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The relationship between project management process characteristics and performance outcomes

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Abstract

Purpose – The aim of this paper is to examine the links between project management process characteristics and project-level and firm-level performance outcomes to test the hypotheses that project management assets being valuable, rare, inimitable and having organizational support leads to competitive advantage.

Design/methodology/approach – This paper analyzes data from responses to an online survey by 198 North American Project Management Institute® members. Regression analysis is used to examine the relationship between six factors extracted from an exploratory factor analysis that comprise the three project management asset characteristics – valuable, rare and inimitable, three factors that comprise organizational support for the project management process, and two factors that comprise project management performance outcomes – project-level and firm-level performance.

Findings – Organizational support for the project management process, specifically project management integration, was found to significantly contribute to both project-level and firm-level performance. Of the asset factors examined, valuable project management knowledge was found to contribute to project-level and firm-level performance, though information technology (IT) tools did not. Inimitable proprietary tangible assets were found to contribute to both project-level and firm-level performance, and inimitable embedded intangible assets were also found to contribute to firm-level performance. Rare knowledge sharing tools and techniques were found to negatively contribute to project-level performance.

Research limitations/implications – Limitations of this study include sample size, response rate and self-report bias, calling for a larger sample in ongoing research.

Practical implications – This study draws managerial attention to project management assets as sources of competitive advantage, highlighting the need to have organizational support for the project management process through organizational integration, and emphasizing the importance of valuable

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project management knowledge-based assets and inimitable project management assets that are proprietary and tangible as well as those that are embedded and intangible.

Originality/value – Few papers have applied the resource-based view of the firm to examine project management capabilities as a source of competitive advantage. This paper contributes to the literature on the resource-based view of the firm and to an improved understanding of project management as a source of competitive advantage.

Keywords Project management, Competitive advantage, Resource-based view, Performance outcomes, Strategic assets, Project management assets

Paper type Research paper

Introduction

Project management is receiving an increasing amount of recognition as a means to improve a firm's competitive position; however, academic literature has focused primarily on operational aspects, and the competitive advantage that can be obtained from the project management process is relatively understudied. The objective of our research is to contribute to an improved understanding of project management as a source of competitive advantage for management theory and practice. Our research agenda is driven by the premise that project management can be leveraged as a source of competitive advantage for a firm and the research question: *What characteristics of project management assets lead to competitive advantage for a firm?*

We examine the project management process with the lens of the resource-based view (RBV) of the firm, and assume the perspective that the project management process is a subset of the resources of a firm, and that some of these project management resources are a source of competitive advantage for the firm. In the strategic management literature, resources are considered a source of competitive advantage, or strategic assets if they provide economic value (V), they are unique or rare (R), they are difficult to copy or inimitable (I) and they have organizational support (O) to leverage these assets (Barney, 1991, 1998, 2002). In an associated theoretical framework referred to as the VRIO framework, a resource that has organizational support contributes to competitive parity by being valuable, it contributes to temporary competitive advantage if it is both valuable and rare, and it provides sustained competitive advantage if it is valuable, rare and inimitable.

The focus on project management practices in the past has been on project management tools and techniques. More recently, scholars have acknowledged the importance of project management assets that are knowledge-based, intangible and embedded in a firm's processes. Prior empirical research has examined the competitive characteristics of project management assets – valuable, rare, inimitable and organizationally supported (Jugdev and Mathur, 2006; Jugdev *et al.*, 2007; Mathur *et al.*, 2007). Prior work has not empirically addressed the link between these characteristics of project management assets and project or firm performance. We build on this prior work, using a new survey instrument that also draws on the VRIO framework to examine the factors that comprise these competitive characteristics of project management assets as well as factors that comprise project management performance outcomes, in an attempt to explore the relationship between assets being valuable, rare, inimitable and having organizational support and the achievement of competitive advantage.

We conducted an exploratory factor analysis of data collected from responses to an online survey by 198 North American Project Management Institute® members using our survey instrument. The factors extracted included six factors that comprise valuable, rare and inimitable characteristics of project management assets, three factors that comprise organizational support for project management assets and two factors that comprise project management performance outcomes – project-level and firm-level performance. In this paper we explore the link between these project management process characteristics and project management performance outcomes, using linear regression analysis to examine how the independent variables (project management process characteristics) predict the dependent variables (project-level and firm-level performance).

The sections that follow include the literature review, the study methodology, results of the exploratory factor analysis, the results and discussion of findings from the regression analysis and the conclusions.

Literature review

In the RBV, a firm is a collection of resources, including financial, human, organizational, physical, social and technological assets. These resources can be tangible (concrete, physical, codified or based on explicit knowledge) or intangible (tacit, unspoken but understood) (Teece *et al.*, 1997). Only a subset of these resources, classified as strategic assets, contributes to a firm's competitive advantage (Amit and Schoemaker, 1993). These strategic assets involve explicit knowledge and tacit knowledge (Eisenhardt and Santos, 2000; Nonaka, 1994) that is embedded in a company's unique skills, knowledge, resources and ways of working (Foss, 1997; Rumelt *et al.*, 1994). Strategic assets include intellectual property rights (Teece *et al.*, 1997), reputation (Kogut, 2000), brand (Powell and Dent-Micallef, 1997) and culture (Conner and Prahalad, 1996). The RBV and the perspective that strategic assets contribute to a firm's competitive advantage are widely accepted in the literature (Kraaijenbrink *et al.*, 2010, Barney *et al.*, 2011).

The VRIO framework has emerged from this perspective as a useful way of characterizing strategic assets in the strategic management literature (Barney, 1991, 1998, 2002). Resources are considered a source of competitive advantage if they have the following characteristics: they provide economic value (V), they are rare (R), they are inimitable (I) and they have organizational support (O). A resource contributes to competitive parity for a firm by being valuable and having organizational support, it contributes to temporary competitive advantage if it is both valuable and rare and has organizational support and it provides sustained competitive advantage for a firm if it is valuable, rare and inimitable and has organizational support.

