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Impact of integration management on construction project management performance

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Abstract

Construction project performance relies on different dimensions of project management. Among those, integration management is of paramount importance since effective project management starts with the integration of processes and people within a construction project. This study investigates the influence of various components of integration management on construction project management performance and quantifies the relationship between those components and integration management. The proposed components of integration management are the development of a project charter, knowledge integration, process integration, staff integration, supply chain integration, and integration of changes; whereas the dimensions of project management performance are time, cost, quality, safety, and client satisfaction. A questionnaire was designed and administered to construction professionals and data from 121 projects was analyzed using structural equation modeling. The data was analyzed by using software, called SPSS AMOS. The findings of the research indicate that integration management has a strong impact on project management performance. The study contributes to the project management body of knowledge in that it develops a conceptual framework consisting of specific components for integration management, reveals the impact of integration management on performance, and proposes several tools and strategies for enabling effective integration along the project life cycle. Industry practitioners may benefit from the framework developed by considering the components proposed and following strategies recommended for construction phases.

Keywords: Integration management; Project management performance; Construction projects

1. Introduction

Integration refers to coordination among processes. Integration management is one of the most important elements of project management, which encompasses all aspects of a project. Project integration management ensures the successful coordination among project activities. Asif et al. (2010) mention integration as a deliberate process of developing a governance structure, which makes the management of key stakeholder requirements more systematic. Eisner et al. (1993) define integration management as the major element of systems engineering. They propose a concept, called "integration engineering", where they list requirements, interfaces, interoperability, impacts, testing, software verification and validation, and architecture development as the main elements. Moreover, they refer to integration management, where they define the main elements as scheduling, budgeting and costing, configuration management, and documentation. These components build the basis for systems engineering.

Project integration ensures the proper coordination among project activities. Therefore, the impact of integration management on project success should be well understood so that project managers might benefit from the positive aspects of properly coordinated project activities. A major portion of existing research studies (Tatum, 1990; Halfawy and Froese, 2007; Ozorhon et al., 2014; Berteaux and Javernick-Will, 2015; Ospina-Alvarado et al., 2016) has previously demonstrated the critical role of effective integration in project management research.

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The Project Management Body of Knowledge Guide (PMBoK) lists the ten main knowledge areas essential to project management and four additional areas in its Construction Extension. Among those, project integration management is listed as the first knowledge area, which involves combination, unification, and coordination processes of project management (PMI, 2013). Because of the essential function of integration in project management, this study develops a comprehensive framework which aims at illustrating the strong link between integration and project management performance, which was not previously investigated. Within this perspective, the study proposes construction-specific components for integration management and measures project management performance by means of different project success indicators. Moreover, a questionnaire was designed based on the developed framework and administered to construction professionals in Turkey.

The research investigates the hypothesized relationship between integration management and project management performance and aims at measuring project management performance according to the proposed indicators. To analyze the validity and the reliability of the proposed measures for the framework, structural equation modeling (SEM) was used. The main contribution of this study is to guide construction practitioners to adopt proposed measures for integration and benefit from the strategies for integration in order to experience higher success rates.

2. Research background

PMI defined a total of 14 areas: the project integration, scope, time, cost, quality, human resource, communications, risk, procurement, stakeholder, safety, environmental, financial, and claim management. A portion of studies measured performance by these knowledge areas or revealed the impact of individual knowledge areas on performance. The knowledge areas proposed by PMI have been used in numerous research studies. Various studies have focused on enhancing risk (Hwang et al., 2014), innovation (Toole et al., 2010), and technology and integration management (O'Connor and Young, 2004) capabilities of construction firms.

Chou et al. (2013) conducted research on the project management knowledge of construction professionals. In Chou's study, a model was proposed where the effects of project scope, time, quality, human resource, communication, risk, and procurement management on the project success and interrelations among the knowledge areas were investigated. Fageha and Aibinu (2013) indicated that effective scope management has a direct impact on project outcome.

The impact of effective time management on enhanced project performance was highlighted in several studies (Gayatri and Saurabh, 2013; Ngacho and Das, 2014). In Salazar-Aramayo et al.'s (2013) study, cost was listed among the most important attributes of the project management model that they have developed. Ali et al. (2013) emphasized that quality of work done is among the most important attributes of project performance measurement. Popaitoon and Siengthai (2014) mentioned that project performance and knowledge absorptive capacity of project teams are highly affected by project human resource management practices. Badir et al. (2012) stated that communication is one of the key components of improved performance. Hwang et al. (2014) revealed that effective risk management leads to improved project performance. Eriksson and Westerberg (2011) indicated that collaborative procurement practices have a positive influence on construction project performance. Stakeholder benefits and satisfaction were demonstrated to be crucial for project success (Takim and Akintoye, 2002; Rad, 2003; Bassioni et al., 2004) Moreover, Kagioglou et al. (2001) emphasized that stakeholder satisfaction is directly associated with performance management in construction.

Cheng et al. (2012) investigated the effect of safety management practices on project performance in the construction industry. Montabon et al.'s (2007) study revealed that there is a strong link between the effectiveness of project environmental management and business performance. Akanni et al. (2015) stated that financial attributes are highly effective on project performance. Vidogah and Ndekugri (1997) demonstrated that effectiveness of claim management is essential in terms of successful completion of project, which in turn leads to enhanced project performance. Jastaniah (1997) also indicated that successful handling of claims is one of the most important components of enhanced performance.

Tatum (1990) described potential competitive advantages of integrated facility engineering such as offering new products in new markets, developing distinctive competence, reducing project schedule, and decreasing life-cycle cost. He emphasized the critical role of integration in competing against forces for change and concluded that success is achieved when addressing forces for change through successful integration of processes. Halfawy and Froese (2007) presented a multitier component-based framework aiming to facilitate the implementation of modular and distributed integrated project systems for supporting multidisciplinary project processes through the project cycle. The main focus of the research was to emphasize the required functionality and approach to developed integrated project systems. Within this context, a framework was developed to define methods that have potential to improve the availability, consistency, and integration of project information and processes.

Ozorhon et al. (2014) focused on the components of the innovation process. They defined the barriers of innovation including resistance to change, inexperience, and unavailability of advanced products and they proposed integration of project participants and effective leadership as one of the solutions to enhance the rate of innovation adoption. However, the paper references one case study selected from the United Kingdom, so the conclusions made could lead to diverse statements with different case studies. Berteaux and Javernick-Will (2015) indicated that project based organizations in the architecture, engineering, and construction (AEC) industry must integrate knowledge and processes adapting to local environments. They investigated the challenges of local adaptation and organizational integration processes by relating to project performance. They concluded that projects having high integration result in richer information exchange than projects having low integration. However, the research has a small sample size and organizational performance was not included in the study, which is one of the limitations of the research.

