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Project success analysis framework: A knowledge-based approach in project management

Marija Lj. Todorović [a,*], Dejan Č. Petrović [a,1], Marko M. Mihić [a,2], Vladimir Lj. Obradović [a,3], Sergey D. Bushuyev [b]

[a] Management and Specialized Management Disciplines, University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia
[b] Project Management Department, Kiev National University of Construction & Architecture, Kiev, Ukraine

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Abstract

One of the major issues for knowledge management in a project environment is the poor project success analysis and the lack of proper documentation on the results of the previous projects. In this research, we investigate in which way project success analysis, presented as a framework, can improve knowledge management in project environment. An empirical research was conducted in order to define the contribution of project success analysis framework to knowledge management in project environment. The data was gathered from 103 project managers in different industries in Serbia during 2013. Research results have confirmed that project success analysis, presented through the definition of critical success factors, key performance indicators and performance-measuring process has a very positive influence on knowledge acquisition and transfer in project environment. This paper presents an integrated framework for project success analysis as a new knowledge-based approach in project management.

Keywords: Project success analysis framework; Project knowledge management

1. Introduction

An increasing number of organizations are implementing their business operations through projects (Kerzner, 2001). By definition, projects are temporary organizations, limited by a certain scope, and implemented within a certain amount of time (PMI, 2004). Due to an organization's fragmentation into project teams, knowledge management and retention becomes necessary (Disterer, 2002; Gann and Salter, 2000; Hanisch et al., 2009; Kang, 2007). Studies have proven that most employees (85%) working on a project gather new knowledge, both explicitly, as well as implicitly, through experience (Turner et al., 2000). Learning in project environment becomes so important for the organization that even the success of a project is determined according to the following two dimensions: project performance and project learning (Arthur et al., 2001). Continuous learning and development is considered to be the highest level an organization can reach in terms of project management maturity. Without summarizing the lessons learned in this process, an organization can even backslide to a lower level in project management (Williams, 2007). Nevertheless, the general conclusion is that only a small number of project-oriented organizations manage to implement systems for identifying and transferring knowledge from past to future projects (Bou and Sauquet, 2004; Disterer, 2002; Hanisch et al., 2009; Kang, 2007). The same authors stress

* Corresponding author. Tel.: +381 69 8893 373.
E-mail addresses: todorovicm@fon.bg.ac.rs (M.L. Todorović), dejanp@fon.bg.ac.rs (D.Č. Petrović), mihicm@fon.bg.ac.rs (M.M. Mihić), obradovicv@fon.bg.ac.rs (V.L. Obradović), sbushuyev@ukr.net (S.D. Bushuyev).
[1] Tel.: +381 69 8893 219.
[2] Tel.: +381 63 493 137.
[3] Tel.: +381 63 493 180.

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numerous challenges of knowledge management in project environment, such as: the lack of procedures and routines for data gathering, the lack of reports and other documentation on the results of the previous projects, and inconsistent documentation that does not always fit the needs of projects.

Certain authors believe that information regarding a project can also be gathered through analysis and monitoring of project results emphasizing the need for collecting information on project success and project performances in order to establish a knowledge base that would enhance the process of managing future projects (Hanisch et al., 2009; Love et al., 2005; Williams, 2007; Yun et al., 2011). After reviewing literature from the area of project management, we can easily detect the trend of defining project management success, determining the factors and criteria of success (mostly summarized in Ika, 2009), measuring the achieved project performance (Bryde, 2005; Keeble et al., 2003; Kerzner, 2011; Kujala et al., 2009; Pillai et al., 2002; Qureshi et al., 2009; Wasioyo, 2010) and analyzing the maturity of an organization in the process of reporting on a completed project (Von Zedtwitz, 2002; Williams, 2007).

It is for that reason that the authors' initial research question was: can the information relevant for a previous project be gathered in a systematic manner, by analyzing and measuring the achieved results, and can this method of project analysis enhance the acquisition and transfer of knowledge from past projects. In the continuation, this paper focuses on the key challenges of knowledge management in project environment and stresses the importance of some of the key challenges.

2. Literature review

2.1. Project knowledge management — benefits and challenges

Knowledge management in project environment is an insufficiently explored topic in project management. Namely, the studies conducted so far mostly relate to individual cases or industries (Bresnen et al., 2005), specific project types (Fong, 2003) and case studies (Koskinen, 2004). Over the last couple of years, the scientific community published papers referring to the influence of knowledge management on project performances. Kulkarni et al. (2007) developed their own theory about knowledge management model on the hypothesis that a higher quality of knowledge, i.e. content of the available knowledge, has a positive influence on knowledge transfer. Lessons learned from projects can lead to far-reaching changes in an organization's strategic focus (Brady and Davies, 2004). The mix of knowledge and expertise developed within project teams positively influences an organization's long-term success (Ordanini et al., 2008), creating knowledge about the values the project results should generate; organizational change knowledge, i.e. knowledge about "solutions" used, about technology and possible changes that might influence the project or are necessary in order to implement project results; and technical design knowledge relating to a specific area the project is implemented (Reich et al., 2012). The positive influence of knowledge management on project performances was confirmed in studies by Faraj and Sproull (2000), Kotnour (2000), Lee and Choi (2003), Barber and Warn (2005), and Quigley et al. (2007). The influence of learning processes on project performances is also present in quality management and operational management studies, where authors often rely on tools such as Six Sigma (Arumugam, et al., 2013; Edmondson et al., 2003). One of the latest studies from the field of project management underlines the importance of managing the project-based knowledge in order to create added value for clients (Reich et al., 2012).

