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From the Editor

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Project Management Journal® Has an Increasing Impact!

The new impact factor metrics from Thompson Reuters are out. Project Management Journal® received a two-year impact factor of 2.714 and a five-year impact factor of 2.487, respectively. Last year the two-year impact factor was 1.765 and the year before it was 1.14, just passing the 1.0 threshold; in the years before, it was below 1.0. In addition, the number of submissions has increased to approximately 600 per year, which means that we have quadrupled the impact factor and number of submissions since we started our turn-around with a new editorial team in 2013. Our strategy is to contribute to the development of project management research and, specifically, to shape the themes and quality of this research and increase its dissemination.

Overall, this is a great success for our journal. I want to thank all our readers, authors, reviewers, my editorial team, and my team members at PMI—from Academic Resources and Publications—who have made this success story possible.

This issue highlights three themes: (1) The PMI awards presented at the International Research Network on Organizing by Projects (IRNOP) conference in Boston, Massachusetts, USA and the European Academy of Management (EJRAM) meeting in Paris, France; (2) A Call-for-Papers for a new special issue on “Exploratory Projects”; and (3) the new articles in this issue.

1. Awards
At the biennial conference of the International Research Network on Organizing by Projects (IRNOP) in Boston, Professor Dr. Svetlana Cicmil, the University of the West of England, Bristol; Professor Dr. Damian Hodgson, the University of Manchester; Professor Dr. Monica Lindgren, the KTH Royal Institute of Technology; and Professor Dr. Johann Packendorff, the KTH Royal Institute of Technology received the very prestigious PMI Research Achievement Award. They were given the award for founding the Making Projects Critical (MPC) network and workshops, as well as for the ongoing research that opens up project management and project-based organizations to critical examination. The four researchers belong to the group, “Making Projects Critical!” founded by Svetlana Cicmil and transformed it into an impactful movement. Damian Hodgson and Svetlana Cicmil were both members of the influential “Rethinking PM Network,” which received considerable funding in the United Kingdom and published impactful articles, including “Rethinking Project Management” (Cicmil, Williams, Thomas, & Hodgson, 2006) and “Directions for Future Research in Project Management” (Winter, Smith, Morris, & Cicmil, 2006). Svetlana Cicmil and Damian Hodgson formed a separate, but overlapping research group along with Monica Lindgren and Johann Packendorff; they hosted their first workshop meeting in Bristol in 2003, involving a range of academics with an interest in project management. This group takes a more social science perspective on project management than has existed in traditional project management research groups. Their group’s ideas and thoughts have been highly influential and the book, Making Projects Critical, by Damian Hodgson and Svetlana Cicmil (2006) is considered a classic text that explores the lived reality of project management team members. In 2006, the eighth conference on making projects critical took place. Johann Packendorff and Monica Lindgren have written influential articles on leadership, for example, “Leadership, Not Leaders” (Crevani, Lindgren, & Packendorff, 2010); “Shared Leadership: A Post-Heroic Perspective” (Crevani, Lindgren, & Packendorff, 2007); and “Project Leadership in Becoming (Packendorf, Crevani, & Lindgren, 2014). A very insightful analysis of the impacts of the works of the Making-Projects-Critical group, the Rethinking Projects Group, and the Scandinavian group of project management researchers was presented by Walker and Lloyd-Walker (2016).

Professor Dr. Raymond Levitt from Stanford University, Palo Alto, California, received the PMI Scholar-Practitioner Award during the Engineering Project Organization Society Conference (EPOC) and the Mega-projects Workshop in Lake Tahoe, California. This is an important award for PMI and its work to establish closer links between research and practice. This award recognizes an individual who has contributed significantly both to scholarship in project management and project management practice and, particularly, in establishing better linkages between these two domains.

Raymond Levitt has authored very influential articles and books on project management and is known for his simulation studies on projects building a formalized theory of project teams, for example, Levitt et al. (1999),

This year, two articles tied for the 2017 Project Management Journal® Paper of the Year Award. The award-winning articles were identified in a two-stage process. During the first stage, all editors of Project Management Journal® assessed a specific number of articles, including all articles published in Project Management Journal®. Then, a short list of candidates was identified; these short-listed articles were then ranked by all editors independently. The two articles with the most first-place rankings won. The assessment criteria during both rounds were: (1) scientific contribution, (2) practical relevance, and (3) methodological rigor.

Professor Dr. Anders Fogh Jensen from Copenhagen University, Professor Dr. Christian Thuesen, and Professor Dr. Joana Geraldi from the Technical University of Denmark (DTU) in Lyngby near Copenhagen received the 2017 Project Management Journal® Paper of the Year Award for their article, “The Projectification of Everything: Projects as a Human Condition” (volume 47, issue 3, pp. 21–34). Their article describes an alternative understanding of projects beyond organizational practices. That is, projects as a human condition, which means that we are defined by the projects we work on. Hereby the human condition emerges through a shift from a merely disciplinary to a merely project society. Four philosophical concepts are used to explain this change: activity, time, space, and relations. The changes in these principles provide a variety of worldviews and explain a number of issues and phenomena observed in recent times. The first author of this article, Anders Fogh Jensen, is a Danish philosopher who is well-known in Denmark for his books. I recommend his short and entertaining book, The Project Society (2012).

Professor Dr. Sylvain Lenfle from the University of Cergy-Pontoise in France received the 2017 Project Management Journal® Paper of the Year Award for his article “Floating in Space? On the Strangeness of Exploratory Projects” (volume 47, issue 2, pp. 47–61). When innovation is strongly radical, the exploration dimension of the project becomes dominant. Can project management concepts be useful in such a domain? Sylvain Lenfle answers this question positively and provides support for structuring such exploratory projects. When compared with traditional projects, the project explored through this in-depth case study in the space industry is said to appear as “strange” or “floating.” Relying on advances in design theory, Sylvain Lenfle proposes that this “strangeness” is not a symptom of mismanagement but rather that it follows a specific “expansion logic” adapted to the discovery situation. By detailing the management practices in a rich case example, he reveals how success was achieved through monitoring knowledge expansion in multiple unknown dimensions of the project while retaining the ability to flexibly respond to change and evolve over time. The use of a project management structure, albeit not a traditional approach, provided specific benefits—in particular in fostering communication, collaboration, and coordination among a “community” of actors spread across different disciplines. Importantly, this article reaffirms extant research (Lenfle, 2008; Lenfle & Loch, 2010) showing that managers need to recognize the type of project at the start, resist institutional pressure to adopt traditional “rational” approaches to all projects, and apply an appropriate approach—one that is tailored for the project type.

Professor Dr. Vijay Kanabar of Boston University received the inaugural PMI Teaching Excellence Award, which recognizes and honors an individual faculty member for excellence in teaching project management, and to his or her strong commitment to improving and enhancing project management curricula in higher education. Over the years, Dr. Kanabar has designed, developed, and delivered market-leading project management courses and programs at the graduate level, both on-campus and online, has led Project Management Professional (PMP®) boot camps for hundreds of Boston University project management students, and was the chief faculty advisor of the current initiative by PMI to make available standard curriculum guidelines for the teaching of project management programs at the undergraduate level.

In addition to the annual academic awards that PMI confers, it also recognizes the work of scholars who present their research findings at the biennial meeting of the International Research Network on Organizing by Projects (IRNOP) and in the Project Organizing Track at the annual meetings of the European Academy of Management (EURAM). These paper prizes have been jointly awarded by IPMA and PMI as part of a collaborative effort that began six years ago. This year the prizes were conferred on the following authors:

IPMA-PMI Best Paper Prize at IRNOP 2017
“Projects as Preconditions: Creating the Preconditions for Routine Operations in Use” by Professor Dr. Hedley Smyth (University College London)

IPMA-PMI Best Student Paper Prize at IRNOP 2017
“The Governance of Major Public Infrastructure Projects” by Maude Brunet, Université du Québec à Montréal
IPMA-PMI Best Paper Prize at EURAM 2017

“Mechanisms of Isomorphism in Project-Based Organizations” by Dr. Maxim Miterev, Professor Dr. Mats Engwall, and Professor Dr. Anna Jerbrant of KTH Royal Institute of Technology

IPMA-PMI Best Student Paper Prize at EURAM 2017

“The Governance of Major Public Infrastructure Projects: The Process of Translation” by Maude Brunet and Professor Dr. Monique Aubry of Université du Québec à Montréal

Congratulations to all award winners!

2. Articles in this Issue

The first article from Ming-Chuan Yu on “Customer Participation and Project Performance: A Moderated-Mediation Examination” proposes a theoretical model to understanding how and why customer participation can promote project performance. The findings confirm the central hypothesis that knowledge integration mediates the positive relationship between customer participation and project performance: It is indeed knowledge integration that transmits the effects of customer participation to project performance. This effect increases with increasing project complexity, which acts as a moderator variable. These findings are highly relevant for customer-centric process models, such as Scrum.

The second article from Per Erik Eriksson, Roine Leiringer, and Henrik Szentes on “The Role of Co-creation in Enhancing Explorative and Exploitative Learning in Project-Based Settings” investigates how co-creation practices influence explorative and exploitative learning in five collaborative construction projects with partnering arrangements. Drawing on a longitudinal case study, their findings reveal two different types of explorative learning processes (i.e., adaptation and radical development) and three different exploitative learning processes (i.e., incremental development, knowledge sharing, and innovation diffusion). Furthermore, co-creation practices enhance adaptation, radical development, and incremental development, which are typical intra-project learning processes. Co-creation practices do not, however, enhance knowledge sharing and innovation diffusion across projects. These findings concur with previous insights that the temporary and one-off nature of projects makes inter-project learning problematic.

Asghar Afshar Jahanshahi and Alexander Brem answer the question: “Does Real Options Reasoning Support or Oppose Project Performance? Empirical Evidence from Electronic Commerce Projects.” There is a consensus among scholars that real options reasoning is crucial for improving project performance but there has been little empirical support thus far; hence, the authors explore how real options reasoning may influence project timeliness, efficiency, and effectiveness. Their longitudinal analysis of 110 electronic commerce projects, drawn from new technology ventures, indicates the differential effects of real options reasoning on project performance. The authors find that higher uncertainty does not always lead to a greater use of real options reasoning. Although perceived environmental state uncertainty is positively linked to real options, perceived environmental effect is not and response uncertainty shows a negative effect. The impact of real options on project performance is also of mixed nature: effectiveness and efficiency of a project are significantly increased, but time overruns are also significantly increasing. The reasons for these findings are explained in the model and its underlying hypotheses. The kind of uncertainty matters, and the kind of performance effects matter too.

Understanding the antecedents and impacts of real options reasoning requires a differentiated view, such as the one presented in this study.

Terry Williams addresses the “The Nature of Risk in Complex Projects.” Risk analysis is important for complex projects; however, systemicity makes evaluating risk in real projects difficult. Looking at the causal structure of risks is a start, but causal chains need to include management actions, the motivations of project actors, and sociopolitical project complexities as well as intra-connectedness and feedback. Common practice based upon decomposition-type methods is often shown to point to the wrong risks. A complexity structure is used to identify systemicity and draws lessons about key risks. Terry Williams describe how to analyze the systemic nature of risk and how the contractor and client can understand the ramifications of their actions.

The world faces enormous challenges in limiting global temperature increases to 2 degrees Celsius in accordance with the Paris Agreement on climate change. Most of the transformation of global economic activity to achieve zero carbon dioxide emission will need to be accomplished in the next 30 years in order to achieve this outcome (Figueroes et al., 2017). This will not only trigger a vast number of large renewable energy projects but also a redesign of many other forms of infrastructure to make them more energy efficient. This implies an unprecedented level of project activity to build new infrastructure and also adapt the existing infrastructure. The study of green building projects in Singapore by Bon-Gang Hwang, Lei Zhu, Yinglin Wang, and Xinyi Cheong, “Green Building Construction Projects in Singapore: Cost Premiums and Cost Performance” shows that this task will also be demanding for project managers.

Using a large sample comparing 121 green building projects with 242 traditional projects, they show that the cost premiums for these projects is in the range of 5% to 10%, and these projects tend to exceed budget by a similar amount. The results also indicate that the green cost premiums range from 5% to 10% and that project type and size are significant factors affecting cost premiums. What is noticeable about these data is the level of innovation that is embedded in
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these projects in the forms of new designs, technology, and materials. Other recent articles (Davies, Macaulay, DeBarro, & Thurston, 2015) are starting to show how construction projects can be managed to successfully incorporate innovation; we will continue to see these practices become more common as the low carbon emission transformation of the economy continues, as it must.

The last two articles in this issue deal with project success in public-private partnerships (PPP) but in very different perspectives. The topic is more than welcome, as many governments are in search of means to increasing the success rates of their projects (Davies, Dodgson, & Gann, 2016; Flyvbjerg, 2017; Williams, 2016). A PPP strategy of engaging the private sector seems to be a promising approach. Both articles make significant contributions to calling attention to some specific success criteria and success factors. In a global contingency perspective, Robert Osei-Kyei and Albert P. Chan in their article, “Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong” suggest that success criteria will differ depending on different contexts, that is in developing versus developed countries. For example, findings show that in Ghana, higher importance is given to disputes minimization, social, and economic developments associated with PPP projects, whereas in Hong Kong they directly relate to efficiency in the cost and service delivery of PPP projects.

The article by Khalid Almarri and Halim Boussabaine, “The Influence of Critical Success Factors on Value for Money Viability Analysis in Public–Private Partnership Projects” aims to rehabilitate the potential of PPP based on value for money viability analysis in the context of the United Kingdom. In a quantitative methodology, they formalize the construct of value for money in three components: economical, financial, and commercial. While the findings show complexity in interaction between variables, the authors identified five key critical success factors: government guarantees, macroeconomic conditions, shared authority between the public and private sectors, social support, and transparent procurement process.

3. Call-for-Papers Special Issue: “Exploratory Projects”

Special issue editors: Sylvain Lenfle, Christophe Midler, and Markus Hällgren

Deadline for paper submission: February 2018

The strategic roles of innovation and exploration in today’s competitive environment have given birth to a research stream in the management of exploration projects for which neither the goals nor the means to attaining them are clearly defined from the outset. This work bridges the project, innovation, entrepreneurship, and discovery management literature and has led to a new approach to projects as experimental learning processes for which new management principles, such as selectionism and sequential learning, have been defined. From the same perspective, this literature underlines the need to differentiate between the management processes for exploratory projects, since the traditional stage-gate approach generally leads to failure, and to design new evaluation methods adapted to their “expansive” nature. We are only at the beginning of the research; thus, the goal of this special issue is to continue to develop the research on exploratory projects. More precisely, we welcome contributions in the following areas:

1. Research that sheds new light on the actor’s practices in exploratory projects.
2. The validity of the management principles proposed in the literature.
3. The functions and roles of the actors in teams involved in exploratory projects.
4. The relationship between the project and its parent organization.
5. The role of exploratory projects in creation of the ecosystem.
6. The types of cognitive processes used during these types of projects.

References


ABSTRACT

This article proposes a theoretical model to understanding how and why customer participation can promote project performance. The research model was empirically examined by collecting data from 245 software development projects. The research found that knowledge integration mediates the positive relationship between customer participation and project performance. Additionally, project complexity strengthens the main effect of customer participation and an indirect effect of knowledge integration was found. Theoretical and managerial implications for project management and research limitations are also discussed.

KEYWORDS: customer participation; knowledge integration; project complexity; project performance

INTRODUCTION

Major changes in marketing trends show that just adopting customer orientation is not enough; organizations must obtain more information and knowledge from customers to create values that can meet their individual and dynamic needs (Prahalad & Ramaswamy 2000; Chan, Yim, & Lam, 2010; Eisingerich, Auh, & Merlo, 2014; Chang & Taylor, 2016). Encouraging customer participation may demonstrate the next frontier in improving competitive effectiveness for projects in organizations (Bendapudi & Leone, 2003), which reflects a major change from a goods-centered to a customer-centered logic in marketing (Vargo & Lusch, 2004; Chan et al., 2010). Customer participation can provide sellers with the knowledge of personalized requirements and solutions, which leads an organization to getting more customers involved in new product development (Fang, 2008; Chang & Taylor, 2016). Therefore, closely linking the customer to the seller during the development process is argued to be a key factor in the success of a new product (Terwiesch & Loch, 1999; Fang, Palmatier, & Evans, 2008).

Both practical and academic domains have realized that new products can benefit from customer participation. For example, Muji, a Japanese clothing company, revealed that the sales of products from the feedback and ideas of customers were five times higher than products based on professional designers’ ideas in the last three years (Nishikawa, Schreier, & Ogawa, 2013). Researchers also realize that customer participation is critical to the functioning of new production (e.g., software project), which has led to a proliferation of research focusing on how to improve project performance through encouraging customers to be involved in new product development (Prahalad & Ramaswamy, 2000; Bendapudi & Leone, 2003; Fang, Palmatier, & Evans, 2008; Chen et al., 2010; Chang & Taylor, 2016). Although the matter of whether customer participation can affect project performance has received the attention of numerous researchers, it still falls short in exploring the process through which it is linked to project performance (Bendapudi & Leone, 2003; Chan et al., 2010). This suggests that examining the process of transmitting the effects of customer participation has been recognized as crucial in advancing the understanding of this matter. Yet, empirical examinations of such processes remain scarce and have thus provided a piecemeal and incomplete understanding of how customer participation impacts project performance and insight that doesn’t necessarily apply to project teams. The key focus of this study is to accumulate knowledge on the role of customer participation in new project development. More specifically, this article aims to address three core research issues:

1. To examine the mediating role of knowledge integration in the relationship between customer participation and project performance.
2. To test the effect of the extent of project complexity on the relationship between customer participation and project performance.

3. To examine whether the indirect effect of customer participation on project performance via knowledge integration is moderated by project complexity.

Regarding the first research issue, both managerial practice and scholars believe that customer participation promotes new project performance but leaves the linkage of customer participation to project performance unclear. This article reveals that customer participation impacts project performance through knowledge integration. Thus, this article reveals knowledge on explicating the mediating mechanism through which customer participation promotes new project success and provides information for further studies targeted at improving project performance.

This research investigates how project complexity influences the impact of customer participation on the knowledge integration of a new project team, which informs the second research issue. Results show that increasing the complexity of a project strengthens the relationship between customer participation and knowledge integration. Furthermore, it offers managerial direction on how the complexity of a project increases the impact of customer participation.

The effect of customer participation on project performance is more complicated than is first apparent. Thus, this study further examined whether or not project complexity moderates the mediating effect of knowledge integration on the customer participation–project performance relationship. The result suggests that increasing the complexity of a project strengthens the indirect effect of customer participation on project process performance via knowledge integration. It provides us with evidence that helps us clarify the intermediate process between customer participation and project performance.

The theoretical expectation was empirically examined by collecting data from 245 software projects. In the following section, this study first develops the conceptual model and hypotheses. Second, this article discusses the data collection procedures, measure operationalization, and analyses strategies. Finally, the results, theoretical and managerial implications, and research limitations are presented.

Theory and Hypotheses

Customer Participation and Project Performance

We have mastered the detailed knowledge of the gravitational field of the definition of customer participation, which takes several forms and levels—from firm production to customer production (Meuter & Bitner, 1998). Because our target is to comprehend project performance when customers are involved in the project process, we do not consider the production of enterprises and customers (e.g., self-service technologies). We adopt the previous definition of customer participation (i.e., professional project services) by conceptualizing customer participation as a behavioral construct that measures the extent to which customers provide or share information and knowledge, make suggestions, and become involved in decision making during the value co-creation and delivery process (Auh, Bell, McLeod, & Shih, 2007; Bolton & Saxena-Iyer, 2009; Hsieh, Yen, & Chin, 2004).

Some studies have confirmed that software project process and product performance should be evaluated at the end of the project (Nidumolu, 1996). It is valuable to appraise both the process performance and product performance, because the project may create conflict between the efficiency of the process and product quality (Nidumolu, 1996). For example, processes that are rigidly controlled and lead to rigid adherence to source budgets (e.g., cost and time), may lead to incomplete function and reduce the flexibility of the long-term software project to address users’ short-term needs. Process performance can be described as the extent to which the development processes of software were managed and the interactive quality between project team members and customers during the development processes of software (Cooprider & Henderson, 1990; Nidumolu, 1996). Product performance was evaluated according to three facets: technical performance of the products, how well the software fulfills the needs of customers, and adaptability to the changing customer needs of the products (Cooprider & Henderson, 1990; Nidumolu, 1996).

A crucial benefit when customers participate in new software project development is the preferred access to useful information about customer needs, because project customer participation can provide feedback on product requirements (Lee, Reinicke, Sarkar, & Anderson, 2015; Chang & Taylor, 2016; Basten, Stavrout, & Pankratz, 2016). If the customer is involved in new project development (e.g., idea generation), he or she can express his or her preferences and needs accurately through face-to-face discussions, or meetings (Urban & Von Hippel, 1988; Fang, 2008). Such communication can improve the possibility of appreciating the related knowledge of project members and customers (Fang et al., 2008). From the view discussed earlier, customer participation means that he or she can provide market and technological information to the project team (Gupta, Raj, & Wilemon, 1986). The project team and customer’s own respective information, technological, and even social resources facilitate smooth implantation of the project. Only by integrating these resources together effectively can the promotion of the processes software project development run smoothly. After these resources have been combined, the joint result can be generated to the processes of new project development. In other words, the combined information and resources will be more valuable. It is more important...
that shared information and resources lead the software project team to obtain more tacit knowledge that promotes effective operation during the process of new project development. This can raise the efficiency of project implementation, thereby saving cost and time (Wang, Lee, Fang, & Ma, 2017).

According to resource-based theory (Pfeffer & Salancik, 1978), the customer and project team rely on each other during the new project development process. This means not only that customers need product-related resources within the project team for solutions to promoting product quality; the project team also relies on customers, because they decide how to allocate resources that are beneficial to project success (Prabhalad & Ramaswamy, 2004). Some scholars have argued that project development is a process that combines different capabilities and resources to search solutions for customer’s needs (Gadrey, Gallouj, & Weinstein, 1995). Djellal and Gallouj (2001) stated that the customer’s technology and capability are crucial resources for new project development. The project team and customer represent technology and the market, respectively, which means that they hold complementary and heterogeneous resources for project development. Therefore, the more that resource-sharing activities occur between the project team and customer, the more heterogeneous resources can be accessed. This will significantly broaden the useful resources of project teams and enhance the performance of a new project (Sundbo, 1998). Taken together, we propose the following hypotheses:

**Hypothesis 1:** Customer participation at the project level enhances project performance.

**Hypothesis 1a:** Customer participation at the project level enhances project process performance.

**Hypothesis 1b:** Customer participation at the project level enhances project product performance.

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**Customer Participation and Knowledge Integration**

Product development is a prime example of how project team members exploit and integrate diverse knowledge fields in order to originate new ideas (Song & Dyer, 1995; Gemünden, 2015). The success of new project development always requires diverse, complementary sources (e.g., knowledge) (Henderson & Clark, 1990; Nickerson & Zenger, 2004; Obstfeld, 2005; Tiwana, 2008). A project solution is described as a combinatorial innovation (Obstfeld, 2005; Tiwana, 2008), which means that a project solution needs to integrate novel ideas and knowledge. At present there are several studies, which have defined the concept of knowledge integration from the project level based on Grant’s (1996) conceptualization (e.g., Carlile & Rebentisch, 2003; Okhuysen & Eisenhardt, 2002; Sabherwal & Becerra-Fernandez, 2005; Tiwana & McLean, 2005; Tiwana, 2008). According to their opinions, knowledge integration was defined as the combinatorial process, which utilizes specialized knowledge from different alliance partners at the project level.

When customers participate in new project development they can strengthen the use of essential information and knowledge. If customers participate in new project development, which can increase the chances of interaction, they can facilitate information disclosure and promote mutual loyalty (Starbuck, 1992). Customer demand and market information guide the project team in finding solutions that address customer demand and enhance the motivation of project team members and customers to integrate knowledge. By embracing the customers’ available heterogeneous resources, the software project team broadens their horizons rather than narrowing any existing ones (Djellal & Gallouj, 2001); creates opportunities for the new integration of diverse perspectives in different professional areas (Sabherwal & Irmabecerra-Femandez, 2005); and then promotes the integration and application of heterogeneous knowledge, which contribute to creating software project value. Taken together, we propose the following hypothesis:

**Hypothesis 2:** Customer participation positively relates to knowledge integration at the project level.

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**Knowledge Integration and Project Performance**

Knowledge integration is included in the entire process of new project development (Morris, 2013). During the process of new project development, both parties (project team and customer) form a common viewpoint of what and how the product should progress through knowledge integration (Lin & Chen, 2006). In order to explain this opinion, Tiwana (2008) provided a case about an internet-based logistics system of how and what kind of knowledge was integrated. Tiwana (2008) pointed out that this logistics heuristics, developed by a shipping company, requires various partners to be involved, including a software company (master ‘software objects’), GPS manufacturer (master satellite positioning), and cartographer (master street-level mapping). The diversified expertise of these fields was jointly effective during different stages (e.g., conceptualization, design, and implementation) of the innovative product.

The project team with the greater extent of knowledge integration means that different alliance partners will be easier to cross-fertilize and will succeed in finding solutions to new project development (Tiwana, 2008). Knowledge integration is beneficial to promoting the recognition and integration of new demanding information from different participants while the project is in progress. Moreover, knowledge integration benefits the correction of misalignment in a constant state of changing external environments and customer demand for information in the process of new project development, which in turn enhances product performance (Tiwana, 2008). Empirical
evidence has examined the positive relationship between knowledge integration and project performance, including studies from Faraj and Sproull (2000); Patnayakuni, Rai, and Tiwana (2007); and Tiwana and McLean (2005), which found that there are positive correlations between the effective integration of varied knowledge and products during the software project development process, which leads to our third hypothesis:

**Hypothesis 3:** Knowledge integration relates positively to project performance at the project level.

**Hypothesis 3a:** Knowledge integration relates positively to project process performance at the project level.

**Hypothesis 3b:** Knowledge integration relates positively to project product performance at the project level.

**The Mediating Effect of Knowledge Integration**

As discussed earlier, this article proposes that customer participation is positively associated with knowledge integration (Hypothesis 2), which in turn correlates with project performance (Hypothesis 3), suggesting that customer participation affects project performance via its effects on knowledge integration. New project development needs the connection and cooperation between project team members and customers outside of the firm (Faraj & Sproull, 2002). Social ties and interactions offer project team members the opportunity to acquire others’ (e.g., customers) knowledge (Tiwana & McLean, 2005; Lin & Chen, 2006). Project team learning from customers and exchanging knowledge enable them to address needs and problems, thereby avoiding mistakes (Faraj & Sproull, 2000; Tiwana & McLean, 2005). Knowledge is recognized as stickiness and tacitness, and is not easy to proactively disperse among different individuals (Grant, 1996; Hansen, 1999; Tsai, 2002).

Through customer participation, the information and knowledge gathered by close connections and interactions can be disseminated throughout the project and integrated to shared language and memory by project team members (Nahapiet & Ghoshal, 1998; Szulanski, 2000; Adler & Kwon, 2002; Chua, 2002). When information and knowledge are integrated effectively, project team members tend to better transfer and make use of knowledge to develop new products effectively and promote valuable innovation outcomes and performance (Gold & Arvind Malhotra, 2001; Sarin & McDermott, 2003; Argote, McEvily, & Reagans, 2003). Accordingly, we infer that knowledge integration plays a mediating role in the relationship between customer participation and project performance. Therefore, the following hypothesis is proposed.

**Hypothesis 4:** Knowledge integration will mediate the relationship between customer participation and project performance.

**Hypothesis 4a:** Knowledge integration will mediate the relationship between customer participation and project process performance.

**Hypothesis 4b:** Knowledge integration will mediate the relationship between customer participation and project product performance.

**The Moderating Effect of Project Complexity**

Hypothesis 2 argued the direct relationship between customer participation and knowledge integration, but it didn’t discuss the boundary of the effect. We believe that project complexity (e.g., the radicalness or degree of innovativeness) has a noteworthy effect on the relationship between customer participation and knowledge integration. This has been corroborated by a minority of researchers who suggested that a new project development process should be characterized by the extent of project complexity (Damanpour, 1991; Dewar & Dutton, 1986; Kessler & Chakrabarti, 1999; Olson, Walker, Ruetker, & Bonnerd, 2001). According to the extent of project complexity, the innovative activities and efforts will be involved in the respective new project development process, which means that the requirements of each project are distinctive (Mehta et al., 2008). Generally speaking, innovative projects should establish more preferred opportunities in the market for differentiation and furnish more advanced superiority, which will lead to a superior competitive advantage, subsequently positively affecting project outcomes (Fang, 2008; Ignatius, Leen, Ramayah, Hin, & Jantan, 2012). More innovative products also correlate with greater risk notwithstanding. Because those projects channelled the firm into uncertain markets and technical circumstances, the possibility of an unanticipated event is higher (Mu, Peng, & MacLachlan, 2009). In contrast, less innovative products are more familiar to the organization; their risk is lower and so coordination is easier with respect to R&D resources and skills (Cooper & Kleinschmidt, 1993). Accordingly, this can improve the probable success of the product.

Ignatius et al. (2012) proposed and observed that the extent of innovativeness be recognized as a typical manifestation of project complexity, which impacts the outcomes of new product development. A complex project can mean uncertainty to the company, suggesting that project team members require more effort to solving problems, relying on more information and knowledge sources (e.g., customers). However, projects with low-level complexity undergo a more passive, routine-based system learning, which limits feedback (Nonaka & Takeuchi, 1995; Slater & Narver, 1998). Needless to say, projects with high-level complexity need project members to interact with customers because they can provide useful information and knowledge to project members, which can promote and channel the project team to collect and integrate
useful information and knowledge to ensure successful implement of the project (Chang & Taylor, 2016).

Consequently, varying degrees of customer participation are anticipated for varying levels of project complexity. To support this argument, Fang et al. (2008) argue that customer participation is potentially detrimental to new product performance and suggests that customer participation must be tailored in terms of different projects. According to this research, the impact of customer participation on knowledge integration is expected to vary as the extent of project complexity moves from high to low. Organizational information processing theory shows that the tasks involved in product development projects, vary in their levels of uncertainty, including lack of information and knowledge about the accurate ways of accomplishing the task. Overall uncertainty level of the task was often recognized as a typical manifestation of new technology in a project (Tatikonda & Rosenthal, 2000). Overall, high-level complex projects (e.g., higher in technological novelty) undergo more complex processes in new project development and require sufficient information and knowledge to abate the uncertainty and ambiguity as well as the unknown conjuncture of the project.

Therefore, customers outside of the company inquire about the project’s knowledge resource to format new information and knowledge that can be acquired and exploited by project members. The more resources there are for project knowledge, the more preferred is the capability of solving problems related to the high complexity of the project. In other words, the high level complexity of a project requires that great knowledge resources be involved in customers’ knowledge, which includes technical and professional competency to confront the perplexities of new project development. The project with the higher level complexity requires more customer participation in new project development to provide greater information and knowledge to abate uncertainty and mature core capabilities for the project team (Thamhain, 2013). As a result, project members will then be encouraged to collect and integrate information and knowledge to ensure successful implementation of the project. Since the level of project complexity has a contingent impact on the relationship between customer participation and knowledge integration, this study anticipates that:

Hypothesis 5: The impact of customer participation on knowledge integration is greater for projects with higher levels of project complexity.

The Moderated Mediating Effect of Knowledge Integration

In conclusion, this article proposes that project complexity not only moderates the relationship between customer participation and knowledge integration, it also moderates the mediating effect of customer participation on project performance via knowledge integration. We propose the hypothesis that knowledge integration mediates the positive relationship between customer participation and project performance (H4), and project complexity positively moderates the relationship between customer participation and knowledge integration (H5). Combining the logic of the two hypotheses, we propose that project complexity moderates the mediating effect of customer participation on project performance via knowledge integration (H6), which was one of the types of moderated-mediator models in Edwards and Lambert’s (2007) research. Although there are many forms of mediating effect models being moderated, in this research, we predict: (1) knowledge integration mediates the positive relationship between customer participation and project performance (H4); (2) project complexity moderates the relationship between customer participation and knowledge integration (H5); therefore, project complexity will moderate the original mediating effect (the mediating effect of customer participation on project performance via knowledge integration) (H6). This article proposes the following hypothesis, and Figure 1 depicts our theoretical model:

H6: Project complexity moderates the mediating effect of customer participation on project performance via knowledge integration, such that the mediating effect is stronger when the level of project complexity is high rather than low.

Methodology

Sample and Data Collection

This research collected data from software projects through a professional data survey corporation (e-Data Power) in Beijing and the authors’ social networks. We received 260 completed questionnaires from project team leaders; the final data included 245 software projects after removing 15 questionnaires due to excessive missing data. Overall, the valid response rate was 94.23%. The average number of days needed for developing software is 443.999 (S.D. = 667.993); most software projects were new projects (73.061%), others were IT solutions for customers.

We explained to the participants the importance of truthful answers for scientific research and ensured confidentiality by guaranteeing that only the researchers would see the individual answers. The software project leader completed a survey containing items for all variables, such as customer participation, project complexity, knowledge integration, project performance, and control variables (e.g., the duration, cost, scale, and type of project).

Operationalization Measures

The research involved five constructs at the project level: customer participation, project complexity, knowledge integration, process performance, and product performance; all measures used five-point scales, ranging from 1 = “strongly disagree, extremely small, or almost never” to 5 = “strongly agree, extremely big, or always” to collect data.
Customer participation was operationalized by five items adopted from Chan et al. (2010) and Auh et al. (2007): Customers spent much time sharing information about their needs and opinions with the project members during the service process (CP1); customers put a lot of effort into expressing their personal needs to the project members during the service process (CP2); customers always provided suggestions to the project members for improving the service outcome (CP3); customers have a high level of participation in the service process (CP4); and customers are very much involved in deciding how the services should be provided (CP5). The Cronbach’s alpha value of this scale was 0.727.

We measured knowledge integration using the five-item scale adopted from Tiwana (2008), which included project members competently blending new project-related knowledge with what they already know (KI1); project members spanning several areas of expertise to develop shared project concepts (KI2); and project members synthesizing and integrating their individual expertise at the project level (KI3). The Cronbach’s alpha value of this scale was 0.630.

Project process performance was measured according to six items developed by Nidumolu (1996). We asked the project leader to answer this question: How do you evaluate the project and software that were delivered on each of the following items in terms of your experience on the project? The measure used five-point scales, ranging from 1 = “very poor” to 5 = “very good”; the six items are as follows: control over project costs (PcP1), control over project schedule (PcP2), overall knowledge acquired by the project through the project (PcP3), overall control exercised over the project (PcP4), quality of communication between the project members and users (PcP5), and users’ feelings regarding participation in the project (PcP6). The Cronbach’s alpha value of this scale was 0.821.

Project product performance was operationalized based on five items according to Nidumolu (1996). We asked the project leader to answer this question: How do you evaluate the project and software that were delivered on each of the following items in terms of your experience on the project? The measure used five-point scales ranging from 1 = “very poor” to 5 = “very good.” The five items were: control over project costs (PdP1), control over project schedule (PdP2), overall knowledge acquired by the project through the project (PdP3), overall control exercised over the project (PdP4), quality of communication between the project members and users (PdP5), and users’ feelings of participation in the project (PdP6). The Cronbach’s alpha value of this scale was 0.762.

Project complexity was operationalized based on two items from Ignatius et al. (2012) and the following questions were asked: (1) How new was the product configuration (PC1)? And (2) How new were the product technologies in this project (PC2)? The Cronbach’s alpha value of this scale was 0.641.

Control Variables: In this article, we controlled for project duration (Nidumolu, 1995), budget (Mitchell, 2006), scale (Tiwana, 2008), and type to rule out alternative explanations for project performance. All four control variables were measured with a single item. The project duration was obtained by calculating the date of the project. Budget was measured according to one item: Compared with another similarly sized project, the budget of this project was ____. The measure used five-point scales, ranging from 1 = “very tight” to 5 = “very slack.” Scale was measured according to one item: Compared with another similarly sized project, the number of project members is ____. The measure used five-point scales ranging from 1 = “very few” to 5 = “a great many.” Project type was measured by...
Customer Participation and Project Performance

A dummy variable, new project development, coded as 0 and solutions for customers, coded as 1.

Nunnally (1978) stated that a Cronbach’s alpha value exceeding 0.6 was an acceptable level of measurement scale. The Cronbach’s alpha value of all five variables in this research exceeded 0.6, suggesting that the reliability levels of all five are acceptable.

Analyses Strategy
This research tested our hypotheses using hierarchical multiple regression analysis with STATA 12.0. We followed Anderson and Gerbing’s (1988) two-step procedures to test the hypothesized model depicted in Figure 1. This article first confirmed the measurement model using signal level CFA. The items for customer participation, project complexity, knowledge integration, and project performance were specified at the project level. The authors of this article then performed CFA in SEM and examined χ2, GFI, IFI, TLI, CFI, RMSEA, and SRMR to assess measurement model fit; then we compared the model with various alternative measurement models. The alternative measurement models, including two four-factor models (Model 2—combining customer participation and knowledge integration; Model 4—project process performance and project product performance, respectively), two three-factor models (Model 3—customer participation and knowledge integration were combined, and project process performance and project product performance were combined; Model 4—knowledge integration, project process performance, and project product performance were combined), and one two-factor model (Model 5—customer participation, knowledge integration, project process performance, and project product performance were combined). Table 1 reveals that no alternative models yielded better chi-square or fit index of the baseline model, indicating a good fit of the baseline measurement model. Thus, the distinctiveness of the five constructs in this study was supported.

Descriptive Statistics
Table 2 shows the means, standard deviations, and correlations for all the variables in this study, presented at their appropriate levels. Table 2 shows that customer participation was positively...
correlated with knowledge integration \((r = 0.486, p < 0.01)\), process performance \((r = 0.388, p < 0.01)\), and product performance \((r = 0.403, p < 0.01)\). Moreover, knowledge integration was correlated with process performance \((r = 0.511, p < 0.01)\) and product performance \((r = 0.483, p < 0.01)\). These results are consistent with our theoretical expectation and provide the initial support for our hypotheses.

**Hypothesis Test**

We conducted a hierarchical multiple regression analysis to test all the hypotheses, except for Hypothesis 6. As shown in Table 3, customer participation was positively related to process performance \((\beta = 0.367, p < 0.01, \text{Model 4})\) and product performance \((\beta = 0.342, p < 0.01, \text{Model 7})\) after entering control variables; thus, Hypothesis 1a and Hypothesis 1b were supported. Additionally, customer participation was positively related to knowledge integration \((\beta = 0.471, p < 0.01, \text{Model 1})\), and knowledge integration was positively related to process performance \((\beta = 0.472, p < 0.01, \text{Model 5})\) and product performance \((\beta = 0.435, p < 0.01, \text{Model 8})\). Thus, Hypothesis 2 and Hypothesis 3 (Hypothesis 3a and Hypothesis 3b) were supported.