Ospina-Alvarado et al. (2016) developed a framework for construction project integration by defining several attributes depending on their critical importance. They proposed the framework as a useful tool for construction practitioners to wisely use their resources for achieving a more integrated project. Despite the attributes mentioned in this study such as coordination, collaboration, leadership, knowledge sharing, and trust, the paper still lacks a complete understanding of integration attributes such as integration of changes and uncertainty management in integration. These studies reported that projects experience higher success rates and improved performance with the adoption of an integrative approach. However, these studies rather focused on software integration, relational integration or contractual integration despite the fact that integration must be evaluated as a core element encompassing different dimensions and impacting several other variables in a project network.

The construction industry still suffers from poor project performance because of its nature where the work is fragmented between different stakeholders and different sub-processes (Rahman and Kumaraswamy, 2004; Ospina-Alvarado and Castro-Lacouture, 2010; Harper, 2014). Moreover, previous studies lack a complete understating of the relationship between integration and performance, which is essential to successfully manage construction projects.

However, the impact of integration management on project management performance was not explicitly investigated in these studies; instead they assess some of the core components of integration on performance.

There is no other study in the literature that proposes construction specific components for integration management and analyzes the relationship between integration and project management performance. Revealing this relationship may help construction professionals to evaluate their projects with the essential parameters and understand the logic behind project integration in the cases where it is hard to manage complex projects. It is essential for construction practitioners to understand, quantify, visualize and simulate the components that affect construction work. Hence, the need for conceptual framework arises to best reflect variables which influence construction business.

Construction is more challenging than other businesses in terms of its dynamic, fragmented and complex nature since it requires involvement of different parties and successful management of processes. This requires the development of well-set strategies and practices to compete against uncertainties and risks. Cost and schedule variances might create undesired consequences, which lead to low customer satisfaction. Therefore, it is crucial to determine underlying parameters that need to be addressed when project success is of utmost importance.

Several studies have been conducted to investigate performance and its relation to different project management constructs. Vickery et al. (2003) mentioned the effects of integrative supply chain on financial performance. Similarly, Kim (2006) investigated the linkage between supply chain integration and firm performance. Mitchell (2006) rather considered the relationship between knowledge integration and information technology performance. As reported, only a limited number of studies the number reveal an explicit linkage between integration management and project management performance. Crawford (2005) states that program or project directors, who use a high level of integration and scope practices are more likely to be top performers. Huang and Newell (2003) also indicated that knowledge integration is determined by three important components: the efficiency of integration, scope of integration, and the flexibility of integration. Heising (2012) underlined the critical role of integration in terms of project portfolio management. In addition, Mitropoulos and Tatum (2000) also indicated that degree of project integration affects project performance.

Previous research highlighted the essential function of integration or its attributes on achieving a higher level of performance, success or innovation. For example, Aronson et al. (2013) mentioned the impact of leader building activities and project spirit's role on project success. Similarly, Ozorhon et al. (2014) listed integration and leadership as enablers in construction innovation. Moreover, Crawford (2005) mentioned that project or program directors using high level of integration and scope practices are more likely to be top performers in companies.

Saraf et al. (2007) implied that information integration with customers and business partners leads to better knowledge sharing, which also results in business performance improvements. Berteaux and Javernick-Will (2015) highlighted the organizational integration of knowledge, process, and strategy, informing that organizational integration improves project performance through the capabilities developed on previous projects and innovations across the organization, which helps the organization remain competitive. It is also mentioned that integration of knowledge and processes improves project and organizational performance. Since conceptualization and effective planning of projects are crucial, integration appears as a critical component in the proper coordination of projects. As previously shown on above studies, integration is strongly linked to the core elements and areas of project management. Hence, one might conclude that integration has a clear and direct impact on project performance.

Therefore, this study aims to fill this gap by developing a framework picturing the core elements of integration and performance. The framework is intended to reflect the relation between integration management and project management performance based on the perceptions of construction companies. Fig. 1 shows the components of the integration management derived in this study and its direct link to project management performance.

3. Research framework

The framework proposed in this study involves the components for integration management and project management performance. In the initial step, based on a comprehensive literature review that focused on studies regarding the integration management and performance, several components are derived. Integration management and project management are factors and 17 components are derived for these two factors. After conducting pilot studies with three university professors and two industry practitioners, some of the components were either combined or removed to best reflect their corresponding factors. Finally, a total of 11 components are obtained. The underlying components of each factor are identified and explained below.

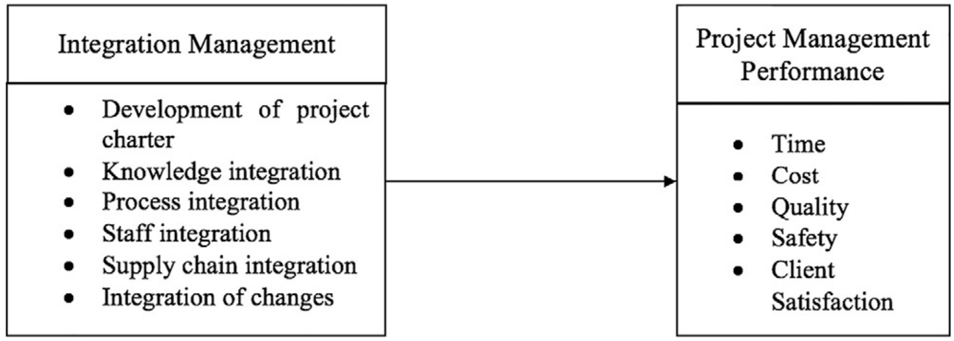

Fig. 1. Link between integration management and project management performance.

3.1. Integration management

The components of integration management are determined as 'development of project charter', 'knowledge integration', 'process integration', 'staff integration', 'supply chain integration', 'integration of changes'.