Numerous studies have pointed to evident faults in the process of information gathering during a project realization and their synthesis into a form that would enable learning and the transfer of knowledge to other projects and the entire organization. In most cases the challenges of knowledge management in project environment are as follows:

- The lack of routines and other appropriate learning mechanisms, as well as the availability of the previously learned lessons and reports from the previous projects (Hanisch et al., 2009).
- Documenting project operations, i.e. recording their organizational processes, rarely fail to fully reflect the course of procedures and activities, which is why their purposefulness is doubtful (Bou and Sauquet, 2004).
- The lack of efficient and effective forecasts, insufficient communication and exchange of information, inadequate use of the previous experience and lessons learned (Desouza and Evaristo, 2006; Huang and Newell, 2003; Koskinen, 2004).
- The uniqueness of projects and their long life cycle; therefore, a long time interval passes before lessons are retrieved, while projects' temporary nature requires new team meetings for each project (Desouza and Evaristo, 2006).
- Action-and-task orientation of project-intensive organizational structure (i.e. temporary organization), where project team members are not geared for learning. Individuals become more able and experienced; nevertheless, there is often no mechanism or motivation for that knowledge to be shared within the company (Williams, 2007).
- A contradiction between short-term goals of projects and long-term goals of organizational learning, where knowledge management depends on the degree of projectization of the company, i.e. on the level of a firm's project maturity (Bresnen et al., 2004).

Regardless of the mentioned challenges, learning from projects represents a unique opportunity for gathering new knowledge and exchanging experiences between teams in an organization (Sense, 2003, Jovanović et al., 2009). Nevertheless, from the previously stated arguments, we can clearly conclude that there is a serious lack of a method for systematic project knowledge accumulation which prevents organizations to properly transfer the knowledge. Knowledge management in an organization implies both explicit and tacit knowledge, i.e. there are methods for passing on knowledge through people

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and through documented information (Carillo, 2004). In their papers Nonaka and Takeuchi advocate an approach according to which tacit knowledge has to be externalized in an explicit form in order to be passed on, i.e. that the conversion of tacit knowledge into an explicit form leads to the creation of new knowledge (Nonaka and Toyama, 2003). Haldin-Herrgard (2000) believes that tacit knowledge should remain in a tacit form, because a significant portion of information can be lost in these conversions, which is why oral information distribution is sometimes regarded as preferential. In other words, the first approach is based on the codification and the other on personalization (Bredillet, 2004; Hansen et al., 1999; Prencipe and Tell, 2001).

As it was already mentioned in this paper, after analyzing individual projects, certain authors believe that the gathering of information on project results can represent an excellent way for establishing a knowledge base that would be useful for managing future projects (Hanisch et al., 2009; Love et al., 2005; Williams, 2007; Yun et al., 2011).

The aim of this paper is to present a framework for analyzing project success that will enable others to gather information on project results achieved in different segments, as well as to examine the influence of the proposed concept of knowledge management in project environment. This refers more to the first of the two abovementioned opinions because it stresses the importance of converting tacit knowledge into an explicit form, thus contributing to the assimilation of tacit knowledge. This enables us to integrate success analysis into management systems, which represents an excellent opportunity for regarding knowledge as the key motor of development.

2.2. Project success analysis

During the 80s, in the XX century, scientists mostly observed traditional criteria for evaluating projects, such as time, costs and quality, while, in the 90s, authors start to conduct studies showing that project success is a multi-dimensional category, as well as that different people have different ways of evaluating project success (Fortune and White, 2006; Prabhakar, 2008). If we take into consideration only time, costs and quality, we will manage activities focusing on the three abovementioned limitations. The development of project management suggests that new models for project performance management should reflect the multidimensionality (more participants/stakeholders) of a project, quality of processes, as well as quality of products. In organizations implementing multiple projects, there is a growing need for a model that would enable project performance management (Kujala et al., 2009; Westerveld, 2003). It has been a long time since theoretical enhancements relating to project success were accompanied by an adequate project management model, not because there is no need for such a model, but because there are practical problems concerning project evaluation that do not relate to costs, time and quality. Morris and Jamieson (2004) stress that one of the ways to comprehensively manage projects is to create a model (framework) that would establish a connection between critical success factors and success criteria.

The first paper that defines critical success factors (CSFs) was published as late as in 1979 (Fortune and White, 2006). According to this definition, they represent a limited number of areas in which the results, if satisfactory, provide successful competitive performances for an organization.

It is believed that defining success factors represents a prerequisite for an organization's success and a way for measuring its maturity level (Khandelwal and Ferguson, 1999). The lists of most common CSFs were presented by Cooke-Davies (2002), Judgev and Muller (2005), and Ika et al. (2012), but the general conclusion is that there is no CSF list common to all projects. Fortune and White (2006) presented a review of 63 publications that focus on CSFs. Based on their research, it is clear that there is only a limited agreement among authors on the factors that influence project success. The same authors propose the use of formal system model (FSM) for analyzing project success. This model involves a set of subsystems: a decision-making subsystem, a performance monitoring subsystem and a set of subsystems that carry out transformations. Another group of authors believes that there are different perspectives for analyzing project success and, among other things, advocates the use of project life cycle concept for evaluating and analyzing project success (Yu et al., 2005).

