

THE ROLE OF STANDARD ISO/TEC 12207 IN INFORMATICS PROJECTS MANAGEMENT

ULOGA NORME ISO/TEC 12207 U UPRAVLJANJU INFORMATIČKIM PROJEKTIMA

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Abstract

Providing informatics products and services is closely based on project principles. The more project principles are embedded, the more mature informatics processes are. Processes are defined by ISO/IEC 12207 standard, defining not only general guidelines for services design and development, but also necessarily followed principles. How successfully informatics companies match those two approaches, authors explored using survey conducted in informatics companies in the counties of Varaždin and Međimurje. The investigation has included the minimum of processes, activities and tasks for the project management, but also the quality of defining tasks which are necessary for starting, development and maintaining the informatics project. Four categories of questions were included: the starting of a project, the project's domain, the quality of the project and the project's influence on business success. Results of the provided research confirmed that the informatics companies sited in counties of Varaždin and Međimurje manage their projects at high level. The average grade is very good (4) on the scale from 1 to 5, according to related categories of standard request. Although the comparison of the results between two counties showed significant difference between companies' approaches from the aspects of quality and projects results influence on company's prosperity, and on the contrary, there is no significant difference between companies' approaches from the aspects of project domain and conditions for their project beginning.

1 INTRODUCTION

Since the times of an accelerated technological progress, based on information-communication prosperity, a great attention has been paid on the project management and international standards application in companies business. Worldwide companies often run their business according to international standards aligned to

Sažetak

Pružanje informatičkih usluga i proizvoda usko je temeljeno na projektnim principima. Što je projektni pristup zastupljeniji informatički su procesi zreliji. Procesni definirani standardom ISO/IEC 12207 ne daju samo opće smjernice za usluge projektiranja i razvoja već i nužno slijede načela. Koliko informatičke tvrtke uspješno povezuju ova dva pristupa, istraženo je putem anketnog upitnika u informatičkim tvrtkama Varaždinske i Međimurske županije. Ispitivanjem je obuhvaćen minimalni skup procesa, aktivnosti i zadaća u vođenju projekata, ali i kvaliteta definiranja zadataka koji su potrebni za pokretanje, razvoj i održavanje informatičkog projekta. Obuhvaćene su četiri kategorije pitanja: uvjeti za pokretanje projekta, domena projekta, kvaliteta i utjecaj projekata na uspjeh poslovanja. Rezultati istraživanja pokazali su da informatičke tvrtke u Varaždinskoj i Međimurskoj županiji vode svoje projekte na zavidnoj razini. Prosječna ocjena je vrlo dobar (4) na skali od 1 do 5, ovisno o određenom zahtjevu norme. Uspoređujući ove dvije županije, utvrđena je signifikantna razlika između pristupa tvrtki iz Varaždinske i Međimurske županije u aspektima kvalitete i utjecaja projekta na poslovanje, dok su s aspekta domene i pokretanja projekta tvrtke u obje županije ujednačene.

project performances (ISO/IEC 12207 standard for informatics projects). Practice of investigated informatics companies in observed regions of North-West Croatia is more/less the same. The cause of difference is the lack of systematic approach to standard application with no interconnection between different standards applied and without synergic effects. To follow higher and higher customer's requests, informatics companies

should improve their approach in quality and the way of managing it according to project performances and customer requests specifications. Project management approach is the way how to individualise informatics service and provides it successfully. Each project requests design of an original idea in the way to realise a certain purpose. Different authors define project in different ways deeply influenced by professional field specifics performances. Comparing those definitions, each of them include essential aspects:

- Timely limited process,
- Goal orientation,
- Unique and innovative, and
- Resource assignment.

According to Kerzner, issues project is considered to be any sequence of activities and tasks /1/ which:

- Have a specific objective to complete within certain specifications,
- Have defined start and end dates,
- Have funding limits (if applicable),
- Consume resources (i.e., money, people, and equipment).

The world organization for standardization of project management application, Project Management Institute, in its guide-book for project management, A Guide to the Project Management Body of Knowledge (PMBOK Guide), defines a project as "a temporary endeavor undertaken to create a unique product, service, or result" /2/. For the purposes of this research stress has been made on:

- The conditions of starting the project,
- The project's domain,
- The project's quality and
- The project's influence on business success.