- *Development of Project Charter*: Development of the document, which authorizes the start of a project and defines project manager's authorization over the project. The approval of the project charter officially announces the authorization of the project. The project charter also authorizes the project manager to assign the organizational resources to the project activities (PMI, 2013).
- *Knowledge Integration*: Knowledge integration refers to the exchange of knowledge among all stakeholders, project parties and sharing of previous and current knowledge, and input of all data into the current knowledge transfer system. The integration of knowledge and ideation in project portfolio management is indicated as the key element of sustainable success (Heising, 2012). Mitropoulos and Tatum (2000) revealed that integration brings the need for exchange of information of knowledge between the interdependent subsystems and they indicated that knowledge is one of the crucial elements of successful integration. Tatum (1989) also indicated that construction knowledge is a necessity for integrating construction methods and design approaches. Knowledge integration for successful projects, organizations, and process groups has also been stated as the core element of project integration management and project management performance (Nonaka, 1994; Grant, 1996; Tether, 2002; Carlile and Rebentisch, 2003; Newell et al., 2004; Soderlund, 2004; Kellogg et al., 2006; Schmickl and Kieser, 2008; Ritala and Hurmelinna-Laukkanen, 2009; Song and Song, 2010; Un et al., 2010; Brettel et al., 2011; Enberg, 2012; Too, 2012).
- *Process Integration*: Process integration simply refers to the organized sequence of all activities in an appropriate manner and well-developed logical relationships among processes. In Birkinshaw et al.'s (2000) study, it is indicated that integrated process in terms of human integration and task integration may foster value creation. Tatum's (1989) study revealed that concurrently designing a product and processing its production lead to increased quality and lowered cost. Mitropoulos and Tatum (2000) stated that there has been an increased emphasis in integrating design of new products or processes with the cost, time, and quality efficiency. Yanwei et al. (2012) listed process integration as one of the dimensions of project integration management. A great portion of the research studies have also investigated process integration and underlined the importance of process integration in project management performance (Wheelwright and Clark, 1992; Enberg, 2012; Kleinschmidt et al., 2007).
- *Staff Integration*: Staff integration refers to the integration of project staff into the current project processes. Staff integration also includes staff's support for integration and management-driven integration for the tools and techniques needed for the successful execution of projects. Mitropoulos and Tatum (2000) stated that organizational integration is one of the integration mechanisms including the components such as partnering, cross-functional teams, and training in-group skills at the project level. In addition, Egan (2002) indicated that teamwork effectiveness is increased by the integration. The study also underlined that integration is desirable for effectively working teams. Staff or team integration is highly investigated in project management research (Carmeli and Schaubroeck, 2006; Dammer, 2008; Carmeli and Meyrav, 2009; Zajac, 2009; Jonas, 2010; Enberg, 2012; Tiller, 2012).
- *Supply Chain Integration*: Supply Chain Integration defines the integration of customers and suppliers into the whole processes and development of knowledge sharing mechanisms among customers, suppliers and project teams. Therefore, supply chain integration is heavily investigated in previous studies conducted on project management area (Wheelwright and Clark, 1992; Gemunden et al., 1996; Griffin and Hauser, 1996; Gruner and Homburg, 2000; Henard and Szymanski, 2001; Cooper et al., 2004; Kleinschmidt et al., 2007; Ernst et al., 2010; Enberg, 2012).
- *Integration of Changes*: Integration of changes refers to the review and evaluation of all change requests in the project, making modifications, updates in project management plan and project documents, and integration of all changes into project deliverables. Mitropoulos and Tatum (2000) indicated that changes might occur severe consequences for project budget and schedule. They also stated that lack of integration in project planning might cause to uncertainty in scope, unclear priorities, and unidentified needs

and constraints, which might lead to changes, rework, and delays. Tatum (1989) also indicated that integration of construction methods and design approaches is very effective in managing projects with the successful handling of changes.

- Previous literatures also prove that effective change management and leadership are strongly associated with successful implementation of organizational initiatives (Gilley et al., 2008; Jones et al., 2005; Turner and Muller, 2005). Moran and Brightman (2001) also indicated that change management is the capability of an organization towards handling changes in accordance with customer needs. Therefore, it constitutes special emphasis in the project integration management since effective integration of changes into the current project deliverables is critical. Previous studies also prove the importance of the integration of changes into the current project conditions in terms of successful project management (Kolodny, 2004; Leybourne, 2007; Hassner-Nahmias and Crawford, 2008; Cummings and Worley, 2009; Soderlund, 2010; Hwang and Low, 2012; Yanwei et al., 2012; PMI, 2013; Hornstein, 2015).

3.2. Project management performance

This study measures project management performance by means of project success as suggested in other studies (Lim and Mohamed, 1999; Wang et al., 2010; Mir and Pinnington, 2014). In terms of project success, majority of the research studies focus on timely completion (Egan, 1998; Lim and Mohamed, 1999; Chan et al., 2002; Cooke-Davies, 2002; Rad, 2003), under budget completion (Bassioni et al., 2004; Nudurupati et al., 2007; Papke-Shields et al., 2010; Berssaneti and Carvalho, 2015), meeting quality criteria (Rad, 2003; Tam et al., 2011; Chang et al., 2013; Chou et al., 2013), safely completed work (Lim and Mohamed, 1999; Bower et al., 2002; Almahmoud et al., 2012), and client satisfaction (Lim and Mohamed, 1999; Rad, 2003; Gayatri and Saurabh, 2013; Cserhati and Szabo, 2014; Liu et al., 2014; Nassar and Abourizk, 2014). In the light of previous studies, this study also utilizes those mostly cited indicators to measure construction project success.

Despite the studies investigating the relationship between integration and performance, a better understanding of integration attributes and its impact on project performance still appears as a challenge in the architecture-construction-engineering (AEC) industry. Hence, this paper aims at defining those specific attributes specific to construction industry and visualizes the relationship between integration and performance by quantifying the effects.

The conceptual framework also includes control variables such as project type and project size. Kog and Loh (2012) indicated that project manager authority, pioneering status, project size, site limitation and location, client top management support, contractor key personnel capability, and contractor team competency are the critical success factors for different components of construction projects.

The following hypothesis is developed based on the strong evidence provided by the literature considering the impact of integration management on project management performance.

H1. Effectiveness of “integration management” has a direct and positive effect on “project management performance” when controlling for project type and project size.

Fig. 2 presents the conceptual framework for this study along the valid indicators developed.

4. Research methodology

An online questionnaire was designed and administered to construction professionals in Turkish construction firms based on the proposed framework (See Appendix A). The questionnaires were addressed to large-scale Engineering, Construction, and Architecture firms. The targeted respondents were selected among the members of Turkish Contractors Association (TCA),

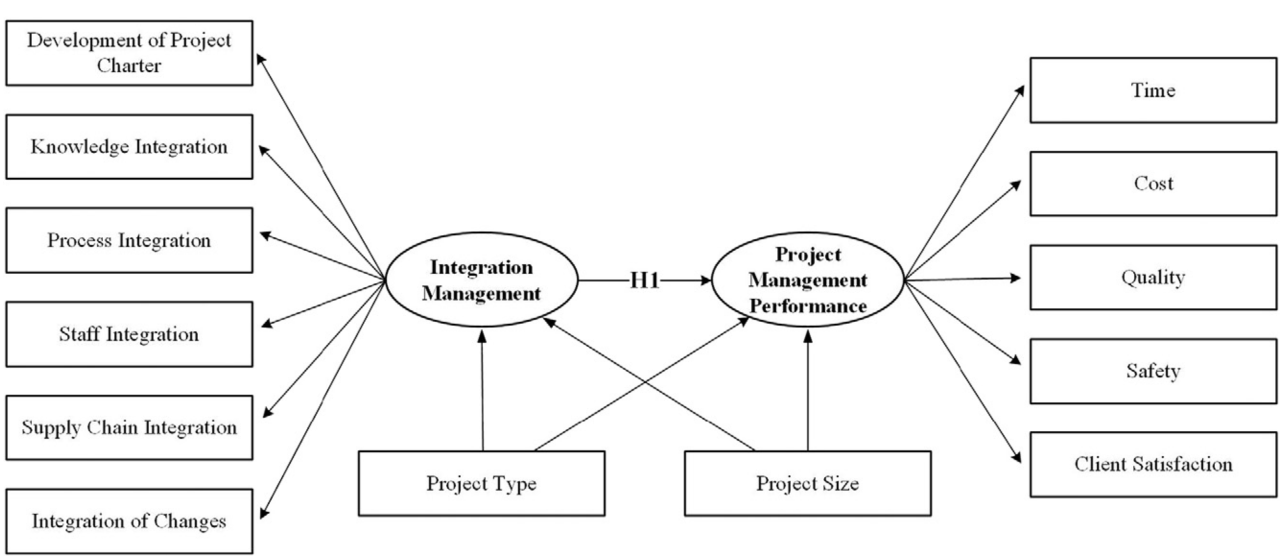

Fig. 2. Conceptual framework.

