An Analysis of Innovation in Oil & Gas Projects

Mahmood Rahimi
Pontis Energy Inc.
474, 3553 31st Street NW
Calgary, Alberta
Canada

Thomas Kenworthy
Odette School of Business
University of Windsor
Windsor, Ontario
Canada

Jaydeep Balakrishnan
Haskayne School of Business
University of Calgary
Calgary, Alberta
Canada

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Abstract

We examine the effects of predictors from firm, project, and individual levels on innovative behaviour within oil and gas projects. The theory and propositions tested in this study stem from extant work on 1) innovation in poor performance conditions and 2) the availability of slack resources. The research findings revealed that innovative behaviors were present regardless of size, type and project performance level. Further, it appears that the relationship between slack and innovation depends on when the innovation is introduced (i.e. when project performance is ahead of, or behind, a plan). Finally, the existence of innovation in 1) under-performing projects did not appear to exert any influence on project outcome and, 2) over-performing projects appeared to exert a negative influence on project outcome.

Keywords: project; innovation; theory; over-performing; under-performing

Introduction

Historically, the teaching and practitioner project management literature bases have used terms such as planning, control, codes, and discipline that indicate a strong emphasis on maximizing efficiency (Morris, 1997). The various innovation literatures, on the other hand, use terms such as divergence, creativity and problem solving that indicate a strong emphasis on novelty and usefulness (Amabile, 1998; Amabile, Conti, Coon, Lazenby, & Herron, 1996; Oldham & Cummings, 1996). The innovation and project management literatures were, therefore, almost mutually exclusive (Anbari, 2005, Davies, 2013). Scholars who support the maintenance of the separation have argued that the internal capabilities of project-based organizations do not match the requirements of the successful development of new products or services (c.f. Gil, Miozzo, & Massini, 2012; Hobday, 2000; Parast, 2011; Volberda, 1998). However, researchers have found that project-based organizations share similar characteristics with large organizations that support innovation – e.g. high professionalism, decentralization of decision-making, and a high degree of interaction between internal and external stakeholders (c.f. Gann & Salter, 2000; Whitley, 2006). Hence, various scholars have argued for the introduction of ad hoc new and/or improved products, services and processes as effective responses to the uncertainty, ambiguity and complexity experienced in project environments (c.f. Lenfle, 2008; Olsen, 2006; Tatikonda & Rosenthal, 2000b).

Brady and Söderlund (2008, p. 466) envision a necessary merging of the disciplines based on observations of our empirical reality:

> In many ways the two fields of research have been kept apart leading to a neglect in the project management area to acknowledge and embrace the unique processes of projects – to cope with uncertainty instead of eliminating it by the use of advanced planning techniques. In the innovation arena, project management has often been looked upon as a simple implementation endeavour with little problems. However, research has time and time again pointed out the difficulties of moving from invention to innovation, of moving from ideas to value creating products – a process where project management potentially would have a very important role.

Murphy, Heaney and Perera (2011) proposed that projects which are used to deliver innovation must concentrate on managing innovation rather than conventional project goals, suggesting that a joint strategy should be used to manage both aspects. Their study supported the proposition that successful innovation in projects is contingent upon the adoption of a stakeholder-centered approach, rather than a process-driven approach, and that it requires appropriate stakeholder management competencies being in place at the appropriate stages of the procurement process.

The relationship between project strategy and innovation has received some attention in the project management literature (c.f. Artto, Martinsuo, Dietrich, & Kujala, 2008). This viewpoint separates those projects that take a tactical role intended for narrowly defined objectives within a parent organization from those autonomous organizations that may have a strategy of their own (Loch, DeMeyer & Pich, 2006; Patanakul & Shenhar, 2011). Subscribers to the latter view contend that autonomous projects have the authority to formulate a strategy with self-directed goals and plans, protected from parent organization interference. The managers of such projects may deploy their own management approaches, decision-making procedures, product development concepts, and contingency plans in relative isolation from their parent organization (c.f. Bryson and Delbecq, 1979; Milosevic, 2002; Chan and Yu, 2005).

This research undertaking focuses on the intersection of project management and innovation in the petroleum and petrochemical (P&P) industry – a critical component of the global energy production, both past and future (c.f. Longwell, 2002; Yergin, 2009). It investigates the existence of innovation in P&P projects[1], and the impacts of favorable and unfavorable conditions, via the testing of hypotheses stemming from institutional theory, the behavioral theory of the firm and attribution theory. In the following sections, we describe the P&P industry; the nature of innovation; the nature of innovation in the P&P industry; and, the theories used to examine innovation phenomena in P&P projects. We explain our research method and present our findings. Finally, we discuss our results.

[1] The focus here is on projects that are not explicitly geared toward innovation. It is intellectually distinct from the growing research stream focused on innovation projects – ones that are intended to produce innovation (c.f. Weiss et al., 2011; Weiss et al., 2013).

Literature Review

Petroleum and Petrochemical Industry

Samuel, Agamuthu and Hashim (2013, p. 395) define petrochemicals as "…chemicals produced from natural gas, natural gas liquids, or refinery products derived from crude oil distillation, or cracking." The global demand for petrochemicals continues to rise, making them, "…a key factor underlying the economies of every industrial nation." (Hassani, Silva and Al Kaabi, 2017). Along with the industry's success has come a great deal of turbulence. Tidey (2015) indicates that the cost to produce a barrel of crude oil has grown by 60% in ten years. The easily accessible resources not controlled by the Organization of Petroleum Exporting Countries (OPEC) are exhausted (Urstadt, 2006; Weijermars, 2009). Various disasters over the years, such as the Piper Alpha incident and Deepwater Horizon accident, force the industry to increase expenditure on human and environmental protection. In the meantime, Decker, Flaaen and Tito (2016) report that crude oil prices are down 70% since a price peak in 2014.

A turn towards innovation is inevitable (Tillerson, 2006; Lord, 2007; Paul, 2007). In fact, the production of shale and tight oil are the result of innovative work and technological breakthroughs (Hassani et al., 2017). However, the technologically timid (Lashinsky, 2010) P&P industry has struggled to embrace innovation. As Perrons (2014, p. 301) notes:

> The shared equity structure of many upstream oil & gas assets frequently makes it difficult for companies to keep new innovations proprietary (Acha, 2002; Sharma, 2005; Perrons and Watts, 2008), thereby creating a problem of "free ridership" within the sector that frequently erodes the competitive advantage that technology might otherwise deliver to an innovating firm. Also, the extreme risks (Daneshy, 2003a, 2003b; Rao and Rodriguez, 2005) and high cost of failure associated with being a first user of new technologies are such that companies frequently prefer to be "fast followers" (Daneshy and Donnelly, 2004, p.28), and the industry's

> innovations consequently take an average of 16 years to progress from the concept phase to widespread commercial adoption (NPC, 2007).

Innovation

The concept of innovation has been widely discussed in management theory (Damanpour, 1991; Kimberly & Evanisko, 1981; Wolfe, 1994). Typically, innovation is defined as involving novelty (Schumpeter, 1943); necessity and sufficiency (Pittaway, Robertson, Munir, Denyer, & Neely, 2004); intentionality (Lansisalmi, Kivimaki, Aalto, & Ruoranen, 2006); a beneficial nature (Camison-Zornoza, Lapiedra-Alcami, Segarra-Cipres, & Boronat-Navarro, 2004); successful implementation (Hobday, 2005; Klein & Knight, 2005); and, diffusion (Holland, 1997).

According Meeus and Edquist (2006, p. 24, italics in original) innovations:

> …include new material goods as well as new intangible services. Process innovations are new ways of producing goods and services; it is a matter of how existing products are produced. They may be technological or organizational. In this taxonomy, only goods and technological product innovations are material. The other categories are non-technological and intangible.

The focus of this undertaking is process innovation – new ways of producing goods and services that can be categorized as 1) technological or 2) organizational. Edquist, Hommen and McKelvey (2000, p. 379, italics in original) characterize the two types of process innovations as follows:

> *Technological process innovations* are units of real capital (material goods) that have been improved through technical change and that lead to productivity growth in their use. Some of these goods may once have been product innovations that were sold as commodities to other firms. In other words, they can appear in two 'incarnations' in the economic system,

> where an industrial robot is a product innovation when produced by ABB in Vasteras and a process technology when used by Volvo in Goteborg.[2]
>
> *Organizational process innovations* are more productive ways to organize work; a new organizational form is introduced. These innovations are intangibles, that is, they are non-material. Examples are just-in-time production, total quality management (TQM) and lean production.

Murphy, Heaney and Perera (2011) proposed that projects that are used to deliver innovation must concentrate on managing innovation rather than conventional project delivery, suggesting that a joint strategy should be used to manage both. Their study supported the proposition that successful innovation in projects is contingent upon the adoption of a stakeholder-centered approach, rather than a process-driven approach, and requires appropriate stakeholder management competencies being in place at the appropriate stages of the procurement process.

The relationship between project strategy and innovation has received some attention in the project management literature (c.f. Artto, Martinsuo, Dietrich, & Kujala, 2008). This viewpoint separates those projects that take a tactical role intended for narrowly defined objectives within a parent organization from those autonomous organizations that may have a strategy of their own (Loch, DeMeyer & Pich, 2006; Patanakul & Shenhar, 2011). Subscribers to the latter view contend that autonomous projects have the authority to formulate a strategy with self-directed goals and plans, protected from parent organization interference. The managers of such projects may deploy their own management approaches, decision-making procedures, product development concepts, and contingency plans in relative isolation from their parent organization (c.f. Bryson and Delbecq, 1979; Milosevic, 2002; Chan and Yu, 2005).

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[2] ABB is an industrial automation manufacturer and Volvo is an auto manufacturer.

Innovation and the P&P Industry

Hassani et al. (2017, p. 6) argue that innovation and technology positively impact the P&P industry in several ways: "…(i) Cost reduction and time saving; (ii) efficiency gains; and (iii) sustainable growth." Numerous efforts to understand the amount and pace of P&P innovation have been undertaken. The majority of the studies focus on large oil producing firms (Helfat, 1994a, 1994b, 1997; Grant, 2003; Cibin and Grant, 1996; Grant and Cibin, 1996; Bastian and Tucci, 2010; Ollinger, 1994). Perrons (2014, p. 302) notes that each of the studies, "…pays little attention to the service companies and other members of the upstream oil & gas ecosystem that play such an important role in the sector's technology development and deployment efforts today." Perrons (2014) sought to understand P&P innovation in a more system-wide manner by collecting data from 199 executives and senior managers, with substantive R&D and/or technology deployment roles, from around the world. Among other things, Perrons (2014) found that service companies file the most patents per innovation. Further, slightly more than 60% of implemented innovations originated within service companies.

