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Abstract

Purpose – The purpose of this paper is to empirically investigate the relationship between project-specific intellectual capital (IC) and project success in the context of information technology (IT) projects.
Design/methodology/approach – Using data collected from surveys of 603 IT professionals across a variety of projects, the authors constructed a structural (structural equation model) model in AMOS to examine the relationships between three dimensions of project-specific IC (project team, project customer and project process) and project success.
Findings – The empirical results support the proposition that IC has a positive impact on project success, and thus may be a good indicator of future projects' performance. More importantly, the authors found out an important mediating role of a project's structural capital (process) in exploiting its human (team) and relational (customer) capital for realising project success.
Research limitations/implications – Interpretation of current results should be considered in light of the following methodological limitations: convenient rather than systematic sampling, use of previously untested measures and prevailing European subjects.
Practical implications – These results suggest that project-based organisations need to invest heavily in their project workforce talent and then translate it into superior project practices in order to produce successful IT projects. They also need to maintain close relationships with their project customers and involve them during the entire project process.
Originality/value – The current empirical evidence extends the understanding of the role of IC in improving project success and thus helps project-based organisations create and maintain competitive advantage in emerging economies.

Keywords Project management, Surveys, Knowledge management, Intellectual capital, Empirical study, Project success
Paper type Research paper

1. Introduction

Modern knowledge-intensive and innovative firms are usually organised around projects. This is particularly evident in the information technology (IT) sector. Unfortunately, project management (PM) literature often reports that these projects are not delivered on time, within budget and/or scope. In the context of IT, the rate of failed projects is as high as 70 per cent (King, 2003; Frese and Sauter, 2003). One of the potential reasons given for such a high project failure rate is that organisations do not possess and/or do not engage their knowledge assets in more beneficial ways to enhance the success rate of these projects (Yeong and Lim, 2010).

Recognising that project success is a knowledge-related issue, some recent literature (e.g. Handzic and Durmic, 2015) addressing PM included discussions of intellectual capital (IC) and knowledge management (KM). In general, from the knowledge-based view, the ability to leverage the required knowledge plays a critical role in competitive performance in the new economy (Drucker, 1993; Grant, 1996). Therefore, project-based organisations are facing two challenges: identifying what kind of project-related knowledge assets they have and need to improve the rate of project success, and

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addressing mechanisms by which they can better manage these assets. In general, IC literature addresses the first, and KM literature the second challenge.

This paper follows the line of studies that examine the relationships between IC, KM and PM. The first study by the same authors focused on the relationship between knowledge processes and project-specific knowledge assets in the context of IT projects (Handzic *et al.*, 2016). This follow-up study addresses the relationship between project-specific IC and project success in the same context. Management literature suggests that every organisation possesses valuable intellectual materials in the form of data, documents, procedures, capabilities, etc. These can be found in people, organisational structures and processes, and customer relationships. A question arises about how useful different types of knowledge assets are for organisational performance. While the question has received substantial conceptual attention (Hansen *et al.*, 1999; Becerra-Fernandez *et al.*, 2004) there has been little empirical attention given to it. Empirical evidence is especially missing in the project environment that is of interest to this study.

Therefore, in response to the current lack of empirical evidence, the main purpose of this study is to test a conceptual model that links project-specific intellectual assets with project success in order to determine how these assets affect project performance. In other words, the study's prime objective is to find out if and how project value is realised from its knowledge assets. To accomplish this, a variety of projects are examined in a highly competitive IT project environment.

The paper is organised as follows: after this brief introduction, relevant IC, KM and PM literature is reviewed, and related research questions (RQs) and model for the current study developed. Next, the research methodology used for empirical examination is described. Then, results from the empirical examination are presented, followed by the discussion of main findings and their contributions. The paper concludes with a brief summary of findings, their limitations, implications, and future research directions.

2. Literature review and research model

The paper draws on representative IC, KM and PM literature to build a theoretical model depicting the relationships between project-specific knowledge assets and project success. The resulting model combines concepts from these three related fields of study and serves as a basis for subsequent empirical examination.

2.1 IC

IC literature primarily examines the kind of intangible resources that drive growth and contribute to value creation. To succeed, organisations need to have a clear understanding of which knowledge assets are important to their success and how these assets are distributed over different parts of the company and among different roles and employees. According to Grant (1996), the portfolio of knowledge assets is typically determined by an organisation's strategic plan.