In order to be able to manage something, we have to know how to measure it, which means that a connection has to be established between CSFs and project success measurement. There is a difference between critical success factors and project success criteria. Critical factors are the factors that contribute to achieving project success. On the other hand, success criteria are measures for determining whether a project is successful or not. The factors that make up success criteria are called key performance indicators (KPIs) (Cooke-Davies, 2002). The KPIs represent a set of measurable data used for evaluating and measuring performances in implementation phase (Kerzner, 2011; Wasioyo, 2010). One of the challenges for contemporary project managers is to determine which critical measures will guarantee project success for all stakeholders. A project manager is to define measures and KPIs based on the partner relations between project manager, client and other stakeholders (Keeble et al., 2003, Todorović et al., 2013).

Having in mind that projects are often influenced by a vast number of factors and that performance indicators do not always have the same importance, Pillai et al. (2002) propose an integrated approach to project performance evaluation, based on active participation in projects and studies involving research and development projects, introducing the Integrated Performance Index (IPI). The IPI is supposed to adequately reflect project performances in any of the life cycle stages, integrating key factors from all stages of project life cycle.

3. Project success analysis framework

The proposed concept is based on the previously presented concepts, methods and research results. It is based on the presumption that each project depends on the unique environment

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specific to the organization where it is implemented, as well as that it also has a wider environment, involving external factors we cannot influence; nevertheless, these external factors can be influenced by project results later on (Engwall, 2003). The goal of presenting project success analysis concept is to point to steps that would enable efficient and consistent monitoring and evaluation of project success during the entire life cycle and enable systematic analysis of the success of the entire project, aiming to enhance knowledge management in project environment. The concept is based on CSFs, project performances, KPIs and project environment methods and models developed so far. The integrated concept of project success analysis is discussed in the next sections.

3.1. The definition of a project's CSFs

Within this step it is necessary to look at the wider project environment, i.e. to look at all factors from the surrounding environment, external to the organization where the project is implemented (Fortune and White, 2006) In addition, it is essential to analyze the environment specific to the project, i.e. the organization where the project is implemented (Engwall, 2003; Thamhain, 2004). It is necessary to take into account all events in the organization relating to the project, processes, procedures, rulebooks and specifications that represent the base for project documentation, availability of human and other resources, technology, the necessary support, etc. On project level, the focus remains on developing the main idea, establishing plans, team organization and leadership, organizing implementation, monitoring the implementation of project activities, delivering results, making decisions, solving conflicts, managing risk, etc. An overview of project management elements, i.e. areas (PMI, 2004), clearly defines key factors for a project's success. The analysis of these elements generates an integrated list of CSFs for a project.

According to Gasik (2011) the identification of needed knowledge is possible at the project level when a manager passes a description of needed knowledge along with the task definition to a team member who is performing an activity. If a similar or the same activity has previously been executed, project team can acquire the knowledge necessary for performing an activity or solving a problem. If it is necessary to gather micro knowledge from project environment, team members have to participate because they are the only ones with authorization to accept activities outside of project scope. The establishment of CSFs creates a base for defining the knowledge necessary for implementing the project, as well as for defining the control parameters.

Since all CSFs do not appear and realize in all project phases, it is necessary to establish a method for an efficient monitoring and measuring of success, thus encompassing all critical success factors (Keeble et al., 2003; Westerveld, 2003). It is for that reason that in this step a project can be presented through life cycle stages, after which the previously defined CSFs can be linked to phases where they appear (Yu et al., 2005). By linking critical success factors to the adequate project life cycle phases, we facilitate the definition of measures that can be used for evaluating project performances and for analyzing project success.

3.2. The definition of a project's KPIs

The basic role of well-defined KPIs recommends future actions and enhances the decision-making process (Kerzner, 2011). Relying only on success criteria such as time, costs and quality leads to an overly narrow definition of project success measures. In his research, Bryde (2005) indicates that the establishment of KPIs without any regard for the project team, organization in which the project is implemented and the environment it generates, can represent a serious obstacle for enhancing project performances. This is why it is necessary to take into consideration the success factors. In addition, certain authors link CSFs and success criteria, for example Morris and Jamieson (2004) and Westerveld (2003), while Qureshi et al. (2009) in their model project management performance assessment (PMPA) stress the need for establishing KPIs as a prerequisite for measuring the achieved project performances. Furthermore, it has been confirmed that project life cycle has an important role in establishing KPIs and measuring project performances (Keeble et al., 2003; Khang and Moe, 2008). All this leads to the conclusion that for each phase of a project's life cycle it is necessary to define measures, according to CSFs specific to that phase, which will serve as basic parameters for evaluating project success. A targeted level is then established for each defined measure and project activities are to reach the targeted level (Kerzner, 2011).

Having in mind the vast number of measures used in project management, as well as the large number of the measures able to reflect a project's success, it is necessary to focus on key performance indicators.

Project knowledge is implemented on project level, because its implementation is integrated with the execution of activities, also managed at project level. The definition of project performance measures and KPIs involves a detailed analysis of all elements of a project and direct identification of the knowledge necessary for performing project activities. In addition, gathering a large number of information on a project currently being implemented contributes to acquiring new knowledge and to its integration into existing project management knowledge base.

3.3. Measuring project success according to defined KPIs and documenting results of success measurement

In this step, it is necessary to document, i.e. record, the level of each individual KPI, which is extremely important for project and organizational sustainability (Keeble et al., 2003), as well as for the decision-making process aimed at future activities (Bryde, 2005; Kerzner, 2011). During project implementation, there are events and results that cannot be accurately measured — in those cases we can only establish a satisfactory level of achievement. This is why data gathering processes are important as a tool that facilitates measuring and evaluation (Mihić et al., 2014). Sometimes, an information gathering method is developed during

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project implementation, but it is necessary to define methods for gathering, analyzing and distributing data during the planning phase.

