathering data about project portfolio managers' technical competences and PMWA usage in their companies. All variables are categorized according to three groups of factors: 1) personal characteristics; 2) technical competences according to IPMA Competence Baseline 3.0; 3) PMWA module usage in accordance with project success.

Table 5: Demographic characteristics of project portfolio managers – second study

Characteristics	n (%)
Sector	
Profit	44 (83.0)
Non-profit	4 (7.5)
Public	5 (9.4)
Enterprise (business) type	
Small and micro	10 (18.9)
Medium	30 (56.6)
Large	13 (24.5)
Management level	
Low	9 (17.0)
Middle	26 (49.1)
Top	18 (34.0)
Field of study	
Natural-mathematics	5 (9.4)
Technical-sciences	18 (34.0)
Law-Economy	13 (24.5)
Social sciences	17 (32.1)

Measures. Technical competences (T3, T4, T8-T19) according to ("ICB - IPMA Competence Baseline, Version 3.0," 2006), respondents ranked on a Likert scale: "1 - very dissatisfied", "2 - dissatisfied", "3 - moderately satisfied", "4 - satisfied," "5 - very satisfied ". In addition, within the technical competences, analysis includes following components: the number of project management trainings that the respondents participated in the last 5 years (T1), the average number of project risks (T2), quality standards definition through PMWA (T6), goals and requirements alignment using PMWA (T5), responsibility matrix definition through PMWA (T7). In addition to technical competences, study 2 involves project portfolio managers' personal characteristics regarding to work experience and participation in projects (B1-B5).

Table 6: IPMA technical competencies and personal characteristics

ID	Description	Mean ± Deviation
B1	Work experience (yearly)	8.7 ± 4.55
B2	Work experience in current position (yearly)	3.67 ± 1.73
B3	Number of work positions	4.26 ± 1.63
B4	Number of projects	8.83 ± 4.28
B5	Number of projects - project manager	4.64 ± 2.6
T1	Number of project management trainings (last 5 years)	2.06 ± 1.03
T2	Number of risks (per project)	8.7 ± 4.55
T3	Success criteria	4.53 ± 0.58
T4	Stakeholder involvement	3.96 ± 1.07
T8	Teamwork	3.94 ± 0.6
T9	Problem solving	4.08 ± 0.9
T10	Project structure definition	3.72 ± 0.91
T11	Scope & deliverables	3.45 ± 0.97
T13	Time appraisal & phases definition	3.45 ± 1.12
T14	Resource management	4.3 ± 0.61
T15	Financial management	4.25 ± 0.59
T16	Procurement & contract	3.4 ± 1.06
T17	Change management	4.06 ± 0.82
T18	Project startup and closeout	3.17 ± 1.09
T19	Information & documentation	3.11 ± 1.14

Table 7: IPMA technical competences - Requirements & goals alignement

ID	Description	Monthly n (%)	Quarterly n (%)
T5	Requirements & goals alignement	25 (47.2)	28 (52.8)

Table 8:IPMA technical competences – quality standard and responsibility matrix definition

ID	Description	Yes n (%)	No n (%)
T6	Quality standards for project web access (PWA)	37 (69.8)	16 (30.2)
T7	Responsibility matrix for PWA	33 (62.3)	20 (37.7)

Data analysis. Data analysis was prepared using RapidMiner Studio 6.0. In the second study objective was to show the relationship between project portfolio managers' individual's background and technical competences in PMWA environment. K-means algorithm was performed in order to identify group characteristics with following parameters: measure types - Bregman Divergences; Divergence - Squared Euclidean Distance; Max optimization steps – 10; number of clusters = 3; Max runs = 10; categorical variables were transformed into numeric (coding type: dummy coding).

Results and discussion. Cluster 0 is related with project portfolio managers' less experience (overall and in the current working position) and the number of projects in which they participated. From the other point of view there is a higher level of technical competences' importance. Characteristics of the cluster 2 are more seniority and greater project involvement. PMWA modules' contribution to business success and project implementation perceived to a greater extent in cluster 0. Technical competences such as stakeholder involvement, decision-making competences, quality standards definition through PMWA, defining responsibilities and risks through PMWA, are slightly higher in cluster 1.