To date, the most popular classification of knowledge assets (or IC) was proposed by Sveiby and Edvinsson in 1994 (Sveiby, 1997; Edvinsson and Malone, 1997). It contains three components: human, relational and structural capital. According to Molodchik *et al.* (2014), human capital (HC) includes the abilities of management and human resource capabilities. Structural capital (SC) covers innovation and internal process capabilities. Finally, relational capital (RC) involves networking capabilities and customer loyalty.

The contention of Grant's (1996) knowledge-based theory of the firm is that value is created or added to an organisation, its customers and stakeholders, through harnessing the knowledge resident in an organisation. Human, structural and relational capital, all affect business performance (Bontis, 1998). However, different organisations may require different types and combinations of knowledge assets. Hence, an important challenge for a project-based company is to determine which type of knowledge capital is best suited for its particular needs. This study will address the issue in the IT project environment.

2.2 KM

While IC literature addresses knowledge from the static "stock" perspective, KM literature focuses more on the dynamic "flow" perspective of knowledge (Kianto *et al.*, 2014). Typically, two distinct KM strategies have been widely recognised: codification and personalisation (Hansen *et al.*, 1999).

The first of the two mentioned KM strategies, termed codification, is a document-centred strategy. Typically, it involves externalisation of knowledge from experts and its storage in knowledge repositories and knowledge maps where it can be accessed and used easily by anyone in the organisation to locate and deliver knowledge (Davenport and Prusak, 1998). In general, the key advantage of codification is considered relatively effortless knowledge reuse, while its main disadvantage is seen in decontextualisation, i.e. the absence of context-specific details about the stored knowledge that weakens its connection to reality.

The other of the two widely acknowledged KM strategies, namely, personalisation, is a people-based approach. It focuses on knowledge creation in teams and its transfer through collaboration and social interaction between people (Nonaka and Takeuchi, 1995). As with codification, there are several advantages and disadvantages associated with personalisation strategy. Thus, personalisation represents an excellent approach for bringing the organisation in touch with people who have deep knowledge and experience in its application. However, it makes the transfer of knowledge across the organisation slow, as it is based on person-to-person interactions.

The choice of a knowledge strategy is a matter of pursuing the right balance between personalisation and codification (Hansen *et al.*, 1999). In general, the emphasis depends on the focus of the organisation's strategic direction and the nature of its business. The codification approach is believed to work well when there are repeated (or similar) tasks and knowledge can be reapplied and reused. In contrast, the personalisation approach is assumed to be a preferable choice if work tasks are unique and employees rely on tacit knowledge to solve problems. These assumptions seem to be in accordance with the contingency approach to management.

2.3 PM

Traditional management literature conceptualises PM from the "task" perspective (PMI, 2013). As such, it focuses on a set of interrelated activities to achieve a specific outcome. More recently, the traditional perspective of PM has been criticised as inadequate to respond to current project challenges. Amidst criticism, several authors offered an alternative "knowledge"-based approach to PM (Andersen, 2008; Shenhar, 2001). Essentially, from the knowledge-based view, a project is envisaged as a temporary organisation with predetermined project resources, a collection of productive intellectual assets that can be put in use in different ways towards achieving project success. In the sense of a knowledge-based view of a project, the ability to leverage the required knowledge plays a critical role in successful project performance.

Recent PM literature discusses a variety of internal and external types of project-related knowledge assets as critical success factors (CSF) of IT projects (Sambamurthy and Zmud, 2014). Following an extensive literature search and identification, Handzic and Durmic (2015) grouped them into: project team, project customer and project process. Essentially, these reflect human, relational and structural components of IC involved in IT projects.

The project team as human capital includes people internal to the project and consists of project manager(s) and team members. The project team is responsible for achieving project outcomes and planning, organising and controlling project tasks. Among important project team assets are: project manager, team commitment and participation, internal and external communication, capability, knowledge and technical skills of the team, project manager's capabilities and experience, team composition, ambition of a project team, education and training provision, productivity and motivation of project team, team experience, losing people with appropriate skills, knowledge transfer, team work, team building, company interest vs personal interest, application of knowledge, working environment, people assigned to a higher priority project, adding people to a project, access to talented people, best practices and lessons learned. The project customer as relational capital involves either internal or external end-users who requested the project and gain benefits or suffer losses from project outcomes. Generally, the quality of project customer capital is assessed in terms of customer involvement, personally involved champion, customer acceptance, customer's resistance to change and understanding of customer's problems.