The RBV and Barney's VRIO framework have been widely used in empirical studies on strategic assets. Strategic assets that have been examined include: the cognitive abilities of entrepreneurs (Alvarez and Busenitz, 2001), human resource skills (Barney, 1998), managerial skills and abilities (Castanias and Helfat, 2001), electronic commerce strategy capabilities (Montealegre, 2002), the effectiveness of the customer service process in the insurance industry (Ray *et al.*, 2004), governance decisions for sourcing technological know-how (Schilling and Steensma, 2002) and technology commercialization (Zahra and Nielsen, 2002). The empirical research on RBV has been assessed broadly (Newbert, 2007) and within narrower arenas, including the

international business literature (Peng, 2001), the strategic human resources management field (Wright *et al.*, 2001), the banking industry (Liu *et al.*, 2010), the home video game industry (Shankar and Bayus, 2003), and entrepreneurial start-ups in Germany (Stubner *et al.*, 2007).

The stream of research on operations management using the RBV lens and the VRIO framework is evolving. Scholars have examined several operational processes and reported that information sharing meets the VRIO criteria (Barratt and Oke, 2007), scheduling estimating and management capabilities positively affect project revenue (Ethiraj *et al.*, 2005), functional areas integrated through organizational knowledge contribute to valuable and rare product features (Paiva *et al.*, 2008) and improvement and innovation routines are distinct bundles that significantly relate to operational performance (Peng *et al.*, 2007). The RBV and the VRIO framework have been applied in a few studies to explore how project management contributes to a company's competitive advantage. In a qualitative field study based on an American-United Kingdom feature film industry project, DeFillipi and Arthur found that although projects involve mobile and rented personnel (human capital), they could accumulate core competencies and create a competitive advantage through possessing inimitable resources (DeFillippi and Arthur, 1998). The VRIO framework has also been applied to a case study of a project in the German music industry to analyze competitive advantage levers (Enders *et al.*, 2009).

Project management is defined as a set of processes that encompasses the tools, techniques and knowledge-based practices applied to projects, to achieve organizational goals and deliver products or services (DeFillippi and Arthur, 1998; Fernie *et al.*, 2003; Project Management Institute, 2013). Project management involves both tangible and intangible assets. Tangible resources involve codified or explicit knowledge, while intangible resources are based on tacit knowledge. Codified and tacit knowledge have also been labeled as "know-what" and "know-how" (Nonaka, 1994). To date, considerable project management literature has focused on the tangible resources and codified knowledge through research on project management offices (Aubry *et al.*, 2007, 2008; Hobbs and Aubry, 2007) and studies on the use of tools and techniques (Besner and Hobbs, 2006, 2008; Kloppenborg and Opfer, 2002; Ulri and Ulri, 2000). We find that several studies extend this stream of research to explore the tools and techniques in relation to project success (Fortune *et al.*, 2011; Patanakul *et al.*, 2010; White and Fortune, 2002). However, based on the RBV and VRIO framework, it is the intangible project management resources that are more likely to be rare and inimitable, and therefore more likely to be sources of competitive advantage. In an empirical study that draws on the RBV literature and the VRIO framework, intangible project management assets were found to be determinants of competitive advantage (Jugdev and Mathur, 2006; Jugdev *et al.*, 2007; Mathur *et al.*, 2007). Intangible project management resources include tacit knowledge, the application and sharing of tacit knowledge and processes and relationships for facilitating this sharing. While explicit knowledge is more formal, codified and transmitted systematically (Polanyi, 1966), tacit knowledge is shared informally through social exchanges (Granovetter, 1985), and some examples in project management include brainstorming, mentoring, learning through shadowing and storytelling (Egbu, 2004; Leonard-Barton, 1992). Project teams often share knowledge through informal exchange of ideas and practice in communities of practice, groups

where members regularly engage in sharing and learning based on their common interests (Lesser, 2000).

With firms increasingly focusing on project management as a source of competitive advantage to help leverage their resources (Cleland and Ireland, 2002; Pinto, 2001), further investigation of the strategic characteristics of project management assets and their relationship to project management performance outcomes is warranted.

Conceptual model

We use a high-level conceptual model based on Barney's VRIO framework (Barney, 2007) to link the characteristics of project management assets, as independent variables, to project management performance outcomes, the dependent variables (Figure 1). Project management assets can have one or more of the following characteristics – valuable (V), rare (R), inimitable (I) and being organizationally supported (O). It is expected that these characteristics of the project management process (V, R, I, O) will affect project management performance outcomes, both project-level and firm-level performance, thereby contributing to competitive advantage.

Previous empirical research reports on factors that constitute project management strategic assets and links them to the achievement of the V, R, I and O characteristics of the project management process (Jugdev and Mathur, 2006; Jugdev *et al.*, 2007; Mathur *et al.*, 2007). We go beyond this work to link the project management process characteristics (V, R, I and O) to project management performance outcomes (project-level performance and firm-level performance).

The model in Figure 1 does not include possible mediating and moderating effects (Baron and Kenny, 1986). Theory would lead us to expect these effects and we will examine these empirically in the next stage of our research using path analysis, outside the scope of the work we report on in this paper. We expect that some of the characteristics of the project management assets will have moderating effects in the relationship between other independent variables and project management performance outcomes. In Barney's VRIO framework, a resource contributes to competitive parity for a firm by being valuable and having organizational support, it contributes to temporary competitive advantage if it is both valuable and rare and has organizational support, and it provides sustained competitive advantage for a firm if it is valuable, rare and inimitable and has organizational support. We therefore expect that

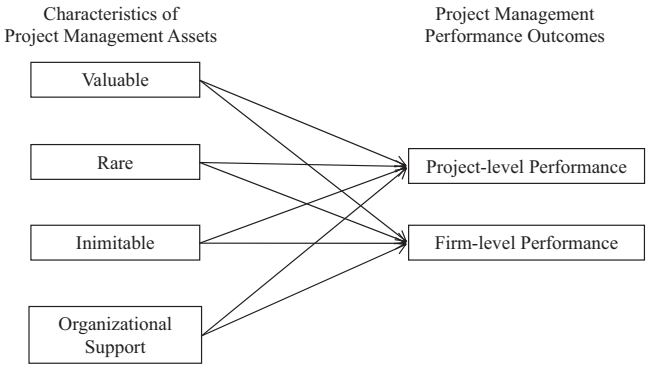

Figure 1.
Conceptual model linking characteristics of project management assets to project management performance outcomes

independent variables O, V and R will moderate the relationship between the independent variable I and the dependent variables P and F; O and V will moderate the relationship between R and the dependent variables; O will moderate the relationship between V and the dependent variables.

