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THE IMPACT OF COGNITIVE AND SOCIO-DEMOGRAPHIC FACTORS AT MEETINGS DURING SOFTWARE DEVELOPMENT PROCESS

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Original scientific paper

Most of the important decisions are taken at team meetings during software development process (SDP) and the way of thinking of project leader plays an important role in achieving quality objectives at these team meetings. Considering this important issue, this paper investigates the impact of cognitive and socio-demographic factors on manager's simple thinking style towards improving the quality of team meetings in SDP. We have performed experimentations among Information and Communication Technologies' (ICT) senior professionals and managers from government and private sector organizations for this purpose. The hypotheses have been developed under different empirical categories and then statistical analysis techniques have been used to draw inferences. The results indicate that "type of team meetings", "project leader's cognitive characteristics" and "adoption of a cognitive model at team meetings" have statistically significant impact on manager's simple thinking in terms of improving productivity and contribution of team meetings.

Keywords: *cognitive complexity, meeting, project management, simple thinking, simplicity, software development*

Utjecaj kognitivnih i socio-demografskih čimbenika na sastancima tijekom procesa razvoja softvera

Izvorni znanstveni članak

Većina važnih odluka donosi se na sastancima tima tijekom procesa razvoja softvera (PRS), a način razmišljanja voditelja projekta igra važnu ulogu u postizanju ciljeva kvalitete na ovim sastancima tima. Uzimajući u obzir ovo važno pitanje, u ovom radu se istražuje utjecaj kognitivnih i socio-demografskih čimbenika na jednostavan stil menadžerskog razmišljanja upravitelja za poboljšanje kvalitete sastanaka tima u PRS. Za tu svrhu proveli smo eksperimentiranja među starijim profesionalcima i menadžerima iz organizacija informacijske i komunikacijske tehnologije (IKT) u državnom i privatnom sektoru. Razvijene su hipoteze prema različitim empirijskim kategorijama, a zatim su iskorištene tehnike statističke analize za izvlačenje zaključaka. Rezultati su pokazali da "vrsta sastanaka tima", "kognitivne karakteristike voditelja projekta" te "usvajanje kognitivnog modela u sastancima tima" imaju statistički značajan utjecaj na menadžersko jednostavno razmišljanje u smislu poboljšanja produktivnosti i doprinosa sastanaka tima.

Ključne riječi: *jednostavno razmišljanje, jednostavnost, kognitivna kompleksnost, projektni menadžment, sastanak, razvoj softvera*

1
Introduction
Uvod

Software Development is a complex and often difficult process and there are several factors, which affect the overall result of software development processes. The decisions taken at team meetings are amongst these factors and have a significant role in achieving quality. In fact, team meetings are the core activities of software development process. This is because software products are not like other products and the decision on some crucial issues may deteriorate the quality of the product. Team meetings are governed by group leaders and the outcomes highly depend on the quality and thinking style of the leaders. In other words, the quality of the product also depends on the decision taken by the group leaders and one of the factors, which has great impact on these decisions, is the simplicity adopted by the project leader. In addition, the thinking style of project leadership is ruled by cognitive activities. This means cognitive activities are associated with the way that managers think and, therefore, have a certain impact.

There are several studies devoted to the manager's roles in software industry (see for example [1] - [7]). Most of these studies focus on leadership qualities. Turner and Müller [6] perform a rigorous literature survey on leadership style and project success. They claim that the literature on project success factors does not mention the project manager's (PM) leadership style or competence as a success factor on projects. From Turner and Müller's work [6] it can also be seen that most of the studies on project leadership were basically based on their properties required for a good project leader. Different people have different ways of thinking, which is defined as the process by which one evaluates information on a given problem. This process is, in many cases, followed by decision making. Therefore, decision making is affected by the way of thinking (i.e. thinking style).

The effect of leadership's thinking style and the cognitive factors on decision making of leaders have not been researched in a reasonable way to our knowledge. In one of our previous works [8], we have shown how much simple thinking affects solving complicated problems during software development process. This study does not consider factors affecting simple thinking in terms of meeting quality.

