Explanations for budget and schedule overrun revisited – a configurational perspective on IT projects

Completed Research Paper

Oliver Krancher
Department of Business IT
IT University of Copenhagen
olik@itu.dk

Christian Østergaard Madsen
Research Centre for Government IT
IT University of Copenhagen
olik@itu.dk

Adam Alami
Department of Computer Science
Aalborg University
adal@cs.aau.dk

Connie Petersson
Research Centre for Government IT
IT University of Copenhagen
olik@itu.dk

Abstract

Although the existing literature portrays information technology projects as complex, dynamic, socio-technical endeavors, research on cost and schedule performance mostly focuses on single factors in isolation. In this paper, we use a configurational approach to overcome this disconnect. We collected interview and objective data from 30 IT projects and conducted a qualitative comparative analysis to examine how configurations of project conditions relate to cost and schedule adherence. Our analysis shows four configurations associated with budget or schedule adherence: Prestigious feedback-based projects, lucky projects, disciplined projects, and team-based projects. We discuss the implications of these results for information technology project management research and practice.

Keywords: Project management, IT projects, IS projects, configurational analysis, QCA, project success, cost overrun, schedule overrun

Introduction

A rich body of literature is now available on the question of why some information technology (IT) projects meet their cost and schedule goals while others do not (Dongus et al. 2015; Flyvbjerg et al. 2002; Lindsjørn et al. 2016; Wallace et al. 2004). Fueled by a strong practical need to identify and avoid potential causes of cost and schedule overrun, this literature has accumulated substantial knowledge about how particular factors affect project efficiency (i.e., the degree to which a project is on time and in budget) (Dongus et al. 2015). Some work focused on the estimation phase, finding that strategic misrepresentation is a key cause of budget overrun (Flyvbjerg et al. 2002), while other research identified factors during a project's execution such as teamwork and control (Dongus et al. 2015; Hoegl and Gemuenden 2001; Tiwana and Keil 2009).

Notwithstanding the considerable insights from this existing body of work, it is marked by two important limitations. First and foremost, much of the existing literature explains project efficiency by a "net effect thinking" (Ragin 2014) perspective, aiming to identify the "uncontaminated" effect of individual factors through correlational methods (Dongus et al. 2015; Gopal and Gosain 2010) or rankings of risk or success factors (Kappelman et al. 2006). Although this approach has produced important knowledge, it falls short

of addressing three important properties of IT projects: equifinality, conjunctural causation, and causal asymmetry. *Equifinality* implies that alternative approaches may lead to the same outcome (e.g., budget adherence) (Fiss 2007), such as when some projects meet cost and schedule goals by leveraging agile methods (Jørgensen 2019; Lindsjørn et al. 2016) and others through rigorous project management using plan-based methods (Alami et al. 2022). *Conjunctural* causation implies that the effects of individual factors depend on the presence of other factors (Fiss et al. 2013), such as when agile software development practices unfold their potential only in conjunction with changes in team practices, management approach, and culture (Hoda and Noble 2017). *Causal asymmetry* implies that a given factor may have a strong effect in one situation but no or an opposed effect in another (Fiss 2007; Park and Mithas 2020). For example, team-based approaches may work well together with other agile practices but not in bureaucratic environments where stakeholders exercise strong control (Hoegl and Gemuenden 2001). If IT projects are characterized by equifinality, conjunctural causation, and causal asymmetry, studies that focus on the net effects of individual factors are likely to produce incomplete insights into the causes of cost and schedule overrun.

A second limitation of existing research is that it mostly subsumes budget and schedule adherence under the more general notion of project efficiency (Krancher 2020; Wallace et al. 2004) or under the even more general notion of project success (Dongus et al. 2015; Lindsjørn et al. 2016). However, projects that meet one success dimension need not meet other success dimensions. For example, a recent survey reported that 60% of the projects met cost targets but only 39% schedule targets, highlighting an important practical need to identify the specific conditions leading to schedule versus budget adherence (Nelson and Morris 2014).

