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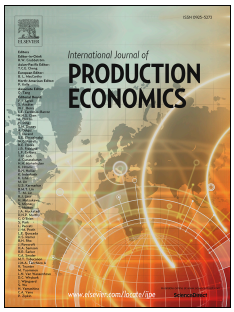

Capturing heterogeneities in orchestrating resources for accurately forecasting high (separately low) project management performance

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Capturing heterogeneities in orchestrating resources for accurately forecasting high (low) project management performance

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Capturing heterogeneities in orchestrating resources for accurately forecasting high (separately low) project management performance

Abstract

Applying complexity theory tenets, the study here contributes an asymmetric modeling perspective for examining resources orchestrations that indicate high (separately low) project management performance (PMP) accurately. Complexity theory tenets include recognizing that the causal conditions resulting in high PMP have different conditions (i.e., ingredients) typically than the causal conditions resulting in low PMP—adopting this perspective supports the usefulness of asymmetric point or interval estimation rather than the currently pervasive symmetric approach to theory construction and empirical modeling of variable directional relationships (VDR). This study constructs a general model and specific configurational propositions that include social capital, processes, and knowledge management effectiveness as causal conditions indicating case outcomes of high and separately low PMP. Using survey data, the study includes examining propositions and models empirically on the causal conditions for completed projects (n = 302, USA sample of executives in product and service industrial firms). The findings support the perspective that high (as well as low) PMP depends on resource orchestration (configurational) antecedent conditions. The findings serve to support the general proposition that applications of complexity theory in project management research respond effectively in building in the requisite variety for deep understanding and accurate forecasting of performance outcomes. This study includes contributions to theory and empirical research that support the perspective that separate sets of resource orchestrations of alternative complex antecedents (rather than a VDR, symmetric, net effects perspective) forecast high (low) project management performances accurately.

Keywords algorithms; configurations; knowledge management effectiveness; performance; project management; social capital

Scientists' tools are not neutral. (Gigerenzer, 1991: 264)

1. Introduction

Gigerenzer's (1991) wisdom underpins the present study: what tools scientists use influences the theories that they construct and restricts/focus their data collection and interpretation of findings. He further notes, "The power of tools to shape, or even to become theoretical concepts is an issue largely ignored in both the history and philosophy of science" (Gigerenzer, 1990: 254). The pervasive adoption of correlation (r), multiple regression analysis (MRA), and structural equation modeling (SEM) in constructing and testing in research in general along with null hypothesis significance tests (NHSTs) without questioning the usefulness of these tools versus alternative tools illustrate the two quoted statements from Gigerenzer (1991). Given their pervasive use in project management, and the telling weaknesses of using r, MRA, and SEM as Armstrong (2012), Fiss (2007, 2011), Hubbard (2015), McCloskey (2002), Trafimow and Marks (2015), Wasserstein and Lazar (2016), Woodside (2019), and Ziliak and McCloskey (2008) describe, supports the call that the present study illustrates theoretically and empirically for moving away from symmetrical to asymmetrical theory construction and empirical analysis.

This study proposes and tests two sets of issues in project management research. The first set of issues concerns identifying complex antecedents conditions[1] of firms' demographic states, knowledge management effectiveness (KME) and social capital for accurately predicting the firm's project management performance (PMP) outcomes. Rather than hypothesizing and testing for symmetrical VDRs, this study proposes and tests for accuracy in predicting case outcomes (e.g., firms in the top quintile for financial performance, and modeling separately, firms in the bottom quintile for firm performance). Rather than asking if a VDR is significant statistically in supporting the alternative hypothesis to the null, the study here asks which simple

[1] While a "variable" is an continuous or discrete attribute, a simple "condition includes a point or limited range of scores for a variable (e.g.," firm age" is a variable, "firms with ages less than ten years" is a condition; "project management performance" (PMP) is a variable, "firms in the top performance quintile" is a condition.

or complex antecedent conditions (if any) predict a given outcome "almost always" (e.g., for projects exhibiting both high social capital and high KME, does high PMP occur almost always)? Operationally here, "almost always" is an asymmetric case model outcome achieving the odds equal or greater than 2-to-1 for the firms with high scores in the complex or simple antecedent condition having high scores in the outcome condition. The specific issues that the study addresses include the following questions. (1-1) Is high KME a necessary and/or sufficient condition[2] for firms achieving high PMP? (1-2) Is high social capital among members of a project team a necessary and/or sufficient condition for firms achieving high KME? (1-3) Is high social capital among members of a project team a necessary and/or sufficient condition for firms achieving high PMP? (1-4) Is high social capital among members of a project team a necessary and/or sufficient condition for firms achieving the combination of high PMP and KME? (1-5) Do firms using a specific type of project management process achieve high social capital? (1-6) Do different profiles of managers indicate (a) high (low) social capital and (b) high (low) KME? (1-7) Do different profiles of managers indicate (a) high and (separately low KME, (b) high versus low (separately) social capital, and (c) high versus low (separately) high PMP and (b) low PMP outcomes?

The second set of issues relates to Rumelt's (2011) perspective on firm-level case anomalies. Theoretically and methodologically, this study also addresses issues relating to anomalies in research findings that occur even when findings support VDR hypotheses. The following issues illustrate potential anomalies in firm project performance research. (2-1) Are some firms with low KME scores also high in PMP even when the findings indicate a

[2] A "necessary" antecedent condition occurs when a simple antecedent condition must be present for an outcome condition to occur; a necessary condition alone is usually insufficient for indicating the outcome condition. "Sufficiency" occurs when an antecedent condition alone or a complex configuration of antecedent conditions accurately predicts an outcome condition; a sufficient simple/complex antecedent condition is unnecessary usually—more than one model predicts an outcome condition accurately (i.e., the "equifinality" tenet from complexity theory of multiple solutions for the same outcome applies).

statistically significant positive KME and PMP VDR? (2-2) Are some firms with high KME scores low in PMP even when the findings indicate a statistically positive KME-PMP VDR? (2-3) If such anomalies do occur, what complex or simple antecedent conditions accurately predict these two types of anomalies? Researchers typically identify cases contrary to a statistically supported hypothesis and findings as anomalies and they usually ignore these anomalies when reporting symmetric VDR findings. Researchers adopting a case-based, asymmetric, outcome perspective embrace Rumelt's (2011: 248) wisdom, "But to others, an anomaly marks an opportunity to learn something perhaps very valuable. In science, anomalies are the frontier, where the action is."

Resource orchestration theory (ROT) is foundational for constructing asymmetric case-based models indicating high (and separately, low) intermediate and/or final project performance outcomes. ROT seeks to explain how managers can combine project resources effectively for high-performance achievement. "The complexity of orchestrating resources in practice has been overlooked in the project field and it is now necessary to go beyond hypothesizing and testing for VDR net effects of individual resources and uncover different resource configurations that maximize profitability" (Hughes, Elliott, & Hughes, 2018, p. 1125). For example, rather than asking if knowledge management effectiveness (KME) has a positive, net, direct effect on performance gains, resource orchestration theory asks, is "KME a necessary and/or sufficient condition for achieving high performance or is high KME one ingredient in a configuration with other ingredients that in combination, indicates high performance? Also, is achieving high social capital a necessary and/or sufficient condition of a project to achieve high performance or does a high social capital occur in nearly all configurations with additional ingredients in orchestrations indicating high performance? The study here contributes to the PMP literature uniquely by

constructing case-base, asymmetric, forecasting models and empirical testing answers to these and related questions.

Thus, the present study applies asymmetric, case-based outcome, configurational theory, modeling, and empirical test these models for consistent accuracy via somewhat precise outcome tests (SPOT) (Woodside, Nagy, & Megehee, 2018). Findings for an asymmetric model indicating the odds are 2-to-1 or higher than a specific high occurs is the SPOT standard set for indicating high accuracy (cf., Ragin, 2008). Though currently comparatively rare to the construction and testing of symmetric VDR hypotheses with NHSTs, prior asymmetric configurational theory construction and empirical research using Boolean algebra appears in the project management literature (Chereshnyuk, et al., 2017; Galeazzo & Furlan, 2018; Kapasli, Roehrich, & Akhtar, 2019; Young & Poon, 2013). Young and Poon (2013, p. 943) provide asymmetric configurational theory and "findings from a fuzzy set analysis" indicating, "top management support—almost always is necessary and sometimes sufficient for success." A "fuzzy set" includes "computing with words [via set theory and Boolean algebra]" (Zadeh, 1996, 2010) using "membership scores"[3] for each case in a study whereby a fuzzy set score is equal to the lowest among the set of two or more conditions in the antecedent model (i.e., recipe). The present study contributes to the nascent project management literature stream of asymmetric modeling and research.

The research perspective here also builds from a foundation of complexity theory pillars (i.e., tenets). These tenets provide propositions that are testable for consistency of their

[3] A membership score is a calibrated number ranging from 0.00 to 1.00 for each condition in a data set. A fuzzy set score for the configuration of KME "AND" social capital for a case with a KME score equal to 0.85 and a social capital score equal to 0.40 is equal to 0.40. The fuzzy set score equal to 0.40 indicates the extent of membership overlap between KME and social capital. "AND" is a Boolean operator indicating the extent that a given case achieves all conditions in a fuzzy recipe statement. Thus, the size of a recipe is limited by its "weakest link" or the simple condition with the lowest score among the conditions in the recipe. For a variable with a range of original values greater than three, a calibrated score is a conversion of original variable numbers into a logistic function membership scores ranging from 0.00 to 1.00. Ragin (2008a) provides details.

predictive accuracies with the objective of achieving "somewhat precise outcome tests (SPOT)"—that is, the predicted outcome occurs for nearly all the projects matching the conditions in a configuration. Consequently, rather than focusing on the net effects of VDRs, applying configurational theory in research on PMP rests on core tenets of complexity theory. In strategic management, Fiss (2007, 2011) points out that focusing on the net effects of independent variables' associations with a dependent variable for a theory attempting to indicate an outcome represents an empirical-theory mismatch.

> This mismatch has caused a number of problems. For example, the classic linear regression model treats variables as competing in explaining variation in outcomes rather than showing how variables combine to create outcomes. By focusing on the relative importance of rival variables, a correlational approach has difficulty treating cases as configurations and examining combinations of variables. This becomes particularly evident in the fact that regression analysis focuses on the unique contribution of a variable while holding constant the values of all other variables in the equation. (Fiss, 2007, p. 1182)

The present study's adoption of asymmetric theory construction, modeling, and data analysis addresses the limitations of symmetric theory constructing and testing with symmetric tools (e.g., multiple regression analysis and the use of null hypothesis significance testing (NHST) and serves to end the mismatch that Fiss (2007, 2011). Theory construction and testing of variable directional relationships (VDRs) has been criticized tellingly in the social science and business (Ragin, 2008a; Hubbard, 2015), economics (Ziliak & McCloskey, 2008), psychology (Gigerenzer & Brighton, 2009) and statistics (Meehl, 1978; Wasserstein & Lazar, 2017) literatures. Variable-directional relationship (VDR) hypothesis construction and NHST are bad science practices for several reasons. In MRA such practices focus on examining whether or not the findings support rejecting the null hypothesis for each independent variable—a particularly low bar of information especially compared to predicting a precise score outcome or an interval range of impact. Learning that a statistically significant positive (negative) relationships exist between XY variables usually provides scant information on the occurrence of a specific

outcome—and the information that is provided on the directionality of relationships frequently is misleading of the nature of the relationship (cf. Anscombe, 1973). Armstrong (11970, 2012) provides examples of the great ease of achieving statistical significance using data from a table of random numbers. The majority of studies using VDR and NSHT fail to consider anomalies to hypothesized, tested, and supported main effects along with moderating effects (Woodside (2019). Discretizing by quintiles and cross-tabulating an antecedent and an outcome condition usually results in the appearance of ten-to-twenty percent of the cases demonstrating the opposite relationships to the VDR even though the VDR supports the hypothesis statistically significantly. While VDR symmetric tests using NHST provide higher fit validation (reports of adjusted R^2 for the models using the data from which the models were developed) in modeling they provide lower predictive validation (validating models using data additional samples) than asymmetric algorithm models (Gigerenzer & Brighton, 2009). The American Statistics Association (ASA) created a committee of prominent statisticians in 2015 to study question on the pervasive use of VDR and NHST by academic given that their use has been severely. The ASA Committee reported in 2017 that the main reason for the continued use of symmetric tests (VDR hypothesis testing by NHST) constitutes a vicious loop.