Innovation Phenomena and Levels of Analysis

Generally speaking, innovation studies examine either organization or individual-level factors. Studies of organizational-level factors have been conceptualized in myriad ways (Damanpour & Aravind, 2011). Studies of individual level factors focus on cognitive capabilities and individual creativity attributes (c.f. Goldenberg, Lehmann, & Mazursky, 2001; Moreau & Dahl, 2005). Felin and Foss (2006) suggest that linking the two levels may promote more sophisticated knowledge creation. Consequently, Crossan and Apaydin (2010, p. 1178) describe an emerging research lens that meets in the middle of firm (Barney, 2001) and individual (Felin & Hesterly, 2007):

> A promising way of combining micro and macro levels of theorizing might be an application of a recently emerged practice-based view (PBV), which could combine the individual, firm, contextual, and process variables prevalent in the literature…to overcome bifurcation of the field between 'individualism', favouring human action while ignoring macro-forces, and 'societism', focusing on large social forces while discounting individual action (Whittington, 2006).

What is not made explicit in the conceptualization above is the project level of analysis. Weiss, Hoegl & Gibbert (2011) contend that most innovation across organizations takes place at the project level, with individual and organization-level factors providing supporting or prohibiting roles. For example, Kelley and Lee (2010) emphasized the role of an experienced project manager as an authority in interpreting the market and understanding the languages of different departments and stakeholders. The researchers noted, as well, the significance of the power structure in the parent organization and the availability of resources at the organizational level as other factors that might affect the performance of an innovative project.

Recently, Midler, Killen and Kock (2016, p.3) acknowledged the, "…growing body of research at the intersection of project and innovation management." They highlight several empirical pieces (c.f. Worsnop, Miraglia & Davies, 2016; Shenhar, Holzmann, Melamed, & Zhao, 2016) that work towards a better understanding of mega-projects via single case study and action research methods (see also Davies, MacAulay, DeBarro & Thurston, 2014). In this research, we take a theory-informed, quantitative analysis of three analytical levels of large (below the scale of megaprojects) P&P projects. In the proceeding section, we associate a key theory with each level in order to generate a research model and test relevant hypotheses.

Research Model

We begin this section by describing three theories that aid in the examination of innovation phenomena: institutional theory, behavioral theory of the firm and attribution theory. Then, we present our research model and hypotheses.

Institutional Theory

The central underlying notion of institutional theory is that social structures – which encompass norms, routines, rules and values – impose an authoritative framework on social behavior and interactions (Scott, 1995). Institutions make for predictable and consistent behavior (Searle, 2005) because individuals seek to 1) avoid punishments and sanctions and 2) gain legitimacy (Tuomela, 1995; Hodgson, 2006; Scott & Meyer, 1991).

Organizational processes can either support or constrain innovation. Dimaggio and Powell (1983) have suggested that institutionalized control processes affect the nature of a firm's response to decline. They argued that downsizing has become an institutionalized and accepted strategic response (McKinley, Sanchez, & Schick, 1995). Highly institutionalized expectations restrict the breadth of a firm's responses to sub-par performance thereby impeding the potential to pursue innovative actions. However, a pro-innovation climate can encourage innovative behavior by: legitimizing experimentation (Nohria & Gulati, 1996; Patterson, West, Shackleton, Dawson, Lawthom, Maitlis, Robinson & Alison, 2005); creating psychological safety for trial and error; and, reducing the perceived negative impact of the risks involved in innovative actions (Chen & Huang, 2010; Salge, 2011).

Project-based structures tend to be established as social structures that are designed to control cost and quality on a set schedule, while minimizing liability and exposure to uncontrolled risk. Hence, a parent organization's oversight can exert a strong influence over the extent of innovation pursued by project managers.

Behavioral Theory of the Firm

The central notion of the behavioral theory of the firm (Cyert & March, 1963) is that organizations: develop stability through the implementation of routines and rules; reduce conflict via goals that are informed by constraints; and, affect change through the implementation of strategies that are aligned with the constraints. The theory has convincingly illustrated the relevance and value of constructs that explain the innovative behavior of organizations. Innovation has been widely discussed in the literature with respect to 1) the availability of slack or disposable resources to support experimentation and 2) managerial discretion or risk-taking (c.f. Bourgeois, 1981; Moses, 1992; Swink, 2003).

The original definition of slack (Cyert & March, 1963), which represents the difference between the resources available to an organization and the total necessary payments, has been revised by a variety of scholars. Of interest here, Bourgeois and Singh (1983) introduced the following classifications of slack: 1) an immediate availability of unexploited resources; 2) recoverable excess costs from which a firm can draw when faced with financial difficulties; and, 3) potential resources that can be generated through future borrowing. The focus of this study is on the first classification – slack that is either intentionally placed in a budget or available by happenstance – because this short-term, unabsorbed slack can be deployed easily in support of managerial activities that influence performance over a standard project cycle (Nohria & Gulati, 1996). Further, Greve (2003) suggests that the real benefit of available slack lies in its contingency value, the potential to generate solutions to as-yet-unidentified problems. Hence, innovation may be viewed as acceptable behavior in the presence of slack because the legitimacy of experimenting is less likely to be questioned (Singh, 1986).

Managerial discretion is characterized as the extent to which decision-making authority is distributed in an organization. In the project context, Naveh (2007, p. 110) states that discretion is, "…spontaneity, desire for change and breaking of rules…" – the opposite of formality, or adherence to the rules, regulations, and codes in an organization. In the project environment, project managers engage in one of two types of search for solutions to a problem: problemistic search and slack search (Cyert & March, 1963). Problemistic search is a project-wide search for an effective solution to performance problems. It occurs in projects that support high levels of discretionary decision-making. Slack search is influenced by the availability of slack resources that may have been 1) planned or 2) generated during a project execution phase due to favorable conditions. The objective of slack search is to find un-programmed opportunities, rather than to solve a problem.

Attribution Theory

The central underlying notion of attribution theory is that causal analysis is intrinsic to one's need to understand social events (Heider, 1958; Jones & Davis, 1965; Kelley, 1967). The causal attributions that one generates, in response to external information, can be categorized as stimulus, person and circumstance (or a combination thereof), according to classical attribution theory (Kelley, 1967, 1973).

Several management researchers have used attributional theory to examine how organizations respond to performance gaps (c.f. Ford, 1985; Nottenburg & Fedor, 1983; Russell, 1982). The attribution theory arguments have proposed a relationship between the intensity of search to find a solution to a problem and the perceived value or uncertainty of an outcome (Weiner, 1986). In the case of organizational decline, Mone, McKinley & Barker III (1998) proposed that top managers view innovation as a potential solution, contingent on causal attributions related to the stability and controllability of the root causes.

Mone et al. (1998, p. 124) define stability as, "…the degree of permanence that managers associate with a given perceived cause of decline." Weiner (1979, p. 9) describes how stability and expectations regarding future performance are related:

> If one attains success (or failure) and if the conditions or causes of that outcome are perceived as remaining unchanged, the success (or failure) will be anticipated with a greater degree of certainty. But if the conditions or causes are subject to change, then there is some doubt that the prior outcome will be repeated.

A manager's willingness to implement an innovative strategy is influenced by perceived stability. For example, a new regulation or fundamental technological shift might be perceived as a permanent change. Conversely, a sudden drop in stock market might be perceived as a temporary change.

The notion of controllability is defined as a decision maker's perceptions of her or his ability to influence the cause of a performance downturn (Weiner, 1979). Langer (1975) and Wortman & Brehm (1975) proposed that decision-makers seek to control and master their environments. They find it difficult to view environments as purely unpredictable and uncontrollable – i.e. attributing outcomes strictly to chance is discomforting. With respect to management, attribution theory suggests that managers are likely to seek and implement solutions to performance gaps that are perceived as within the control of a firm. The opposite would also be expected.

The Research Model

The model below incorporates variables and relationships that can be examined using institutional theory, behavioral theory of the firm and attribution theory. The derivation for each hypothesis is explained below. We include a brief discussion of project performance and relevant hypotheses, as well.

Insert Figure 1 about here

Organizational Level Hypotheses

Mone et al. (1998) suggested that organizations restricted by highly institutionalized control are prone to inward turns during periods of underperformance. They may experience threat-rigidity and escalating commitment. Mone et al. (1998) further argued that innovation-suppressing dynamics are more likely to take hold during performance distress.

Project-based firms are generally known to be highly-formalized and centrally-controlled. The need for institutionalized practices tends to increase as 1) markets expand and 2) relational networks in different domains (e.g., distributed engineering, global procurement, cross-cultural labor) become more complex and differentiated. In such conditions, an organization must manage more internal and boundary-spanning interdependencies. Hence,

H1a: Institutionalized control will negatively affect innovation activities in under-performing projects.

On the other hand, institutionalized practices in some organizations have been associated with increases in innovation. Kimberly and Evanisko (1981) argued for the type of innovation and its relationship with key decision-makers. For example, in organizations with fairly autonomous key decision-makers, the adoption of innovation may be more frequent at the technical level. In contrast, innovation in administrative subsystems might be expected more frequently in organizations with institutionalized control. These arguments may be more readily supported in projects that have a healthy performance, as there is less urgency associated with finding problems and thus, less tension between the institutional control and managerial discretion. Hence, *H1': Institutionalized control will positively affect innovation activities in over-performing projects.*

Project Level Hypotheses

Mone et al. (1998) noted that organizations with a decentralized power structure might be better suited to develop innovative responses to organizational decline. A project manager with substantial discretionary decision-making power may be able to respond effectively to project underachievement through identification of potential causes, development of innovative options, and implementation of those options. Hence,

H2. Discretionary power will positively affect innovation activities in under-performing projects.

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The availability of slack resources has been found to facilitate innovative actions, especially under the threat of environmental pressure. Slack facilitates innovation in the form of new products, process experimentation or new market entry by providing a safety net for failure (Bourgeois, 1981; Nohria & Gulati, 1996). Thus, as environmental disruptions jeopardize the progress of work, project managers with the availability of slack may survive and succeed by seeking out alternative solutions to a performance problem. Hence,

H3. Uncommitted resources will positively affect innovation activities in poor-performing projects.