All these constitute our motivation for the present study. The present work may be distinguished from what we have visited so far in the literature, because we are concentrating on leaders' thinking style (i.e. simple thinking) in terms of meeting quality. In other words, the present study investigates how much cognitive and socio demographic factors are affecting the thinking style and ultimately impacting the decisions taken by the leaders at team meetings.

The paper is organized in the following way. In Section 2, we show the relation between cognitive complexity, leadership style and simplicity. The hypothesis development and research methodology are demonstrated in Section 3 and 4 respectively. The analysis of the results and the discussion are given in sections 5 and 6. The conclusion is given in Section 7.

2
Cognitive complexity, socio-demographic characteristics and simplicity
Kognitivna kompleksnost, socio-demografska obilježja i jednostavnost

In the endeavour to develop an effective leadership,

apart from other common features, which are reasonably discussed in the literature, thinking style and especially simplicity is a major factor. Furthermore, being a special type of thinking style, simplicity is affected by cognitive processes and complexities.

Albert Bandura [3] points that self efficiency beliefs affect human behaviour. He explains how cognitive processes affect the leadership style. Self-efficacy beliefs function as an important set of proximal determinants of human motivation, and they operate on action through motivational, cognitive, and affective intervening processes. Furthermore, self-efficacy beliefs affect thought patterns that may be self-aiding or self-hindering. These cognitive effects take various forms. He further explains [3] that human behaviour is regulated by forethought embodying cognized goals. In conclusion, Bandura proves that the cognitive processes and complexities play an important role in deciding the behaviour of leadership style.

Other researchers have also established relation between thinking style and cognitive complexity. Schroder et al. [9] state the existence of the differences in the individuals' ability to differentiate and integrate parts of information stimuli. Weiss and Wysocki [10] also, claim that cognitive skills of a PM play a central role in his success.

Simplicity (or simple thinking) is an element of cognitive complexity. In fact, cognitive complexity is linked to improved performance in many management contexts [11] and can be identified by the level of simplicity. Various researchers have indicated the importance of experience and education level of PM's for the level of simplicity [11-13], [31-32]. Additionally, as noted before, Miller [14] reports the tendency towards becoming "simplistic" in thinking for most managers. As we mentioned earlier, there are several studies on leadership qualities, and other issues. However, the impact of cognitive complexities on the simple thinking style of project leaders has not been studied yet, to our knowledge.

3 Hypotheses
Hipoteze

Software development process includes a number of team meetings where software professionals interchange their points of view, evaluate progress, discuss their problems and make future plans more effectively [15]. However, the literature is not conclusive for usefulness of team meetings [16-17]**.** Some researchers fully support team meetings and they propose different approaches (see for example [18-19]). Some other researchers [20-21] are not in favour of team meetings. According to the second group, team meetings are not always valuable in improving the quality of the product and, therefore, should be avoided in some cases (see, for example, [20-22]). They argue that team meetings may reduce the speed of software development process and hence increase the development time depending on circumstances. On the other hand, project management has always been a key to improve the competitiveness of a team [23] and, therefore, has a significant role in SDP [11]. Furthermore, one of the quality factors is related to manager's simplicity, which is a human behaviour and, therefore, can be related to socio-demographic and cognitive factors [25]. Therefore, the present study performs a systematic analysis to investigate the impact of cognitive and socio-demographic factors on "manager's simple thinking towards quality of team meetings". One of the cognitive factors included in the analysis is the type of team meetings. Meetings require different structures depending on their types (physical meetings, meetings using ICT, etc.) and, hence, are considered as a cognitive factor. Another factor is PM's cognitive characteristics, which corresponds to PM's mental process including aspects such as awareness, perception, reasoning, and judgment. The third factor is the adoption of a cognitive model in team meetings. The cognitive model is simply defined as a way of describing the process which humans go through to solve deductive reasoning problems. Usage of tools at team meetings, which includes tables, forms, slides, and graphical and textual representations constitutes the last cognitive factor in the present study.