> Q: Why do so many colleges and grad schools teach $p = 0.05$?
> A: Because that's still what the scientific community and journal editors use.
> Q: Why do so many people still use $p = 0.05$?
> A: Because that's what they were taught in college or grad school.
> (Wasserstein & Lazar, 2017)

The rest of the paper has the following structure. First, we review existing literature regarding the constructs in this study and the development of theory and empirical tests regarding these constructs. Second, we present the core tenets of complexity theory. Third, we present the configurational theory of the antecedent conditions indicating high versus low PMP. Fourth, we present our methodology and this includes the method for scale development, data

collection, and data analysis. Fifth, we present the findings. Finally, the study concludes by presenting the discussion section, describing the study's contributions to project management theory, practice, and limitations.

2. Literature review on project success/failure modeling

The phenomenon of project performance has received great interest from both academicians and practitioners in recent years because recognize the strategic importance of successes or failures of projects for firms. Project performance receives extensive discussion in the relevant literature with several factors contributing to the success of projects (Arumugam et al., 2013; Clark, 1989; Han & Hovav, 2013; Hughes et al., 2018; Justin, 2018; Malach-Pines et al., 2009; Marzagão, 2016; Moser et al., 2018; Thoumy & Vachon, 2012; Unterhitzenberger & Bryde, 2019). Likewise, the roles of knowledge in the organization have received extensive examination in the literature (Argote & Ingram, 2000; Cummings & Teng, 2003; Inkpen & Tsang, 2005; Landaeta, 2008; Mowery et al., 1996). However, these studies typically apply symmetric analysis for predicting whether or not the VDRs of specific variables have a positive or negative association with firms' project performance without examining the configurations of conditions (though a few of the studies sometimes examine the statistical significance of two-way interaction of the independent variables in VDR multiple regression models) that may contribute to the success or failure of projects. For example, Tseng (2014) examines the net VDR effects of knowledge management capability (KMC, a variable similar to KME) and supplier relationship management (SRM) indicating corporate performance in a sample of middle-top managers from 114 of the 500 largest Taiwanese firms. Tseng (2104) proposes and tests two hypotheses. "H1. The degree of KMC will have a positive effect on corporate performance" (Tseng, 2014, p. 41). "H2: The association between the degree of KMC and corporate performance is mediated by SRM" (Tseng, 2014, p. 42). Tseng (2014) reports empirical support for both hypotheses via MRA in

that the b-coefficient for each variable (i.e., KMC and SRM) is significantly statistically greater than zero in predicting corporate performance. Identifying the positive mediating effect of SRM on the KMC and PMP relationship is a valuable contribution by Tseng (2014). Similarly, using moderated regression analysis, Yang (2010), shows that a knowledge management and strategy-performance connection is contingent on both performance-driven strategies, (including reward system and process innovation) and knowledge management-based competencies, such as R&D from past projects, market intelligence, and intra-organizational knowledge sharing.

The present study expands on Tseng's H2 (2014) and Yang's (2010) H2 by going beyond the positive interaction VDR perspective of KMC and SRM to propose and test configuration models of complex antecedents indicating high PMP outcomes—and separate (asymmetric) configuration models indicating low PMP outcomes. Tseng (2014) builds theory from prior work (Dyer and Nobeoka, 2002; Frazier et al., 2009; Goffin et al., 2006; Lee et al., 1997; Liu et al., 2012; Paulraj et al., 2008). These studies are suggestive of the general statement that some combinations of project management conditions indicate high PMP while some alternative complex project management conditions indicate low PMP—and the existence of high KMC or KME alone is insufficient for indicating high PMP accurately with high consistency. The same perspective holds for SRM and social capital. The present study's focus is on point/interval estimates of outcomes and not VDRs (e.g., some firms identifiable by demographic combinations having high scores in social capital "AND" high scores in KME achieve high PMP scores with high consistency—this statement is an example of a "somewhat precise outcome proposition" (Woodside, 2018) that focuses on predicting outcomes, not relationships—such accurate asymmetric models typically do achieve 100 percent accuracy in their predictions that cases (e.g., projects) with high membership scores in the complex antecedent conditions all have high scores in the simple or complex outcome conditions.

Tseng (2014) does not report net effects of demographic variables or combinatory effects of demographics, KMC, and SRM on corporate performance—through his study included collecting and summarizing data firm profiles for five demographics (Tseng, 2014, Table 1, p. 42). Yang (2010) included demographic variables as independent terms in his moderate regression models but Yang does not test for the moderating effects of the demographic variables (i.e., firm age, size, and innovation diffusion) with the knowledge management strategy variables on PMP in his findings (Yang, 2010, Table 2, p. 220). Doing such testing would likely show that knowledge management strategy (KMS) and innovation diffusion interactive positively (statistically significantly) in predicting strategic performance. This speculation follows from the statistically significant correlation ($r = 0.27$, $p < 0.05$) for KMS and innovation diffusion in Table 1 in Yang, 2010, p. 219). The research practice of collecting business demographic information but not examining their effects on dependent variables as moderators occurs frequently in the project and firm performance literature (e.g., Gu, Jitpaiponn, & Yang, 2017; Hong, et al. 2011) and not doing so has been identified as a bad science practice in behavioral science, business (Woodside, 2016), and in medical science on the efficacy of new ethical drug benefits (Krauss, 2018).

Because of the aforementioned strategic benefits of projects in the firm, this paper draws from the social capital theory, KME, project management processes, and PMP research for a cross-section of project participants. The study focuses on deriving configurations to predict high or low project management performance in separate sets of asymmetric models as well as high or low knowledge management effectiveness and social capital.

2.1. Social Capital

Social capital includes “the norms and networks that create the necessary trust for people to cooperate to solve collective action problem” (Garrido, 2014: 413). Colclough and Sitaraman

(2005) and Gibbs et al. (2015) propose the relationship embeds in these social networks and in individual's positions within them provide people with a substantial amount of resources and power than they would normally hold (i.e., “linking” social capital), through access to resources such as information, knowledge, people, money and power (i.e., “bridging”’ social capital) and psychological support which builds trust and reciprocity (“bonding” social capital) (Teo & Lesomore, 2017).

Regarding social capital in sociology and project management, Coleman (1988) suggests that a relationship network with strong connections resembles social capital. “Social capital” is a configurational concept in project management that refers to innovation, transformative capacity, and knowledge integration in project team leader’s network connections (Kao and Shen, 2009). According to social capital theory and relating to PMP, interpersonal skills and relationships have a direct influence and affect the contributions within a research team that influence performance (Stewart & Barrick, 2000). Research findings in the PMP literature support the view that the depth of a social network reflects the importance of a person acting as the information or knowledge source within his or her associated organization or society (Björk & Magnusson, 2009; Tsai, 2001). Metaphorically, a high social capital assessment may serve as the conduit for effectively generating downstream project success via coupling with high KME)—high social capital by members as well as an entire project management team may authenticate high KME. Without the presence of high social capital, a project exhibiting high KME may be thwarted from achieving high PMP because of “the forces of inertia” (Huff & Huff, 2000). The forces of inertia thwart the conversion of high KME into activities necessary for high accomplishments. The forces of inertia may include policies, procedures, and necessary support of additional teams, departments, and actors who are blocking actions and plans by a project team. “We knew what to do and how to do it, but could not get the firm-level support

necessary to enact our plans," is a narrative expression of the following configurational model: KME●~SC → ~PMP, where the mid-level dot represents the Boolean operator of the logical "AND", the arrow represents "indicates" and sideway tilde, "~" indicates negation.

2.2. Knowledge management effectiveness

Knowledge management effectiveness (KME) is how well an organization creates, stores, transfers, and reuses its knowledge (Song et al., 2007, 2008). Knowledge management involves an effort to gain useful knowledge within the organization by encouraging communication and the free flow of ideas between employees, work units, and business units. KME in the organization involves the integration of knowledge from different sources (Ramesh & Tiwana, 1999). KME may impact process innovation and improvement, executive decision-making, and organization adaptation in numerous contexts (Earl, 2001). In the business environment, the difference between a successful firm and an unsuccessful organization may be the way the firm attempts to achieve team manage knowledge. As project' team members interact within and across teams, they share and transform information which leads to the creation, storage, and transfer of knowledge.

2.3. Project participant configurations

Prior work in project management usually report the distributions of the demographic variables of the participants but rarely describes how the identities of the participants impact project management processes and outcomes (Han & Hovav, 2013; Landaeta, 2008; Malach-Pines, 2009). The present study does examine how demographic configurations of participants impact PM process, social capital, and knowledge management effectiveness. Such analysis builds from the proposition that R&D managers with several decades of work experience, having a Ph.D. in electrical engineering, and ten years as a project manager interpret a specific project process and outcomes differently from an operations manager that has few years of work experience with no

post-graduate training and one year experience as a project manager. The study findings below do confirm that the executives in different profiles of the participants completing the survey impact how project management processes, social capital, and KME affect project performance outcomes.

2.4 Project Management Processes

Project management process refers to the methodology used for the planning, scheduling, enacting, and controlling of the project. The agile, traditional (waterfall) and hybrid are the project management process methodologies that the relevant literature identifies and examines. The agile methodology is an iterative process that is organic, people-centric and involves the extensive collaboration of the project team members (Nerur et al., 2005). The waterfall approach is a sequential method where prior phases of the project are completed before the next phase. The hybrid methodology combines the traditional approach as well as the agile approach. Organizations applying the agile process model organize project implementation in small interdisciplinary teams designed to complete a single project iteratively, rather than using a more formal hierarchical structure; which keeps the team members both informed and connected (Bartleby, 2018). Thus, cases implementing agile processes may generate high project outcomes.

Waterfall process uses less iterative and flexible approaches that the agile model—as progress flows in largely one direction ("downwards" like a waterfall) through the phases of conception, initiation, analysis, design, construction, testing, deployment, and maintenance (Rodriquez & Williams, 1998). Relevant literature describes substantial criticisms of the waterfall model since the model's use typically operates in one direction (e.g., after needs are set, the setting is not revisited/revised based on downstream knowledge and design changes). A hybrid PM process is when activity is initially sequential, and then iterative throughout the

development process. “The hybrid model creates a disciplined timeline that allows for client alignment, but still flexible enough to iterate and refine. Due to the sudden shift from sequential to iterative, strong project management is needed, in order to keep the project’s decision making on track” (Justin, 2018). Firm “own internal” process models include highly modified versions with combinations of the characteristics of the other three PM process models. The respondents in the study were asked which of the four models best described the process in-use in implementing their project; the respondents had the additional option to answer, “Other” as well. Almost all respondents were able to select one of the first four process models to describe their projects’ process models.

Before implementing the survey stage, the present study included completing long face-to-face interviews individually with ten members of project teams; these interviews indicating the possibility that members of some projects might be emphatic in describing their PM process to be highly unique and created internally by their firm/organization. Denison, Hart, and Kahn (1996) include related findings from 200 long open-ended interviews that members of some teams claim their PM processes to be unique. Thus, learning the presence, antecedents, and outcomes of this PM process uniqueness perspective prompted the inclusion of “own internal PM process” in the survey instrument.

3.0. Complexity Theory Tenets

Table 1 includes five complexity theory tenets. The first tenet is the insufficiency tenet that represents the XY association whereby high X is necessary but insufficient for identifying cases having high Y scores. The second tenet in Table 1 states that an asymmetric model may be sufficient for identifying cases having high X scores that have high Y scores consistently—nearly always. A complex X is a configurational statement, for example, cases high in KME as well as being high in social capital—a specific project operation must have high scores in both

KME and social capital for a high X score. Original scores are calibrated using a 0.00 to 1.00 scale and the Boolean "AND" operation of using the lowest score for the simple conditions to represent the set score. Thus, if a project operation has a KME calibrated score equal to 0.35 and a social capital calibrated score equal to 0.95, the configurational score equals 0.35—the amount of scoring that the two conditions share. Consequently, for symmetric scoring combining two simple conditions into a complex score requires both scores to have high calibrated scores—for example, a second project operation having a KME score equal to 0.80 and a social capital score equal to 0.81, its complex score would equal 0.80.

Table 1 here.