Over-performing projects may not similarly benefit from slack. Slack may isolate an organization from its environment, leading to a greater disconnect and irresponsiveness. For example, available slack in the form of financial resources has been blamed for a competitive disadvantage, as it may slow a firm's responsiveness to the changing environment (Litschert & Bonham, 1978; Simon, 1977; Yasai-Ardekani, 1986). Financial slack can induce managerial aversion to risk.

Given that managers can suffer the outcomes of project risk, they may choose safe options rather than those that maximize project performance and shareholder value. Furthermore, the safety net provided by slack may engender hubris, possibly delaying the detection of problems (relative to a project that has little or no margin of error). Hence,

H3'. Uncommitted resources will negatively affect innovation activities in over-performing projects.

Individual Level Hypotheses

A number of scholars (c.f. Ford, 1985; Russell, 1982; Nottenburg & Fedor, 1983; Greve, 2003) have argued that managers of declining firms who attribute decline to temporary or unstable causes are less motivated to allocate resources toward an innovative response because the underlying causes may not 1) occur again or 2) be relevant by the time an innovative action plan is ready for implementation. Hence,

H4. Perceived stability of causes will positively affect innovation activities in under-performing projects.

Project managers of over-performing projects would be hesitant to commit their available slack to innovative actions unless convinced that the favorable operating conditions that produced the slack would continue for an extended period. Hence,

H4'. Perceived stability of causes will positively affect innovation activities in over-performing projects.

Causal attribution arguments indicate that the perception of control may improve manager self-confidence, thereby translating into higher levels of aspiration, persistence, and goal achievement (Mone et al., 1998). The project management literature focused on leadership style and traits suggests that there is a close relationship between a leader's perception of project success and his or her personality and contingent experiences (Gehring, 2007; Turner & Müller, 2005). The confidence and self-belief based on personal knowledge and experience are likely to play an important role in a manager's ability to deliver a project successfully (Lee-Kelley & Leong, 2003). Hence,

H5. Perceived controllability of causes will positively affect innovation activities in under-performing projects.

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Project Performance

There is much knowledge to be gained through empirical research of the innovation – performance relationship in projects (Brady & Söderlund, 2008; Geraldi, Turner, Maylor, Soderholm, Hobday & Brady, 2008; Keegan & Turner, 2002). The hypotheses here are informed by the firm-level research, which tends to fall into one of two intellectual streams. The necessity stream argues that poor performance acts as a catalyst for new innovation (Amabile & Conti, 1999; Barker & Barr, 2002; Mone et al., 1998). The abundance stream argues that slack resources gained from exceptional performance act as a catalyst for innovation (Bourgeois, 1981; Cyert & March, 1963; Singh, 1986; Hambrick & D'Aveni, 1988; Greve, 2003). Hence,

H6. Project innovation will positively affect and project performance in under-performing projects

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Research Method

Scale Development

A review of related conceptual and tested measures in the extant literature was conducted in order to select items. Where possible, each of the constructs presented in the model above was evaluated by multi-item measures (Churchill, 1979). In some cases, reliable items could not be found. In others, a new element was being tested. Hence, new items were formulated, and their reliability and validity tested during wide-scale data collection. The item measurement information is presented in Appendix A.

Pilot Test

A pilot test was undertaken in order to further validate the relevance, coverage, and clarity of the literature-derived and new measurement items. It involved the participation of four practitioners (i.e. project managers from the industry and four project management scholars. The project managers had at least five years of work experience in the energy sector. The scholars had more than 10 years of research and/or teaching experience in the field.

Each participant attended a one-hour interview, during which they completed the questionnaire. The participants were asked to indicate, on a Likert scale, the relevance of each item used to measure the various constructs. Then, the subjects were asked to 1) indicate means of improving the relevance, coverage, understandability, and clarity of the measurement items and 2) suggest important items that did not appear on the questionnaire. The single most important modification resulting from the pilot test was the addition of short narratives that explicated over- and under-performing projects.

Project performance was considered to be a function of time, cost and scope. If the continuous monitoring of a project's performance variance shows that the overall performance of a project is considerably behind what was planned, then the project is under-performing. Projects that are behind schedule and/or over budget due to, for example, detecting a quality problem with products, an unexpected machine break down and a disruption in the supply of materials or services result in unfavourable conditions (possibly requiring innovative interventions). If the continuous monitoring of a project's performance variance shows that the overall performance of a project is considerably better than planned, then the project is over-performing. Projects that are ahead of schedule and/or under budget, due to, for example, unexpectedly good weather, expedited deliveries of supplies and early availability of machinery result in favourable conditions (possibly for innovation). (Jelinek & Schoonhoven, 1990)

Data Collection

The data collection was separated into two phases. The first phase involved identifying key contacts at the companies with ongoing projects in Alberta. In 2010, there were nine conventional oil and gas projects and fifty-six oil sands (sometimes call tar sands) projects under development. Contacts were secured from the sixty-five companies (called 'producer' in Table 1) via phone calls, e-mails and personal referrals. The second phase involved identifying key contacts at specialty service firms responsible for various aspects of project management in engineering, design and construction. Typically, such firms execute projects and make decisions at all levels of project governance. A total of seventy-five contacts were secured via several rounds of e-mails and face-to-face meetings. The total number of valid responses was eighty-seven.

Target respondents were expected to possess sufficient knowledge in order to accurately complete the instrument. The ideal respondents required three main attributes to participate. First, a respondent was expected to report on one or more recently completed / ongoing project(s). Each respondent was asked to focus on one significantly positive and one significantly negative gap (actual minus planned) in the performance of a project. Second, a respondent should have a similar role in both projects (e.g., project manager, project sponsor, and so on) if reporting on more than one project. Third, all projects undertaken should be in the same project-based organization (e.g., all projects were in the same company's portfolio of projects) if reporting on more than one project.

A missing values analysis was performed by review of frequency distributions in order to determine whether or not a large amount of data was missing from survey questions. The analysis revealed that the majority of variables had less than 5% missing data. An analysis to determine differences in skipped survey questions was deemed unnecessary given that the amount of missing data was small (Tabachnick & Fidell, 2001).

Sample

The nature of the Alberta-centric, oil and gas company sample is demonstrated in the descriptive statistics presented in Table 1. Several types of firms were captured by the data collection process. Specialized single-function firms such as engineering / design firms focus on the front-end aspects of a project. Other firms, such as design-build and engineering-procurement-construction (EPC), are involved in all phases from engineering to construction. The types of projects captured vary from routine to non-routine, with the preponderance of projects considered somewhat routine.

Insert Table 1 about here

The number of employees involved in the projects varied from less than twenty to greater than one hundred. Project budgets ranged from less than $50M CDN to greater than $500M CDN. On average, projects in the sample had a budget of $325M and 156 employees.

The role of the respondents varied from project manager in charge of a single project to project sponsor to educator (formerly a project manager). The gender balance of the respondents was seventy-seven percent male to twenty-three percent female. Most of the respondents reported project management training: twenty percent attained a project management professional (PMP) designation; fifty-six percent received extensive project management training; and, twenty percent reported some project management training.

Control Variables

The control variables are industry, project size and project type. Their selection was driven by arguments in the complexity and uncertainty literature (Loch et al., 2006; Sommer & Loch, 2004) and empirical research (Kimberly and Evanisko, 1981; Kozlowski and Bell, 2004).

Industry. The focal industry here, oil and gas construction, has used the project-based organizational form across a wide variety of activities in the sector (Bresnen, Goussevskaia & Swan, 2005; Gann & Salter, 2000; Hobday, 2000). Oil and gas industry projects often experience permanent changes, such as deregulation in the energy industry, which result in substantive changes in the way that clients commission projects (Keegan & Turner, 2002). Such changes have led to the transfer of more risk to the project-based firms.

Project Size. Size is one of the most important factors affecting the structure and processes, i.e. complexity, of an organization (Blau, 1970; Kimberly, 1976). Both advantages and disadvantages are associated with large size. Large organizations have more slack resources for new projects and diversification and more control over the external environment. Alternatively, they are more bureaucratic and less flexible, i.e. unable to change and adapt quickly (Hitt, Hoskisson & Ireland, 1990; Whetten, 1987). By comparison, small organizations are considered innovative because they are flexible to adapt and improve.

Project Type. The type of project also speaks to complexity. Tatikonda and Rosenthal (2000a, p. 87) define complexity as, "The nature, quantity, and magnitude of organizational subtasks and subtask interactions posed by the project." Energy industry project types range from single function (e.g., design, engineering, construction) to binary functions (e.g., procurement and construction) to more comprehensive in scope (e.g., engineering-procurement-construction or engineering, procurement, construction, and management). A project team experiences higher degrees of work complexity as the type of contract changes and the variety of activities (and their interdependencies) in the scope of work increases. Hence, project type is controlled in order to account for the degree of departmentalization or functional differentiation (i.e., the variety of specialists that work in an organization) as predictors of innovation (Aiken, Bacharach, & French, 1980; Damanpour, 1996; Kimberly & Evanisko, 1981). For this undertaking, project types were based on commonly accepted project classifications and validated by industry professionals.

Empirical Results

Factor Analysis

Factor analysis (FA) was performed for data reduction and identification of constructs. Principal component analysis with Varimax rotation was performed to simplify factors by maximizing the variance of loadings within factors and across variables. The data used for this analysis met the various assumptions for FA aside from the number of observations (87 out of a required minimum of 100). The Keiser criterion, which maintains that only factors with Eigen values greater than one should be retained in the analysis, was used.

The factor analysis of the seven main constructs in the model showed the emergence of 13 sub-scales for both models combined. The variability accounted for met the qualification of an effective factor analysis, which usually accounts for 60-70% of variability (Tabachnick & Fidell, 1996). The summary of the FA results is presented in Table 2.

Insert Table 2 about here

The initial reliability analysis with the items on the measures for innovation in over- and under-performing projects revealed constructs with reliability coefficients that fall under the desired threshold of 0.7 – a cut-off point for internal reliability analysis that was proposed in early works in the field (Cronbach, 1951; Tabachnick & Fidell, 1996). It should be noted that such a high degree of reliability can only be achieved when established, pre-tested measures are already developed, employed, and refined by previous research.