Prior research indicates that the RBV can be tested using intermediate (disaggregate) dependent variables versus the more aggregate dependent variable of firm performance (Henderson and Cockburn, 1994; Ray *et al.*, 2004). As Ray explains, firm performance depends on the effects of multiple business processes. While the model in Figure 1 is used to test the effect of the independent variables, project management asset characteristics on the dependent variable P and F, in this research, we expect that P will also have a mediating effect on the relationship between the independent variables and F. We will be examining this mediating effect using path analysis in the next stage of our research.

This paper provides the exploratory factor analysis of data collected using a survey tool to explore the factors that constitute the independent and dependent variables. In accordance with the VRIO framework, an asset can have one or more of the four characteristics: valuable (V), rare (R), inimitable (I) and being organizationally supported (O). For each project management asset we address in our research, we asked survey participants to assess the asset for each of these four characteristics. Since the factors extracted are factors that constitute asset characteristics, a project management asset is likely to appear in more than one factor. In the VRIO framework, a resource contributes to competitive parity for a firm by being valuable and having organizational support, it contributes to temporary competitive advantage if it is both valuable and rare and has organizational support and it provides sustained competitive advantage for a firm if it is valuable, rare and inimitable and has organizational support. Therefore, an asset that has more than one of the four characteristics (i.e. appears in more than one factor) is expected to have a higher contribution to performance outcomes.

We use hierarchical linear regression analysis to test the hypotheses that the factors that represent these four characteristics of project management assets will contribute to project management performance outcomes. We examine the following hypotheses in the sections that follow:

H1. If a project management asset is valuable, then it contributes to project-level performance.

H2. If a project management asset is valuable, then it contributes to firm-level performance.

H3. If a project management asset is rare, then it contributes to project-level performance.

H4. If a project management asset is rare, then it contributes to firm-level performance.

H5. If a project management asset is inimitable, then it contributes to project-level performance.

H6. If a project management asset is inimitable, then it contributes to firm-level performance.

H7. If a project management asset has organizational support, then it contributes to project-level performance.

H8. If a project management asset has organizational support, then it contributes to firm-level performance.

Methodology

We developed a survey questionnaire to gather data on project management processes focusing on the constructs in our conceptual model. We anchored our instrument on Barney's VRIO framework (Barney, 2007), the strategic management literature (Barney, 1998; Chakraborty, 1997; Mata *et al.*, 1995), the literature on project management success (Belassi and Tukel, 1996; Pinto and Slevin, 1988a, 1988b; Shenhar *et al.*, 2002; Wateridge, 1998) and the literature on project management practices (Barczak *et al.*, 2007; Besner and Hobbs, 2002, 2004; Jugdev and Thomas, 2002; White and Fortune, 2002). We used multiple items for each construct in our instrument. We used a focus group process with seven experienced project managers to further develop our items. The instrument was pretested with five colleagues representing industry and academia and further refined. We followed survey design practices using the guidelines recommended by experts (Couper *et al.*, 2001; Dillman *et al.*, 1993; Fowler, 1992; Groves *et al.*, 2009). The final cross-sectional survey consisted of 17 structured questions and an 18th open-ended question soliciting feedback on additional comments on the survey topic. The survey was based on a 7-point ordinal Likert Scale, appropriate for perception-oriented questions, with the anchors being "Strongly Agree" and "Strongly Disagree". Since this was an exploratory study, we did not know a priori if a true neutral point existed in terms of responses. While an even numbered scale is preferable for studies interested in forcing choices, such as in studies interested in reducing social desirability bias (Garland, 1991), we did not view this as an objective for our study. The survey questionnaire is provided in a prior publication (Mathur *et al.*, 2013).

We minimized retrospective bias by asking participants to respond in the context of projects they had worked on within the past year. Since our survey was intended to gather data to analyze the project management process, and since project durations vary considerably across project contexts, we chose the past year rather than the last project as the context for the survey. While data were reported by individual participants, the unit of analysis was the project management process rather than an individual project manager or project team. Although project teams enhance project success (Pinto *et al.*, 1993), and project teams represent how project work is done, this study did not collect or analyze data at the project team level. We did not gather data on project type or complexity in this study.

We purchased a randomly generated mailing list for 4,000 members from the Project Management Institute®. The list represented a subset of the institute's members from North America – 3,200 members from the USA and 800 members from Canada. We mailed letters to solicit interest in participation in the survey. Out of the 4,000 letters mailed, 315 letters (7.9 per cent) were returned as undeliverable. A total of 240 individuals indicated by email to us that they were interested in completing the survey. We acknowledge that our survey involved nonresponse bias because we were only able to follow up with those who indicated interest in completing the survey. We emailed these interested participants the survey link to complete the survey online and followed up with two email reminders, each approximately a week apart. We hosted our survey

at Zoomerang®, as online surveys are faster and more cost-effective than mail-out surveys and can help reduce nonresponse errors (Couper, 2000).

This approach enabled us to secure 212 responses, which is a response rate of 5.75 per cent, a "fair" rate for Internet-based surveys. Different survey approaches involve different variables and response rates (Groves *et al.*, 2009; Tabachnick and Fidell, 2006). Online surveys such as ours are subject to low response rates, as low as 3 per cent as reported in a study of survey response rates in information systems (IS) journals (Sivo *et al.*, 2006). While a low response rate affects the generalizability of the results from our study, our use of random sampling, 4,000 names from the project management institute (PMI) membership database, improves our external validity. This is an exploratory study for which we believe we have a representative response, and we will be validating the findings of this article in ongoing research for which we have gathered data from a larger sample of information technology (IT) project managers. The data were collected in 2008. After data cleaning, we found we had a sample size of 198 respondents, which is considered "fair" for exploratory factor analyses and multivariate analysis (Tabachnick and Fidell, 2006).