The reality of contrarian cases to the variable-directional hypothesis is one way of expressing the third tenet of complexity theory. Even when an XY relationship in a study indicates a statistically significant finding rejecting the null hypothesis, contrarian cases usually occur—cases showing the opposite relationship in an XY plot or by discretizing both X and Y data and cross-tabbing using quintiles. Using quintiles, the findings in Table 2 from the present study for KME and PMP illustrate this tenet and findings. Cases exist in all four corners of the 5 by 5 cross-tabulation of KM and PMP in Table 2 even though the phi coefficient indicates a statistically significant positive relationship between X and Y (phi = 0.714, $p < 0.000$). Positive PMP outcomes occur for cases having low KME conditions for nine percent of the 302 cases in the study (i.e., the cases in the upper-right cells in Table 2). Negative PMP outcomes occur for cases having high KME conditions for five percent of the 302 cases (i.e., the cases in the lower-left cells in Table 2). Adopting an asymmetric perspective and discretizing via quintiles indicates the usefulness of examining cases in all four complex outcomes via asking when does high, as well as low KME, indicate high PMP and when do high as well as low KME indicate

low PMP rather than simply reporting a statistically significant, positive, variable-directional relationship.

Table 2 here.

The reality of causal asymmetry (cf. Misangyi et al., 2016; Woodside, 2014)) is the fourth complexity theory tenet. The causal conditions indicating cases having high outcome scores usually vary in content from the causal conditions indicating cases having low outcome scores. "Emergence" is the fifth complexity theory tenet in Table 1. The fifth tenet refers to the principle that a screen whereby a case has to achieve high scores (e.g., ≥ 0.90) for each of several conditions (a non-compensatory rule) is a tougher requirement than setting a screen whereby a case has to achieve a high score (e.g., ≥ 0.90) on the sum of several conditions (a compensatory rule).

Configurational Theory of Complex Antecedent Conditions Indicating High (Low) PMP

Figure 1 is a visual of the general asymmetric theory of antecedents and outcomes of project high versus low in KME, in social capital, and in PMP. Figure 1 builds from the perspective that ongoing success in project management depends on choosing the right mix of new product strategy, organizational structure, and NPD processes (Barczak, 1995; Henard & Szymanski, 2001). This general theory focuses on predicting outcomes accurately with high consistency and not proposing and testing variable-directional hypotheses. Figure 1 is a visual of complex antecedent conditions for KME and social capital as well as KME and social capital as simple and within complex antecedent conditions indicating high versus low PMP outcomes. This section describes the eleven propositions appearing in Figure 1. These propositions provide a rich and deep understanding of the complex antecedent configurations indicating high (and modeled separately) low outcomes.

Figure 1 here.

P1a: KME ≤ PMP. The following asymmetric statement expresses P1a; cases high in KME indicate cases that are high in PMP with high accuracy.

P1b: ~KME ≤ ~PMP. Cases low in KME indicate cases that are consistently low in PMP. This proposition examines the impacts of the negation of KME on PMP.

Propositions (P1a and Pb) are consistent with the literature (Haas, 2006; Liu et al., 2011; Mitchell 2006) that posits that the way knowledge is managed on the project impacts the performance of the project. The proposition raises these two possibilities: First, cases high in KME are consistently high in PMP, that is, identifying project achieving high KME is sufficient for identifying cases high in PMP. Second, cases low in KME are consistently low in PMP, that is, identifying project achieving low KME is sufficient for identifying cases low in PMP.

P2a: Social capital ≤ KME. Cases high in social capital is sufficient for predicting cases high in high in KME.

P2b: ~ Social capital ≤ ~KME. Cases that are low in social capital is sufficient for predicting cases that are consistently low in KME.

Because the present study defines project high in social capital to include high scores in separate metrics for both bonding and bridging mechanisms—the emergence tenet in complexity theory applies here, the study applies a strict operational definition of social capital as a complex antecedent condition (i.e., bonding●bridging = social capital, where the mid-level dot "●" represents the logical Boolean algebra "AND" operation and the directional arrow, "→", indicates prediction). Consequently, the resulting computation for social capital represents a

complex "fuzzy" statement (Ragin, 2008). Projects with high calibrated scores in bonding AND high calibrated scores in bridging results in high calibrated scores in social capital.

Consistent with the literature (Ajmal & Koskinen, 2008), social capital influence on KME is positive when social capital is high and negative when social capital is low. Via bridging and bonding, social capital may enable and expand KME and PMP. Relatedly, the low KME is likely to occur in a project having comparatively low social capital.

P3a: Social capital ≤ PMP. Cases that high in social capital are sufficient for predicting cases high in PMP.

P3b: ~Social capital ≤ ~PMP. Cases that low in social capital are sufficient for predicting cases low in PMP.

Propositions 3a and 3b are consistent with the literature. For instance, Bartsch et al. (2012) found that social capital positively influences learning in projects, Di Vincenzo & Mascia (2012) found empirical support that social capital positively impacts project performance. Likewise, Villena et al. (2011) provide empirical support that social capital may impede value creation while Villalonga-Olives, & Kawachi (2017) found that social capital can have a negative effect on health outcomes.

P4a: Social capital ≤ PMP. Cases that high in social capital are sufficient for predicting cases high in KME AND high PMP.

P4b: ~Social capital ≤ ~KME● ~PMP. Cases that low in social capital are sufficient for predicting cases low in KME AND high PMP.

P5a: Social capital ● KME ≤ PMP. Cases that high in social capital and KME are sufficient for predicting cases high in PMP.

P5b: ~Social capital ● KME ≤ ~PMP. Cases that low in social capital and KME are sufficient for predicting cases low in PMP.

Relevant literature examines the roles of social capital, knowledge, and performance in the organization. Maurer et al., (2011) argues that high social capital in organizations fosters knowledge transfer and innovative performance., Kim et al. (2013) reports that in the tourism sector, high social capital positively impacts knowledge sharing and organization performance and Suseno & Ratten (2007) posited that high social capital impacts the firms' knowledge development and alliance performance. Hoffman et al., (2005) argued that high social capital and knowledge results in superior performance in the market. Invariable, the low KME and PMP capital are likely to occur in a project having comparatively low social capital. Likewise, low PMP is likely to occur in projects having low social capital and KME.

P6a: The knowledge of project team participant demographic profiles and project management processes are sufficient for indicating projects high in social capital.

P6b: The knowledge of project team participant demographic profiles and project management processes are sufficient for indicating projects low in social capital.

P7: The knowledge of project team participant demographic profiles and project management processes are sufficient for indicating projects high in KME and PMP

P8: Knowledge of project team participant demographic profiles are sufficient for indicating projects high in social capital.

Rather than focusing on the relative worth of the agile versus waterfall models (i.e. instead of viewing project management processes to be competing against each other), the present study focuses on the more complex question of the contexts in which each process model is an ingredient in complex antecedent configuration models indicating high social capital (or models for low social capital). We examine the impact of each of the four PM process models: agile, waterfall, hybrid, and firm internal models and the demographic profiles of the project participants.

Team members working on the projects differ frequently in training and expertise and vary by job function, gender, age, and years of project management experience (PME)—creating such requisite variety in among team members enable bringing multiple skills to bear for achieving high social capital or high KME and PMP. However, while configurations of information describing specific team members may be a useful ingredient in complex antecedent conditions indicating high social capital, such information may be too meager to do so consistently. We examine complex configurations for social capital, KME, and PMP as the outcome conditions.

P9: Project member demographic profiles and project management processes are sufficient information to indicate the project management performance consistently. While the specific project member participant may be a contributing ingredient in identifying a project management process, we examine the complex configuration about information about project participants as well as the methodology used for managing the project for accurately identifying the project management performance consistently. Combining the demographic profiles of the project participants and the methodology used may provide an insight into their configurations and how they impact project performance. As the prior sections discuss, most studies use the demographic profiles as control variables, we posit that assessing demographic conditions as integral in case outcome modeling (as well as VDR survey and experiment modeling are necessary (cf. Krauss, 2918). The extant literature (Bartleby, 2018; Nerur et al., 2005) also suggests that the agile methodology offers great benefits to project outcomes but we argue that that the methodology used in an ingredient in combination with other profiles of project participants will provide a good insight of these outcomes.

4.0. Methods

This section describes the study's survey instrument, the procedure for data collection, the data, and the data analysis steps.

4.1. Data collection and Respondents

The present study includes an empirical examination of configurations in the context of project participants, project management processes, social capital, KME, and PMP. The survey was completed by project managers from the USA using the survey questionnaire. The study data collection was done using USA Qualtrics, Inc. survey panel. Project managers were asked to complete the survey online. Because of the bias of the survey panel, several attention filters were included randomly in the questionnaire to increase the quality of the data. For instance, at random places in the survey, responders were asked to pick either agree, disagree or somewhat agree, and if they pick the incorrect response, they were immediately exited out of the survey. A total of 746 respondents completed the questionnaire; 197 failed an attention filter and were removed from the survey data, 246 were not project managers and were also removed from the survey, and 303 were project managers successfully completed the survey. Of the 303 questionnaires, one was unusable due to incomplete responses and was subsequently removed from the analysis. Hence, a total of 302 responses were used for the data analysis

A total of 157 (52%) of the respondents were male while 145 (48%) were female. In terms of age, 3% were between 18 and 24 years old, 43% between 25 and 34 years old, 38% between 35 and 44 years old, 12% between 45 and 54 years old and 5% were 56 or older. Only one of the respondents reported having less than a year experience as a project manager (PM), 11.6% reported having 1 to 2 years' experience as a PM, 20.2% have 3-4 years' experience as a PM, 52.3% have 5-10 years of experience as a PM, 10.3% have 11-15 years of experience as a PM and about 5.3% reported having more than 15 years of experience as a PM. A total of 124 respondents reported having a bachelor's degree (41%), 83 (27%) have a graduate degree (27%),

28 (9%) have an associate degree, 27 (9%) have some college and 15 (5%) have a Ph.D. degree. The processes used in the project are as follows. A total of 86 (28.4%) of the projects used the waterfall (traditional) method, 86 (28.4%) used the hybrid method, 52 (17.2%) used the agile, and 79 (26.2%) did not have an established project management process.

The primarily functional area of the respondents are as follows: 129 (42.7%) are in productions and project, 53 (17.9%) in research and development, 40 (13.2%) in administration, 36 (11.9%) in sales and marketing, 43 (14.2%) in human resources, purchasing, customer service, IT support and finance and account. The breakdown of the type of project is as follows: 63 (20.9%) construction project, 49 (16.2%) are design projects, 40 (13.2%) are R&D projects, 37 (12.3%) are new product development projects and the remaining 113 (37.4%) are maintenance, administrative, computer software, strategic, architectural development, applications, and infrastructure projects. The descriptive statistics and correlations for the different variables are in Table 3. A comparison of the findings in Tables 2 and 3 supports the perspective that discretized findings can identify a substantial share of firms having contrarian associations to the statistically significant relationship found by correlation analysis: 9% of the firms have low KME and high PMP and 5% of the firms have high KME and low performance in Table 2 though the correlation between KME and PMP is highly significant statistically ($r = 0.61$, $p < .001$).

Table 3 here.

4.2. Survey Instrument

The questions in the study include multiple-item scales measured on the seven-point Likert scales. Question options ranged from 1 (“strongly disagree”) to 7 (“strongly agree”).

Exploratory factor analysis using varimax rotation was used to extract the factors and reliability of the constructs was done by calculating the Cronbach alphas. The survey comprises of four parts including bonding capital, bridging capital, project management performance, knowledge management effectiveness, The Appendix includes question items and Cronbach alphas for constructs. Prior studies informed the development of these items and they were contextualized into the domain of project management.

Bonding Capital. The bonding capital scale included four items based on the work of Seashore (1954). Cronbach's alpha was 0.85.

Bridging Capital. The bridging capital items are based on the work of Ellison et al., (2007). In the factor analysis, one of the items cross-loaded on bonding capital and was subsequently was removed from further analysis. Cronbach's alpha was 0.89.

Project management performance. The five items measuring PMP are based on the work of Malach-Pines et al. (2009) and adapted from Han & Hovav (2013). Cronbach's alpha was 0.84.

Knowledge management effectiveness. The three items measuring KME were adapted from the work of Song et al. (2007). Cronbach alpha for this scale equaled 0.81.