A couple of considerations were given to the cut-off issue prior to continuing the analysis, given that some of the constructs showed a reliability measure below the 0.7 threshold. First, there are several studies which suggest that the 0.7 cut-off point is not a rigid limit for all study types and sample sizes (Lance, Butts and Michels, 2006). Second, there are published studies that have lower than expected internal reliability. For example, Chung and Petrick (2013) contained a measure with composite reliability of 0.45.

Table 3 presents the reliability measures for the instrument.

Insert Table 3 about here

Statistical Tests

The collected data was sorted into one of two groups: strong project performance and weak project performance. A multivariate analysis of variance (MANOVA) was conducted to examine the difference between the two groups. The three identified factors in project innovation (i.e., value creation, enabling effect, and co-creation of insight) were used as variables for the MANOVA. The Wilks' Lambda multivariate test of overall difference between the over- and under-performing projects was statistically significant (p=0.078). Analysis of the univariate F-tests reported in the MANOVA output confirmed that only one significant pair was involved between the two datasets: the pair-wise test of the *value creation* dimension of the project innovation construct. Table 4 presents the results of MANOVA and the univariate F-tests.

Insert Table 4 about here

Hypothesis Testing

Five hypotheses were tested for each group of over- and under-performing projects. Hierarchical regression was used to assess the effect of the contextual variables, as well as identified control variables, on project innovation in each dataset. Hypotheses H1a through H5a represent the hypothesized effects in under-performing projects. Hypotheses H1a´ through H5a´ represent the hypothesized effects in over-performing projects. For the following hypotheses, based on both under- and over-performing projects, only the statistically significant relationships are reported here.

H1. Institutionalized control will negatively affect innovative activities in under-performing projects

All variables aside from the variable of interest and the control variables were regressed on the three dimensions of project innovation. Then, both dimensions of the institutionalized control construct were entered into the model. The results of the hierarchical regression analysis are presented in Table 5.

Insert Table 5 about here

As presented in the Table 5, there is a significant relationship between reflexive control dimension of institutionalized control and the enabling-effect dimension of project innovation in under-performing projects. The negative β coefficient supports the hypothesis that increased institutionalized control could stifle innovation.

H2. Discretionary power will positively affect innovative activities in under-performing projects

All variables aside from the variable of interest and the control variables were regressed on the three dimensions of project innovation. Then, both dimensions of the managerial discretion construct were entered into the model. Although the overall model fit showed a significant relationship (F values of 2.499 and 2.627 respectively at $p<.05$), it did not support the associated beta coefficients (-.145 and .175 for Constrained Optimization and Bold Intervention). Hence, the hypothesis was not supported.

H3. Uncommitted resources will positively affect innovative activities in under-performing projects

All variables aside from the variable of interest and the control variables were regressed on the three dimensions of project innovation. Then, both dimensions of the project slack construct were entered. The availability of uncommitted resources showed a significant model fit, but neither of the beta coefficients was significant. Hence, the hypothesis was not supported.

H4. Perceived stability of cause will positively affect innovative activities in under-performing projects

All variables aside from the variable of interest and the control variables were regressed on the three dimensions of project innovation. Then, the perceived stability construct was entered. The results showed a significant model fit, but no significant relationship between perceived stability and innovation in under-performing projects.

H5. Perceived controllability of cause will positively affect innovative activities in under-performing projects

All variables aside from the variable of interest and the control variables were regressed on the three dimensions of project innovation. Then, the perceived controllability construct was entered. The results are presented in Table 6.

Insert Table 6 about here

Perceived controllability has a significant effect on the enabling-effect dimension of project innovation. The positive significant coefficient in the regression (i.e., .116) suggests a positive relationship between perceived controllability and project innovation in under-performing projects. This suggests that as the perception of controllability increases, the probability of innovative intervention in an under-performing project increases as well.

H6. Project innovation will positively affect project performance in under-performing projects

The result of the regression analysis suggested that there is no significant relationship between expected effect of project innovation and project performance in under-performing projects.

An identical statistical procedure to that used above is employed to test the following hypotheses. For the sake of brevity, the statistical procedure will be explained only when there is an exception or an extra step involved.

H1'. Institutionalized control will positively affect innovative activities in over-performing projects

The results are presented in Table 7. The model fit for the value creation dimension was found to be significant, but the regression coefficients were not significant. Hence, the hypothesized relationship was not supported.

The positive coefficient for formal control suggests a positive relationship between institutionalized control and the co-creating insights dimension of the innovation construct.

Insert Table 7 about here

H2'. Discretionary power will positively affect innovative activities in over-performing projects

The results are presented in Table 8. The results reveal that the only significant relationship between managerial discretion and project innovation is present between the bold intervention dimension of the former and the value creation dimension of the latter. The positive coefficient suggests a positive relationship between the two sub-constructs. Hence, we suggest that the hypothesis is partially supported.

Insert Table 8 about here

H3'. Uncommitted resources will negatively affect innovative activities in over-performing projects

The results of the analyses are presented in Table 9. The analyses revealed that the only significant relationship between project slack and project innovation is limited to the offensive slack dimension of project slack and value creation dimension of project innovation. The results suggested a negative relationship between the two sub-constructs, which partially supports the proposed hypothesis.

Insert Table 9 about here

H4'. Perceived stability of cause will positively affect innovative activities in over-performing projects

The regression model did not show any significant relationship between the different dimensions of the two constructs of perceived stability and project innovation. Hence, the hypothesis was not supported.

H5'. Perceived controllability of cause will positively affect innovative activities in over-performing projects

The results are presented in Table 10. The predictor of perceived controllability has a positive and significant effect on the co-creating insights dimension of project innovation. This result partially supports the proposed hypothesis.

Insert Table 10 about here
----

*H6'. Project innovation will positively affect and project performance in over-*performing projects

The results are presented in Table 11. The result of the regression analysis suggested that innovation has a significant, but negative relationship with the efficiency dimension of project performance.

Insert Table 11 about here

Discussion

The main research objective of this undertaking was to shed light on innovation in large projects in the P&P industry. The results indicate that innovative behaviors are present in P&P projects, regardless of size and type. This finding is very interesting given that such projects are typically characterized by rational measures such as planning, implementation schedule and cost control. It may allay some of the concerns of those who argue that the P&P industry will suffer without creative thinking and innovation. For example, Hassani et al. (2017, p. 5) argue that, "…if the

P&P industry fails to innovate and improve their technologies for sourcing, producing and transporting oil and gas, then the industry is likely to find itself going out of business as demand could drop rapidly owing to successes in innovation and technology in competing industries."

The findings also indicate that innovation is present regardless of performance level. This is particularly interesting in light of the extensive literature that promotes innovation as a solution to firm-level performance woes. Our results with respect to over-performing projects are consistent with Damanpour and Evan (1984). High-performing innovative firms would not only accomplish their primary tasks more effectively, but also use their resources and skills to create new opportunities, e.g., by introducing new products or services. However our study goes deeper into the nature of innovation. We observed that the nature of innovation in over-performing projects appears to be substantively different from that of under-performing projects. In over-performing projects, innovation was determined to be construed as either *value creation* or *co-creating insights*. Examples of value creation are reducing waste, improving safety, and improving organizational agility in response to environmental shifts. Examples of co-creating insights are working collectively to develop a method to capture lessons learned; classifying information for better access in future projects; and, inventing new ways of hiring and training local labor.

In under-performing projects, our results are consistent with the results of (Bowen et al. (2010), Chandler (2008), Cyert & March (1963), Meyer (1982) and Singh (1986). The individual, project-level, and organizational level expectation of innovation is to solve problems and bring a project back on track. The statistical significance of the *enabling effect* dimension aligns with extant research findings indicating that performance below an aspiration level will lead to problemistic search for remedial actions (Cyert & March, 1963) and a wide range of actions viewed as consequential to performance, such as innovation (Bolton, 1993; Greve, 2003). That the other innovation dimensions, value creation and co-creating insights, are not relevant fits with the desire at various organizational levels to shun high-risk innovation. Stuart & Podolny (1996) felt that such low risk paths would include improving existing technologies even marginally, or enhancing the methods of doing project tasks

The findings with respect to slack are also very interesting. The general expectation in organizational behavior research is to find a positive relationship between slack and innovative behavior at the firm level. The under-performing projects examined here did not demonstrate any relationship between slack and innovation. However, there is some evidence that over-performing projects introduce innovation via slack for offensive purposes, i.e. pre-emptive (such as accelerating upcoming critical activities) or exploitive (such as using resources for experimentation).

On one hand, the availability of resources has been positively linked to innovation through autonomous behaviour and emergent management style (Tatikonda & Rosenthal, 2000a). Contrary to the prior argument, excessive organizational slack has been associated with sub-optimal behaviour (Bourgeois, 1981; Nohria & Gulati, 1996). This may be due to behaviour based on a lowered threshold of "acceptability," resulting in less-than-optimal solutions to a problem (Cyert & March, 1963). This excessive slack may lead to undisciplined behaviour which generates less-than-ideal outcomes (Nohria & Gulati, 1996). However, these studies do not differentiate between poorer and better performing situations. Our study provides some finer analysis. It appears that the relationship between slack and innovation depends in part on how well the project is doing. Hence, knowing how well a project is doing is important in understanding whether slack is useful.

Finally, the research revealed interesting findings with respect to project performance. First, the existence of innovation in under-performing projects did not appear to exert any influence on project outcome. This finding does not align with the firm-level notion of necessity as the mother of invention (McKinley, 1993), which suggests that a positive outcome will materialize. However, it appears consistent with Hitt, Hoskisson, & Kim (1997), who found no significant relationship between innovation and organizational performance. Indeed, studies on the relationship between innovation and future organizational performance have been conflicting, varying from positive (Matsuo, 2006) to negative (Balkin, Markman, & Gomez-Mejia, 2000), in addition to the non-significant results of Hitt, Hoskisson, & Kim (1997). Thus, extrapolating to the project environment, it may not be surprising that we find no relationship between innovation and project performance.

Second, the existence of innovation in over-performing projects appeared to exert a negative influence on project outcome. This finding does not align with the firm-level notion that, for example, high-performing firms use slack to introduce products or services never previously offered (Damanpour & Evan, 1984) and generate additional shareholder value. It should be noted that the findings with respect to performance may not be particularly surprising given the nature of the sample and the qualitative reporting process. The respondents, largely project managers, may not hold particularly positive views of creative behavior, possibly because of how they are trained and evaluated. Further it is important to reiterate that studies on the relationship between innovation and organizational performance have provided conflicting results.