We acknowledge self-report bias as a limitation in empirical research. However, we do not expect this to be a major issue in our study given the nature of the constructs that did not involve questions about socially undesirable behavior or sensitive topics, the random selection of 4,000 Project Management Institute® members from approximately half a million members across North America, and the use of the online survey at Zoomerang® (Donaldson and Grant-Vallone, 2002; Malhotra *et al.*, 2006).

Table I provides the descriptive statistics for the survey participant pool. The study participants represented a diverse group of experienced project management professionals. A large majority of the participants (80 per cent) had their Project Management Professional designation. Nearly 60 per cent of the participants worked as project managers, and nearly 30 per cent worked in senior-level capacities. Over half (55 per cent) had advanced degrees. About four-fifths of the participants were from four economic sectors – Information Technology, Financials, Government, Health Care and Industrial. Close to three-quarters of the study participants came from companies with annual sales revenues greater than $50 million. About half of the respondents worked at companies with over 5,000 employees. Roughly half the participants represented companies that were 0-50 years old and the rest were from companies that were older and more established. The gender ratio was 74.7 per cent male to 25.3 per cent female. We could not account for multiple respondents from the same company; however, given that we secured a random list of 4,000 members from approximately half a million members from the Project Management Institute®, we do not expect company bias to be significant.

We used IBMSPSS® v. 21 to conduct descriptive statistics and factor analysis to extract factors representing project management resource characteristics (independent variables) and project management performance outcomes (dependent variables). Real factor analysis was conducted using a formative model (Coltman *et al.*, 2008). We used the Principal Components Extraction method with Varimax (variance maximizing) rotation. This extraction method is widely used, understood and conforms to the factor analytic model in which common variance is analyzed with the unique and error variances removed (Tabachnick and Fidell, 2006). We used 0.40 as a cutoff to identify items with the highest loadings for inclusion with a factor (Conway and Huffcutt, 2003).

Category	Frequency	%	Valid %	Cumulative %
Participant's company's approximate annual sales revenue (in millions of dollars)				
Valid				
1 $0-$1 million	9	4.2	5.5	5.5
2 $1-$10 million	13	6.1	7.9	13.3
3 $10-$50 million	21	9.9	12.7	26.1
4 Over $50 million	122	57.5	73.9	100.0
Total	165	77.8	100.0	
Missing	47	22.2		
Total	212	100.0		
Participant's company's best fit into the following economic sectors				
Valid				
1 Energy	7	3.3	3.8	3.8
2 Materials	9	4.2	4.8	8.6
3 Industrial	18	8.5	9.7	18.3
4 Consumer discretionary	8	3.8	4.3	22.6
5 Consumer staples	2	0.9	1.1	23.7
6 Health care	18	8.5	9.7	33.3
7 Financials	30	14.2	16.1	49.5
8 Information technology	57	26.9	30.6	80.1
9 Telecommunications services	10	4.7	5.4	85.5
10 Utilities	2	0.9	1.1	86.6
11 Government	23	10.8	12.4	98.9
12 Other	2	0.9	1.1	100.0
Total	186	87.7	100.0	
Missing	26	12.3		
Total	212	100.0		
The number of full-time employees at participant's company				
Valid				
1 1-50	15	7.1	8.1	8.1
2 51-250	24	11.3	13.0	21.1
3 251-1,000	19	9.0	10.3	31.4
4 1,001-5,000	36	17.0	19.5	50.8
5 5,001-20,000	34	16.0	18.4	69.2
6 Over 20,000	57	26.9	30.8	100.0
Total	185	87.3	100.0	
Missing	27	12.7		
Total	212	100.0		
Participant's role in project management				
Valid				
1 Senior-level project executive	55	25.9	29.6	29.6
2 Project manager	108	50.9	58.1	87.6
3 Project team member	23	10.8	12.4	100.0
Total	186	87.7	100.0	
Missing	26	12.3		
Total	212	100.0		

Table I.
Descriptive statistics for survey participant pool (212 participants)

(*continued*)

	Frequency	%	Valid %	Cumulative %
Age of participant's company				
Valid				
1 Less than 10 years old	20	9.4	10.8	10.8
2 11-25 years old	37	17.5	20.0	30.8
3 26-50 years old	42	19.8	22.7	53.5
4 51-75 years old	24	11.3	13.0	66.5
5 Over 76 years old	62	29.2	33.5	100.0
Total	185	87.3	100.0	
Missing	27	12.7		
Total	212	100.0		
Participant holds a project management designation				
Valid				
1 Yes	148	69.8	80.0	80.0
2 No	37	17.5	20.0	100.0
Total	185	87.3	100.0	
Missing	27	12.7		
Total	212	100.0		
Participant's highest level of education				
Valid				
1 High school	4	1.9	2.2	2.2
2 College diploma/certificate	25	11.8	13.5	15.7
3 Undergraduate degree	54	25.5	29.2	44.9
4 Master's degree	95	44.8	51.4	96.2
5 Doctoral degree	7	3.3	3.8	100.0
Total	185	87.3	100.0	
Missing	27	12.7		
Total	212	100.0		
Participant's gender				
Valid				
1 Male	136	64.2	74.7	74.7
2 Female	46	21.7	25.3	100.0
Total	182	85.8	100.0	
Missing	30	14.2		
Total	212	100.0		

Table I

Eigenvalues over 1 were used to extract reliable factors. Cronbach's alpha measures how well a set of items measures a single unidimensional latent construct. A reliability coefficient of 0.70 or higher is acceptable in the social sciences (Nunnally, 1978). We used this test to assess the internal consistency of the items within each construct and all extracted factors had Cronbach's alpha greater than 0.7. None of our item loadings were lower than 0.5 in the results of the first factor analysis run. We dropped items that cross-loaded on two or more factors with a difference of less than 0.1; two of the 12 items were dropped from each of the independent variables. After conducting the factor analysis again, we dropped two items for interpretability reasons and reran the factor analysis; both items had factor loadings between 0.5 and 0.6. All of our remaining items had loading of greater than 0.6.

We extracted two factors each for the independent variables – valuable, rare and inimitable characteristics of project management resources. We extracted three factors for the independent variable organizational support. We extracted two factors for the dependent variables, project-level performance and firm-level performance. The results of the factor analysis are provided in the section that follows.