4.3. Analysis

The current study employs a set-theoretic approach based on fuzzy set QCA that allows for a detailed analysis of how causal conditions contribute to an outcome of interest. Fuzzy set QCA is suitable for analyzing causal processes because it provides a configurational understanding of how causes combine to lead to different outcomes (Fiss, 2007; Ragin, 2000, 2008). The basic tenet underlying QCA is that cases are best understood as configurations of attributes and that a comparison of cases can allow a researcher to sort out attributes that are unrelated to the outcome

of interest (Fiss, 2011). The set-theoretic analysis examines causal patterns by focusing on the subset relationship. “For instance, to explain what configurations lead to high performance, it examines members of the set of “high-performing” organizations and then identifies the combinations of attributes associated with the outcome of interest (high performance) using Boolean algebra and algorithms that allow logical reduction of numerous, complex causal conditions into a reduced set of configurations that lead to the outcome” (Fiss, 2011: 402).

Fuzzy-set theory (Zadeh, 1965, 1996, 2010) enables expressing a case's degree of membership in a set in fine gradations ranging from full non-membership (0.05 and below) to full membership (0.95 and above). The analysis requires calibrating the original value for a variable for a case against a range of membership scores that represent the accumulated knowledge about a set. The membership scores that represent the set are estimated by examining information on the entire set (Ragin, 2008a) to identify the threshold for full non-membership (set at 0.05); the point of “maximum membership ambiguity” (set at 0.50); and the threshold of full membership (set at 0.95). Calibrating original values into fuzzy-set scores transforms ordinal or interval scales into the degree of membership in the target set. Ragin (2008b: 183) refers to this as “a truth value” that reflects each case's position in an established set, which allows comparison of each case against a known external standard; and enables the identification of fine gradations in the degree of membership of a set. In the current study, all antecedent conditions and the outcome conditions were calibrated based on records for the full set for each condition. The analysis includes the median value as the point of maximum ambiguity (0.50); full membership (0.95) was equal to the value immediately below the highest 14 percent of all available projects; full non-membership was equal to the value immediately above the lowest 14 percent of all available projects. The calibration subroutine in the software program (available at fsQCA.com) computed the scores for all nations in the study. With no appreciable changes

resulting in the findings, the present study included performing an alternative calibration procedure that the one recommended by Ragin (2008a, 2008b) whereby the 0.05 value was set at the 14th percentile level and the 0.95 score was set at the 86th percentile value. For all conditions, three slightly different sets of breakpoints were tested to confirm that the findings did not vary in calibrating either full- or non-membership points. The calibration subroutine in the software, fsQCA.com, applies a logarithmic function is calibrating all other original values into membership scores.

4.4. Consistency and coverage

Consistency is an index measure of the degree to which a specific recipe is consistent with the outcome. A high consistency score indicates that nearly all cases with a high membership score in the recipe of conditions also have a high score in the outcome condition. Consistency occurs when a case's level of membership in the causal recipe is less than or equal to its level of membership in the outcome (i.e., the causal recipe is a subset of the outcome) (Ragin, 2008a provides explicit examples for Computing consistency and coverage). The fsQCA software estimates consistency ($Xi \leq Yi$), by dividing the sum of the minimum of Xi or Yi by the sum of Xi. Consistency ($\mathbf{Xi \leq Yi}$) = Σ {min ($\mathbf{Xi, Yi}$)}/Σ ($\mathbf{Xi}$), where Xi is the case i's membership score in set X; Yi is the case i's membership score in the outcome condition, Y. This approach penalizes consistency scores for occurrences when Xi exceeds Yi in proportion to the size of the inconsistency. Calculation of consistency is definable as performing “somewhat precise outcome testing (SPOT)” (Woodside, 2017). SPOT is an alternative summary metric to symmetric test's null hypothesis statistical tests (NHST) (Woodside, 2017). In order for a proposition to be supported, the consistency index has to be at least 0.8.

The coverage index in fsQCA assesses the degree to which a causal configuration accounts for instances of an outcome. Coverage should only be considered after consistency is

established. Set theory accommodates the idea that there are alternate causal recipes that lead to the outcome. QCA compares alternate configurations by determining the proportion of cases that are consistent with a particular configuration (Ragin, 2008a). If a configuration accounts for more cases then it is more informative. To calculate coverage, the fsQCA software calculates the proportion of cases where the degree of membership in the configuration is less than the membership in the outcome, but this time divides it by the total score for the outcome condition. This coverage calculation estimates the level to which the configuration (the subset) covers the outcome (the larger set) (Ragin, 2008a). Coverage (**Xi** ≤ **Yi**) = Σ {min (**Xi, Yi**)}/Σ (**Yi**).

5.0. Findings

Section 5 reports the findings of the fuzzy-set qualitative comparative analysis (fsQCA) that was used for modeling both positive and negative paths to high scores in an outcome variable. We also discuss the findings relating to the configurations of antecedents' conditions ant their role in predicting the outcome variable.

5.1 Detailed findings

P1a: receives partial support*. Cases high KME is somewhat sufficient for indicating cases high in PMP.* The findings in Table 4 and Figure 2 partially support P1a because the consistency index is 0.78 which is slightly below the consistency index threshold selected for this study equal to 0.8. Hence, we suggest that projects high in KME are sufficient marginally for indicating successful PMP consistently. Hence, KME alone is one ingredient among a few in indicating high PMP, KME alone is not necessary for the occurrence of high PMP. These findings support the perspective that high KME alone is insufficient for predicting high PMP. The project cases low in KME and high in PMP support the perspective that additional asymmetric models are needed that may include the negation of KME and additional conditions for indicating high PMP consistently.

Table 4 and Figure 2 here.

P1b: does not receive support*. Cases low KME are insufficient for indicating cases low in PMP.* The findings in Table 4 and Figure 2 does not support P1b because the consistency index is 0.73.

P2a receives support. *Cases high social capital are cases high in KME.* The findings in Table 4 and Figure 3 supports P2a with a consistency index of 0.808 and coverage of 0.66. Bonding capital by itself and bridging capital by itself do not predict cases with high KME consistently. Bonding and bridging capital have to both be present to predict cases high in KME.

Figure 3 here.

P2b does not receive support. *Cases low in social capital are not sufficient for indicating cases low in KME.* The findings in Table 4 and Figure 3 does not support P2b because the consistency index is 0.74 and coverage of 0.86.

P3a receives support. *Cases high in social capital is sufficient for indicating cases high in PMP* The findings in Figure 3 supports P3a with a consistency index of 0.86 and coverage of 0.65. Bonding capital by itself and bridging capital by itself do not predict cases with high PMP. Bonding and bridging capital have to both be present to predict cases high in PMP. The XY plot from testing P2b (Figure 4) indicates that the odds are greater than 4-to-1 that cases high in social capital are cases high in PMP.

Figure 4 here.

P3b does not receive support. *Cases low in social capital is not sufficient for indicating cases low in PMP.* The findings in Figure 3 does not support P3b, the consistency ratio is 0.71.

P4a does not receive support. *Cases high in social capital are not consistently high in the joint outcome for KMP●PMP.* The consistency index for this model is equal to 0.73 with coverage equal to 0.76.

P4b does receive support. *Cases low in social capital are consistently low in the joint outcome for KME●PMP.* The consistency index for this model is 0.86 with coverage equal to 0.83.

P5a receives support. *Cases high in social capital and KME is sufficient for indicating cases high in PMP.* The findings in Table 4 support P5a. The consistency index equals 0.90 and the coverage index equals 0.55 for this model. The high consistency supports the conclusion that the combination of high social capital (bonding and bridging) in combination with high KME is sufficient for predicting cases having high PMP consistently. The findings include the odds being greater than 4-to-1 that projects having high scores for the complex antecedent condition have high scores on PMP.

Figure 5 here.

P5b does not receive support. *Cases low in social capital and KME is not sufficient for indicating cases low in PMP.* The findings in Table 4 and Figure 6 do support P5b. The consistency index equals 0.69 and the coverage index equals 0.94 for this model.

P6a and P6b receive support. *Project-participant demographic configurations are sufficient for indicating cases high (low) in KME.* The findings in Table 4 provide details from testing P6a and P6b. These propositions predict that specific demographic configurations indicate high (low) scores for the complex outcome of KME. Tables 5a and 5b provide details for the findings for

P6a and P6b. Examining tables 5a and 5b indicate that the demographic feature can be positive or negative for different recipes with the outcome of high social capital occurring (i.e., the complexity theory equifinality tenet receives support)

Tables 5a and 5b here.

P7a and P7b receive support. *Project-participant demographic configurations are sufficient for indicating cases high (low) in social capital.* The findings in Tables 6a and 6b provide details from testing P7a and P7b. These propositions predict that specific demographic configurations indicate high (low) scores for the complex outcome of bonding AND bridging (i.e., social capital). Tables 6a and 6b provide details for the findings for P7a and P7b. Examining tables 6a and 6b indicate that the demographic feature can be positive or negative for different recipes with the outcome of high social capital occurring (i.e., the complexity theory equifinality tenet receives support)

For instance, model 1 in Table 6a indicates that cases having the following PM membership profile have high social capital: older male managers with many years of experience as a project manager whose functional working area is sales & marketing and with high or low education. Examining Table 6b indicates that the demographic feature can be positive or negative for different recipes with the outcome of high social capital occurring (i.e., the complexity theory equifinality tenet receives support)—with one exception. A project manager with a high number of years of experience is a feature in all three configurations in Table 6a.

Tables 6a and 6b here.

P8a and P8b receive support: *PM participant demographic profiles indicate cases high (low) in PMP*. The consistency of the configurations is 0.85 and 0.89 as shown in Table 4. Tables 7a and 7b provide the details of the configurations. Specific deep (i.e., configurational) descriptions of project managers do indicate high and low PMP separately.

Tables 7a and 7b here.

P9 receives support. *Project participant demographics AND project management process in combination are sufficient for indicating cases for the complex outcome high in KME AND high PMP*. The findings in Table 4 support P9 with an overall solution consistency of 0.86 and coverage of 0.17. The finding suggests that the demographics of the project participants AND project management process are sufficient for predicting high scores in the complex outcome of KME AND PMP. Table 8 provides the details of the configurations. For example, model 1 in Table 8 predicts that cases with the following PM process and demographic profile have high KME AND PMP: a young female who is highly educated, who works in production, the project is not R&D and uses the agile project process and project management experience is irrelevant in this model.

Table 8 here.

6.0 Discussion

6.1 Research implications

The study here applies a holistic view of a configurational approach and provides a complex understanding of project management performance and knowledge management effectiveness outcomes. This approach does appear previously in operations management (Cai & Jun, 2018; Castka, 2018; Dul et al, 2010). The study here is using a configurational approach to develop and

identify complex antecedent conditions of firms' demographic states, knowledge management effectiveness (KME) and social capital for accurately predicting a firm's project management performance (PMP) outcomes accurately. The study identifies complex or simple antecedent conditions that accurately predict outcomes. The findings of this study provide strong support for casual asymmetry complexity (P1a – P5b) and equifinality (P6a-P8b).

Configurational case outcome research is underdeveloped in the project management literature, hence, our research makes important contributions from a theoretical perspective. First, this study examines and tests for accuracy in predicting case outcomes (Cai & Jun, 2018; Castka, 2018; Dul et al., 2010; Woodside 2013; Woodside et al., 2018) rather than the variable directional hypothesis testing. The findings support the first complexity tenet that a single antecedent condition is insufficient usually for indicating cases with high scores in an outcome condition. This perspective receives support generally even when the correlation between the single antecedent and outcome condition is very high (e.g., $r = 0.70$, $p < .001$). Thus, if a researcher focuses on predicting outcomes accurately rather than showing that one or more relationships do not have a zero correlation, the researcher needs to construct and test theories of recipes (Ordanini et al. 2014).

Second, by recognizing the inherent complexity in achieving high (as well as low) project management performance (PMP), in the context of project management the study here offers workable theoretical and empirical solutions to the crucial problem in strategic management of firm heterogeneity—"why firms adopt different strategies and structures, why heterogeneity persists, and why competitors perform differently" (Powell, Lovallo, & Fox, 2011, p. 1370). The solutions include embracing Weick's (2007, p. 17) call for richness in the study of project management (PM): "Simple accounts mean that you are not paying attention." Applying and confirming complexity theory tenets in the present study enrichens theory construction and

empirical testing to represent the inherent richness and complexity occurring in PM. Testing the consistency of predicting outcomes with algorithms (i.e., "computing with words,(CWW)" Zadeh, 1996, 2010) rather than testing the existence of VDRs via null hypothesis significance tests (NHST) enables shifting to good science practice and away from bad science practice (cf. Hubbard, 2015; Wasserstein & Lazer, 2017; Ziliak & McCloskey, 2008).