Association of Turkish Consulting Engineers and Architects (ATCEA), The Turkish Employers' Association of Construction Industries (TEACI), and Architectural Archive of Turkey (ARKIV). From the 508 questionnaires sent, 121 were returned, where 22 were face-to-face interviews, resulting in a response rate of 24%. Face-to-face interviews were conducted with 22 professionals to increase the response rate. Respondents were requested to fill in the questionnaires considering the project management practices of their completed projects based on fourteen knowledge areas. The collected data include information regarding 121 different construction projects, which were undertaken by 82 different firms where some of the firms provided multiple data.

The questionnaire consists of two main parts: (i) general information about the company, respondent and the project; and (ii) variables related to the project management performance. The respondents were asked to evaluate their project management practices based on the listed variables using a 1–5 point Likert scale (1: very low, 2: low, 3: medium, 4: high, 5: very high).

All respondents are upper-level managers of large-scale firms. Based on the questionnaire results, the average firm age is found to be 33 years and the average turnover is 612 million USD. The respondent profile consists of the contractors (64%) while small portion consists of structural designers (16%) and architectural designers (7%); subcontractors (6%), owners (5%) and others project executors (2%). The collected data involves building projects (31%); transportation (20%); infrastructure (18%); industrial construction (18%); water structures (10%), and other projects (3%). The questionnaire also gathered information regarding the project ownership. According to this information, it is assessed that the majority of the firms (75%) are solely responsible for the project, and for the remainder of the firms, project ownership belongs to joint ventures (24%) and consortiums (5%). Further information provided that the average project duration is 2.9 years and the average contractual duration is 2.4 years, which shows that some projects were completed with delays.

Analysis of Moment Structures (AMOS), a SEM tool, was used as the software package for analyzing the data collected from 121 questionnaires. SEM is a multivariate statistical methodology, which adopts confirmatory approach to analyze a structural theory based on a phenomenon. SEM also tests hypotheses among observed and latent variables (Bollen and Long, 1993; Hoyle, 1995; Kline, 1998; Byrne, 2012). SEM is also known as causal modeling, causal analysis, simultaneous equation modeling, analysis of covariance (ANCOVA) structures, path analysis, dependence analysis, or confirmatory factor analysis (CFA).

The reason why SEM was selected for this study is that it offers several advantages in terms of validity, reliability, and complexity. SEM allows use of several indicator variables for a construct simultaneously providing valid conclusions on the construct level. Moreover, SEM takes measurement error into account corresponding to the measurement error portions of observed variables, which in turn lead to unbiased conclusions. Finally, SEM provides several benefits to model and text complex patterns of relationships allowing the analysis of multitude of hypotheses simultaneously as a whole (Werner and Schermelleh-Engel, 2009).

SEM typically consists of two parts, which are the measurement and the structural model (Kline, 1998). The measurement model presents the measurement of hypothetical constructs in terms of observed variables. The structural model specifies the causal relationships among the latent variables (Byrne, 2012). A structural model is composed by the definition of the relationships among the latent variables and by the specification of the measurement method of latent variables. SEM also necessitates testing of the validity of the hypothesized constructs. Validity is simply defined as the extent to which the construct is measured by its instruments.

In a structural equation model, there are two types of validity that must be achieved. Construct validity refers to the "degree of agreement of indicators hypothesized to measure a construct and the distinction between those indicators and indicators of a different construct" (Chen and Fong, 2012). The achievement of construction validity is essential for the reliable model testing. Content validity refers to the degree to which the construct is represented by its indicators in its domain (Dunn et al., 1994). Content validity must be also achieved for reliable model testing.

5. Data analysis and findings

The questionnaire collected data regarding the level of success achieved for each component. Fig. 3 presents the ratings for each component of integration management. Abbreviations were used for each component (I1 = Development of Project Charter, I2 =Knowledge Integration, I3 = Process Integration, I4 = Staff Integration, I5 = Supply Chain Integration, I6 = Integration of Changes) and ratings are presented accordingly. According to Fig. 3, it can be seen that all components are rated around 3.5 and Cronbach's alpha value is calculated as 0.896, which proves the reliability of the components in terms of explaining its construct.

Fig. 4 presents the ratings for each component of project management performance. Abbreviations were used for each component (P1 = Time, P2 = Cost, P3 = Quality, P4 = Safety, P5 = Client Satisfaction) and ratings are presented accordingly. According to Fig. 4, it is seen that firms are more successful in achieving "quality" in their projects. It is also shown that firms satisfy "safety" objectives as well as "time".

Since there is no formal statistical test for content validity, researcher judgment and insight is applied in this study (Garver and Mentzer, 1999). An in-depth literature review was conducted to derive the indicators of each construct. With the contribution of two industry practitioners (one board member, one project manager) and three university professors, who took

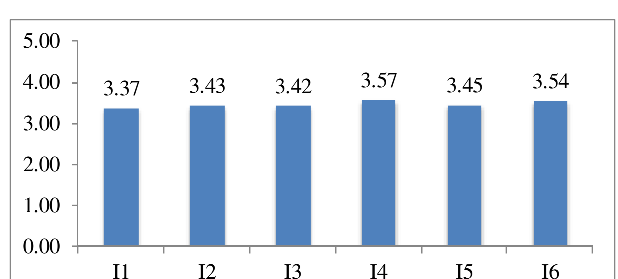

Fig. 3. Ratings for components of project integration management.

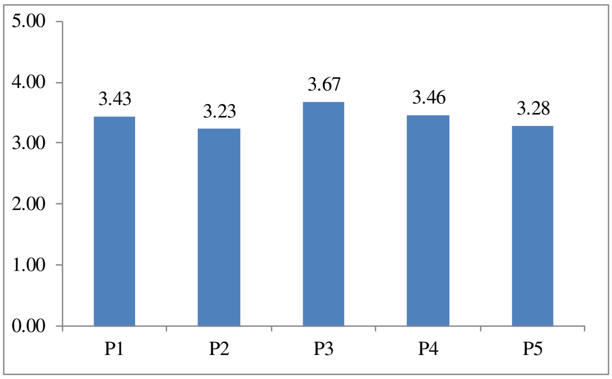

Fig. 4. Distribution of components of project management performance.