The decision variables were categorized into two empirical factors as follows: (i) cognitive (type of team meetings, project leader's cognitive characteristics, adoption of a cognitive model in team meetings, usage of tools in team meetings) and (ii) socio-demographic (PM's experience in ICT and PM's education level). The justification for each empirical factor and the corresponding hypotheses are provided below.

Cognitive: The success of an SDP mainly depends on the PM's opinions, perceptions [26] and his cognitive complexity level [28-29]. This can also be explained by his/her level of simplicity [18] in SDP and the level of simplicity depends on various factors in a project [11, 18]. The present study, therefore, proposes the following hypotheses for this category:

$H1_1$: Type of team meetings has predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

$H1_2$: Project leader's cognitive characteristics in team meetings have predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

$H1_3$: Adoption of a cognitive model in team meetings has predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

$H1_4$: Usage of tools at team meetings has predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

Socio-Demographic: Studies that focus on various issues in software development process generally reported the significance of education and training on project performance (see for example, [31] and [32]). This is also true for the experience of project leadership (see for example [26], [33] and [34]). Manager's experience is an important factor in overcoming the difficulties arising with the increasing size of projects [35]. Berntsson-Svensson [35] also reports the relationships between the simplicity and complexity of software projects. All these mean that the impact of experience and education level of project leadership's simplicity towards improving meeting quality during SDP deserves further inspection and, therefore, the following hypotheses are postulated.

$H2_1$: Education has predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

$H2_2$: Experience has predictive effect on PM's simplicity in terms of productivity and contribution of team meetings in SDP.

4
Research methodology
Metodologija istraživanja

This study adopts a survey approach for investigating the impact of cognitive and socio-demographic factors on manager's simplicity towards the quality of team meeting in SDP. The data were obtained by means of a questionnaire prepared in Turkish and English. The respondents were project managers from major government and private sector organizations who were the attendees of one-day seminar organized by a leading international IT company. The respondents participated in the study voluntarily. The data was collected by using direct (live) survey method and a total of 69 completed survey questionnaires were received at the end of the day. The overall internal reliability as measured by Cronbach alpha [24] was found to be 0,87. This means the data is reliable since, usually, 0,7 and above is acceptable [30]. Furthermore, the correlations between the dependent and independent variables were observed to be significantly high since these values change between 0,823 and 0,987.

To be consistent with the available literature [18], [20], [32], the research instrument contains 3 main questions corresponding to dependent (Y) and independent (X) variables and inquiring data as follows:

I) How much project leadership's simple thinking helps in being productive in team meetings in SDP (5=very much,..., 1= very little) (Y)?

II) How much is the impact of the following cognitive factors on the contribution of team meetings in SDP (5=very much,..., 1=very little) (X_1)?

1) Type of team meetings (X_{11})
2) Project leader's cognitive characteristics (X_{12}).
3) Adoption of a cognitive model in team meetings (X_{13}).
4) Usage of tools in team meetings (X_{14}).

III) What is your level for the following socio-demographic factors (X_2)?

1) What is your education level (a. vocational school, b. university graduate, c. University graduate with M. S., d. University graduate with Ph. D.) (X_{21})?
2) What is your professional ICT experience in years (a. 1-5, b. 6-10, c. 11-15, d. 16-20, e. more than 20) (X_{22})?

V) Research instrument also contains three additional variables (X_3, X_4 and X_5) for descriptive purposes as follows: What is the role of team meetings in SDP (5=very much,..., 1= very little) (X_3)?

V) What is the role of simple thinking in the management of SDP in general (5=very much,..., 1= very little) (X_4)?

VI) Does simple thinking help being successful in project leadership in SDP (5=very much,..., 1= very little) (X_5)?

The Likert Scale is one of the most effective tools in collecting data in survey type studies. It is an ordered, one-dimensional scale from which respondents choose one option that best aligns with their view. In the present study, the data was collected using a five-point Likert Scale (5=very much, 4=much, 3=moderate, 2=little, 1=very little) for each item in the questionnaire.