We use SPSS to perform linear regression and hierarchical regression analysis to examine how the nine independent factors predict the two dependent factors. We report on the results of the regression analysis in this paper.

Exploratory factor analysis results

The factors that resulted from the exploratory factor analysis are discussed in this section. Exploratory factor analysis tables are provided in the Appendix (Table A1-Table A8). A detailed discussion of the exploratory factor analysis and the survey instrument were published in an earlier paper (Mathur *et al.*, 2013).

The two factors each that comprised the valuable, rare and inimitable characteristics of project management assets, the three factors that comprised organizational support for the project management assets (the nine independent variables) and two factors that comprised the project management performance outcomes (the two dependent variable) that were extracted from the data analysis are labeled to reflect the items that define them. The items in each of these 11 factors, the variance explained by these factors and the Cronbach's alpha are provided for each factor. We have labeled these factors based on the items.

Factors V1 and V2 represent valuable project management resources and were extracted from data collected on valuable resources. The total variance explained by these was 65.3 per cent.

V1 *Valuable Project Management Resources* (*Project Management Knowledge*) consisted of six items with factor loadings from 0.609 to 0.815 and a Cronbach's alpha of 0.863. The variance explained was 42.6 per cent. The items included project job shadowing, project management methodologies, project management offices, project management templates, databases and printed project management material.

V2 *Valuable Project Management Resources (IT Tools*) consisted of two items with factor loadings from 0.847 to 0.855 and a Cronbach's alpha of 0.703. The variance explained was 22.7 per cent. The items included computer hardware and software.

Both factors consist of valuable project management assets. The first is composed of assets that capture and disseminate project management knowledge by making it explicit, structuring it for sharing and establishing processes that facilitate the sharing. The second is composed of assets that assist in this knowledge capture and dissemination through technology.

Factors R1 and R2 represent rare project management resources and were extracted from data collected on rare resources. The total variance explained by these was 66.5 per cent.

R1 *Rare Project Management Resources (Knowledge Sharing Processes*) consisted of six items with factor loadings from 0.628 to 0.791 and a Cronbach's alpha of 0.849. The variance explained was 35.0 per cent. The items included project job shadowing, project mentoring, project databases, project management communities of practice, project management offices and printed project management material.

R2 *Rare Project Management Resources (Knowledge Sharing Tools & Techniques)* consisted of four items with factor loadings from 0.732 to 0.917 and a Cronbach's alpha of 0.895. The variance explained was 31.5 per cent. The items included project software, project computer hardware, project management methodologies and project management templates.

Both factors consist of rare project management assets. The first is composed of processes that document and share project management knowledge that is unique to a company, including knowledge sharing at the interpersonal level and knowledge sharing through fluid and informal processes in addition to structured processes. The second is composed of assets that enable sharing of such project management knowledge, these being rare when customized for a company's unique processes.

Factors I1 and I2 represent inimitable project management resources and were extracted from data collected on inimitable resources. The total variance explained by these was 66.6 per cent.

I1 *Inimitable Project Management Resources (Proprietary Tangible Assets)* consisted of six items with factor loadings from 0.678 to 0.846 and a Cronbach's alpha of 0.877. The variance explained was 36.2 per cent. The items included difficult-to-imitate project management-related software, computer hardware, databases, project management methodologies, printed project management material and project management templates.

I2 *Inimitable Project Management Resources (Embedded Intangible Assets)* consisted of four items with factor loadings from 0.768 to 0.846 and a Cronbach's alpha of 0.866. The variance explained was 30.4 per cent. The items included difficult to imitate project social capital, tacit project management knowledge, project management communities of practice and mentoring.

Both factors consist of inimitable project management resources. The first is composed of tangible assets that embody codified knowledge that is company-specific or proprietary and therefore hard to copy. The second is composed of intangible assets that are embedded in a company's routines and relationships and are therefore hard for competitors to imitate.

Factors O1, O2 and O3 represent organizational support for project management assets and were extracted from data collected on organizational support for project management.

O1 *Project Management Alignment* consisted of three items with factor loadings from 0.896 to 0.928 and a Cronbach's alpha of 0.904. The variance explained was 84.0 per cent. The items included the importance of the quality of project management practices to the company's mission, services and products.

O2 *Project Management Communication* consisted of three items with factor loadings from 0.881 to 0.925 and a Cronbach's alpha of 0.893. The variance explained was 82.6 per cent. The items included ability to communicate upward in the project hierarchy, upward in the company hierarchy and openly on the project.

O3 *Project Management Integration* consisted of five items with factor loadings from 0.774 to 0.884 and a Cronbach's alpha of 0.900. The variance explained was 71.9 per cent. The items included a company environment that promotes sharing of knowledge/information, a company environment that encourages learning, people trusting each other, people working well together and upper management support, even in critical project phases.

Factors P and F represent the dependent variable, project management performance outcomes. These factors were extracted from the data collected on project-level performance and firm-level performance, respectively.

P *Project-level Performance* consisted of five items with factor loadings from 0.846 to 0.913 and a Cronbach's alpha of 0.932. The variance explained was 78.9 per cent. The items included achievement of project scope requirements, project schedules, customer expectations, quality of deliverables and project costs through project management processes.

F *Firm-level Performance* consisted of six items with factor loadings from 0.806 to 0.856 and a Cronbach's alpha of 0.912. The variance explained was 69.8 per cent. The items included achievement of sales targets, customer loyalty, profitability levels, market share, continuous innovation and customer satisfaction through project management resources and capability.

Regression analysis results and discussion of findings on the relationship between the extracted factors are reported in the next section. After the factor analysis, and before the regression analysis, composite scores were created by taking the mean of the items that loaded on a factor. We do not use summated scales because we want to save as many cases as possible in our regression analysis, due to missing values of certain items. Using the means allows us more comparable scores across factors given that the number of items loading on a factor varies. We are also able to retain the scale of the items to allow for easier interpretation. We do not use weighted factor scores because the composite scores are easier to compute than weighted factor scores and can be easily applied to cases that are not included in the original factor analysis.