Hypothesis 4 proposed that knowledge integration mediates the relationship between customer participation and project performance. When customer participation and knowledge integration were entered simultaneously, the positive correlations between customer participation and process performance, product performance decreased from 0.367 \((p < 0.01, \text{Model 4})\) and 0.342 \((p < 0.01, \text{Model 7})\) to 0.180 \((p < 0.01, \text{Model 6})\) and 0.171 \((p < 0.01, \text{Model 8})\), respectively.

### Table 2: Descriptive statistics and correlations.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Type</td>
<td>0.269</td>
<td>0.445</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Cost</td>
<td>3.637</td>
<td>0.860</td>
<td>-0.075</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Time</td>
<td>5.428</td>
<td>1.249</td>
<td>-0.028</td>
<td>-0.048</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Scale</td>
<td>3.351</td>
<td>0.598</td>
<td>-0.057</td>
<td>0.018</td>
<td>0.159**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 CP</td>
<td>3.542</td>
<td>0.581</td>
<td>-0.006</td>
<td>0.156</td>
<td>-0.032</td>
<td>0.386**</td>
<td>(0.727)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 PC</td>
<td>3.541</td>
<td>0.730</td>
<td>-0.047</td>
<td>-0.006</td>
<td>-0.002</td>
<td>0.256**</td>
<td>0.398**</td>
<td>(0.641)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 KI</td>
<td>3.962</td>
<td>0.595</td>
<td>0.075</td>
<td>0.178**</td>
<td>-0.076</td>
<td>0.163*</td>
<td>0.486**</td>
<td>0.336**</td>
<td>(0.630)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 PcP</td>
<td>3.938</td>
<td>0.571</td>
<td>-0.001</td>
<td>0.314**</td>
<td>-0.007</td>
<td>0.101</td>
<td>0.386**</td>
<td>0.375**</td>
<td>0.511**</td>
<td>(0.821)</td>
<td></td>
</tr>
<tr>
<td>9 PdP</td>
<td>4.153</td>
<td>0.457</td>
<td>0.066</td>
<td>0.228**</td>
<td>0.057</td>
<td>0.229**</td>
<td>0.403**</td>
<td>0.350**</td>
<td>0.485**</td>
<td>0.626**</td>
<td>(0.762)</td>
</tr>
</tbody>
</table>

Note: *p < 0.05; **p < 0.01; CP = customer participation, PC = project complexity, KI = knowledge integration, PcP = process performance, PdP = product performance. Values set in boldface on the diagonal are the Cronbach’s alpha value of each variable.

### Table 3: Regression analysis.

<table>
<thead>
<tr>
<th>Knowledge Integration</th>
<th>Process Performance</th>
<th>Product Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Type</td>
<td>0.084</td>
<td>0.092†</td>
</tr>
<tr>
<td>Cost</td>
<td>0.109†</td>
<td>0.122*</td>
</tr>
<tr>
<td>Time</td>
<td>-0.052</td>
<td>-0.049</td>
</tr>
<tr>
<td>Scale</td>
<td>-0.007</td>
<td>-0.030</td>
</tr>
<tr>
<td>CP</td>
<td>0.471**</td>
<td>0.402**</td>
</tr>
<tr>
<td>PC</td>
<td>0.188**</td>
<td>0.175**</td>
</tr>
<tr>
<td>CP*PC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KI</td>
<td>0.257**</td>
<td>0.286**</td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ R²</td>
<td>0.029</td>
<td>0.015†</td>
</tr>
</tbody>
</table>

Note: †p < 0.1, *p < 0.05; **p < 0.01; CP = customer participation, PC = project complexity, KI = knowledge integration.
Customer Participation and Project Performance

(p < 0.05, Model 9), respectively, whereas knowledge integration was still found to be positively related to process performance ($\beta = 0.398$, $p < 0.01$, Model 6) and process performance ($\beta = 0.363$, $p < 0.01$, Model 9). Hence, Hypothesis 4 was preliminarily supported according to the steps proposed by Baron and Kenny (1986). We tested the indirect effects of customer participation on project performance via knowledge integration using bias-corrected confidence intervals derived from bootstrap estimates, which provides further evidence of the mediating effect of knowledge integration. We constructed bias-corrected confidence intervals by drawing 1,000 random samples with replacements from the full sample. An indirect effect is significant when the 95% confidence interval excludes zero (Edwards & Lambert, 2007). In our data, the size of the indirect effect of customer participation on process performance via knowledge integration from the full sample was 0.183, of which 95% was the confidence interval (0.115, 0.258), and the indirect effect of customer participation on product performance via knowledge integration from the full sample was 0.135, of which 95% was the confidence interval (0.081, 0.195). The 95% confidence interval from the bootstrap analysis both excluded zero (see Table 4); thus, Hypothesis 4 was supported.

Hypothesis 5 proposed that project complexity moderates the relationship between customer participation and knowledge integration. As shown in Table 4, the interaction between customer participation and project complexity was positively related to knowledge integration ($\beta = 0.129$, $p < 0.05$, Model 3). We plotted the interaction effects using Stone and Hollenbeck’s (1989) procedure. Figure 2 shows that customer participation is more positively related to knowledge integration when project complexity is high; hence Hypothesis 5 was supported.

Hypothesis 6 predicts that project complexity moderates the customer participation–knowledge integration–project performance mediating linkage. To examine this hypothesis, we conducted Edwards and Lambert’s (2007) general path analytic framework. The results, summarized in Table 5, show that the size of the difference in the indirect effect of customer participation on process performance was 0.008, with the 99% confidence interval computed using

<table>
<thead>
<tr>
<th>Path</th>
<th>Indirect Effect</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP→KI→Process Performance</td>
<td>0.183</td>
<td>(0.115, 0.258)</td>
</tr>
<tr>
<td>CP→KI→Product Performance</td>
<td>0.135</td>
<td>(0.081, 0.195)</td>
</tr>
</tbody>
</table>

Note: CP = customer participation, KI = knowledge integration

Table 4: Indirect effect between customer participation and project performance via knowledge integration.
bootstrap estimation, excluding zero; product performance was 0.003, with the 99% confidence interval computed using bootstrap estimation, including zero. Specifically, the indirect effect of knowledge integration on the relationship between customer participation and process performance was significantly stronger at a high level of project complexity, but the effect of project complexity on the mediating relationship between customer participation and product performance via knowledge integration was insignificant. Thus, Hypothesis 6a was supported but Hypothesis 6b wasn’t supported.

**General Discussion**

**Theoretical Implications**

One strength of this research model of customer participation is that it explains knowledge integration as a mediator that transmits the effects of customer participation to project performance. Although previous studies have observed and examined that customer participation is linked with high coordination effectiveness (Fang et al., 2008), information sharing (Fang et al., 2008), and service quality (Ngo & O’Cass, 2013), Chang and Taylor’s (2016) conceptual model and Joshi and Sharma’s (2004) research on customer knowledge development have implied that the linkages between customer participation and project performance might occur via knowledge integration. For example, the research conclusions of Martín-de Castro and colleagues have revealed that knowledge integration is a predictor and key potential mechanism of new project performance (Martín-de Castro, López-Sáez, Delgado-Verde, & Koch, 2011). Although existing studies have revealed that customer participation should positively affect project performance (Chan et al., 2010), it is unclear how and why customer participation in a project can promote project performance. Customer participation can promote project performance and follows an increase in access to knowledge and information, which contributes to success of a new project. The customer has been conceptualized as a key knowledge and information source associated with project team competence in which the customer provides his or her diversified useful knowledge and information to improve project performance. Although this implies the linkage between customer participation and project performance via knowledge integration, Chang and Taylor (2016) argued that the conclusions on the mediating effects of knowledge-related processes on the relationship between customer participation and new project performance were mixed. Although resource-based models facilitate shedding light on how customer participation enhances project performance, the existing research avoids testing the mediating role played by knowledge integration in the association between customer participation and project performance, which leaves open the issue of whether such resources explain the effects of customer participation on project performance. Therefore, this research empirically examined Chang and Taylor’s (2016) conceptual model, using knowledge integration to explain how and why this critical resource affects project performance.

Second, this article’s findings confirmed that the effect of customer participation on outcomes depends on the level of project complexity. Previous research has revealed that project complexity can strengthen the positive effects
Customer Participation and Project Performance

of customer participation on new product innovativeness (Fang, 2008) and the positive effects of technological learning on new product development outcomes (Ignatius et al., 2012). Although these findings are plentiful, there are few studies exploring the benefit of project complexity from a knowledge management perspective. This article’s findings about the moderating role of project complexity in strengthening the positive effects of customer participation on knowledge integration bridge a gap between project complexity and knowledge integration from a knowledge management perspective. Previous studies have revealed that customer participation brings many benefits to a new project team (Chang & Taylor, 2016), yet no studies have uncovered the positive association with knowledge-related processes. Finding a way to strengthen the beneficial effects of customer participation in a project has become a fast-growing topic in project management. The project management literature, however, reveals little about project-level strengthening characteristics, despite the argument that a project’s features can effectively increase the beneficial effects of customer participation (Fang, 2008). In light of the fact that project complexity requires the inclusion of multiple sources in a new project (Fang, 2008), and that the lead project member should pay more attention to project-related knowledge and information (which is likely to act as a critical project feature that will strengthen access to various types of knowledge and information that promote knowledge integration and project performance). Therefore, the finding of this article provides an ideal foundation for future research testing the strengthening effects of project complexity on the impacts of other forms of knowledge and information sources. We expect that our examination into the project feature area will inspire further project complexity research in various contexts, which can help us capture a synthetic picture of project complexity in increasing the positive effects of multiple knowledge and information sources.

Finally, examination of project complexity reveals the limited conditions of knowledge integration’s mediating role in customer participation and project performance. The findings of this article indicate that knowledge integration’s mediating effects are stronger when project complexity is higher, but become weaker when project complexity is lower. These findings extend the existing studies that deal with customer characteristics only as influencing factors of new product development outcomes, thereby ignoring the joint effects of mediator (e.g., knowledge integration) and moderator (e.g., project complexity). The findings of this article guide us to challenge the approach adopted in previous studies and we propose that the mediating impacts of knowledge integration are moderated by project complexity. These moderating effects are not at all surprising as project complexity needs more inclusion, which creates more chances for interaction and benefits the exposure of novel linkage during co-creation processes (Milliken & Martins, 1996). Therefore, project characteristics should be considered as a critical moderator that offers limited conditions for the mediating effect of knowledge integration in the linkage between knowledge and information sources and project performance. Accordingly, the results of this research imply that future studies focusing on knowledge-related processes of project performance should adopt more precise ways to test the joint effects of knowledge source and project characteristics.

Managerial Implications

The findings of this article confirm that customer participation can promote knowledge integration, which in turn positively correlates with project performance. When developing a new project, the project leader should establish the procedure or mechanism to facilitate the customer involved in the project. During the process of solving problems, both sides can cultivate mutual behavioral norms and common symbols, which can promote the integration of knowledge and project performance. Simultaneously, firms should establish co-determination and feedback mechanisms to facilitate more knowledge and information lacking in the project team, which in turn promotes project performance. Furthermore, the enterprise should alert project teams to realizing the fact that encouraging customers to participate in the process of projects can catch customers’ needs, which can potentially benefit the project team and firm. This can improve customers’ acceptance and satisfaction with the project.

Additionally, this article found that project complexity moderates the relationship between customer participation and knowledge integration, along with the mediating role of knowledge integration on the relationship between customer participation and project performance. Specifically, when the level of project complexity is higher, the positive relationship between customer participation and knowledge integration, as well as the positive indirect effect of customer participation on project performance via knowledge integration, is stronger. When firms conduct a new project they should, in terms of the characteristics of the project, guide the customer to participate in the development of a new project. For example, firms should emphasize the importance of sharing knowledge to promote integration of knowledge under conditions of high-level project complexity.

Limitations

Our research also has some limitations, which future studies could address. First, we collected data from a single source, which may lead to common method variance, despite our efforts to ensure the quality of the questionnaire. In future studies, we should collect data from multiple sources or multi-wave sources to control the potential influence created by the common method variance.

Second, our research only considered knowledge integration as a mediator to interpreting the mediating
mechanism, but there may be other mediators between customer participation and project performance. For example, technological learning has been posited to be positively related to project performance (Ignatius et al., 2012) and the customer as important information and knowledge sources, which can encourage project members to adopt the learning behavior required to get more information and knowledge from customers (Chan et al., 2010). Therefore, we can conduct empirical research on considering other mediators to explain the mechanisms between customer and project performance.

**References**


Customer Participation and Project Performance


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The Role of Co-creation in Enhancing Explorative and Exploitative Learning in Project-Based Settings

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ABSTRACT

We study how co-creation practices influence explorative and exploitative learning in five collaborative construction projects with partnering arrangements. Drawing on a longitudinal case study, our findings reveal two different types of explorative learning processes (i.e., adaptation and radical development) and three different exploitative learning processes (i.e., incremental development, knowledge sharing, and innovation diffusion). Furthermore, co-creation practices enhance adaptation, radical development, and incremental development, which are typical intra-project learning processes. Co-creation practices do not, however, enhance knowledge sharing and innovation diffusion across projects. These findings concur with previous insights that the temporary and one-off nature of projects makes inter-project learning problematic.

KEYWORDS: project-based learning; exploration; exploitation; co-creation; collaboration; partnering; construction

INTRODUCTION

The importance of simultaneously facilitating short-term efficiency by exploiting existing knowledge and technologies to make profits today, and long-term innovation by exploring new knowledge and technologies to adapt for future demands, is continuously highlighted in the management literature (e.g., Jansen, Tempelaar, van Den Bosch, & Volberda, 2009; March, 1991; O’Reilly & Tushman, 2013). Most prior research has studied exploration and exploitation at the firm and business unit levels, investigating their effects on performance. Research targeting how exploration and exploitation are managed at the project level is less common (Junnii, Sarala, Taras, & Tarba, 2013; Turner, Maylor, & Swart, 2015). This is surprising given that project-based organizations (PBOs) consistently struggle with organizational learning challenges (Bakker, Cambré, Korlaar, & Raab, 2011; Chronéer & Backlund, 2015; Scarbrough et al., 2004a). For many PBOs, innovation and explorative intra-project learning are critical aspects of developing and delivering complex and customized products that satisfy evolving customer demands, whereas exploitative inter-project learning is necessary to achieve efficient use of limited project resources (Brady & Davies, 2004; Eriksson & Leiringer, 2015; Turner et al., 2014). However, inherent characteristics such as the uniqueness, autonomy, and short-term focus of each project, and the interdependencies between project actors and their activities make it difficult to manage both explorative and exploitative learning (Davies, Dodgson, & Gann, 2016; Eriksson, 2013; Söderlund, 2008).

In the particular context chosen for this article—construction projects—the above described difficulties are especially prevalent. De-centralization and dispersed modes of working in inter-organizational projects are defining characteristics of the industry (cf. Leiringer, Green, & Raja, 2009). Construction projects are temporary, often highly customized and rarely undertaken within a standard framework. Moreover, clients and end-users are rarely the same, and even large repeat clients have their projects spread across time and space (Winch & Leiringer, 2016). The downside of this arrangement is that the autonomy afforded to individual project teams increases the risk of their becoming disconnected from other projects within the same organization, with detrimental implications for inter-project learning (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003).

Project learning processes are commonly impeded by temporary and often adversarial relationships that lead to coordination problems on the more complex projects (Bresnen, 2007). In recent years, therefore, collaborative arrangements (mostly termed “partnering”) have
been increasingly implemented to enhance coordination, joint problem solving, and co-development processes among the project actors (Bygballe, Jahre, & Swärd, 2010; Eriksson, 2015). Prior studies on partnering projects have indicated the positive effects of improved collaboration on efficiency-related aspects such as cost savings, reduction in disputes, shorter construction time, and improved predictability (Crespín-Mazet, Ingemansson, & Linné, 2015; El Asmar, Hanna, & Loh, 2013), as well as innovation-related aspects, such as increased chance of implementing innovations (Bosch-Sijtema & Postma, 2009; Manley, 2008; Worsnop, Miraglia, & Davies, 2016). Accordingly, it has been suggested that partnering arrangements might serve as engagement platforms that enable clients and contractors to co-create value on construction projects (Jacobsson & Roth, 2014).

While the co-creation concept originates from the service industries and business-to-consumer (B2C) markets (e.g., Payne, Storbacka, & Frow, 2008; Prahalad & Ramaswamy, 2000, 2004a), there is now an increasing interest in connecting co-creation practices and learning processes at the project level in the literature on innovation and new product development (NPD). For example, Mahr, Lievens, and Blazevic (2014) highlight the importance of integrating different actors’ knowledge sets and engaging in joint explorative and exploitative learning when co-creating value. Indeed, the core of co-creation is the joint learning processes that involve the integration of these different knowledge sets (Kleinsmann, Buijs, & Valkenburg, 2010). It is on this emerging strand of literature that this article seeks to build in investigating how co-creation practices and learning processes are related to explorative and exploitative learning within and across construction projects.

The purpose of this article is to investigate if and how project actors engage in co-creation practices, and if and how this influences explorative and exploitative learning in collaborative construction projects. More specifically, we first identify central explorative and exploitative learning processes and how they are interrelated in collaborative construction projects. Second, we investigate if and how the client, designer, and contractor engage in co-creation practices and how this might influence the different learning processes.

We begin with a theory section that discusses the key concepts of explorative and exploitative learning and value co-creation and link this to the construction project context. Subsequently, the method is described and positioned against prior research highlighting the central roles of processes and interactive practices in value co-creation (e.g., Payne et al., 2008; Vargo & Lush, 2004). The empirical investigation involves longitudinal case studies to develop a deeper understanding of why and how processes emerge and evolve. The findings are structured around the main themes identified through thematic data analysis (Braun & Clarke, 2006), describing five central learning processes and how these are influenced by co-creation practices. Particular importance is given to the origins of, and drivers for, these co-creation practices and their links to particular project challenges. The article ends with conclusions outlining the interrelations among co-creation practices and the different types of learning processes in a project-based industry, namely construction.

**Theoretical Background**

**Explorative and Exploitative Learning**

In the organizational learning literature, two main types of learning modes are typically distinguished—exploration and exploitation—following the seminal work of March (1991). Explorative learning involves a distant search for, and assimilation of, new knowledge and technologies to enhance creativity and to achieve innovation and radical development of new solutions. Exploitative learning instead involves a local search for familiar knowledge and technologies to deepen the current knowledge set and achieve incremental development and continual improvement of existing solutions. Accordingly, exploration is generally associated with terms such as: adaptability, flexibility, risk taking, distant search, experimentation, radical development, and long-term orientation. Exploitation, on the other hand, is associated with refinement, control, routinization, local search, efficiency, incremental development, and short-term orientation (Andriopoulos & Lewis, 2010; Junni et al., 2013; March, 1991; O’Reilly & Tushman, 2004).

Due to the fundamentally different natures of the two learning modes, they are considered difficult to manage together, as highlighted in the literature on organizational ambidexterity (e.g., de Visser, de Weerd-Nederhof, Faems, Song, & van Looy, 2010; O’Reilly & Tushman, 2013). A commonly suggested solution at the firm level is to put in place structural and/or sequential separation of exploration and exploitation in different units/periods, along with a centralized integrating mechanism (Jansen et al., 2009; O’Reilly & Tushman, 2004). However, the uniqueness and autonomy of each project mean that such integrating mechanisms are difficult to implement in PBOs, which further complicates combining explorative and exploitative learning at the project level (Söderlund, 2008; Turner et al., 2014; 2015). Instead, it has been argued that intra-project exploration and inter-project exploitation can be facilitated by inter-organizational collaboration (Eriksson, 2013; Scarbrough et al., 2004a, 2004b).

**Exploration and Exploitation in Construction**

Construction projects are complex and uncertain endeavors that require explorative intra-project learning to handle development and adaptability challenges during project execution (Eriksson, 2013). Furthermore, the systemic nature of construction innovation and technology development requires coordination of many interdependent
Co-creation in Project-Based Settings

components and sub-systems. Hence, different actors often need to collaborate in joint development processes (Bosch-Sijtsema, 2009; Ozorhon, 2013). As parts of PBOs, construction projects also benefit from exploitative inter-project learning to achieve efficient use of limited resources (Eriksson & Leiringer, 2015).

In construction, knowledge can be considered context specific, making it difficult to transfer across projects due to competing and varying personal, professional, and organizational interests (Bresnen et al., 2003). Additionally, time constraints and geographical distances between construction sites, coupled with the commercial necessity of keeping a constant workflow, forces project teams to disband before, or upon, completion of projects, making knowledge sharing across projects even more difficult (Bresnen, Goussevskaia, & Swan, 2004). Nonetheless, there is now an emerging literature base that shows that inter-project learning, in terms of sharing and diffusing knowledge and innovations across projects, can be facilitated by collaborative and long-term relationships in which actors achieve improved communication, knowledge integration, and mutual understanding (e.g., Poirier, Forgues, & Staub-French, 2016).

In summary, prior research has highlighted the importance and challenges of managing explorative and exploitative learning within and across projects, and there are studies that indicate that collaboration may enhance both learning modes (Scarbrough et al., 2004a, 2004b; Tiwana, 2008). In construction, however, the relative autonomy and uniqueness of each project and the traditional temporary and adversarial nature of relationships affect the nature and timing of collaborative work, which increases the challenges of intra- and inter-project learning (Davies et al., 2016; Eriksson, 2013).

Co-creation of Value

In conventional value creation processes, suppliers and customers have distinct and separated roles in production and consumption, which enables sequential creation and adds value based on standardization and maximum production efficiency (Prahalad & Ramaswamy, 2004a; Vargo & Lush, 2004). In contrast, co-creation is an interactive practice into which customers and suppliers bring their own unique resources (e.g., competences and technologies) to co-create value reciprocally through integration (Saarijärvi, Kannan, & Kuusela, 2013; Vargo, Maglio, & Archpru Akaka, 2008). Value is here created synchronously and jointly by customers and suppliers in collaboration (Normann & Ramirez, 1993; Prahalad & Ramaswamy, 2004b). Accordingly, co-creation involves a change from supplier-led customization, in which customers tailor their purchases by choosing from many features, to an approach in which customers add their competences and experiences and become co-creators of the customized content (Prahalad & Ramaswamy, 2000).

The literature on value co-creation is diverse and the concept has been studied and operationalized in different ways across research domains. Originating from strategic management (e.g., Normann & Ramirez, 1993; Prahalad & Ramaswamy, 2000), the concept has become strongly linked to service marketing (e.g., Vargo & Lush, 2004), where studies mostly focus on the usage stage and co-creation of value in use (e.g., Vargo et al., 2008). Recently, co-creation has also stimulated increased interest in innovation and new product development literature (e.g., Lau, Tang, & Yam, 2010; Mahr et al., 2014), with focus on how firms can involve customers in co-development work (e.g., Candi, Van den Ende, & Gemser, 2016; Kleinmann et al., 2010). From a project management perspective, it is notable that the production stage is often left out in these broad literature sets. Therefore, the focus here is on the recent studies that have started to differentiate co-creation practices on the basis of their timing and content, and dividing co-creation practices into different stages such as (1) design/development, (2) production/manufacturing, and (3) delivery/implementation/usage (e.g., Alves, Fernandes, & Raposo, 2016; Saarijärvi et al., 2013; Voorberg, Bekkers, & Timmers, 2015). Most studies focus on only one of these stages, but some span over two or all, such as the study by Payne et al. (2008) who argue that co-creation practices involve an interactive dialogue in each stage of value creation, from product design through delivery.

In the innovation and new product development literature there is an explicit connection between co-creation and learning; specifically, how co-creation involves knowledge integration based on iterative and interactive learning on the parts of both the customer and the supplier (Kleinmann et al., 2010; Mahr et al., 2014). Even so, findings diverge regarding the benefits of involving customers in co-creation practices. Many argue that customer involvement in co-development is beneficial and results in improved products and/or innovation processes (e.g., Chen, Tsou, & Ching, 2011; Lau et al., 2010), whereas, others conclude that customer involvement has no, or even negative, effects (e.g., Un & Asakawa, 2015). Two issues stick out as having an effect on the outcomes: (1) the type of learning mode and (2) the timing of the co-creation practices. In terms of the type of learning mode, several studies show that customer involvement in co-development is especially important in achieving exploration (e.g., Candi et al., 2016; Lettl, 2007), whereas others have found that tight couplings with the customer enhances exploitation (e.g., Andriopoulos & Lewis, 2009). In terms of the timing of co-creation practices, the common argument is that customers should be involved either early in the design stage to provide input to the co-development work, or at the implementation stage to learn how to use the finalized product. Customer design input in the production stage is commonly portrayed as negatively
affecting time and cost performance (Menguc, Auh, & Yannopoulos, 2014; Rönberg-Sjödin & Eriksson, 2010). Despite differences in approaches and findings, what is clear in the above-mentioned studies is that the timing, nature, and extent of co-creation practices affect different explorative and exploitative learning processes.

Co-creation on Construction Projects
Many construction projects face high complexity and interdependencies among specialized actors and their activities; thus, a wide set of disparate knowledge sets and technologies must be integrated and coordinated for a project to be completed (cf. Cacciatori & Jacobides, 2005). Temporary and adversarial relationships, along with the difficulties in accurately assessing the quality of the end product and its technical complexity, create a significant moral hazard for the client because once the construction work starts, it becomes inconvenient to change contractors (ibid.). Consequently, integrating strategies, such as partnering arrangements, are increasingly deployed in attempts to avoid the coordination problems experienced with traditional competitive and disintegrated strategies (Bresnen, 2007; Crespin-Mazet et al., 2015). Partnering is based on collaborative procurement strategies, which enhance joint problem solving and co-development between the client and contractor throughout project execution (Eriksson, 2015). Partnering arrangements are, thereby, based on both formal (e.g., joint project objectives, open books, and mutual incentives) and informal aspects (e.g., trust and commitment) to serve as engagement platforms for co-creation practices (Crespin-Mazet & Gauri, 2007; Jacobsson & Roth, 2014). While there are many examples of partnering arrangements facilitating the engineering of trust and cooperation, there are also many examples of where this has not happened. The fundamental problem is that, in temporary project settings, there is often limited opportunity for the development of deeper, more resilient forms of trust (Bresnen, 2007).

It is clear that the temporary relationships in project-based business-to-business (B2B) contexts make it more challenging to collaborate, share knowledge, and combine resources. Accordingly, there is a difference between how co-creation practices are managed during the design and production stages of construction projects and how the practices are managed in continuous manufacturing industries and consumer services industries. It is therefore relevant to further investigate how project actors engage in co-creation practices, and if and how this influences explorative and exploitative learning on collaborative construction projects. In this empirical context, co-creation could be understood as practices in which different project actors combine and integrate their resources when collaborating to jointly create value in the design and production stages. It is, however, important to point out that even if a construction project can be divided into design and production stages (as we do in this article), these stages are not perfectly separated and distinguishable. To the contrary, design and production are commonly split into sub-stages, and projects consist of many different types of sub-systems, in which the production of one sub-system may be executed before the design of another sub-system.

Research Method

Research Design
Following O’Reilly and Tushman’s (2013) call for more exploratory and qualitative in-depth studies on how to achieve exploration and exploitation, we adopted a case study approach to investigate five large construction projects. We sought to apply a replication strategy; hence, only projects with outspoken collaborative arrangements procured by professional clients were selected. This is partly because professional clients with repeat business should, arguably, have the competence to engage in co-creation practices to customize products and processes, and partly because a formal collaborative arrangement can be viewed as an ambition to create a platform for co-creation practices. A second consideration was the size of the projects and available resources. Organizational size affects access to resources (Lau et al., 2010; Un & Asakawa, 2015) and, more specifically, project size affects the amount of activity that a project can incorporate (Candi et al., 2016). This is important, because a lack of resources has been found to hinder simultaneous management of exploration and exploitation in smaller organizational settings (March, 1991; O’Reilly & Tushman, 2013). Therefore, large projects with a contract value of more than 500 million SEK (i.e., >60 million US dollars) were chosen, as they were deemed to provide more opportunities to manage exploration and exploitation through different types of organizational learning processes. As such, the selected cases can be viewed as favorable critical cases (cf. Flyvbjerg, 2006). If co-creation practices are not performed in collaborative projects procured by repeat clients, and different learning processes are not simultaneously managed in large project settings, these practices and processes will be even more scarce and difficult to manage in other types of projects.

We also found it important to investigate a broader range of organizational settings, both to extend the applicability of the emerging theory (Eisenhardt & Graebner, 2007) and to obtain sufficiently rich and comprehensive empirical material, from which to gain insight and illustrate different ways of managing co-creation practices and organizational learning processes in different project settings. Hence, the selection of projects includes the two main construction sectors in Sweden (i.e., building construction and infrastructure construction) (see Table 1).

Projects 1 through 3 were parts of two large infrastructure projects procured by the Swedish Transport Administration.

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(STA) in accordance with their internally developed collaboration model. Project 1 belonged to Megaproject A and involved tunneling through bedrock and associated road and concrete lining works. Projects 2 and 3 belonged to Megaproject B and involved highway construction and additional minor access roads and overpasses. The embedded nature of these projects was deemed beneficial for investigating inter-project learning processes. All three infrastructure projects involved civil engineering work, in which the actors faced major geological uncertainties. Projects 4 and 5 were both complex building projects with explicit partnering arrangements. Project 4 involved a large multi-story office building where the client, a real-estate developer, had a signed contract with a specific tenant when the design and construction started. Project 5 involved the construction of industrial premises, which included office areas and extensive and advanced ground work.

Data Collection

Interviews were conducted in three rounds over a four-year period: the first round was conducted during project execution (May 2011–December 2011); the second round was conducted when the projects were more or less completed (May 2012–August 2013); and the third round was conducted one to two years after project completion (April 2013–November 2015). In total, 36 interviews were conducted with the project managers of the client and the contractor and the design managers for each project. In Projects 3 and 5, the client’s project manager also served as design manager. In some cases, a respondent was interviewed on three occasions, but due to staff turnover and the transient nature of the construction business, a majority of the respondents were interviewed twice. In Projects 1 and 4, there was a change of the clients’ project managers during the production stage, and in Project 5, the contractor’s project manager changed as the project came to close out. See Table 2 for more information about the respondents.

The longitudinal data collection process adopted an abductive approach and followed the advice of Alvesson (2011) to be more open, general, and broad in the early stages and more specific and delimited toward the end; hence, each round was more specific in terms of theoretical constructs. Following Andriopoulos and Lewis (2009), all interviews in Round 1 began with questions covering general topics: project description and organization, key actors and their relationships, and prioritized performance criteria. The focus then turned to the development and implementation of new and existing work methods and solutions on the project. The interviews were conducted at the project offices using a semi-structured approach, with open-ended questions loosely informed by the organizational learning literature. In Round 2, the respondents were asked to describe and reflect upon how their projects had been executed. Here, the questions were focused on how different organizational and managerial practices had influenced project performance and learning processes. In addition, they were asked to describe examples of development work and to elaborate on why, how, and by whom it was undertaken. In Round 3, the respondents were asked specific questions regarding how the parties collaborated and if and how this had influenced the

<table>
<thead>
<tr>
<th>Project</th>
<th>Object Type</th>
<th>Client</th>
<th>Number of Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tunnel, roadwork</td>
<td>Swedish Transport Administration</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Road, overpasses</td>
<td>Swedish Transport Administration</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Road, overpasses</td>
<td>Swedish Transport Administration</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Office building</td>
<td>Commercial real-estate developer</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Industrial premises</td>
<td>Municipality-owned company</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 1: Summary of the five engineering projects.

<table>
<thead>
<tr>
<th>Type of Actor</th>
<th>Age</th>
<th>Number of Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client 1A (initial)</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>Client 1B (successor)</td>
<td>65</td>
<td>1</td>
</tr>
<tr>
<td>Contractor 1</td>
<td>54</td>
<td>2</td>
</tr>
<tr>
<td>Designer 1</td>
<td>41</td>
<td>2</td>
</tr>
<tr>
<td>Client 2</td>
<td>38</td>
<td>3</td>
</tr>
<tr>
<td>Contractor 2</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Designer 2</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>Client 3</td>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td>Contractor 3</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>Client 4A (initial)</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td>Client 4B (successor)</td>
<td>42</td>
<td>1</td>
</tr>
<tr>
<td>Contractor 4</td>
<td>55</td>
<td>2</td>
</tr>
<tr>
<td>Designer 4</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>Client 5A (parallel)</td>
<td>48</td>
<td>3</td>
</tr>
<tr>
<td>Client 5B (parallel)</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Contractor 5A (initial)</td>
<td>44</td>
<td>2</td>
</tr>
<tr>
<td>Contractor 5B (successor)</td>
<td>52</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Information about the respondents.
development, implementation, and diffusion of new or improved solutions and work methods. Furthermore, the project outcomes were briefly discussed in retrospect. All three rounds of interviews were recorded digitally.

Data Analysis
The empirical data were analyzed using an exploratory thematic analysis procedure inspired by Braun and Clarke (2006) and Spiggle (1994). Data analysis followed a four-stage iterative approach involving repeated rounds of reading and categorizing of the data. Stage 1 involved line-by-line open coding while listening to the recordings and reading the transcriptions and field notes from each interview. We, thereby, identified a long list of initial codes related to the three aggregate dimensions of exploration, exploitation, and co-creation from the data within each case. In Stage 2, we searched for links among the first-order codes within each case, which facilitated grouping them together into second-level categories and third-level themes (Braun & Clarke, 2006; Spiggle, 1994). A core aspect of this stage was that we allowed concepts and relationships to emerge from the data, rather than being guided by an explicit and detailed theoretical framework. In Stage 3, we conducted cross-case analysis, looking for similar concepts and relationships across cases, comparing the categories and themes produced in the second stage. We conceptualized and labeled these themes by capturing the content within each case, which facilitated grouping them together into second-level categories and third-level themes (Braun & Clarke, 2006; Spiggle, 1994). (Braun & Clarke, 2006) and Spiggle (1994). Data analysis procedure inspired by Braun and Clarke (2006) and Spiggle (1994). Data analysis involved either process or product development. Exploration occurred in terms of: (1) adaptation, which involved dealing with changes derived from different sources of uncertainty related to ground conditions, poor tendering documents, client requirements in the early stages, and late end-user involvement; and (2) radical development, which involved either process or product development. Exploitation occurred in terms of: (3) incremental development, which involved continual improvement of existing knowledge and technologies; (4) knowledge sharing across projects through post-project review meetings and lessons-learned sessions; and (5) innovation diffusion across projects and organizations. These five learning themes form the overarching frame of the empirical findings presented in the next section. In addition, the thematic analysis identified four themes related to the co-creation dimension: (1) co-creation during the design stage, (2) co-creation during the production stage, (3) barriers to co-creation, and (4) drivers for co-creation. See the Appendix at the end of the article for additional details on codes and themes.

Findings and Analysis
Adaptation: Dealing With Uncertainty
In all five projects, substantial changes of existing plans and routines in terms of adaptations to dealing with unpredictable or changing circumstances were major parts of daily work. Adaptation is related to explorative learning in the sense that it involves challenging change efforts that require new solutions to either production processes or the end product. Project participants were proud of being able to resolve any problems that occurred, and adaptation processes were deemed to have saved some of the projects from failure. The empirical findings identify four main categories of adaptation processes. These categories are related to dealing with challenges stemming from uncertain ground conditions, poor tendering documents, uncertain client requirements in the early stages, and late end-user involvement.

Dealing With Uncertain Ground Conditions
All projects that included extensive civil engineering work (i.e., Projects 1, 2, 3, and 5) faced challenges stemming from uncertain ground conditions, in terms of issues with the groundwater and geological challenges of working in rock and clay. These difficult ground conditions, which were especially apparent in work involving tunneling, piling, and excavation, led to significant adaptation during production, because work plans and routines had to be changed. For example, Project 5 experienced major problems caused by groundwater when excavating the bottom of the shaft for a fuel bunker 15 meters (approximately 50 feet) below ground level. The original design using a ‘cut and cover’ procedure caused a severe inflow of contaminated groundwater, which exceeded the capacity of the pumping equipment. The escalating and chaotic situation was managed by the client and the contractor who combined their competences to jointly devise a new solution: “During the excavation, we encountered an unforeseen problem with the groundwater flow. We were afraid that we would drain the whole city. In true partnering spirit the contractor suggested that we would investigate whether a diaphragm wall could be an option, which is relatively new as a permanent structure in Sweden. At that point we had great collaboration” (Client 5B).

Dealing With Poor Tendering Documents
Another critical antecedent of adaptation processes in the projects was the poor quality of the clients’ original designs, plans, and tendering documents. The low-level quality of these initial documents and plans meant that the parties routinely needed to develop and re-negotiate new plans, solutions, and drawings because errors were revealed.
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during the production stage. This type of adaptation challenge was visible in all five projects, but was especially severe in Project 2 where, among other things, the initial plans and solutions for temporary traffic were defective and impossible to execute. The initial project scope and contract sum grew by 34% and, halfway through the project, 600 change orders had been implemented. To manage these challenging adaptations, the client and contractor combined their knowledge to jointly develop alternative solutions acceptable to both parties: “When I got involved in the project, we soon found that it was impossible to build in accordance to the tendering documents. We had to change everything. We have shown a remarkable capacity to work together, to change things for the better” (Client 2). Contractor 2 pinpoints the importance of joint creativity during these adaptation processes: “Both we and the client were forced to think outside the box due to all the changes we faced. The client was often involved and contributed with ideas when we discussed alternative solutions. There was a degree of creativity involved, forced upon us by the poor design.”

Dealing With Uncertain Client Requirements in the Early Stages

If client requirements are uncertain and ill-defined in the early project stages, there may be numerous changes and additions to the initial plans and solutions that significantly creep in scope. In our set of cases, these problems were more apparent in building construction than in infrastructure projects. This is by no means surprising, given that the requirements of tenants are rarely set in the early stages of commercial building projects. Hence, as the client gets a better overview of what is wanted and required, changes and modifications become necessary (Cacciatori & Jacobides, 2005).

Project 4 had change orders of 20% of the initial project cost, mostly due to adaptations initiated by the client, who simply did not know what they wanted until the actual tenants were confirmed. Change orders were particularly prevalent toward the end of the production stage: “We were in a great hurry to deliver a building according to the requirements that were set two and a half years prior. But the customer’s customer only had a six-month foresight regarding their internal tenants who were to use the building. Once the tenants were finally confirmed, they wanted to transform the building to fit their current business. To manage all that was, in the end, really hard” (Contractor 4). The adaptation processes resulting from these uncertain client requirements were ordered by the client without offering any assistance to the contractor: “As the design manager, I was involved in the project for an unusually long period. Mainly, this was due to the amount of late change orders that required changes to the design up until the very end of the project. Even afterwards, the client wished to demolish and rebuild several spaces, but the contractor put a very high price tag on it with the message that they did not want to do this work” (Designer 4).