To start a project according to customer requests specification, defined by project's stakeholders, is to satisfy starting conditions as basis for planning. It is necessary to collect all the information and requests as ground work for the contract preparation by choosing the best negotiated terms of contract.

The project's domain is related to all the activities which follow the starting of a project, till the final realization and obtaining the project's results. A project management plan defines the information on the project itself and various phases in the project's development. It has already been mentioned that the project is actually development of a certain idea in stages of realization. Therefore, in order to complete the project, the principles of the best practice should be used, and that is the responsibility of the project management.

Managing the project implies a high level of professionalism and quality. The quality issues on the project are highly related to early recognition

of stakeholders' request. According to this they should be verified and validated through whole project realization process, in order to monitor how the previously defined terms are fulfilled. Great attention should also be put on documenting each stage of project realization, especially on the risks of prevention, and to reduce them to decrease their influence on the project success. The review reveals and solves all the possible complications which can occur while leading the project. The project's impact on business success is related to the project efficiency in companies business. Project approach to modelling and designing informatics products and services has strong influence on business strategy and goals realisation in increasing market competitiveness. Relation to this fact, continuous alignment of business strategic goals provides higher quality via continuous business change according to inner requests and those form company business and social environments.

The project management's goal is to enrich the project's success. The manager focuses the project toward success and bears responsibility for achieving the project's aims, according to project's terms and assigning budget /3/.

The project's manager is the most designated person to evaluate the project's success, whose responsibility comprises the responsibility for the project's realization. It is difficult to isolate the most important characteristic of a successful project's manager. Actually, one can say that the project's manager is successful if he possesses, along with the expertise, other communication and organizational skills, with the purpose of successful project's conclusion and efficient use of available resources /4/.

The standard ISO/TEC 12207 defines necessary tasks for development, realization and maintaining the informatics projects. In each process a group of outcomes is related to the purpose of the project itself. The organizational structure has to insure the prestigious communication of its participants and other interesting parties close to the project. The structure of the standard ISO/TEC 12207 accompanies the informatics project life cycle, starting from the idea, research and development, quality examination, verification and validation process, problems' solving, to the sole project's realization, control and support for the final users. The structure of the standard makes flexible and modular means easy for implementation, based on the two principles:

- Modulation and
- Responsibility.

The modulation implicitly includes the processes satisfying the minimum and maximum of demands. Responsibility establishment for every procedure

alleviates the standard's application in the projects in which numerous participants are included.

2 THE AIM OF THE RESEARCH

The aim of this research is to verify whether the informatics companies are familiar with the standard ISO/IEC 12207, and what is the implementation level of standard's guidelines in managing their projects. Also, research should estimate if implementing level differs between companies in counties of Varaždin and Međimurje.

3 THE RESEARCH METHODOLOGY

3.1. Measurement instrument

A questionnaire was made for the investigation of the minimum of the standard's ISO/IEC 12207 demands in the informatics establishments of the counties Varaždin and Međimurje. The questionnaire has the total of 66 questions, distributed in 4 categories:

- The starting of the project – 11 questions,
- The project's domain – 23 questions,
- The project's quality – 23 questions,
- The project's impact on business success – 9 questions.

The questions in the questionnaire are the ones of the Likert type; they are the questions of intensity and are derived based on the norm ISO/TEC 12207. The research participants had to answer the questions by circling one of the suggested answers (1 - 5), where the mark 1 meant *I completely disagree*, and the mark 5 meant *I completely agree*. The highest mark described the complete business coordination with the standard ISO/TEC 12207.

3.2. Research participants

Informatics companies from Varaždin and Međimurje counties participating the survey were chosen randomly: eighteen project leaders from Varaždin and twelve from Međimurje counties. They were chosen not only as leading companies' project managing experts, but also as professionals responsible for strategic development and aligning projects' results to fulfil companies' mission and vision. Their knowledge, experience and opinions were of great benefit for research issues.

3.3. Research procedure

Survey was distributed to participants (to all registered informatics companies in Varaždin and Međimurje counties) by e-mail as electronic document. To emerge companies' staff, authors visited companies to present and clarify the research goal and expecting results from project

managers. Participants' anonymity and the privacy of gathered information was assured by using number codes. There were 50 questionnaires distributed among informatics companies. Such approaching to the participants was successful: 30 returned questionnaires were properly processed. It means that 60% of the planned number of good quality questionnaires was collected.