Limitations

It is important to appreciate the nature and generalizability of the insights gleaned from this undertaking given its various and attendant limitations. The primary limitation involves the nature of the sample. First, it is solely focused on projects within the P&P industry in the province of Alberta, Canada. A survey implemented in other regions may shed different light on the innovation activity of P&P projects. Second, the projects – taken from a subset belonging to project organizations with relevant entries in the Alberta Major Projects database – focused on oil sands, oil and gas, pipeline, and biofuel projects. It is conceivable that, for example, conventional and oil sands projects are managed by organizations with such vastly different management structures that they should be treated as separate samples[3]. However, we hope that the following mitigating information minimizes any effect on the generalizability of the results. First, concern for this issue did not arise when consulting industry experts during survey design and pre-testing. Second, anecdotal evidence suggests that within the same organization, while oil sands and non-oil sands organizations are separate, the project management philosophy appears consistent. Third, only a small percentage (6%) of the sample came from the oil and gas producers themselves.

[3] We wish to thank one of the reviewers for suggesting this possibility. It should be noted that we discussed this issue with knowledgeable managers with experience at three major Canadian oil and gas companies with oil sands operations. Further, we presented the issue to the Oil and Gas Partner in the Calgary office of one of the 'big four' advisory organizations and a manager at a software supplier to major oil and gas companies with oil sands operations. The results of our qualitative work indicate that project management practices in such large organizations are 1) supported by a common project management office and 2) consistent across oil sands and E&P divisions.

The second limitation of this investigation involves the relatively low reliability of scores associated with the new items on the questionnaire. The item purification process and wording adjustments partially enhanced the reliability of new items for some of the constructs (e.g., project slack, project innovation). However, the comprehensive treatment of complex constructs such as slack, innovation, and performance would require a bigger set of questions that had been pre-tested and validated in a relatively large pilot study.

The third limitation of the research process involves the nature of the research design. On one hand, the cross-sectional design allowed for the examination of correlations amongst the theory-driven variables and the derivation of related inferences. On the other hand, the survey method suffers from several weaknesses such as respondent memory accuracy and social desirability bias.

Conclusion

Our findings are provocative. They shed light on the nature, extent and effects of innovation in the western Canadian petroleum and petrochemical project setting. If the theories utilized here offer the potential for generalization, the findings may have implication for P&P projects around the world.

The first contribution of the research is to provide evidence that innovation exists at the project level, regardless of project performance status. This realization may have implications for C-level executives, project managers and other stakeholders, including educators. The second contribution of the research is the testing of hypotheses derived from three popular management theories. It responds to calls for more theory-driven research in project management, as well as use of appropriate theories from other fields. Further, additional use of the theories will eventually lead to judgments of their value (Meehl, 1990) at the intersection of project management and innovation literatures. The third contribution is its use of slack in a project context, specifically the delineation of defensive and offensive modes of slack usage.

It is hoped that future empirical research in this vein further explores the nature of innovation in large scale projects. A case study approach may serve to better understand innovative processes in P&P projects. Further, the collection of panel data may help to draw more generalizable inferences about innovation in P&P projects.

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References

Acha, V. (2002).Framing the past and future: the development and deployment of technological capabilities by the oil majors in the upstream petroleum industry (D.Phil.dissertation). Science and Technology Policy Research Unit (SPRU) at the University of Sussex, Brighton, United Kingdom.

Aiken, M., Bacharach, S. B. & French, J. L. (1980). Organizational structure, work process, and proposal making in administrative bureaucracies. *Academy of Management Journal* 23(4): 631-652.

Amabile, T.M. & Conti, R. (1999). Changes in the work environment for creativity during downsizing. *Academy of Management Journal* 42(6): 630-640.

Anbari, F.R. (2005). Innovation, project management, and six sigma. In: Rahim, M.A and Golembiewski, R.T. *Current topics in Management*, Vol.10. Eds. New Brunswick. NJ: Transaction Publishers: 101-116.

Artto, K., Martinsuo, M., Dietrich, P. & Kujala, J. (2008). Project strategy: strategy types and their contents in innovation projects. International Journal of Managing Projects in Business 1(1): 49-70.

Balkin, D. B., Markman, G. D., & Gomez-Mejia, L. R. (2000). Is CEO pay in high-technology firms related to innovation? Academy of Management Journal 43(6): 1118-1129.

Barker, V. L. & Barr, P. S. (2002). Linking top manager attributions to strategic reorientation in declining firms attempting turnarounds. *Journal of Business Research* 55(12): 963-979.

Bastian, B.L. & Tucci, C. (2010). An empirical investigation on the effects of political risk on technology strategies of firms. Paper presented at the DRUID Summer Conference. Imperial College Business School. London,UnitedKingdom: 16-18.

Blau, P. M. (1970). A Formal Theory of Differentiation in Organizations. *American Sociological Review* 35: 201-218.

Bolton, M. (1993). Organizational Innovation and Substandard Performance: When Is Necessity the Mother of Innovation? *Organization Science* 4(1): 57-75.

Bourgeois, L. (1981). On the measurement of organizational slack. Academy of Management. The *Academy of Management Review* 6(1): 29-39.

Bourgeois, L. & Singh, J. (1983). Organizational slack and political behavior among top management teams. *Academy of Management Proceedings*, 43-47.

Bowen, F., Rostami, M., & Steel, P. (2010). Timing is everything: A meta-analysis of the relationships between organizational performance and innovation. Journal of Business Research 11(11): 1179-1185.

Brady, T. & Söderlund, J. (2008). Projects in innovation, innovation in projects: selected papers from the IRNOP VIII conference. Guest editorial, special Issue. *International Journal of Project Management* 26: 465-468.

Bresnen, M., Goussevskaia, A. & Swan, J. (2005). Organizational Routines, Situated Learning And Processes Of Change In Project-Based Organizations. *Project Management Journal* 36(3): 27.

Bryson, J. M. & Delbecq, A. L. (1979). A Contingent Approach to Strategy and Tactics in Project Planning. *Journal of the American Planning Association* 45(2): 167-179.

Chan, E. H. W. & Yu, A. T. W. (2005). Contract strategy for design management in the design and build system. *International Journal of Project Management* 23(8): 630-639.

Chandler, L. (2008). The multiple dimensions of slack: Effects on innovation and firm performance during environmental shock. Unpublished D.B.A., Nova Southeastern University, United States -- Florida.

Chen, C.-J., & Huang, Y.-F. (2010). Creative workforce density, organizational slack, and innovation performance. *Journal of Business Research* 63(4): 411-417.

Chen, K. L., Tan, B. & Chiu, J.-Z. (2008). The impact of organisational culture and learning on innovation performance. *International Journal of Innovation and Learning* 5(4), 413-428.

Chung, J. Y., & Petrick, J. F. (2013). Price Fairness of Airline Ancillary Fees An Attributional Approach. *Journal of Travel Research* 52(2): 168-181.

Churchill, G. (1979). A Paradigm for Developing Better Measures of Marketing Constructs. *Journal of Marketing Research* 16(1): 64-73.

Cibin, R. & Grant, R.M. (1996). Restructuring among the world's leading oil companies, 1980–92. *British Journal of Management* 7(4): 283–307.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests *Psychometrika* 16(3): 297-334.

Cyert, R., & March, J. (1963). *A behavioral theory of the firm*. NY: Prentice Hall.

Damanpour, F. (1991). Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators. *The Academy of Management Journal* 34(3): 555-590.

Damanpour, F. (1996). Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models. *Management Science* 42(5): 693-716.

Damanpour, F. & Aravind, D. (2011). Managerial Innovation: Conceptions, Processes, and Antecedents. *Management and Organization Review* 8(2): 423-454.

Damanpour, F. & Evan, W. M. (1984). Organizational Innovation and Performance: The Problem of "Organizational Lag". *Administrative Science Quarterly* 29(3): 392-409.

Daneshy, A. (2003a). Dynamics of innovation in the upstream oil and gas industry (Guest Editorial). *Journal of Petroleum Technology* November: 16–18.

Daneshy, A. (2003b). Evolution of technology in the upstream oil and gas industry. *Journal of Petroleum Technology* May: 14–16.

Daneshy, A. & Donnelly, J. (2004). A JPT roundtable: the funding and uptake of new upstream technology. *Journal of Petroleum Technology* 56(6): 28–30.

Davies, A. (2013) Innovation and Project Management. In Dodgson, M., Gann, D. and Phillips, N. (Eds.), *The Oxford Handbook of Innovation Management*, Oxford University Press, Oxford: 625-647.

Davies, A., MacAulay, S., DeBarro, T. & Thurston, M. (2014). Making Innovation Happen in a Megaproject: London's Crossrail Suburban Railway System. *Project Management Journal* 45(6): 25-37.

Decker, R., Flaaen, A. & Tito, M. (2016). Unraveling the Oil Conundrum: Productivity Improvements and Cost Declines in the U.S. Shale Oil Industry. Feds Notes. Available via: https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/unraveling-the-oil-conundrum-productivity-improvements-and-cost-declines-in-the-us-shale-oil-industry-20160322.html [Accessed: 22.07.2017].

DiMaggio, P. J. & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review* 48(2): 147-160.

Edquist, C., Hommen, L. & McKelvey, M. (2000). Product versus process innovation: Implications for employment. In Edquist, C., and McKelvey, M (Eds.), Systems of innovation: Growth, competitiveness and employment. Cheltenham, UK: Edward Elgar Publishing, p. 377-400.

Ford, J. D. (1985). The effects of causal attributions on decision makers' responses to performance downturns. *Academy of Management Review* 10(4): 770-786.

Gann, D. M. & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. *Research Policy* 29(7-8): 955-972.

Gehring, R. (2007). Applying traits theory of leadership to project management. *IEEE Engineering Management Review* 35(3): 109-122.

Geraldi, J. G., Turner, J.R., Maylor, H., Soderholm, A., Hobday, M. & Brady, T. (2008). Innovation in project management: Voices of researchers. *International Journal of Project Management* 26(5): 586-589.

Gil, N., Miozzo, M. & Massini, S. (2012). The innovation potential of new infrastructure development: An empirical study of Heathrow airport's T5 project. *Research Policy* 41(2): 452-466.

Goldenberg, J., Lehmann, D. R. & Mazursky, D. (2001). The idea itself and the circumstances of its emergence as predictors of new product success. *Management Science* 47(1): 69-84.