The uneven importance of the established KPIs, as well as the fact that exceeding a targeted level (high value of KPIs) may have negative effects on the project, point to a need to establish a common analysis method for all KPIs when evaluating project performances and analyzing the success of a project (Pillai et al., 2002). In a certain phase of a project, each KPI is attributed a grade in relation to other KPIs, after which it is necessary to establish a weighted coefficient for each indicator. It is very important to independently analyze each indicator that exceeds the targeted level (i.e. has a high value) and the negative influence it may have on the project (such as: the number of complaints, quantity of waste, and number of risk events).

3.4. Final evaluation of project success and creation of the final project report

By measuring project success according to the defined KPIs we can achieve a more comprehensive evaluation of the project. Learning based on post-project audits is considered to be one of the 10 best practices (Williams, 2007). Nevertheless, according to a research that included 27 interviews (in Hewlett-Packard, DaimlerChrysler, SAP, Unisys, the US Army), reports on completed projects are a rarity even in large organizations (Von Zedtwitz, 2002). This is often contributed to a lack of time, will, organizational or individual ability to draft a report. However, this will also show us whether there were any deviations in the project, in which areas, processes and/or end results and whether these deviations show any signs of a permanent trend. Since the achieved results are measured during project implementation, these data can direct us towards corrective measures that would decrease deviations at the end of project implementation. In other words, the data gathered in a previous step will indicate whether it is necessary to enhance performances and/or processes, as well as whether the defined KPIs are valid for that particular case. It is necessary to keep documented records about the implementation of each individual step, according to a previously defined template.

The implementation of project success analysis concept can be presented through an algorithm (Fig. 1). The prerequisites for executing the abovementioned steps are: an orderly project management process, a previously established reporting system and templates for project reports, the defined distribution of responsibilities, as well as a previously established method for data collection, analysis and distribution.

The presented project success analysis process contains steps used for gathering information necessary for evaluating project performances according to defined KPIs. Based on this, we can conclude that project success analysis has to be linked with knowledge management in project environment in order to provide for a more efficient gathering of adequate information that can be passed on and increase the knowledge base. In the continuation of this paper, we will try to point to basic sub-processes in project environment knowledge management that served as a basis for this research. The following knowledge management sub-processes occur at project level: externalized learning, identification of needed knowledge, knowledge acquisition, knowledge creation, knowledge transfer, knowledge application, identification and documentation of gathered knowledge (Gasik, 2011).

The main hypothesis of this study is:

H0. The implementation of an adequate project success analysis can contribute to knowledge management in project environment.

The abovementioned link was formed based on the following hypothesis and its auxiliary hypotheses:

H1. The definition of CSFs contributes to knowledge management in project environment.

H2. The definition of KPIs contributes to knowledge management in project environment.

H3. The documentation of results relating to project success evaluation according to the defined KPIs contributes to knowledge management in project environment.

H4. Reporting on the final results of project success evaluation contributes to knowledge management in project environment.

4. Research method

4.1. Questionnaire design

In order to confirm or disprove the previously defined hypothesis, the authors have established a statistical model in which they have considered 5 variables, 4 of which are independent as the elements of project success analysis and 1 of which is dependent and relates to the acquisition and transfer of knowledge from the previous projects. The questions were based on literature overview and previous studies in this field. Afterwards, the authors conducted structured interviews with project managers in different industries, after which the questions were modified in order to generate the most precise answers.

The questionnaire was divided into three parts. The first part of the questionnaire was composed of questions relating to demographic characteristics of respondents: branch of industry, education, position on the project, and number of projects they participated in.

4.1.1. Independent variables

In relation to the previously mentioned literature and research, the second part of the questionnaire contains questions regarding the definition of factors that influenced the success of their projects, i.e. the level in which they defined the CSFs in relation to immediate project environment – organization in which the projects are implemented; wider project environment – outside of the organization in which the projects are implemented; and the project itself (Cooke-Davies, 2002; Engwall, 2003; Fortune and White, 2006; Ika et al., 2012; Khang and Moe, 2008; Thamhain, 2004). Furthermore,