In Project 5, the contract cost increased by 110%, mostly due to the client demanding significant additions, such as an additional office floor and an adjacent pumping station. It should be noted, however, that the client had anticipated such changes, and adaptation was explicitly stated as a success criterion at the beginning of the project. Yet, despite the stated early project intentions, in the midst of production, managing these changes of original plans and solutions was very challenging for all parties involved, especially the contractor. Ultimately, the need for adaptation became overwhelming and created pressures on resources and time, which had negative consequences on both the relationships in general and the co-creation practices in particular: “The collaborative process has deteriorated from how I perceived it in the beginning. However, it is only natural that as the project budget and schedule become increasingly tight and strained, it will affect the relationships” (Client 5B).

Dealing With Late End-User Involvement

In line with prior studies on innovation and new product development projects that highlight the importance of end-user involvement (e.g., Chen et al., 2011; Lau et al., 2010), our findings show that end-user involvement facilitated customization and value co-creation in the two building construction projects. Embracing end-users into the design work does, however, increase the risk of scope creep, since their expectations typically crystallize into more concrete specifications as the design process starts to generate solutions that can be assessed (Grabher, 2004). In Project 5, the end-users (i.e., representatives of those who were to move into the finished premises) were not formally part of the project organization; nonetheless, they were intensively involved in providing ideas and design input, particularly in the production stage. This resulted in a customized building that satisfied many of their requirements and desires. Moreover, their late design input caused adaptation challenges in terms of problematic changes to the original solutions, plans, and routines: “One reason for the numerous changes is that the end-user group has been active up until the end of the project. They saw an opportunity through the partnering arrangement to continuously add stuff. This should, of course, have been done during the design stage. Now it became a pain as it happened during the production stage” (Client 5A). This is in line with prior studies that have highlighted the importance of involving end-users early in the design stage, as this allows for the design to be frozen sufficiently early to not delay production planning (Eriksson, 2015; Menguc et al., 2014).

Overview and Discussion of Adaptation Processes

It should be noted that adaptation, as well as dealing with uncertainty, are inherent in projects that have a high degree of customization and site-specific production and, therefore,
central to how project-based industries work (Defilippi & Sydow, 2016). The four processes we have identified above are representative examples of the root causes of this uncertainty. Of importance here is that, although adaptation is something that most practitioners take great pride in being able to achieve, it is mainly something negative, at least in relation to pre-determined project objectives. Undesirable changes to original plans disturb and delay the production stage and are a leading contributor to rework (Love, Edwards, & Smith, 2016).

It was apparent from all five projects that co-creation practices are central to adaptation processes, in the sense of combining competences and experiences in joint work efforts to find new solutions that are acceptable for all key actors. In particular, the integration of the complementary competences and experiences of different actors speeds up the process of proposing and implementing new, feasible solutions. Contractor 2 illustrated the importance of a competent client to enable co-creation when managing adaptation: “When we ran into problems, we handled them jointly; we were flexible and found solutions together. The cooperation was based on staff in the client organization being highly competent. You have to be equally competent; otherwise there will be no good dialogue.” There is, however, a distinct difference between our context and the more generalist literature on co-creation in terms of the separation of the design and production stages. In our context, co-creation during production does not involve co-production in the form of the client helping the contractor with manufacturing and assembly activities. Instead, it involves joint problem-solving activities to design and develop viable solutions to deal with sudden and unforeseen adaptation challenges during the production stage. As the examples from Projects 4 and 5 show, this is not always the case and there are instances when the adaptation processes are pushed on to the supply side. Hence, co-creation in our project setting is more likely to materialize under circumstances in which the project actors face adaptation challenges forced upon them by external factors, rather than when the adaptations are initiated by one of the actors (e.g., derived from uncertain client requirements).

It is also worth noting that in the organizational learning literature, adaptation is a core aspect of explorative learning related to long-term adaptability to changing environmental circumstances (Andriopoulos & Lewis, 2010). Contrastingly, in our project-based setting, adaptation is mostly short-term and reactive. If these reactive adaptation processes become the overarching focus, it has repercussions for the aspirations of more proactive and value-adding developments. This finding is perhaps best illustrated by another example from Project 5 in which the many unforeseen change orders resulted in cost and time pressures that hindered innovation work. Additionally, the client had initial expectations of joint incremental development through co-creation practices, but these hopes were soon dashed when the focus shifted to the management of change orders and adaptations. “The schedule is so tight that there is no time for incremental developments. We hoped that we could do more in the spirit of partnering, where we together with the contractor fine-tune plans and solutions to become even better and more efficient. But we have had such a shortage of time and resources that when the first proposed solution has been developed, we have used it immediately; there is no time for any improvement dialogue” (Client 5B). Ultimately, uncertain environments lead to excessive adaptation, which in turn results in chaotic organization and difficulties in retaining control and continuity. Accordingly, the stressful and urgent nature of reactive adaptations creates negative effects that go beyond the direct costs of the resources spent on handling them.

**Radical Development**

Notwithstanding the arguments made earlier regarding how reactive adaptation affects proactive development, a core aspect of exploration is radical development (de Visser et al., 2010; Lin & McDonough III, 2011). In the projects, radical development involved new working methods to improve the production processes (i.e., process development) and new technical solutions, components, or sub-systems to improve the end product (i.e., product development).

**Process Development**

There were many examples of process development in the projects related to finding new production methods or using new technology in production processes. Indeed, the respondents all agreed that process development had higher priority than product development, as summarized by Contractor 3: “It is important to find new ways of working, to find new ways to build old things.”

In Project 1, the project actors had an explicit focus on development work and contractual incentives for finding ways to cut costs, which resulted in several process innovations. Early in the design stage, the client and designer jointly developed a production approach in which blasted rock and stone were kept as reinforcement materials for road construction. This novel production solution saved a lot of work and had, according to the respondents, never been used in a Swedish road tunnel before. This was not an isolated case, because project actors often combined their competences and undertook much development work together through co-creation practices in joint design meetings in which the client, designer, and contractor discussed design solutions. The contractor initiated some development processes; for example, standardizing and prefabricating the extractor fan foundations rather than adopting the normal procedure of casting them in situ. This innovation would not have been possible without
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the diverse knowledge sets of all three actors: “We have assisted the contractor in their innovation efforts, for example when they suggested that we should go for a prefab solution for the fan foundation that hangs from the tunnel ceiling. This has never been done before. We assisted and served as an advisor to the client in the decision process on this” (Designer 1).

In Project 2, the contractor and designer combined their technical competences and experiences to co-develop an innovative bridge solution that saved time and money during production by reducing the amount of onsite concrete work. The collaborators removed an entire foundation structure to simplify the production of the bridge. Although the client project manager was not actively involved in this particular development, he accepted the new solution on the basis of trust and sharing in the economic savings from it.

Product Development

There were some examples of product innovations in the five projects, although the actors focused more on developing their production processes. In Project 1, the contractor designed wall linings in the tunnel consisting of a new application of prefabricated concrete elements that protect the tunnel from groundwater leakage. This was a novel solution that, according to the respondents, had never previously been used in Sweden. This part of the project was separated into a design-build contract, in which the actors did not have joint design meetings. As a result, this particular development process did not involve co-creation practices to the same extent as other developments on the project. The solution was developed separately by the contractor’s specialists in Germany and initially required subsequent correction and adaptation, since the design of the ceiling was not in accordance with the client’s expectations. Lack of communication and difficulty in assessing this complex solution resulted in differing expectations and views on what was required: “We submitted a proposal for a new interior lining to the client, which they approved. Then, as we started assembling the solution they said it couldn’t look like that. Apparently, they had not reviewed our proposal thoroughly enough. When they saw how it looked in reality it was not as they expected. How could we know what they had expected” (Contractor 1)? This example illustrates the difficulties for contractors in performing product development in-house without client involvement due to the customized, non-standardized, and uncertain nature of the project environment.

In Project 4, a new type of hybrid façade solution was jointly developed by the client, tenant, contractor, and designer, which included meeting the tenant’s requirement of a glass façade and the client’s requirement of a concrete frame. The tenant and the client were satisfied with this compromise of a hybrid solution and the co-creation practices it was based on. The designer and the contractor both saw potential for this unique solution to be used in future projects and invested central organizational development funds in designing and developing it. Despite this, and in contrast to the other two parties, they were not satisfied with the co-creation practices involved: “We worked with the facade for far too long before we were told what it should look like. We set up mock-ups, and the [tenant’s] architect inspected these several times. But then he went directly to the tenant and talked with them rather than with us. It was a process where we felt we were close to being circumvented” (Designer 4).

Overview and Discussion of Radical Development Processes

In four out of five projects, radical process and product developments were achieved through co-creation practices, in which the actors contributed with their complementary competences and experiences. In these cases, the clients engaged in the design stage in order to help develop customized products. This is very much in line with findings in the new product development and co-creation literature in that collaboration enhances explorative learning and innovation (e.g., Chen et al., 2011; de Visser et al., 2010; Shenhar, Holzmann, Melamed, & Zhao, 2016).

In a project-based industry, such as construction, the extent to which such co-creation can take place is directly dependent on the right contractual conditions having been put in place. We have argued that collaborative partnering arrangements are one such favorable context, as they facilitate and put in place mutual benefits and contractual incentives for project actors to engage in joint development (El Asmar, 2013; Jacobsson & Roth, 2014). Even so, findings from Project 3 illustrate that the mere existence of such arrangements might not be enough. It was clear that, although the client was well aware of the importance of a creative contractor in the beginning of the project, many innovative solutions suggested by the contractor were turned down due to a lack of trust and the absence of explicit contractual incentives: “We often received suggestions for alternative or novel solutions [from the contractor], but we seldom saw any benefits for us. We felt that the contractor earned too much from these new solutions while we got nothing. In retrospect, maybe we should have let the contractor carry out more of these changes and accept that they had earned this extra money. But at that time, we felt a bit cheated” (Client 3). Contractor 3 verified the lack of trust and the negative consequences it had on development work: “The degree of trust was low. They probably thought we somehow tried to snatch money from them improperly. We had our meetings and they told us they didn’t trust us.” What this shows is that formal partnering agreements are no guarantee that co-creation practices will ensue. Both formal contractual mechanisms (e.g., mutual incentives) and informal aspects (e.g., trust and commitment)
are needed. Yet, even if they are in place, there might still be tensions between the need for the development of trust and the commercial realities that prompt contractual partners to act in more traditional and adversarial ways. In such instances co-creation practices will clearly suffer.

**Incremental Development**

Incremental development is a core aspect of exploitation (Andriopoulos & Lewis, 2010; de Visser et al., 2010). It is not surprising, therefore, that many of our respondents stated that small adjustments and continual improvements of existing knowledge and technologies are important; indeed, they are often more important than radical developments. However, they also saw how continual improvements were often neglected, partly due to time pressures and partly due to heavily institutionalized practices that are not easily changed. Consequently, in the five projects there were examples of incremental development and fine-tuning, but ultimately many existing solutions were reused without further development.

In Project 1 the client aimed for robust, tried, and tested solutions, minimizing unnecessary risks, but also pinpointed the importance of continual improvement: “Fine tuning the small things in life, is more important than radical developments.” The design manager mentioned a few incremental developments they were involved in, working together with the contractor in joint design meetings to refine existing solutions. One example of this was to improve the working environment of mining workers by providing sufficient space so they would not need to splice the drill steel in front of the drilling machine. Despite the client’s outspoken wish for fine-tuning, however, the design manager believed that there was a lack of continual improvement: "We are bad at fine-tuning and incremental development, we often do as we always have done."

In Project 3, the actors formulated mutual objectives for the project, one of which was to identify and develop ten improvements that would generate increased efficiency for both parties; thus, the client encouraged the contractor to come up with improvements. Even so, they did not reflect on their own part in this work and instead opted for a predominantly monitoring role: “We have said to the contractor: find all the adjustments and simplifications you can that have the same quality [as the original design], then we will decide on how we share the profits. That will be a win–win situation.” Not having specified how to share the profit in advance, however, stilled most attempts at joint development.

In Project 4 there was a lack of co-creation practices for incremental development due to weak contractual incentives for the client to engage in cost reduction. In contrast to most other partnering arrangements, the client on this project had created a highly beneficial situation: the client would get paid by the tenant for any additional costs, whereas the contractor had to pay the costs that were above the initial price, which according to the contractor and designer, diminished joint incremental development: “There was a guaranteed maximum price, which is not suitable in a partnering contract. The client has not been committed to aiding us in cutting costs. We have tried to find cheaper solutions that will benefit both actors, but the client’s attitude has been that: no, it is there [in the design], so it should be included” (Designer 4).

**Overview and Discussion of Incremental Development Processes**

In innovation research, there is a clear link between incremental development and the exploitation of existing knowledge and technologies (e.g., de Visser et al., 2010; Lin & McDonough III, 2011). It is also commonly claimed that collaboration can enhance such incremental developments (e.g., Andriopoulos & Lewis, 2009). On the contrary, we found that exploitation involves trying tried and tested technical solutions and work methods as they are, without any development efforts in the front end. Two main reasons for this lack of development stand out. First, the deeply institutionalized belief in the tried and tested and the related skepticism among many clients toward insufficiently tested solutions. Second, as shown in the examples from Projects 3 and 4, the lack of mutual benefits hinders co-creation practices in incremental development processes. Indeed, co-creation in incremental development seemingly requires mutual incentives, so that both parties can benefit from the collaborative development work. Hence, the arrangements used in the new product development environment might not lend themselves immediately to the project-based nature of the construction industry, where the complex and systemic nature of technical solutions and temporary relationships work against the establishment of mutual incentives for collaborative incremental development work.

**Knowledge Sharing Between Projects**

Another learning process related to exploitation readily identifiable in the studied projects is knowledge sharing between projects. As previously noted, prior research has found that inter-project learning in terms of knowledge sharing between projects is difficult for project-based organizations (Bakker et al., 2011; Brady & Davies, 2004; Bresnen et al., 2003). This was also evidently clear in our five projects, as the interviewees all struggled with the two main, formal mechanisms that had been put in place to facilitate it: post-project reviews and lessons-learned sessions.

**Post-Project Reviews**

In all five projects, post-project review meetings with key project actors were held with the aims of discussing experiences and learning from good and bad practices for the benefit of subsequent projects. Several respondents, however, highlighted that these reviews were problematic. The client in Project 2, for example, did not find it very useful: "We had a review meeting and I wrote a final report to
my superiors. Afterwards, I probably took the report to my summer house and used it to light the fire in the fireplace. I think each project participant gained experience and knowledge from the project, but that we would be able to create an overall shared experience, no, I don’t think so.”

In a similar vein, the contractor in Project 5 found these reviews, in general, to be too shallow and that the actors were not trying to engage in sufficiently deep discussions of their experiences: “It is not easy, this experience feedback we have after each project. We do it, but it is often rather shallow. There is never really any depth. I’ve been to a number of such meetings, but it is very much just scratching at the surface” (Contractor 5B).

Continuous Lessons-Learned Meetings

In line with a few prior studies pinpointing the value of continuous lessons learned rather than post-project reviews (e.g., Chronéer & Backlund, 2015; Scarbrough et al., 2004b), some respondents argued that post-project review meetings are problematic, because it is too late to discuss experiences when the project is finished and people have moved on. The contractor in Project 1 was clear about this and suggested that lessons-learned sessions should be arranged regularly throughout project duration. “Actually it would be good with some kind of session after each project stage. For example, when you are finished with the tunneling we could have a lessons-learned session just for that—discussing what has worked well and less well. You could have such meetings as different stages are finished.” As it turned out, the client in Project 1 had tried to put this into practice, but just not very effectively. As Projects 1, 2, and 3 were parts of megaprojects, attempts were made to achieve continuous knowledge sharing across the different sub-projects to capture good and bad experiences, which were worth imitating or avoiding. On Megaproject A, Client 1 felt that these forums were arranged too infrequently: “I’ll be a bit self-critical. We did not have enough coordination meetings, we should have arranged more knowledge sharing sessions among the sub-projects and the mega-project manager.” On Megaproject B, the client provided extra resources in order to facilitate inter-project learning and had a specially appointed person responsible for coordinating such meetings: “To share the experience among us in the various projects, we have a technology coordinator who holds technical meetings every two weeks. I think he has had about 157 meetings since the project started” (Client 3).

Overview and Discussion of Knowledge-Sharing Processes

It has long been customary in project-based industries to conduct post-project reviews and lessons-learned sessions to try to learn from good and bad experiences and feed this knowledge into the design and production stages of subsequent projects (Bakker et al., 2011; Scarbrough et al., 2004a). In line with prior studies, we found that these knowledge-sharing processes are problematic, mainly due to the temporary and one-off nature of construction projects (Eriksson & Leiringer, 2015). Nonetheless, our findings divert from what is commonly claimed in terms of knowledge sharing in the organizational learning literature. Continuous knowledge sharing across functional units and organizations is less problematic in the manufacturing industry, where work is undertaken through continuous and standardized processes and by partners collaborating in supply chain management activities over extended periods of time. In the construction industry, and many other project-based industries, the commercial realities are very different. The industry is characterized by a highly fragmented and temporary delivery structure, in which a myriad of loosely coupled organizations, often deliver to lowest cost agendas, driven on by competitive tendering, in markets where even the large repeat clients would have their projects spread across time and space. In this context, there is a stronger focus on temporary projects than on continuous processes (Chronéer & Backlund, 2015). Hence, the idea of co-creation facilitating inter-project learning for long-term benefits will likely need to be set aside for other more pressing short-term commercial concerns, even in projects where the emphasis is on collaboration.

Innovation Diffusion Across Projects and Organizations

Given the difficulties experienced in knowledge sharing across projects, it is not surprising that the respondents also claimed that exploitation of the new solutions developed on the projects, in terms of innovation diffusion, had turned out to be very challenging. This is also in line with the findings from a plethora of prior studies on innovation in the construction industry (e.g., Bosch-Sijtesma & Postma, 2009; Manley, 2008; Ozorhon, 2013). Nevertheless, a few of the aforementioned radical and incremental innovations developed in the five projects were diffused to other projects or within the organizations participating in the development work. Some solutions that were developed within Projects 1, 2, and 3 were diffused by the clients to other sub-projects in Megaprojects A and B. For example, the solution of reusing blasted rock and stone as reinforcement material in the road construction in Project 1 was applied to another sub-project in Megaproject A, in which the rock quality was sufficiently high for re-use as reinforcement.

In Megaproject B, the innovative bridge solution, which was developed by the contractor and designer in Project 2, was adopted by the client when procuring the next sub-project. Of note here is that this type of client-led innovation diffusion can be very beneficial for the client but not necessarily for the contractor and designer who invested resources in the development work: “When the client produced the tendering documents for the subsequent project we saw that all of a sudden there was a...”
blurry cloud of revisions, indicating that solutions had been changed. So, it was very obvious that after we had presented the new [bridge] solution, it showed up in documents for the next stage. That felt flattering, but okay, then we have burnt that card [laughing]” (Designer 2).

Many respondents also highlighted the challenge of diffusing project-specific innovations. In simple terms, they did not know if or when they would encounter similar project conditions; hence, they were uncertain if these innovative solutions could be applied elsewhere. This was especially apparent in the civil engineering projects, where varying ground conditions and geological circumstances mean that projects have a degree of uniqueness: “In our industry, projects don’t repeat themselves so often. It is not certain that a new solution is applicable in the next project. It is built elsewhere under other circumstances with other people, other suppliers, etc. We are like a traveling circus putting up our tent in various places. There is a new audience and new actors every time we get together and new circumstances for us when we put up our tent” (Contractor 1). Due to the difficulties of diffusing innovations and the risk of competitors copying them, several contractors and designers were of the opinion that investments in radical development mostly have to pay off on the project at hand.

**Overview and Discussion of Innovation Diffusion Processes**

Several studies have shown that inter-project learning is enhanced by long-term relationships over a series of projects (Scarbrough et al., 2004b) and by a centralized integrating mechanism that can assimilate and transfer knowledge from one project where intra-project learning takes place to other parts of the project portfolio (Brady & Davies, 2004; Eriksson & Leiringer, 2015). This is not, however, easy to achieve in construction. In contrast to manufacturing industries, where investments in innovation processes are often initiated by centralized decisions and considered of strategic importance, innovation in the construction industry is mostly conducted in, and financed through, regular construction projects (Eriksson, 2013). This, along with the lack of long-term contracts, has repercussions for innovation diffusion since innovations tend to be developed and customized for the project conditions at hand, rather than for the purpose of being diffused across many projects. This, in turn, results in hesitation to invest in innovation processes. In temporary intra-project collaborative arrangements, the lack of long-term contracts means that there is no platform for co-creation practices regarding inter-project learning processes, such as innovation diffusion. Hence, the symbiotic and interdependent nature of explorative development and exploitative diffusion processes is especially problematic in this empirical setting. A convincing case could be made that megaprojects, consisting of several sequential projects, can rectify one aspect of this problem if a centralized learning mechanism is put in place in the client organization to facilitate innovation diffusion across the different client teams. However, unless the project is particularly large, or several projects are offered, this does little to justify the contractors’ innovation investments.

**Conclusions**

Although the importance of knowledge integration and learning processes have been emphasized in prior co-creation research (e.g., Payne et al., 2008; Vargo & Lush, 2004), there is a lack of studies explicitly investigating how explorative and exploitative learning are managed when buyers and suppliers co-create value. Similarly, although some studies suggest that collaboration enhances exploration and exploitation (e.g., Scarbrough et al., 2004a; Tiwana, 2008), there is a lack of research on how co-creation influences explorative and exploitative learning. We address these literature gaps by cross-fertilizing the literature on organizational learning and co-creation in our study of how co-creation practices influence explorative and exploitative learning in collaborative construction projects.

**Theoretical Contributions**

We contribute to the co-creation literature by showing how clients, design consultants, and contractors engage in co-creation practices to cope with inherent and emerging challenges in the design and production stages of partnering projects, and how this influences explorative and exploitative learning processes. Prior literature emphasized that co-creation involves a change from customization performed by the supplier, to an approach where customers co-create the customized product along with the supplier (Prahalad & Ramaswamy, 2000). We argue that this change from supplier-led customization to co-creation is especially important in the project-based construction industry. The inherent complexity and uncertainty characterizing many construction projects make it difficult for suppliers to develop customized solutions on their own. Hence, the client needs to be involved in co-creation practices along with designers and contractors to enhance customization.

Recent studies pinpoint the importance of distinguishing between different co-creation stages (e.g., Alves et al., 2016; Saarijärvi et al., 2013; Voorberg et al., 2015). Whereas prior co-creation literature focuses primarily on the design or the usage stage, our findings show that much co-creation takes place in the production stage of construction projects. In particular, this takes the form of the joint design and development of new solutions when sudden and unforeseen circumstances make original plans inappropriate. Our findings also show the additional complexities brought about by the common practice of having some sub-systems produced before the design of other sub-systems, which further highlights the importance of customization during the production stage.
Co-creation in Project-Based Settings

Our findings also contribute to the organizational learning literature by showing that it is not only the two main learning modes (i.e., exploration and exploitation) that compete for scarce resources, as discussed in the ambidexterity literature (e.g., March, 1991; O’Reilly & Tushman, 2013). We have identified five central learning processes within the two main modes that need to be managed in the project setting. Specifically, we show how too much focus on reactive adaptation in some sub-systems crowds out proactive development in others. The drawbacks of adaptations are further compounded by difficulties in diffusing their outcomes. Adaptations are mostly highly customized and tailored to specific time- and space-related circumstances. Such demand for uniqueness limits the scope for reuse and modularity on the product level (Grabher, 2004). Prior research views adaptation in terms of long-term adaptability to changing environmental circumstances of strategic importance (Andriopoulos & Lewis, 2010; O’Reilly & Tushman, 2004). In contrast, we have found that in construction projects adaptation occurs in the often rather stressful production stage; thus, it is a short-term type of exploration, which is even more difficult to exploit in future projects than radical development. Finally, organizational learning processes require knowledge integration to occur through ongoing social interaction (Kleinsmann et al., 2010; Tiwana, 2008). Yet, our findings show that co-creation practices are more suited to the intra-project learning processes (i.e., adaptation, radical development, and incremental development). Co-creation practices in the inter-project learning processes (i.e., knowledge sharing and innovation diffusion) are more problematic even in projects within the same megaproject.

Managerial Implications

Prior co-creation research has identified the importance of sharing risks, benefits, and responsibilities among customers and suppliers to enhance co-creation practices (Prahalad & Ramaswamy, 2004b). Our study adds to the understanding of these barriers and drivers for co-creation by showing that (1) partners need to trust each other to engage in co-creation practices; (2) all actors need to have sufficient competencies, which can add value in combination with others’ competencies; and (3) partners seek to profit from joint development efforts, which influences decisions to spend resources on co-creation practices. An important managerial implication, therefore, is that successful co-creation requires mutual trust, contributing competence among all key actors, and contractual incentives.

Additionally, co-creation practices require cross-functional integration in the supplier firm to reach alignment between the functions that make and deliver the customer promise (Payne et al., 2008). Our findings show that there is also a need for cross-functional integration in the customer organization, so that end-user involvement is not misdirected and ends up hindering value creation. It is, indeed, clear that late end-user involvement during production stages triggers short-sighted and reactive adaptation. The easy solution, which is commonly put forward in the extant literature, is that end-users should be involved early in proactive co-development practices, when their knowledge and experience can provide important input to joint design work (Rönngb Sjödin & Eriksson, 2010; Menguc et al., 2014). In the project-based environment we have studied, this is a real challenge. End-users typically do not belong to the temporary project organization, but to the permanent line organization that will use the facilities when they are finished (Eriksson, 2015). Much more effort is, therefore, required to take them away from their ‘day-job’ and involve them in co-creation practices.

Limitations and Future Research

This study has some limitations that also spur suggestions for future research. In line with the co-creation literature, we have focused on co-creation practices between the client and contractor, although we have also included the designer to obtain a fuller understanding of exploration and exploitation during the design stage. Due to the large number of key actors in complex construction projects, and the systemic nature of construction innovation, it would be relevant to investigate wider partnering arrangements, which also include the involvement of subcontractors and material suppliers in innovation processes. Another limitation is that we have studied projects with temporary collaborative arrangements only. Arguably, co-creation practices, knowledge sharing processes, and innovation diffusion processes are heavily affected by the length of the collaborative arrangement. As illustrated by Projects 2 and 3, which were parts of a larger megaproject, knowledge sharing and innovation diffusion can be enhanced by repetition and longer project processes. It would, therefore, be relevant to study strategic partnering arrangements spanning a series of projects to investigate how a long-term perspective affects co-creation practices and intra- and inter-project learning processes.

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References


Co-creation in Project-Based Settings


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### Co-creation in Project-Based Settings

#### Appendix: Codes and themes in empirical analysis.

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<td>Dealing with uncertain ground conditions</td>
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<td>Developing and/or implementing new production IT tools</td>
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<td>Process development</td>
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<td>Knowledge sharing between projects</td>
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<td>Diffusing radical developments to other projects and organizations</td>
<td>Innovation diffusion across projects and organizations</td>
<td>Innovation diffusion across projects and organizations</td>
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<td>Innovation diffusion across projects and organizations</td>
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<tr>
<td>Proactive joint development</td>
<td>Co-development</td>
<td>Co-creation in the design stage</td>
<td>Co-creation</td>
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<tr>
<td>Reactive Join-problem solving</td>
<td>Joint-problem solving when dealing with adaptations</td>
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<td>Lack of competence hinders co-creation</td>
<td>Barriers to co-creation</td>
<td>Barriers to co-creation</td>
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<td>Lack of contractual incentives hinders co-creation</td>
<td>Barriers to co-creation</td>
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<td>Lack of trust hinders co-creation</td>
<td>Barriers to co-creation</td>
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<tr>
<td>Combinative competences drives co-creation</td>
<td>Drivers for co-creation</td>
<td>Drivers for co-creation</td>
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<td>Contractual incentives drives co-creation</td>
<td>Drivers for co-creation</td>
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<td>Trust drives co-creation</td>
<td>Drivers for co-creation</td>
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INTRODUCTION

Real options reasoning provides a fruitful framework for project managers to better account for the different types of uncertainties that impact investment decisions (Avadikyan & Llerena, 2010) and help limit downside risk and simultaneously capture potential opportunities. In recent project management research there has been considerable interest in understanding how real options reasoning might usefully affect project performance (Fichman, Keil, & Tiwana, 2005; Tiwana, Wang, Keil, & Ahluwalia, 2007). Real options reasoning presents a rational survival strategy for project managers to use flexibility in order to cope with environmental uncertainty. The usefulness of real options logic highly depends on the amount of uncertainty perceived by project managers (Dixit & Pindyck, 1994). In other words, a real option has no value whenever there is low level uncertainty (Kogut & Kulatilaka, 2001).

Drawing on an extensive body of past research on strategic management, we first tested how perceived environmental uncertainty influences the usage of real options reasoning and then how greater use of real options may impact e-commerce project performance, a state that has received scant attention in strategic management research (Swamidass & Newell, 1987). Our work has two specific aspects. First, in line with recent real options reasoning studies (Huchzermeier & Loch, 2001; Tiwana et al., 2007; Fichman, 2004), we conceptualized real options reasoning at the project level rather than at the firm level (Podoynitsyna, Song, van der Bij, & Weggeman, 2013). This approach helps gain a finer understanding of the usability of real options reasoning from the viewpoint of project outcome (Klingebiel & Adner, 2014).

Second, in contrast to some environmental uncertainty–strategy research, which considers environmental uncertainty as a unidimensional construct, we use it as a distinct set of constructs. In a seminal article, Milliken (1987) unfolded the construct of perceived environmental uncertainty in the management interpretation process into three types: (1) Management can be uncertain about what is happening (state uncertainty), (2) how it will impact their organization (effect uncertainty), and (3) what they are going to do about it (response uncertainty). Given that decisions about how many real options should be created and when to exercise them are taken at the managerial level, and the managerial action is highly determined by subjective perception (Child, 1997; Priem, Love, & Shaffer, 2002), the study of real options reasoning has to be based on managers’ perceptions (Verdu, Tamayo, & Ruiz-Moreno, 2012).
Does Real Options Reasoning Support or Oppose Project Performance?

By breaking down perceived environmental uncertainty into Milliken’s (1987) typology, the following question arises: How do various types of uncertainty perceptions influence the number of real options used at the project level? A complementary research question yet to be answered in this context is the following: Can project performance be guaranteed when real options are used in greater numbers? These two questions are fundamental to enriching our understanding of real options reasoning in strategic management and the answer is a key to progress in research on this topic (Tong & Reuer, 2007). By answering the first question, we challenge well-accepted beliefs in the real options context of “the higher uncertainty, the greater use of real options” (Dixit & Pindyck, 1994; Kagut & Kulatilaka, 2001). We highlight that the higher usage of real options is highly contingent on the type of perceived environmental uncertainty.

Despite a growing body of research that emphasizes the prominent role of real options reasoning on firms’ performance by reducing different types of uncertainties (Bloom & Van Reenen, 2002; Podoyntsyna et al., 2013), little is known about the effect of real options on project performance (Klingebiel & Adner, 2014). We extend the real options theory by adapting it to the electronic commerce context and examining the possibility that real options reasoning at the project level may both promote and impede performance.

Furthermore, we contribute to upper echelons theory by showing how individuals’ perceptions may influence their actions and consequently how their actions may impact the firms’ level of performance.

This article is organized as follows. First, we outline the key literature on real options reasoning, perceived environmental uncertainty, as well as project performance. Then we present our five hypotheses, our methodology and sample, as well as our key results. The discussion leads to our implications for further research, and finally, our limitations.

**Literature Review**

**Real Options Reasoning**

Real options reasoning has its roots in financial options theory, which was introduced by Black and Scholes (1973) and received notable attention in the contexts of entrepreneurship (Miller & Folta, 2002), innovation (Verdu et al., 2012), networks (Podoyntsyna et al., 2013), information technology (Fichman et al., 2005), and capability development (Kogut & Kulatilaka, 2001). At the project level, real options reasoning has been used as an appropriate organizational strategy or behavior to reduce environmental uncertainty in supply chains (Hult, Craighead, & Ketchen, 2010), information technology (Fichman et al., 2005; Tiwana, Keil, & Fichman, 2006), innovation (McGrath & Nerkar, 2004), and strategic investment decisions (Krychowski & Quelin, 2010).

Real options reasoning offers six types of possible actions to project managers in the face of environmental uncertainty: unlocking, switch use, scale, stage, defer, and abandonment (Fichman et al., 2005; Hult et al., 2010; Tiwana et al., 2007; Zhang & Babovic, 2011, 2012). An unlocking or growth option is present when an electronic commerce project creates the possibility of pursuing upcoming strategic opportunities (Hult et al., 2010). The stage options refer to the possibility of completing an electronic commerce project with a series of incremental investments (Majd & Pindyck, 1987) that allow the project manager to terminate the investment if unforeseen changes later on warrant doing so (Tiwana et al., 2007). A scale option is present in electronic commerce projects when there is a possibility to contract or expand the allocated resources (financial and human, logistic systems, hardware, and software in electronic commerce projects) (Fichman, 2004). The defer option exists when the initiation of an electronic commerce project can be delayed or postponed to a later point in time, without the risk of foregone a valuable opportunity (Benaroch & Kauffman, 1999; Tiwana et al., 2007). According to Trigeorgis (1993), a switch use option allows for electronic commerce investments to be redeployed to another application. Finally, an abandonment option is present when an electronic commerce investment or project can be terminated prior to completion, freeing up remaining resources to be used in another project (Hult et al., 2010).

Using these six types of real options not only provides a considerable amount of flexibility to project managers in order to meet project objectives in the face of environmental uncertainty (McGrath, Ferrer, & Mendelow, 2004), but these real options also enable them to seize upside opportunities more effectively. However, a wait-and-see strategy such as real options did not always appear to be taken very seriously by project managers or to have been implemented in all strategic decisions (Zardkoooh, 2004), because it necessitates spending a considerable amount of time, which may reduce the possibility of completing a project on time. Furthermore, the probability of changing or stopping the project in terms of market and environmental conditions may erode the morale of project team members, which might ultimately degrade project efficiency and effectiveness. Project managers may squander the main goals of a project when there is great room for terminating, redeploying, and postponing the project.

**Perceived Environmental Uncertainty**

It appears to be widely accepted in the strategic management literature that environmental uncertainty significantly impacts new technology venture (NTV) strategies (Oriani & Sobrero, 2008; Liu, Shah, & Babakus, 2012; Beckman, Haunschild, & Phillips, 2004; Afshar Jahanshahi, 2016) and performance (McCabe, 1990; Podoyntsyna et al., 2013). The perception of uncertainty is
fundamental for management, because managers form the foundations for their strategic choices based on their perceptions (Child, 1997; Priem, Love, & Shaffer, 2002; Downey, Hellriegel, & Slocum, 1975).

In trying to handle uncertainties, first one needs to know the types of uncertainties one is facing (Grote, 2009). Milliken (1987) suggested that managers may perceive three distinct types of uncertainties as they seek to understand and respond to changes in a business environment: state uncertainty, effect uncertainty, and response uncertainty.

State uncertainty refers to the inability of decision makers to predict how the main components of a business environment might be changing. “For example, one might be uncertain both about the likelihood of deregulation and the likely behavior of competitors if deregulation occurs. Thus, in this case, one knows neither the probability of deregulation nor the probability of a price war if deregulation occurs” (Milliken, 1987).

Effect uncertainty refers to the inability of decision makers to predict the impact of changes in the business environment on their organizations. Milliken (1987) gave the example of “knowing that a hurricane is headed in the general direction of your house does not mean you know how it will affect your particular house.” Finally, perceived response uncertainty is the inability to predict the likely consequences of a response choice. Milliken added: “Administrators would most likely experience response uncertainty in the course of either choosing from a number of possible strategies or formulating a response to an immediate threat in the environment” (Milliken, 1987). Following Milliken’s typologies allowed us to gain a deeper understanding of how the perceptions of different types of environmental uncertainties may influence the usage of real options reasoning. State uncertainty arises from a lack of information about future changes and spreads uniformly across ventures in the same industry (Miller & Shamsie, 1999). Perceived effect uncertainty, however, is context-dependent and contingent on the project manager’s analytical and creative capabilities of realizing cause–effect relationships (Aragon-Correa & Sharma, 2003). Perceived response uncertainty is related to the level of confidence of project managers in making decisive decisions with almost predictable outcomes (Lewis & Harvey, 2001; Milliken, 1990; Ashill & Jobber, 2009; Ashill & Jobber, 2014). The inability to distinguish between these three types of uncertainties may lead to inconsistent and noncumulative research findings (Ashill & Jobber, 2009; Miller & Shamsie, 1999; Doty, Bhattacharya, Wheatley, & Sutcliffe, 2006).

**Project Performance**

In uncertain environments, the performance of a project is the primary concern of project managers (Liu & Deng, 2015; Yazici, 2009). The project manager must balance tightening available budgets, time constraints, and quality requirements to meet a unique acceptable performance level (Aubry, 2015; Landoni & Corti, 2011). Ignoring one or the other may lead to project failure. The measurement items that have been used frequently by researchers to determine the performance of IT-related projects are project efficiency; the quantity in terms of both the amount produced and adherence to budget constraints; project effectiveness; the quality of work produced, and meeting project objectives and project timeliness, that is, undertaking tasks in a time-efficient manner and launching the project on time (Henderson & Lee, 1992; Liu, Chen, Chen, & Sheu, 2011).

Electronic commerce projects have always carried great risk and uncertainty (Bergendahl, 2005), which makes it difficult to predict their exact completion time. These uncertainties arise from many sources, such as unexpected problems in the underlying project hardware, programming languages, internet connection, database technologies, system software, and customer acceptance (Jahanshahi, Zhang, & Brem, 2013). The uncertainty inherent in electronic commerce investments results in the need for special strategies that provide adequate flexibility. Please see Figure 1 for a theoretical model of antecedents and consequences of real options reasoning in electronic commerce projects.

**Research Hypotheses**

According to Upper Echelons Theory, organizations are reflections of their top management teams (Hambrick & Mason, 1984). The main idea behind this theory is that there is a direct relationship among top management cognition (how they perceive and interpret the environmental changes), their strategic choices, and the resultant performance outcomes (Finkelstein & Hambrick, 1990). Following this theory, we propose that the project manager’s perception of environmental uncertainty will explain the variance in real options usage in organizations (strategic choices) and subsequent project performance.