Table 1
Latent and constituent variables of the model.

No	Model variables	Factor loadings
F1	**Integration management**	
V1	Development of project charter	0.737
V2	Knowledge integration	0.813
V3	Process integration	0.851
V4	Staff integration	0.686
V5	Supply chain integration	0.708
V6	Integration of changes	0.763
F2	**Project management performance**	
V7	Time	0.855
V8	Cost	0.729
V9	Quality	0.808
V10	Safety	0.755
V11	Client satisfaction	0.983

part in the pilot studies for establishing the content validity of the constructs, the indicators were revised.

The components omitted for the project integration management construct were: information integration, scope integration, customer integration, and integration of project updates. After having in-depth interviews with industry experts, university professors and based on subjective judgment, some of the components were embedded in the other components since they were thought to be repetitive for deciding on the core components. For example, information integration is evaluated part of the knowledge integration by considering knowledge integration as a core component of integration management. Similarly, scope integration and integration of project updates are evaluated part of integration of changes since those represent the plan updates and changes in scope. Customer integration is addressed in the context supply chain integration having a dominant role in supply chain processes. Risk and scope were also selected as performance indicators in the first components matrix but these two components were omitted since performance more relies on meeting cost, schedule, quality, and safety objectives along with customer satisfaction. These two components were omitted after taking expert opinions and in-depth literature review.

Construct validity involves convergent validity, discriminant validity, and reliability. Convergent validity tests whether the items measuring a latent variable form a single latent variable. Convergent validity is assessed by the examination of factor loadings and goodness of fit indices. Discriminant validity investigates whether two measures differ statistically in terms of indicating a construct as opposed to the convergent validity. Discriminant validity is assessed by the evaluation of inter-correlations between the measures of a construct (Byrne, 2012). Examination of factor loadings is essential in confirmatory factor analysis for deleting the statistically insignificant indicators from the model. This operation helps to improve the internal reliability and fit indices as well.

Table 1 presents the factor loadings for the latent and constituent variables of the model. Factor loadings for each factor prove that the all factors are well represented by their variables.

Slight differences were observed for the two factors' variables depending on their placements on factors. For instance, client satisfaction (factor loading: 0.983) had stronger association with project management performance than cost (0.729) and safety (0.755), which were also found as valid indicators. A similar evaluation criterion was applied for both two factors and it was concluded that the variables for each factor were all found as valid indicators although they have slightly different placements on their representing factors. This leads to the conclusion that components selected for each construct were valid indicators and best represent their construct. This may be interpreted as a solid model involving valid indicators.

Table 2 represents the reliability values and fit indices for the constructs of the framework. Reliability is traditionally defined as the internal consistency of the constructs. Reliability refers to the magnitude of direct relations with the measure for which the reliability is assessed excluding the error terms in a structural model (Bollen, 1989). The reliability test is assessed by Cronbach's 'α' coefficient in this study. Constructs' reliability is satisfied when Cronbach's 'α' coefficient exceeds 0.7 for all the constructs (Nunnally, 1978). Given the results of reliability analysis, it is concluded that constructs of integration management and project management performance are consistent.

Chi-square test was performed to test goodness of fit. In SEM, Chi-square ($\chi 2$) is used to detect any significant difference between the actual and predicted matrices. The smaller the $\chi 2$ value, the better fit is observed. In AMOS, a ratio of $\chi 2$/df (degree of freedom) is proposed as a fit measure. Although there is no agreed consensus on $\chi 2$/df value, a ratio lower than 5.0 is an acceptable range (Marsh and Hocevar, 1985). In the analysis of the model, a ratio of $\chi 2$/df was achieved as 2.808 and 2.901 for integration management and project management performance constructs, respectively. This concludes that the data shows a good fit to the model.

Table 2
Reliability and fit indices for the constructs of the model.

Index	Recommended value	F1	F2
Cronbach's Alpha	>0.7	0.869	0.850
X^2/df	<5.0	2.808	2.901
RFI	>0.90	0.927	0.911
CFI	>0.90	0.963	0.952
TLI	>0.90	0.930	0.903
RMSEA	<0.10	0.096	0.098

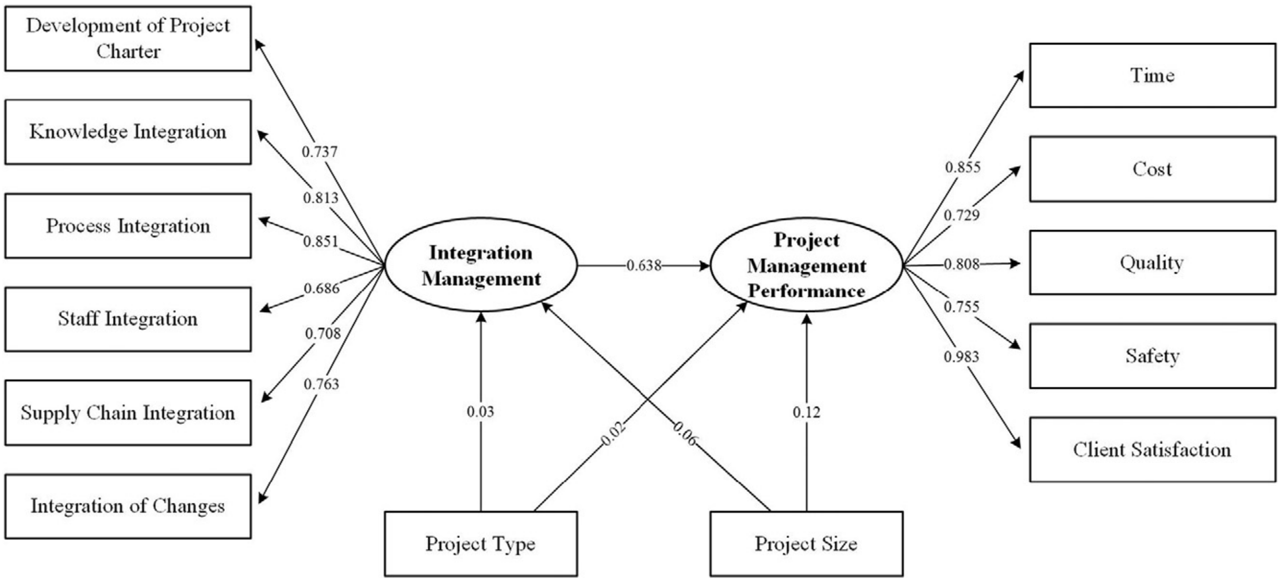

Fig. 5. Project management performance framework with path coefficients.