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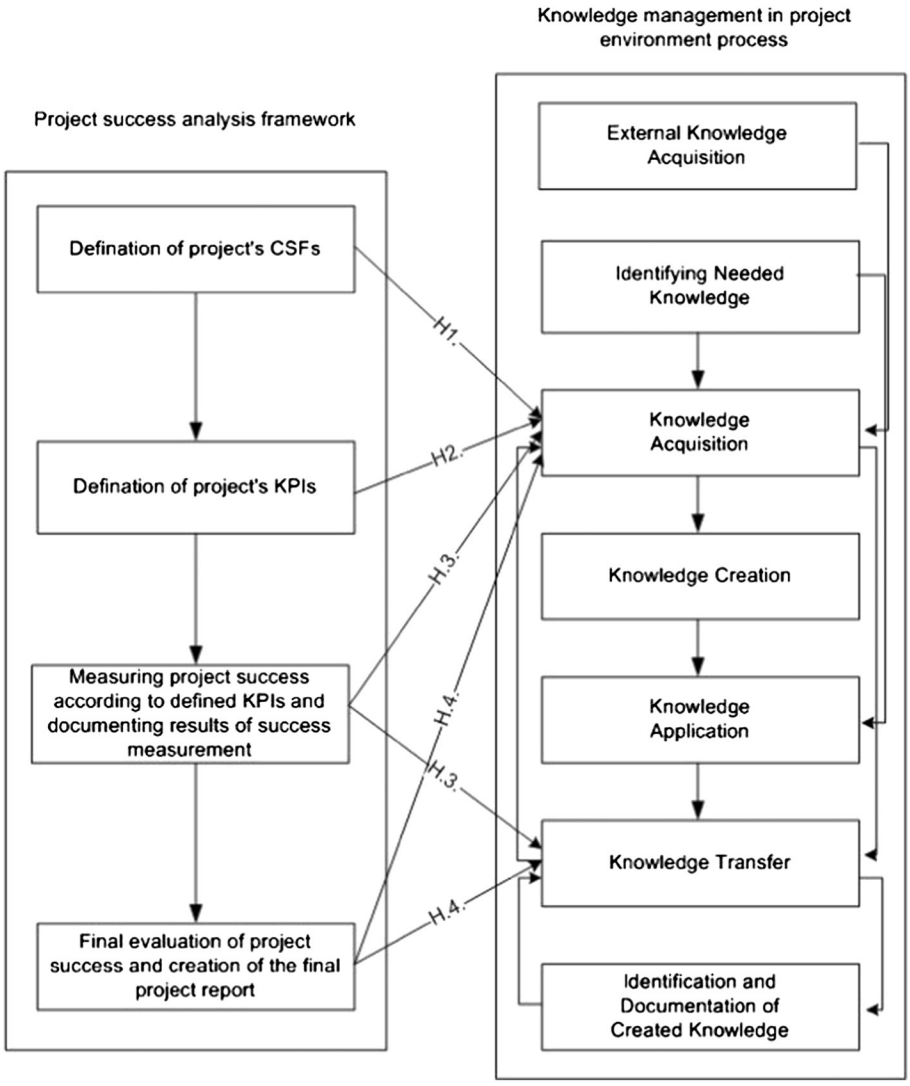

Fig. 1. Project success analysis framework aimed at enhancing knowledge management in project environment.

the questions also related to the level in which they determined the measures of performances and KPIs used for measuring project success (Qureshi et al., 2009; Westerveld, 2003). Afterwards, the authors examined whether the respondents are using previously defined KPIs for measuring project success and at which extent the results of project success analysis are documented according to the previously defined KPIs (Keeble et al., 2003). The documentation of the project results is linked with the next part of the questionnaire. That part of the questionnaire relates to determining the frequency of reporting on completed projects (Von Zedtwitz, 2002; Williams, 2007).

4.1.2. Dependent variable

Since the lack of documentation and documentation inadequate for users' needs, as well as underdeveloped routines and procedures for gathering and transferring information are regarded as frequent obstacles when it comes to knowledge management in project environment, the authors wanted to examine whether this represents a real problem. Because of that, the third part of the questionnaire contains questions relating to knowledge management problems. The respondents were asked to grade the level in which they are able to acquire project knowledge by documenting the achieved results, changes, problems and risks on a project. In addition, this paper examines whether the knowledge from the previous projects can be transferred using reports and other documentation relating to project results.

One of the goals of this research was to determine the link between enhancing project management and gathering and transferring knowledge acquired during the previous projects. Consequently, the respondents were given a choice to opt for the most prominent benefits generated by the knowledge they acquired from the previous projects and to grade the extent to which certain elements of project management were enhanced.

After reviewing literature published so far on this topic, the authors have determined that there are no scientifically established scales (measures in percentages) when it comes to the relevance of defining KPIs, CSFs, project documentation and reporting, gathering and transferring knowledge through the means of project documentation. Therefore, the respondents

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were offered to choose between categories for each question, based on which they were asked to provide answers. This type of questionnaire is most often used in project management researches (Ika et al., 2012; Khang and Moe, 2008; Müller and Turner, 2007; Qureshi et al., 2009). On the other hand, categorical variables are not adequate for conducting multiple regression, as one of the most frequent types of analysis in this area. Consequently, the questions relating to the acquisition and transfer of knowledge using documentation from the previous projects were summed up in a scale and represent an interval dependent variable, which satisfies one of the prerequisites for using multiple regression analysis (De Vaus, 2002).

4.2. Sample description

Out of 400 distributed questionnaires to project managers in different industries (i.e. construction sector, IT sector, energy sector, public sector, education, NGO, agro-industry) 107 or 26.75% participants have completed the survey, 4 questionnaires have been rendered as inadequate on the grounds of being incomplete. Therefore, only 103 questionnaires have been taken into consideration. 54% of respondents were project managers or coordinators of several projects, while the remaining respondents were project team members. As much as 45% of them participated in over 15 projects. 93% of respondents hold a university degree. Besides the abovementioned demographic data, the research also encompassed questions relating to the definition and measuring of project success, as well as methods for documenting the data gathered through measuring. The following section presents the results of the research processed in SPSS 17.0.

5. Data analysis and results

5.1. Data reliability

One of the basic prerequisites for regression analysis is the independency of variables observed. In order to detect the possible autocorrelation between the variables, the authors used Durbin–Watson test (Durbin–Watson = 2.054), whose value indicates that there is no autocorrelation (Savin and White, 1977). In addition to this, the authors verified whether there are certain deviations in relation to the remaining responses. Mahalanobis' distance (MD) has a maximal value of 21.901 (which is $p < 0.001$ above the acceptable level). After sorting all cases, the authors concluded that only one case deviates, i.e. has a higher MD value than the one indicated as acceptable, as well as that Cook's Distance is ($0.182 < 1$), which is why all cases were taken into consideration.

The reliability of data was verified for each research construct using Cronbach's alpha. Cronbach's alpha for the construct of project success analysis equals 0.816, which is above the acceptable 0.7 (Pallant, 2005). These results point to the reliability of further analysis, without the need to exclude certain parameters.