The rationale behind our arguments is based on two reasons. First, firms in the same industry experience environmental state uncertainty almost equally (Miller & Shamsie, 1999), yet they perceive environmental effect and response uncertainty differently (Ashill & Jobber, 2009; Ashill & Jobber, 2014; Lewis & Harvey, 2001; Milliken, 1990). One organization may see environmental changes as a significant threat and consider itself subject to a sharp effect uncertainty; simultaneously, the other organization may not see such a state. In this line of research, Miller and Shamsie (1999) showed that under a condition of high state uncertainty, firms prefer diversity; under effect and response uncertainty, they prefer simplicity in their strategic choices. It seems that differences in view, capability, or resources may yield to different reactions to unforeseen changes in the same situation. Second, the natures and sources of these three types of uncertainty are extremely
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It is a well-accepted statement in the real options literature that higher uncertainty in the business environment increases the value of real options (Dixit & Pindyck, 1994; Driouchi, Leseure, & Bennett, 2009; Driouchi & Bennett, 2012). Project managers can be more certain about their strategic choices and actions in highly uncertain conditions when they have multiple alternatives (Eisenhardt, 1999). The possibility of investing in multiple stages, for example, gives project managers an opportunity to start a project with a minimum level of risk of losing. At a later date, when enough information about different aspects of the market is obtained, project managers will be in a better position to either scale investment or switch to another project. The project manager uses a greater number of real options because a flexible strategy such as real options increases the number of choices available to project managers and allows them to face upcoming environmental uncertainty more effectively (Podoyntisyna et al., 2013).

State uncertainty mainly arises from the lack of critical information about unexpected changes in key trends and events (Miller & Shamsie, 1999). In electronic commerce investments, these key events are unpredictable as to which technology will emerge to dominate the industry (Tegarden, Hatfield, & Echols, 1999); volatility in competitors’ propensity to introduce new electronic services to the market (Ashill & Jobber, 2009); and lack of information about customer acceptance. Making a significant investment without knowing enough about these issues may eventually reduce the chance of project success. Thus, firms need to opt for a behavior or strategy that maximizes the receipt of novel information about project usefulness, customer acceptance, and market changes.

Generally, higher environmental uncertainty necessitates higher flexibility in investment decisions (Gerwin, 1993; Song, Makhija, & Kim, 2015). By buying time through real options, project managers can repeatedly quest for novel information about the market and the business environment (Mittendorf, 2004; Ziedonis, 2014). Using the updated information, project managers are able to change the project’s course of action if the information is unfavorable (Huchzermeier & Loch, 2001). Thus, one way to face state uncertainty is using the wait-and-see strategy to gain a better understanding of the different unknown aspects of changes in the market (Sirmon, Hitt, & Ireland, 2007). In this regard, in the first hypothesis, we predict that the perception of high environmental state uncertainty increases the tendency of project managers to create and exercise a greater number of real options. Thus, we propose that:

\[ H1: \text{The higher the state uncertainty perceived by a project manager, the higher the use of real options reasoning in electronic commerce projects.} \]

In the second hypothesis, we suggest that when project managers are subjected to high environmental effect uncertainty, they may be more prone to creating multiple types of real options. A project manager with enough analytical capability and skills to evaluate the likely effects of key trends and events/changes in the environment on their projects will pay less attention to real options because he or she is in the position to complete all stages of the project.
as quickly as possible (Iansiti, 1995). In contrast, the lower predictability of the effects of changes forces project managers to spend enough time and resources to analyze the project outcome from different perspectives.

Real options allow firms to make a small initial investment at an early stage (Majd & Pindyck, 1987). This initial investment is more appealing under conditions of effect uncertainty. Through this incremental investment, project managers may have the chance to learn about different facets of the market and the environment before making a significant commitment. They also have the possibility of expanding the investment if they receive favorable information over time or switch to another project if unfavorable information is received. Thus, similar to our first hypothesis we propose that:

**H2:** The higher the effect uncertainty is perceived by the project manager, the greater the use of real options reasoning in electronic commerce projects.

Increased ambiguity about decision outcomes leads to increased inertia in firms’ investing decisions (Illeditsch, 2011). In the context of action, perceived state uncertainty stimulates the frequency of need for action (McMullen & Shepherd, 2006), and response uncertainty represents the most impactful impediment to individuals’ decisions to act (McKelvie, Haynie, & Gustavsson, 2011). Furthermore, perceived response uncertainty complicates the administration and use of existing capabilities and resources to pursue proactive strategies, such as creating a portfolio of real options (Aragón-Correa & Sharma, 2003). In addition, when managers experience high levels of ambiguity with regard to the consequences of each response option, the diversity in decision options is dramatically reduced (Miller & Shamsie, 1999). Creating a greater number of real options complicates the prediction of the consequence of each decision option. Managers may prefer to concentrate on available options. A project manager cannot be expected to exercise a growth option, for example, when he or she is unable to predict the expected outcome of such a decision to a satisfactory extent. Because project managers are not highly sure about their decisions, they may prefer to focus on existing projects rather than creating multiple types of real options. Thus, we hypothesize that:

**H3:** The higher the perceived response uncertainty by the project manager, the less the use of real options reasoning in electronic commerce projects.

A real options reasoning embodies defensive possibilities (for example, delay, defer, and abandon), as well as proactive possibilities (for example, unlocking, switch use, and scale (Driouchi & Bennett, 2012). This gives project managers an excellent opportunity to take some flexible actions in the future without any obligation. In order to reduce environmental uncertainty, project managers should spend some time learning more about a given situation before taking a specific action. They may rely highly on defensive and conservative real options (for example, delay, defer, and abandon options), which, in turn, may create constraints that make it particularly difficult to complete an electronic commerce project in a timely manner. Thus, we propose that:

**H4:** The higher the usage of real options reasoning by project managers will be negatively related to project timeliness.

Through real options, project managers are able to postpone a given commitment (hold and phasing options) until a substantial portion of environmental uncertainty has been resolved by the passage of time or by receipt of updated information (Adner & Levinthal, 2004a). The quality of work produced should be higher when project managers are not under pressure to continue to commit resources without enough understanding of the outcome. Informed decisions and actions by the project manager could make a big difference.

Overall, investment based on real options gives project managers not only enough time to search for new information from the market and environment (McGrath & Nerkar, 2004; Janney & Dess, 2004), it also creates an excellent opportunity for them to appropriately exploit their resources in order to meet project objectives. Thus, we suggest that the higher usage of real options reasoning by project managers helps meet project objectives more effectively:

**H5:** The higher usage of real options reasoning by project managers will be positively related to project effectiveness.

In the last hypothesis we predict that the higher usage of real options reasoning by project managers will enhance project efficiency. Project efficiency includes quantity in terms of both the amount produced and adherence to budget constraints (Peters & Karren, 2009). Real options reasoning provides a dynamic framework for project managers to modify their tangible and intangible resources in accordance with market, technology, and environmental changes without strict guidelines.

Furthermore, decreasing the number of available scenarios for a given investment (by creating fewer real options) puts firms in inflexible positions, and firms are forced to continue the project even if they are hesitant about its outcome. This may reduce the possibility that a firm elects to exercise only those options that are “in the money” and allows the remainder of the options to expire (McGrath & Nerkar, 2004). Thus:

**H6:** The higher usage of real options reasoning by project managers will be positively related to project efficiency.

**Methodology**

**Sample and Data Collection**

Our study sample comprises 377 new technology ventures (NTVs) in Iran. We
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drew the sample from the Science & Technology Parks database, the most comprehensive database on technology ventures in Iran. Iranian new technology ventures provide the ideal context for this study owing to their extraordinarily high level of environmental uncertainty. The environmental uncertainty in Iran was particularly high during our study period owing to sanctions and policy volatility (due, in part, to sanctions). These sanctions and volatilities greatly increase environmental uncertainties, including (1) financial uncertainty, such as fluctuation in currency; (2) market demand uncertainty affecting the export of products and services; and (3) supply uncertainty, such as the availability of critical raw materials due to trade embargoes. Although all of these uncertainties affect new technology ventures operating in Iran, new technology ventures perceive these environmental uncertainties to varying degrees and have different perceptions about how they may affect their venture and what they should do to deal with said uncertainties.

In order to collect data, first we asked respondents whether they had recently undertaken (or completed) electronic commerce projects. We identified 126 project managers (126 of 377 new technology ventures) who have been involved in electronic commerce investments in the past year and were willing to participate in our study. The sampling frame comprises a wide range of industry segments, including electronics (28%), computer equipment (23%), chemicals (16%), telecommunications equipment (10%), pharmaceuticals and medicines (9%), agriculture (7%), and others (7%).

The measurement items were translated into Persian using the double-back-translation method to ensure accuracy (Brislin, 1970). In doing so, first we hired two independent expert translators to translate the items into Persian and asked two bilingual strategic management professors to translate it back into English. Second, we conducted a meeting with the individuals who were involved in the translation process (we conducted a meeting with the four translators) to compare the original items with the translated ones to check for conceptual equivalence. Third, to ensure face validity of the scales and confirm appropriateness of the questionnaire, we conducted five in-depth interviews with project managers in new technology ventures, wherein we asked them to identify ambiguity and wording format. These project managers were asked to first complete the survey and then provide detailed feedback. To refine the questionnaire measures, a pre-test study with ten project managers (not included in the main sample) was conducted using our Persian survey. To enhance the clarity of questions, we asked the respondents to review the items carefully. Any confusing words were revised before we began launching the questionnaire.

We collected data in three different phases. First, telephone notifications were executed before the initial mailing to identify key informants, verify mailing addresses, and solicit cooperation. In the second step, we sent surveys with independent and control variables in mid-2013. We addressed the survey strictly to the project managers. In order to increase the response rate, after three weeks of initial distribution, we made telephone calls and requested those from whom we had not yet received feedback to complete and return the survey. Finally, in the first wave of data collection, 114 usable survey responses were received, resulting in a response rate of 41%. Given that the average project duration was 11 months, approximately one year later, we distributed our second survey containing dependent variables to the same ventures and managers (one new technology venture had ceased operations). In this phase, we received 110 completed surveys.

We checked for the non-response bias effect in our findings. It was assumed that late respondents were more similar to non-respondents than to early respondents. By using the time trend extrapolation test (Armstrong & Overton, 1977), we compared the early respondents (first 25%) with the late respondents (late 25%). This test provided evidence that the data are not subject to non-response bias.

Furthermore, the Harman one-factor test was conducted to check for common method variance; no single factor emerged nor did a single factor account for the majority of the variance (Podsakoff, 1986). In addition, we sent the project performance items to the firms’ CEOs. Eventually, we received 22 responses from CEOs. The comparison of both groups of respondents (project managers versus CEOs) showed a high and statistically significant correlation. The correlation of respondents for project timeline was 0.818, for project efficiency 0.884, and for project effectiveness 0.864 (p < 0.001), respectively. A strong correlation between the two responses indicates that the original assessments are not susceptible to bias (James, Demaree, & Wolf, 1984).

The average new technology venture age was 8.21 years (S.D. = 3.15), the average number of employees was 57 (S.D. = 32.31), the average project team size was 8.16 (S.D. = 4.11), and the average project duration was 10.99 months (S.D. = 4.57).

Measurement

**Project Performance**

In the present research, electronic commerce project timeline, effectiveness, and efficiency were measured in terms of nine items adopted from Henderson and Lee (1992). Cronbach’s alpha values of project timeline, effectiveness, and efficiency were 0.940, 0.868, and 0.887, respectively.

**Real Options Reasoning**

In the present study, we focus our analysis on the project level rather than the firm level. The independent variable that we included in the study is real options reasoning. We used 19 items (α = 0.97) to measure the existence...
of real options reasoning in electronic commerce investment based on the works of Tiwana et al. (2007). All 19 items were loaded onto one factor, so we used real options aggregately in our modeling.

**Perceived Environmental Uncertainty**

We assessed perceived state ($\alpha = 0.89$), effect ($\alpha = 0.79$), and response ($\alpha = 0.82$) uncertainties using nine items (Ashill & Jobber, 2009). Examples of items include: “You have the information to understand how your business environment will change in the future” (state uncertainty); “You fully understand the effect of the environment factor on your decision making” (effect uncertainty); and “You can accurately anticipate the consequences/outcomes of decisions before implementing them” (response uncertainty) (Ashill & Jobber, 2009). In the current study, multi-item Likert scales were used to measure the dependent and independent constructs (see the Appendix for items and factor loading).

**Control Variables**

Some variables not considered in the hypotheses are presented herein, and these variables may still influence real options reasoning and project performance. At the individual level, we controlled project manager age, education, and gender. At the firm level, we controlled new technology venture size (logarithm of number of employees) and age (logarithm of years of operation). At the project level, we controlled project net present value (NPV), team size (logarithm of number of individuals involved in the project), complexity, duration (logarithm of number of months required for project completion), and direct responsibility of project managers (whether respondent had direct personal responsibility for initiating the project). All project level control variables were adapted from Tiwana et al. (2007).

**Results**

In Table 1, we summarize the descriptive statistics and correlations of all variables in the study. To test the hypothesized relationships meaningfully, it was first necessary to establish that the types of uncertainty were, in fact, differentiable. An exploratory factor analysis (EFA) revealed that the factors grouped themselves according to the theory (Kaiser-Meyer-Olkin = 0.932; Bartlett’s = 0.000).

To reduce the threat of multicollinearity, dependent variables were centered before conducting regression analyses. In addition, we checked variance inflation factors (VIF) to exclude multicollinearity. The results of VIF testing of all our variables were significantly below 5, suggesting that our model of study did not have a serious multicollinearity problem (Cohen, Cohen, West, & Aiken, 2013).

To test the study hypotheses, we performed a hierarchical multiple regression analysis. In the first step, we entered the control variables with real options reasoning as dependent variables. In the second step of each regression equation, we entered the independent variables (state, effect, and response uncertainty).

As summarized in Table 2 and Figure 2, the perceived environmental response uncertainty is significantly negatively related to real options reasoning ($B = -0.503, p < 0.01$). Hypothesis 3 was fully supported by our results. This means that under higher environmental response uncertainty, project managers prefer to consider fewer real options.

The fourth hypothesis predicted that real options reasoning would be negatively associated with project timeliness. As predicted, our results demonstrated that higher usage of real options reasoning decreases the project timeliness ($B = -0.632; p < 0.001$). Thus, Hypothesis 4 was supported by our results.

Hypothesis 5 proposed that real options reasoning would be positively associated with project effectiveness. As predicted, our results confirmed that the higher usage of real options reasoning leads to higher project effectiveness ($B = 0.393; p < 0.001$). Hypothesis 5 was fully supported. And finally, consistent with Hypothesis 6, we found that real options reasoning significantly and positively relates to project efficiency ($B = 0.393; p < 0.001$).

Among the control variables, surprisingly, education was negatively related to project timeliness ($B = -0.389; p < 0.05$) and positively related to project effectiveness ($B = 0.434; p < 0.05$) and efficiency ($B = 0.381; p < 0.05$). Consistent with the argument of Tiwana, Wang, Keil, and Ahuwalia (2007), we found a negative relationship between project net present value (NPV) and the usage of real options ($B = -0.376; p < 0.001$). This means that project managers associate real options reasoning with perceived project value in e-commerce projects with low NPV.
Table 1: Descriptive statistics and correlations.

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<td>0.14</td>
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<td>0.622**</td>
<td>-0.689**</td>
<td>0.630**</td>
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**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).
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<th>Real Options Reasoning</th>
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<th>Main Effects</th>
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<td>Adj. R²</td>
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<td>F</td>
<td>4.206***</td>
<td>7.832***</td>
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+ p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001

Table 2: Regression analysis with real options reasoning as criterion variable.

<table>
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<tr>
<th>Project Timeliness</th>
<th>Project Effectiveness</th>
<th>Project Efficiency</th>
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<tr>
<td>Control Variables</td>
<td>Main Effects</td>
<td>Control Variables</td>
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<td>Net Present Value</td>
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<td>Real Options Reasoning</td>
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<td>0.393***</td>
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<tr>
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<td>Adj. R²</td>
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<td>F</td>
<td>5.232***</td>
<td>10.319***</td>
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</table>

*p < 0.05; **p < 0.01; ***p < 0.001; 1p < 0.10

Table 3: Regression analysis with project timeliness, effectiveness, and efficiency as criterion variables.
Discussion

Despite the growing recognition of the importance of real options reasoning, little is known about the major antecedents and consequences of this phenomenon on the project level. Our research addresses this gap by focusing on the relationship between the perception of environmental uncertainty and real options reasoning and the resultant project performance. In support of our expectations, the results indicate that:

1. The perception of state increases and the perception of response uncertainty decreases project managers’ tendency to consider real options in electronic commerce projects. Under conditions of response uncertainty, the accepted tenet of greater uncertainty leading to more real options reasoning usage is not valid. In fact, under response uncertainty conditions, project managers would reduce their real options reasoning usage.

2. The use of greater numbers of real options decreases project timeliness.

3. The use of greater real options increases project effectiveness and efficiency.

4. In contrast to our prediction, we didn’t find a significant relationship between perceived effect uncertainty and real options reasoning.

The findings of our study challenge a common belief in the context of real options literature, which is “the higher the uncertainty, the greater is the real options usage.” Higher or lower use of real options in investment decisions is contingent on the type of uncertainty faced by a project manager. The result of this study reveals that when project managers are less certain about the outcomes of their decisions (response uncertainty) they prefer to use fewer real options. They use greater numbers of real options when they are faced with an unpredictable environment (state uncertainty).

Although real options reasoning is widely considered a promising line of research (Trigeorgis, 1996; Zardkoohi, 2004) with important practical implications (Fichman, 2004), its actual use at the project level has not been smooth (Adner & Levinthal, 2004b; Barnett, 2008). The possible reasons for this are varied, such as the impact of differing managerial perceptions of option-based decisions and difficulty in managing abandonment options (Adner & Levinthal, 2004a; Adner & Levinthal, 2004b). Our research extends the real options literature by empirically testing real options in electronic commerce investments, a context that presents high levels of uncertainty to project managers and drives much of the competitive activity in the current economy.

However, our work highlights that the application of real options reasoning does not always enhance project performance under conditions of higher uncertainty. Greater use of real options is essential to meeting project efficiency and effectiveness, but it decreases project timeliness. Moreover, when project managers use fewer real options, it may reduce the quality of the work produced and affects the completion of electronic commerce project objectives, yet it helps to complete the project in a time-efficient manner.

The findings of this study are worthwhile because they emphasize the need to treat environmental uncertainty as a distinct set of constructs as opposed to a unidimensional concept (Sutcliffe & Zaheer, 1998). Previous empirical studies on real options reasoning and investment decisions (Fichman et al., 2005; Tiwana et al., 2007) have partially neglected the important roles of different types of perceived uncertainties on real options reasoning decision endeavors and efforts. This fact is insofar surprising that the different types of uncertainties may have distinct effects on real options reasoning based decisions.

Anchored in the Upper Echelons Theory (Hambrick & Mason, 1984; Hambrick, 2005; Carpenter, Geletkanycz, & Sanders, 2004), the results of this study provide a clearer picture of the
general relationship among top managers’ perceptions, their actions, and the subsequent outcomes than was previously available. Furthermore, we advanced the current understanding of how Upper Echelons Theory applies in non-western contexts (Hambrick, 2007).

Even though it is not part of our main hypotheses, we found a negative relationship between the net present values of projects and real options reasoning. This finding is in line with Tiwana et al. (2007), who showed that project managers are less likely to use real options reasoning when they estimate the net present value of a project to be high. Our finding is in contrast with the Bowman and Moskowitz (2001) argument, which asserts that investments in based real options reasoning make economic sense only when the value of the option exceeds the cost of the option.

An important implication of the findings of the present study is that project managers in new technology ventures need to clearly prioritize their objectives for each electronic commerce project so that they can adopt the appropriate strategy to facilitate the achievement of their objectives. If project time efficiency is the main goal under the condition of uncertainty, for example, our findings reveal that project managers need to create and exercise fewer real options. In contrast, under such a condition, if the priority of project managers is to produce high quality work that ensures the satisfaction of project objectives, the greater use of real options is suitable.

Limitations and Directions for Future Research

Our work has some limitations. Because our project performance measures are subjective and we are unable to prove that the perceptual measure of study is a valid predictor of more “objective” project performance measures, one could argue that different results might be obtained for other project performance measures. Thus, future work in the context of project performance may include more objective project performance measures to provide confidence in their robustness. Our results concern young and high technology based ventures, which may limit their applicability to other sectors. It might be worthwhile to consider firms in low-technology environments and older firms to reinforce the generalizability of our findings. Finally, national culture is an influential factor in risk and uncertainty perception (Weber & Hsee, 1998), which was not assessed herein. Iranian culture exhibits a high preference for avoiding uncertainty. This feature makes it difficult to generalize our findings disregarding of cultural background. The research results could be generalized into other national cultures via cross-cultural comparisons in future studies.

References


Does Real Options Reasoning Support or Oppose Project Performance?


Does Real Options Reasoning Support or Oppose Project Performance?


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Appendix: Construct measures.

<table>
<thead>
<tr>
<th>Construct Category</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived environmental state uncertainty</strong> (Adapted from Ashill and Jobber, 2009)</td>
<td></td>
</tr>
<tr>
<td>How often do you feel and believe that:</td>
<td></td>
</tr>
<tr>
<td>• You have the information to understand how your business environment will change in the future.</td>
<td>0.674</td>
</tr>
<tr>
<td>• Your information about your business environment is adequate for your decision making.</td>
<td>0.859</td>
</tr>
<tr>
<td>• You are unable to get the necessary information about your business environment for your decision making (R)</td>
<td>0.773</td>
</tr>
<tr>
<td><strong>Perceived environmental effect uncertainty</strong> (Adapted from Ashill and Jobber, 2009)</td>
<td></td>
</tr>
<tr>
<td>How often do you feel and believe that:</td>
<td></td>
</tr>
<tr>
<td>• You are unable to predict the impact of your business environment on your project (R)</td>
<td>0.538</td>
</tr>
<tr>
<td>• You fully understand the effect of the environment factor on your decision making.</td>
<td>0.887</td>
</tr>
<tr>
<td>• Please indicate your “sureness” (level of certainty) as to how each environmental factor affects your decision making? (Not at all sure about how it will affect my decision making/ completamente sure about how it will affect my decision making).</td>
<td>0.825</td>
</tr>
<tr>
<td><strong>Perceived environmental response uncertainty</strong> (Adapted from Ashill and Jobber, 2009)</td>
<td></td>
</tr>
<tr>
<td>How often do you feel and believe that:</td>
<td></td>
</tr>
<tr>
<td>• You can accurately anticipate the consequences/outcomes of making decisions before making them.</td>
<td>0.618</td>
</tr>
<tr>
<td>• You know how to respond to changes in the external environment.</td>
<td>0.767</td>
</tr>
<tr>
<td>• You are able to determine what the response options should be in light of changes in the external environment.</td>
<td>0.666</td>
</tr>
<tr>
<td><strong>Real options reasoning</strong> (Adapted from Tiwana et al., 2007)</td>
<td></td>
</tr>
<tr>
<td>For our organization, this project is:</td>
<td></td>
</tr>
<tr>
<td>• Necessary for unlocking future project opportunities</td>
<td>0.683</td>
</tr>
<tr>
<td>• Necessary for developing future capabilities</td>
<td>0.784</td>
</tr>
<tr>
<td>• First in a chain of interrelated follow-on projects in the future</td>
<td>0.83</td>
</tr>
<tr>
<td>This project could be easily:</td>
<td></td>
</tr>
<tr>
<td>• Funded incrementally in stages</td>
<td>0.767</td>
</tr>
<tr>
<td>• Managed in incremental stages</td>
<td>0.86</td>
</tr>
<tr>
<td>• Completed as a series of smaller projects</td>
<td>0.769</td>
</tr>
<tr>
<td>• Decomposed into smaller independent sub-projects</td>
<td>0.859</td>
</tr>
<tr>
<td>This project could easily:</td>
<td></td>
</tr>
<tr>
<td>• Use a set of different resources (e.g., new technologies, new suppliers) to produce the same product</td>
<td>0.872</td>
</tr>
<tr>
<td>• Be reconfigured to produce different products to satisfy emerging market needs</td>
<td>0.788</td>
</tr>
<tr>
<td>• Serve a different strategic purpose</td>
<td>0.874</td>
</tr>
<tr>
<td>It would be very easy to expand or contract the following resources initially allocated to this project</td>
<td></td>
</tr>
<tr>
<td>• Budget</td>
<td>0.894</td>
</tr>
<tr>
<td>• Personnel</td>
<td>0.886</td>
</tr>
<tr>
<td>• Other resources</td>
<td>0.851</td>
</tr>
<tr>
<td>If this project were postponed by two years</td>
<td></td>
</tr>
<tr>
<td>• Project requirements would be clearer</td>
<td>0.882</td>
</tr>
<tr>
<td>• Many technical uncertainties would be resolved</td>
<td>0.877</td>
</tr>
<tr>
<td>• Uncertainty around the business model would be reduced</td>
<td>0.867</td>
</tr>
<tr>
<td>To what extent could the following resources be put to other uses if this project were abandoned prior to completion?</td>
<td></td>
</tr>
<tr>
<td>• Allocated budget</td>
<td>0.894</td>
</tr>
<tr>
<td>• Personnel</td>
<td>0.882</td>
</tr>
<tr>
<td>• Other resources</td>
<td>0.867</td>
</tr>
</tbody>
</table>

(continued)
Does Real Options Reasoning Support or Oppose Project Performance?

<table>
<thead>
<tr>
<th>Factor</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Timeliness</strong> (Adapted from Henderson and Lee, 1992)</td>
<td></td>
</tr>
<tr>
<td>• The team’s adherence to schedules</td>
<td>0.762</td>
</tr>
<tr>
<td>• The speed at which the team did its work given the level of quality</td>
<td>0.81</td>
</tr>
<tr>
<td>• The team’s ability to meet the goals as quickly as possible</td>
<td>0.773</td>
</tr>
<tr>
<td><strong>Project Efficiency</strong> (Adapted from Henderson and Lee, 1992)</td>
<td></td>
</tr>
<tr>
<td>• The efficiency of team operations</td>
<td>0.785</td>
</tr>
<tr>
<td>• The team’s adherence to budgets</td>
<td>0.806</td>
</tr>
<tr>
<td>• The amount of work the team produces</td>
<td>0.682</td>
</tr>
<tr>
<td><strong>Project Effectiveness</strong> (Adapted from Henderson and Lee, 1992)</td>
<td></td>
</tr>
<tr>
<td>• The quality of work the team produces</td>
<td>0.653</td>
</tr>
<tr>
<td>• The effectiveness of the team’s interactions with people outside the team</td>
<td>0.892</td>
</tr>
<tr>
<td>• The team’s ability to meet the goals of the project</td>
<td>0.742</td>
</tr>
</tbody>
</table>
The Nature of Risk in Complex Projects

Terry Williams, Risk Institute, University of Hull, Hull, United Kingdom

ABSTRACT

Risk analysis is important for complex projects; however, systemicity makes evaluating risk in real projects difficult. Looking at the causal structure of risks is a start, but causal chains need to include management actions, the motivations of project actors, and socio-political project complexities as well as intra-connectedness and feedback. Common practice based upon decomposition-type methods is often shown to point to the wrong risks. A complexity structure is used to identify systemicity and draws lessons about key risks. We describe how to analyze the systemic nature of risk and how the contractor and client can understand the ramifications of their actions.

KEYWORDS: complexity; systems thinking; risk; project risk analysis; mapping

INTRODUCTION

Business is becoming increasingly projectized or project oriented, with many billions of dollars being spent annually on projects around the world. Building new capital assets, carrying out unique large-scale enterprises, or developing new technological products, all require major projects to be undertaken. The benefits of projectization and a good approach to project management can clearly be seen in many ways: these include motivation, satisfaction, and giving meaning to the work of individuals and teams (Thomas & Mullaly, 2008). However, the reputation of project management with most people is that it is generally unsuccessful, with projects being late, overspent, and often not technically successful. The media delights in reporting on large public construction projects that have suffered huge cost or time overruns, such as the United Kingdom's Scottish Parliament ("10 times over budget and more than three years late," Tempest, 2004), or a healthcare project in the United Kingdom with "much uncertainty about the costs . . . unlikely to complete . . . anywhere near its original schedule." (House of Commons, 2007)

This article concentrates on complex projects, because the effects of risks within such projects are difficult to understand without analysis. We use the well-known Simon (1982) description of a complex system being one in which the behavior of the whole is difficult to deduce from understanding the inputs to the system. Thus, in a complex project, understanding what is likely to impact the project does not lead simply to an understanding of what that impact might be. We therefore use a structured approach to project complexity to help identify where the risks are occurring.

Although this article concentrates on complex projects, it does not imply that the uncertainties facing “complex” projects are any greater than those impacting any other type of project. Rather, these uncertainties are likely to be more interconnected, likely to change, there will need to be reactions within a highly paced project, or there will be socio-political risks whose effects are uncertain. This mixture will create a project risk that is difficult to comprehend in its totality, whose key uncertainties are difficult to detect, and for which risks are likely to compound and cause an overall greater risk picture.

Study has advanced in understanding complexity in projects (Geraldi, Maylor, & Williams, 2011) and has enabled a transactional-cost understanding of behavior within a project (Brown, Potoski, & Slyke, 2016). This work, and the study of the behavior of particular projects, has led to the realization that the consideration of risk before a project starts, and particularly the common practices in project risk analysis, are woefully inadequate for complex projects. Indeed, common practices can sometimes divert attention away from the key risks to less important ones. Understanding comes from looking at the lived experience of projects (Cicmil, Williams, Thomas, & Hodgson, 2006) along the lines of Blomquist, Hällgren, Nilsson, and Söderholm’s (2010) project-as-practice research.
Risks set up causal chains, often involving human motivational reactions to events and decision making by the project parties. The problems are significantly exacerbated when these chains lead to positive feedback loops. Furthermore, understanding the behavior of such projects therefore becomes difficult, taking away the rational basis for decision making by the project parties that Brown et al. (2016) assumes. The risks discussed in this article are known within the project and information systems literature, and this literature already considers both residual risks and unintended consequences. However, this article shows the lack of consideration to some of the ramifications of such risks, specifically the risks that enlarge rather than mitigate through actions. Such issues will often overwhelm in size the issues described in project risk management practice and literature. These issues, therefore, need attention if the credibility of project risk management is to be salvaged and indeed the credibility of our ability to set up and manage complex projects.

This article will look at the idea of systemicity in complex projects to identify the issue and will review the current risk management thinking and practice to identify the gap. It will then follow Geraldi et al.’s article to look at the implications of complexity, and how unexpected risks can become more significant within a project.

**Projects and Systemicity**

A conventional view of projects breaks them down into their constituent parts—in scope (work breakdown structure), time (critical path networks), cost (budgets), risk (risk registers), and so on. (In some of the other aspects, there has been more progress in looking holistically, but risk work still generally revolves around decomposition into individual parts). This, however, is inadequate for complex projects, as defined by Simon earlier.

There has been recognition in the literature that risks can be inter-related. Dating back to 1990, Al-Bahar and Crandall (1990) recognized the systemic structure of risks, which was continued by Williams, Ackermann, and Eden (1997) and, more recently, by Kwan and Leung (2011) for software risks and Fang, Marle, and Zio (2012) for engineering projects. Nevertheless, these are still largely single risks, recognized by standard risk identification techniques, which are then sometimes taken to be in a systemic relationship. Cavallo and Ireland (2014) working in a different field (disaster preparedness) start to consider what they call “unforeseeable risks”; they use Soft Systems Methodology (SSM) to understand the underlying system of risks. In this article, we will consider the “softer” human and socio-economic causal relationships that link these risks and approach the risks as a systemic whole.

Over the past 30 years, our view of the behavior of complex projects has developed in many ways, in particular, in the use of systemic modeling. This began with Cooper’s work on the Ingalls Shipbuilding case (Cooper, 1980) and continued with others at PA Consulting/MIT. A second team at Strathclyde University (of which this author was a member) started with the Channel Tunnel “Shuttle Wagons” project (Ackermann, Eden, & Williams, 1997) by using mapping to structure causality and providing an interface with System Dynamics quantitative modeling (Howick, Eden, Ackermann, & Williams, 2008). A review of this body of work (Williams, 2005) and its implications showed not only that project behavior could be explained by systemic inter-related sets of causal factors rather than linking effects to single causes but, specifically, behavior (resulting from the dynamics set up) that turned into positive feedback loops, or ‘vicious circles.’ This positive feedback can cause significant over-spend and “runaway.” The Shuttle Wagons project, for example, had a specific major change following a fire, and continuous (multiple, small) approval delays, leading to a structure such as that shown in Figure 1. In this very simplified illustrative diagram, we can see some simple positive feedback loops initiated by the delays caused by design changes and delays in owner approvals and linked to the very tight timescale. The delays led to activities being carried out more in parallel than would be appropriate in engineering terms, leading both to more delays (in a feedback loop) and also to a delay in the overall system freeze. These, in turn, mean that more work needs to be done without the necessary surrounding engineering information completed and frozen. Further, while some of this work will remain sound, some will need to be re-worked, hence exacerbating the delays and increasing the positive feedback. Lyneis and Ford (2007) provided a survey of the use of System Dynamics in modeling projects.

The idea that issues within projects arise from systemic causal sets of reasons is gaining increasing recognition (some recently described by Lefle and Loch, 2010). Keil and Mähring (2010) identified a key problem of project escalation as seeing problems as isolated incidents, so that a piecemeal approach to solving the problems is ineffective because this approach does not get to the “underlying root causes of problems.” They identified many fine strategies without identifying the underlying systemicity and vicious-circle nature of the problems addressed. Merrow, basing his comments on the analysis of his large database of megaprojects, stated:

“In projects, bad things tend to happen in groups, not individually . . . . Events that affect projects in major ways . . . tend to go together. Even when one of those things occurs individually, it tends to trigger a cascade of problematic effects.” (Merrow, 2011, p. 327)

Similarly, Thamhain stated:

“Undesirable events (contingencies) are often caused by a multitude of problems . . . these problems often cascade, compound, and become intricately linked . . . clearly even small and anticipated contingencies . . . can lead to issues with other groups, confusion, organizational conflict, sinking team spirit, and fading commitment.” (Thamhain, 2013, p. 29)
Thamhein emphasized the importance of dealing with these risks early in the project life cycle; however, he also acknowledged the "enormous difficulties" of actually predicting the risk situations and understanding their systemic complexity. He also noted that senior managers rated the performance impact of risks, on average, to be 30% lower than project managers did—possibly showing the higher expectations of the project manager to manage perturbations and perhaps also revealing less understanding of the cascading nature of project risks.

**Current Risk Management Thinking and Practice**

In this environment of complex projects, how are risks identified and managed in practice? We use the term “risk” here in the typical sense as relating to any uncertainty that has an effect on a project. We are not trying to look for definitional distinctions, but recognize two essential points. First, uncertainties are a collection of both aleatoric (i.e., those to which probabilities can be objectively related) and epistemic (i.e., those stemming from a lack of sufficient knowledge) with many combining both aspects (Williams & Samset, 2010). Second, risks might include “good” opportunities as well as downside risks.

Risk management has become a core part of project initiation and execution since its formal recognition in projects in the 1980s. However, the methods used in practice still reflect the early reliance on lists (or “risk registers”) of individual risk items (Williams, 1994). The Project Management Institute’s *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* - Fifth Edition (2013) (which is an ANSI standard) in its latest version makes brief mentions of the existence of methods to deal with interrelatedness. In the United Kingdom, the Association for Project Management’s *Project Risk Analysis and Management Guide* (2004) has an appendix on the issue but later publications, including their guide on *Prioritising Project Risks* (Association for Project Management, 2008), are clearly geared toward understanding and prioritizing individual risks. Leitch (2011) points out that ISO 31000 offers no recommendations on aggregating, splitting, or combining risks. Indeed, an influential review risk management standard in 2005 made no mention of risk combinations (Raz & Hillson, 2005). These standards do not actually prohibit more systemic thinking. However, Hodgson’s (2002) Foucauldian analysis shows how, although

![Figure 1: Generic delays in the Shuttle project.](image-url)
The Nature of Risk in Complex Projects

those advocating project management toolkits claim them to be “universal and politically neutral,” their actual use in practice enforced by management leads to a specific way of thinking and indeed ontology inculcated into an organization, thus actually inhibiting systemic thinking.

There is some recognition in standard methodology that comprehending overall risk is needed to achieve proper understanding. PMI’s Practice Standard for Project Risk Management (Project Management Institute, 2009) and the United Kingdom’s Association for Project Management’s (2012) Body of Knowledge have started talking about two-level definitions of risk, covering both individual risks and “overall project risk.” In general, however, project risk processes still only address the former level, and there is little advice on how to address the latter. Hopkinson’s (2011) Project Risk Maturity Model states that “achieving the highest RMM [Risk Management Maturity] level (Level 4) does depend upon the use of quantitative techniques to understand the implications of overall project risk. Using a simple qualitative approach based on managing risks on a risk-by-risk basis will therefore limit a project to having a level 3 RMM capability at best”; this, however, still only provides a passing mention in one paragraph (p. 138) to the way that complexity in projects produces systemic risks. Indeed, while cross-risk correlation is discussed, Monte Carlo schedule analysis is used without specifically modeling management activity or human reactions within the project, which is an important element in producing the systemicity. Williams (2004) shows that using Monte Carlo schedule analysis without modeling how management reacts to project events and progress provides misleading results.

The academic project literature clearly recognizes complexity within projects. Nonetheless, with the exception of those authors who were quoted in the previous section (Thamhain, 2013; Merrow, 2011), the explicit identification and analysis of risk are not typical features of the discussion, although the issues are recognized. The risk chapter of the project management “state-of-the-art” handbook by three leading academics (Winch & Maytorena, 2011) provides limited information on risk inter-relationships. The literature indeed addresses the increasing complexity and intra-connectedness of projects, yet the implications for project risk are not drawn out. For example, the chapter on project risk by Loosemore (2006) in Pryke and Smyth’s work tellingly entitled “Managing Project Risks” (in the plural), has a deeper understanding of what an individual risk represents but does not consider risk combinations and the resulting causal chains involving humans. Cooke-Davies’s (2011) edited book states that “complexity in projects probably has its greatest impact in the sphere of risk management,” although it does not provide specific advice for the practical use of the ideas in risk management. Hass’s (2009) popular book on managing complex projects describes some of the problems covered in this article, stating that “risk management is one of the most neglected aspects of managing complex projects” and suggests some useful management ideas for retaining a view of the risk systemicity. Remington and Pollack’s (2008) book seeking tools for complex projects also recognizes the issue of risk inter-dependence, and indeed includes a chapter with a technique called “Risk Interdependencies,” which goes some way in recognizing the issues but does not explore the ramified causal chains or the human elements of those causal chains. Ackermann, Howick, Quigley, Walls, and Houghton (2014) recognize and expand on some of these issues further.