Third, the findings here support the perspective that the study of low project management performance (~PMP) require models with features and configurations separate and unique from models of high PMP. This perspective is suggestive for scholars working on topics relating to the highly reliable organization (HRO), for example, Weick (1987), LaPorte and Consolini (1991), and Weick, Sutcliffe, and Obstfeld, D. (2008). PMP outcomes include failure, mediocrity, as well as success. The evidence in the present study provides an indication of how low PMP occurs and that forecasting projects resulting in low PMP is possible.

Fourth, the results of this study serve to indicate that models of high and low PMP should include modeling the impacts of PM participants' demographic profiles, and project processes. Research in the project management literature frequently reports classifications and distributions for these features in the data collected for a wide range of projects but ignores these features in its modeling. The general theory supports the perspective that these PM features can have direct and/or indirect impacts on projects' social capital, KME, and performance.

Fifth, the theory and findings of this study support the perspectives that alternative configurations which include project management participants, processes, and project type, impact both KME and social capital. The theory and findings extend prior work on asymmetric modeling in project management (Ordanini, et al., 2014), individual project management

attributes have complex trade-off effects that only certain combinations of attributes act as sufficient conditions for high PMP.

6.2 Practice implications

Although several factors influence project management outcomes, project managers may benefit by recognizing several factors/ configurations impact project outcomes. For example, projects having high bridging capital alone or high bonding capital may not achieve high performance. But most projects that achieve both high bonding and high bonding achieves high performance. Also, knowledge management effectiveness (KME) alone does not indicate high project performance, KME needs to be combined with high social capital in other for the project to achieve high performance via this configuration.

Project managers may benefit from realizing that because certain simple and complex antecedents and configurations may achieve high project outcomes, the exact opposite of the antecedents may not impact project performance negatively. For instance, projects that achieve high social capital will achieve high performance but projects that have low social capital will not achieve low-performance. Likewise, projects that have high social capital will not achieve a combination of high-performance and knowledge management effectiveness but projects that have low social capital will achieve a combination of low performance and knowledge management effectiveness.

The type of methodology used for managing the project should be chosen with consideration of the demographic configurations for those that would be on the project team. The agile methodology receives attention in the extant literature and thus is usually recommended. But our study shows that the use of waterfall was not an indicator of cases high in the project indicators. Agile was found to be an ingredient in models specifying specific categories of

projects for indicating projects achieving both high KME and high PMP. Thus, agile does matter but managers must learn how this method matters and research needs to go deeper rather than specifying agile as a simple main effect on social capital on project performance.

6.3 Limitations and Future Research

Limitations of the present study include the need for examining the general theory in additional studies on PMP. Also, additional studies are necessary that include asymmetric modeling of data that includes interviewing two or more team members working on the same project. Though rarely appearing in the extant literature, the possibility exists of examining projects where project team members' responses are in high, medium, and low levels agreement and to build separate asymmetric models for each of these three sets of projects (e.g., Cheng, Chang, & Li, 2012). Also, the need exists to rely not solely on project managers' responses to surveys but to directly observe their behavior as well in field studies and subsequently to construct asymmetric forecasting models (e.g., Gladwin, 1980). Consequently, while the general theory and findings in the present study are encouraging, they are limited by depth and scope of coverage. Future reach may include splitting the sample into two equal-sized and performing predictive cross-validation checks.

6.4 Conclusion

The present study supports two primary conclusions. First, while unnecessary for achieving high PMP, achieving both high social capital and high KME do indicate projects achieving high PMP with high accuracy. Also, projects with both low social capital and/or low KME indicate cases achieving low PMP with high accuracy. The orderly, frequent, and consistent occurrences of high social capital and high KME in models indicating cases high in PMP coupled with the frequent occurrences of low social capital and low KME indicating low PMP support the

perspective that advancing theory of PMP benefits from the study of both project social capital and KME with applications of complexity theory and configurational analysis. Second, the theory and findings in the present study support the view that applying complexity theory tenets and using asymmetric modeling methods are viable solutions to moving beyond symmetric modeling using MRA/SEM with null hypothesis significance tests (NHST).

By posing and answering the research questions in the introduction, this study offers a useful perspective for developing a point/interval asymmetric outcome sufficiency theory in predicting high and (separately) low PMP. Regarding answering question 1-1 (high KME is sufficient for identifying high PMP), examining the findings in Figure 2 and the consistency index for P1a most project managers would be unlikely to rely on achieving high KME for achieving high PMP—project managers are more likely to install additional conditions to achieve nearly "fail-safe" (Kusek et al., 2013) outcomes to increase the odds that high PMP will occur in practice—achieving 2-to-1 odds for success by achieving high KME is unlikely to be sufficient in practice. The empirical findings in the present study offer higher odds (i.e., 4-to-1) that high KME follows from achieving high social capital—the second research question (1-2). However, the present study is not a longitudinal examination but the study provides exploratory support for a positive answer to the second research question. The present study provides a positive answer empirically for the third research question (1-3): high social capital among members of a project team is a sufficient complex condition for firms achieving high PMP even though the negation of PMP is an insufficient condition for indicating the negation of PMP as an outcome.

The findings do not support a positive answer to the research question 1-4. High social capital among members of a project team is not a sufficient condition for indicating firms achieving the combination of high KME and PMP—but low social capital does support the

perspective that the combination of KME and PMP occurs with odds of this outcome found to be 5-to-1. The findings support a positive answer to research questions 1-5—firms using a specific type of project management process achieve high social capital with agile plus additional conditions rather than using the waterfall process—even though Justin (2018) reports that the waterfall versus the agile process has a higher share of use in managing projects. The answer is yes, for questions 1-7—different profiles of managers do indicate (a) high versus low KME outcomes, (b) high versus low social capital outcomes, and high versus low PMP outcomes; the findings appear in Tables, 4, 5, and 6. Both positive and negative individual conditions appear in all six sets of these demographic profiles indicating outcomes. Consequently, these findings support this perspective that demographic configurations indicating high KME, social capital, and PMP are identifiable having high consistency indexes, but generalizing that males versus females or high versus low years of experience, or another other single condition nearly always occurs for high performance is likely to be an inaccurate perspective—and the same conclusion applies (separately) for configurations indicating negative outcomes.

Related to the set of questions guiding this study, the finding supports and expands on Rumelt's (2011) perspective on firm-level case anomalies. The second set of issues relates to Rumelt's (2011) perspective on firm-level case anomalies. The findings support a positive response to question (2-1): some firms with low KME membership scores also high in PMP even when the findings indicate a statistically significant positive KME and PMP for a variable directional relationship. The findings in Figure 5 extends this view that a number of firms low in the configuration of KME "AND social capital still manage to be high in the PMP outcome. Additional research would be useful to explain and predict how this negative complex antecedent condition and positive outcome condition occurs. The findings in Figure 4 support a positive answer to question 2-2 as the cases in the top left of Figure 4 indicate: some firms with high

social capital scores are low in PMP even when the findings indicate a statistically positive KME-PMP VDR. The odds are high (i.e., 4-to-1) that projects achieving a high KME have high PMP scores but information that a project achieves high social capital alone appears to be incapable information that high KME will always occur. Finally, while the findings in the present study provide substantial evidence that anomalies occur that run counter to simple asymmetric relationships in PMP, additional research is necessary to answer a rewording of question 2-3). Given that such anomalies do occur, what complex or simple antecedent conditions accurately predict these two types of anomalies?

Appendix

Construct	Coding	Items	Cronbach's alpha (α)
Bridging Capital	BR1	On my project, members feel they are part of the organization	0.89
	BR2	On my project, members are interested in what goes on in the organization	
	*BR3	On my project, members are willing to contribute extra time to meet deadlines	
	BR4	Interacting with people in our organization makes my project team feel like a part of the organization	
	BR5	On my project, team members are willing to spend time to support general organization activities	
	BR6	In my organization, my project team come into contact with new people all the time	
	BR7	Interacting with people in our organization reminds members of my project that everyone in the world is connected	
	BR8	Interacting with people in our organization makes members of my project want to try new things	
Bonding Capital	BO1	On my project, members defend one another from criticisms	0.85
	BO2	On my project, members help each other on the project	
	BO3	On my project, members get along with each other	
	BO4	Om my project, members stick together	
Project Performance	PF1	I believe my project is meeting the project schedule goals	0.84
	PF2	I believe my project is meeting the project budget (man-hour) goals	
	PF3	I believe my project s meeting the project functional requirements and specifications	
	PF4	I believe our project answer customer's needs	
	PF5	I believe customers are satisfied with our project	
KME	KME1	The way knowledge is managed has made my project more creative and adaptive	0.81
	KME2	The way knowledge proposition has improved the effectiveness of my project	
	KME3	Overall, I am satisfied with knowledge management in my project	
Methodology	Method	Please identify what methodology is/ was used on this project? a. Agile b. Traditional (water fall) c. Hybrid d. No established PM methodology e. Others	
Type of Project	TOP	What type of project is this project? a. R&D b. Maintenance c. Construction d. New product development e. Administrative f. Design g. Strategic h. Architectural development i. Infrastructure j. Applications k. Computer software development	
Highest Level of Education	HLE	What is your highest level of education? a. High School b. Some College c. Associate Degree	

		d. Bachelors e. Graduate Degree f. PhD	
Job Function	JF	What is your job primary functional area in your organization/corporation? a. Production Project b. Finance and Accounts c. Human Resources d. Administration e. Purchase f. Research & Development g. Customer Service h. IT Support	
Project Manager's Experience	PME	How many years of experience do you have as a project manager?	

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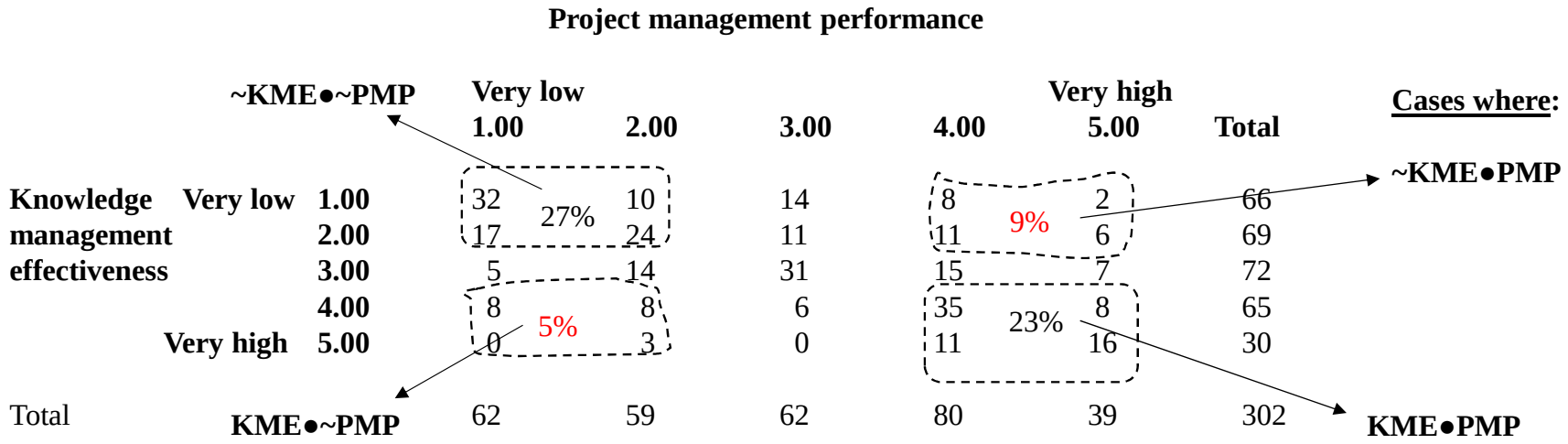
Table 1
Core Tenets of Complexity Theory

Tenet	Concept	Description	Boolean Expression
T1	Insufficiency	High X may be necessary but this condition is insufficient for identifying as cases high in Y	$X \not\rightarrow Y$
T2	Equifinality	A few, not one, distinctly unique complex configurations of antecedent conditions indicate the same outcome	$(X \bullet R) \leq Y + (\sim X \bullet T) \leq Y$
T3	Contrarian	Both high X and low X associate with high Y Both high X and low X associate with low Y	$(X \dot{\bullet} R) \leq Y + (\sim X \bullet T) \leq Y$ $(X \dot{\bullet} W) \leq \sim Y + (\sim X \bullet F) \leq \sim Y$
T4	Causal asymmetry	Complex antecedent conditions for low Y are not the mirror opposite of complex antecedent conditions for high Y	$(X \dot{\bullet} R) \leq Y \neq (\sim X \bullet \sim R) \leq \sim Y$
T5	Emergence	System effects occurring in creating configurations of simple conditions are greater than the sum of the simple conditions (where SE = self-esteem, GSE = generalized self-efficacy, LC = locus of control, ES = emotional stability, and CSE = core self-evaluations	$(SE \bullet GSE \bullet LC \bullet ES > CSE_{total})$

Key: Boolean algebra operational meanings: mid-level dot, "●", indicates the logical "and"; sideways tilde, "~", indicates negation; the plus size "+" indicates "or"; the less than or equal sign, "≤" and the directional arrow ("→") indicate scores for the model input statement are all or nearly all lower than scores for the outcome, Y or (Y • Z); the not equal sign, "//→" indicates that the input model (simple or complex) does not indicate an asymmetric pattern that screens for Y or ~Y where "Y" refers to cases with high Y scores and "~Y" refers to cases with low Y scores, the negation of a Y score; "X" refers to high X scores and "~X" refers to low X scores. X, R, F, and W refer to simple antecedent conditions; Y and Z refer to simple outcome conditions; "≠" refers to causal asymmetry.