3.4. Data analysis methods

To assure good quality of the data and its analysis, measuring instrument validity and reliability were tested:

- Instrument validity was estimated by Content validity method, and
- Instrument reliability was estimated by Cronbach α coefficient.

To validate the quality of collected data, methods of descriptive statistics were used. To compare and explore the differences of the collected answers according to the level of ISO/IEC 12207 standard applied in the participated companies from Varaždin and Međimurje counties, Analysis of variance was applied (ANOVA).

3.4.1. The validity of the measurement instrument

To estimate the measuring instrument means to assure its proper function (how to measure) and determined measuring subject (what to measure) /5/. Not less significant is to assure proper level of instrument preciseness (measure correctness and variability). In most cases, the measurement instrument validity is based on correlation according to criteria variable. The criteria variable is a complex activity or the state of participants allowing empirical determination, or some other measurement instrument the validity of which has already been verified /6/.

There are three aspects of measurement instrument validity /7/:

- Contents',
- Criteria's, and
- Construct.

The contents' validity implies examination measured by an instrument which comprises the relevant contents of the measurement subject and explaining whether the representation of individual contents is appropriate. That mean of determining the validity is the most appropriate for the tests of knowledge and the tests of determining the amount the participants have learned in specific skills. The instrument is valid if it provides good representation of the contents measured and its specific features. To estimate the degree of the contents' validity is

mainly the object of quantitative estimation and theoretical verifiability.

3.4.2. *The reliability of the measurement instrument*

It is necessary to measure the reliability of the measurement instrument in order to prove that its use in repeated measuring would show equal measurement indicators. To approximate the reliability of an instrument, its degree of internal consistency should be determined, no matter what is the subject of measurement. Statistics procedures are often used in order to evaluate the instrument reliability. Procedures are used to calculate various reliability coefficients. It is considered, for the instrument to have a satisfying reliability, if coefficient of reliability is 0.70, some authors use 0.75 or 0.80 as cut-off value, while others are as lenient as 0.60. In general this varies by discipline /8/.

There are several methods used to estimate the reliability /9/:

- Repeated measuring,
- Applying the parallel instrument forms, and
- Exploring the internal instrument consistency.

The reliability estimation of a measurement instrument, based on the internal consistency, could be done in the way that:

- Each instrument particle is considered to be an individual instrument,
- The cross-correlations between all particles are calculated, and
- The whole instrument is evaluated based on the average amount of given particles' cross-correlation.

Cronbach α test is mostly used to apply described method by using the internal consistency coefficient. The α coefficient provides the lowest expected reliability estimation. If the coefficient is high, instrument is reliable, and if it is low, the measurement instrument is not reliable, so there is the need to explore reliability in another way. If the indicator comes close to 1, it does not mean that the instrument is perfect, but could also stress the redundancy of the particles' reliability.

3.4.3. *Analysis of variance (ANOVA)*

The most appropriate method to evaluate the difference among the collected data between informatics companies in Varaždin and Međimurje counties is the Analysis of variance.

The analysis of variance is a set of analytic procedures based on a comparison of two estimates of variance /10/. One estimates the differences

among scores within each group, and the second difference between group means, and this is considered to be a reflection of group differences or a treatment of effects and errors. If these two estimations of variance do not differ significantly, the conclusion is that all the groups means come from the same sampling distribution of means, and that the slight difference among them is due to a random error. Also, if the group means differ more than expected, it is concluded that they come from different sampling distributions of means and the null hypothesis should be rejected. So, the analysis of variance (ANOVA) is used for:

- Testing the hypothesis on the equality of arithmetic means of the k basic groups, by using the independent random samples,
- The analysis of the drafts of statistic experiments, and
- Testing the hypothesis on parameters (variables) in regressive models.

The division of the analysis of variance according to the number of independent variables recognizes the univariate and multivariate analysis of variance. For the purpose of this research for testing hypothesis on means equality of the two basic groups, in the analysis of variance were used:

- The null hypothesis (H_0) – arithmetic means of all basic groups are equal, meaning the differences among the arithmetic means can be described as random and are not significant, and
- The alternative (H_1) hypothesis – the arithmetic means are not equal, meaning the differences among the arithmetic means cannot be described as random.