Where complexity within project risk is recognized, some try to capture the complexity by the use of simple spreadsheets and questionnaires; Maylor, Turner, and Murray-Webster (2013) is one example. Similarly, Maynard (2013) looks at eight dimensions of project complexity, split further by a mind-map-type decomposition (although the first dimension, “Risks and opportunities,” shows risk as an input to complexity, rather than uncertainty being the input and risk being the resultant issue). The Treasury Board of Canada (2013) provides a similar full scoring model but, again, this model does not capture systemicity; similarly, the spreadsheet used by the Commonwealth of Virginia, with its 15 risk questions and 16 complexity questions. Perhaps the most research-based model is the GAPPS CIFTER analysis (discussed by Aitken and Crawford, 2007). These methods offer useful pointers to decision makers, and can identify broad areas of likely complexity, but they do not help us to identify, understand, or model the systemic risks of a project and the causal chains.

Given the lack of information in the standard methodologies then, does it mean that the topic of this article is unimportant? There are mixed views on the extent to which current risk management has an effect on project success. Some authors (for example, de Bakker, Boonstra, & Wortmann, 2010; Cooke-Davies, 2000) show that, not surprisingly, even some levels of attention to project risk help projects achieve their objectives. de Bakker, Boonstra, and Wortmann (2012) point to the simple identification of risks as having the most effect. Beyond this, however, the evidence about the relationship between risk management and project success is at best mixed (Zwikael & Globerson, 2006, describe it as a “low impact process”; see also, e.g., Ropponen & Lytyinen, 1997). This suggests that current methods are not convincing users of the successful handling of risk and perhaps not providing understanding of the overall risk to the project. We will now therefore try to understand in a more structured way what risk means in a complex project.

Hardy and MacGuire (2016) draw upon the work of Foucault and explore the “implications of organizations’ being situated in a dominant discourse of risk” and the difficulties of changing those
ways, even when it is known that they are ineffective. The established norms of (separate) risk identification and management risk-by-risk, undertaken by particular actors who have legitimacy to identify, quantify, and manage those risks, means that risk becomes (quoting, Gephart, Van Maanen, & Oberlechner, 2009, p. 143) “identifiable through scientific measurement and calculation, and [can] be controlled using such knowledge.” Changing this dominant discourse means “challenging the privileged position” of risk “experts” and drawing on “alternative discourses,” particularly in the case of systemic risks where causality is less clear.

The Structure of Complexity

A contingency view of projects recognizes the need to take project complexity into account. Williams (2005) calls for different ways of understanding and managing projects in situations of high structural complexity, high uncertainty, and high pace. Similarly, Shenhar’s “Diamond” model (Shenhar & Dvir, 2007) divides projects (and thus what is needed to manage them) by project (structural) complexity, pace, novelty, and technology (although this does not have the underlying basis of the systemicity reasoning as described earlier). As our guide for this article, we refer to Geraldi et al. (2011), who try to define this overall set of concepts that describe the complexity of projects according to five dimensions: structural, uncertainty, dynamics, pace, and socio-political. What then are the implications for how we regard risk?

Structural complexity implies multiple interacting elements. Where there are uncertainty and dynamics in the system, then multiple interacting risks will be present. Thus, the first straightforward implication is:

(1) Technical complexity means a system view of risk needs to be taken.

However, when the system is further disrupted by pace so that acceleration decisions need to be made, the internal socio-complexity of the project needs to be considered—in other words, the fact that projects are carried out by teams of humans. There are two key elements that need to be considered.

The first and perhaps more straightforward element is that human project managers will react to perturbations in the project. An example of this is the move to increased parallelism or working on unfrozen items as shown in Figure 1. Indeed, it is the ramifications of such actions within systemicity that means that sometimes they have apparently counter-intuitive effects (Eden, Williams, Ackermann, & Howick, 2000). This is particularly so in projects subject to high pace or high time constraints. In such projects, attempts to accelerate the project increase the parallelism and make the project even more difficult to manage and less stable, and so costs spiral out of control, making it difficult to relate project spend to individual parts of the project (Eden, Ackermann, & Williams, 2005).

More complex is that the project workforce will react to perturbations within the project. For example, there can be an increase in nugatory work, making this work less meaningful, increasing errors and, in Thamhein’s words above, there is “confusion, organizational conflict, sinking team spirit, and fading commitment.” In recent years, there has been increasing emphasis on the importance of effective experience in motivating work. Seo, Barrett, and Bartunek (2004) demonstrate the implications on goal performance of a “pleasant” core effect or, conversely, the effect of a negative emotional reaction when project events occur. Where project workers become disheartened, or fatigued, or start to make mistakes, then these effects are keys to the progress of the project. Even if these clearly identified aspects are avoided, creativity and innovation will decrease. Disruption (under high “pace”) can cause a project team to lose its “conceptual slack” and its ability to sensemake (Grabher & Thiel, 2014), and a negative mood if combined with a lack of empowerment diminishes creativity (To, Fisher, & Ashkanasy, 2015). Interpersonal conflict, within the project or with the client, damages project performance through negative emotions (Zhang & Huo, 2015).

In the back of many project workers’ minds, when there are signs that a project is not proceeding well, there is the fear of project failure (Shepherd & Car- don, 2009). Theories of human behavior, such as that by Bourdieu (1998) (see a discussion of how this can be used in the understanding of project behavior in O’Leary, 2012) can be useful in understanding the human aspects of project behavior. However, more work is needed to quantify the relationships between drivers, such as changes or conflict and outcomes such as productivity or error-rate, and the role of emotions within these relationships. Nevertheless, it is a key feature of the system modeling of projects above, that such human aspects are essential links in the causal chains that explain the behavior of projects. Thus, the second implication:

(2) The human reactions to events need to be accounted for in analyzing risk.

The fifth dimension of socio-political risk acknowledges the increasingly recognized political effects within projects. This is especially so for “softer” types of projects, such as IT-enabled change (e.g., see the analysis of the UK Government so-called “Phoenix programme” [O’Leary & Williams, 2013]). For mega-projects in particular, the (permanent) political environment within which the (temporary) projects sit becomes increasingly important to give the project, and thus the work within the project, meaning. In general, the actions of the two parties (client and contractor) within that environment can have a significant effect on projects. In the transaction-cost structure expounded by Brown et al. (2016), a key to success of a contract is whether each party acts in a “perfunctory” or “consummate” manner (the former conforms to the “letter” of the contract but has small gains for the
The Nature of Risk in Complex Projects

party but greater losses for the other side; the latter conforms to the spirit of “win-win” and has small losses for the party but greater gains for the other side). How the parties react to project events and risk outcomes has a strong effect on the project out-turn. Under conditions of complexity, this is particularly problematic, as often the ramifications of those reactions is not clear to the party undertaking them, so the party might not realize the damaging effects that it is setting up. Thus, the third implication is:

(3) The contracting parties’ reactions to events need to be accounted for in analyzing risk.

However, even these do not fully account for the complexity of risk outcomes in a project. As described above, where risks set up causal chains—which might include human motivational reactions to events and/or decision making by the project parties—these can be significantly exacerbated when these chains lead to positive feedback loops. Indeed, some systems modelers will say that the feedback system provides a good explanation of how the system will behave. That is, where the project is in homeostasis (Thurston, 2016) the project is under control, but once unwanted positive feedback loops (or “vicious circles”) are set up, the project becomes out of control. In this way, seemingly quite small risks, if they come about, can have effects that are exacerbated with ramifications far greater than the original risk. When identified, the first goal should be to consider how to “break” such loops—in other words, management actions that can remove one or more of the causal loops that form the loop (such as considering a system freeze as shown in Figure 1). Thus, the fourth implication is:

(4) Detrimental positive feedback needs to be identified in analyzing risk.

The implication therefore is that risk needs to be treated differently within complex projects. The discussion above therefore facilitates a structured understanding of why:

- Structural complexity implies multiple interacting elements; where there are uncertainty and dynamics in the system, risks will then have causal chains of ramifications, and risks will interact in multiple inter-connecting ways.
- When the system is further disrupted by pace, acceleration becomes both necessary and problematic because actions will interact with the causal chains of these ramifications.
- These interactions include socio-complexity in the causal chains of ramifications from human reactions to events.
- These causal chains can interact with ramifications from the socio-political complexity of the project environment, in particular reactions to events from the contracting parties.
- All of these ramified causal chains make the understanding of risk difficult and requires analysis; however, an extra dimension of complexity comes where these causal chains combine into detrimental positive feedback. In this way, risks collectively become a serious significant overall risk.

Key Risks in a Project
A main conclusion of this article is that the risks identified by current methods as the most important risks might not actually be the key risks in a project. When risks are identified and analyzed in a conventional risk analysis, it is those risks with the greatest direct impact, when considered on their own, that are always placed as the most important, and which thus gain the most attention of management. In a complex project, however, the ramifications of risks might be greater than the direct impacts. Examples are reviewed next, in the order as discussed above.

1. The Combination of Risks and Human Reactions
A project in which the author was involved in was an arbitration that involved the manufacture of a ship, of a type which was technologically advanced and whose design was far from finalized. Thus, the two risks were: the state-of-the-art technology being used and the immaturity of the design. There were two additional sources of risk within the project: first, the acceptance criteria were not well-defined; and second, (a probably unidentified risk) the client’s inspection team were (the contractor felt) unreasonably demanding. Each of these four risks, except for possibly the first, would probably not have appeared as major risks on a risk register. The combination of all of them, however, meant that the inspection and acceptance process proved very problematic, as demanding inspectors could claim that novel items, with some aspects not agreed on pre-contract due to the immature design, did not meet their stringent interpretation of the ill-defined criteria. Furthermore, as well as the risks themselves interacting, the causal chains emanating from these combinations included designers disagreeing with inspectors, being over-ruled, having to re-work, becoming disheartened and thus lowering productivity and increasing error rates, and so on (see Figure 2). Each risk individually might have been manageable; when they are combined with the resulting human reactions then they are not manageable. Following the logic discussed earlier meant that some of these items looped back to create vicious circles.

Sometimes significant risks are simply increases in the degree of risks that are accepted as normal project issues: The approval delays depicted in Figure 1 were simply an increase of delays over and above the contracted limit, the cumulative effect of which would be difficult to assess. The extreme example of 15,000 design changes is quoted below.

2. Pace and Management Actions
The “Shuttle Wagons” work referred to earlier (Ackermann et al., 1997) describes the need to make management decisions in a high-pace project
(see Figure 1). In this case, this included parallel working and pre-emptive designs, which exacerbated the positive feedback loops of work-arounds, rework, and subsequent disruptions and delays. In this way, initiating risks, which are manageable in themselves (such as the effects of the London fire referred to earlier), create causal loops that have effects much greater than expected.

3. **Individuals within the Parties**

The construction of the Scottish Parliament infamously resulted in a cost ten times higher than the original (under-estimated) budget. At the public enquiry in 2004, the project manager was reported as stating that there had been 15,000 design changes to the building (British Broadcasting Corporation [BBC], 2004). Each individual change would have had little effect on the project; on the other hand, the effect of a deluge of temporally overlapping design changes caused considerable problems. These were both engineering problems and designers’ reactions to multiple changes, with their work sometimes becoming futile. It is interesting to reflect on whether “lack of governance within the client” (which was perhaps what allowed the users to specify changes continuously) would or should have been a risk identified at the start of the project, let alone its true impact. (Further, even if a client had been aware of the changes, would he or she have been aware of the effects of the changes on the project?)

4. **Inter-Personal Relationships between the Project Parties**

Some of the risks themselves can be interpersonal rather than technical; thus the character of the project manager, for example, can cause problems in agreeing on designs, changes, and client acceptance. The need for trust between client and contractor (Kadefors, 2004) and within an alliance (Krishnan, Martin, & Noorderhaven, 2006) and the effect of lack of trust on the performance of the project are well-known. A difficult character, or troubled interpersonal relationships, can produce delays and the need for additional work, which dishearten the team, disrupt the project, and set up vicious circles of delay and disruption. Indeed, some would say that trust between the contractor and owner is one of the most important contributors to project success, yet trust rarely appears on a risk register. Eden, Ackermann, and Williams (2005) present an example of a rolling-stock project, in which the passenger doors were not sufficiently watertight to satisfy the customer, because under extreme test conditions there was a small amount of water ingress. The contractor argued that no train had ever met these criteria, and it was clear that the contract was ambiguous on the performance specification. This led to many tests, studies by independent experts in the field, and a final solution, but this caused many designs to be revisited and changed, which created ripple effects and schedule delays. Again, there was a small initiating risk, but there were also major ramifications.

5. **Contracts between the Project Parties**

Risks can result from different interpretations of contracts between the customer and contractor. Eden et al. (2005) present an example of a rolling-stock project, in which the passenger doors were not sufficiently watertight to satisfy the customer, because under extreme test conditions there was a small amount of water ingress. The contractor argued that no train had ever met these criteria, and it was clear that the contract was ambiguous on the performance specification. This led to many tests, studies by independent experts in the field, and a final solution, but this caused many designs to be revisited and changed, which created ripple effects and schedule delays. Again, there was a small initiating risk, but there were also major ramifications.

6. **Culture within the Project Parties**

In cases in which the industrial sector has moved from the public sector to the private sector, it can be said that contractual relationships have changed to reflect the new environment, yet culture and working practices have not. Where a public-sector client is used to

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**Figure 2:** Combinations of risks and the resulting human reactions.
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being part of the same organization executing a project, the associated behavior may not match the demands of a well-defined contractual relationship. A culture that is used to continuous design review or ongoing changes mid-project is at odds with a fixed-price contract. This can lead to redesign and rework as a project tries to meet increasingly unrealistic fixed time- and cost-targets, while requirements keep changing, leading to a cycle of increased work, more delay, frustration, loss of control and/or meaning felt by designers and engineers, and increased workarounds.

7. Changes to the Project Parties

Changes in the client’s strategy can be a significant risk. In December 1994, following direction from the U.S. government, Amtrak was given the goal of eliminating its need for federal operating subsidies. Working through the implications of this meant that Amtrak had to rethink their strategy; at the same time, it was engaged in a project to design and produce the new Northeast Corridor Acela trains. It has been suggested, therefore, that it is no coincidence that there were major changes to this project and thus rework; thus causing all the natural human reactions to major changes to work already done in a project and subsequent significant disruption to the project. Again, the client’s change in strategic direction is unlikely to have been on the original project risk register, but can cause major ramifications.

It is likely that none of these risks would appear on a risk register, let alone a list of “top ten” risks; however, by setting up vicious circles of disruption, they can cause much more damage to project performance than simple one-off risks. The risks likely to produce vicious circles are those likely to produce the most risk to the project. An individual risk whose effect can be contained will only have that effect on the project. Where a risk sets up causal chains of effects through human reactions to the events, and whose ramifications are multiplied by unwanted positive feedback, with management actions exacerbating these feedback loops, its effects will be much greater. Humans have significant difficulty in estimating the probabilities and impacts of epistemic risks (see, for example the, discussion in Winch & Maytorena, 2011, pp. 350–351). It could therefore be argued that the degree of positive feedback from a risk is a more reliable indicator of importance to the project, although the organization must be set up to comprehend the full implications of a risk rather than a siloed view of direct consequences.

One Aid: Mapping Risk

As an aid to looking at risks with the features just described, a natural method is to structure the risks in a “risk map.” This term is used here to denote a causal map capturing systemicity (rather than simplistic probability-impact grids, for example, Jordan, Jorgenese, and Mitterhofer, 2013). Mapping project effects is a recognized part of systemic modeling work, and indeed has recently been extended into other uses in understanding projects (Ackermann & Alexander, 2016). Initial mapping is often loose, dealing with rough concepts; to trace causality, however, this needs to be honed into a map of clearly defined variables. This should be at least a “Stage 2 Influence Diagram” of Howick et al. (2008); being able to put “+” for a positive influence (or “−” for a negative influence) is an essential part of identifying positive feedback (see Sterman, 2000). Some positive feedback may be beneficial (“virtuous circles”), but it is the detrimental positive feedback that needs to be identified.

Risk mapping carried out by an individual can start from the risks that would form a risk register and the project objectives that will be affected by “risk.” Then, by considering causal chains between items on the map, and “so what if this happens” and “what would make this happen” (i.e., the causal chains both up to and following an item), a causal map of the possible occurrences within a project can be built. The key is to include within the map the mitigation actions that would be taken (whether or not by conscious decision) by the project team and the expected behavior of the project participants since, as discussed above, these can often be critical elements in the causality.

The process of developing the risk map is as useful as the output and requires clarity, because thought is given to the chaining, yet it also enhances creativity as different future pathways are suggested. Positive feedback loops can be identified, as well as synergistic actions that will ameliorate a set of risks. Figure 3 illustrates a small example of a map with three risks (with no border), causing chains of consequences—four of which (with no border but italic) are human responses to the risks—resulting in two outcomes (in oval borders). (This simple map has multiple loops, although removing the element “Engineers disheartened” removes one third of them.)

“Individuals only ever have a partial view of risk” (Hardy & McGuire, 2016). The method becomes particularly useful in a group, as it aids communication and brings out interactions as well as cultural differences between groups, thus providing a richer set of knowledge. This requires the group to be suitably heterogeneous, and within the group there needs to be an overview of the whole project and an understanding of the management and team’s likely reactions to events. Discussion can lead to paradigmatic differences or even incompatibilities as heterogeneous risks (including, for example, both engineering and psychological concepts) are combined—but this in itself aids intra-group communication and establishment of the overall risk picture.

The information on the map is valuable in various ways (Ackermann et al., 2014), including the following:

1. The information contains knowledge of the systemicity.
Use of mapping software can categorize the risks in various ways (e.g., as shown in Figure 3) and show the “big picture” or detail.

The map provides understanding, traceability of the information, and the identification of synergistic risk mitigation actions.

The map can be used to identify prospective feedback loops and prompt questions on how to ‘break’ such loops.

The map can help in scenario analysis as the likely effects of outcomes are explored.

The map can underpin project categorization (Ackermann et al., 2007).

The map can also provide a foundation for quantification. This can be a major task, which has been used more in post-hoc arbitration than in a priori risk analysis. It can provide a traceable structured basis for system dynamics analysis (Howick et al., 2008), which can help us understand how causalities are likely to interact or predict the likely behavior of an upcoming project (Rodrigues & Williams, 1998). It can also provide a useful basis for risk assessment, particularly since assessing subjective probabilities is fraught with difficulty if the causes are not split out explicitly or if the item whose probability is being assessed is part of a positive feedback loop (so its very presence makes itself more likely). For example, consider that we need to assess a probability that a client will delay design approvals too much; in this case, however, there is positive feedback (as shown in Figure 4) and the probability needs very careful definition to estimate. In this type of situation, the input causes need to be split out (probabilities associated with the different arrows in Figure 4 assessed separately) or the probability needs to be identified as at time zero, or some other clear definition of the probabilities to be estimated. In practice, if a significant detrimental positive-feedback loop is identified, then the first discussion will be about how to ‘break’ that feedback loop; once that has been done, the remaining risk can be quantified.

**Conclusions**

Front-end analysis and preparation are becoming increasingly important in the management of complex projects (Williams & Samset, 2012). A vital part of this is understanding the risks that the project faces. Standard methodologies evaluate these risks individually and without considering the human ramifications of each risk. Our understanding of complex projects shows us that risks affect projects in combinations...
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![Diagram](image.png)

Figure 4: Risks within feedback loops.

and structures of risks. While this has been recognized to some extent in the literature, the key here is that the important causal linkages are the reactions to risks; in particular, there are reactions by the project manager in the context of needing to make fast decisions in the heat of the project, and reactions by the project team in terms of motivation and fatigue. Often the risks that cause project runaway are not individual, separate risks, but rather combinations of risks in causal chains that, along with management actions and team reactions considered, build up “vicious circles” of disruption. If one looks at a typical risk register in practice, the types of risks discussed in this article often don’t appear at all, although they might be the critical risks that will bring a project to, or near, failure. We have used Geraldi et al. (2011) to structure where such risks appear at all, even if so inclined. Systemic risk elicitation: Using causal maps to engage stakeholders and build a comprehensive view of risks. European Journal of Operational Research, 238(2), 290–299.

References


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ABSTRACT

This study aims to investigate the cost premiums and cost performance of green building projects. After an extensive literature review, relevant data from 242 traditional and 121 green building projects performed by 30 different companies were collected through a survey in Singapore. The results indicate that the green cost premiums range from 5% to 10% and that project type and size are significant factors affecting the cost premiums. Furthermore, the cost performance is mostly over budget, ranging from 4.5% to 7%. Finally, this study proposes some feasible solutions for cost premiums reduction and cost performance improvement.

KEYWORDS: green building; cost premiums; cost performance; cost improvement

INTRODUCTION

Green buildings are becoming increasingly popular and more evident in countries, including the United States, Germany, the United Kingdom (Menassa, Mangasarian, El Asmar, & Kirar, 2012; Rosenow, Eyre, Bürger, & Rohde, 2013), and Singapore (Darko & Chan, 2016; Zhao, Hwang, & Gao, 2016). Moreover, Dodge Data and Analytics (2016) reported that the green expansion would continue in developed countries such as the United States, Germany, and the United Kingdom. Singapore is also in the midst of a robust increase in the level of green activities (Dodge Data & Analytics, 2016), driven by Green Building Masterplans and several green initiatives (Building and Construction Authority [BCA], 2014, 2016). The term ‘green building’ refers to the use of environmentally friendly techniques and technologies in the design and construction of the built environment (Love, Niedzweicki, Bullen, & Edwards, 2012). According to the United Nations Environment Programme (UNEP, 2009), a 30% to 80% cut in energy consumption of buildings is attainable if the right green technologies are used. Additionally, the World Green Building Council (WorldGBC, 2014) reported that the design of an office building impacts the health, well-being, and productivity of its occupants. Therefore, green buildings also bring social and financial benefits to key stakeholders.

In spite of the benefits of green buildings and the various efforts being made to promote a sustainable built environment, key building stakeholders are still somewhat skeptical about the financial benefits that green buildings can deliver. Many industry professionals have the perception that the design and construction costs of green buildings are 10% to 20% higher than those of traditional buildings (WorldGBC, 2013). In light of this perception, the higher costs associated with “going green,” which were termed green cost premiums, are the most common reason hindering the widespread development of green buildings (Dodge Data & Analytics, 2016; Robichaud & Anantatmula, 2011).

As a result, the objectives of this study are: (1) to investigate the cost premiums of green building projects and the significant reasons for them; (2) to compare the cost performance between green and traditional building projects; and (3) to examine plausible solutions that can improve the cost performance of green building projects, eventually cutting off their cost premiums. This study will contribute to the green building body of knowledge by adding to discussions of cost premiums and the cost performance of green building projects. Furthermore, the findings from this study can assist
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key building professionals in making better cost-related decisions right at the beginning of green building projects.

Background

Green Buildings and the Rationales

The green building revolution is sweeping across most of the world. The definition of green building varies from different construction perspectives. Generally, the goal of a green building is to take responsibility for achieving energy and resource efficiency, realizing long-term economic, environmental, and social health (Sahamir & Zakaria, 2013; Yoon & Lee, 2003; Zhao, Hwang, & Lee, 2016). The terms green building and sustainable construction are sometimes used interchangeably. However, the term sustainable construction is applied from the period of preconstruction to the disposal of the building and focuses on the ecological, social, and economic issues involved with a building (Kibert, 2008). From this perspective, green building is an integral part of the sustainable construction.

Green buildings have environmental, economic, and social benefits. Green buildings first benefit the environment. Globally, buildings are responsible for 40% of annual energy consumption, including 12% of all fresh-water use and produce up to 40% of our solid waste (UNEP, 2011). Moreover, buildings were responsible for about one-third of greenhouse gas (GHG) emissions in the world (WorldGBC, 2013). Therefore, the building sector could lead to a great and efficient reduction of GHG emission if appropriate green technologies, materials, and construction methods were used (Wu, Xia, Pienaar, & Zhao, 2014; Wu, Zia, & Zhao, 2014). Green buildings also bring economic benefits to the key stakeholders involved. Green buildings can bring about energy and water savings, which lower operating costs. Fowler and Rauch (2008) reported that some green buildings consumed 26% less energy and saved 13% of maintenance costs when compared to average commercial buildings. Carpenter (2009) showed that the average energy savings of six green building projects were up to 40%, and believed that the long-term energy savings could be higher if the first year operational issues were worked out.

Green buildings not only lead to energy savings but also provide the comfortable environment that can improve social benefits, including the increase in occupants’ satisfaction, and positive impacts on occupants’ health and productivity (Asdrubali et al., 2013). Singh, Syal, Grady, and Korkmaz (2010) and Thatcher and Milner (2014) investigated the effects of a green office building on the perceived health and productivity of occupants and identified that the green building significantly contributed to an increase in the self-reported productivity and physical well-being of employees. In addition, Barrett, Zhang, Moffat, and Kobbacy (2013) carried out a study on 751 students from 34 various classrooms in seven different schools in the United Kingdom. The results showed that the “best” and “worst” classrooms, defined by six significant built environment design parameters—color, choice, connection, complexity, flexibility, and light—were estimated to have a significantly different impact on a student’s study progress. Because of these social benefits, green buildings have the additional potential to generate higher rent and sale prices. A study carried out in Hong Kong indicated that “green development” is one of the considerations when people purchase apartments. Additionally, end users are generally willing to pay more to purchase apartments with green features (Chan, Qian, & Lam, 2009).

Cost Premiums of Green Building Projects

The development of green buildings is often greatly discouraged by the perceived higher costs, commonly termed green cost premiums, compared with traditional non-green buildings, despite the fact that green buildings have economic, social, and environmental benefits (Dodge Data & Analytics, 2016). There is no standardized definition for green cost premiums and no clear methodology to describe the components and estimation methods of green cost premiums (Dwaikat & Ali, 2016; Houghton, Vittori, & Guenther, 2009). Kats (2010) defined green cost premiums as the differential cost between a green and traditional version of the same building. Houghton et al. (2009) defined green cost premiums as the additional design and construction costs associated with specific green components. In terms of the general costs of a typical building, which consist of capital costs, operation costs, as well as repair and maintenance costs (Hendrickson & Au, 1989), Furr and colleagues (2009) stated that the additional capital costs of green building features are commonly termed green premium by the industry. Moreover, Dodge Data and Analytics (2016) found that the higher costs, which were ranked as the top challenge to green building, were actually referred to additional capital costs because they were used to make comparisons with the decreased operating costs of green buildings. In light of the above review, this study defines green cost premiums as the additional capital costs of green building features.

Design and construction costs are perceived as contributing to the green cost premiums. Green building projects generally have more complex designs as compared with traditional building projects (Johnston, 2000). In order to achieve sustainability, green building projects generally require the use of special specifications, materials, construction methods, and building practices (Lam, Chan, Poon, Chau, & Chun, 2010; Robichaud & Anantatmula, 2011). Moreover, the productivity of the design and construction of green building projects is currently lower than that of traditional projects because practitioners still need time to learn and become proficient in these technologies. Furthermore, unfamiliarity with green technologies and technical difficulties...
during the construction process can not only affect the project schedule, but can also lead to cost increases through rework (Hwang, Thomas, Haas, & Caldas, 2009; Hwang, Zhao, & Tan, 2015; Tagaza & Wilson, 2004).

Properly facing this barrier, some countries, such as the United States, United Kingdom, and Australia, investigated high green cost premiums (Dwaikat & Ali, 2016). Kats (2010) conducted a large-scale study based on extensive financial and technical analyses of more than 150 green buildings in the United States and 10 other countries. The results of the study showed that green buildings cost roughly 2% more to build than traditional buildings. Moreover, Kim, Green, and Kim (2014) concluded that the green cost premiums for residential project development in Los Angeles were 10.77%. In addition, Houghton et al. (2009) found that the green cost premiums for healthcare buildings in the United States ranged from 0% to 5% without any financial incentives. In the United Kingdom, Building Research Establishment (BRE) and Cyril Sweett (2005) asserted that the green cost premium ranged from 0% to 7%. In Australia, Davis Langdon (2007) reported that the impact on the construction cost ranged from 3% to 5% for a five-star rating, and more than 5% for six-star, non-iconic design solutions. Dodge Data and Analytics (2016) also conducted a study on the challenges of green buildings and identified that higher perceived first costs were one of the top three challenges in nearly all of the 13 surveyed countries. This challenge was selected by over 50% of the respondents only in the United States (70%), Mexico (54%), Colombia (67%), Germany (52%), the United Kingdom (52%), and China (60%).

The building industry of Singapore recognizes the importance of sustainable construction to create a high-quality living environment for all. The Building and Construction Authority of Singapore (BCA) has launched three editions of its Green Building Masterplan from 2006 to aid in the greening of Singapore’s current and future buildings (Building and Construction Authority [BCA], 2009, 2014). Singapore is now in the midst of a robust increase in the level of green activity (Dodge Data & Analytics, 2016) and plans to green at least 80% of buildings by 2030 (Building and Construction Authority [BCA], 2014). Particular attention should be paid to the fact that, given the influence of the mandate in the Singapore Green Plan 2012, environmental regulations are clearly the driving force for green adoption (Dodge Data & Analytics, 2016). On the other hand, the high premium cost associated with green building construction, the lack of expressed interest from clients or market demand, and the costly green building practices were identified as significant obstacles encountered in Singapore (Hwang & Tan, 2012). Furthermore, higher up-front costs were recognized as the top obstacle to green development in Singapore (Chan et al., 2009; Hwang & Tan, 2012).

However, compared with other leading countries, Singapore lacks knowledge and data on green cost premiums. Furthermore, there is limited research on green cost premiums and cost performance in Singapore. Wong, Tay, Wong, Ong, and Sia (2003) examined the initial cost implication of having a green roof in Singapore and identified that the initial costs were 82%, 36%, and 50% higher for an inaccessible extensive green roof, an accessible intensive roof with shrubs, and an accessible intensive green roof with trees, respectively, than those for counterpart conventional roofs. Deng and Wu (2014) investigated the economic returns of residential green building investment in Singapore from developers’ perspectives to clear public doubt regarding the financial viability of investments in energy efficiency. An investment in energy-efficient real estate development can only be financially sustainable if the additional selling price of a green building, termed green price premiums, is large enough compared to the green cost premiums. The results of this study showed that the developers claimed 4% market premium of green mark-rated units at the presale stage to cover the additional costs of energy efficiency during construction. Goh (2016) investigated the whole-life costs of nonresidential green-rated building developments in Singapore to propose a whole-life building cost index. The limitation of the study was that the formulation of the proposed index lacked data support.

Cost Performance of Green Building Projects

Cost overrun is another hindrance in green building projects. Because green buildings use more technologies and material with less environmental impact, they are more complicated than traditional buildings. Moreover, many requirements to achieve a green certificate and shareholders’ unfamiliarity with the requirements and technologies tend to lead to cost overruns, project delays, and productivity losses (CII, 2008; Nalewaik & Venters, 2010). Hwang and Leong’s (2013) empirical study in the context of Singapore also found that about 32% of green building projects were completed behind schedule, while 16% of the traditional building projects were delayed.

Cost performance indicates how well costs are kept under control, in other words, over budget or under budget. Cost overrun is generally a symptom of poor management. Thus, many researchers start to pay great attention to the research on cost overrun assessment (Chandramohan, Narayanan, Gaurav, & Krishna, 2012), identification of important factors affecting cost performance (Son, Lee, & Kim, 2015), and comparison of the impact of pre-project planning between green and traditional building on cost performance (Kang, Kim, Son, Lee, & Limsawasd, 2013). In addition, considering the unique
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characteristics of green buildings and green construction, Robichaud and Anantatmula (2011) tried to improve the chances of delivering the project within acceptable costs by suggesting some construction management adjustments to traditional project management practices. However, there is generally still a lack of studies that investigate the actual cost performance of green building projects.

A few studies have been conducted on the cost performance of traditional building projects as compared with green building projects. Two indicators commonly used for measuring the general project cost performance by the construction industry institute (CII) (Thomas, Macken, Chung, & Kim, 2002) are project cost growth and project budget factor. The formulas for the two indicators are shown in Equation 1 and Equation 2.

\[
\text{Project Cost Growth} = \frac{\text{Actual Total Project Cost} - \text{Initial Predicted Project Cost}}{\text{Initial Predicted Project Cost}} \quad (\text{Equation 1})
\]

\[
\text{Project Budget Factor} = \frac{\text{Actual Total Project Cost}}{\text{Initial Predicted Project Cost} + \text{Approved Changes}} \quad (\text{Equation 2})
\]

Using these two indicators, Thomas et al. (2002) conducted a survey on 617 U.S. domestic and international traditional construction projects to investigate the impacts of two delivery systems—design-build (DB) and design-bid-build (DBB)—on project cost performance. The results showed that the project cost growths for DB and DBB projects were −0.041 and −0.030, respectively, from the owners’ perspective; the project cost growths for DB and DBB projects were 0.038 and 0.056, respectively, from the contractors’ perspective. The results indicated that the cost performance of the U.S. traditional construction projects was below or slightly above budget. The project budget factor for DB and DBB projects were 0.966 and 0.948, respectively, from the contractors’ perspective, indicating that the changes generally contributed to a 3% to 5% cost increase. Shrestha, Burns, and Shields (2013) also conducted a survey to investigate the magnitude of construction cost and schedule overruns in public projects in the United States. The results showed that the mean construction cost and schedule overrun for the 363 sample projects were 2.95% and 1.54%, respectively.

In addition, Xiao and Proverbs (2002) compared the levels of contractor cost performance in three countries: Japan, the United Kingdom, and the United States. The survey results showed that the estimated percentage of total budget overrun against the original contract price was 5%. The percentages of budget overrun for Japan, the United Kingdom, and the United States were 3.63%, 5.89%, and 5.05%, respectively. The total number of design variations, which have been identified as one of the major contributing factors for budget overruns, was 54.55. Using project cost growth, Chen, Zhang, and Zhang (2014) investigated the impacts of different types of owner-contractor conflict on cost performance in Chinese construction projects. In light of the above, this study used the project cost growth to investigate the cost performance of green building projects in Singapore. This study did not use the project budget factor because valuing changes/variations is, practically speaking, very challenging for respondents.

Methodology and Data Presentation

The questionnaire survey technique was adopted in this study because it is a systematic method of collecting data and has been widely used to collect professional views in sustainable construction research (Hwang, Zhu, & Ming, 2017; Wu & Low, 2012). This study first carried out an extensive literature review from multiple sources, such as government websites, reports from private institutions, and journal papers, to provide a better understanding of the current market situation of green building and the issues relating to cost premiums and cost performance of green building construction projects. Then a survey questionnaire was subsequently developed (1) to capture the current perceptions of professionals on cost premiums and cost performance of green building projects, (2) to identify the significant reasons for cost premiums, and (3) to gauge the effectiveness of proposed solutions to reduce green cost premiums and improve cost performance. The collected data were analyzed by the Statistic Package for Social Science (SPSS) statistical software.

The questionnaire first provided a definition of green cost premiums, which was the premise of the survey. Subsequently, the questionnaire included questions meant to profile the companies and respondents. Furthermore, the respondents were asked to indicate the cost premiums of green building projects by different project types and sizes. They were also asked to rate the significance of the reasons for the difference in the cost premiums between green and traditional building projects by using a five-point scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). Afterward, the number of traditional and green building projects with different cost performance values was indicated. Finally, the effectiveness of the solutions to reduce the cost premiums of green buildings and improve their cost performance was rated by using the five-point scale (1 = least efficient, 2 = somewhat efficient, 3 = neutral, 4 = efficient, and 5 = most efficient). In addition, post-survey interviews were carried out with two green building professionals who had more...
than three years of experience in the green building industry, especially in green building costs management, to validate the findings from the survey.

The population of this study consisted of all the professionals who were past award winners of the BCA Green Mark certificate, members of the Singapore Institute of Surveyors and Valuers (SISV), as well as the BCA directory of registered contractors and licensed builders with more than three years of experience in the green building industry and who specialized in green building cost performance. The survey questionnaires were randomly sent out to the professionals via email. Thirty responses were received. Although the sample size was relatively small, statistical analysis could still be performed because the central limit theorem holds true when the sample size is no less than 30, which is a generally accepted rule (Ott & Longnecker, 2010). The profiles of the respondents, companies, and projects are provided in Table 1.

The respondents consisted of project managers, quantity surveyors, and contractors. Most of the respondents (70%) had at least two years’ experience in green building construction. Because the duration of a normal building project is around two years in Singapore, the years of working indicated that the respondents could have reliable cost assessments and objective judgment, implying that the collected cost-related information is reliable. The percentages of respondents from architecture, quantity surveying, and contractor firms are 7%, 17%, and 76%, respectively.

A total of 242 and 121 traditional and green building projects were recorded from the survey, respectively. The percentages of the three types of projects (office, commercial, and residential) in traditional and green building project are generally comparable. The number of office building projects recorded from the survey is notably smaller than the numbers of commercial and residential building projects.

### Analysis Results and Discussions

#### Overall Perceptions on Green Cost Premiums

The overall perceptions of the survey respondents regarding cost premiums for green buildings are summarized in Figure 1. A total of 43% of the respondents perceived green cost premiums to be 5% ~ 10%, followed by 34% and 23% of the respondents who perceived green

<table>
<thead>
<tr>
<th>Classification</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job title</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project manager</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Quantity surveyor</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Contractor</td>
<td>17</td>
<td>56</td>
</tr>
<tr>
<td>Years of experience of respondents in green building construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>1 to less than 2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 to less than 3</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>3 to less than 4</td>
<td>6</td>
<td>20</td>
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<tr>
<td>4 and above</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>Type of company</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Architecture</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Quantity surveying</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Contractor</td>
<td>23</td>
<td>76</td>
</tr>
<tr>
<td>Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
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<td></td>
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<tr>
<td>Commercial</td>
<td>124</td>
<td>51</td>
</tr>
<tr>
<td>Offices</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Residential</td>
<td>98</td>
<td>41</td>
</tr>
<tr>
<td>Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>57</td>
<td>47</td>
</tr>
<tr>
<td>Offices</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Residential</td>
<td>54</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 1: Profiles of respondents, companies, and projects.

![Figure 1: Overall perception on green cost premiums.](image-url)
Green Building Construction Projects in Singapore

cost premiums to be 10% ~ 15% and 0% ~ 5%, respectively. None of the respondents perceived green cost premiums to be above 15%. This result was in line with the argument made by Houghton et al. (2009) that green cost premiums were getting lower as a result of decreasing capital cost over time. Furthermore, according to a report from WorldGBC (2013), building professionals—both with experience and without any experience in green projects—tended to perceive green cost premiums to be up to 13% and 18%, respectively, which was not significantly different from the analysis results of this study.