Notes. A useful heuristic is to discretize scores when calibrated values of a variable into fuzzy-set scores so that all cases in the lowest quintile have fuzzy-scores ≤ 0.10 and cases in the highest quintile have fuzzy-scores ≥ 0.90. Configural analysis and setting consistency requirements are "fuzzy" in deciding what constitutes low (e.g. ~Y) and high (Y) scores and in deciding on the limit necessary for models of complex antecedent conditions to surpass to indicate high accuracy in predicting Y or ~Y.

Table 2
Cross-tabulation of case outcomes via discretizing using quintiles:
Knowledge management effectiveness (KME) and project management performance (PMP)



Key: The mid-level dot, "●", indicates the Boolean logical "AND" operation; the sideways tilde, "~", indicates the negation of a calibrated score. The numbers in Table 2 indicate the number of cases occurring in each of the 25 cells in this 5-by-5 crosstab.
Notes.

- Phi = 0.714, $p < .000$ for this cross-tabulation of quintiles.
- $r = 0.615$, $p < .000$ using original continuous values of the data.
- Linear regression analysis: PMP = 2198.85 + (29.27●KME), for b coefficient, $t = 11.17$, $p < .000$.
- Even though the symmetric analysis indicates a highly statistical significant relationship (e.g., b coefficient = 29.27 supports the alternative hypothesis that $b \neq 0.00$), discretizing the data into quintiles and cross-tabulating KME by PMP indicates 14% of the cases are contrary to a positive main effect for KME and PMP.
- Asymmetric analysis includes modeling cases in all four corners: cases where high KME indicates high PMP; cases where high KME indicate low PMP; cases where low KME indicate high PMP; and cases where low KME indicate low PMP.

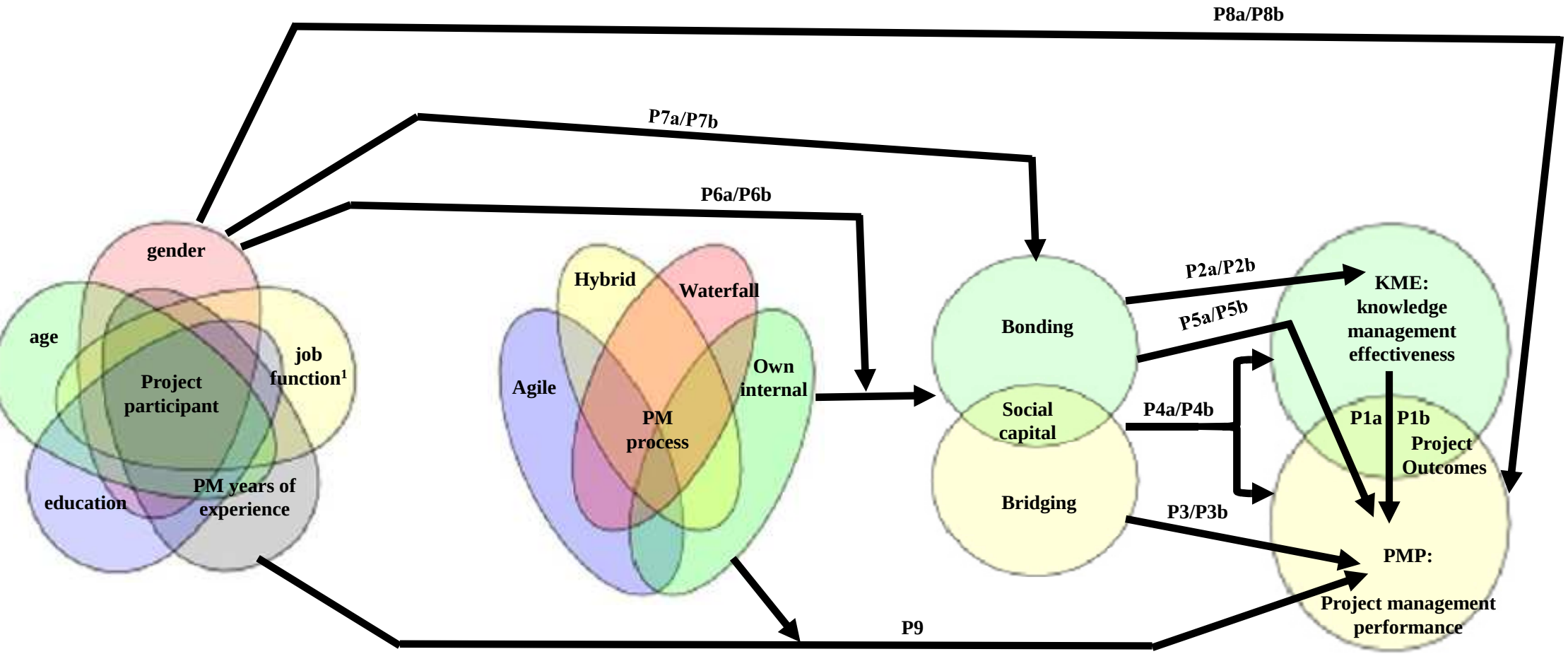


Figure 1
The general theory of project management practices and performance outcomes

Note. Given the study's adoption of the asymmetric complexity theory tenet that complex causal antecedents indicating high scores in an outcome condition differ in substance from the complex causal antecedents indicating low scores in an outcome condition, two sets of models are necessary for each proposition: Pa are models predicting high outcomes while Pb are models predicting low outcomes. [1]Job function = administration production/operations, R&D, sales/marketing, or other.

Table 3
Descriptive Statistics of Variables

Variables	Mean	Std. Deviation	Gender	Age	Method	PME	KME	PMP	Bridging capital	
Gender	1.48	0.5								
Age	36.33	8.902	-0.102							
Method	2.65	1.07	0.089	0.097						
PME	7.08	5.33	-0.066	.566**	-0.033					
KME	5.75	0.93	-0.046	-0.032	-0.082	0.019				
PMP	5.88	0.86	-0.027	0.018	-0.004	0.006	.615**			
Bridging capital	5.75	0.89	-0.041	0.002	-0.058	0.085	.582**	.596**		
Bonding Capital	5.73	0.86	-0.007	0.018	-0.055	0.019	.537**	.642**	.618**	

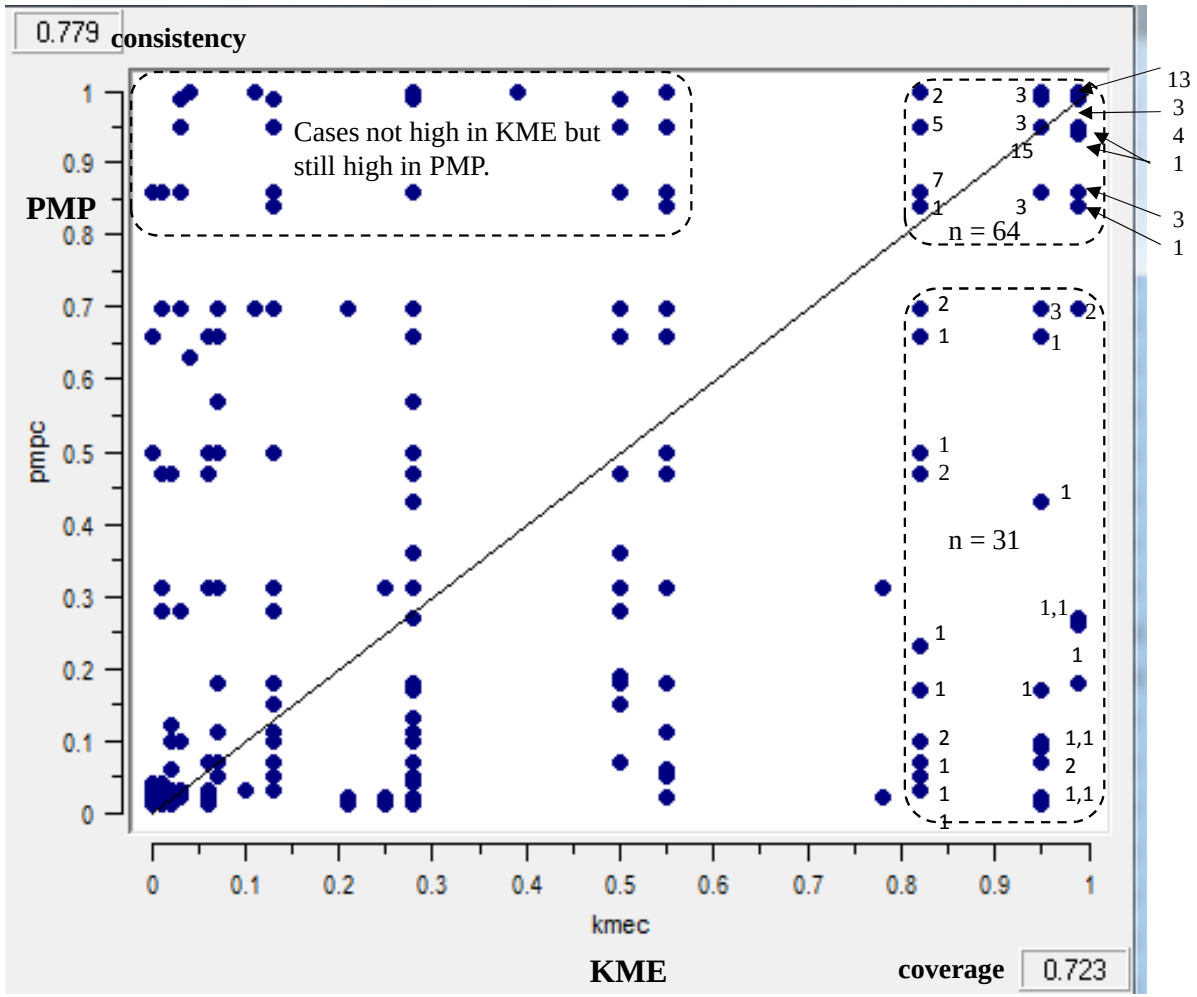
**. Correlation is significant at the 0.01 level (2-tailed).

PME = PM years of Experience, KME = Knowledge Management Effectiveness, PMP = Project Management Performance, Method = Methodology.