We address these two gaps through the following research question: *Which configurations of IT project conditions lead to cost or schedule adherence*? We identified these configurations through qualitative comparative analysis (QCA) (Ragin 2014), which is appropriate for phenomena characterized by equifinality, conjectural causation, and causal asymmetry (Fiss 2007). We relied on a unique dataset consisting of comparable archival data and in-depth interview data about 30 recent Danish IT projects. Key contributions of our work include unprecedented empirical insights into configurations leading to cost and schedule adherence and an impetus for the methodological diversity of IT project management research, which hitherto has paid limited attention to configurational perspectives. In the remainder of this paper, we selectively review the literature on IT project management, present our QCA methods and results, and discuss implications.

Background literature

IT projects are regarded as complex, nonroutine, and dynamic temporary organizations that involve substantial uncertainty (Wiener et al. 2016). A significant body of research has examined various facets of the success of IT projects, including efficiency (i.e., budget and schedule adherence) (Flyvbjerg et al. 2002; Gopal and Gosain 2010), quality (Gopal and Gosain 2010; Krancher 2020), and business impact (Coombs 2015). Given the complex, multifaceted nature of IT projects, it is not surprising that many research streams have evolved, focusing on distinct aspects contributing to these success dimensions. While readers are referred to recent reviews and meta-analyses for more comprehensive reviews (Dongus et al. 2015; Keil et al. 2020), we highlight five streams that have developed important explanations for project and IT project success.

A first literature stream points to the limited rationality of project managers and sponsors. A key work in this regard is Flybjerg et al.'s study on transportation infrastructure projects, which revealed that cost estimations are often "systematically misleading" (Flyvbjerg et al. 2002). Flyvbjerg et al. conclude that a key problem is that stakeholders may lie about the true potential benefits and costs of projects that are of high prestige for their stakeholders. Another problem in such projects is escalation of commitment, i.e., that "troubled projects are continued instead of being abandoned or redirected" (Keil et al. 2000, p. 633). Especially in high-prestige projects, managers may prefer to continue a project, fearing they would look bad in others' eyes if they declared the project a failure (Keil et al. 2000).

A second stream focuses on the control of IT projects. This literature has established that formal controls (i.e., specifying and evaluating expected outcomes and behaviors) can direct projects toward specific outcomes (Wiener et al. 2016). For instance, formal controls focusing on behaviors and efficiency outcomes were shown to increase project efficiency, while formal controls focused on quality outcomes can decrease

efficiency (Gopal and Gosain 2010). This literature also highlights that highly formal control approaches may be ill-suited for knowledge-related outcomes such as innovation (Wiener et al. 2019).

A third literature stream explores the role of relational and human factors in IT projects (Jørgensen 2019; Mohagheghi and Jørgensen 2017). Several studies report that many project managers nowadays focus on team building, collaboration with stakeholders, and knowledge sharing (Alami et al. 2021; Hoegl and Gemuenden 2001). A meta-analysis has demonstrated that relational factors such as knowledge integration (Walz et al. 1993) are among the strongest predictors of IT project success (Dongus et al. 2015).

A fourth stream focuses on agile software development methods and their interplay with traditional project management methods. Agile software development methods aim at enhancing a team's ability to trigger and respond to change through feedback processes such as incremental design, iterative development, and inspect and adapt cycles, and through collaborative relationships, typically in the form of cross-functional teams (Baham and Hirschheim 2022). Qualitative research has shown that the adoption of agile methods is often accompanied by changes in teamwork, management practices, and culture (Hoda and Noble 2017). Quantitative studies have shown mixed evidence on the effects of feedback processes (Krancher 2020) and teamwork quality (Lindsjørn et al. 2016) on IT project success, including efficiency.

Last but not least, a fifth literature stream has examined project complexity, risks, and their implications for project management (Barki et al. 2001; Wallace et al. 2004; Xia and Lee 2005). In line with the literature on relational and human factors, this literature has found that risks and complexities originate to a large extent from the social subsystem of projects, which manifest in uncertain requirements and thereby make project management more complex (Wallace et al. 2004; Xia and Lee 2005). Drawing on these ideas, scholars have suggested that agile methods are most suitable for projects characterized by uncertain requirements and other sources of complexity (Boehm and Turner 2003).