5.2. Pearson's correlation and linear regression

In order to prove the stated hypotheses, we have isolated four key independent variables: 1) *the definition of CSFs*; 2) *the definition of KPIs*; 3) *documentation of project success evaluation according to KPIs*; and 4) *creation of final project report*.

Further research was aimed at establishing whether each of the said elements has positive effects on knowledge management in project environment. The respondents were asked whether they acquire and transfer knowledge from the previous projects using reports and other documentation on the results achieved in those projects. This question was treated as a dependent variable in relation to the previously presented independent variables.

Table 1 contains the correlations between the independent and dependent variables. Based on the presented results, we can conclude that all research hypotheses have been confirmed ($p < 0.01$). In addition, we can see a positive correlation between variables (correlation coefficient above 0.3), which means that when one variable changes, the other variable also changes in accordance with it in a positive direction. The highest value was attributed to the definition of project's KPIs (0.775), which means that it has the strongest connection to the dependent variable. Other independent variables: definition of project's CSFs, documentation of project success measurement according to KPIs and creation of final project report also have high coefficient values (0.634, 0.604, 0.612 respectively), with $p < 0.01$.

A regression analysis was conducted in relation to dependent variable *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects*. By examining collinearity using Tolerance and Variance Inflation Factor (VIF) parameters, from the last two columns in Table 2, where the value of VIF is lower than 10, and Tolerance remains above 0.2, it was established that there is no multicollinearity between the variables (Pallant, 2005). The regression analysis shows that the dependent variable

Table 1
Correlations between dependant variables and elements of project success analysis.

	1	2	3	4	5
Definition of project's CSFs	1				
Definition of project's KPIs	.628**	1			
Documentation of project success measurement according to KPIs	.453**	.532**	1		
Creation of final project report	.449**	.540**	.581**	1	
Acquisition and transfer of knowledge using documentation on the results achieved in the previous projects	.634**	.775**	.604**	.612**	1

** Correlation is significant at the 0.01 level (2-tailed).

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Table 2
Regression analysis on relation to elements of project success analysis.

	Unstandardized coefficients	Standardized coefficients		t	Sig.		Collinearity statistics
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	.205	.082		2.488	.015		
CSFs	.167	.069	.179	2.431	.017	.580	1.726
KPIs	.411	.068	.479	6.037	.000	.497	2.013
DocKPIs	.126	.055	.167	2.282	.025	.586	1.706
Report	.141	.059	.176	2.391	.019	.581	1.720

Dependent variable: Acquisition and transfer of knowledge using reports and other documentation on the results achieved in the previous projects.
R^2 = .693 and Adjusted R^2 = .681.

acquisition and transfer of knowledge using documentation on the results achieved in the previous projects is significantly influenced by all four independent variables. This model explains 68.1% cases in *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects* (R^2 = .693, Adjusted R^2 = .681 located below the regression analysis table). The highest beta coefficient is 0.479, which means that the *definition of KPIs* has the greatest influence on predicting the dependent variable. The value of results of other variables can be presented in the following order: *definition of CSFs*, *creation of report on implemented project* and *documentation of project success measurement according to defined KPIs* (the significance of stated variables is <0.05).

Having in mind that a certain number of studies confirm the positive influence of knowledge management on project performances, Faraj and Sproull (2000); Kotnour (2000); Lee and Choi (2003); Barber and Warn (2005); Quigley et al. (2007), the authors intended to investigate whether the benefits generated by knowledge acquired on the previous projects can be linked to the recommended method for knowledge acquisition and transfer. The majority of project managers and team members said that the benefits from knowledge acquired on the previous projects mostly relate to: *a more efficient planning of time schedule*, *improved control of work processes*, *a more efficient communication*, *faster task execution*, *enhanced problem solving* and *decreased resource consumption*. All of the stated variables were regarded as independent variables in this part of the research. Just as in the previous case, the dependent variable was *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects*. In this model, Durbin–Watson is 2.109 which points to the lack of correlation between the observed variables. MD has a maximal value of 32.113 (which is above the acceptable level, by $p < 0.001$). After sorting all cases, the authors concluded that only one case deviates, i.e. has a higher than acceptable value of MD, as well as that Cook's Distance (0.083 < 1), which is why all cases were taken into consideration.

The reliability of data was verified for each construct of the research by using Cronbach's alpha, which, in this case, equals 0.863, confirming the reliability of future analysis.

Based on the results in Table 3, we can see that there is a strong correlation between the variables in the positive direction.

The correlation between independent variables and dependent variable was examined using bivariate correlation analysis. Pearson's correlation coefficient points to the positive correlation between independent variables and dependent variable (correlation coefficient above 0.3, as shown in Table 3). Based on these results, we can conclude that the most prominent relation is the one between *enhanced problem solving* and *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects* (0.593). Other independent variables: *a more efficient planning of time schedule*, *improved control of work processes*, *a more efficient communication*, *faster task execution*, and *decreased resource consumption* have also high coefficient values (0.373, 0.324, 0.393, 0.551, 0.503 respectively), with $p < 0.01$.

Regression analysis showed that dependent variable *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects* is influenced by the mentioned independent variables. This model accounts for

Table 3
Correlations between dependent variable and benefits of knowledge acquired on the previous projects.