3.4.3.1. *The assumptions for the use of the variance analysis method*

To successfully provide such test, based on random samples, following assumptions should be examined:

1. The variable whose arithmetic mean is tested is distributed according to the normal distribution. This assumption can be tested with help of the Kolmogorov-Smirnov test and the Shapiro-Wilk W test; and
2. The distributions of basic groups have equal variances. This assumption can be tested by the Leven test and the Brown-Forsythe test. The Leven test is mostly used to test the samples of equal sizes. While testing the samples of different sizes the Brown-Forsythe test is more sensitive and robust. If variances are not equal, the analysis of variance is pursued by the weighted analysis of variance, i.e. the Welch analysis.
3. The samples chosen from the basic groups are

independent. The independence of samples is ensured by randomly chosen participants.

3.4.3.2. Testing the hypothesis on equality of arithmetic means of K basic groups – the single factor analysis of variance

Let us assume that one sample of n element size is chosen out of every K normally distributed basic groups with equal variances. The sum of squares of deviations of the element values in each sample from the common arithmetic value can be established in partitions /11/:

$$\sum_{i=1}^n (x_{ij} - \bar{X})^2 = n(\bar{X}_j - \bar{X})^2 + \sum_{i=1}^n (x_{ij} - \bar{X}_j)^2$$

x_{ij} - i^{th} variable value from the j^{th} sample

\bar{X} - great arithmetic mean (of all samples)

\bar{X}_j - arithmetic mean of the j^{th} sample

The analogue partition was applied to provide the sums of squares for each of the K samples. Adding all K expressions provides square sums of deviations of all K samples containing n elements,

$$\sum_{j=1}^K \sum_{i=1}^{n_j} (x_{ij} - \bar{X})^2 = n \sum_{j=1}^K (\bar{X}_j - \bar{X})^2 + \sum_{j=1}^K \sum_{i=1}^{n_j} (x_{ij} - \bar{X}_j)^2$$

i.e. analysis of variance /12/.

The total sum of squares of variance deviations, belonging to the common arithmetic mean, is divided in two partitions. The left part of the equation of the analysis of variance represents the sum of squares of deviations of the arithmetic mean from each sample of the great arithmetic mean, whereby the mentioned sum is multiplied with the number of elements n , chosen for the sample.

The second part of the equation of the analysis of variance on its right side represents the sum of squares of variable deviations of each element from the arithmetic mean of the related sample. These squares of deviations are firstly summed within each sample, thus this part is based on the variances within each sample. Afterwards all the sums of deviations within the sample are summed for all the samples. The essence of applying the Analysis of variance method in testing the hypothesis, is in the fact that using each of the two sums of squares of deviations, the variance of the basic groups could be evaluated, starting with the null hypothesis as being true. The estimated variances of the basic type are also called the "mean square".

If null hypothesis is true, the differences between arithmetic means are random, not significant. If the

variance estimation of the basic sample generated by the sum of squares according to variations between the groups is much higher than the variance estimation generated by the sum of squares according to variations within the groups, the conclusion is that the variations between arithmetic means are not random and H_0 should be rejected, whereas H_1 should be accepted: arithmetic means of basic samples are equal. The decision, whether the difference of basic sample variances estimations is random or significant, is made based on the two evaluations of the basic group variance /13/:

$$F = \frac{\delta_2^2}{\delta_1^2}$$

Sample distribution of F indicators is theoretical F - distribution used for hypotheses confirmation. In order to test the hypotheses, one establishes the theoretical value F under certain degrees of freedom and for the chosen level of the testing significance. If the empirical calculated value F is of smaller value than the theoretical one, the differences between the two variances estimations of the basic groups can be described as random, it is concluded that the null hypothesis can be accepted. Contrariwise, if the calculated value F is equal to or higher than the theoretical value F , one concludes that the difference between the two variance estimations is the one of the basic group and significant on the chosen significant level. This means that the null hypothesis should be rejected and the alternative one should be accepted. The same issue could be provided based on the probability value p . With the significant value $\alpha=0,05$ and the value p higher than 0,05, one cannot reject the null hypothesis, meaning the differences between the samples arithmetic means are random and not significant, while on the contrary, if the value p is, with the significant level $\alpha=0,05$, less than 0,05, one cannot determine that the differences between the samples arithmetic means are random, on the contrary, they are significant.