Grant, R.M. (2003). Strategic planning in a turbulent environment: evidence from the oil majors. *Strategic Management Journal* 24(6): 491–517.

Grant, R.M. & Cibin, R. (1996). Strategy, structure and market turbulence: the international oil majors, 1970–1991. *Scandinavian Journal of Management* 12(2): 165–188.

Greve, H. R. (2003). A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Academy of Management Journal* 46(6): 685-702.

Hambrick, D. C. & D'Aveni, R. A. (1988). Large Corporate Failures as Downward Spirals. *Administrative Science Quarterly* 33(1): 1-23.

Hassani, H., Silva, E.S. & Al Kaabi, A.M. (2017). The role of innovation and technology in sustaining the petroleum and petrochemical industry. *Technological Forecasting and Social Change* 119: 1-17.

Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.

Helfat, C.E. (1994a). Evolutionary trajectories in petroleum firm R&D. *Management Science* 40(12): 1720–1747.

Helfat, C.E. (1994b). Firm-specificity in corporate applied R&D. *Organization Science* 5(2): 173–184.

Helfat, C.E. (1997). Know-how and asset complementarity and dynamic capability accumulation: the case of R&D. *Strategic Management Journal* 18(5): 339–360.

Hitt, M. A., Hoskisson, R.E. & Ireland, R.D. (1990). Mergers and Acquisitions and Managerial Commitment to Innovation in M-form Firms. *Strategic Management Journal* 11: 29-47.

Hobday, M. (2000). The project-based organisation: An ideal form for managing complex products and systems? *Research Policy* 29(7-8): 871-893.

Hodgson, G.M. (2006) What are institutions? *Journal of Economic Issues* 40(1): 1–25.

Jelinek, M., & Schoonhoven, C. (1990). The Innovation Marathon: Lessons from High Technology Firms. San Francisco: Blackwell.

Jones, E. E. & Davis, K. (1965). From acts to dispositions: The attribution process. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 2: 219–266). New York: Academic.

Keegan, A. & Turner, J. R. (2002). The Management of Innovation in Project-Based Firms. *Long Range Planning* 35(4): 367-388.

Kelley, H. H. (1967). Attribution theory in social psychology. In D. Levine (Ed.), *Nebraska Symposium on Motivation* (192–238). Lincoln: University of Nebraska Press

Kelley, H. H. (1973). The process of causal attribution. American Psychologist 28(2): 107–128.

Kelley, D. & Lee, H. (2010). Managing Innovation Champions: The Impact of Project Characteristics on the Direct Manager Role. *Journal of Product Innovation Management* 27(7): 1007-1019.

Kimberly, J. R. (1976). Organizational Size and the Structuralist Perspective: A Review, Critique, and Proposal. *Administrative Science Quarterly* 21: 571-597.

Kimberly, J. R. & Evanisko, M. J. (1981). Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *The Academy of Management Journal* 24(4): 689-713.

Kozlowski, S. W. J. & Bell, B. S. (2004). Work Teams. Encyclopedia of Applied Psychology 3: 725-732.

Lance, C. E., Butts, M. M. & Michels, L. C. (2006). The Sources of Four Commonly Reported Cutoff Criteria What Did They Really Say? *Organizational Research Methods* 9(2): 202-220.

Langer, E. J. (1975). The illusion of control. Journal of personality and social psychology 32(2): 311-328.

Lashinsky, A. (2010). There will be oil. *Fortune* 161(5): 86–94.

Lee-Kelley, L. & Leong, K. (2003). Turner's five-functions of project-based management and situational leadership in IT services projects. *International journal of project management* 21(8): 583-591.

Lenfle, S. (2008). Exploration and project management. *International Journal of Project Management* 26(5): 469-478.

Litschert, R.J. & Bonham, T.W. (1978). A Conceptual Model of Strategy Formation. *Academy of Management Review* 3(2): 211-219.

Loch, C. C., DeMeyer, A. & Pich, M. T. (2006). *Managing the unknown : a new approach to managing high uncertainty and risk in projects*. Hoboken, NJ: John Wiley & Sons, Inc.

Longwell, H.J. (2002). The future of the oil and gas industry: past approaches, new challenges. *World Energy* 5(3): 100–104.

Lord, R. (2007). Technological breakthroughs advanced upstream E&P's evolution. *Journal of Petroleum Technolog*y 59(10): 111–116.

Matsuo, M. (2006). Customer orientation, conflict, and innovativeness in Japanese sales departments. Journal of Business Research 59(2): 242-250.

Matzler, K., Schwarz, E., Deutinger, N. & Harms, R. (2008). The Relationship between Transformational Leadership, Product Innovation and Performance in SMEs. *Journal of Small Business and Entrepreneurship* 21(2): 139-151.

McKinley, W. (1993). Organizational decline and adaptation: Theoretical controversies. *Organization Science* 4(1): 1-9.

McKinley, W., Sanchez, C. & Schick, A. (1995). Organizational Downsizing: Constraining, Cloning, and Learning. *Academy of Management Executive* 9(3): 32-42.

Meehl, P.E. (1990). Appraising and amending theories: The strategy of Lakatosian defense and two principles that warrant it. *Psychological Inquiry* 1(2): 108-141.

Meyer, A. (1982). Adapting to Environmental Jolts. Administrative Science Quarterly 27(4): 515.

Midler, C., Killen, C.P. & Kock, A. (2016). Project and Innovation Management: Bridging Contemporary Trends in Theory and Practice. Guest editorial. *Project Management Journal* 47(2): 3-7.

Milosevic, D. Z. (2002). Selecting a culturally responsive project management strategy. *Technovation* 22(8): 493-508.

Mone, M. A., McKinley, W. & Barker, V. L., III. (1998). Organizational Decline and Innovation: A Contingency Framework. *The Academy of Management Review* 23(1): 115-132.

Moreau, C. P. & Dahl, D. W. (2005). Designing the solution: The impact of constraints on consumers' creativity. Journal of Consumer Research 32(1): 13-22.

Moses, O. D. (1992). Organizational slack and risk-taking behaviour: Tests of product pricing strategy. *Journal of Organizational Change Management* 5(3): 38-54.

Murphy, M., Heaney, G. & Perera, S. (2011). A methodology for evaluating construction innovation constraints through project stakeholder competencies and FMEA. *Construction Innovation* 11(4): 416-440.

Naveh, E. (2007). Formality and discretion in successful R&D projects. *Journal of Operations Management* 25(1): 110-125.

Nohria, N. & Gulati, R. (1996). Is slack good or bad for innovation? *Academy of Management Journal* 39(5): 1245-1264.

Nottenburg, G. & Fedor, D. B. (1983). Scarcity in the environment: Organizational perceptions, interpretations and responses. *Organization Studies* 4(4): 317-337.

NPC (2007). Facing the hard truths about energy: a comprehensive view to 2030 of global oil and natural gas. National Petroleum Council (an oil & natural gas advisory committee to the U.S. Secretary of Energy), Washington, DC.

Ollinger, M. (1994). The limits of growth of the multidivisional firm: a case study of the U.S. oil industry from 1930–90. *Strategic Management Journal* 15(7): 503–520.

Olsen, N. O. E. (2006). Managing of flexibility in projects. *International Journal of Project Management* 24(1): 66-74.

Parast, M. M. (2011). The effect of Six Sigma projects on innovation and firm performance. *International Journal of Project Management* 29(1): 45-55.

Patanakul, P., & Shenhar, A. J. (2011). What project strategy really is: The fundamental building block in strategic project management. *Project Management Journal* 43(1): 4-20.

Patterson, M. G., West, M. A., Shackleton, V. J., Dawson, J. F., Lawthom, R., Maitlis, S., Robinson, D.L. & Alison, M. (2005). Validating the organizational climate measure: links to managerial practices, productivity and innovation. *Journal of Organizational Behavior* 26(4): 379-408.

Paul, D.L. (2007). Technology to meet the challenge of future energy supplies. *Journal of Petroleum Technology* 59(10): 153–155.

Perrons, R.K. (2014). How Innovation and R&D Happen in the Upstream Oil & Gas Industry: Insights from a Global Survey. *Journal of Petroleum Science and Engineering* 124: 301-312.

Perrons, R.K. & Watts, L. (2008). The selfish technology gene (GuestEditorial). *Journal of Petroleum Technology* 60(4): 20–22.

Rao, V. & Rodriguez, R. (2005). Accelerating technology acceptance: hypotheses and remedies for risk-averse behavior in technology acceptance. Paper presented at the Society of Petroleum Engineers (SPE) Annual Technical Conference and Exhibition, 9–12 October 2005 in Dallas, Texas, USA. Paper Number SPE98511.

Russell, D. (1982). The Causal Dimension Scale: A measure of how individuals perceive causes. *Journal of Personality and Social Psychology* 42(6): 1137-1145.

Salge, T. O. (2011). A Behavioral Model of Innovative Search: Evidence from Public Hospital Services. *Journal of Public Administration Research and Theory* 21(1): 181-210.

Samuel, V.B., Agamuthu, P., Hashim, M.A. (2013). Indicators for assessment of sustainable production: a case study of the petrochemical industry in Malaysia. *Ecological Indicators* 24: 392–402.

Schumpeter, J. (1943). *Capitalism, Socialism and Democracy*. New York: Harper.

Scott, W. R. (1995). *Institutions and organizations*. Thousand Oaks, CA: Sage.

Scott,W. R. & Meyer, J.W. (1991). The organization of societal sectors. In W. W. Powell & P. J. DiMaggio (Eds.), *The new institutionalism in organizational analysis* (108-140). Chicago: University of Chicago Press.

Searle, J. R. (2005). What is an institution? *Journal of Institutional Economics* 1(1): 1-22.

Sharma, A.K. (2005). Technology collaboration between competitive firms in the upstream oil industry: the effect of operational control on collaborative behavior (Submitted as part of the Executive Doctor of Management Program). Case Western Reserve University, Cleveland, Ohio, USA.

Shenhar, A.J., Holzmann, V., Melamed, B. & Zhao, Y. (2016). The Challenge of Innovation in Highly Complex Projects: What Can We Learn from Boeing's Dreamliner Experience? *Project Management Journal* 47(2): 62-78.

Simon, H.A. (1977). *The New Science of Management Decision Making*. Englewood Cliffs, NJ: Prentice-Hall.

Singh, J. V. (1986). Performance, Slack, and Risk Taking in Organizational Decision Making. Academy of Management Journal 29(3): 562-565.