Project process as structural capital defines typical IT project phases and activities. The exact sequence and number of steps in the process depends on the specific life cycle methodology applied (Kumar *et al.*, 2013; Hoffer *et al.*, 2008; Sambamurthy and Zmud, 2014). Common to all methods are three generic project phases: project planning, project execution and project termination. Project planning is considered the most important of all, because other project activities follow what is initially set in this stage. Project execution covers design and coding steps and moves the problem domain towards the solution domain. Project termination comprises programme testing and code verification and considers internal and β releases as a preview of the final release. This project activity ensures that all features outlined in the requirements specification are implemented and functioning as intended.

Project success is the ultimate target value expected to be realised through harnessing project-related IC. Typically, project success is defined in terms of three criteria: time, budget and scope. In order to be successful, a project needs to be completed within the defined time, budget and scope constraints (Bakker *et al.*, 2009; Hoffer *et al.*, 2008; Attarzadeh and Ow, 2008). According to these criteria, reviewed projects are often divided into three groups: successful, challenged and failed projects with an intention of finding out common factors that affect the project's final status (Frese and Sauter, 2003; Wan and Wang, 2010; Zouaghi and Laghouag, 2012; Zwikael and Globerson, 2006). The research model presented in the following section addresses this challenge in an IT project environment.

2.4 RQs and model

Based on the above literature review, the following two *RQs* are defined for the current study:

RQ1. Do different project-related knowledge assets (i.e. project team, project process, project customer) influence project performance (i.e. success/failure)?

RQ2. How do different project-related knowledge assets (i.e. project team, project process, project customer) influence project performance (i.e. success/failure)?

These questions are examined from the perspective of professionals involved in development and implementations of IT projects. Hence, all relevant variables and measures are defined from the project supplier and not user point of view.

Several alternative models have been proposed recently on how knowledge-based issues affect organisational performance (Kianto *et al.*, 2014). The model presented in Figure 1 is developed from IC, KM and PM literature specifically for the IT project environment. Essentially, the model combines elements from these three related fields in a way that suggests how these factors can increase the rate of project success in organisations. Specifically, the model includes two people-related factors: project team and project customer as the project's human and relational capital, respectively. The model also includes a project process element that reflects a project's structural capital. Finally, the model incorporates the project success component as the ultimate value to be realised by harnessing the knowledge capital of an organisation.

With respect to relationships among different components, the model proposes that, in an IT project environment, both people-related factors (project team and project customer) and process-related factors (project process) directly affect project success. These relationships are tested empirically in order to determine whether and how different types of organisational IC involved in an IT project influence project success. All three proposed relationships are hypothesised to be positive.

3. Research methodology

3.1 Research design and instrumentation

The field survey was adopted as the most suitable research design for current study because of its versatility, efficiency and generalisability. Surveys enable cost effective measurement of many variables and allow the researcher to safely generalise the findings from the representative sample to the study population (Check and Schutt, 2012). A questionnaire was used as a survey instrument for data collection, as suggested by Polit and Hungler (1997). Survey questions were designed to capture the participants' perceptions of a specific IT project they worked on, as well as their opinions about the effectiveness of various team, customer and process-related aspects of the project. A five-point Likert scale was used to capture participants' responses relative to negative and positive end-points (1 – strongly disagree, 5 – strongly agree). The questionnaire was developed through three stages. The initial form was designed as a result of an extensive literature review. It was followed by a pilot study conducted with 20 IT professionals from a large software company. The feedback from the pilot test was used to reword some questions for clarity and shorten the final questionnaire.

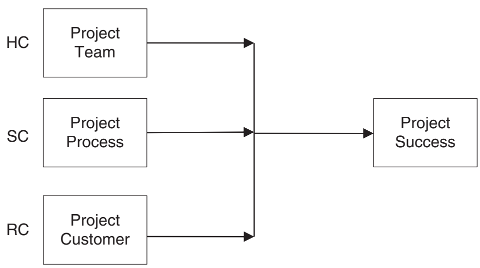


Figure 1. Conceptual model of relationship between intellectual capital and project success

3.2 Subjects and procedure

The target population for this study were IT professionals who were involved in IT project development worldwide and held different roles in a project team. When choosing the respondents, the aim was to cover both technical and business aspects of the project in order to get the most realistic picture of the importance of different factors for project success. Two approaches were used for data collection: sending surveys to IT-oriented organisations so that they could distribute them among their employees; and sending a survey via an online link to IT professionals individually using the professional social network LinkedIn. Data collection was carried out during 2013 and lasted for two months. The collected questionnaire responses were encoded, entered into a computer and combined into one file. Out of 662 responses received (25 per cent response rate), 603 were usable for further analysis. This sample size was found to be sufficient to perform the model tests with statistical power (Garson, 2007).