Relative fit index (RFI) (Bollen, 1986), Comparative fit index (CFI) (Bentler, 1990), and Tucker-Lewis index (TLI) (Tucker and Lewis, 1973) are measures for comparing the proposed model to the null or independence model. The values of those indices lie between 0 and 1.0 where values approaching 1.0 indicate good fit. The root mean square error of approximation (RMSEA) (Steiger and Lind, 1980) is a parsimony-adjusted index, which includes a built-in correction for model complexity. A threshold value of RMSEA was previously proposed by the researchers indicating that the values <0.10 show acceptable fit (Kline, 1998).

Table 2 proves that the reliability of all constructs meets Nunnally's (1978) recommendation since all Cronbach's 'α' values are above 0.7. It is shown that all fit indices are the acceptable ranges indicating that the measurement model shows a good fit to the data. Finally, it is demonstrated that all values for RMSEA of all constructs are below the threshold value proving acceptable fit for the data to the model.

SEM tests the hypotheses between the validated constructs. In this respect, the relationship between integration and performance was investigated. Fig. 5 presents the hypothesized relationships with path coefficients. In Fig. 5, project integration management and project management performance are exogenous variables where project charter, knowledge integration, supply chain integration are endogenous variables. In addition, project size and project type are control variables in the system. The arrows represent the direction of influence between the parameters of the framework where the numbers on the arrows show the path coefficients. Path coefficients are the equivalents of regression weights except that there is no intercept term in SEM.

An interpretation guideline adopted from Murari (2015) is used for evaluating the strength of association between variables where the path coefficient ranging from 0.1 to 0.3 shows weak association; 0.3 to 0.5 (moderate), and 0.5 to 1.0 (strong).

The findings of the study reveal the ***strong effect*** of integration management on project management performance (0.638). Moreover, the effect of project type on integration and performance was found to be very weak, respectively (0.03; 0.02) Similarly, weak effect of project type on integration and performance was observed, respectively (0.06; 0.12).

Table 3 presents the reliability values and fit indices for the model. Although there has not been a consensus on the threshold values of fit indices and some authors adopted a threshold value of 0.95 for most of the indices in SEM (Schreiber et al., 2006; Lei and Wu, 2007), the authors adopted the threshold values recommended by the pioneers of SEM.

Cronbach's 'α' values were found higher than 0.7 as recommended by Nunnally (1978). RFI, CFI, and TLI values were also found around 0.9, which indicates good fit of the model to the data. Furthermore, RMSEA values were found to be below the threshold value as recommended by (Kline, 1998). In the initial step, 131 responses were collected. However, responses having missing data or outliers were excluded from the analysis resulting in a response number of 121. Normality check was also assessed and the data was found to be normally distributed. Finally, the correlation matrices were calculated for all constructs and the intercorrelations were all found below 0.90, which indicated that there is no multicollinearity (Hair et al., 1998) (See Appendix A).

Table 3
Reliability and fit indices.

Index	Recommended value	Model
Cronbach's Alpha	>0.7	0.980
χ^2/df	<5.0	2.024
TLI	0 (no fit) to 1 (perfect fit)	0.930
IFI	0 (no fit) to 1 (perfect fit)	0.949
CFI	0 (no fit) to 1 (perfect fit)	0.948
RMSEA	<0.10	0.091

This evidences that the fit between the initial and final models and the data is quite satisfactory.

6. Discussion

The hypothesis regarding the relation between integration and performance was validated. This reveals the strong interaction between integration and performance. Integration is one of the most important components of successful project execution. Hence, the construction industry is still in great need of well-set practices and strategies. This study enlightens the critical role of integration management and poses its clear link with project management performance.

Based on the clear link between integration management and project management performance, it is worth discussing the impact of individual components of integration management on project management performance.

- ***Development of Project Charter***: Project charter is the document that authorizes the start of a project. Therefore, it is critical to have the approval of the project charter on a timely manner. Provided with a high factor loading (0.737), project charter is undoubtedly one of the most important components of integration management affecting project success. PMI (2013) also implies the functionality of project charter in terms of describing project manager's authority. Considering the role of project managers in project management performance, one might conclude that projects managers are likely to achieve higher success in managing projects where a solid project charter exists including clear and proper description of authorities.
- ***Knowledge Integration***: Knowledge exchange among stakeholders and project parties is crucial in terms of project success. Heising (2012) also emphasizes that knowledge integration and ideation is essential in sustainable success. Several research studies mentioned the essential role of knowledge integration in project management performance (Schmickl and Kieser, 2008; Ritala and Hurmelinna-Laukkanen, 2009; Song and Song, 2010; Un et al., 2010; Brettel et al., 2011; Enberg, 2012; Too, 2012). Provided with a high factor loading (0.813), knowledge integration is concluded as a strong indicator of integration management. This leads to conclude that firms achieving success in knowledge integration have potential to perform better in their projects.
- ***Process Integration***: Organized sequence of project activities and logical relationships within processes frame process integration. Process integration may foster value creation when synthesized with human and task integration (Birkinshaw et al., 2000). The role of process integration in project management performance was also highlighted by several studies (Wheelwright and Clark, 1992; Enberg, 2012; Kleinschmidt et al., 2007). Provided with a high factor loading (0.851), process integration is dominant in terms of explaining integration management. It is undeniable that firms implementing effective process integration activities are likely to achieve better performance in their projects. One might not discard the essential role of process integration in increased success.
- ***Staff Integration***: Project staff constitutes an important place in project management success. Therefore, integration of project staff, collaboration and coordination among them affect project management activities. It is reported that integration increases team work effectiveness (Egan, 2002). Therefore, composition of effectively working teams has a positive impact on project management performance. Reported with a high factor loading (0.686), staff integration should be addressed properly in terms experiencing higher levels of success. The necessity of staff integration as part of project management is underlined in several studies (Carmeli and Meyrav, 2009; Zajac, 2009; Jonas, 2010; Enberg, 2012; Tiller, 2012).
- ***Supply Chain Integration***: Supply chain is in the critical chain of construction activities in terms of successful execution of projects. Its impact on project management is revealed in several studies (Griffin and Hauser, 1996; Gruner and Homburg, 2000; Henard and Szymanski, 2001). Provided with a high factor loading (0.708), supply chain integration is one of the core elements of integration management. The revealed link between integration and performance makes supply chain integration as one of the most important components to be addressed when firms desire to achieve higher rates of success.
- ***Integration of Changes***: Changes might create uncertainties in project management. Thus, timely handling of changes is essential to the success of a project. Integration of changes covers activities such as review and evaluation of change requests, modifications, and updates in project management plan. Research studies underlined that integration of changes is of utmost importance to experience better performance in managing projects (Hassner-Nahmias and Crawford, 2008; Cummings and Worley, 2009; Soderlund, 2010). Reported with a high factor loading (0.763), integration of changes becomes essential in integration management. This might be interpreted as firms should carefully address integration of changes when higher rates of success is desired.