**Actual Cost Premiums of Green Building Projects**
The cost premiums for green projects by project size (i.e., less than S$5 million, S$5 million to less than S$50 million, S$50 million and above) and type (i.e., green commercial, office, and residential buildings) are summarized in Table 2.

This result was derived from the respondents’ inputs, which were based on green building projects in which they had been involved. As shown in Table 2, there were indeed cost premiums for going green, generally ranging from 0% to less than 15%, regardless of the project type and size. This result was consistent with the overall perception on the green cost premiums presented in the previous section.

**Actual Cost Premiums by Project Type**
To obtain the mean cost premiums by project size and type, the mid-values of the four ranges of the premiums, in other words, 2.5%, 7.5%, 12.5%, and 17.5%, were used in this study. The mean cost premiums of green building projects by project size and type are shown in Table 3.

The overall mean of green cost premiums ranged from 2.5% to 12.5%.

This result was comparable with the conclusion drawn by Kansal and Kadambari (2010) that the initial costs of a green building were 7.5% more than those of the ordinary building. Additionally, it is obvious that green residential has the highest cost premiums, followed by green commercial and green offices for three different size classifications. The mean for the residential green building was very close to the result found by Kim et al. (2014) that green residential building costs were 10.77% more than those of the traditional residential buildings. The relatively higher cost premiums for green residential projects could be a result of the respondents’ lack of green expertise in green residential as compared with green commercial and office building.

### Table 2: Cost premiums of green building projects by project type and size.

<table>
<thead>
<tr>
<th>Project Size (S$ · million)</th>
<th>Capital Cost Premiums (CCP)</th>
<th>Number of Green Commercial</th>
<th>Number of Green Offices</th>
<th>Number of Green Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 (small)</td>
<td>0% = &lt; CCP &lt; 5%</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5% = &lt; CCP &lt; 10%</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10% = &lt; CCP &lt; 15%</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>15% = &lt; CCP &lt; 20%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>20% = &lt; CCP</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 to 50 (medium)</td>
<td>0% = &lt; CCP &lt; 5%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5% = &lt; CCP &lt; 10%</td>
<td>9</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10% = &lt; CCP &lt; 15%</td>
<td>9</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15% = &lt; CCP &lt; 20%</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>20% = &lt; CCP</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50 and above (large)</td>
<td>0% = &lt; CCP &lt; 5%</td>
<td>11</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>5% = &lt; CCP &lt; 10%</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10% = &lt; CCP &lt; 15%</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>15% = &lt; CCP &lt; 20%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>20% = &lt; CCP</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3: Mean cost premiums of green building projects by project size and type.

<table>
<thead>
<tr>
<th>Project Size (S$ · million)</th>
<th>Mean of Green Cost Premiums</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial</td>
</tr>
<tr>
<td>Less than 5 (small)</td>
<td>7.0%</td>
</tr>
<tr>
<td>5 to 50 (medium)</td>
<td>7.7%</td>
</tr>
<tr>
<td>50 and above (large)</td>
<td>3.8%</td>
</tr>
</tbody>
</table>
projects. Respondents without sufficient green building expertise in residential projects would have difficulty in complying with the green specifications, leading to delays and increased costs (Architecture Week, 2001).

Although the BCA Green Mark for Office Interiors had been launched recently, in 2009, the learning curve for green offices were relatively steep, resulting in the lowest green cost premiums (Nalewaik & Venters, 2010). The opinion from post-survey interviews revealed that it may be much easier to comply with green specifications for green office projects. Another reason could be a result of the relatively small data set for green office building projects recorded from the survey responses.

A one-way analysis of the variation (ANOVA) test was performed to test whether the project type has a significant effect on green cost premiums. The null hypothesis $H_0$ is that there is no statistically significant difference in the cost premiums by project type; the alternative hypothesis $H_1$ is that there is a statistically significant difference in the cost premiums by project type. Because the one-way ANOVA test does not show which specific building types significantly differ, the Tukey post hoc (TPH) test was subsequently performed to further analyze the difference. Table 4 summarizes the results.

The p-values from the ANOVA test for projects under S$50 million were smaller than 0.05, indicating that the hypothesis $H_0$ should be rejected at a 95% confidence level. This result implied that the building type had a significant effect on the mean of green cost premiums when the project size was small or medium. When the project size was large, the building type did not have a statistically significant effect on the mean of green cost premiums.

According to the results from the TPH test, the means of the cost premiums were statistically different between commercial and residential building projects, and between office and residential building projects when the project size was small. As for medium-sized projects, only commercial and residential building projects had statistically different cost premiums.

**Actual Cost Premiums by Project Size**

From the perspective of project size, large-scale projects have the lowest means of green cost premiums for all three building types, followed by small- and medium-scale projects, as shown in Table 3. One possible explanation for this result is that respondents involved in large-scale projects were mainly professionals with a good deal of experience in green building projects. Professionals who have sufficient green building experience are able to efficiently utilize green products without increasing overall design and construction costs (Malin, 2000). Additionally, the cost of green buildings might not increase if the right strategies were used (Bordass, 2000). Respondents with sufficient experience in green building were more likely to adopt the right strategies, lowering green cost premiums accordingly. Another reason derived from the post-survey interviews was due to the economies of scale for green features, products, and materials.

A one-way ANOVA test was performed to test whether the project size has a significant effect on green cost premiums. The null hypothesis $H_0$ is that there is no statistically significant difference in the cost premiums by project size; the alternative hypothesis $H_1$ is that there is a statistically significant difference in the cost premiums by project size.

The results generated from the ANOVA and TPH tests are shown in Table 5. The p-values from the ANOVA test for three building types were all smaller than 0.05, indicating that the hypothesis $H_0$ should be rejected at a 95% confidence level. This result implied that the project size had a

<table>
<thead>
<tr>
<th>Project Size (S$ - million)</th>
<th>p-value (ANOVA)</th>
<th>p-value (Tukey Post Hoc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 (small)</td>
<td>0.000</td>
<td>C vs R 0.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R vs O 0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C vs O 0.110</td>
</tr>
<tr>
<td>5 to 50 (medium)</td>
<td>0.045</td>
<td>C vs R 0.038</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R vs O 0.197</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C vs O 0.998</td>
</tr>
<tr>
<td>50 and above (large)</td>
<td>0.601</td>
<td>No difference</td>
</tr>
</tbody>
</table>

Note: C, O, and R denote commercial, office, and residential building, respectively.

**Table 4: ANOVA and TPH results by project type.**

<table>
<thead>
<tr>
<th>Project Type</th>
<th>p-value (ANOVA)</th>
<th>p-value (Tukey Post Hoc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial projects</td>
<td>0.010</td>
<td>Small vs. medium 0.888</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium vs. large 0.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small vs. large 0.124</td>
</tr>
<tr>
<td>Office projects</td>
<td>0.010</td>
<td>Small vs. medium 0.059</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium vs. large 0.009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small vs. large 0.428</td>
</tr>
<tr>
<td>Residential projects</td>
<td>0.000</td>
<td>Small vs. medium 0.875</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium vs. large 0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small vs. large 0.000</td>
</tr>
</tbody>
</table>

**Table 5: ANOVA and TPH results by project size.**
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significant effect on the mean of green cost premiums regardless of the building type.

Further analysis based on the p-value from the TPH test indicated that green cost premiums were statistically different for medium- and large-scale projects in all three building types, whereas cost premiums were statistically different for small- and large-scale projects only in residential projects.

Reasons for Different Cost Premiums Between Green and Traditional Building Projects

The one-sample t-test was performed to determine whether each of the reasons had a significant effect on the difference in cost premiums between green and traditional building projects. Because a five-point scale was used, the test value was 3, which is the middle value of the scale. Table 6 summarizes the test results as well as the ranking of the reasons.

With the analysis result, it can be concluded that R1, R5, and R6 had the statistically different means from the test value of three because the p-values of these reasons were all below 0.05. Because the mean of R5 (3.70) was much greater than 3, R5 had a statistically significant effect on the difference; however, because the means of R1 and R6 were much lower than 3, the effects of R1 and R6 could not be considered significant. Although the p-values of R2, R3, R4, and R7 were greater than 0.05, their mean values were all greater than the test value of 3, implying that these could be relevant reasons for explaining the difference as well.

The analysis results suggested that the “high cost of green technologies and materials” was the top reason for the difference in cost premiums between green and traditional building projects. As the design and construction practices of green buildings grow more complex, green technologies and materials not only greatly affect the capital cost, but also affect project productivity (Hwang et al., 2017; Lam et al., 2010). Moreover, green materials usually have higher production costs because these materials lack the economies of scale and also require special orders and manufacturing (Kibert, 2008; Malin, 2000). All the interviewees who participated in the post-survey interview also agreed with this result.

“High research and development costs for green building products and systems” was ranked second, further contributing to the difference in the cost premium. New green products and systems usually require more efforts in testing and code approvals, which leads to an increase in research and development costs (Malin, 2000). “Lack of required green expertise and information,” which ranked third, could also lead to an unnecessary increase in cost premiums because the key building players are unable to utilize green products efficiently (Malin, 2000). Additionally, without sufficient green building expertise, key building players most probably encounter reworks and changes because they have difficulty in complying with the green standards, leading to an increase in the capital cost for green building projects (Architecture Week, 2001).

“Lack of government incentives/subsidies for green building projects” is not a significant reason. This finding coincides with the results from Hwang and Tan (2012) in which the lack of government support (e.g., incentives) is not an obstacle encountered in Singapore green building projects. This is most probably because of the extensive efforts made by the government to support the building industry in Singapore. “Higher consultant and designer fees” was not rated as a significant reason, perhaps because it is not the root cause or a direct reason. Another possible reason may be that getting specialized consultants and designers is not difficult and the cost is not very high (Architecture Week, 2001).

Comparison of Cost Performance Between Traditional and Green Building Projects

Table 7 summarizes the cost performances of traditional and green building projects by project type.

The negative and positive percent-ages indicate an “under budget” and “over budget” cost performance of projects, respectively. Using the mid-values of the four ranges of the performance, in other words, −7.5%, −2.5%, 2.5%, and 7.5%, the mean cost growth of the traditional and green building projects by project type were calculated and are depicted in Figure 2.

<table>
<thead>
<tr>
<th>SN</th>
<th>Reasons</th>
<th>p-value</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Higher consultant and designer fees</td>
<td>0.022</td>
<td>2.60</td>
<td>6</td>
</tr>
<tr>
<td>R2</td>
<td>Lack of required green expertise and information</td>
<td>0.315</td>
<td>3.10</td>
<td>3</td>
</tr>
<tr>
<td>R3</td>
<td>Difficulty in getting green services from contractors and subcontractors</td>
<td>0.5000</td>
<td>3.00</td>
<td>5</td>
</tr>
<tr>
<td>R4</td>
<td>Difficulty in getting green resources, e.g., materials, technologies, etc.</td>
<td>0.444</td>
<td>3.03</td>
<td>4</td>
</tr>
<tr>
<td>R5</td>
<td>High cost of green technologies and materials</td>
<td>0.000</td>
<td>3.70</td>
<td>1</td>
</tr>
<tr>
<td>R6</td>
<td>Lack of government incentives/subsidies for green building projects</td>
<td>0.034</td>
<td>2.57</td>
<td>7</td>
</tr>
<tr>
<td>R7</td>
<td>Higher research and development costs for green building products, systems, technologies, etc.</td>
<td>0.221</td>
<td>3.13</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 6: Ranking of the reasons for the difference in cost premiums.
As can be seen in Figure 2, traditional projects had negative mean cost growth. In contrast, green projects had positive mean cost growth for all three types of projects. This result meant that green projects generally had a cost overrun, whereas traditional projects were generally under budget. The cost overrun of green building projects first could be a result of the key building players’ unfamiliarity and insufficient expertise in green building projects compared with traditional projects. Another possible reason for the cost overrun of green building projects was that they were more likely to be delayed than traditional projects. Hwang and Leong (2013) found that 33.33% of green projects encountered a delay, as opposed to only 17.39% for traditional projects. Furthermore, green office projects had the highest mean cost overrun among the three types of projects. One possible reason was that the respondents were unfamiliar with green office projects, which could be inferred from the small data set for such projects.

In order to statistically identify the equality in cost growth between green and traditional projects, the independent sample t-test for mean and Levene’s test for variance were carried out. The results are summarized in Table 8.

The means of cost growth between green and traditional projects in all three types of projects were statistically different because all p-values under t-test were lower than 0.05. Moreover, the variances of cost growth between green and traditional projects in office and residential types of projects were
Green Building Construction Projects in Singapore

<table>
<thead>
<tr>
<th>Project Types</th>
<th>Levene’s test (Variance)</th>
<th>T-test (Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>0.315</td>
<td>0.000</td>
</tr>
<tr>
<td>Office</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Residential</td>
<td>0.071</td>
<td>0.000</td>
</tr>
</tbody>
</table>

According to the test results, the mean values for the solutions S1 (3.7), S5 (3.83), S6 (3.80), and S8 (3.47) were statistically greater than the test values of three because all p-values were below 0.05. Moreover, all solutions except S2 and S3 could be considered relevant for reducing cost premiums and improving the cost performance of green building projects because their mean values were statistically equal to or greater than the test value.

“Tax relief,” which was ranked as the most powerful solution, is a more flexible and feasible solution. It can be given to both businesses and individuals who make the effort to use green products and systems (Bourgeois, Breaux, Chiasson, & Mauldin, 2010). This was confirmed by the post-survey interview for this study. The interviewees agreed that tax relief was a specific solution that can directly benefit shareholders.

“Availability of skilled and experienced project team” was ranked second, which is consistent with Jiang’s (2010) study. Green building projects generally have a more complex design as compared with traditional building projects (Hwang et al., 2017; Johnson, 2000). With a skilled and experienced project team, both lower cost premiums and better cost performance can actually be achieved because the right green design features and materials can be correctly and efficiently adopted during the design and construction period (Hydes & Creech, 2000; Malin, 2000). Furthermore, if a project team has sufficient green building expertise, the cost performance of green buildings can be much improved because costs caused by unnecessary rework and changes can be avoided (Architecture Week, 2001).

“Incentives/subsidies for green building projects” and “subsidies for green building professional and specialist courses from the government” were ranked third and fourth, respectively. From a practical standpoint, incentives from the government are extremely important for attracting and motivating hesitant building professionals to build green (Popovec, 2006), which could enlarge the green market. Additionally, a good education on green products and systems can increase the productivity and improve the learning curve of using these products. Both cost premiums reduction and cost performance improvement could be achieved if the building players were more familiar with green products and

<table>
<thead>
<tr>
<th>SN</th>
<th>Solutions to Reduce Cost Premiums</th>
<th>p-value</th>
<th>Mean</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Government to provide incentives/subsidies for green building projects</td>
<td>0.000</td>
<td>3.70</td>
<td>3</td>
</tr>
<tr>
<td>S2</td>
<td>Low-interest loans</td>
<td>0.242</td>
<td>2.83</td>
<td>7</td>
</tr>
<tr>
<td>S3</td>
<td>Financial institutions to introduce lending schemes customized for green building projects</td>
<td>0.173</td>
<td>2.77</td>
<td>8</td>
</tr>
<tr>
<td>S4</td>
<td>Government to provide subsidies for research and development of green building products, systems, and technologies</td>
<td>0.109</td>
<td>3.33</td>
<td>5</td>
</tr>
<tr>
<td>S5</td>
<td>Tax relief for developers and contractors for use of green building products, systems, and technologies</td>
<td>0.000</td>
<td>3.83</td>
<td>1</td>
</tr>
<tr>
<td>S6</td>
<td>Availability of skilled and experienced project team and contractors</td>
<td>0.000</td>
<td>3.80</td>
<td>2</td>
</tr>
<tr>
<td>S7</td>
<td>Government to provide green building educational courses for key building players so as to flatten the learning curve of green construction</td>
<td>0.116</td>
<td>3.30</td>
<td>6</td>
</tr>
<tr>
<td>S8</td>
<td>Government to provide subsidies for green building professional and specialist courses</td>
<td>0.038</td>
<td>3.47</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 9: Ranking of the solutions to reduce cost premiums of green buildings.
systems (Nalewaik & Venters, 2010). The results also coincide with the view from Ong (2013), who pointed out that green courses and educational programs can be funded by the government.

Conclusions and Recommendations

Green buildings are becoming increasingly popular in Singapore; however, despite the benefits of green buildings and various efforts being made to promote a sustainable built environment, the delivery of green buildings is still hindered by the higher cost associated with “going green.” As a result, this study aimed to investigate the current cost premiums of green building projects and identify the significant reasons for these cost premiums. In addition, the cost performance of green and traditional building projects was compared, and finally, some plausible solutions that can reduce cost premiums and improve the cost performance were proposed.

The first finding from this study was that the majority of the respondents perceived green cost premiums to be 5% ~ 10%, with green residential buildings having the highest cost premiums, followed by green commercial and green office buildings. Furthermore, it was proven that “project type” and “project size” were statistically significant variables that affected cost premiums. This study also identified that “high cost of green technologies and materials,” “higher research and development costs for green building products, systems, technologies, etc.,” and “lack of required green expertise and information” were the top three reasons for the cost premiums of green building projects. As for current cost performance, it was concluded that green building projects were generally over budget (4.5% ~ 7%), which was worse than traditional building projects. Finally, “tax relief” was identified as the most efficient solution that could have a significant impact on reducing cost premiums and improving the cost performance of green building projects.

Although the main objectives of this study were achieved, there are some limitations. First, caution should be given when the analysis results are interpreted and generalized because the sample size was relatively small. Particularly, the data for green office building projects were relatively small and thus might not fully represent the specific project type. Second, the data were mainly about the perceptions of the respondents rather than the exact cost figures as a result of some confidentiality issues. The subjective evaluation could be influenced by the experience and attitude of the respondents. Lastly, the findings from this study were well interpreted in the context of Singapore, which may be different from the contexts of other countries.

Nonetheless, this study still provides an in-depth understanding of the cost premium and control solutions in green building projects for both practitioners and researchers. Key building professionals can make better cost-related decisions right at the beginning of green projects, based on the findings from this study. In addition, although the findings appear to be geographically specific to green buildings in Singapore, they would not be limited to the context of Singapore, as Singapore has been globally recognized as one of the leading countries advocating sustainability of the built environment through green buildings. From this perspective, the findings from this study will have important implications to the existing body of knowledge as well as to the global construction industry.

Further studies can investigate green building projects performed in other countries in the sense of cost premiums and cost performance, and provide the results from comparisons of projects. In addition, because this study was focused on new green building projects, other kinds of green building projects, such as green retrofit or maintenance projects, can be studied further. It would be also interesting to examine other types of green building projects, such as schools and hospitals.

References


Green Building Construction Projects in Singapore


**Davis Langdon. (2007).** The cost and benefit of achieving green buildings. Davis Langdon Management Consulting, Australia.


Ott, R. L., & Longnecker, M. (2010). *An introduction to statistical methods and


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Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong

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ABSTRACT

The criteria for measuring the success of public–private partnership (PPP) projects have become very topical because of the global interest in PPP project success. This article empirically investigates the differences and similarities of PPP project success criteria in developing and developed economies, represented by Ghana and Hong Kong, respectively. Results reveal profitability, meeting output specifications, and adherence to budget as the top three success criteria in Ghana, whereas adherence to budget, adherence to time, and effective risk management are considered more important in Hong Kong. The findings inform practitioners of the success measures considered in PPP in developing and developed countries.

KEYWORDS: public–private partnerships; success criteria; project success; Ghana; Hong Kong; developing economy; developed economy

INTRODUCTION

Over the last couple of decades, the concept of public–private partnership (PPP) has gained considerable attention in both developing and developed countries (Osei-Kyei & Chan, 2015a; Zhang, 2005). The PPP policy is now considered as an effective and established strategy for procuring public infrastructure (Chou & Pramudawardhani, 2015). Through PPP schemes, the public sector is able to outsource risks to the private investor so that cost efficiency and value for money are enhanced in delivering public facilities. Furthermore, through PPP schemes, public facilities are better managed and maintained compared with the conventional bid–build procurement system (Ke, Wang, Chan, & Cheung, 2011).

Importantly, considering the global interest in the PPP concept, many researchers have attempted to explore the critical success factors for PPP projects in both developing and developed economies/countries (Osei-Kyei & Chan, 2015a; Cheung, Chan, & Kajewski, 2012; Liu & Wilkinson, 2013; Li, Akintoye, Edwards, & Hardcastle, 2005a; Babatunde, Opawole, & Akinsiku, 2012). Despite the wide coverage of studies on critical success factors, the success criteria for PPP projects in developing and developed economies have received little or no attention in the mainstream literature. In recent times, success criteria have become very crucial because, without an in-depth insight into the criteria for PPP project success, it will be very challenging for investors and public authorities in either a developing or developed economy to completely assess whether their implemented projects have become successful or not. Nonetheless, there have been reported controversies in both developing and developed economies on whether or not implemented PPP projects have been successful (c.f. Tam, 1999; Osei-Kyei & Chan, 2015b). This therefore calls for the need to empirically evaluate the success criteria for PPP projects in developing and developed economies (Osei-Kyei, Chan, Javed, & Ameyaw, 2017).

As part of a larger research project that aims to develop a best practice framework for PPP implementation in Ghana, drawing on international experiences specifically from Hong Kong (Osei-Kyei & Chan, 2017), this article empirically investigates the differences and similarities of the success criteria for PPP projects in developing and developed economies, represented by Ghana and Hong Kong.

The basic reason for conducting a comparative study between a developing and developed economy is because PPP policy has grown and is now a global concept in which investors, consultants, financiers, and public officials are engaged irrespective of their cultural backgrounds and/or geographical differences (Osei-Kyei & Chan, 2017). Therefore, it will not be considerably
beneficial to explore the success criteria for PPP projects from a specific economic jurisdiction or country’s perspective (i.e., developing or developed economy). Comparing the differences and similarities of PPP project success criteria in diverse economies is more appropriate; essentially, this will inform international private investors of the core areas where resources are needed in order to achieve success when entering into PPP arrangements in any part of the world (Osei-Kyei & Chan, 2017). Additionally, governments, which have yet to adopt the PPP concept, will understand the success measures considered by other countries with similar or different economic conditions.

The findings of this study add to the knowledge on international best practices for PPP; specifically, they provide in-depth insight into what constitutes PPP project success in either a developing or developed economy. Moreover, they inform practitioners of the prevailing similarities and differences on the criteria for measuring PPP project success in developing and developed economies and/or countries. It is expected that international investors will be informed of the expectations of countries with different economic conditions when engaging in PPP arrangements.

**Literature Review on PPP Project Success Criteria**

Success criteria are defined as principles or standards by which something is judged as successful (Lim & Mohamed, 1999). Specifically, when a set of objectives for a project are fully achieved, then that project can be deemed successful (Ika, 2009). Over the past few decades, many researchers have explored the success criteria for construction projects, particularly for traditional bid-build projects (Jugdev & Müller, 2005). Time, cost, and quality have been the most frequently identified criteria for measuring the success of construction projects (Pinto & Slevin, 1989; Lim & Mohamed, 1999).

These criteria are what Atkinson (1999) labeled, the ‘iron triangle.’ (Ika, 2009)

Essentially, the iron triangle has been criticized by many traditional researchers for being narrow and geared toward the satisfaction of only clients and contractors (Al-Tmeemy, Abdul-Rahman, & Harun, 2011). In this regard, studies, including those by Ahadzie, Proverbs, and Olomolaiye (2008), Westerveld (2003), Cox, Issa, and Ahrens (2003), and Toor and Ogunsola (2010) have presented additional success measures that encompass more qualitative success criteria. Some of the qualitative measures include no contractual disputes, safety, technology transfer, low environmental impact, trust and respect, and long-term partnerships.

Considering that PPP projects have unique characteristics and features, such as the sharing of risks and responsibilities, mutual objectives and goals, and long-term arrangements (Akintoye, Hardcastle, Beck, Chinyio, & Asenova, 2003), very few success criteria of traditional bid-build projects are equally applicable. However, a review of past studies with a focus on the performance objectives, performance indicators, and performance measures of PPP projects could help to develop concise and well-defined success criteria for PPP projects (Osei-Kyei et al., 2017). Satisfying the need for public facility and/or service has been identified to be a critical performance objective in PPP project delivery (Yuan, Zeng, Skibniewski, & Li, 2009). Very often, PPP projects are initiated out of a special need. For example, in Norway, one of the critical needs for procuring the E39 Klett-Baarshaug project through a PPP scheme was to reduce the number of reported road accidents (COST Action TU1001, 2014). Thus, a considerable reduction in the number of accidents means that the need for such public facility using the PPP approach has been satisfied. It must be highlighted, however, that different countries may have different needs for procuring PPP projects and, emphatically, this varies among developing and developed economies.

Reduced public sector administration cost has also been reported to be a critical performance objective for PPP projects, thus a potential candidate for PPP project success criteria (Zhang, 2006; Yuan et al., 2009). Considering the fact that PPP allows the public sector to transfer risks to the private sector, it is expected that the administrative costs of the public sector will be reduced (Li, Akintoye, Edwards, & Hardcastle, 2003b). Importantly, this is not often seen in traditional bid-build procurement projects. In traditional public construction projects, the public sector retains more risks, which most of the time increase its administrative costs. The public sector’s administrative costs could even be much higher in very complex projects procured using the traditional bid-build system.

Effective risk management is very important in measuring PPP project success and has been mentioned as a critical performance measure of PPP projects (Dixon, Pottinger, & Jordan, 2005; Liu, Love, Davis, Smith, & Regan, 2015). Risk management is a key component of PPP project management (Xu et al., 2010). If risks are not properly managed, the tendency for a project to fail is very high (Chou & Pramudawardhani, 2015). Effective risk management simply implies properly identifying risks, assessing and completely allocating them to the party with better control of mitigation measures (Osei-Kyei et al., 2017). Furthermore, there are many projects around the world that have failed to progress successfully due to improper risk identification and incomplete transfer of risks (Osei-Kyei & Chan, 2015b).

Reduced public and political protests in PPPs are very relevant when assessing the success of PPP projects (Osei-Kyei et al., 2017). Public and political protests often disrupt the flow of the PPP process. Because of political protests, PPP projects could take several years before being implemented.
Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong

Protests occur when the general public and political parties are not convinced with the transparency and accountability of the procurement process. Toll hikes can also cause public and political agitation (Osei-Kyei & Chan, 2015b). However, it must be emphasized that the significance of this criterion depends on the political, social, and economic settings of a country.

Output specifications are used mostly in PPPs compared with input specifications (Lam & Javed, 2015). Thus, meeting output standards and/or requirements in a PPP arrangement could be considered to be a success measure (Osei-Kyei et al., 2017). Meeting output specifications contributes substantially to the satisfaction of users and the public client.

Local economic development is one of the success measures considered to be peculiar to PPP projects (Osei-Kyei et al., 2017). Generally, there is an expectation that through PPP schemes more job opportunities will be created because of the large scale and complexity of PPP projects. In addition, PPP projects are expected to offer better standards of living within the communities in which they are implemented (Osei-Kyei & Chan, 2015b); therefore, PPP projects that do not contribute substantially in terms of job opportunities and better access to public facilities could be deemed unsuccessful. The criticality of this criterion also depends on the jurisdiction; essentially, its significance could vary among developing and developed countries.

Research Methodology

Prior Literature and Pre-Testing
Based on a thorough review of earlier literature, Osei-Kyei et al. (2017) developed a comprehensive set of criteria for measuring PPP project success. The set of criteria was then sent to six PPP experts from the academic and industrial sectors—four from Ghana and two from Hong Kong (Osei-Kyei & Chan, 2017). The purpose of the pre-testing was to confirm the suitability of the criteria in each jurisdiction. Essentially, the experts confirmed the applicability and adequacy of the criteria within each jurisdiction. Table 1 shows the set of criteria for measuring PPP project success (Osei-Kyei et al., 2017).

Empirical Questionnaire Survey
A questionnaire survey was undertaken in Ghana and Hong Kong with relevant PPP practitioners between May 2015 and April, 2016 (Osei-Kyei & Chan, 2017). The questionnaire required respondents to rate the importance of each PPP project success criterion on a five-point Likert scale (i.e., 1 = least important and 5 = extremely important), as applied in their respective jurisdictions. Respondents were selected based on a two-stage sampling approach (Osei-Kyei & Chan, 2017). First, pre-defined criteria were used to identify initial prospective respondents. The criteria were: (1) the respondent should have in-depth knowledge on the general practice of PPP and should have followed the development of PPP in Ghana or Hong Kong very closely; and (2) the respondent should have extensive hands-on (i.e., at least one project) and/or research experience in PPP project delivery in Ghana or Hong Kong (Osei-Kyei & Chan, 2017). In the second stage, the identified respondents were asked to suggest potential colleagues who may be interested in participating in the research study. Most of the suggested prospective participants willingly agreed to participate in the study and were included in the final list of respondents (Osei-Kyei & Chan, 2017).

Overall, 207 respondents from the academic and industrial sectors were sourced and identified from dedicated private sector organizations, PPP-related publications with a focus on Ghana or Hong Kong, and public institutions with a strong interest in PPP projects (e.g., Ghana [Ghana Highways Authority, Department of Urban Roads, Public Investment Division, Ghana Water Company Limited, Ghana Ports and Harbours Authority, local government departments]; and Hong Kong [Housing Department; Hospital Authority, Highways Department, Efficiency Unit]) (Osei-Kyei & Chan, 2017). Of the total respondents identified, 120 came from Ghana, whereas 87 came from Hong Kong. A large number of respondents (i.e., 120 respondents) were identified in Ghana because, during the last couple of years, more public institutions have introduced quite a large number of PPP projects (i.e., over 18 major construction PPP projects) (Ministry of Finance and Economic Planning, 2011); therefore, more people are involved with PPP practices in Ghana than in Hong Kong. In addition, the population size of Ghana (approximately 26.7 million) is much higher than the population size of Hong Kong (approximately 7.24 million) (World Bank Group, 2015) (Osei-Kyei & Chan, 2017), thus there is a tendency to identify more potential respondents in Ghana than Hong Kong. Questionnaires were distributed to targeted respondents either through face-to-face meetings (i.e., the majority of questionnaires administered in Ghana) and/or emails (i.e., the majority of questionnaires administered in Hong Kong) (Osei-Kyei & Chan, 2017).

In total, 103 completed questionnaires were received—77 from Ghana and 26 from Hong Kong, which represent response rates of 64.17% and 29.89% for Ghana and Hong Kong, respectively (Osei-Kyei & Chan, 2017). The higher response rate in Ghana was anticipated considering that the majority of questionnaires were administered in person, which always yields a favorable response rate compared with online and telephone surveys (Szolnoki & Hoffman, 2013; Aquilino, 1994; Osei-Kyei & Chan, 2017). Although a lower response rate was obtained in Hong Kong, the sample size of 26 is considered satisfactory and reasonable when compared with previous related studies, which were conducted in Hong Kong (see, for example, Cheung et al., 2012 [34 responses]; Javed, 2013).
### Table 1: A set of 15 success criteria for PPP projects (Osei-Kyei et al., 2017).

<table>
<thead>
<tr>
<th>Success Criteria</th>
<th>Descriptions</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td>A continuous income/profit is received by parties during project operation.</td>
<td>X 2</td>
</tr>
<tr>
<td>Long-term relationship and partnership</td>
<td>Cordial relationship and well-established coordination are instituted among stakeholders.</td>
<td>X 3</td>
</tr>
<tr>
<td>Satisfying the need for public facility and/or service</td>
<td>An implemented PPP project fully satisfies the need for a public facility and/or service.</td>
<td>X 4</td>
</tr>
<tr>
<td>Adherence to time</td>
<td>Project is constructed on and/or before time schedule for commissioning.</td>
<td>X 5</td>
</tr>
<tr>
<td>Adherence to budget</td>
<td>Project is constructed according to the estimated cost and is without any operational cost overruns.</td>
<td>X 6</td>
</tr>
<tr>
<td>Reduced litigations and disputes</td>
<td>Contract litigations and disputes are minimized throughout the project life cycle.</td>
<td>X 7</td>
</tr>
<tr>
<td>Reduced public sector administrative cost</td>
<td>Lower cost is incurred by the public sector in the administration of the project because major project risks are allocated to the private sector.</td>
<td>X 8</td>
</tr>
<tr>
<td>Effective technology transfer and innovation</td>
<td>Technical knowledge and innovation are effectively shared among stakeholders, particularly with local practitioners.</td>
<td>X 9</td>
</tr>
<tr>
<td>Local economic development</td>
<td>The project contributes to the economic development of the community within which the project is developed.</td>
<td>X 10</td>
</tr>
<tr>
<td>Environmental performance</td>
<td>The project does not affect the health and safety of residents or the environment.</td>
<td>X 11</td>
</tr>
<tr>
<td>Reduced project life cycle cost</td>
<td>Lower life cycle cost is realized, which enhances the project’s value for the money.</td>
<td>X 12</td>
</tr>
<tr>
<td>Reliable and quality service operations</td>
<td>Continuous and uninterrupted project services are provided and according to the satisfaction of users.</td>
<td>X 13</td>
</tr>
<tr>
<td>Meeting output specifications</td>
<td>The project meets the expected output standards and/or requirements and delivery.</td>
<td>X 14</td>
</tr>
<tr>
<td>Effective risk management</td>
<td>Risks are properly identified. The risk sharing and transfer mechanisms are agreed on and effectively implemented by the public and private parties.</td>
<td>X 15</td>
</tr>
<tr>
<td>Reduced public and political protests</td>
<td>There are reductions in agitation and protests, which often arise due to increases in tariffs, lack of transparency, corruption, and so forth.</td>
<td>X 16</td>
</tr>
</tbody>
</table>


[18 responses]). More importantly, the respondents from Hong Kong possess rich PPP experience both in practice and research, which makes their responses suitable and adequate for further analysis (Table 2). Notwithstanding, the overall sample size of 103 is adequate and suitable for analysis when compared with past related studies, including those from Cheung et al. (2012) (45 responses—34 from Hong Kong and 11 from Australia) and Liu, Wang, and Wilkinson (2016) (57 responses—32 from China and 25 from Australia) (Osei-Kyei & Chan, 2017). A summary
Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong

of the respondents’ profiles is presented in Table 2 (Osei-Kyei & Chan, 2017).

Analytical Techniques
The Statistical Package for Social Sciences (SPSS) 21.0 was used to perform statistical tests, including Kendall coefficient of concordance, mean score ranking, and the Mann–Whitney U test. First, the degree of consistency on responses within each respondent group (i.e., Ghana and Hong Kong) was measured using the Kendall’s concordance analysis. This analysis was conducted because different respondents from different sectors (i.e., public, private, and academic sectors) participated in the survey, thus it was vital to test the degree of consistency among responses in each respondent group (i.e., Ghana and Hong Kong) was measured using the Kendall’s concordance analysis. The analysis was conducted because different respondents from different sectors (i.e., public, private, and academic sectors) participated in the survey, thus it was vital to test the degree of consistency among responses in each respondent group (i.e., Ghana and Hong Kong) (Osei-Kyei & Chan, 2017). Second, the ranking of factors (i.e., PPP project success criteria) in each respondent group was determined using the mean score analysis. Third, the Mann–Whitney U test was used to identify the similarities in the top and bottom rankings of factors, the mean values were grouped into quartiles (upper and lower quartiles). Based on the groupings, the success criteria for PPP projects with similar rankings in both countries were identified (Osei-Kyei & Chan, 2017).

Results and Discussion
Consistency of Responses in Each Group
The Kendall’s coefficient of concordance (W) was conducted for each independent group at a significance level of 0.05. The test was conducted with a hypothesis that there is no consistency on the ranking of factors among respondents in a respondent group. Thus, a p-value of less than 0.05 means a rejection of the null hypothesis. The computed W values are 0.345 and 0.561 for Ghana and Hong Kong, respectively. Both respondent groups had 0.00 as their significance value, which is below 0.05; thus, the null hypothesis is rejected for each group. This suggests that there are consistency and agreement on the ranking of factors among respondents in each group, which reaffirms the validity and genuineness of the survey responses for further analysis.

Mean Analysis and Significant Difference(s) on the Rankings of PPP Project Success Criteria in Ghana and Hong Kong
The mean ranking of PPP project success criteria for each respondent group is shown in Table 3. It is noticeable that the mean values range from 2.70 to 4.40 for Ghana and 2.23 to 4.42 for Hong Kong, respectively. The standard deviations in responses are 1.7 and 2.19 for Ghana and Hong Kong, respectively. Clearly, the large deviation in Hong Kong suggests that the Hong Kong respondents did not rate the set of criteria similarly as their Ghanaian counterparts.

The last column in Table 3 shows the significant test results on the ranking of PPP project success criteria among respondents from Ghana and Hong Kong. The test was conducted at a pre-defined significance test value of 0.05. Thus, a success criterion with a p-value of less than 0.05 indicates that respondents from both countries view the importance of that criterion differently. As presented in Table 3, nine of the fifteen PPP project success criteria are significantly different among the two countries. Clearly, this finding
supports assertions that PPP practice varies among different economies, specifically among developing and developed economies (Osei-Kyei & Chan, 2015a). Thus, different criteria are used to measure the success of PPP projects in these two diverse economies (Osei-Kyei et al., 2017).

Importantly, the success criteria with significant differences that are ranked higher in Ghana and lower in Hong Kong relate directly to dispute minimization and social and economic developments associated with PPPs. These include profitability, reduced public and political protests, reduced litigations and disputes, local economic development, and effective technology transfer and innovation. This is not surprising considering the fact that disputes in PPPs due to public opposition are common setbacks in developing countries, particularly in Ghana and other sub-Saharan African countries (Osei-Kyei & Chan, 2015b; Amadi, Carrillo, & Tuuli, 2014). In addition, economic and social developments associated with PPP implementation have been identified as some of the reasons why governments in developing economies, particularly Ghana, enter into PPP arrangements (Osei-Kyei, Dansoh, & Ofori-Kuragu, 2014).