The respondents represented a broad cross-section of different IT projects in different world regions (Europe and Africa 62 per cent, North and South America 30 per cent, Asia and Pacific 8 per cent). The overwhelming majority of 87 per cent respondents were male and only 13 per cent female. They came from different age groups and educational backgrounds. About one-third (29 per cent) of the respondents were aged below 30, one-third (38 per cent) between 30 and 40 and one-third (33 per cent) above 40 years old. About half the respondents (46 per cent) had undergraduate degrees, 45 per cent had graduate degrees, while the remaining 9 per cent were college graduates. The majority (76 per cent) of respondents were qualified computer software or computer system engineers, while the remaining 24 per cent had various business and technical qualifications. They held a variety of project roles. About one-half (51 per cent) were developers, 29 per cent were engineers and 20 per cent managers. Their experience ranged from one year to 46 years, with 13 years as an average.

For the analysis of collected data, a mix of statistical methods was employed including descriptive statistics and factor analysis using SPSS 20 programme and structural equation modelling (SEM) using AMOS 20 software. SEM has become a widely used technique by researchers across disciplines. SEM has the ability to test relationships between constructs with multiple indicators, provides estimates of paths and indices that help in model identification (Kline, 2011).

4. Results

4.1 Descriptive statistics

The means and standard deviations for the proposed model variables are reported in Table I. The results for project success reflect a moderate overall IT success status. The mean score for the success variable is 3.71 (out of 5). The standard deviation of 1.06 indicates a relatively low dispersion around the mean. Furthermore, the results show that, on average, participants rated their project teams and customers as average. The mean scores for team and customer variables are 3.49 and 3.63, respectively.

Table I.
Descriptive statistics

Variable	*n*	Mean	SD
Project team (human capital)	603	3.49	0.74
Project customer (relational capital)	603	3.63	0.99
Project process (structural capital)	603	3.55	0.82
Project success (realised value)	603	3.71	1.06

Low values of their standard deviations (0.74 and 0.99) are indicators of a low dispersion of these responses around the means.

Similarly, the participants perceived their project process as average. The mean score for process variable is 3.55. Its respective standard deviation (0.82) reflects a low dispersion of responses around the means. Overall, these results are consistent with previous research that identifies the need for improving the success rate of IT projects. They also show the need for enhancing relevant knowledge capital (human, relational and structural) in IT project development.

4.2 Measurement model

The summary results of the measurement model test are presented in Table II. Factor analysis was first conducted through a principal component analysis using varimax rotation in SPSS to assess the measurement model. Internal consistency and convergent and discriminant validities were assessed to validate the model. All were above recommended thresholds (Nunnally, 1978).

Table II includes four proposed constructs, twelve extracted factors, composite reliabilities and variances extracted (AVE). Results in Table II indicate that project team and process are composite constructs with five dimensions each. Cronbach's α-values for all factors were in the range of 0.700-0.932, thus establishing adequate reliability.

Furthermore, the table shows that the AVE scores for the constructs ranged from 0.750 to 0.870, which is above the generally recognised cut-off value of 0.5, thus demonstrating convergent validity. Finally, high within-construct loadings (all above 0.4 and most above 0.6) provide additional evidence for convergent, as well as for discriminant validity. Loadings are excluded from Table II due to limited paper length. Satisfactory discriminant validity was confirmed by the observed square root of AVE values for each construct above the correlation between any pairs of constructs (Gefen and Straub, 2005).