According to data presented in this study, majority of the responding firms indicated that they perform very well in "staff integration" in their projects. Secondly, firms reported that they successfully handle with the "integration of changes" to perform well in project integration management. The high ratings for "supply chain integration", "knowledge integration", "process integration" and "development of project charter" prove that firms perform well in the achievement of those components for the project success. Previous studies also reported that high performance in the realization of integration management functions such as process integration, knowledge integration, and supply chain integration are keys to achieve project success (Ernst et al., 2010; Heising, 2012; Kleinschmidt et al., 2007).

Several research studies also prove that safely completed work and on time completion are the most important project success indicators (Khosravi and Afshari, 2011; Chan et al., 2002). Firms provided that they mostly achieve "client satisfaction" and "cost" objectives in their projects. The importance of satisfying the client and completing the project under budget in terms of project success was previously shown in several studies (Shields et al., 2003; Nassar and Abourizk, 2014). The importance of the components made strategies to follow even more important when managing construction project. Based on the findings of this study, it is clear that integration management has a positive and strong impact on project management performance. The questionnaire results also indicated that responding firms that are successful in operating integration management activities experienced higher levels of success. To operationalize the components of integration and to provide solutions for better managing projects in terms of stages of construction, Table 4 proposes several tools/strategies for each phase in a construction project. The tools and strategies proposed in the table are expected to explain the roadmap for achieving higher rates of success in relation with integration components.

- *Change and Issue Management*: Changes in projects might have both direct and indirect and impact on cost, scheduling and duration of the projects (Ibbs et al., 2001). Hence, dealing with changes in a construction project is critical to achieve higher success. Bronn and Bronn (2002) indicate that issue management is critical to have a solid foundation in strategic management. They mention that issue management concentrates on identifying and understanding the forces in a firm's environment. Therefore, issue management is also recommended as a strategy to experience improved performance.
- *Enterprise Resource Planning* (*ERP*): ERP systems are the software tools for managing the enterprise's data and serve as information providing tools when needed (Ragowsky and Somers, 2002). ERP systems also provide support for key business processes (Kurbel, 2010). Thus, those systems are effective in the integration activities in business processes ensuring that the information is delivered to the people when they need it. Companies are advised to use such systems to experience improved performance.
- *Building Information Modeling* (*BIM*): BIM is a "set of a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle" (Penttila, 2006). Kimmance (2002) implies that there is a considerable need for a BIM framework to serve as an integration of product and process modeling tool. Azhar (2011) states that BIM help to integrate the roles of stakeholders on a project. Several researchers also imply the integrative feature of BIM between graphical and non-graphical data for different construction business functions (Jung and Gibson, 1999; Sanvido and Medeiros, 1990; Teicholz and Fischer, 1994).
- *Lean Project Delivery* (*LPD*): LPD system is developed as "a set of interdependent functions (the systems level), rules for decision making, procedures for execution of functions, and as implementation aids and tools, including software when appropriate". LPD system proposes that project delivery team provides what the customer wants but more importantly guides the customer decide what they want. (Ballard, 2008). It is ascertained that project organization is one of the core components of project delivery systems, and fragmented traditional project organizations experience waste, increased cost and time (CMAA, 2010). Hence, research studies suggest that the construction industry need to adopt more collaborative and integrated approaches to overcome those problems (Egan, 1998; Mitropoulos and Tatum, 2000; Fairclough, 2002). LPDS serves as a well-structured strategy to deliver more value to the customer while minimizing waste. The term just-in-time hence constitutes a critical role ensuring the supply of materials at the right time and in the right amount (Tommelein and Li, 1999). Last Planner System (LPS) is also developed to provide cost and schedule benefits and enables more stabilized project based production systems. Alarcon (2001) indicated that implementing LPS on a construction project provided considerable budget and productivity improvements.
- *Integrated Project Delivery* (*IPD*): IPD system aims at improving project outcomes by adopting a collaborative approach, which aligns the incentives and goals of the project team through shared risk and reward and early involvement of all parties. Well-defined contractual relationships, early definition of project goals and early team formation are indicated to be the most important factors in IPD success in addition to the clearly defined work scope, roles, relationships, and responsibilities (Kent and Becerik-Gerber, 2010). Thus, IPD is aligned with the elements of successful integration processes.
- *Agile management*: Agility is defined as "market knowledge and a virtual corporation to exploit the profitable opportunities in a volatile marketplace" (Naylor et al., 1999). Christopher (2000) listed a set of characteristics, which makes a supply chain truly agile. Those characteristics include market sensitivity, creating virtual supply chains, and process integration and networks. Weber and Wild (2005) indicated that the integration of workflow management and conversational case-based reasoning are crucial to achieve agility in workflow management systems. Hence, agility brings up the need for effectively integrated systems and approaches.

Table 4
Strategies/tools for construction phases.

	Phase				
	Conception	Planning & design	Construction	Operation & maintenance	Close-out
Strategy/tool	·Change management ·Issue management	·BIM ·Implementation of Last Planner System ·Adopting lean principles ·ERP ·Change management	·BIM ·Project based knowledge management systems ·Agile management ·JIT delivery Change management	·BIM ·Use of project based knowledge management systems ·Change management	·Change management

During the conception phase, companies are recommended to use change and issue management as a strategy to handle changes in a project and make ready processes for change control. Since construction projects are fragmented, several issues might arise with project parties. Thus, issue management is critical to handle potential problems with suppliers, material shortages, technical failures and staff.

The planning phase is one of the most critical phases of construction projects (Laufer and Tucker, 1987; Chua et al., 1999; Frimpong et al., 2003). Construction companies mostly struggle with on-time and under-budget completion. Therefore, it is recommended that companies implement the Last Planner System, which ensures the delivery of projects more safely, faster or at reduced cost. Within this context, adopting lean principles are worth being mentioned since they aim at minimizing waste while maximizing value to the customer. Enterprise Resource Planning (ERP) systems are also effective in planning and design phase since they make the workflow tracking easier across various departments. They also enable better and faster collaboration among all departments. Jarrar et al. (2000) presented several case studies regarding the implementation of ERP by different companies. According to the results provided in the study, ERP implementation resulted in annual savings, productivity improvement, cost reduction, and achieved integration between processes, which in turn lead to improved project performance.

During the construction phase, companies are advised to use building information modeling (BIM) tools to visualize the construction and resolving conflicts by improving communication. The impact of BIM on project success has already been assessed in different projects. For example, Howell and Batcheler (2005) have provided evidence for benefits of using BIM in The Bart's and The London Hospital project. They mentioned that project team's success was apparent in adopting a model-based design process and generating coordinated documents using a BIM approach during construction, which led to enhanced project performance. On the other hand, development of project-based systems is another important approach since construction projects are unique in nature. Evaluation of construction projects in terms of their specific attributes provides a more effective system of workflow and control. Moreover, the use of agile concepts in construction execution deserves special emphasis since it allows customer collaboration, contractors' rapid response to changes at job sites and improves overall project responsiveness to change. Just-in-Time (JIT) delivery is proposed as a strategy to increase efficiency and to decrease waste.