Regression analysis results and discussion of findings

Descriptive statistics for the composite factor subscales are provided in Table II. A correlation matrix of the factors that comprise the independent variables (V, R, I, O) and those that comprise the dependent variables (P, F) is provided in Table III. Names for the 11 factors are listed below:

Independent variable factors (characteristics of project management assets)

V1 valuable project management knowledge
V2 valuable information technology (IT) tools
R1 rare knowledge sharing processes

Table II.
Descriptive statistics for composite factor subscales

Variable	Mean	*SD*	Range	*N*
P	4.7574	1.22243	1.0-7.0	182
F	2.4650	0.69277	1.0-4.0	182
V1	4.6333	1.26137	1.0-7.0	182
V2	5.6758	1.17260	1.0-7.0	182
R1	3.7546	1.34619	1.0-7.0	182
R2	3.2940	1.63545	1.0-7.0	182
I1	3.2635	1.34199	1.0-6.5	182
I2	3.4766	1.35784	1.0-7.0	182
O1	5.5659	1.35715	1.0-7.0	182
O2	5.6447	1.18234	1.0-7.0	182
O3	4.8665	1.17404	1.0-7.0	182

Variable	P	F	V1	V2	R1	R2	I1	I2	O1	O2
P										
F	0.675***									
V1	0.580***	0.394***								
V2	0.277***	0.164*	0.466***							
R1	−0.199**	−0.182*	−0.013	0.049						
R2	−0.301***	−0.137	−0.134	−0.066	0.642***					
I1	0.362***	0.354***	0.344***	0.163*	0.006	−0.002				
I2	0.299***	0.326***	0.220**	0.037	0.120	0.148*	0.517***			
O1	0.414***	0.333***	0.324***	0.126	−0.242***	−0.212**	0.201**	0.165*		
O2	0.556***	0.515***	0.255***	0.169*	−0.064	−0.121	0.114	0.163*	0.408***	
O3	0.669***	0.608***	0.459***	0.311***	−0.056	−0.079	0.188*	0.326***	0.416***	0.733***

Notes: [a] Significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; all two-tailed

Table III.
Correlation coefficients[a] between factors

R2 rare knowledge sharing tools and techniques
I1 inimitable proprietary tangible assets
I2 inimitable embedded intangible assets
O1 project management alignment
O2 project management communication
O3 project management integration

Dependent variable factors (project management performance outcomes)

P project-level performance
F firm-level performance

The relationships which are significant are highlighted in Table III using the criteria: absolute value of coefficients > 0.3 and significance levels < 0.05. Taking > 0.5 as the indicator of collinearity between independent variables, we believe there is no significant collinearity between the blocks of independent variables.

Linear regression analysis was performed for single project management asset characteristics predicting dependent variable. Looking first at the *Project-level Performance* and not controlling for other variables, organizational support for project management assets explain 48.1 per cent, valuable assets explain 33.0 per cent, rare assets explain 8.9 per cent and inimitable assets explain 14.8 per cent of the variance in performance (Table IV). Looking next at the *Firm-level Performance* and not controlling for other variables, organizational support for project management assets explain 38.8 per cent, valuable assets explain 16.4 per cent, rare assets explain 3.0 per cent and inimitable assets explain 15.6 per cent of the variance in performance (Table V).

The most significant predictors of *Project-level Performance* are *Project Management Integration (O3)*, *Valuable Project Management Knowledge (V1)* and *Inimitable Proprietary Tangible Assets (I1)*. An unexpected finding was that *Rare Knowledge Sharing Tools and Techniques (R2)* was a negative predictor of *Project-level Performance*. A possible explanation is that rare knowledge sharing tools and techniques are not considered to be a valuable investment. Given that IT tools for project management are relatively standardized, this is a plausible explanation.

The most significant predictors of *Firm-level Performance* are *Project Management Integration (O3)*, *Valuable Project Management Knowledge (V1)*, *Inimitable Proprietary Tangible Assets (I1)* and also *Inimitable Embedded Intangible Assets (I2)*.

Since project management assets can have one or more of the characteristics represented by the four independent variables (nine factors), we used hierarchical linear regression analysis, entering variables in the order of the contingencies indicated in the VRIO framework – first block O, then block V, then block R, then last block I. This order of entry would be consistent with the theoretical consideration that a resource need organizational support to leverage its potential; a resource needs to contribute economic value in order to contribute to competitiveness; a valuable resource needs to be rare to have competitive advantage; in order for competitive advantage from a valuable and rare resource to be sustained, it must be inimitable (Barney, 2007; Mathur *et al.*, 2013).

Performing hierarchical regression entering one variable block at a time to predict *Project-level Performance*, we find that the characteristics O, V, R and I collectively explain 63.4 per cent of the variance of the dependent variable (Table VI; Models 1-4). Assets that are organizationally supported explain 47.5 per cent of the variance.

Table IV.
Results of linear regression analysis for single project management asset characteristics predicting dependent variable project-level performance

Variable	Model 1	Model 2	Model 3	Model 4
O1	0.153*			
O2	0.105			
O3	0.532**			
V1		0.569**		
V2		0.011		
R1			−0.017	
R2			−0.287**	
I1				0.285**
I2				0.150
Total R^2	0.481	0.330	0.089	0.148
ΔF(df1, df2)	56.009** (3,181)	45.042** (2,183)	8.885** (2,182)	15.665** (2,181)

Notes: *significant at 0.05 level; **significant at 0.01 level

Table V.
Results of linear regression analysis for single project management asset characteristics predicting dependent variable firm-level performance

Variable	Model 1	Model 2	Model 3	Model 4
O1	0.079			
O2	0.134			
O3	0.479**			
V1		0.417**		
V2		−0.028		
R1			−0.119	
R2			−0.071	
I1				0.237**
I2				0.218**
Total R^2	0.388	0.164	0.030	0.156
ΔF(df1, df2)	38.035** (3,180)	17.863** (2,182)	2.789 (2,181)	16.755** (2,181)