Profitability is ranked first in Ghana and eleventh in Hong Kong. In essence, there is a very wide mean difference between the two jurisdictions (i.e., 4.40 in Ghana and 3.31 in Hong Kong). This finding is in line with assertion by the World Bank, Infrastructure Consortium for Africa (ICA), and Public–Private Infrastructure Advisory Facility (PPIAF) (2009) that PPP projects in African countries, including Ghana, that are not likely to generate enough profit for parties stand the chance of not being successful. Profitability is critical in Ghana because of the many risks associated with PPP projects, which make them very costly. Emphatically, procuring PPP projects in Ghana requires huge capital due to the unfavorable economic conditions; thus, project parties are very keen on the profitability of the project. It must be emphasized that in Ghana’s PPP practice, it is not only the private investor who desires to achieve adequate profit; the government also expects maximum investment returns. This is because most projects are supported financially by the government, either in the form of debt or equity financing (Ministry of Finance and Economic Planning, 2011). More importantly, the Government of Ghana (GoG) aims to use the proceeds from PPP

<table>
<thead>
<tr>
<th>PPP Project Success Criteria</th>
<th>Ghana Mean Rank</th>
<th>Hong Kong Mean Rank</th>
<th>Mann–Whitney U test</th>
<th>U statistics</th>
<th>Z</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting output specifications</td>
<td>4.32 2</td>
<td>4.15 4</td>
<td>4.28 1</td>
<td>830.5</td>
<td>-1.485</td>
<td>0.137</td>
</tr>
<tr>
<td>Adherence to budget</td>
<td>4.23 3</td>
<td>4.42 1</td>
<td>4.28 2</td>
<td>825</td>
<td>-1.467</td>
<td>0.142</td>
</tr>
<tr>
<td>Adherence to time</td>
<td>4.14 4</td>
<td>4.35 2</td>
<td>4.19 3</td>
<td>849.5</td>
<td>-1.258</td>
<td>0.208</td>
</tr>
<tr>
<td>Profitability</td>
<td>4.40 1</td>
<td>3.31 11</td>
<td>4.13 4</td>
<td>320.5</td>
<td>-5.513</td>
<td>0.000*</td>
</tr>
<tr>
<td>Effective risk management</td>
<td>3.78 6</td>
<td>4.27 3</td>
<td>3.90 5</td>
<td>644.5</td>
<td>-2.938</td>
<td>0.003*</td>
</tr>
<tr>
<td>Reliable and quality service operations</td>
<td>3.87 5</td>
<td>3.88 5</td>
<td>3.87 6</td>
<td>1000.5</td>
<td>-0.004</td>
<td>0.996</td>
</tr>
<tr>
<td>Environmental performance</td>
<td>3.64 7</td>
<td>3.38 10</td>
<td>3.57 7</td>
<td>843</td>
<td>-1.306</td>
<td>0.191</td>
</tr>
<tr>
<td>Reduced public and political protests</td>
<td>3.49 10</td>
<td>3.08 12</td>
<td>3.39 8</td>
<td>681</td>
<td>-2.615</td>
<td>0.009*</td>
</tr>
<tr>
<td>Long term relationship and partnership</td>
<td>3.38 11</td>
<td>3.42 9</td>
<td>3.39 9</td>
<td>985.5</td>
<td>-0.127</td>
<td>0.899</td>
</tr>
<tr>
<td>Reduced litigations and disputes</td>
<td>3.55 9</td>
<td>2.58 13</td>
<td>3.30 10</td>
<td>438.5</td>
<td>-4.53</td>
<td>0.000*</td>
</tr>
<tr>
<td>Local economic development</td>
<td>3.56 8</td>
<td>2.23 15</td>
<td>3.22 11</td>
<td>212</td>
<td>-6.335</td>
<td>0.000*</td>
</tr>
<tr>
<td>Effective technology transfer and innovation</td>
<td>3.36 12</td>
<td>2.38 14</td>
<td>3.12 12</td>
<td>450.5</td>
<td>-4.37</td>
<td>0.000*</td>
</tr>
<tr>
<td>Reduced public sector administrative cost</td>
<td>2.96 13</td>
<td>3.54 7</td>
<td>3.11 13</td>
<td>589.5</td>
<td>-3.448</td>
<td>0.001*</td>
</tr>
<tr>
<td>Reduced project life cycle cost</td>
<td>2.84 14</td>
<td>3.69 6</td>
<td>3.06 14</td>
<td>398</td>
<td>-4.999</td>
<td>0.000*</td>
</tr>
<tr>
<td>Satisfying the need for public facility and/or service</td>
<td>2.70 15</td>
<td>3.46 8</td>
<td>2.89 15</td>
<td>509.5</td>
<td>-3.918</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

Table 3: Mean ranking and Mann–Whitney U test results of the success criteria for PPP projects in Ghana and Hong Kong.
projects to strengthen its infrastructure investment fund and other funding schemes.

Unlike Ghana, Hong Kong does not consider profitability a key success measure for PPP projects, which is understandable because, according to Chan, Lam, Chan, Cheung, and Ke (2009), over the last couple of years, Hong Kong has enjoyed abundant financial reserves and a budget surplus, therefore, financial drive is not as critical as that seen in Ghana. Although private investors in Hong Kong may consider profit important, the government certainly does not consider it a priority in PPP arrangements (Cheung et al., 2012).

Reduced public and political protests are ranked tenth in Ghana and twelfth in Hong Kong. Although this is a close ranking, the mean difference is large (i.e., 3.49 in Ghana and 3.08 in Hong Kong). Public and political protests in PPPs are not uncommon in Ghana. Very often the lack of transparency and accountability on the part of project parties raise questions and doubts among the general public. Other protests may also come as a result of high user charges and lack of cooperation (Ismail & Haris, 2014). This was seen in the Ghana National Housing Project attempted by the GoG in 2011. In that project, there were countless demonstrations and political agitations on the accountability and transparency of the PPP arrangement. A section of the populace believed that the government had not bargained in the interest of the general public but favored the private investor (Ghana News Agency, 2010). This notwithstanding, in Nigeria, which is a developing economy, Osei-Kyei and Chan (2015b) reported that several demonstrations and protests occurred as a result of high user fees and the lack of cooperation among stakeholders. Although public and political protests over PPP arrangements may be difficult to eradicate in Ghana, essentially their occurrences should be reduced to the lowest in order to make PPP projects successful.

With respect to Hong Kong, public and political protests are not as rampant as those seen in Ghana and other African countries. Thus, it is understandable as to why this criterion is ranked lower by the Hong Kong respondents. Emphatically, most of the past PPP projects in Hong Kong had not suffered so much from public and political protests. Some examples include the Cross Harbour Tunnel initiated in 1969; the Asia World Expo project, which opened in 2005; and the Hong Kong Disneyland Theme Park, which also opened in 2005.

The success criterion, ‘reduced litigations and disputes’ is ranked ninth in Ghana, whereas the Hong Kong respondents ranked it thirteenth; this is a large mean difference of 0.97 (i.e., 3.55 in Ghana and 2.58 in Hong Kong). In Ghana’s PPP practice, litigations and disputes in PPP arrangements stem from the lack of experience of contracting authorities in contract negotiations. This is because, very often, public officials agree on contract terms that are not in the interest of the general public and, more importantly, they retain excessive risks and responsibilities. In the long term, these actions result in litigations and disputes, which subsequently end up in high unplanned costs, contract abstraction, and reputation and relationship damage (Cisse, Menon, Segger, & Nmehielle, 2013). Practically, within the Ghanaian context, it may be difficult to completely eliminate litigations and disputes in PPPs; however, their occurrence could be reduced to the lowest level. Ideally, a well-structured and defined dispute resolution mechanism will help achieve a reduced number of litigations and disputes in PPP contracts (Osei-Kyei et al., 2017).

Unlike Ghana, Hong Kong is not completely new to the concept of PPP. Importantly, the private sector has played a very active role in developing Hong Kong’s economy compared with that in Ghana. When it comes to contract negotiations, their public authorities are experienced enough to engage in fruitful negotiation processes. This, therefore, has helped to minimize litigations in most of their past PPP arrangements, including the Cross Harbour Tunnel, Asia World Expo, and Hong Kong Disneyland projects. Notwithstanding, Hong Kong has a well-organized legal system, which deals with litigations and disputes in a cordial manner compared with that in Ghana. These are the possible reasons why Hong Kong may not place more emphasis on reduced litigations and disputes when measuring PPP project success.

Local economic development is ranked eighth in Ghana and fifteenth in Hong Kong. In essence, there is a large mean difference of 1.33 (i.e., 3.56 in Ghana and 2.23 in Hong Kong). Local economic development refers to the economic benefits associated with PPP projects, which includes employment opportunities and easy access to public facilities by local commuters (Osei-Kyei et al., 2017). Emphatically, some of the motives of the Ghanaian government engaging in PPPs include solving the huge infrastructure deficit and creating more job opportunities for the people of Ghana (World Bank, 2009). Unemployment and pressure on public facilities are very high in Ghana due to the rapid urbanization growth rate. The current unemployment rate in Ghana among youth stood at 8.70% in 2013 (World Bank, 2015). In addition, the infrastructure deficit in Ghana requires an annual expenditure of US$1.5 billion (World Bank, 2009). The PPP concept is therefore viewed by the government as a means to reducing the unemployment rate and bridging the infrastructure gap. With PPP projects, different job opportunities requiring both skilled and unskilled labor, are often created (Osei-Kyei et al., 2017).

In Hong Kong, it is understandable why local economic development is not a critical PPP project success criterion. Obviously, Hong Kong is one of the jurisdictions in the world with rapid infrastructure growth and a low unemployment rate (i.e., 3.4% as of 2016) (Census and Statistics Department, 2016); therefore, PPP implementation
is not perceived to be very impactful in terms of reducing unemployment and boosting infrastructure growth as that seen in Ghana. It is worth noting, however, that although past projects may have contributed to the economic development of Hong Kong in terms of providing job opportunities, local economic development is not necessarily an important criterion in judging the success of PPP projects in Hong Kong. In essence, other criteria are more critical than this criterion based on the ranking.

The success criterion, ‘effective technology transfer and innovation’ is ranked twelfth by respondents from Ghana and fourteenth by their Hong Kong counterparts. Although this ranking is quite close, the mean difference is large (i.e., 3.36 in Ghana and 2.38 in Hong Kong). A study conducted by Osei-Kyei et al. (2014) pointed out that technology transfer and innovation in PPPs is one of the reasons for PPP implementation in Ghana. In Ghana, the direct foreign investment in infrastructure development is gradually increasing. As of 2008, 9.52% of the total GDP came from direct foreign investment in infrastructure in different economic sectors (Global Economy, 2016). Essentially, the government aims to use PPP schemes to help local practitioners, so that they can benefit from the skills and expertise of international firms (Ministry of Finance and Economic Planning, 2011). Certainly, in the long term, local practitioners will be equipped with the skills and knowledge, which will enable them to undertake large-scale projects or partner with other international firms; this will therefore expand the local PPP market and enhance the practice of PPPs.

In Hong Kong the issue of technology transfer to local enterprise is not as critical as that seen in Ghana (Cheung et al., 2012). This is because most of the past PPP projects in Hong Kong have been undertaken by local practitioners who have adequate experience. A typical example of such projects is the Cyber Port PPP Project, constructed and managed by the Pacific Century Group (Lee, 2005). In support of this finding, Li et al. (2005a) also emphasized that technology transfer is certainly not relevant in the United Kingdom because of the rich experience of local practitioners’ in delivering private finance initiative PFI projects.

Effective risk management, reduced public sector administrative cost, reduced project life cycle cost, and satisfying the need for public facility and/or service are ranked higher in Hong Kong than in Ghana. In essence, they directly relate to the efficiency in the cost and service delivery of PPP projects. This outcome is not surprising, because a study conducted by Cheung, Chan, and Kajewski (2010) identified efficiency-related factors as the important reasons for PPP implementation in Hong Kong. Effective risk management is ranked third by Hong Kong respondents, whereas their Ghanaian counterparts ranked it sixth. This success criterion encompasses the proper identification, equitable allocation, and effective treatment of risks (Osei-Kyei et al., 2017). Certainly if risks are properly managed, the overall cost of the project is reduced, which therefore enhances cost efficiency.

In recent times, risk management has become very important in Hong Kong’s PPP practice because of the experience of past projects, including the Western Harbour Crossing project. In the Western Harbour Crossing project, the demand and/or market risk was fully allocated to the private investor, who had no adequate mitigation measures for such risk because of the existence of alternative routes (Tam, 1999). Ideally, the demand and/or market risk should have been shared among parties as seen in other PPP projects, such as the Hong Kong Disneyland Theme Park (Shen, Platten, & Deng, 2006). The misallocation of the demand and/or market risk in the project has caused serious financial loss to the private investor. In addition, there has been agitation by the general public and members of the Legislative Council on toll hikes (Tam, 1999). Due to these previous experiences, managing risks effectively in PPP projects is a critical issue, which has been emphasized in the policy guideline for PPPs issued by the Efficiency Unit in Hong Kong (Efficiency Unit, 2008).

Unlike Hong Kong, effective risk management is not critical in Ghana. This is because Ghana has very little experience with PPP implementation, particularly for construction projects. Essentially, few projects have been implemented, with many projects still at the preparatory stages; therefore, there is little experience when it comes to risk management in PPPs. Importantly, as more projects are being implemented, effective risk management may become a critical issue such as that seen in Hong Kong.

Reduced public sector administrative cost and reduced project life cycle cost are ranked seventh and sixth in Hong Kong, respectively. In Ghana, these success criteria for PPP projects are ranked thirteenth and fourteenth, respectively; the mean difference between both countries is large for each criterion. In Hong Kong, the public sector incurs many administrative costs when procuring public projects. This is primarily because of the excessive risks retained by the public sector. Therefore, it is expected that through PPP, the public sector will transfer more risks to the private investor, thereby reducing the administrative cost of procuring public facilities. Similarly, public construction projects are very costly to procure and maintain in Hong Kong considering many factors, including the complexity of projects, and the lack of land and labor. Hence, PPP is considered as the ideal option to offer a more reduced project life cycle cost compared with the traditional bid-build procurement method (Efficiency Unit, 2008).

With respect to Ghana, public authorities do not incur much administrative cost when procuring some public projects. This is basically because public projects, including six-unit classroom...
Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong

blocks and public markets, are low complexity and do not have many risks as those seen in Hong Kong. Thus, the drive to use PPP as an ideal approach to reducing administrative costs when procuring most public projects is lacking.

Satisfying the need for public facility and/or service is ranked eighth by the Hong Kong respondents, whereas their Ghanaian counterparts ranked it fifteenth. Generally, conducting need analysis is required prior to PPP implementation; however, this has become more critical in Hong Kong because of the specific functions required of PPP projects implemented in Hong Kong. In essence, Hong Kong mostly has specific and special reasons for implementing specific PPP projects, which is unusual in Ghana. Projects may be implemented specifically to boost tourism or for information technology development. Emphatically, the needs for a PPP project in Hong Kong go beyond bridging the infrastructure gap and budgetary constraints. Because of this, the Efficiency Unit emphasized in their 2008 policy guideline for PPP that the need analysis of PPP projects must be carefully and effectively done prior to PPP implementation in Hong Kong. On the other hand, Ghana does not implement PPP projects with specific and special reasons as those realized in Hong Kong’s PPP practice. The emphasis placed on satisfying the specific need for PPP projects in Hong Kong is certainly not the same in Ghana. The specific and special expectations for PPPs in Hong Kong also include the usage of green technologies and sustainability measures in PPPs.

Similarities on the Ranking of PPP Project Success Criteria among Respondents from Ghana and Hong Kong

The similarities in the top and bottom rankings by respondents from Ghana and Hong Kong are identified using quartile groupings (Table 4).

<table>
<thead>
<tr>
<th>Quartiles</th>
<th>Ghana Project Success Criteria</th>
<th>Mean</th>
<th>Hong Kong Project Success Criteria</th>
<th>Mean</th>
</tr>
</thead>
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<tr>
<td>Upper Quartile</td>
<td>Profitability</td>
<td>4.40</td>
<td>Adherence to budget</td>
<td>4.42</td>
</tr>
<tr>
<td>Q1(Ghana) = 4.14</td>
<td>Meeting output specifications</td>
<td>4.32</td>
<td>Adherence to time</td>
<td>4.35</td>
</tr>
<tr>
<td></td>
<td>Adherence to budget</td>
<td>4.23</td>
<td>Effective risk management</td>
<td>4.27</td>
</tr>
<tr>
<td>Q1(K) = 4.15</td>
<td>Adherence to time</td>
<td>4.14</td>
<td>Meeting output specifications</td>
<td>4.15</td>
</tr>
<tr>
<td></td>
<td>Effective technology transfer and innovation</td>
<td>3.36</td>
<td>Reduced public and political protests</td>
<td>3.08</td>
</tr>
<tr>
<td>Lower Quartile</td>
<td>Reduced public sector administrative cost</td>
<td>2.96</td>
<td>Reduced litigations and disputes</td>
<td>2.58</td>
</tr>
<tr>
<td>Q1(Ghana) = 3.36</td>
<td>Reduced project life cycle cost</td>
<td>2.84</td>
<td>Effective technology transfer and innovation</td>
<td>2.38</td>
</tr>
<tr>
<td>Q1(K) = 3.08</td>
<td>Satisfying the need for public facility/service</td>
<td>2.70</td>
<td>Local economic development</td>
<td>2.23</td>
</tr>
</tbody>
</table>

Note: Quartiles cut-off values are calculated using the Quartile function in MS Excel.

Table 4: Quartile groupings of PPP project success criteria in Ghana and Hong Kong.
countries (i.e., 4.14 in Ghana and 4.35 in Hong Kong). Basically, time is very critical in PPP project delivery. This is because the earlier the investor completes the project, the faster the project parties are able to start operation and recoup their investment returns. This is one of the fundamental reasons why many PPP projects around the world are often completed either before or on time (Osei-Kyei & Chan, 2015b; Kumaraswamy & Zhang, 2001). In essence, adhering to time makes the public facility available for usage by the general public earlier; in this regard, irrespective of cultural and geographical differences, adherence to time in PPPs is beneficial to both the project parties and users.

Meeting output specifications is ranked second and fourth by respondents from Ghana and Hong Kong, respectively. Similarly, it has very close mean values for both respondent groups (i.e., 4.32 in Ghana and 4.15 in Hong Kong). This success criterion refers to meeting the expected output requirements and/or standards of a facility (Osei-Kyei et al., 2017). In PPP project arrangements, output-based specifications are provided rather than input specifications (Lam & Javed, 2015). This is done so that the investor can adopt innovative and creative approaches in delivering the project. In traditional bid-build procurement projects, this PPP project success criterion may be labeled as quality or technical specification adherence. Similarities in the top and bottom quartile groupings (i.e., upper quartile (top ranking) and lower quartile (bottom ranking)). The results reveal that adherence to budget, adherence to time, and meeting output specifications are very critical in both countries. On the contrary, effective technology transfer and innovation are of low importance in both countries, particularly in Hong Kong.

Conclusion

This article has empirically compared the criteria for measuring the success of PPP projects in developing and developed countries, using Ghana and Hong Kong as examples. An empirical questionnaire survey was undertaken in both countries with relevant experienced PPP practitioners. The Kendall’s concordance analysis, mean score ranking, Mann–Whitney U test, and quartile groupings were used for analysis. The results from the Kendall’s concordance test indicated the agreement and consistency on the ranking of factors (i.e., PPP project success criteria) within each respondent group. The mean ranking analysis shows that respondents from Ghana ranked the factors similarly as their Hong Kong counterparts. Additionally, nine project success criteria for PPP projects emerge as critical in Ghana, whereas seven PPP project success criteria are critical in Hong Kong. The significant test results reveal nine PPP projects success criteria with varying levels of importance among respondents from the two independent groups. Emphatically, those that are ranked higher in Ghana and lower in Hong Kong relate to dispute minimization and the social and economic developments associated with PPP projects. These include: profitability, reduced public and political protests, reduced litigations and disputes, local economic development, and effective technology transfer and innovation. On the other hand, criteria that are ranked higher in Hong Kong and lower in Ghana directly relate to the efficiency in cost and service delivery of PPP projects, which include effective risk management, reduced public sector administrative cost, reduced project life cycle cost, and satisfying the need for public facility and/or service. Similarities in the top and bottom rankings were identified using quartile groupings (i.e., upper quartile (top ranking) and lower quartile (bottom ranking)). The results reveal that adherence to budget, adherence to time, and meeting output specifications are very critical in both countries. On the contrary, effective technology transfer and innovations are of low importance in both countries, particularly in Hong Kong.

The outputs of this study contribute substantially to the knowledge on the international best practices of PPP. Moreover, international developers and public authorities in both developing and developed countries can be informed of the core areas where resources need to be channeled in order to achieve success. More importantly, practitioners in developing and developed countries will have the opportunity to evaluate whether or not their projects have been successful.

The major limitation of this study lies in the fact that low samples are used for comparison; therefore, the results cannot be readily generalized. However, considering that the majority of respondents have a reasonable number of years of research and/or industrial experience in PPPs in their respective jurisdictions, the research outputs are still significant and valuable for future reference.
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Acknowledgments
This article forms part of a research project entitled “A Best Practice Framework for PPP Implementation for Infrastructure Development in Ghana,” from which other articles have been produced with different objectives and/or scopes but sharing the same background and methodology. The research project described is fully supported by the Hong Kong PhD Fellowship Scheme from the Research Grants Council (RGC) of the Hong Kong Special Administrative Region and The Hong Kong Polytechnic University, Hong Kong. The authors wish to express their sincere gratitude to all PPP practitioners and researchers in Ghana and Hong Kong who participated in this research study.

References


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The Influence of Critical Success Factors on Value for Money Viability Analysis in Public–Private Partnership Projects

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ABSTRACT

Governments are increasingly entering partnerships with the private sector through the public–private partnership (PPP) model for the development of public projects. Value for money analysis is used to assess the viability of these ventures. This research aims to investigate the contribution of the PPP critical success factors to value for money viability analysis. Relevant data were collected through a questionnaire to establish the PPP critical success factors and value for money success criteria. Data were collected from 92 participants. The data obtained were analyzed using mean score, t-test, and regression analysis. The research found that government guarantees, macroeconomic conditions, shared authority between the public and private sectors, social support, and transparent procurement process contributed positively to value for money viability analysis. The results imply that practitioners should consider these key indicators for improving the value for money viability of PPP projects.

KEYWORDS: PPP; critical success factors; value for money; viability analysis

INTRODUCTION

The PPP terminology was first introduced in the United Kingdom in 1997. Prior to this, other arrangements of a similar collaborative form of engaging the private sector fell within the private finance initiative, which was introduced by the UK government in 1992 (Broadbent & Laughlin, 2003, 2004). PPPs are expected to help maximize value in the development of public projects. This is based on the theory that additional value can be realized through the participation of the private sector in the provision of public services (Broadbent & Laughlin, 2004; Williams, 2016). This is attributed to the fact that the private sector is capable of minimizing life cycle costs, efficiency in risk management, producing clear service outputs, and specifying robust technological requirements for the full duration of the project (The European PPP Enterprise Centre [EPEC], 2012; The Canadian Council for PPP, 2011). Another factor that leads to the proliferation of PPPs is the integration of the project development cycle stages. This integration consists of funding, planning, constructing, managing, and maintaining the projects by private investors (Almarri & Blackwell, 2014; Broadbent & Laughlin, 2003; European Commission [EU], 2003). Moreover, PPP contracts are aimed at using the private sector experience to manage risk, quality, efficiency, innovation, and finance (Osei-Kyei & Chan, 2015). The PPP model is shaped by three major factors: ownership, internal control, and funding (University of Melbourne, 2011). Ownership refers to the financial gearing of the project, where the equities are clearly defined; internal control refers to the management of the project to achieve its goals; and funding refers to financial support that either party is willing to contribute. PPPs are reported to have high success rates in terms of efficiency, innovation, quality, funding, and risk (Alfen, 2010). Because of these perceived benefits, PPPs have become an extremely popular mechanism for procuring public work around the world (Alfen, 2010; Rouboutsos & Saussier, 2014). However, developing public projects under the PPP method depends to a large extent on the outcome of value for money viability analysis. Realizing value for money in PPP depends on the ability to identify and allocate risks to those parties that have the ability to manage them in a better manner. The underlying principle of risk allocation is that each risk should be allocated to the party that is able to control its occurrence and impact on the project, as well as absorb its consequences with the smallest financial impact (Chou, Tserng, Lin, & Yeh, 2012; The World Bank Institute [WBI], 2012). In order for PPPs to deliver the anticipated value from risk management, stringent success criteria must be put in place to make sure the...
The Influence of PPP Critical Success Factors on Value for Money Analysis

planned value is delivered as assumed (Williams, 2016). The underlying concept of success in PPP projects can be interpreted in several ways. For instance, success could be measured by the partner partnerships based on particular criteria—for example, governance, collaboration, and so forth—as cited by Jeffares, Helen, and Boivard (2009). Others view success from the standpoint of broader societal benefits, such as the efficiency of public services delivery. Success is also viewed from the development and operation of PPP projects’ aspects, using factors such as communication, teamwork, and so forth. The latter concept of success is measured based on the outcomes of the PPP contract at the stage of completion and the ongoing operational performance of the project. All these views and others have their own merits. In this study, success is associated with factors that lead to the achievement of value of money objectives during the project viability analysis stage.

There is a common understanding that the PPP method has prospered because of its perceived ability to deliver value for money. However, a recent report, re-evaluating PPP projects by the UK government, eluded to the idea that PPP is becoming expensive and is not delivering value for money as it is supposed to do (The National Council for PPP, 2012). Thus, there is a need to investigate the factors that lead to better value for money (Ameyaw, Adjei-Kumi, & Owusu-Manu, 2015). Ismail (2013) examined the drivers that would help achieve value for money. The author found only two constructs (private sector technical innovation and competitive tender), which were perceived by practitioners to enhance value for money creation. A study by Zhen, Chen, and Zhang (2014) identified factors that influence value for money in PPP projects in Japan. The authors identified “operational environment, balancing the interests of both public and private sectors, and promoting the participation of the private sector in the timely provision of necessary public works and services” as key determinants of value for money (Zhen et al., 2014, p. 167). Although several studies have been conducted to prove the success of PPP applications, the underlying pattern in the existing literature on both critical success factors and value for money success criteria focuses on the importance and ranking of the critical success factors and value for money drivers (Ismail, 2013; Li, Akintoye, Edwards, & Hardcastle, 2005; Sarmento & Renneboog, 2016; Yuan, Zeng, Skibniewski, & Li, 2009). Notwithstanding the reporting on the success of PPP worldwide, numerous issues have led to failure in PPP projects, where value for money was not returned to the public sector. Mohsin and Zhang (2013) have identified failure drivers through the life cycle of PPP transportation projects. They found that several projects in the United Kingdom and the Netherlands did not achieve their value for money potential. In particular, the authors found that conflicts between partners are among the highly probable causes for not achieving value for money. Other authors have pointed to the issue of PPP projects’ failure to meet delivery outputs’ minimum requirements (McCann, Aranda-Mena, & Edwards, 2015). Research on critical success factors and value for money success also tends to concentrate on or study each of the themes in isolation; in reality, however, there is a potential interplay between the two constructs. Furthermore, most studies tend not to go beyond the listing and ranking of critical success factors and value for money constructs (i.e., factors affecting value for money). Thus, the aims of this investigation are to assess the contribution of critical success factors to value for money viability analysis.

This article is divided into six sections. The first section, Introduction, was an overview of the article. The second section presents a synthesis of the theoretical discussions regarding project critical success factors and value for money viability analysis factors. The third section presents the methodological approach that was followed to derive the results. The fourth section presents an analysis of the results; the fifth section presents the discussion and the implications of the results. The sixth and final section presents the conclusions and limitations of the study.

The Theoretical Background

Critical success factors are essential for the success of any process, and identifying and analyzing them according to their importance in creating value helps the practitioners to adhere to the contexts under which the projects are being developed (The Global Green Growth Forum, 2012). Also, critical success factors help direct the efforts and resources of the project team in more important areas, which leads to the successful delivery of the objectives (Gupta, Gupta, & Agrawal, 2013). “The ‘Critical Success Factors’ (CSF) concept was developed by Rockart and the Sloan School of Management with the phrase first used in the context of information systems and project management” (Jefferies, Gameson, & Rowlinson, 2002, p. 354). Jack Rockart was an American organizational theorist and a senior lecturer and co-founder of the MIT Sloan School of Management. The concept focuses on areas in which positive outcomes are critical for the organization to achieve its objective in an efficient and effective way (MIT CISR, 2017). Rockart’s classification of the critical success factors is widely used in the literature and particularly in public–private partnership research (Gudienė, Banaïtis, Podvezko, & Banaïtienė, 2014; Liu, Love, Davis, Smith, & Regan, 2014a; Medeiros, Perez, & Lex, 2014). Rockart classified critical success factors as industrial (industry characteristics), environmental (economy, competition, infrastructure), strategic (stakeholder objectives), and temporal (internal forces, barriers) (Jefferies et al., 2002). Others grouped them into discrete groups. Such factors can be studied collectively or
individually to establish, for example, the causal, contextual, and intervening effects and how they contribute to the success of PPP projects. Critical success factors proposed by Li et al. (2005), Zhen et al. (2014), and Cheung (2009) were used in this study. Table 1 shows the list of critical success factors included in this study. Further details about the backgrounds of these factors can be found in the References section.

### Value for Money Indicators

Value for money means delivering the required public services with the optimal cost and benefits (Akintoye & Chinyio, 2005). It is a key indicator used by the public sector to assess whether a PPP project will offer better value over other conventional procurement options. Akintoye and Chinyio (2005) and Henjewele, Sun, and Fewings (2011) stated that achieving value for money should be the benchmark strategic objective of PPP projects. Yuan et al. (2009, p. 257) stated that the strategic objective of value for money encompasses the "public client’s overall strategic plan and mission objectives, private sector’s long-term development and payoff strategy, the general public’s requirements of quality public facilities and services." Liu, Love, Smith, Regan, and Sutrisna (2014b) cited Henjewele et al. (2011) to state that “meeting client’s requirements should be considered as a core dimension in performance measurement of PPPs.” (Liu et al., 2014b, p. 502) Furthermore, Kušljic and Marenjak (2013, p. 949) stated that “a PFI project can be described as successful if it delivers value for money in the form of cost effective, reliable and timely services at agreed prices and to agreed quality, as defined in the contract.” These studies have highlighted the importance of conducting value for money analysis. There are different approaches for conducting value for money assessment. One approach is to check qualitatively that guidelines’ stipulations to achieve value for money are met, such as checking how well the PPP concession is structured. The other common approach is quantitative assessment, which is used for the identification of the critical success factors and their association with the local context. However, in practice, the two approaches are combined to appraise PPP projects through comparing key factors such as fiscal costs, risk adjusted costs, or economic cost-benefit to the conventional procurement options (The European PP Expertise Centre [EPEC], 2012; The Canadian Council for PPP, 2011; The World Bank Institute [WBI], 2012). No matter how robust the analysis, there are always unseen obstacles that may prevent PPPs from generating value for money. These include behavioral, policy, capital, technological, and coordination failures. Such difficulties impede competitiveness and the overall value for money efficiency of PPP projects. This poses the need to find solutions to overcome value creation performance problems. This research postulates that PPPs can offer additional value for money when there is synchronization between the project success factors and value for money viability analysis. The most cited factors that contribute to value for money include optimized risk allocation, competitive bid process, improved services to the community, clear output specifications, improved facilities to the users, optimization of assets efficiency, technical innovation, the private sector’s project management skills, incentives for private parties, appropriate capital structure, long-term engagement, efficient dispute resolutions, low life cycle cost, early service delivery, reduced negative environmental impact, and low tariffs (Li, 2003; Li et al., 2005). These value for money factors are also extensively cited and recognized in the PPP literature (Cheung, Chan, & Kajewski, 2009; Chou & Pramudawardhani, 2015; Ismail, 2013; Osisi-Kyei & Chan, 2015).

As demonstrated above, most studies tend to concentrate either on critical success factors or value for money factors. This study furthers the existing literature by addressing the

<table>
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<tr>
<th>Code</th>
<th>Items</th>
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<tbody>
<tr>
<td>SF1</td>
<td>Appropriate risk allocation</td>
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<tr>
<td>SF2</td>
<td>Commitment of public and private parties</td>
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<td>SF3</td>
<td>Committed and competent public agency</td>
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<td>SF4</td>
<td>Competitive procurement process</td>
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<td>SF5</td>
<td>Detailed cost/benefits assessment</td>
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<td>SF6</td>
<td>Favorable legal framework</td>
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<tr>
<td>SF15</td>
<td>Social support</td>
</tr>
<tr>
<td>SF16</td>
<td>Sound economic policy</td>
</tr>
<tr>
<td>SF17</td>
<td>Strong private consortium</td>
</tr>
<tr>
<td>SF18</td>
<td>Transparent procurement process</td>
</tr>
</tbody>
</table>

Table 1: PPP critical success factors.
The Influence of PPP Critical Success Factors on Value for Money Analysis

question of how likely critical success factors contribute to the value for money viability of PPP projects. It is common for most PPP procurement guides to suggest that each project be checked for viability and adherence to the goals of value for money and affordability agenda and objectives. For example, the UK’s HM Treasury stipulates that the PPP projects must be appraised for their value for money at very early stages by the procuring departments to show their economic, financial, and commercial viability. Thus, this research proposes to cluster the value for money factors that contribute to the viability of the PPP projects into economic, financial, and commercial clusters.

**Economic:** The purpose of the economic appraisal is to determine the impact of the proposed project on the cash flow and overall financial status of the procurer (Boussabaine, 2006). This appraisal must take into consideration the timing of cash flow occurrence and the cost of capital. The research hypothesizes that the following value for money indicators contribute to the economic viability of PPP projects (Cheung et al., 2009; Li et al., 2005):

- Low life cycle cost,
- Optimized risk allocation,
- Improved services to the community,
- Optimization of asset efficiency, and
- Early service delivery.

**Financial:** The financial value for money viability analysis provides an assessment of the funding solution in terms of affordability and impact on the procurer’s finances (Boussabaine, 2006). It is essential for the procurer to ascertain the capacity to pay for developing, operating, and maintaining the project for the intended contract period. This research hypothesizes that the following value for money indicators contribute to the financial viability of PPP projects (Li et al., 2005):

- Incentives for private parties, and
- Appropriate capital structure.

**Commercial:** The commercial value for money viability appraisal deals with key elements, such as the procurement process, the contract and its key elements, and risk transfer and payment mechanisms (Boussabaine, 2006). Most PPP guidelines do not make it a requirement to provide a commercial appraisal at an early stage of a project’s development. However, in order to realize the full potential of value for money from project development, we advocate some sort of analysis to inform the evaluation of comparisons between alternative options.

The research hypothesizes that the following value for money indicators contribute to the commercial viability of PPP projects (Cheung et al., 2009; Li et al., 2005):

- Technical innovation,
- Competitive bid process,
- Clear output specification,
- Efficient dispute resolutions,
- Long-term engagement, and
- Private sector’s project management skills.

The relationship between value for money indicators and project critical success factors is explored and tested through the following general hypotheses (Figure 1 illustrates the conceptual relationship between the research elements):

H1: The critical success factors correlate positively to value for money indicators.

H2: There is a statistically significant effect of critical success factors on value for money viability analysis in PPP projects.

This study further contributes to the theory of PPP critical success factors and value for money viability analysis by grouping the value for money success factors under three clusters—economic, financial, and commercial—and investigates further whether critical success factors contribute positively to the value for money’s viability analysis agenda.

**Methodology**

This research adopted the Saunders, Lewis, and Thornhill’s (2011) process for research development and design. The authors utilized a deductive approach to embrace both existing theories on critical success factors and value for money analysis, and to generate new empirical results. A survey design was selected to acquire data in a systematic manner from transitional and developed economies.

![Figure 1: Success factor (SF) variables influencing value for money (VFM) outcomes.](image-url)
The United Arab Emirates (UAE) was chosen as a representative of transitional economies, whereas the United Kingdom was chosen from the developed economies because of its pioneering role in PPP development and because its procurement processes are similar to those of the UAE.

The format of the questions was adapted from the template questionnaire designed by Li et al. (2005). The template consisted of separate segments for testing the attractive factors, value for money factors, and the critical success factors for PPP/PFI projects in the United Kingdom. This template and its contents are widely discussed and cited in the PPP literature (Cheung et al., 2009; Chou & Pramudawardhani, 2015; Ismail, 2013; Osei-Kyei & Chan, 2015). More important, Li et al.’s (2005) template was designed based on an extensive literature review. For example, eight critical success factors were imported from the work of Qiao, Wang, Tiong, and Chan (2001) in build–operate–transfer (BOT) projects in China: appropriate project identification; stable political and economic situation; attractive financial package; acceptable toll/tariff levels; reasonable risk allocation; selection of suitable subcontractors; management control; and technology transfer. These factors were then cross-checked with other studies. For example, reasonable risk allocation, Li et al. (2005) asserted, was supported by the work of Grant (1996) and Arthur Andersen and Enterprise LSE (2000). Another example is the available financial market, which is supported by the work of Jefferies et al. (2002) and McCarthy and Tiong (1991). Similar studies have also used the same techniques.

The questionnaire was conducted simultaneously in the United Kingdom and the UAE in 2015. The participants were selected from the public and private sectors and researchers. Professional experience in the field of PPPs in the UAE and PFI/PPP in the United Kingdom was mandatory. The chosen sampling criteria for this study were convenient sampling criteria. The reason for this selection was that the pool of respondents in the United Kingdom was difficult to penetrate and referrals were the only means of reaching qualified respondents. In addition, the pool of respondents from which to draw was relatively scarce in the UAE and the population that was sampled was unknown. This restricted the minimum requirement for using the random sampling process to make the sample representative of the population (Ellsberg, Heise, & World Health Organization, 2005). There were 30 qualified responses from the UAE and 62 from the United Kingdom. The process used to analyze the data is shown in Figure 2.

The research hypotheses were tested using univariate and bivariate analysis techniques. The testing was carried out in three stages. In the first stage, univariate techniques were used to study the characteristics of each of the value for money and success factor variables. In the second stage, Pearson correlation analysis was utilized to discover the interrelationships among the critical success factors and the value for money constructs. It was also used to test the first study hypothesis. In the third stage,
The Influence of PPP Critical Success Factors on Value for Money Analysis

The following regression equation was used to test hypothesis H2:

\[ \text{VFM} = \alpha + \beta \sum_{i=1}^{n} \text{CSF}_i + \varepsilon \]

VFM is the value for money indicators as described above.

\( \alpha \) is the estimated constant;

\( \beta \) is the estimated coefficient for each of the PPP critical success factors; and

CSF represents the independent critical success factors variables.

The data about the factors, which contribute to value for money analysis, were collected in a format similar to the critical success factors. Thirteen factors were extracted from the literature. Statistical Package for the Social Sciences (SPSS) software was used to cluster these into three groups—economic, financial, and commercial—as explained in the previous section. These formed three dependent value for money variables (constructs). Simple regression and Pearson correlation were used to assess whether critical success factors contribute positively to the three clusters of value for money viability analysis. The critical success factors that had insignificant \( P \) values were excluded from the multiple regression analysis.