The survey data were analyzed using multiple regression technique. This technique is well known and appears in many of the standard textbooks on probability and statistics [36]. However, to our best knowledge, it has not been used in the context of analyzing the role of manager's simplicity in SDP. We treated the problem as linear for dependent variable as follows:

$$Y_i = a_{i0} + a_{i1}X_{i1} + ... + a_{ij}X_{ij} \text{ where } i = 1, 2;\ j \le 4.$$

The chi-square test method is used whenever there is a need to examine the relationship between variables [36].

5
Analysis of results
Analiza rezultata

The percentage of the respondents who are managers in the field of IT appears to be 32 % whereas the others reported their seniority in this field with 10 years of experience or higher. Most of the respondents were from private sector (72 %). Observations were accumulated to be 82 % for university graduates with or without masters' degree. This percentage for vocational school graduates and Ph. D. holders are just 3 % and 15 % respectively.

All the six hypotheses were investigated at 5 percent significance level. The hypotheses, along with the results of multiple regressions, are given in Tab. 1.

Table 1 *Test results for simple thinking*
Tablica 1. *Rezultati ispitivanja za jednostavno razmišljanje*

Empirical factor	Ind. Var.	Hyp.	Mult. regression	
			Coeff.	p-value
Cognitive	X_{11}	$H1_1$	–0,4120	0,013*
	X_{12}	$H1_2$	–0,4658	0,040*
	X_{13}	$H1_3$	0,4842	0,017*
	X_{14}	$H1_4$	–0,0043	0,983
Socio-demographic	X_{21}	$H2_1$	0,1034	0,347
	X_{22}	$H2_2$	–0,1112	0,579

* indicates statistical significance at 5 % significance level

Cognitive: The hypotheses were investigated at 5 percent significance level and are given in Tab. 1 for this category.

Contrary to what is expected, based on regression results for "cognitive factors", only the hypothesis $H1_4$ is rejected (alpha-value = –0,0043, p-value = 0,983). This means "usage of tools" does not have any statistically significant predictive impact on PM's simplicity for having productive and contributive team meetings. Interestingly, the inspection of p-values in Tab. 1 states that all the other hypotheses, namely $H1_1$, $H1_2$ and $H1_3$, are accepted. In other words, "type of team meetings" (alpha-value = –0,4120, p-value = 0,013), "project leader's cognitive characteristics" (alpha-value = –0,4658, p-value = 0,040) and "project complexity" (alpha-value = –0,4842, p-value = 0,017) have statistically significant predictive effect on managers' simplicity in terms of productivity and contribution of team meetings.

Socio-demographic: The hypotheses were investigated at 5 percent significance level and are given in Tab. 1, along with their perspective p-values, for this category.

Surprisingly, all the hypotheses in this category are rejected. In other words, "education level" (alpha-value =

0,1034, p-value = 0,347) and "experience" (alpha-value = –0,1112, p-value = 0,579) do not have any impact on the simplicity of project leadership in terms of productivity and contribution of team meetings in SDP.

6 Discussion
Rasprava

Surprisingly, most of the respondents agree that the "role of team meetings" is below average (78 %) in SDP (Question IV). However, it is found that there is a significant relationship between the "type of team meetings" (Question II.1) and "role of team meetings" in SDP (Question IV) (χ^2 = 12,117; df = 4; p-value = 0,017). It is interesting to note that, in this study, 26 % of respondents admitted the "role of PM's simple thinking" is "very high" in SDP (Question V). This percentage is 50 % for the category "high". These percentages show similar dispersion for the "role of simplicity for being successful" in project leadership in SDP (Question VI). The chi-square test results have shown a significant relationship between the two (χ^2 = 22,25, df = 2, p-value = 0,000). This indicates that existence of leadership simplicity has a positive role for success of project leadership in SDP.