Singh, J. V., House, R. J. & Tucker, D. J. (1986). Organizational change and organizational mortality. *Administrative Science Quarterly* 31(4): 587-611.

Sommer, S. C. & Loch, C. H. (2004). Selectionism and Learning in Projects with Complexity and Unforeseeable Uncertainty. *Management Science* 50(10): 1334-1347.

Stuart, T. E., & Podolny, J. M. (1996). Local search and the evolution of technological capabilities. Strategic Management Journal 17(S1): 21-38.

Swink, M. (2003). Completing projects on-time: How project acceleration affects new product development. *Journal of Engineering and Technology Management* 20(4): 319-344.

Tabachnick, B. G. & Fidell, L. S. (1996). *Multivariate statistics. Using multivariate statistics*. Harper Collins College Pubs., New York.

Tabachnick, B. G. & Fidell, L. S. (2001). *Using multivariate analysis*. California State University Northridge: Harper Collins College Publishers.

Tatikonda, M. V. & Rosenthal, S. R. (2000a). Successful execution of product development projects: Balancing firmness and flexibility in the innovation process. *Journal of Operations Management* 18(4): 401-425.

Tatikonda, M. V., & Rosenthal, S. R. (2000b). Technology novelty, project complexity, and product development project execution success: A deeper look at task uncertainty in product innovation. *IEEE Transactions on Engineering Management* 47(1): 74-87.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509-533.

Tidey, A., 2015. Breaking the Cycle? Cost Efficiency in Upstream Oil and Gas. Available via: https://www.woodmac.com/blog/breaking-the-cycle-cost-efficiency-in-upstream-oil-and-gas/ [Accessed: 22.07.2017].

Tillerson, R. (2006). The high-tech reality of oil. *Newsweek* (Issues2007): 54–55.

Tuomela, R. (1995) *The Importance of Us: A Philosophical Study of Basic Social Notions*. Stanford University Press

Turner, J. R., & Müller, R. (2005). The Project Manager's Leadership Style as a Success Factor on Projects: A Literature Review. *Project Management Journal* 36(1): 49-61.

Urstadt, B. (2006). The oil frontier. *Technology Review* 109(3): 44–51.

Volberda, H. (1998). *Building the Flexible Firm: how to remain competitive*: Oxford University Press.

Weijermars, R. (2009). Accelerating the three dimensions of E&P clockspeed – a novel strategy for optimizing utility in the oil & gas industry. *Applied Energy* 86(10): 2222–2243.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational psychology* 71(1): 3-25.

Weiner, B. (1986). An attributional theory of achievement motivation and emotion. *Psychological Review* 92(4): 548-573.

Weiss, M., Hoegl, M., & Gibbert, M. (2011). Making Virtue of Necessity: The Role of Team Climate for Innovation in Resource-Constrained Innovation Projects. *Journal of Product Innovation Management* 28(s1): 196-207.

Weiss, M., Hoegl, M., & Gibbert, M. (2013). The influence of material resources on innovation projects: the role of resource elasticity. R&D Management 43 (2): 151-161.

Whetten, D. A. (1987) Organizational Growth and Decline Processes. *Annual Review of Sociology* 13: 335-358.

Whitley, R. (2006). Project-based firms: new organizational form or variations on a theme? *Industrial and Corporate Change* 15(1): 77-99.

Wolfe, R. A. (1994). Organizational Innovation: Review, Critique, and Suggested Research Directions. *Journal of Management Studies* 31(3): 405-431.

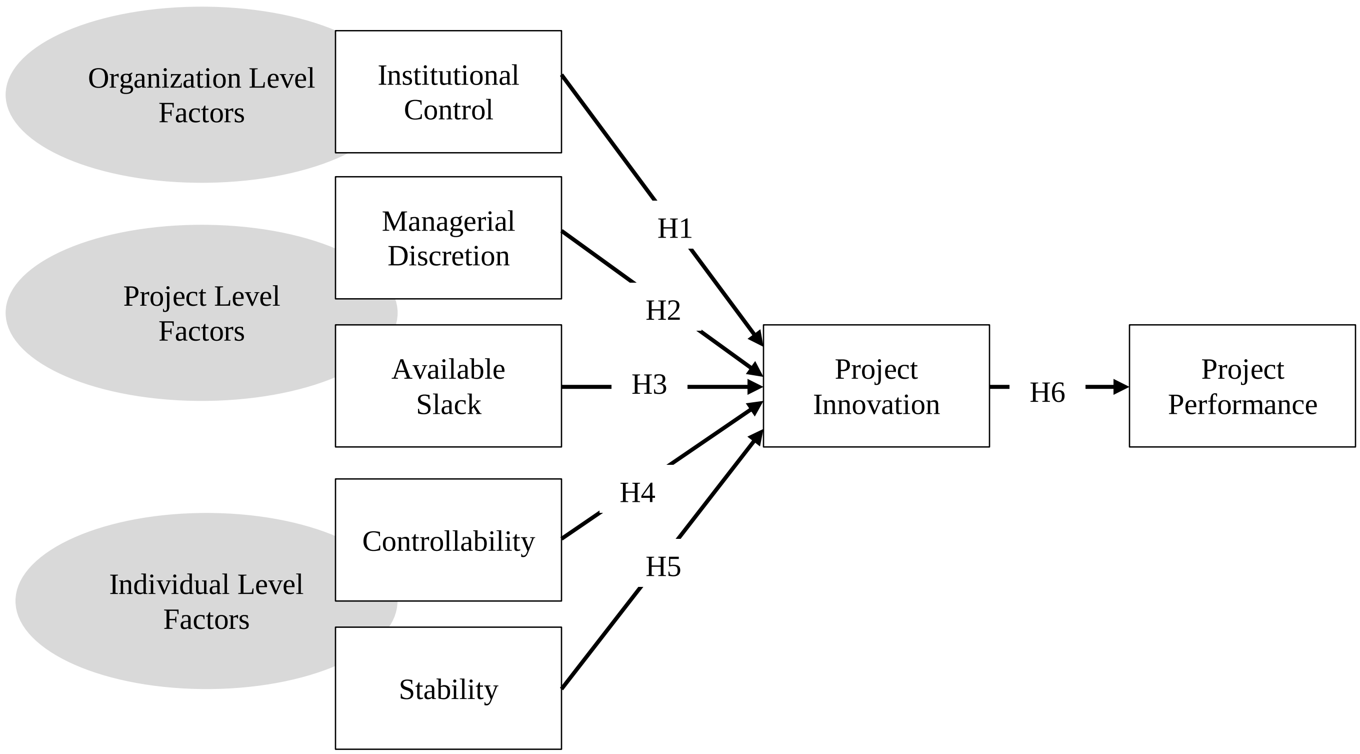
Worsnop, T., Miraglia, S. & Davies, A. (2016). Balancing Open and Closed Innovation in Megaprojects: Insights from Crossrail. *Project Management Journal* 47(4): 79-94.

Wortman, C. B. & Brehm, J. W. (1975). Responses to uncontrollable outcomes: An integration of reactance theory and the learned helplessness model. In L. Berkowitz (Ed.). *Advances in experimental social psychology* Vol. 8 (278-336).

Yasai-Ardekani, M. (1986). Structural Adaptations to Environments. *Academy of Management Review* 11(1): 9-21

Yergin, D. (2009). It's still the one. *Foreign Policy* 19: 89–95.

Figure 1: Research Model



Appendix A: Item Measurement

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Project Innovation	Q6F1	Value creation	Q6b. A new approach to resolve the performance deviation was employed that could provide unanticipated additional benefits (e.g. Cost reduction, customer satisfaction, quality improvement, profitability improvement) to both the project and the customer	Sarin and McDermott (2003)
			Q6e. Formulating innovative response to performance gap is often challenging due to the nature of the project	Grover and Malhotra (2003)
			Q6f. Although generic action plan to address the performance gap can be created, it would often need to be highly customized	Grover and Malhotra (2003)
	Q6F2	Recombining knowledge	Q6c. The approach to closing the performance gap is clearly defined (reverse coded)	Grover and Malhotra (2003)
			Q6d. There are standard solutions or approaches on how to respond to performance deviations (reverse coded)	Grover and Malhotra (2003)
	Q6F3	Co-creating insights	Q6a. Several new ideas (not included in the original plan) were introduced to address the performance gap	Sarin and McDermott (2003)

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Institutionalized Control	Q1F1	Formal Control	Q1a. Our project has a highly formalized channel of communication for routine processes and practices	Baum and Wally (2003)
			Q1b. Our standard operating procedures manual helps us deal with routine processes	Baum and Wally (2003)
			Q1c. Staff must follow formal procedures for non-routine processes	Baum and Wally (2003)
			Q1g. The rules, policies, and procedures levels are specified not only in term of what to do; but also in term of how to do project work activities.	Naveh (2007)
	Q1F2	Reflexive Control	Q1d. There are no written instructions for doing non-routine tasks	Baum and Wally (2003)
			Q1e. In responding to a performance gap, the Project Manager is allowed to figure out the best way to complete non-routine tasks	Baum and Wally (2003)
			Q1f. Formal progress review is held regularly (sometimes also called design, gate, phase, or stage review?)	Naveh (2007)

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Project Slack	Q4F1	Project Slack: Offensive Mode	Q4e. The project's available resources can be used to accelerate upcoming critical activities	New Item
			Q4c. The project resources may be used for experimentation with new technologies or untested techniques that may be employed in the current or future projects	New Item
			Q4d. The available resources may be used to revisit the improvement opportunities in the past –elements of the project	New Item
	Q4F2	Project Slack: Defensive Mode	Q4a. The scope of the project may have to be adjusted to match the available project's resource	New Item
			Q4b. The project's timescales are often adjusted to match the available resources	Gilgeous (1995)
			Q4f. There is a reserved budget that can be used in addressing the performance gap	Gary and Larson (2002)

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Managerial Discretion	Q5F1	Constrained Optimization	Q5a. I am authorized to determine the interim schedule targets	Naveh (2007)
			Q5b. I have the discretion of choosing the format of progress report	Naveh (2007)
			Q5c. I have enough freedom in determining the project management approach	Naveh (2007)
			Q5d. I am authorized to adapt the project's rules, policies, and procedures to the changing performance	Naveh (2007)
	Q5F2	Bold Intervention	Q5e. I can approve the decision to adopt new technologies	Pearce and Zahra (1991)
			Q5f. I have the discretion of formulating responses to performance gap	Nohria and Gulati (1995)
			Q5g. I have the discretion of making resource investment decisions for intended actions	Nohria and Gulati (1995)
			Q5h. I have direct contact with the people in the senior management roles	Wisner, Stringfellow, Yougdahi, Parket (2005)