Notes: *significant at 0.05 level; **significant at 0.01 level

Variable	Model 1	Model 2	Model 3	Model 4
O1	0.151*	0.082	0.039	0.018
O2	0.109	0.183*	0.164*	0.173*
O3	0.527**	0.345**	0.369**	0.350**
V1		0.368**	0.353**	0.299**
V2		−0.043	−0.044	−0.040
R1			−0.041	−0.042
R2			−0.173**	−0.189**
I1				0.154**
I2				0.043
ΔR^2	0.475	0.093	0.038	0.028
ΔF(df1, df2)	53.758** (3,178)	18.941** (2,176)	8.421** (2,174)	6.514** (2,172)
Total R^2	0.475	0.568	0.606	0.634

Notes: *significant at 0.05 level; **significant at 0.01 level; [a]standardized regression coefficients are shown; number of cases entered into the model = 182

Table VI. Results of hierarchical regression analysis for O, V, R and I, predicting dependent variable project-level performance[a]

Valuable assets explain an additional 9.3 per cent controlling for organizationally supported assets. Assets that are rare explain an additional 3.8 per cent controlling for organizationally supported and valuable assets. Assets that are inimitable explain an additional 2.8 per cent controlling for the other three project management asset characteristics. The most significant predictors of *Project-level Performance* are *Project Management Integration (O3)*, *Valuable Project Management Knowledge (V1)*, *Rare Knowledge Sharing Tools and Techniques (R2)* and *Inimitable Proprietary Tangible Assets (I1),* with *R2* being a negative predictor of *Project-level Performance.*

Performing hierarchical regression entering one variable block at a time to predict *Firm-level Performance* we find that the characteristics O, V, R and I collectively explain 47.7 per cent of the variance of the dependent variable (Table VII; Models 1-4). Assets that are organizationally supported explain 38.5 per cent of the variance. Valuable assets explain an additional 2.3 per cent controlling for organizationally supported assets. Assets that are rare explain an additional 2.0 per cent controlling for organizationally supported and valuable assets. Assets that are inimitable explain an additional 4.9 per cent controlling for the other three project management asset characteristics. The most significant predictors of *Firm-level Performance* are *Project Management Integration (O3)* and *Inimitable Proprietary Tangible Assets (I1)*.

We examined the Variance Inflation Factor (VIF) for each regression coefficient for all the models, Model 1–Model 4, for independent variables predicting the dependent variables (*Project-level Performance and Firm-level Performance*). Since all of the VIF's were less than 5, ranging from 1.243 to 2.950, multicollinearity is not considered to be an issue.

Summary and conclusions

Drawing on the RBV of the firm, we expect that the valuable, rare and inimitable characteristics of project management assets will contribute to project management performance outcomes in the presence of organizational support for these assets, thereby contributing to competitive advantage. Using an online survey with 198 North American Project Management Institute® members and exploratory factor analysis, we identified the factors that comprise the valuable, rare and inimitable characteristics of

Table VII.
Results of hierarchical regression analysis for O, V, R and I, predicting dependent variable Firm-level performance[a]

Variable	Model 1	Model 2	Model 3	Model 4
O1	0.080	0.045	0.008	−0.020
O2	0.133	0.163	0.173*	0.186*
O3	0.477**	0.408**	0.402**	0.375**
V1		0.190**	0.202**	0.131
V2		−0.085	−0.073	−0.067
R1			−0.173*	−0.176*
R2			0.051	0.028
I1				0.200**
I2				0.064
ΔR^2	0.385	0.023	0.020	0.049
ΔF(df1, df2)	37.169* (3,178)	3.478* (2,176)	3.018 (2,174)	8.052** (2,172)
Total R^2	0.385	0.409	0.428	0.477

Notes: *significant at 0.05 level; **significant at 0.01 level; [a]standardized regression coefficients are shown; number of cases entered into the model = 182

project management assets, organizational support for these assets and project management performance outcomes. In this paper we examine the relationship between characteristics of project management assets, as independent variables and management performance outcomes, as dependent variables. Our results indicate that organizational support for the project management process, specifically project management integration, significantly contributes to both project-level and firm-level performance. Valuable project management knowledge was found to contribute to project-level performance, though IT tools did not. Inimitable proprietary tangible assets were found to contribute to both project-level and firm-level performance and inimitable embedded intangible assets were also found to contribute to firm-level performance. Rare knowledge sharing tools and techniques are assets that were found to negatively contribute to project management performance.

While we acknowledge the limitations of sample size, response rate and self-report bias in this study, we believe that we have a valid and reliable instrument and will test the results of this study using a larger database of survey data from IT project managers. We also acknowledge the limited scope of the study; we did not collect data to analyze if our findings would be affected by project type and complexity. Our ongoing research will examine the moderating effects of project management asset characteristics on the relationship between the other asset characteristics and performance outcomes and the mediating effect of project-level performance on the relationship between project management asset characteristics and firm-level performance. Areas of future research will include exploring the relationship between project management process characteristics and performance outcomes for projects categorized by type and complexity.

Few empirical studies have applied the RBV of the firm to examine project management capabilities as a source of competitive advantage. Our research is an attempt to contribute to the understanding of the characteristics of project management assets that lead to a firm's competitive advantage. This understanding has significant value for scholars interested in project management. It is differentiated from prior research that has explored the link between assets and the achievement of the VRIO

characteristics from the process by extending the conceptual model to link VRIO characteristic to project and firm performance.

Given the pervasive focus on tools and techniques in project management (Besner and Hobbs, 2006; Fortune *et al.*, 2011), implications for project management education and industry training include developing a broader understanding of project management assets and their contribution to a firm's competitive advantage, distinguishing between different types of project management asset characteristics, and emphasizing the importance of intangible project management assets. This research highlights the need for industry is go beyond the traditional emphasis on project management tools and techniques to appreciate the contribution of tangible and intangible knowledge-based assets in project-level and firm-level performance outcomes.

This study draws the attention of managers and management scholars to project management assets as sources of competitive advantage, highlighting the need to have organizational support for the project management process through organizational integration, and emphasizing the importance of valuable project management knowledge-based assets and inimitable project management assets that are proprietary and tangible as well as those that are embedded and intangible. We believe that further research linking project management assets to project management performance outcomes that validates the importance of organizational support for the project management process will help guide managers toward more strategic investments in project management resources that are not only sources of operational efficiency but also sources of sustainable competitive advantage.