Table 9: Clusters' characteristics in accordance with project portfolio managers' individual's background and technical competences in PMWA environment

Attribute		**Cluster 0 (n=37)**	**Cluster 1 (n=16)**
Enterprise type	Small and micro	24.3%	6.3%
	Medium	62.2%	43.8%
	Large	13.5%	50.0%
Management level	Low	16.2%	18.8%
	Middle	51.4%	43.8%
	Top	32.4%	37.5%
Gender	Male	64.9%	50.0%
	Female	35.1%	50.0%
Field of study	Technical sciences	32.4%	37.5%
	Social sciences	35.1%	25.0%
	Law-Economy	24.3%	25.0%
	Natural-mathematics	8.1%	12.5%
Quality standards for PWA	Yes	64.9%	81.3%
	No	35.1%	18.8%
Responsibility matrix for PWA	Yes	54.1%	81.3%
	No	45.9%	18.8%
Requirements&goals alignment	Monthly	56.8%	25.0%
	Quarterly	43.2%	75.0%

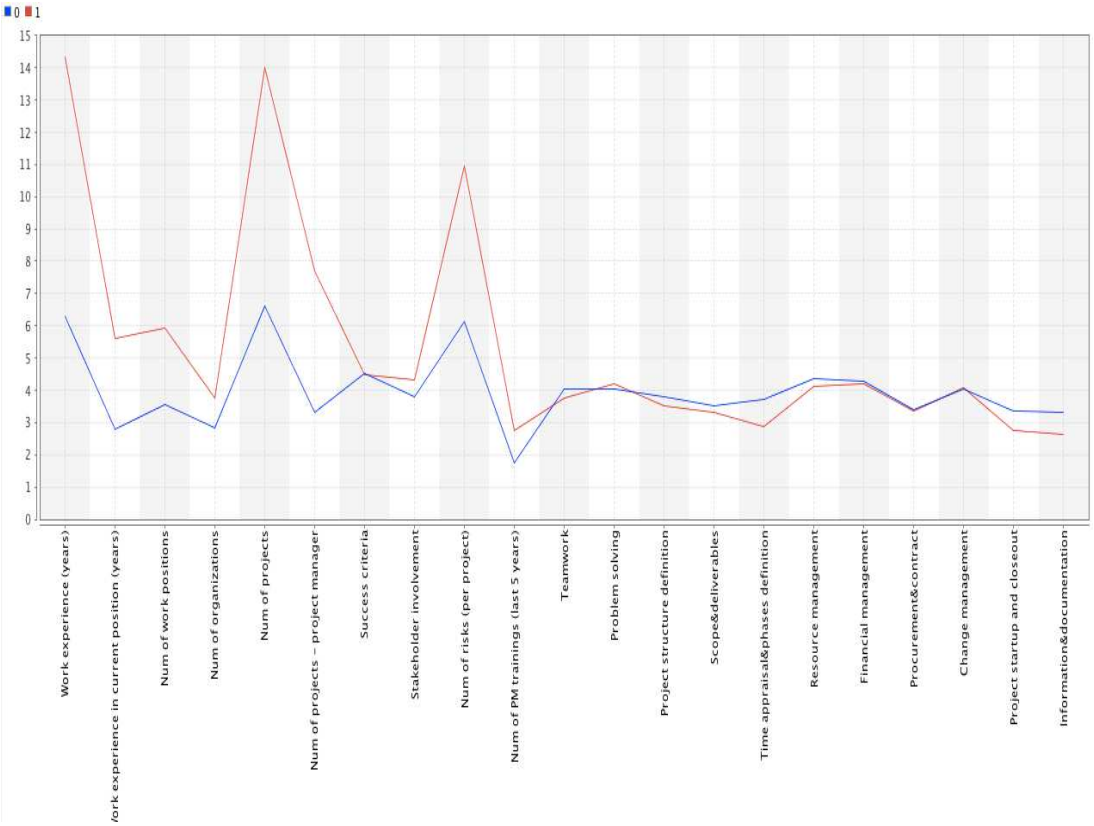

Figure 4: Clusters' centroids in accordance with project portfolio managers' individual's background and technical competences in PMWA environment

4. DISCUSSION AND CONCLUSION

This study confirms some of the previous results from authors worldwide, but also provides new information for the project management maturity models implementation, as well as technical competence evaluation in web-based environment. The significance of this research is supported by the fact that an increasing number of companies are using modern technologies (mobile devices and remote access) to facilitate the participants in the project. These results may have important implications for organizational processes' improvement and knowledge based framework design in the mentioned field, as well as collecting best practices, which according to Han et al. (2008) are a key profit prediction factors within the business. The obtained results also provide more detailed information about the factors that influence organizational maturity and project managers' competences.

Large number of project-oriented organizations in Serbia can be categorized as a business model for project networks, where the primary objective according to Wikström et al. (2010) is related with functionality and operational costs, rather than the potential profits. This stands out as the preferred system integration, which appears as the first issue in this research. Analyzing business intelligence systems' maturity Popovic et al. (2009) point out that higher quality content across all modules for business intelligence contributes efficient projects implementation. The results indicate a high correlation between modules Resource Management and Risk and issue management, but there is no difference in the usage level in organizations with and without PMWA. The results show that the modules Portfolio selection and analytics, Financial Management, Time and Task Management, Collaboration, Business Intelligence and reporting significantly greater extent used in organizations that have implemented a web-based approach.