4 THE RESEARCH RESULTS

Before the analysis of collected data started, the reliability and validity of the measurement instrument are explored to assure quality of the instrument:

- The validity was established through the construction of instrument content; the aligning of the stated questions and the way of how they are grouped, and the ISO/IEC 12207 standard requests applying in business processes is verified.
- The reliability of the measurement instrument

is verified through instrument internal consistency by Cronbach α coefficient. The reliability analysis, according to the questionnaire categories, issues coefficients' values of good quality:

- For the category of questions on starting the project, the Cronbach coefficient α was 0.76166
- For the category of questions on the project's domain, the coefficient was 0.78437
- For the category of questions on the project's quality, the coefficient was 0.78044, and
- For the category of questions on project's influence on business, the coefficient was 0.65441.

As all Cronbach coefficients α are higher than 0.7, except the part of the project's influence on business, the α value of which is 0.65441, what is considered as acceptable by certain authors, one can rely on the measurement instrument and its measurement results. By calculating average degree the following results were obtained (Table 1).

Parts of the questionnaire	The county	
	Vara�din The average mark	Međimurje The average mark
Starting the project	3,91	3,77
The project's domain	4,03	3,88
The project's quality	4,03	3,71
The project's influence on business	4,22	3,93

Table 1: The average grades of certain categories of questions

In the previous table and the next graphic chart it is clearly visible that the examinees from the informatics companies from the county of Vara din gave a higher average grade for each category of questions, which leads to a conclusion that the project managers from the county of Vara din are more familiar with and apply more often the standard ISO/TEC 12207. It is interesting to notice that the average grade in both counties was approximately 4.00, which refers to a satisfying knowledge and applying the standard to business processes.

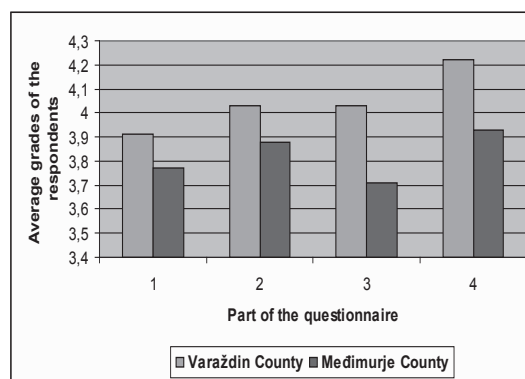


Figure 1: The average degree according to individual categories of questions

Before using the analysis of variance method, three basic assumptions were tested:

- Given results are congruent to a normal distribution,
- The variances of examined categories are statistically equal, and
- The categories of questions that were tested are independent.

The independence of samples was ensured through the process of collecting data, while the following two assumptions were tested by applying certain tests. The results of testing the data normality are shown in the following pictures.