Cognitive. As noted before, team meetings are technical tasks carried out by human beings using cognitive activities [37]. In team meetings, the cognitive activities can be studied from the individual's perspective, which is concerned especially with mental mechanisms, strategies and the knowledge used to conduct meeting. The present study investigated the existence of impact of cognitive factors on PM's simplicity in terms of productivity and contribution of team meetings in SDP. The test results have shown that "type of team meetings", "project leader's cognitive characteristics" and "adoption of a cognitive model in team meetings" have statistically significant impact on PM's simplicity towards meeting quality. According to [38] the type of team meetings and their structure should be decided at the beginning of development life cycle. The model is then developed to include all the related items and the agenda. In addition, for each stage of software development, the scope and the objectives of the team meetings must be decided in advance. The modelling approach not only models the mental workload successfully but also simulates the driving performance, thereby reflecting the mental workload from both subjective- and performance-based measurements [39]. Surprisingly, the test result is not in favour for the hypothesis H_{14}. In other words, "usage of tools" does not have any significant impact on PM's simplicity towards improving meeting productivity. However, as noted by [40] graphics, diagrams, tables, forms, structured document, etc., will be useful to reduce the negative effect of cognitive behaviour since such tools increase cognitive synchronization.

Most of the available literature, although they do not consider simplicity perspective, support that cognitive aspects are important to improve project management performance. For example, Razali et al. [41] introduce a cognitive framework for usability assessment of a UML-based formal modelling and report that cognitive tools are not only useful but also easy-to-learn and easy-to-use. This means tools and technologies should be evaluated based on their usability from human point of view [42]. Demirbas and Vayvay [43] also report that project leadership must have cognitive characteristics such as communication skills, skills for use of tools, change management, etc.

Socio-demographic. In general, socio-demographic factors are identified as one of the most important factors found to have significant impact on various issues in SDP and have attracted special interest of many researchers in the last two decades. The articles by Rasch [34], Rasch and Tosi [44], Chung and Guinan [33], Chau [45], Belout and Gauvreau [46], Jiang and Naudé [47], Clave [48] and Donaldson [49] are examples of such studies.

Surprisingly, the present study found that the decision variables "education" and "experience" have no significant impact on simplicity of project leadership in terms of productivity and contribution of team meetings in SDP. Conflicting results were reported by other studies. For example, McGuire and Randall [27] report that there should be considerable emphasis on training and education in team-based organizations. They also point out the importance of continuous training. Rasch [34] reports that experience and other qualifications were among the most important factors that affect productivity in software engineering. Donaldson [49] introduces the choice of education versus training, which can have a profound impact on the eventual success of a project. Additionally, Chung and Guinan [33] point that experience may moderate the effect of participative management and report significant relationship between participative management and professional experience. All these also mean that productivity gains are weakened by a lack of sufficient training and experience in SDP [47]. One plausible explanation for our finding may be that PM's experience and education level may not be significant alone. This means, the quality of meetings might be impacted when combined with the education and experience level of the project members. However, contrary to the present study, the available literature did not consider the context of impact of simple thinking on the quality of team meetings.

In this study, "university graduates" and "university graduates with M. S." were found to be dominant (82 %). This is expected because it is generally observed that organizations from both private and public sector prefer to employ university graduates or higher for their managerial IT positions since IT is considered to be vital for business operations. This observation is especially true for government sector. Surprisingly, there is no significant relationship between PM's education level and simple thinking of project leadership during SDP. We observed significant diversity in the distribution of experience and its correlation with the contribution of team meetings was not found to be significant. Additionally, PM's experience level is not related to his/her cognitive characteristics. However, the correlation between experience and usage of a cognitive model in team meetings was found to be significant (p-value = 0,045).

7 Conclusion
Zaključak

The managers' thinking style is one of the key factors in the success of software development process, which has not been considered fully in the literature. Simple thinking is a thinking style, which has an important impact on the decisions taken by project leaders. The present study, therefore, has exposed the factors which affect the simple

thinking towards improving the quality of team meetings. The test results indicated that "type of team meetings", "project leader's cognitive characteristics" and "adoption of a cognitive model in team meetings" have significant impact on leadership's simple thinking in terms of productivity and contribution of team meetings towards quality in SDP. However, surprisingly, "usage of tools in team meetings", "PM's education level" and "PM's experience level" did not show any such significance.

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