A higher level of maturity is associated with organizational problems, while a lower maturity level is associated directly with project issues, such as documentation, time schedule, tools and technologies (Beecham et al, 2003). As a part of the information systems' strategy implementation, management commitment and prototyping have a significant impact on software quality and project performance, while training influence on software quality, and functional and structural simplicity affect on project performance. Organizations with higher levels of individual and project maturity favored to a greater extent PMIS modules than those with lower levels of maturity. Comparing high and low level of project maturity, it's not noticeable difference for Time and task management modul usage. In organizations with higher organizational maturity levels following modules are extensively applied: Time and task management, Business intelligence and reporting, Resource management and Risk and issue management.

In previous years there has been increased interest in the study of maturity components and process assessment. Project management best practices, as a part of maturity assessment process, are closely linked to project success and project strategic orientation, and therefore individual, project and organizational components' correlation in maturity assessment are stated as a second issue in this research. IT governance performance are positively correlated with internal IT structures in companies, defining relationships and organizational structure, but from the other hand there is no correlation with project maturity level (Simonsson et al, 2010). The research results show that in addition to the criteria enterprise type and number of projects, the dominant deciding point whether an organization chooses PMWA depends on project portfolio analysis components (module selection and portfolio analytics, project selection criteria, project strategic selection), as well as project managers' leading competences, which indicates that companies apply PMWA in order to align business process and goals with strategic orientation in most cases.

Small and micro enterprises with expensive services in software industry generally don't have a time to implement a system for maturity assessment and process improvement (Staples et al, 2007), and organizations have to take into account maturity model

application and evaluation (Lester et al, 2010). Cluster analysis' results indicate that mature organizations significantly emphasize less usage of Resource management modul. Also, 63.6% "low mature organizations" are small and micro enterprises, while "high mature organizations" consists mostly of medium-sized and larger enterprises. Increasing trend in PMWA usage occurs as a result of a higher maturity level, regarding to increasing trend in individual, project and organizational factors.

Recent research suggests competency based approach rather than task based approach (Soderquist et al, 2010) that is consistent with the IPMA Delta maturity model. The third issue considers relationship between technical competences, project portfolio managers' personal characteristics and PMWA. Crawford et al.(2011) emphasize worker tenure as a factor that affects the IT technical competence, while Eskerod (2010) highlights "action learning" as a development approach in acquiring project management competences. Profit sector to a greater extent apply PMWA. Cluster analysis' resultsindicate that the project portfolio manager's experience (work experience, work experience in current position, number of work positions, number of projects, number of projects as a project manager) in the web-based environment is negatively associated with level of technical competences (teamwork, project structure definition, scope and deliverables, time and appraisal phase definition, resource management, financial management, project startup and closeout, information and documentation).

Anbari et al. (2008) point out post project reports as a strategic driver for continuous learning and development, both internally and externally oriented. The results suggest that skillful project portfolio managers evaluate less important project starting and closing, as well as information and documentation, which is directly related with organizational knowledge management system. Also, the intensity of stakeholder engagement in the various project phases is directly associated with organizational maturity and portfolio success.

Success definition criteria are most noticeable component in PMWA application, according to goals and requirements alignment and responsibility definition. The results show that experienced project portfolio managers evaluated a higher importance for stakeholder management, and therefore they are more focused on responsibility definition and problem solving in PMWA environment.

Cluster analysis show that 75% of experienced project manager define requirements and objectives on quarterly basis, while less experienced project managers prepared the same analysis on a monthly basis. These differences imply that experienced project managers in mature organizations strive to decrease the technical competences' level. This study may provide a basis for modeling and creating different patterns and guides that may have a positive influence on the organizational maturity and project managers' competences.

5. LIMITATIONS AND SUGESTIONS FOR FURTHER RESEARCH

Project management software characteristics - companies that were included in this study used a variety of information systems, project management softwares, such as MS Project, MS Project Server, Primavera, Jira, etc. The software market value is not the same, and consequently the investment and development of appropriate modules within PMIS is not the same. Also, companies that are not included in this study belong to a group that uses self-created and adapted project management software. In the next period, the authors plan to extend study to the mentioned groups.

Time gap in research - surveys were conducted during the period of one year. As first, it was necessary to determine project management systems that organizations use, in order to realize the second study, which included only PMWA organizations.

Short period of IPMA Delta model application - IPMA Delta model is a new model for assessing the project maturity, and therefore there is a lack of knowledge base best practices. Also within the IPMA Competence Baseline 3.0, only technical competences were considered. Future research will include other two types of competence - contextual and behavioral in web-based environment.

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