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Perceived Stability	Q3F1	Perceived Stability	Q3a. In the future, the cause that created the performance gap will continue to influence the progress of this project or any new project, regardless of all other things	Frunham, Sadka, Brewin (1992)
			Q3b. The cause that has created the performance gap will also affect other areas of the project operations as well	Frunham, Sadka, Brewin (1992)
			Q3c. The gap in project's performance is temporary, and will be self-adjusted as the project progresses	New Item

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Perceived Controllability	Q2F1	Perceived Controllability	Q2a. I have some control over the causes of the performance gap	Lau and Woodman (1995)
			Q2b. I am likely to gain rather than lose by action in response to the performance gap	Sharma (2000)
			Q2c. I have the technical knowledge to formulate appropriate actions to address the performance gap (item was reversed coded in the original survey)	Sharma (2000)
			Q2d. I have means to exploit the opportunity/ mitigate the risk introduced by the performance gap	Barr and Glynn (2004)
			Q2e. There is a high probability of achieving the intended outcomes of the actions in response to a gap in performance	Barr and Glynn (2004)

Scale Label	Sub-Scale Code	Sub-Scale Label	Sub-Scale Items Description	Source
Expected Implication of Innovation on Projects Performance	Q7F1	Internal Efficiency performance Dimensions	Q7a. I expect that my non-routine approach will improve project's cost performance	Tatikonda and Montaya-Weiss (2001)
			Q7b. I expect that my non-routine approach will improve project's time performance	Tatikonda and Montaya-Weiss (2001)
			Q7d. I expect that my non-routine approach will improve customer satisfaction	Tatikonda and Montaya-Weiss (2001)
	Q7F2	External Effectiveness Performance Dimensions	Q7c. I expect that my non-routine approach will improve project's scope coverage	Tatikonda and Montaya-Weiss (2001)
			Q7e. I expect that my non-routine approach will improve project's social performance (i.e. improvement in safety, reduction in inconvenience for the neighbouring communities, job enrichment for project's staff)	Tatikonda and Montaya-Weiss (2001)
			Q7f. I expect that my non-routine approach will improve environmental performance (i.e. reducing harmful by-products, reducing emissions, reducing fuel consumption, improving water quality)	Tatikonda and Montaya-Weiss (2001)

Table 1: Descriptive Statistics

Firm Type

Alternative energy projects	1%
Design-Build	59%
Engineering/Design	16%
EPC(M)	9%
Producer	6%
Utility Management	1%
Others	8%

Individual Role

Project manager in charge of a single project	57%
Senior project manager responsible for multiple projects	20%
Project sponsor	7%
A member of the project management office	8%
Educator	3%
Others	5%

Project Type

Non-routine, one of a kind, highly complex with multiple new technologies or approaches involved	11%
Routine, similar to previous projects, limited to no requirement for new technology	14%
Somewhat routine, mostly similar to previous projects, but with some requirement for new technologies or approaches	75%

Number of Project Members

Less than 20	2%
20-50	18%
51-100	47%
over 100	33%

Project Budget

Less than $50M	10%
$50M-$100M	17%
$101M-$200M	29%
$201M-$500M	34%
Over $500M	10%

Table 2: Summary Results of Principal Component Analysis of Scale Items

Construct	Number of Items	Number of Factors Extracted	% of Variance Explained	KMO	Factor Loadings		
					Component 1	Component 2	Component 3
Institutionalized Control	5*	2	51.33	0.605	Q1b : .743	Q1f:.762	
					Q1g: .741	Q1d:.557	
					Q1a: .503		
Perceived Controllability	5	1	51.65	0.785	Q2e:.834		
					Q2c:.802		
					Q2a:.688		
					Q2b:.676		
					Q2d: .560		
Perceived Stability	3	1	55.16	0.585	Q3a: .819		
					Q3c: .794		
					Q3b: .596		
Project Slack	5	2	69.25	0.523	Q4e: .847	Q4b: .879	
					Q4c: .804	Q4a: .848	
					Q4d: .726		
Managerial Discretion	6**	2	51.97	0.679	Q5a: .792	Q5e: .769	
					Q5b: .753	Q5g: .734	
					Q5d: .515	Q5f: .710	
Project Innovation	6***	3	70.62	0.511	Q6e: .861	Q6c: .848	Q6a: .955
					Q6f: .703	Q6d: .840	
					Q6b: .551		
Expected Implication of Innovation on Project Performance	6	2	51.4	0.513	Q7e: .860	Q7b: .686	
					Q7f: .831	Q7a: .679	
					Q7c: .491	Q7d: .664	

(*) This is the number of items remaining in the scale after eliminating items Q1b and Q1d from the original scale.
(**) This is the number of items remaining in the scale after eliminating items Q5c and Q5h from the original scale.
(***)This is the number of items remaining in the scale after eliminating items Qb from the original scale.

Table 3: Summary Results of Internal Consistency Reliability of Scale Items

Construct Label	Factor Label	Number of Items	Crombach's Alpha	Crombach's Alpha Standardized
Institutionalized Control	Formal Control	3	0.634	0.634
	Reflexive Control	2	0.581	0.584
Perceived Controllability	Perceived Controllability	5	0.758	0.759
Perceived Stability	Perceived Stability	3	0.601	0.612
Project Slack	Offensive Mode	3	0.682	0.707
	Defensive Mode	3	0.688	0.708
Managerial Discretion	Constrained Optimization	3	0.692	0.692
	Bold Intervention	3	0.659	0.662
Project Innovation	Value Creation	3	0.557	0.570
	Enabling Effect	2	0.606	0.652
	Co-creating insight	1		
Expected Implication of Innovation on Project Performance	Internal Efficiency	3	0.409	0.414
	External Efficiency	3	0.576	0.567

Table 4: Multivariate Analysis of Variance

Tests involving 'TIME' Within-Subject Effect.
EFFECT .. TIME
Multivariate Tests of Significance (S = 1, M = 1/2, N = 40 1/2)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.07847	2.35585	3.00	83.00	.078
Hotellings	.08515	2.35585	3.00	83.00	.078
Wilks	.92153	2.35585	3.00	83.00	.078
Roys	.09122				

Note: F statistics are exact.

Univariate F-tests with (1,85) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
Value Creation	2.814	42.741	2.813	.502	5.596*	.020
Enabler Effect	.02326	71.476	.0232	.840	.0276	.868
Co-creating Insights	1.140	76.860	1.139	.904	1.260	.265

Table 5: Regression Results for H1

	B(Std. B)	*F*	*df*	*R^2*
Block 1: All variables entered, excluding Institutionalized Control				
DV1: Value Creation Formal Control Reflexive Control				
Block 1: All variables entered, excluding Institutionalized Control		2.200**	16,62	.362
DV2: Enabling Effect Formal Control Reflexive Control	-.353*(-.331*)	2.637**	18,60	.442
Block 1: All variables entered, excluding Institutionalized Control				
DV3: Co-creating Insights Formal Control Reflexive Control				

*p<.10 **p<.05 ***p<.01

Table 6: Regression Results for H5

	B(Std B)	*F*	*df*	*R^2*
Block 1: All variables entered, excluding Perceived Controllability				
DV1: Value Creation Perceived Controllability				
Block 1: All variables entered, excluding Perceived Controllability		2.441***	17,61	.405
DV2: Enabling Effect Perceived Controllability	.116*(.228)*	2.637***	18,60	.442
Block 1: All variables entered, excluding Perceived Controllability				
DV3: Co-creating Insights Perceived Controllability				

*p<.10 **p<.05 ***p<.01

Table 7: Regression Results for H1’

	B(Std β)	*F*	*df*	R^2
Block 1: All variables entered, excluding Institutionalized Control				
DV1: Value Creation Formal Control Reflexive Control				
Block 1: All variables entered, excluding Institutionalized Control				
DV2: Enabling Effect Formal Control Reflexive Control				
Block 1: All variables entered, excluding Institutionalized Control		1.171	16,59	.241
DV3: Co-creating Insights Formal Control Reflexive Control	.189*(.440)*	1.963**	18,57	.383

**p*<.10 ***p*<.05 ****p*<.01

Table 8: Regression Results for H2’

	B(Std. B)	*F*	*Df*	R^2
Block 1: All variables entered, excluding Managerial Discretion		2.221**	16,59	.376
DV1: Value Creation Constrained Optimization Bold Intervention	.218*(.232)*	2.246**	18,57	.415
Block 1: All variables entered, excluding Managerial Discretion				
DV2: Enabling Effect Constrained Optimization Bold Intervention				
Block 1: All variables entered, excluding Managerial Discretion				
DV3: Co-creating Insights Constrained Optimization Bold Intervention				

**p*<.10 ***p*<.05 ****p*<.01

Table 9: Regression Results for H3'

	B(Std β)	*F*	*df*	R^2
Block 1: All variables entered, excluding Project Slack		2.033**	16,59	.355
DV1: Value Creation Offensive Slack Defensive Slack	-.227*(-.282)*	2.246**	18,57	.415
Block 1: All variables entered, excluding Project Slack				
DV2: Enabling Effect Offensive Slack Defensive Slack				
Block 1: All variables entered, excluding Project Slack				
DV3: Co-creating Insights Offensive Slack Defensive Slack				

*p<.10 **p<.05 ***p<.01

Table 10: Regression Results for H5'

	B(Std. B)	*F*	*df*	R^2
Block 1: All variables entered, excluding Perceived Controllability				
DV1: Value Creation Perceived Controllability				
Block 1: All variables entered, excluding Perceived Controllability				
DV2: Enabling Effect Perceived Controllability				
Block 1: All variables entered, excluding Perceived Controllability		1.629*	17,58	.323
DV3: Co-creating Insights Perceived Controllability	.091*(.294)*	1.963**	18,57	.383

*p<.10 **p<.05 ***p<.01

Table 11: Expected Effect of Innovation on Project Over-Performance

	B	*F*	*df*	R^2
DV1: Efficiency Value Creation Enabling Effect Co-creating Insights	 -.415**(-283)**	5.251***	3,78	.168
DV2: Effectiveness Value Creation Enabling Effect Co-creating Insights				

*p<.10 **p<.05 ***p<.01