	1	2	3	4	5	6	7
A more efficient planning of time schedule	1						
Improved control of work processes	.740**	1					
A more efficient communication	.669**	.633**	1				
Faster task execution	.374**	.514**	.529**	1			
Enhanced problem solving	.488**	.449**	.612**	.584**	1		
Decreased resource consumption	.261**	.359**	.537**	.495**	.508**	1	
Acquisition and transfer of knowledge using documentation on the results achieved in the previous projects	.373**	.324**	.393**	.551**	.593**	.503**	1

** Correlation is significant at the 0.01 level (2-tailed).

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Table 4
Regression analysis in relation to benefits from knowledge acquired on the previous projects.

	Unstandardized coefficients	Standardized coefficients		t	Sig.	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	.173	.169		1.018	.311		
A more efficient planning of time schedule	.125	.056	.280	2.255	.026	.352	2.842
Improved control of work processes	−.082	.063	−.157	−1.300	.197	.374	2.675
A more efficient communication	−.092	.053	−.213	−1.744	.084	.366	2.735
Faster task execution	.129	.043	.304	3.006	.003	.532	1.880
Enhanced problem solving	.127	.039	.339	3.231	.002	.495	2.022
Decreased resource consumption	.125	.043	.277	2.917	.004	.601	1.663

Dependent variable: Acquisition and transfer of knowledge using documentation on the results achieved in the previous projects.
R^2 = .478 and Adjusted R^2 = .446.

44.6% of the cases in *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects* (R^2 = .478 and Adjusted R^2 = .446). Tolerance and Variance Inflation Factor (VIF) parameters (Table 4), where the value of VIF is lower than 10, and Tolerance remains above 0.2, means that there is no multicollinearity between the variables (Pallant, 2005).

In order to evaluate the contribution of each independent variable to the successful forecasting of knowledge acquisition and transfer using documentation and results from the previous projects, we use standardized coefficients and data from column beta (regardless of the negative value) (Pallant, 2005).

The highest beta coefficient is 0.339, which means that the *enhanced problem solving* had the greatest influence on predicting the dependent variable and was followed by *faster task execution*, *decreased resource consumption* and *a more efficient planning of time schedule*. Nevertheless, it was established that the dependent variable cannot be correlated to *a more efficient communication* or *improved control of work processes* on the current project (the significance of the said variables is >0.05). This stresses the role of oral knowledge transfer and leads to a conclusion that other organizational processes, organizational culture and values can influence knowledge management process in project environment. This supports the opinion of Sense (2007), according to which the factors that influence the creation of an environment where the learning process can generate all benefits and stresses the following five influential behaviors: cognitive style, relationships between participants in the learning process, hierarchy, knowledge management and situational context. Therefore, organizational structure and the values of project team members have a significant influence on the knowledge management process in a project environment.

In addition, it is obvious that the value of beta coefficient for the variable *improved control of work processes* and *a more efficient communication* is negative. According to the literature, this implies the following: as control of work process improves and the communication is more efficient, the less the knowledge is acquired and transferred using documentation on the results from the previous project. Nevertheless, the analysis of correlations between dependent and independent variables, presented above, shows a high degree of decidedly positive correlation (Table 3). Since 1941, numerous scientists focused on examining such events in statistical data analysis (summed in Paulhus et al., 2004), pointing to the concept called suppressor situation. This situation happens when a regression analysis includes several predictors, i.e. when the addition of a new predictor increases or decreases the importance of the previous predictor, or when the addition of a new predictor changes the value of the beta coefficient, as in this case. This situation can lead to an erroneous interpretation of results. Therefore, it is recommendable to additionally examine such cases by using, for example, the Sobel test, as a specialized t test for categorical variables (Paulhus et al., 2004). In this research this is only an additional explanation because, referring to statistical results, dependent variable cannot be correlated to *a more efficient communication* or *improved control of work processes* on the current project (the significance of the said variables is >0.05).

6. Discussion

6.1. Correlation of elements in project success analysis

Studies conducted so far focused on the elements of the proposed concept of success analysis only partially. For example, the focus was only on determining CSFs and success criteria, and then, correlating CSFs and success criteria (Fortune and White, 2006; Westerveld, 2003; Yu et al., 2005); determining KPIs for measuring project performances (Bryde, 2005; Keeble et al., 2003; Khang and Moe, 2008; Qureshi et al., 2009); evaluation of organizational maturity in terms of reporting on a completed project (Von Zedtwitz, 2002; Williams, 2007), etc. Factor analysis determined that there is a significant correlation between the mentioned elements of the proposed project success analysis concept (all coefficients are significantly above 0.3 with $p < 0.01$), i.e. that a more significant presence of CSF definition generates a greater presence of KPI definition, measuring of achieved results according to the defined KPIs and their documentation, as well as the report on a completed project (Table 1). By proving the correlation between these elements, the results of this research will contribute to the previous studies which only partially link them. In addition, these results can be used to confirm the basis

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for the formation of the proposed concept for project success analysis.