Across these five streams of research, there is an important disconnect that is rarely discussed in IS project management research. On the one hand, research emphasizes the complex, dynamic, socio-technical nature of IT projects (Hoda and Noble 2017; Jørgensen 2019; Wallace et al. 2004; Walz et al. 1993; Wiener et al. 2016), which calls for a focus on the conjunctural interplay of several factors beyond a set of linear relationships. On the other hand, most work aiming to empirically explain variance in project success (including cost and schedule adherence) is designed to isolate the effects of single factors or, at most, examine the interaction of two factors (Dongus et al. 2015; Gopal and Gosain 2010; Hoegl and Gemuenden 2001; Lindsjørn et al. 2016; Wallace et al. 2004). This disconnect is problematic because it can lead to wrong conclusions. For example, if a given factor affects project success only in conjunction with other factors, a research design focusing on "net effect thinking" (Ragin 2014) can erroneously conclude that the factor is unimportant.

In this paper, we aim to overcome this disconnect by building explanations based on the conjunctural causation resulting from the interplay of several factors. To keep this focus manageable within the realm of a single paper, we limit our attention to two key dependent variables: cost and schedule adherence. Notwithstanding the relevance of other dimensions of IT project success, cost and schedule adherence are among the most challenging dimensions, as shown in a recent survey where 39% of the projects met schedule goals, 60% cost goals, and 87% or more goals related to quality, impact, learning, and satisfaction.

Method

In this study, we use Qualitative Comparative Analysis (QCA) (Ragin 2014) to identify configurations of conditions underlying the causes of IT projects' cost and schedule adherence. QCA uses set theory and Boolean algebra to explain how configurations of multiple conditions relate to outcomes of interest, allowing to account for conjunctural causation, equifinality, and causal asymmetry (Mattke et al. 2022; Park and Mithas 2020; Ragin 2014; Schneider and Wagemann 2012). Although QCA can be used in a variety of ways, a possible use is "intermediate-N" settings of 15 to 50 cases where researchers combine detailed case knowledge with an iterative and inductive approach to develop new theoretical, configuration-based arguments (Berg-Schlosser et al. 2009; Schneider and Wagemann 2012). Despite the wealth of existing research on IT project management, we preferred an inductive approach because it allowed a fresh, configurational perspective and because prior research based on net effect thinking could potentially have discounted factors that matter only in conjunction with other factors or are subject to causal asymmetry.