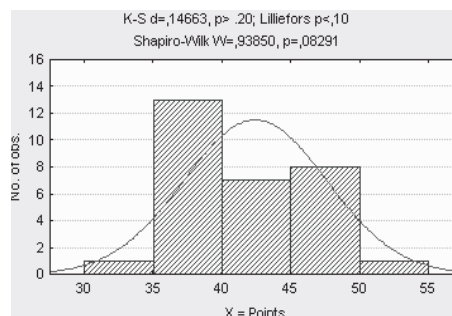


Figure 2: Grades achieved for category conditions for starting the project

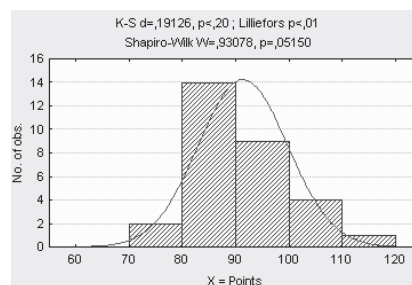


Figure 3: Grades achieved for the category project domain

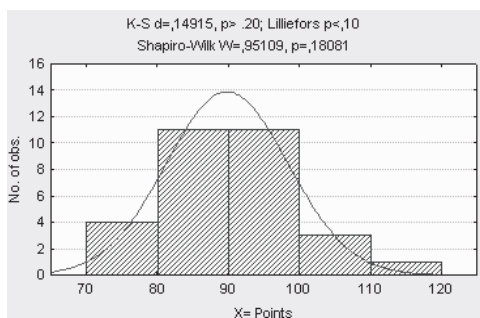


Figure 4: Grades achieved for the category project's quality

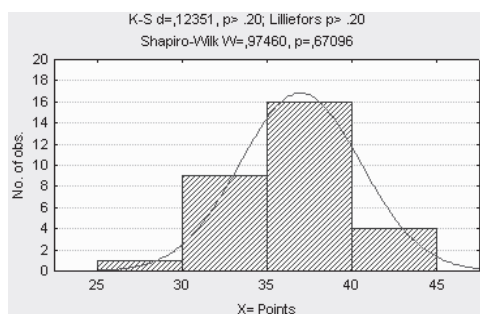


Figure 5: Grades achieved for the category project's influence to the company business success

Looking at the previous pictures and the probability value p at the significant level $\alpha=0.05$, it could be concluded that all distributions are close to normal distribution. The homogeneity of variances was tested via Leven and Brown-Forsythe tests. The data on variance homogeneity follow in Table 2.

Parts of the questionnaire	Tests on variance homogeneity	
	Leven test	Brown-Forsythe test
	p-value	p-value
Starting the project	0,153	0,133
Project's domain	0,607	0,600
Project's quality	0,811	0,722
Project's influence on business	0,564	0,569

Table 2: The tests results on variance homogeneity

The null hypothesis (H_0), that the variances of both compared samples are equal, is also proved by probability value p , which is for all parts of the questionnaire higher than $\alpha=0.05$. All previous results indicate that all assumptions for the use of the analysis of variance method are satisfied. The results of analysis of variance used for determination of differences between arithmetic

means of samples from counties of Vara zdin and Međimurje in the knowledge about and application of the standard for informatics projects management follow in Table 3.

Parts of the questionnaire	Variance analysis	
	F-value	p-value
Starting the project	0,525	0,475
Project's domain	1,429	0,242
Project's quality	6,186	0,019
Project's influence on business	4,764	0,038

Table 3: Analysis of variance

- Stated hypothesis:
 $H_0... \mu_1 = \mu_2 = \mu$ and $H_1... \mu \neq \mu, j=1.2.$
- The significance level $\alpha=0.05$.

The test values are empirical F - ratios: $F=0.525$ for starting the project, $F=1.429$ for the category project's domain, $F=6.186$ for the category project's quality and $F=0.746$ for the category of questions concerning project's influence on business of a company. Theoretical value of distribution for the value $\alpha=0.05$ and for the number of degrees of freedom $df=1.28$ is 4.21.

This provides the empirical F -ratio which is smaller than the theoretical value for the categories of starting the project and project's domain, which results in accepting the null hypothesis on the significance level. The conclusion stays the same if it is based on the value p . This value is higher than the significance level $\alpha=0.05$, for the categories of questions of starting the project it is 0.475 and for the category of project's domain it is 0.242, which refers to accepting the null hypothesis. One cannot accept the assumption, based on given results, that there is a difference in applying the standard for the first two categories of questions between the ways of work of companies in the counties of Vara zdin and Međimurje.

The opposite decision was made for the categories of questions on project quality and for the category project's influence on business success, where the empirical F ratio for the category project quality is $F=6.186$ and for the category of project's influence on business $F=4.764$, while the theoretical value is 4.21 for the significance level $\alpha=0.05$ and the degrees of freedom $df=1.28$, which leads to conclusion that the differences in arithmetic means between the companies of counties of Vara zdin and Međimurje are not random, they are significant. The same decision is made based on the value p , which is 0.019

for the significance level $\alpha=0.05$ for the category of questions on project quality, and 0.038 for the category project's influence on business success. The obvious similarity for the first two categories and the significant difference for the second two categories, according to applying the standard are also visible through arithmetic means of samples from counties of Vara zdin and Međimurje, showed in pictures 6 to 9.