4.3 Structural model

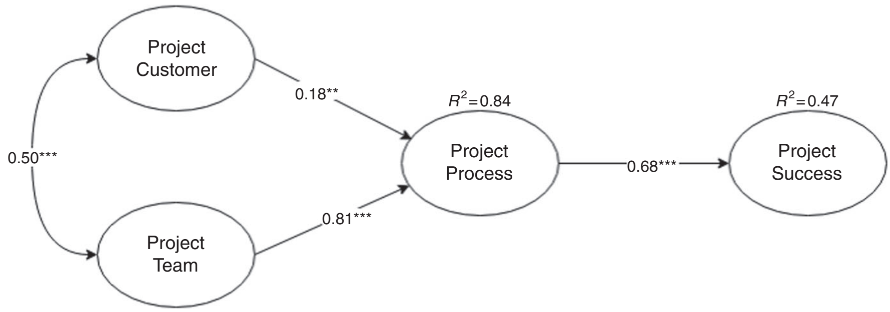
Several plausible structural models were tested to identify the one that best fits empirical data. The selected model specifications are presented in Figure 2. The figure

Project team		
Team leader (TL)	0.898	0.850
Team members (TM)	0.864	0.790
Team capabilities (TC)	0.801	0.795
Team interests (TI)	0.814	0.751
Team dynamics (TD)	0.700	0.870
Project customer		
Project customer (PC)	0.849	0.847
Project process		
Project planning (PP)	0.908	0.762
Project execution (PE)	0.866	0.779
Project testing (PT)	0.932	0.762
Project monitoring (PM)	0.875	0.750
Quality assurance (QA)	0.910	0.857
Project success		
Project success (PS)	0.853	0.831

Table II. Proposed constructs, extracted factors, composite reliabilities and AVE shows the empirical model composed of unobserved endogenous variables that correspond to the main components of the proposed conceptual model (i.e. project customer, team, process, success). Observed endogenous variables defined through factor analysis, and unobserved exogenous variables that stand for various errors are removed from the empirical model for clearer presentation. The model also shows path coefficients and the R^2 values obtained from model tests summarised below.

First, the estimates, standard errors and critical ratios were calculated for model regression weights. From these results it could be seen that all parameters had satisfying values ($p < 0.05$). From further analysis of results, it could be observed that the covariance between project customer and project team was also significant. An assessment of the standardised regression weights for the constructs was performed next in order to find out the strength of the relationship between model variables. Values of standardised path coefficients less than 0.1 show "weak" effects, the values around 0.3 indicate "medium" effects and values equal or above 0.5 represent "large" effects. For each endogenous (dependent) variable in the model, R^2 or squared multiple correlation was also calculated. It represents the per cent variance explained in that variable (Garson, 2007). Further evaluation results revealed significant positive correlation between project customer and team factors.

Besides estimates of individual parameters, the evaluation of a structural model considers the overall fit of the model to the data. In this research, the overall fit of the structural model was examined using a range of indices that reflect different aspects of absolute and relative fit as suggested by Kline (2011). These are summarised in Table III. Across the set of indices, the proposed model shows evidence of a fairly good fit to the data in terms of the CMIN/DF, RMSEA, GFI, CFI, RMR, TLI, IFI and NFI.



Notes: $^{**}p<0.05$; $^{***}p<0.01$

Figure 2.
Empirical model of relationship between intellectual capital and project success

Table III.
Fit indices guidelines and test results

Fit index	Referent value	Test value
CMIN/df	<2-5	2.909
RMSEA	<0.10	0.056
GFI	>0.90	0.959
CFI	>0.90	0.970
RMR	<0.05	0.029
TLI	⩾0.95	0.962
IFI	>0.90	0.970
NFI	>0.90	0.955

5. Discussion

The research model in this study was tested empirically to determine whether and how different types of project-related intellectual assets (project team, project customer and project process) influence project success in the context of IT projects. Two main findings resulted from the data analysis: empirical evidence supports the proposition that IC has a positive impact on project success, and thus may be a good indicator of future projects' performance; and optimal IC structure indicates an important mediating role of a project's structural capital (process) in exploiting its human (team) and relational (customer) capital for realising project success.

These findings make two important contributions to the body of scientific (PM) knowledge that enrich the collective understanding of the role of knowledge capital in realising project value. First, they fill the lack of empirical research of the issue from the knowledge perspective. Second, they provide valuable insights into developing an appropriate IC strategy within a project to enhance the project's final success. The following sections highlight the most important aspects of the study findings and their contributions.

5.1 IC impact on project success

The first research question posed by this study is whether project-related intellectual assets influence project success. The main findings of the study provide a positive answer. Adopting a knowledge perspective makes a difference in project performance. In short, knowledge works. This is clearly demonstrated by significant direct and indirect effects of project team, process and customer variables on project success.