6.2. The influence of project success analysis on element of knowledge management in project environment

The regression analysis proved that the elements of project success analysis can predict 68.8% of variance *acquisition and transfer of knowledge using documentation on the results achieved in the previous projects*. These results confirm hypotheses H1, H2, H3 and H4, i.e. that each of the elements of the concept used for project success analysis has a positive influence on acquisition and transfer of knowledge in project environment. This also confirms the main hypothesis, H0, i.e. that the implementation of an adequate project success analysis can contribute to knowledge management in project environment. The general conclusion based on Pearson's correlation and regression analysis is that the element with the most prominent influence on the dependant variable relating to acquiring and transferring knowledge is definition of project's KPIs. The second most important variable is definition of project's CSFs. As presented in Table 3, CSFs are the focal point of many papers in project management literature, but the most important thing is that CSFs can represent the basis for defining project success criteria and KPIs. The third and fourth most important variables are creation of final project report and documentation of project success measurement according to KPIs. The results of a certain number of studies point to the fact that the same mistakes keep repeating during project implementation. This is regarded as the consequence of the lack of information from the previous projects or inadequate (insufficiently coordinated) exchange of knowledge (Desouza and Evaristo, 2006; Huang and Newell, 2003; Koskinen, 2004). Accordingly, the results of regression analysis, in which every element of the proposed project success analysis is statistically important for predicting the method of acquisition and transfer of knowledge in project environment, teach us how to systematically acquire and transfer knowledge in project environment. In the same way, these results contribute to studies published by Brady and Davies (2004), Love et al. (2005) and Hanisch et al. (2009) whose main conclusion is that the establishment of a knowledge base is crucial to the success of future projects. In order to create this knowledge base, it is necessary to gather information on project success and project performances.

6.3. The examination of correlation between the benefits of knowledge gathered from the previous projects and proposed ways of gathering and transferring knowledge

Previous studies undoubtedly prove that knowledge management contributes to achieving better project performances on future projects, while, on the other hand, scientists do not agree whether every implicit knowledge should (Nonaka and Toyama, 2003) or should not be (Haldin-Herrgard, 2000) transferred to explicit knowledge. The results of this research confirm that more notable benefits such as *enhanced problem solving*, *faster task execution*, *decreased resource consumption*, and *a more efficient planning of time schedule* cause a greater prominence of the dependent variable. Nevertheless, a research determined that the communication efficiency is not significantly statistically correlated to the method in which knowledge is acquired and transferred. This leads us to the conclusion that communication can be enhanced regardless of the structured and systematic methods for acquiring knowledge such as the documentation on the results achieved in the previous projects which is in accordance with the opinion of Haldin-Herrgard (2000), Sense (2007) and Kang (2007), authors who discussed the role of tacit knowledge in knowledge management process.

7. Conclusion

The paper presents a project success analysis framework comprised of four key elements: the definition of CSFs, the definition of KPIs, measuring project success according to defined KPIs and documentation of project success measurement according to the KPIs, as well as the creation of final project report. On the other hand, we observed sub-processes of knowledge management process in project environment aiming to prove the benefits of using the proposed project success analysis framework, from the aspect of knowledge management. Based on the data gathered from 103 respondents who participated on projects in different industries, the results of regression analysis indicated that all key elements of the presented framework, when it comes to project success analysis, have a positive influence on acquisition and transfer of knowledge in project environment. Furthermore, it confirms the main hypothesis of this paper that the implementation of an adequate project success analysis can contribute to knowledge management in project environment, defined by four subhypotheses.

The main conclusion revolves around the following – if we use a systematic approach when analyzing project success, we can contribute to overcoming one of the key problems in knowledge management in project environment – the lack of proper documentation on the results of the previous projects. This systematic approach would include: determining the project's CSFs, what are the most important factors used for evaluating project performances, what will be the project's KPIs, in which way we plan to implement success analysis and what is our plan for gathering data on completed project success analysis. Having in mind different opinions of authors when it comes to codification of tacit knowledge, we can say that the presented concept supports the approach according to which the knowledge acquired during a project should be codified in order to be passed on. The analysis of the correlation between the way in which the knowledge is acquired and transferred and the benefits this generates for project managers and team members, showed that documenting previously acquired knowledge contributes to a more efficient planning of time schedule, problem solving, decreased resource consumption, faster task execution, while the same is not true for communication efficiency and improved control of work processes on current project. This confirms that there are

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multiple benefits from implementing the proposed concept for knowledge acquisition and transfer. Nevertheless, we cannot overlook the role of tacit knowledge and soft management components when managing knowledge in project environment.

8. Contribution of this research and study limitations

The results presented in this paper complement the studies previously performed in this field. Various authors presented models for knowledge management (Disterer, 2002; Gasik, 2011; Reich et al., 2012); examined the influence of knowledge management in project environment on project performances (Barber and Warn, 2005; Faraj and Sproull, 2000; Kotnour, 2000; Lee and Choi, 2003; Quigley et al., 2007), problems and challenges in this field (Desouza and Evaristo, 2006; Hanisch et al., 2009; Williams, 2007) etc. The first part of this paper presents project success analysis that represents the sublimation of the previous research and theories, while the second part examines the correlation between every element of project success analysis and acquisition and transfer of knowledge by using documentation on the results achieved in the previous project, which has not been taken into consideration until now.

The key contribution of this paper is the proposal of a project success analysis framework, as a way to promote knowledge management in project environment, through the codification of acquired knowledge that facilitates an efficient and effective knowledge acquisition and transfer. Statistical data processing confirmed that the implementation of an adequate project success analysis can contribute to knowledge management in project environment, which was the main hypothesis of this paper.

This paper has two main limitations:

The first limitation relates to the fact that this research has a national character, i.e. that it applies only to Serbia. One of the advantages is that this research encompasses different types of projects and different industries; nevertheless, we believe that any further research should focus on examining the influence of elements pertaining to project success analysis on the methods for acquiring and transferring knowledge in project environment in other countries.

In relation to the previously stated facts, another limitation of this research is the uneven presence of knowledge management processes in project environment in respondents' organizations. This is why survey questions focused on knowledge acquisition and transfer from and between projects, as the most common processes in respondents' organizations.

This paper represents the first step in the process of analyzing success analysis framework based on knowledge. Further research should focus on examining the influence of the presented framework on the process of identifying knowledge for future projects, as well as on knowledge creation process.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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