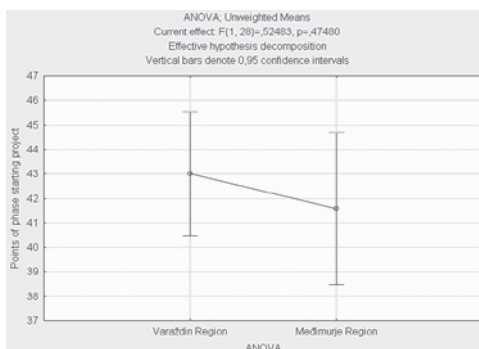


Figure 6: Starting the project - analysis of variance (ANOVA)

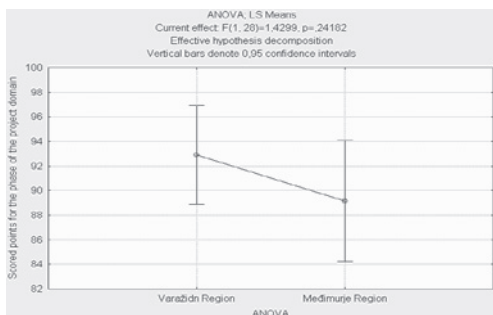


Figure 7: Project's domain - analysis of variance (ANOVA)

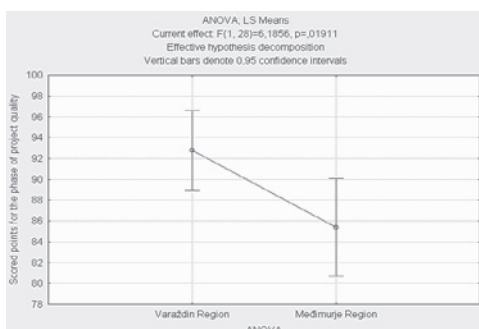


Figure 8: Project's quality: analysis of variance (ANOVA)

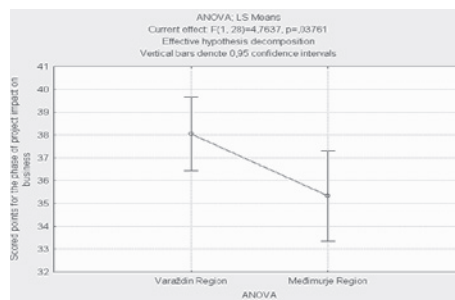


Figure 9: Project's influence on business success – analysis of variance (ANOVA)

5 CONCLUSION

In order to successfully manage informatics projects it is important to have knowledge and experience to apply standard ISO/IEC 12207, providing guidelines for project planning, implementation and realization. The research in the counties of Vara zdin and Međimurje provided estimation whether there is a minimal group of processes, activities and tasks, defined by the standard ISO/IEC 12207, embedded in project management in informatics companies. Also, familiarity to the standard's content and how this knowledge makes difference in using the standard between the companies in the counties of Vara zdin and Međimurje, was investigated.

The result analysis of the providing research pointed out that the knowledge about requests of the standard ISO/TEC 12207 implementation in the informatics companies business in both of the counties is satisfying, according to the fact that the average grade in the questions categories was approximately 4.00. The variance analysis provides significant difference in application of the standard in the counties of Vara zdin and Međimurje; the differences are in the categories of questions regarding the project quality and project's influence on companies business success, which provides the conclusion that the companies in the county of Vara zdin take the technological coordination with the international standards more seriously, meaning that the informatics companies manage their projects in a more congruent manner to the standard mentioned.

Such results are expected and the research determines the real state of the informatics market, There are more informatics companies in the county of Vara zdin having more employees, a wider business domain, good practice and academic and experience community in informatics field.

The research results indicate, among other things, that the project managers in informatics companies

have developed the consciousness on the importance of constant technological improvement and the aligning with the international guidelines, if they wish to be recognizable in the market and keep pace with the competition to reach business prosperity.

In spite of valuable issues, a lack of expert knowledge to recognise the quality parameters influencing companies business success strongly should be stressed. Project issues need organisational changes and new organisational knowledge and culture. Project coordination request unique and specific knowledge based on flexible coordination between project and classical way of running business. The clash of classic and project organisational cultures is the main cause of problems in informatics business, especially the ones according to the fast information-communication technology development. Implementing project management to run informatics companies is the tool how to avoid obstacles making business mess.

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