During the operation and maintenance phase, use of BIM tools and project-based knowledge management systems provide advantages to better coordinate operation and maintenance activities. In close-out phase, companies are advised to adopt change management principles to reduce the impact of severe changes.

Following the strategies provided in this study and evidence from the real cases, it is apparent that firms may enhance their performance in integration management with the adoption of proper strategies. However, one should note that these strategies proposed are conceptual and require further research to deepen their theoretical and empirical foundation. Therefore, future work is encouraged with cases from construction projects, where the strategies proposed are applied to best reflect their impact on project success rates.

7. Conclusions

This study investigates the relation between integration management and project management performance. In this perspective, a set of construction-specific components were proposed for integration and performance constructs. Data was collected from 121 projects through a questionnaire survey. SEM was used to validate the framework and test the hypothesis of a possible relation between integration and performance in addition to the potential impact of better integration management on improved project management performance.

Findings of the study reveal that integration management has a considerable impact on project management performance, and it is suggested that this link is of considerable strength. When past studies are examined for the exposition of this link, it is indicated that there is a gap in the literature and the impact of integration management needs special emphasis. Hence, this study demonstrates the core component of integration management with its construction specific components and clearly visualizes the strong tie between integration and performance.

Based on the findings of this study, several activities, tools, and strategies are listed based on the construction projects' phases. With respect to the strong influence of integration management on the project management performance, it is essential that project managers effectively coordinate the processes and relevant parties. Some of the dominating strategies during construction phase are listed as use of IPDS, BIM tools, LPD, JIT delivery, and ERP and agile management.

The proposed project management performance framework could be used by project managers in the construction industry to devise and implement effective strategies. It could be used to ensure project success prior to the start of a project, as well as a post project evaluation tool upon the completion of a project. The main limitations of this study are that the data was collected from Turkish companies and it reflects their experiences and opinions, and the proposed strategies are recommended based on their needs. In this respect, data from different projects undertaken by different companies might result in varying findings. In addition, the research also has some limitations in that some of the performance measures are subjective measures, which were identified based on an extensive literature review and expert opinions. Different measures might affect the results of the study. Information regarding procurement methods of the project was not gathered in the questionnaire. Therefore, this appears as another limitation of the study since different procurement methods might affect integration management and in turn project management activities.

However, considering the high volume of Turkish contractors in domestic and overseas projects and the fact that the data collected belongs to high scale projects around the world, one might conclude that the results are generalizable and proposed strategies might be adopted by international contractors as well. The proposed framework could easily be used in other studies dealing with the construction sector and the findings may be used for comparison. Similar frameworks having different components could also be developed for other project-based industries. Moreover, new frameworks that analyze integration at the company and portfolio level would be very effective to compare the results of this study. One may comment on the results without bias in case more frameworks are available including different components to assess integration management.

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Appendix A. Descriptive statistics

Section 1: General information about the company, respondent and the project

1) Field of operation

☐ Engineering ☐ Architecture ☐ Construction

2) Number of years that your company has been operating in the construction industry

☐ 0-10 years ☐ 10-20 years ☐ 20-30 years ☐ 30-40 years ☐ >50 years

3) Areas of expertise of your company

☐ Infrastructure ☐ Transportation ☐ Building ☐ Industrial ☐ Water Structures ☐ Other….......

4) Annual turnover of your company...

5) Your position at the company

☐ Owner ☐ Board Member ☐ Director ☐ Manager ☐ Engineer ☐ Other…….

6) Your experience in the construction industry

☐ 0-5 years ☐ 5-10 years ☐ 10-15 years ☐ 15-20 years ☐ >20 years

7) Type of the project

☐ Infrastructure ☐ Transportation ☐ Building ☐ Industrial ☐ Water Structures ☐ Other……

8) Project Ownership

☐ Sole ☐ Joint Venture ☐ Consortium ☐ Other…….

9) Role in the project

☐ Contractor ☐ Designer ☐ Client ☐ Sub-Contractor ☐ Other

10) Start Date of Project……………………………………………………………………………………………………...

11) Finish Date of Project…………………………………………………………………………………………………….

12) Start Date in the Contract………………………………………………………………………………………………..

13) Finish Date in the Contract………………………………………………………………………………………………

14) Contractual Budget of the Project……………………………………………………………………………………….

15) Contract type

☐ Unit Price ☐ Lump Sum ☐ Turnkey ☐ Cost Plus Fee ☐ Other………

Section 2: Project management performance framework

Success criteria		Extent it is realized by the company				
		Very low 1	Low 2	Medium 3	High 4	Very high 5
Project integration management	Timely development of project charter					
	Effectiveness of knowledge integration					
	Efficiency of process integration					
	Effectiveness of staff integration					
	Effectiveness of supply chain integration					
	Effectiveness of incorporation of changes					

Section 3: Performance indicators of Turkish construction companies

Objectives		Extent it is realized by the company				
		Very low 1	Low 2	Medium 3	High 4	Very high 5
Project management performance	Complete the project within schedule					
	Complete the project within budget					
	Achieve required quality					
	Achieve required safety					
	Satisfy the client					

Appendix B

Correlations

		Int1	Int2	Int3	Int4	Int5	Int6
Int1	Pearson correlation	1	0.706 **	0.652 **	0.465 **	0.448 **	0.553 **
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000
	N	121	121	121	121	121	121
Int2	Pearson correlation	0.706 **	1	0.768 **	0.454 **	0.546 **	0.589 **
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000
	N	121	121	121	121	121	121
Int3	Pearson correlation	0.652 **	0.768 **	1	0.556 **	0.573 **	0.691 **
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000
	N	121	121	121	121	121	121
Int4	Pearson correlation	0.465 **	0.454 **	0.556 **	1	0.657 **	0.606 **
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000
	N	121	121	121	121	121	121
Int5	Pearson correlation	0.448 **	0.546 **	0.573 **	0.657 **	1	0.583 **
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000
	N	121	121	121	121	121	121
Int6	Pearson correlation	0.553 **	0.589 **	0.691 **	0.606 **	0.583 **	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	
	N	121	121	121	121	121	121

Correlations

		Performance1	Performance2	Performance3	Performance4	Performance5
Performance1	Pearson correlation	1	0.574 **	0.519 **	0.348 **	0.496 **
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	121	121	121	121	121
Performance2	Pearson correlation	0.574 **	1	0.424 **	0.363 **	0.370 **
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	N	121	121	121	121	121
Performance3	Pearson correlation	0.519 **	0.424 **	1	0.668 **	0.704 **
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	121	121	121	121	121
Performance4	Pearson correlation	0.348 **	0.363 **	0.668 **	1	0.589 **
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	121	121	121	121	121

(*continued*)

Correlations

		Performance1	Performance2	Performance3	Performance4	Performance5
Performance5	Pearson correlation	0.496 **	0.370 **	0.704 **	0.589 **	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	121	121	121	121	121

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

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