Table 4
General theory propositions and findings: Mainly testing simply antecedents statements as necessary conditions

Propositions	Consistency (C1)	Coverage (C2)	Pi Supported?
P1a High KME is sufficient for indicating (→) high project management performance (PMP)	0.78	0.72	Partially
P1b: Low KME is sufficient for indication (→) low project management performance (~PMP)	0.73	0.79	No
P2a: High social capital (SC) is sufficient for indicating (→) high KME, bonding●bridging → KME	0.81	0.66	Yes
P2b: Low social capital (~SC) is sufficient for indicating (→low KME, ~(bonding●bridging) → ~KME	0.74	0.86	No
P3a: High social capital is sufficient for indicating (→) high PMP, that is, bonding●bridging → PMP	0.86	0.65	Yes
P3b: Low social capital is sufficient for indicating (→) low PMP, that is ~(bonding●bridging)→ ~PMP	0.71	0.89	No
P4a: High social capital is sufficient for indicating (→) high KME●PMP	0.73	0.76	No
P4b: Low social capital is sufficient for indicating (→) low ~(KME●PMP)	0.86	0.83	Yes
P5a: High social capital AND KME (SC●KME) indicate cases high in PMP	0.90	0.55	Yes
P5b: Low social capital AND KME: ~(SC●KME) indicate cases low in ~PMP	0.67	0.94	No
P6a: Project participant demographic profile and project management process → social capital	0.73	0.32	No
P6b: Project participant demographic profile and project management process → ~ social capital			
P7a Project participant demographic profiles → high social capital	0.86	0.10	Yes
P7b Project participant demographic profiles → low social capital	0.85	0.59	Yes
P8a Project participant demographic profiles → high PMP	0.85	0.21	No
P8a Project participant demographic profiles → low PMP	0.89	0.01	No
P9 Project participant demographic profiles AND project management process → high KME●PMP	0.89	0.11	Yes

Note. Ex ante set requirement set for high consistency ≥ 0.82. Key: KME = knowledge management effectiveness;
PMP = project management performance; "→" "is sufficient for indicating"; "●"; "~" indicates negation (i.e., 1 minus the causal condition)



Note. The following is an interpretative guide for reading the XY plots in the study.

Numbers in Figure 2 are the numbers of cases per dot.

This model is an asymmetric analysis with the objective of constructing a model that is sufficient (but not necessary) for indicating cases with high membership scores in the outcome condition.

The asymmetric model, KME ≤ PMP (i.e., KME→PMP) is Useful! Cases high in knowledge management effectiveness (KME) alone is a reasonable useful indicator of high project Management performance (PMP). The odds are 2 to 1 (63/31) that cases high in KME are high PMP.

However, high KME does not predict all cases high in PMP. Thus, high KME is not necessary for high PMP. But the model demonstrates sufficiency for indicating cases high in PMP..

The XY plot for P1b is not included. The finidngs do not support P1b: ~KME ≤ ~PMP does not receive support (consistency index is equal to 0.73; coverage index = 0.79. Conclusion: a project having low KME is an insufficient indicator for concuding the project has low PMP.

Figure 2
Findings for model for P1a: KME ≤ PMP
Knowledge management effectiveness (KME) indicating project management performance (PMP)

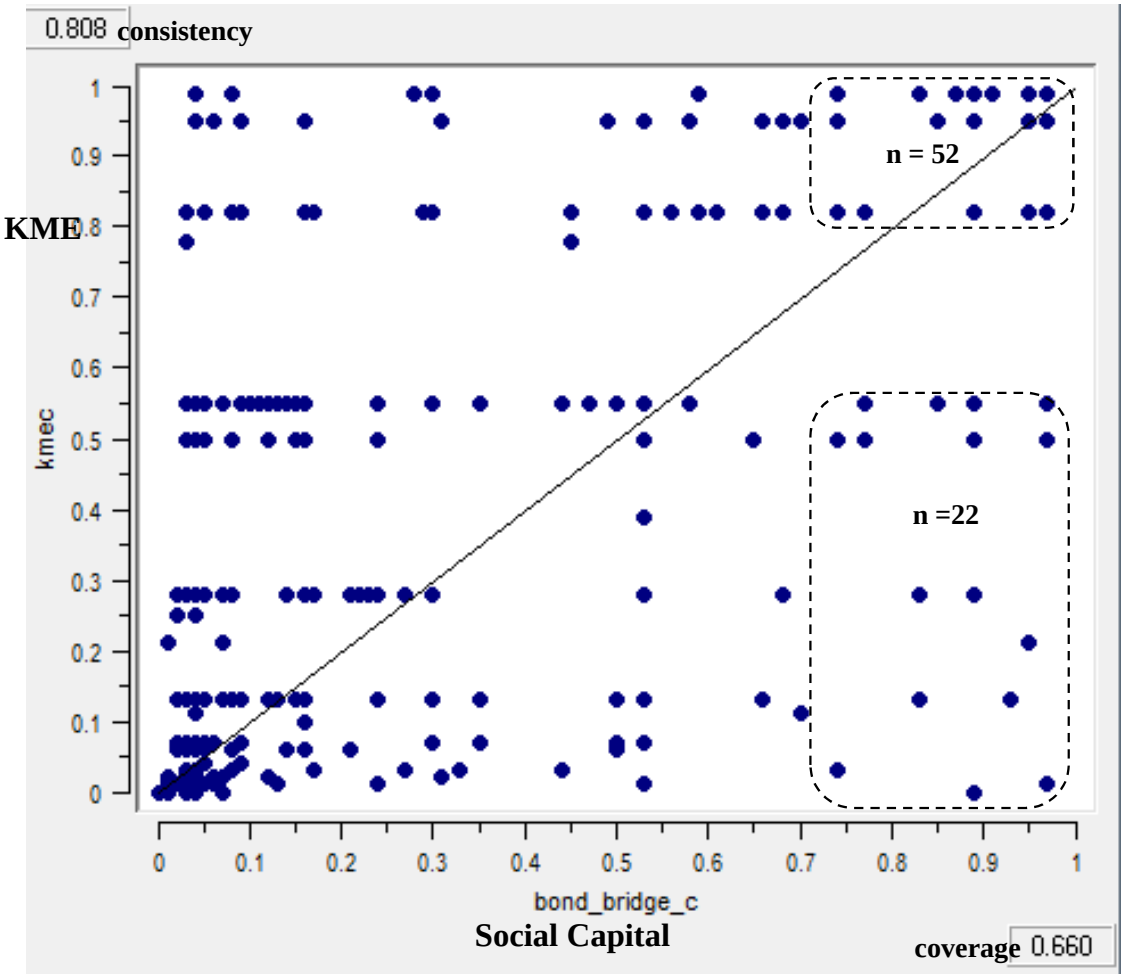
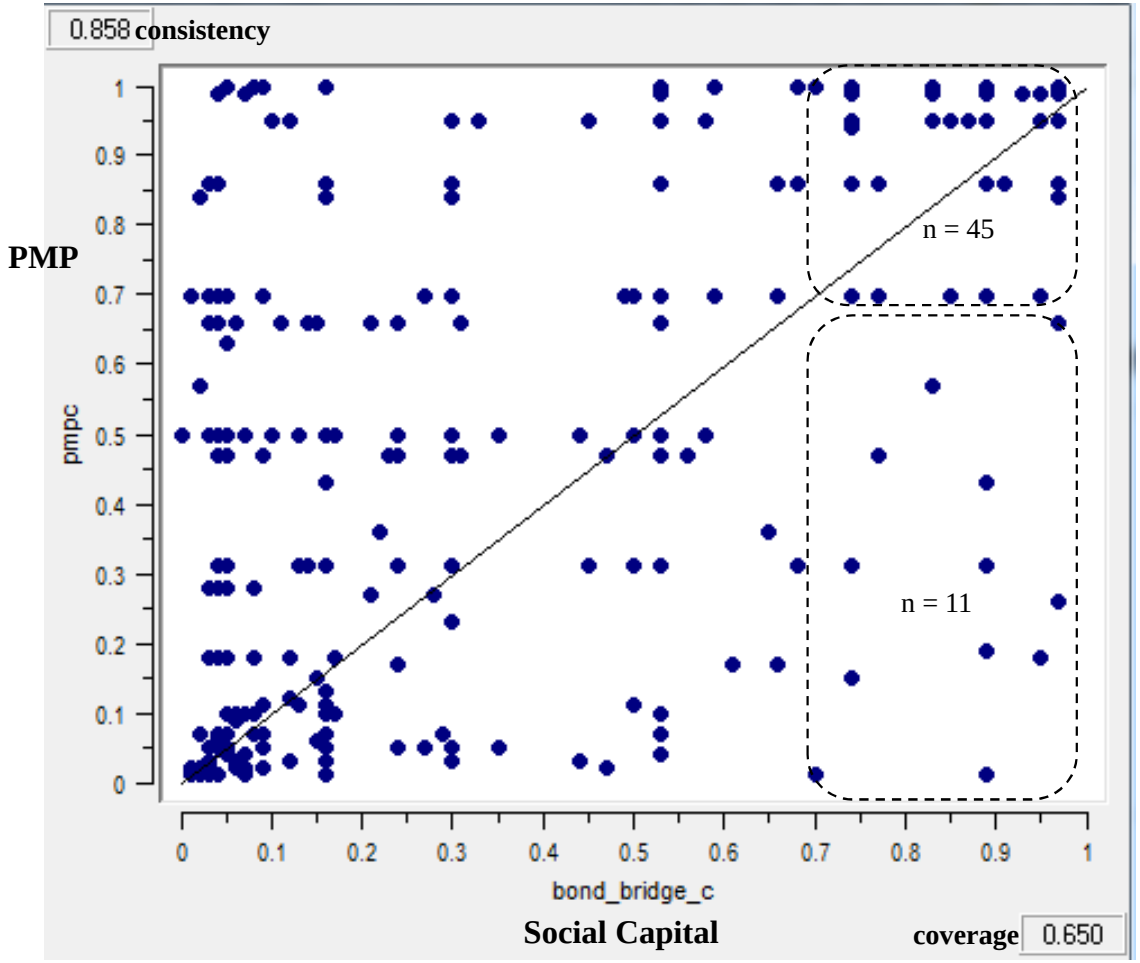


Figure 3
Model for P2a: Social Capital ≤ KME
Social capital (Bonding & Bridging) indicating knowledge management effectiveness (KME)



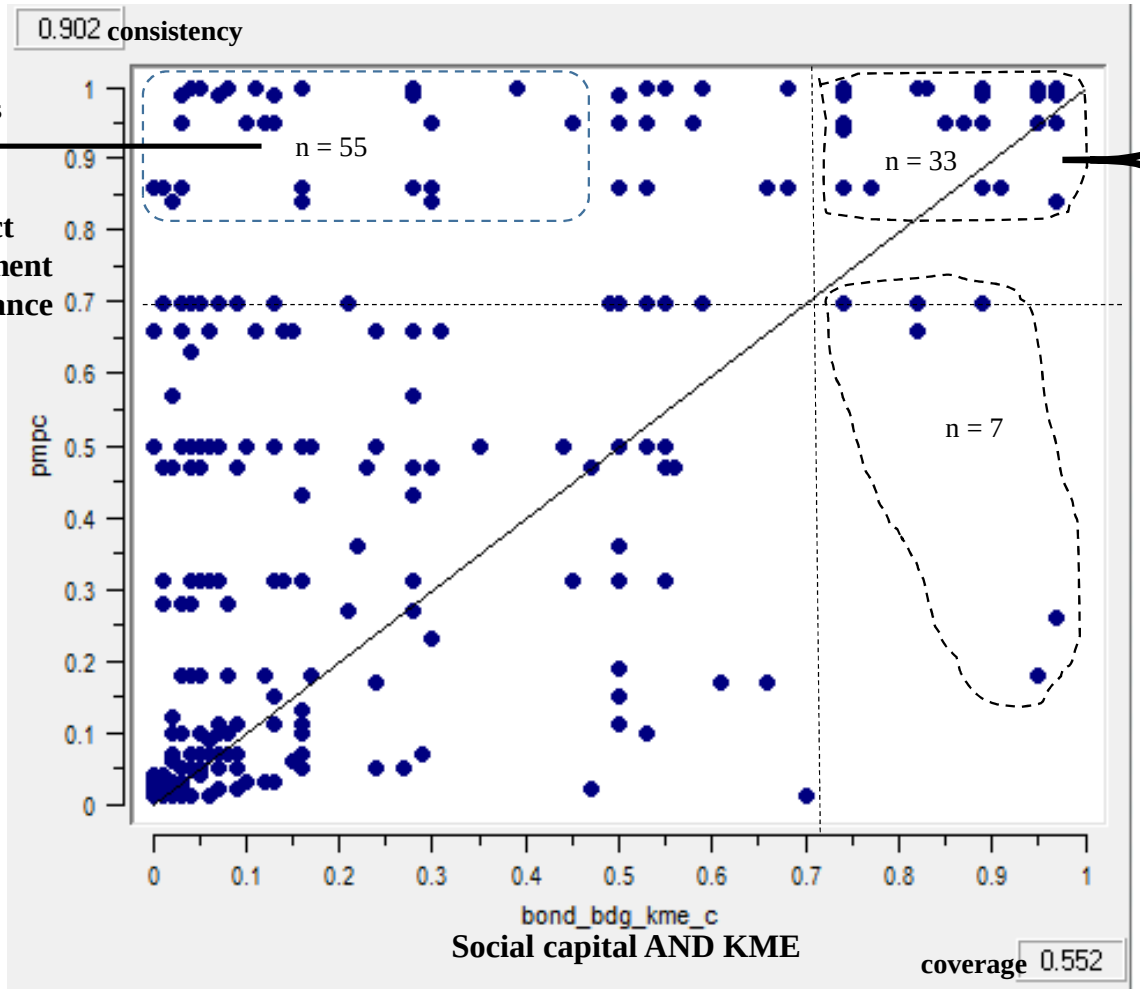
Notes.
Model tested: bond●bridge ≤ PMP.