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Appendix

Results of exploratory factor analysis

Items constituting valuable project management resources	Factor 1 Project management knowledge	Factor 2 IT tools
q1.6 Project job shadowing is a valuable resource	*0.815*	
q1.5 Project management methodologies are valuable resources	*0.799*	
q1.10 Project management offices are valuable resources	*0.785*	
q1.7 Project management templates are valuable resources	*0.742*	
q1.2 Databases are valuable resources	*0.703*	
q1.1 Printed project management material is a valuable resource	*0.609*	
q1.3 Computer hardware is a valuable resource		*0.855*
q1.4 Software is a valuable resource		*0.847*
% of variance explained	42.6%	22.7%
Cronbach's alpha	0.863	0.703

Table AI.
Rotated component matrix of independent variable, valuable project management resources

Notes: Extraction method: principal component analysis; rotation method: varimax with Kaiser normalization; rotation converged in three iterations; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Items constituting rare project management resources	Factor 3 Knowledge sharing processes	Factor 4 Knowledge sharing tools & techniques
q2.6 Project job shadowing is a rare resource	*0.791*	
q2.12 Project mentoring is a rare resource	*0.756*	
q2.2 Project databases are rare resources	*0.734*	
q2.9 Project management communities of practices are rare resources	*0.709*	0.427
q2.10 Project management offices are rare resources	*0.645*	
q2.1 Printed project management material is a rare resource	*0.628*	
q2.4 Project software is a rare resource		*0.917*
q2.3 Project computer hardware is a rare resource		*0.873*
q2.5 Project management methodologies are rare resources	0.443	*0.738*
q2.7 Project management templates are rare resources	0.464	*0.732*
% of variance explained	35.0%	31.5%
Cronbach's alpha	0.849	0.895

Table AII.
Rotated component matrix of independent variable, rare project management resources

Notes: Extraction method: principal component analysis; rotation method: varimax with Kaiser normalization; rotation converged in 3 iterations; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Items constituting inimitable project management resources	Factor 5 Proprietary tangible assets	Factor 6 Embedded intangible assets
q3.4 My company's software is a resource that is very difficult for competitors to copy	*0.846*	
q3.3 My company's computer hardware is a resource that is very difficult for competitors to copy	*0.820*	
q3.2 My company's databases are resources that are very difficult for competitors to copy	*0.747*	
q3.5 My company's project management methodologies are resources that are very difficult for competitors to copy	*0.733*	
q3.1 My company's printed project management material is a resource that is very difficult for competitors to copy	*0.709*	
q3.7 My company's project management templates are resources that are very difficult for competitors to copy	*0.678*	
q3.8 At my company, project social capital is a resource that is very difficult for competitors to copy		*0.846*
q3.11 My company's tacit project management knowledge is a resource that is very difficult for competitors to copy		*0.840*
q3.9 At my company, project management communities of practices are resources that are very difficult for competitors to copy		*0.814*
q3.12 At my company, mentoring is a resource that is very difficult for competitors to copy		*0.768*
% of variance explained	36.2%	30.4%
Cronbach's alpha	0.877	0.866

Notes: Extraction method: principal component analysis; rotation method: varimax with Kaiser normalization; rotation converged in three iterations; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Table AIII. Rotated component matrix of independent variable, inimitable project management resources

Items constituting project management alignment	Factor 7
q5.1 Quality of project management practices is important to the company's mission	*0.928*
q5.2 Quality of project management practices is important to the company's services	*0.925*
q5.3 Quality of project management practices is important to the company's products	*0.896*
% of variance explained	*84.0%*
Cronbach's alpha	*0.904*

Notes: Extraction method: principal component analysis; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Table AIV. Component matrix of moderating variable, project management alignment

Items constituting project management communication	Factor 8
q6.1 At my company, I can communicate upwards in the project hierarchy	*0.925*
q6.2 At my company, I can communicate upwards in the company hierarchy	*0.919*
q6.3 At my company, I can communicate openly on the project	*0.881*
% of variance explained	*82.6%*
Cronbach's alpha	*0.893*

Table AV.
Component matrix of moderating variable, project management communication

Notes: Extraction method: principal component analysis; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Items constituting project management integration	Factor 9
q7.5 At my company, the environment promotes sharing knowledge/information	*0.884*
q7.4 At my company, the environment encourages learning	*0.872*
q7.2 At my company, people trust each other	*0.863*
q7.3 At my company, people work well together	*0.844*
q7.1 At my company, upper management supports me, even in critical project phases	*0.774*
% of variance explained	*71.9%*
Cronbach's alpha	*0.900*

Table AVI.
Component matrix of moderating variable, project management integration

Notes: Extraction method: principal component analysis; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Items constituting project-level performance	Factor 10
q8.3 Project management processes allow us to meet project scope requirements	*0.913*
q8.4 Project management processes allow us to meet project schedules	*0.908*
q8.2 Project management processes allow us to meet customer expectations	*0.892*
q8.1 Project management processes allow us to meet deliverables quality	*0.880*
q8.5 Project management processes allow us to meet project costs	*0.846*
% of variance explained	*78.9%*
Cronbach's alpha	*0.932*

Table AVII.
Component matrix of dependent variable, project-level performance

Notes: Extraction method: principal component analysis; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Items constituting firm-level performance	Factor 11
q9.4 Project management resources and capability allow us to achieve sales targets	*0.856*
q9.6 Project management resources and capability allow us to achieve customer loyalty	*0.856*
q9.1 Project management resources and capability allow us to achieve profitability levels	*0.847*
q9.2 Project management resources and capability allow us to achieve market share	*0.838*
q9.5 Project management resources and capability allow us to achieve continuous innovation	*0.808*
q9.3 Project management resources and capability allow us to achieve customer satisfaction	*0.806*
% of variance explained	*69.8%*
Cronbach's alpha	*0.912*

Notes: Extraction method: principal component analysis; italic entries in a column indicate items that load on the particular factor
Source: Published in an earlier paper, Authors (2013)

Table AVIII.
Component matrix of dependent variable, firm-level performance

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