**Descriptive Statistics and Ranking**

In total, 92 qualified questionnaires were returned out of the 326 distributed; of these, 23 responses came from the public sector, 40 from the private sector, and 29 from academics. The UK respondents accounted for 61.3% of the sample (Table 2). Although the number of respondents from the UAE was smaller, the statistical tests showed that there was no statistical difference between the two groups. For example, the Chi square value for the UAE and the UK samples are 114.89 and 141.70, respectively. This is significantly higher than the critical Chi square value of 27.59 when the degree of freedom is 17. Therefore, the null hypothesis—that there is a significant difference in the observations—is rejected, and the rankings provided by each group on the critical success factors for implementing PPPs are established to be consistent. Thus, the two samples were combined for carrying out a regression analysis as demonstrated in Figure 2. The Cronbach alpha reliability for the factors is 0.820. This suggests that the data collected are reliable and that all the critical success factors should be included in any further statistical analysis.

The relative ranking of the critical success factors and value for money was measured by mean Likert rating scale questions. This survey measurement instrument is widely used in the literature. For example, Li et al. (2005), Cheung (2009), Cheung, Chan, Lam, Chan, and Ke (2012), and Ismail (2013) used a similar scale to measure the importance of critical success factors. The results of the ranking are presented in the following subsections.

**Ranking of Critical Success Factors**

The mean scores for the nine highest critical success factors for PPP implementation were all above 4.00 (see Table 3). This shows that the selected critical success factors are of major importance.

The commitment of the public and private parties to the cause of PPP models is the most critical success factor indicated by the respondents from both the UAE and the United Kingdom. It ranked second and fourth in studies conducted by Cheung (2009) and Li (2003), respectively, which shows the persisting importance of this critical success factor. The public party must show its commitment by facilitating all means for the private party to maximize the success of the project through the provision of permits; legislations; legal frameworks; public support; access to the financial market; and so on, for the project. The private party must show commitment to the project by maximizing efforts to develop and manage the PPP project in the most effective and efficient way that balances the generation of profits for both parties

<table>
<thead>
<tr>
<th>Profession sector</th>
<th>UAE Frequency</th>
<th>%</th>
<th>UK Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researchers</td>
<td>3</td>
<td>10.0</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>Public sector practitioner</td>
<td>6</td>
<td>20.0</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Private sector practitioner</td>
<td>21</td>
<td>70.0</td>
<td>37</td>
<td>59.7</td>
</tr>
<tr>
<td>Organizational level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top management</td>
<td>17</td>
<td>56.7</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Middle management</td>
<td>10</td>
<td>33.3</td>
<td>36</td>
<td>58.1</td>
</tr>
<tr>
<td>General staff</td>
<td>3</td>
<td>10.0</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Years of experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 6 years</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>9.7</td>
</tr>
<tr>
<td>6–10 years</td>
<td>7</td>
<td>23.3</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>11–20 years</td>
<td>15</td>
<td>50.0</td>
<td>24</td>
<td>38.7</td>
</tr>
<tr>
<td>Above 21 years</td>
<td>8</td>
<td>26.7</td>
<td>15</td>
<td>24.2</td>
</tr>
<tr>
<td>Currently involved in UK PFI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11</td>
<td>36.7</td>
<td>44</td>
<td>71.0</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>63.3</td>
<td>18</td>
<td>29.0</td>
</tr>
</tbody>
</table>

Table 2: Personal and job-related variable frequencies.
with improved and cost-effective services for the public. The second most highly rated critical success factor was appropriate risk allocation. This factor was identically ranked second in Li’s (2003) study and fifth in Cheung’s (2009) study. This pattern indicates that this factor retains its importance as one of the most significant factors influencing the success of PPP projects. The main feature of PPP models is that they establish clearly the responsibilities that each party should bear during the development and operation of the project. Risk allocation should be based on very clear criteria, where the reason for allocating such risks is well established. Ranked third was the critical success factor ‘committed and competent public agency.’ This factor was ranked 12th by Cheung (2009) and seventh by Li (2003). This inconsistency between the three factors could be attributed to the fact that competence and commitment are already integral parts of the procurement practice in these researchers’ countries and there was no need to emphasize it. The public agency acts as a one-stop shop for the private party to deal with all governmental departments that are involved in the project. Large projects such as PPPs require permits and approvals throughout the development phases of the project, and facilitating such requirements will improve the chances for the project’s success. A transparent procurement process was ranked fourth by the respondents, with a mean score of significance of 4.33. This indicates how important the transparency of the bid process is, as it plays one of the most significant roles in awarding the project to the right bidder. Cheung (2009) and Li (2003) ranked this factor tenth and eleventh, respectively. This might be attributed to the fact that the procurement process is mature in their countries, and this factor is marginally significant.

The respondents gave the same significance to a strong private consortium. This item was ranked first in Li (2003) and third in Cheung (2009), indicating the importance of this critical success factor. The stronger the consortium, the more experience it brings to design and develop the most efficient and effective project.

The critical success factor competitive procurement process was ranked sixth by the respondents. It was ranked ninth and twelfth in Cheung (2009) and Li (2003), respectively, indicating this factor’s moderate significance. The competitive procurement complements the transparency of the bidding process in providing a mechanism for the prequalification of bidders, ensuring that negotiations are focused on bringing the best bidder and not only the best financial offer. Political support was ranked in seventh place by the respondents, with a mean score of significance of 4.17. Political support is very critical to the success of PPP; it must be durable throughout the life cycle of the PPP project, regardless of any change in parliaments or cabinets. The project should

<table>
<thead>
<tr>
<th>Code</th>
<th>Items</th>
<th>Mean 2016</th>
<th>Rank 2016</th>
<th>Cheung 2009</th>
<th>Li 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF2</td>
<td>Commitment of public and private parties</td>
<td>4.70</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>SF1</td>
<td>Appropriate risk allocation</td>
<td>4.70</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>SF3</td>
<td>Committed and competent public agency</td>
<td>4.43</td>
<td>3</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>SF18</td>
<td>Transparent procurement process</td>
<td>4.33</td>
<td>4</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>SF17</td>
<td>Strong private consortium</td>
<td>4.33</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>SF4</td>
<td>Competitive procurement process</td>
<td>4.27</td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>SF12</td>
<td>Political support</td>
<td>4.23</td>
<td>7</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>SF5</td>
<td>Detailed cost/benefits assessment</td>
<td>4.17</td>
<td>8</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>SF7</td>
<td>Good governance</td>
<td>4.13</td>
<td>9</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>SF6</td>
<td>Favorable legal framework</td>
<td>4.00</td>
<td>10</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>SF11</td>
<td>Multi-benefit objectives of all stakeholders</td>
<td>3.97</td>
<td>11</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>SF13</td>
<td>Project technical feasibility</td>
<td>3.97</td>
<td>12</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>SF14</td>
<td>Shared authority over public and private sectors</td>
<td>3.90</td>
<td>13</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>SF15</td>
<td>Social support</td>
<td>3.83</td>
<td>14</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>SF16</td>
<td>Sound economic policy</td>
<td>3.80</td>
<td>15</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>SF8</td>
<td>Government guarantees</td>
<td>3.63</td>
<td>16</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>SF10</td>
<td>Macroeconomic conditions</td>
<td>3.53</td>
<td>17</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>SF9</td>
<td>Local financial market</td>
<td>3.50</td>
<td>18</td>
<td>8</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 3: Mean and ranking of critical success factors (SF) for PPPs.
be protected from changes in legislation or regulations that might affect its objectives. The critical success factors detailed cost/benefits assessment and good governance had almost the same mean score. These critical success factors are integral parts of the project appraisal process, and very important factors for the success of PPP projects. Life cost studies give an early indication of the true value of the project in order to make a decision on whether to award them or not. Such assessments will identify financial and technical alternatives to maximize the benefits of the project. Furthermore, good governance and the favorable legal framework are very important for the success of PPP projects. The private party will seek a legal system that guarantees the proper interpretation and implementation of the agreements. This will ensure the satisfaction of all stakeholders and maximize the project’s chances for success.

The critical success factors that had a mean score of less than four were multi-benefit objectives of all stakeholders, project technical feasibility, shared authority between the public and private sectors, social support sound economic policy, government guarantees, macroeconomic conditions, and the local financial market. Although the ranks of these factors were low compared with the ranks of other factors, it does not mean that these critical success factors do not contribute to the success of PPP projects. In any case, their scores are well above the average score.

**Ranking of Value for Money**

The literature review showed that there were 16 main factors influencing the achievement of value for money in PPP projects (Table 4). The respondents selected optimized risk allocation, competitive bid process, improved services to the community, and clear output specification, as the most important factors that might influence value for money agenda. This indicates their importance in achieving the value for money objectives, and probably explains why some governments prefer PPP models over other conventional methods. Risk allocation plays a significant role in maximizing the success of PPP projects, leading to optimized performance and more value from the project.

A competitive bid process is critical to the success of PPP projects and to the value that they offer. Coherent and transparent bidding processes are essential for the success of the project and the maximization of its value for money (WBI, 2012). Clear output specification also was deemed significant. This is because PPP contracts are long-term projects in which input specifications vary over time. Thus, specifications must be very clear to avoid unnecessary disputes and to ensure that the public receives the right services and facilities as anticipated. Improved services for the community were ranked among the most important outcomes of PPPs. The private party seeks state-of-the-art technologies and innovative ideas for the development and operation of the project, all of which lead to better services and improved facilities to the community. The value for money factor improved facilities was also ranked among the most important factors for achieving value for money by the UAE respondents. The reason for this may be that the respondents look at PPPs as a new vehicle for acquiring new technologies in which innovative ideas are utilized to improve the return on investment. In the United Kingdom, the services are already at the highest level of maturity. The same can be said regarding the optimization of assets’ efficiency factor. It was deemed important by the UAE but not the UK respondents. There was also disagreement between the respondents on ranking technical innovation and private sector project management skills. This slight difference could be attributed to the maturity of knowledge of PPPs in the UK industry. Incentives for the private party, appropriate capital structure, long-term engagement, efficient dispute resolutions, low life cycle

<table>
<thead>
<tr>
<th>Items</th>
<th>UAE</th>
<th>Rank</th>
<th>UK</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimized risk allocation</td>
<td>4.20</td>
<td>1</td>
<td>4.13</td>
<td>2</td>
</tr>
<tr>
<td>Competitive bid process</td>
<td>4.20</td>
<td>2</td>
<td>4.15</td>
<td>1</td>
</tr>
<tr>
<td>Improved services to the community</td>
<td>4.17</td>
<td>3</td>
<td>3.94</td>
<td>4</td>
</tr>
<tr>
<td>Clear output specification</td>
<td>4.13</td>
<td>4</td>
<td>3.97</td>
<td>3</td>
</tr>
<tr>
<td>Improved facilities to the users</td>
<td>4.00</td>
<td>5</td>
<td>3.84</td>
<td>9</td>
</tr>
<tr>
<td>Optimization of assets efficiency</td>
<td>3.93</td>
<td>6</td>
<td>3.87</td>
<td>7</td>
</tr>
<tr>
<td>Technical innovation</td>
<td>3.83</td>
<td>7</td>
<td>3.90</td>
<td>5</td>
</tr>
<tr>
<td>Private sector’s project management skills</td>
<td>3.80</td>
<td>8</td>
<td>3.82</td>
<td>10</td>
</tr>
<tr>
<td>Incentives for private party</td>
<td>3.77</td>
<td>9</td>
<td>3.90</td>
<td>6</td>
</tr>
<tr>
<td>Appropriate capital structure</td>
<td>3.77</td>
<td>10</td>
<td>3.81</td>
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</tr>
<tr>
<td>Long-term engagement</td>
<td>3.70</td>
<td>11</td>
<td>3.76</td>
<td>12</td>
</tr>
<tr>
<td>Efficient dispute resolutions</td>
<td>3.70</td>
<td>12</td>
<td>3.74</td>
<td>14</td>
</tr>
<tr>
<td>Low life cycle cost</td>
<td>3.63</td>
<td>13</td>
<td>3.87</td>
<td>8</td>
</tr>
<tr>
<td>Early service delivery</td>
<td>3.37</td>
<td>14</td>
<td>3.53</td>
<td>15</td>
</tr>
<tr>
<td>Reduced negative environmental impact</td>
<td>3.30</td>
<td>15</td>
<td>3.40</td>
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</tr>
<tr>
<td>Low tariffs</td>
<td>3.20</td>
<td>16</td>
<td>3.74</td>
<td>13</td>
</tr>
</tbody>
</table>

**Table 4:** Mean and ranking of value for money factors for PPPs.
cost, early service delivery, reduced negative environmental impact, and low tariffs were ranked lower than other factors by the respondents. This should not suggest that these factors are important in the analysis of value for money in all contexts.

**Correlation Analysis**

Pearson correlation analysis was performed to discover the interrelationships among the critical success factors and the value for money constructs. The results are illustrated in Table 5. The results revealed that competitive procurement process, local financial market, and political support are not significantly correlated with the economic value for money viability analysis construct. Furthermore, the critical success factors, appropriate risk allocation and commitment of public and private parties, are not significantly correlated with financial viability constructs. The critical success factors, local financial market and multi-benefit objectives, are also insignificantly correlated with value for money commercial viability constructs. Table 5 also demonstrates that most critical success factors are correlated with the value for money viability constructs at a 0.05 significant level or above. It is also noticeable in the table that the correlation strength is below 0.5, with the exception of favorable legal framework, which moderately correlates with value for money financial viability. The most correlated critical success factors to value for money economic viability are shared authority between the public and private sectors, social support, and transparent procurement process, whereas the most correlated critical success factors to value for money financial viability are the favorable legal framework, good governance, government guarantees, social support, sound economic policy, and transparent procurement process. It is noticeable that only two (social support and transparent procurement process) out of the 18 show better correlation with value for money commercial viability. It appears also that social support and transparent procurement process of the critical success factors are important for all three value for money viability constructs.

**Regression Analysis**

Both simple and multiple regression analyses were used to explore the interdependent relationships between the critical success factors and value for money viability constructs. In both experiments, value for money viability constructs are used as dependent variables and critical success factors as independent variables. The simple regression was used to check how significant each of the critical success factors’ contribution is to the variation of value for money viability constructs. The results, illustrated in Table 6, indicate that four critical success factors (competitive procurement process, good governance, local financial market, and political support) did not contribute significantly to value for money economic viability, whereas only two critical success factors (appropriate risk allocation and detailed cost/benefits assessment) did not contribute to financial value for money viability. Normally, risk allocation is one of the key drivers in value creation in PPP contracts. In addition, cost-benefit analysis is necessary to make sure the PPP option is better than a generic version of the project. One plausible explanation why the contribution of these critical success factors is not significant at a p-value of 0.05 is because the respondents may view it as related to economic viability. Similarity, only local financial market and multi-benefit objectives returned insignificant contributions to commercial value for money viability. This might be a result of the fact that the respondents view

<table>
<thead>
<tr>
<th>SF1</th>
<th>Econ_VFM</th>
<th>Fin_VFM</th>
<th>Com_VFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF2</td>
<td>0.242*</td>
<td>0.197</td>
<td>0.306**</td>
</tr>
<tr>
<td>SF3</td>
<td>0.329**</td>
<td>0.384**</td>
<td>0.387**</td>
</tr>
<tr>
<td>SF4</td>
<td>0.295**</td>
<td>0.434**</td>
<td>0.321**</td>
</tr>
<tr>
<td>SF5</td>
<td>0.157</td>
<td>0.254*</td>
<td>0.238*</td>
</tr>
<tr>
<td>SF6</td>
<td>0.277**</td>
<td>0.151</td>
<td>0.218*</td>
</tr>
<tr>
<td>SF7</td>
<td>0.255*</td>
<td>0.564**</td>
<td>0.386**</td>
</tr>
<tr>
<td>SF8</td>
<td>0.191</td>
<td>0.458**</td>
<td>0.283**</td>
</tr>
<tr>
<td>SF9</td>
<td>0.270**</td>
<td>0.457**</td>
<td>0.229*</td>
</tr>
<tr>
<td>SF10</td>
<td>0.135</td>
<td>0.316**</td>
<td>0.154</td>
</tr>
<tr>
<td>SF11</td>
<td>0.301**</td>
<td>0.376**</td>
<td>0.299**</td>
</tr>
<tr>
<td>SF12</td>
<td>0.263*</td>
<td>0.267**</td>
<td>0.148</td>
</tr>
<tr>
<td>SF13</td>
<td>0.137</td>
<td>0.391**</td>
<td>0.244*</td>
</tr>
<tr>
<td>SF14</td>
<td>0.255*</td>
<td>0.255*</td>
<td>0.274**</td>
</tr>
<tr>
<td>SF15</td>
<td>0.429**</td>
<td>0.219*</td>
<td>0.379**</td>
</tr>
<tr>
<td>SF16</td>
<td>0.441**</td>
<td>0.421**</td>
<td>0.402**</td>
</tr>
<tr>
<td>SF17</td>
<td>0.271**</td>
<td>0.448**</td>
<td>0.391**</td>
</tr>
<tr>
<td>SF18</td>
<td>0.375**</td>
<td>0.401**</td>
<td>0.388**</td>
</tr>
<tr>
<td></td>
<td>0.431**</td>
<td>0.395**</td>
<td>0.412**</td>
</tr>
</tbody>
</table>

**Table 5**: Correlation between critical success factors (SF) and the value for money (VFM) constructs.
The Influence of PPP Critical Success Factors on Value for Money Analysis

Table 6: Simple regression results.

<table>
<thead>
<tr>
<th>IV</th>
<th>R²</th>
<th>sig</th>
<th>F</th>
<th>R²</th>
<th>sig</th>
<th>F</th>
<th>R²</th>
<th>sig</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF1</td>
<td>0.058</td>
<td>0.02</td>
<td>5.578</td>
<td>0.039</td>
<td>0.06</td>
<td>3.633</td>
<td>0.094</td>
<td>0.003</td>
<td>9.307</td>
</tr>
<tr>
<td>SF2</td>
<td>0.098</td>
<td>0.001</td>
<td>10.897</td>
<td>0.147</td>
<td>0.000</td>
<td>15.524</td>
<td>0.150</td>
<td>0.000</td>
<td>15.895</td>
</tr>
<tr>
<td>SF3</td>
<td>0.087</td>
<td>0.004</td>
<td>8.571</td>
<td>0.188</td>
<td>0.000</td>
<td>20.903</td>
<td>0.103</td>
<td>0.002</td>
<td>10.328</td>
</tr>
<tr>
<td>SF4</td>
<td>0.025</td>
<td>0.134</td>
<td>2.286</td>
<td>0.064</td>
<td>0.015</td>
<td>6.204</td>
<td>0.056</td>
<td>0.023</td>
<td>5.324</td>
</tr>
<tr>
<td>SF5</td>
<td>0.077</td>
<td>0.007</td>
<td>7.496</td>
<td>0.202</td>
<td>0.152</td>
<td>2.080</td>
<td>0.048</td>
<td>0.037</td>
<td>4.489</td>
</tr>
<tr>
<td>SF6</td>
<td>0.065</td>
<td>0.014</td>
<td>6.269</td>
<td>0.310</td>
<td>0.000</td>
<td>41.876</td>
<td>0.149</td>
<td>0.000</td>
<td>15.753</td>
</tr>
<tr>
<td>SF7</td>
<td>0.036</td>
<td>0.069</td>
<td>3.394</td>
<td>0.209</td>
<td>0.000</td>
<td>23.833</td>
<td>0.080</td>
<td>0.006</td>
<td>7.846</td>
</tr>
<tr>
<td>SF8</td>
<td>0.073</td>
<td>0.009</td>
<td>7.105</td>
<td>0.209</td>
<td>0.000</td>
<td>23.780</td>
<td>0.052</td>
<td>0.028</td>
<td>4.967</td>
</tr>
<tr>
<td>SF9</td>
<td>0.018</td>
<td>0.200</td>
<td>1.670</td>
<td>0.100</td>
<td>0.002</td>
<td>9.983</td>
<td>0.024</td>
<td>0.143</td>
<td>2.185</td>
</tr>
<tr>
<td>SF10</td>
<td>0.091</td>
<td>0.003</td>
<td>8.997</td>
<td>0.142</td>
<td>0.000</td>
<td>14.863</td>
<td>0.090</td>
<td>0.004</td>
<td>8.868</td>
</tr>
<tr>
<td>SF11</td>
<td>0.069</td>
<td>0.011</td>
<td>6.680</td>
<td>0.071</td>
<td>0.010</td>
<td>6.927</td>
<td>0.022</td>
<td>0.160</td>
<td>2.009</td>
</tr>
<tr>
<td>SF12</td>
<td>0.019</td>
<td>0.193</td>
<td>1.723</td>
<td>0.153</td>
<td>0.000</td>
<td>16.252</td>
<td>0.059</td>
<td>0.019</td>
<td>5.681</td>
</tr>
<tr>
<td>SF13</td>
<td>0.070</td>
<td>0.011</td>
<td>6.774</td>
<td>0.065</td>
<td>0.014</td>
<td>6.245</td>
<td>0.075</td>
<td>0.008</td>
<td>7.304</td>
</tr>
<tr>
<td>SF14</td>
<td>0.184</td>
<td>0.000</td>
<td>20.327</td>
<td>0.048</td>
<td>0.036</td>
<td>4.555</td>
<td>0.144</td>
<td>0.000</td>
<td>15.096</td>
</tr>
<tr>
<td>SF15</td>
<td>0.195</td>
<td>0.000</td>
<td>21.789</td>
<td>0.177</td>
<td>0.000</td>
<td>19.373</td>
<td>0.161</td>
<td>0.000</td>
<td>17.318</td>
</tr>
<tr>
<td>SF16</td>
<td>0.073</td>
<td>0.009</td>
<td>7.122</td>
<td>0.201</td>
<td>0.000</td>
<td>22.597</td>
<td>0.153</td>
<td>0.000</td>
<td>16.278</td>
</tr>
<tr>
<td>SF17</td>
<td>0.140</td>
<td>0.000</td>
<td>14.685</td>
<td>0.161</td>
<td>0.000</td>
<td>17.200</td>
<td>0.157</td>
<td>0.000</td>
<td>15.977</td>
</tr>
<tr>
<td>SF18</td>
<td>0.186</td>
<td>0.000</td>
<td>20.528</td>
<td>0.156</td>
<td>0.000</td>
<td>16.633</td>
<td>0.170</td>
<td>0.000</td>
<td>18.428</td>
</tr>
</tbody>
</table>

Table 7: Multiple regression results.

<table>
<thead>
<tr>
<th>IV</th>
<th>Beta</th>
<th>sig</th>
<th>Beta</th>
<th>sig</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF1</td>
<td>0.002</td>
<td>0.986</td>
<td>—</td>
<td>—</td>
<td>0.066</td>
<td>0.547</td>
</tr>
<tr>
<td>SF2</td>
<td>0.029</td>
<td>0.833</td>
<td>0.205</td>
<td>0.755</td>
<td>0.017</td>
<td>0.900</td>
</tr>
<tr>
<td>SF3</td>
<td>0.058</td>
<td>0.573</td>
<td>0.225</td>
<td>0.716</td>
<td>0.067</td>
<td>0.649</td>
</tr>
<tr>
<td>SF4</td>
<td>—</td>
<td>—</td>
<td>—0.296</td>
<td>0.589</td>
<td>—0.117</td>
<td>0.299</td>
</tr>
<tr>
<td>SF5</td>
<td>0.138</td>
<td>0.210</td>
<td>—</td>
<td>—</td>
<td>0.117</td>
<td>0.310</td>
</tr>
<tr>
<td>SF6</td>
<td>0.045</td>
<td>0.700</td>
<td>0.109</td>
<td>0.827</td>
<td>0.057</td>
<td>0.661</td>
</tr>
<tr>
<td>SF7</td>
<td>—</td>
<td>—</td>
<td>0.184</td>
<td>0.756</td>
<td>0.072</td>
<td>0.568</td>
</tr>
<tr>
<td>SF8</td>
<td>0.138</td>
<td>0.206</td>
<td>0.612</td>
<td>0.170</td>
<td>0.108</td>
<td>0.337</td>
</tr>
<tr>
<td>SF9</td>
<td>—</td>
<td>—</td>
<td>—0.771</td>
<td>0.151</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SF10</td>
<td>0.086</td>
<td>0.505</td>
<td>0.972</td>
<td>0.082</td>
<td>0.120</td>
<td>0.310</td>
</tr>
<tr>
<td>SF11</td>
<td>0.017</td>
<td>0.884</td>
<td>0.007</td>
<td>0.989</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SF12</td>
<td>—</td>
<td>—</td>
<td>—0.765</td>
<td>0.061</td>
<td>—0.238</td>
<td>0.059</td>
</tr>
<tr>
<td>SF13</td>
<td>—0.077</td>
<td>0.557</td>
<td>0.227</td>
<td>0.668</td>
<td>0.000</td>
<td>0.999</td>
</tr>
<tr>
<td>SF14</td>
<td>0.162</td>
<td>0.191</td>
<td>0.644</td>
<td>0.152</td>
<td>0.187</td>
<td>0.126</td>
</tr>
<tr>
<td>SF15</td>
<td>0.292</td>
<td>0.012</td>
<td>0.899</td>
<td>0.021</td>
<td>0.264</td>
<td>0.025</td>
</tr>
<tr>
<td>SF16</td>
<td>—0.052</td>
<td>0.715</td>
<td>0.005</td>
<td>0.993</td>
<td>—0.064</td>
<td>0.644</td>
</tr>
<tr>
<td>SF17</td>
<td>0.020</td>
<td>0.868</td>
<td>0.264</td>
<td>0.625</td>
<td>0.089</td>
<td>0.474</td>
</tr>
<tr>
<td>SF18</td>
<td>0.242</td>
<td>0.070</td>
<td>0.968</td>
<td>0.079</td>
<td>0.213</td>
<td>0.108</td>
</tr>
</tbody>
</table>

The purpose of the second experiment is to examine how much each of the critical success factors contributes to value for money viability when all the critical success factors are combined together. It also aimed to find which of the critical success factors contribute positively to the value for money agenda when all other critical success factors are considered constant. All of the critical success factors that demonstrated insignificant contribution to value for money viability were excluded in the second experiment. The results of the experiment are shown in Table 7.

Multiple regression analysis results based on the economical dependent variable (see Table 7) show that the model is significant ($\beta = 4.353, F = 3.456, p = 0.000$) and accounted for 27.4% of the variance in the data set. The majority of the critical success factors showed a positive influence. Although the overall model is significant at $p < 0.001$, the results also showed that only social support has a significant $\beta$ value at $p < 0.05$. The results also showed that the critical success factors committed public agency, project technical feasibility, and sound economic policy affect economic value for money analysis in negative directions. It is important to point out that the influence of these critical success factors is very small (less than 8%), as demonstrated by the values of their $\beta$. The value of variance inflation factor (VIF) is below 10, which indicates that collinearity does not exist. It is plausible that these negative coefficient values may be a result of low correlation between the critical success factors and dependent variables. To overcome this problem, all the critical success factors with small $\beta$ values were removed from the regression. The new results show that shared authority between the public and private sectors,
social support, and transparent procurement process contribute positively to economic value for money viability, as shown in Table 7.

Multiple regression analysis results (see Table 7) based on the value for money financial viability dependent variable show that the model is significant ($\beta = 4.353$, $f = 3.485$, $p = 0.000$) and accounted for 30.4% of the variance in the data set. Although the overall model is significant at $p < 0.001$, the results also showed that only social support has a significant $\beta$ value, at $p < 0.05$. However, several critical success factors have significant $\beta$ values at 90% confidence level ($p < 0.1$). The results also depict that the competitive procurement process, local financial market, and political support critical success factors have negative contributions to the value for money viability analysis. To eliminate the possibility of collinearity between the critical success factors, the critical success factors with positive $\beta$ values were selected for further experimentation. Using the backward regression method, the results showed that government guarantees, transparent procurement process, and social support have significant $\beta$ values at $p < 0.05$, as shown in Table 7.

Multiple regression analysis results based on the commercial dependent variable (see Table 7) show that the model is significant ($\beta = 4.210$, $f = 3.411$, $p = 0.000$) and accounted for 29.8% of the variance in the data set. All other critical success factors showed a positive influence. Although the overall model is significant at $p < 0.001$, the results also showed that only social support has a significant $\beta$ value, at $p < 0.05$. The results showed that the critical success factors competitive procurement process, political support, and sound economic policy affect economic value for money analysis in negative directions. Further analysis shows that macroeconomic conditions, social support, and transparent procurement process are the only factors that have significant $\beta$ values at $p < 0.05$ or below, as shown in Table 7. As demonstrated in Table 8, the research’s second hypothesis is accepted for only five of the critical success factors.

The literature speculates that government support through legalization and financial guarantees is essential for the success and viability of PPP projects. This finding supports the existing views in the literature that government guarantee is an important key factor in the success of PPP projects. Social support, for allowing the private sector to develop and run public services through developing and issuing policies that facilitate PPP provision, is also deemed important (Li et al., 2005). Negative public opinion about the private sector could hamper the use of PPP to deliver public projects. Thus, public support will certainly aid in the commercial viability of PPP projects. The issue of realistic assessment of costs and benefits is also highlighted in the literature as one of the important success factors in PPP projects (Li et al., 2005). This research agrees with the existing findings and confirms that this factor significantly contributes to value for money economic viability. It is reported that PPP projects should be able to provide better value for money than a pure public sector project approach to justify the extract financial burden (Boussabaine, 2013). Several authors have cited stable macroeconomic environment as one of the key success factors for PPP implementation. The findings from this research confirm this assertion.

**Discussion**

The main objective of this study has been to provide an understanding of the critical success factors that contribute to value for money viability analysis in PPP projects. Transparent procurement process and social support had significant correlations with all of the three value for money viability constructs—economic, financial, and commercial. Social support was the most significant critical success factor when regressed to all value for money viability constructs.

Although it was ranked by the respondents as the fourteenth most significant critical success factor for the success of PPP projects, when it was regressed to the value for money viability constructs, social support seems to have the most influence on the viability analysis of the project. Social support refers to the

<table>
<thead>
<tr>
<th>DV Econ-VFM</th>
<th>DV Fin-VFM</th>
<th>DV Com-VFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2 = 0.311$, $\beta = 7.75$</td>
<td>$R^2 = 0.338$, $\beta = 2.088$</td>
<td>$R^2 = 0.270$, $\beta = 7.608$</td>
</tr>
<tr>
<td>$F = 14.71$, sig = 0.000</td>
<td>$F = 20.535$, sig = 0.000</td>
<td>$F = 12.276$, sig = 0.000</td>
</tr>
</tbody>
</table>

**Table 8:** Final models summary.
The Influence of PPP Critical Success Factors on Value for Money Analysis

This study implies some limitations that future researchers should consider further factors and empirical data. It is very difficult to generalize the results to PPP procurement value for money creation based on one sample and limited geographical data. It is recommended that future studies determine additional success factors. Future research should seek to investigate the interrelations among the value for money determinants, risk allocation, and critical success factors. This will show if risk allocation has a significant contribution to value for money viability as suggested by the literature.

Conclusion

This study set out to explore relationships between critical success factors and value for money viability constructs. The key contribution of this article is the tracking of the critical success factors that contribute to a positive value for money viability analysis. The critical success factor classification presented in this study complements studies that previously investigated PPP projects. It was envisaged that several critical success factors contribute to the value for money viability analysis. The article examined the correlation between critical success factors and the key value for money viability analysis constructs. The results show that most critical success factors are correlated with the value of money viability constructs at a p < 0.05 significant level or above. Given that several critical success factors are reported in the literature, this research was able to determine the principal critical success factors that are key in value for money viability analysis. This study found that government guarantees, macroeconomic conditions, shared authority between the public and private sectors, social support, and transparent procurement process all provide a great opportunity for achieving better value for money from PPP projects. Further empirical study should confirm if this is the case. This study provides a foundation for further research to investigate the complexity of interaction among all the variables that are part of the PPP project. This investigation has several limitations, among them the fact that the research applies mainly to the UAE and UK contexts. Also, the analysis is based on data from surveys rather than empirical analysis.

References


The Influence of PPP Critical Success Factors on Value for Money Analysis


Khalid Almarri, PhD, is an Assistant Professor of Project Management in the Engineering and IT Department of the British University in Dubai, United Arab Emirates. He is acclaimed for setting a high standard of accomplishment by holding the first PhD award in project management in the Gulf region. Dr. Almarri has an undergraduate degree in civil engineering from the University of Arizona and a master’s degree in engineering management from the Catholic University of America. After earning his degrees, he commenced his engineering career in 1996 in the Dubai Municipality and has been in government services in the Sewerage & Irrigation Department and the Roads Department as head of the Roads Construction Section.

Through a doctoral program, Dr. Almarri produced the first framework for developing projects through public–private partnerships (PPP) in the United Arab Emirates. This framework is the first to lay the foundations for a standardized PPP practice in the UAE for practitioners; it highlights the most important factors for the success of PPP projects, such as value for money, risk sharing and allocation, renegotiation, and the roles of public and private parties.

Dr. Almarri is also credited for developing a framework for establishing a nuclear research reactor project in the UAE through the utilization of public–private partnerships. This was one of the first frameworks for PPPs in research reactor projects in the world and followed strict safeguards and required full awareness of nuclear safety, security, and control of nuclear materials handling. He can be contacted at Khalid.almarri@buid.ac.ae

Halim Boussabaine, PhD, has more than 25 years of experience in risk modeling and management. He holds a PhD and MSc from Manchester University in the United Kingdom. His consistent research interest has been to pull together and integrate various modern scientific theories and state-of-the-art modeling techniques in order to gain a better understanding of the complexity of risk. Recently, his research portfolio has been expanded to encompass the impact of emerging risks on a variety of complex human decisions that affect natural systems, social systems, and human-made networks. He has published four books and more than 100 research articles and has supervised more than 20 doctoral research projects. He has acted as external PhD examiner for several UK and European universities and serves as a peer reviewer for many leading international journals. He assesses research proposals and final reports for UK and European Union research councils and has delivered training courses in the United Kingdom, Europe, Asia, and MENA regions; he is also an honorary visitor to Liverpool and Manchester Universities in the United Kingdom. His current research agenda focuses on identifying, quantifying, and modeling risk dynamics that create failure/opportunity in enterprises and projects. He can be contacted at halim@buid.ac.ae
AUGUST

14–16 August
PMI Malaysia Chapter
International Symposium 2017
Kuala Lumpur, Malaysia. The premier project management event in Malaysia, the International Symposium brings together project practitioners from diverse backgrounds and industries. This year’s symposium will address the importance of project management leadership for change and survival. symposium.pmi.org.my.

17 August
PMI Honolulu, Hawaii Chapter
Professional Development Day 2017
Honolulu, Hawaii, USA. Save the date! We welcome our project management community and anyone interested in leadership and professional development. pmihnl.org.

SEPTEMBER

18 September
PMI Michigan Thumb Chapter
David and Goliath—How to Battle Small and Large Projects
Frankenmuth, Michigan, USA. Build your arsenal by learning to compare and contrast the level of project management required for both small and large projects, as well as simplified technical processes for all projects, including Earned Value Management and Monte Carlo Analysis. Featuring Doug Boehinger, PMP. pmi-thumbchapter.org/overview.

18 September(145,602),(962,623)

20–22 September
PMI New Zealand Chapter
New Zealand Project Management Conference
Christchurch, New Zealand. Theme—Building the Future. Our three-day conference will deliver master classes, keynote speakers and three concurrent speaker streams focusing on building the project management profession, sustainable projects and examples of using innovative solutions and community engagement from New Zealand’s experience in rebuilding. projectmanagementconference.org.nz.

22–23 September
PMI Mass Bay Chapter
Professional Development Day South 2017
Norwood, Massachusetts, USA. The chapter’s second Professional Development Day event this year will bring together talented speakers and quality product and service firms to produce a high-caliber conference aimed at increasing awareness of the positive impact of project management on portfolio management, risk and change management, and advanced agile concepts. pmimassbay.org/professional-dev-day.

22–23 September
PMI Norway Chapter
Adapt or Die? PMI Norway Chapter Annual Conference 2017
Oslo, Norway. This year’s theme is “Transforming Project Management to Embrace the Challenges of Tomorrow.” The conference focuses on how projects in the future must mirror changing business trends and adapt in scope, domain, content, and schedule to an ever-faster changing world. The event, an all-English conference with a program that extends into the evening, features six keynote speakers. pmi-no.org/arskonferansen.

25–28 September
PMI Minnesota Chapter
2017 Professional Development Days and Symposium Day
St. Paul, Minnesota, USA. Be one of hundreds of participants to attend our 24th annual event offering up to 30 PDUs over four days. During Education Days, we offer 28 half-day, one-day, and two-day classes. Symposium Day provides attendees an array of choices with 24 sessions organized along six topical tracks, our annual vendor fair with a variety of exhibitors, and nationally known keynote and endnote speakers. pmimn.org.

OCTOBER

2–3 October
PMI Silicon Valley, CA Chapter
10th Annual Symposium
Santa Clara, California, USA. This year’s symposium theme is “Creating Business Value Through Project Leadership.” The two-day event will feature themed keynote presentations, concurrent breakout sessions, and networking opportunities. Join hundreds of project and program leaders to share and learn with like-minded professionals from Silicon Valley and around the world. pminsv.org/overview-symposium-2017.
Calendar of Events

10–11 October
PMI Southern Caribbean Chapter
9th Biennial International Project Management Conference
San Fernando, Trinidad. The two-day conference is the region’s largest project management event. This year’s theme is “Versatility in Times of Economic Adjustments: Doing More with Less.” pmisscc.org.

PMI Tour Cono Sur 2017
Under the motto “Learn, Share, Inspire,” this year’s Tour Cono Sur offers a varied selection of featured speakers and cities where you may strengthen the skills that compose the PMI Talent Triangle®. This will help you remain relevant and competitive, and will enhance your ability to achieve success.

We invite you to visit the chapter websites where you will find valuable information.

Live Webinars from ProjectManagement.com
As a valued member of the ProjectManagement.com community, you can access webinars that provide insight from the industry’s most respected voices on the most relevant and important topics today—and earn PDUs.

17 August, 3:00 p.m. EDT (UTC –4)
Project HEADWAY: Working Out Loud: Making Progress Visible
One of the largest challenges that we have as project managers is communication. We need to build awareness of our projects, maintain visibility of our progress, and maintain the focus of our project teams. And yet, the tools by which we plan and visualize our projects have barely changed in more than 50 years. We need to reinvent the way we think about and illustrate our projects and our progress. Presented by Mark Mullaly, PhD, PMP.

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