Model statement via "computing with words":
Projects with high membership scores for both
Types of social capital (bonding "AND" bridging)
are high in project management performance (PMP).

Findings: consistency index (0.85) is high, among the projects equal or above 0.70, the odds are greater than 4-to-1 that these projects have PMP membership scores above 0.7; coverage (0.65) is high—a 0.65 consistency index indicates that nearly two-thirds of the projects with high PMP scores have high scores in social capital. Coverage here indicates cases equal and above 0.50 in social capital for the cases eual or above 0.50 in PMP.

Figure 4
Model for P2b: Social Capital ≤ PMP
Social Capital (Bonding & Bridging) indicating project management performance (PMP)

The social capital and KME model is an asymmetrical statement, Thus, the model includes no prediction about cases with low scores in the model and high outcome scores. Alternative complex antecedent models are needed to accurate predict these cases.



The odds are nearly 5 to 1 that cases with high scores (> 0.70) for the model have have high scores for the outcome condition (i.e., project management performance.)

Figure 5
Findings for alternative asymmetric perspective of cases high in social capital AND high KME indicating cases high in PMP (project management performance)

Table 5a

P6a receives support: Project manager demographic profiles accurately indicating cases high scores in KME

Model: kmec = f(mgr_yr_exp_c, age_c, edu_c, r_d, admin, prodops, salesmtg, gender_c)

INTERMEDIATE SOLUTION: frequency cutoff: 2.00; consistency cutoff: 0.86

	coverage	consistency
1. mgr_yr_exp_c●age_c●~r_d●admin●~prodops●~salesmtg●~gender_c	0.06	0.84
2. ~mgr_yr_exp_c●age_c●edu_c●~r_d●~admin●~prodops●~salesmtg●gender_c	0.06	0.95
3. mgr_yr_exp_c●~age_c●edu_c●~r_d●~admin●~prodops●salesmtg●gender_c	0.04	0.92

solution coverage: 0.12; solution consistency: 0.88

Table 5b

P6b receives support: Project manager demographic profiles accurately indicating cases low (negation of) scores in KME

Model: not_kmec = f(mgr_yr_exp_c, age_c, edu_c, r_d, admin, prodops, salesmtg, gender_c)

INTERMEDIATE SOLUTION: frequency cutoff: 2.00; consistency cutoff: 0.86

	coverage	consistency
1. ~mgr_yr_exp_c●~age_c●~r_d●~admin●~prodops●~salesmtg●~gender_c	0.05	0.89
2. ~age_c●~edu_c●~r_d●~admin●~prodops●~salesmtg●gender_c	0.07	0.83
3. ~mgr_yr_exp_c●age_c●edu_c●~r_d●admin●~prodops●~salesmtg	0.08	0.91
4. ~age_c●edu_c●r_d●~admin●~prodops●~salesmtg●gender_c	0.06	0.87
5. mgr_yr_exp_c●age_c●~r_d●admin●~prodops●~salesmtg●gender_c	0.06	0.92
6. mgr_yr_exp_c●~age_c●~edu_c●r_d●~admin●~prodops●~salesmtg●~gender_c	0.03	0.87
7. mgr_yr_exp_c●age_c●edu_c●~r_d●~admin●~prodops●~salesmtg●~gender_c	0.03	1.00
8. ~mgr_yr_exp_c●age_c●edu_c●~r_d●~admin●prodops●~salesmtg●~gender_c	0.07	0.86
9. ~mgr_yr_exp_c●~age_c●edu_c●~r_d●~admin●~prodops●salesmtg●gender_c	0.03	0.87

solution coverage: 0.32; solution consistency: 0.84

Table 6a: P7a receives support--Project management demographic profiles predict high social capital accurately

Model: bond_bridge_c = f(mgr_yr_exp_c, age_c, edu_c, r_d, admin, prodops, salesmtg, gender_c)
INTERMEDIATE SOLUTION: frequency cutoff: 1.00; consistency cutoff: 0.87.

Models	**coverage**	**consistency**
1 mgr_yr_exp_c●~age_c●~r_d●~admin●~prodops●salesmtg●gender_c	0.04	0.94
2 mgr_yr_exp_c●age_c●~edu_c●~r_d●~admin●~prodops●~salesmtg●~gender_c	0.03	0.87
3 mgr_yr_exp_c●age_c●~edu_c●r_d●~admin●~prodops●~salesmtg●gender_c	0.07	0.88
Solution coverage: 0.10; solution consistency: 0.86.		

Note. Example of reading models ("computing with words"): model 1 states that male managers with high years of experience working sales & marketing, and with high or low education indicates high social capital.

Table 6b: P7b receives support—Project management demographic profile predicts low (negation of) social capital accurately

Model: not_(brdg_bond) = f(r_d, admin, mgr_yr_exp_c, age_c, edu_c, prodops, salesmtg, gender_c)
INTERMEDIATE SOLUTION --- frequency cutoff: 2.00; consistency cutoff: 0.85.

Models	**coverage**	**consistency**
1 ~r_d●~admin●~age_c●~edu_c●prodops●~salesmtg	0.15	0.83
2 ~r_d●~admin●~mgr_yr_exp_c●prodops●~salesmtg●~gender_c	0.13	0.79
3 ~r_d●~admin●~age_c●~edu_c●~salesmtg●gender_c	0.13	0.85
4 ~r_d●~admin●~mgr_yr_exp_c●~age_c●~edu_c●~prodops●~gender_c	0.06	0.89
5 ~r_d●~mgr_yr_exp_c●~age_c●edu_c●~prodops●~salesmtg●~gender_c	0.07	0.95
6 ~r_d●admin●mgr_yr_exp_c●age_c●~edu_c●~prodops●~salesmtg	0.05	0.87
7 ~admin●mgr_yr_exp_c●age_c●edu_c●~prodops●~salesmtg●~gender_c	0.05	0.87
8 r_d●~admin●~age_c●edu_c●~prodops●~salesmtg●gender_c	0.05	0.94
9 ~r_d●~admin●~mgr_yr_exp_c●age_c●edu_c●~salesmtg●gender_c	0.10	0.89
10 ~r_d●~admin●mgr_yr_exp_c●~edu_c●prodops●~salesmtg●gender_c	0.09	0.82
11 ~r_d●admin●age_c●edu_c●~prodops●~salesmtg●gender_c	0.06	0.92
12 r_d●~admin●mgr_yr_exp_c●~age_c●~edu_c●~prodops●~salesmtg●~gender_c	0.03	0.93
13 ~r_d●~admin●~mgr_yr_exp_c●~age_c●edu_c●~prodops●salesmtg●gender_c	0.03	0.88
14 ~r_d●~admin●mgr_yr_exp_c●age_c●edu_c●~prodops●salesmtg●gender_c	0.04	0.88
15 ~admin●~mgr_yr_exp_c●~age_c●~edu_c●~prodops●~salesmtg●gender_c	0.07	0.84
16 ~r_d●admin●~mgr_yr_exp_c●~age_c●edu_c●~prodops●~salesmtg	0.06	0.92
17 r_d●~admin●~mgr_yr_exp_c●~age_c●~prodops●~salesmtg●gender_c	0.05	0.84
18. ~r_d●admin●~mgr_yr_exp_c●edu_c●~prodops●~salesmtg●gender_c	0.05	0.89
Solution coverage: 0.59; solution consistency: 0.81.		

Notes. A greater number of project demographic management (PDM) models indicate low PMP outcomes than the PDM models indicating high social capital outcomes.

Table 7a: P8a receives support— Project managers demographic profiles accurately indicate cases having high project management performance

Model: pmp = f(mgr_yr_exp_c, age_c, edu_c, r_d, admin, prodops, salesmtg, gender_c)
INTERMEDIATE SOLUTION: frequency cutoff: 2.00; consistency cutoff: 0.86

Models	Coverage	Consistency
1 ~mgr_yr_exp_c●~age_c●edu_c●~r_d●~prodops●~salesmtg●gender_c	0.08	0.85
2 ~age_c●edu_c●~r_d●~admin●~prodops●salesmtg●gender_c	0.05	0.95
3 mgr_yr_exp_c●age_c●~edu_c●~r_d●admin●~prodops●~salesmtg●~gender_c	0.04	0.88
4 ~mgr_yr_exp_c●age_c●edu_c●~r_d●admin●~prodops●~salesmtg●~gender_c	0.05	0.90
5 mgr_yr_exp_c●age_c●~edu_c●r_d●~admin●~prodops●~salesmtg●gender_c	0.05	0.87
6 mgr_yr_exp_c●~age_c●edu_c●r_d●~admin●~prodops●~salesmtg●gender_c	0.05	0.91
Solution coverage: 0.21; solution consistency: 0.85.		

Example reading, model 1: young, male, project manager with few years of experience, high education level, not working in production/operations, nor in sales/marketing, nor in R&D indicates high PMP.

Table 7b: P8b receives support—Project manager demographic profiles accurately indicate projects having low (negation of) project management performance

Model: not_pmpc = f(mgr_yr_exp_c, age_c, edu_c, r_d, admin, prodops, salesmtg, gender_c)
INTERMEDIATE SOLUTION ---frequency cutoff: 2.00; consistency cutoff: 0.88.

Models	Coverage	Consistency
1 ~mgr_yr_exp_c●~age_c●~r_d●~admin●~prodops●~salesmtg●~gender_c	0.05	0.88
2 mgr_yr_exp_c●age_c●edu_c●~r_d●~admin●~prodops●~salesmtg●~gender_c	0.03	0.95
3 mgr_yr_exp_c●age_c●~edu_c●~r_d●admin●~prodops●~salesmtg●gender_c	0.04	0.89
Solution coverage: 0.08; solution consistency: 0.89.		

Example reading model 1: young female project manager with few years experience, low or high education attainment, and not in administration or production/operations or in sales/marketing indicates low PMP.

Table 8
P9 receives support: PM process and project manager demographic profiles accurately indicating cases having high scores in the complex outcome of high KME AND high PMP

Testing P9: Model: kme_pmp_c = f(agile_c, r_d, admin, prodops, salesmtg, gender_c, mgr_yr_exp_c, age_c, edu_c)
INTERMEDIATE SOLUTION: frequency cutoff: 1.00; consistency cutoff: 0.86.

Models

		coverage	consistency
1.	agile_c●~r_d●~admin●prodops●~salesmtg●~gender_c●~age_c●edu_c	0.05	0.93
2.	agile_c●~r_d●~admin●prodops●~salesmtg●mgr_yr_exp_c●~age_c●edu_c	0.08	0.90
3.	~agile_c●r_d●~admin●~prodops●~salesmtg●gender_c●mgr_yr_exp_c●~age_c●~edu_c	0.06	0.86
4.	agile_c●~r_d●~admin●~prodops●salesmtg●~gender_c●~mgr_yr_exp_c●~age_c●edu_c	0.03	0.94
5.	agile_c●~r_d●admin●~prodops●~salesmtg●gender_c●~mgr_yr_exp_c●~age_c●edu_c	0.04	0.90
6.	agile_c●r_d●~admin●~prodops●~salesmtg●~gender_c●mgr_yr_exp_c●~age_c●edu_c	0.03	0.98
7.	~agile_c●~r_d●~admin●~prodops●salesmtg●gender_c●mgr_yr_exp_c●~age_c●edu_c	0.04	0.90

Solution coverage: 0.17; solution consistency: 0.86