The relationship involving variables project process (structural capital) and project success (realised value) was supported as expected. The significant regression coefficient for process on success confirms the notion that improved project practices lead to an enhanced rate of project success. These findings agree with earlier research on CSF that can significantly improve project performance (Pinto and Slevin, 2008). As mentioned earlier, the stepwise project process involving planning, execution and verification activities ensures that all specified project requirements are fulfilled as intended. Overall, it was found to positively influence project success. These results are consistent with expectations from IT PM literature (Sambamurthy and Zmud, 2014; Kumar *et al.*, 2013; Hoffer *et al.*, 2008).

With respect to the relationships involving team and customer variables with project success, there were no significant direct effects. Instead, team and customer factors were found to impact success indirectly via process. Regression coefficients corresponding to the team and customer relationships to process were significant. It was found that enhanced team and customer familiarity with project practices led to improved project process. These findings echo earlier reported interrelationships found among three elements of organisational IC (Bontis, 1998) with human and relational capital positively related to structural capital. These assets play a critical role in competitive performance in the new economy (Drucker, 1993; Stewart, 1997). Furthermore, these findings suggest that, in order to boost project process, the project team and customer need to have relevant knowledge of best project practices. Socio-technical KM initiatives (Handzic, 2011) such as repositories of lessons learnt, communities of practice, IT training and orientation programs are some possible means that should enhance people's knowledge and skills, and consequently their effectiveness in the project realisation process.

5.2 Optimal IC configuration for project success

The second research question posed by this study is how project-related intellectual assets influence project success. The main findings of the study reveal the optimal IC configuration that accounts for interrelationships among three project-related assets in realising project success.

Specifically, the optimal IC structure indicates an important mediating role of a project's structural capital (process) in exploiting its human (team) and relational (customer) capital for realising project success. This is demonstrated by significant path coefficients of project team and customer variables on project process. Another interesting finding is a significant correlation found between team and customer variables. It suggests interrelated people factors of project success. It is possible that a project team may help a project customer and vice versa to be more effective in the project process. In summary, the study indicates that favourable people factors in the project environment encourage better project practices and thus bring performance benefits for projects in terms of improved rate of successful completions.

According to Bontis (1998) such findings make intuitive sense. First, they confirm the existence of an interplay between three project-related IC components. Second, they suggest that isolated stocks of knowledge that reside in project team members may be useless without a supportive project process that can utilise their skills. However, the question arises regarding the applicability of these findings in different project circumstances. The current study did not take into account any potential differences among projects studied. Yet, the contingency approach (Hansen *et al.*, 1999; Shenhar, 2001; Snowden, 2002) suggests that the usefulness of different components of project IC may depend upon project complexity. The analysis of actual project data in this study shows that the majority were fairly simple. In such circumstances, reliance on well-defined and codified procedures (structural capital) is considered the most appropriate knowledge strategy. The same strategy may not hold in complex project circumstances, where contingency approach posits increased value of people over structures. This remains an open question that warrants future research.

6. Conclusion

This empirical study tested a conceptual model linking three project-specific dimensions of IC with project success in order to determine whether and how value from knowledge assets is being realised in a project environment. In particular, the study determined that all three project-related knowledge assets (team, customer and process) were significant factors of project success. In addition, the study revealed an important mediating role of project process (structural capital) in utilising project team (human capital) and project customer (relational capital) for enhancing IT project success.

However, these results should be considered in light of the current methodological limitations. Thus, the study employed convenient rather than systematic sampling that may weaken the strength of causal inferences. In the absence of any agreed measures for assessing IT success factors, the study developed novel but reliable measures. The majority of respondents were European IT professionals, so the question arises if current results would hold among different subjects from different world regions. Finally, the current study did not consider potential differences among studied projects. These limitations can be addressed by applying different methods in different contexts and with different subjects in order to verify and generalise current findings.

Nevertheless, the results of this study have important implications for research and practice in the fields of IC, KM and PM. For research, the study contributes empirical evidence that project performance is a knowledge-based issue. In particular, the study clarifies the mediating role of project-specific structural capital (project process) in the impact of human and relational capital (project team and customer factors) on project success. Such findings suggest that organisations need to turn their project workforce capabilities into proper project practices in order to produce successful IT projects. They also need to involve their project customers during the entire project process.

Future research may extend current study to other open questions. The research model in this study explained only one-half of project success factors, thus providing opportunity for examining the other half. Also, a deeper investigation into each model factor is called for in order to get better insights into their structure and dimensions. Other recommended research directions include comparative analysis of successful and failed projects, and the impact of various project contingencies, especially project complexity.

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