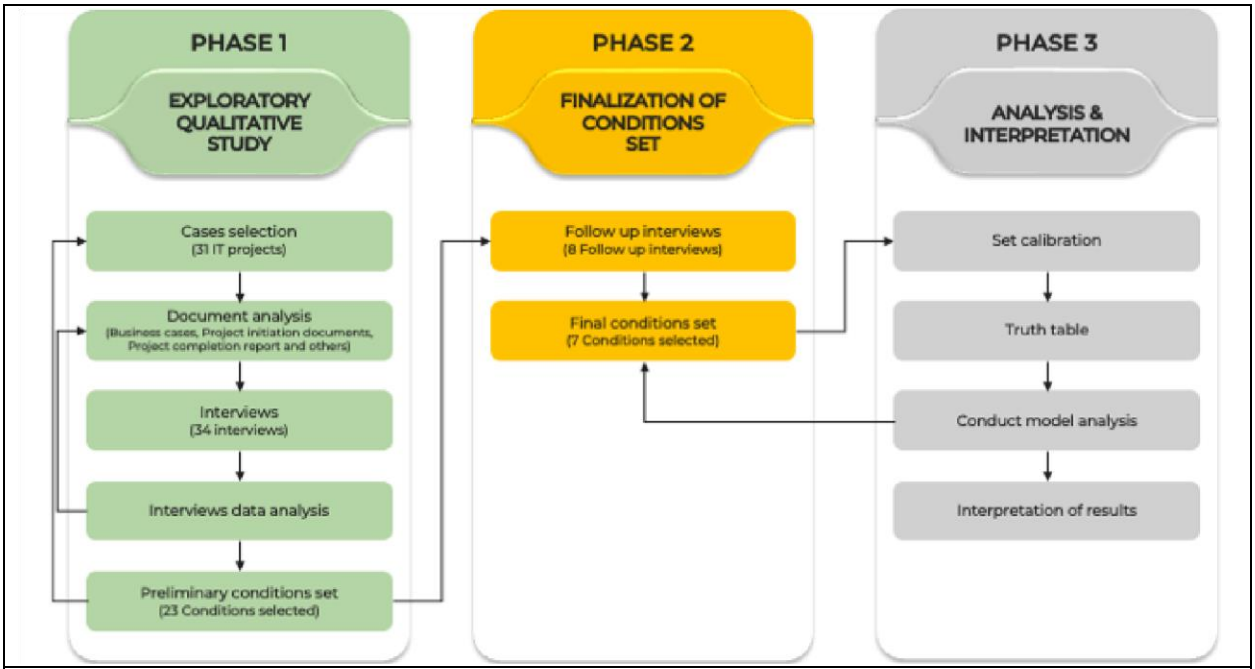

Figure 1. Research process

Our study iterated between three phases, as shown in Figure 1. In the exploratory Phase 1, we identified cases and potential conditions. In Phase 2, we collected additional data to fine-tune and finalize the conditions set prior to conducting the QCA analysis in Phase 3. This research approach allowed us to leverage a unique dataset, which combined objective data on cost and schedule adherence measured in a uniform way across projects and rich qualitative data from extensive project documentation and interviews, giving insights into the causal mechanisms leading to cost and schedule performance.

Phase 1: Exploratory qualitative study

The aim of Phase 1 was to propose a preliminary set of conditions. We began by selecting a set of candidate cases from our database of 70 Danish national IT projects sourced from the Danish Division for Central Government ICT Management (the division). All Danish government IT projects that have an estimated budget of at least 10 million DKK (≈ $1.38) (appr. 1.38 million USD) and involve software development are formally required to be risk-assessed by the division. These projects must submit reporting documentation, including the project initiation document, a business case, half-yearly status reports, and final report upon completion to the division. The reporting guidelines defined by the division ensured that each project reported cost and schedule outcomes in a uniform way, creating a unique source of objective and comparable data. We collected these documents and built a database to store key information on each project. The projects were completed in the period from 2011 to 2021. They had varied scopes but commonly involved either software development or IT-related activities such as systems integration, data migration, or hardware upgrades.

Given our interest in cost and schedule adherence, we extracted data on estimated and realized cost and schedule from each project. Subsequently, we calculated each project's cost and schedule overrun. We adhered to Flyvbjerg's (Flyvbjerg et al. 2018) recommendation of focusing on the estimated budget and schedule figures at the earliest point in the project's lifecycle. This data is closest to the "time of decision to build" (Flyvbjerg et al. 2018). To determine cost overrun, we adjusted the actual costs to constant prices,

choosing the project's initiation year as a baseline. Then, we calculated the relative cost overrun as actual cost minus estimated costs in percent of estimated costs (Flyvbjerg et al. 2018). For the schedule, we determined the project's duration by converting start and end dates to days and calculated relative schedule overrun using the same formula as for cost overrun (Flyvbjerg et al. 2018).

#	Budget (in million DKK)	Schedule (in days)	Year	Interviewee
P1	26 - 59 ($3.68 - 8.36)	400 - 599	2017	Project manager
P2	26 - 59 ($3.68 - 8.36)	400 - 599	2017	Project manager
P3	26 - 59 ($3.68 - 8.36)	1000 – 1199	2018	Project manager
P4	10 - 25 ($1.41 - 3.54)	1000 – 1199	2014	Project manager, deputy director
P5	26 - 59 ($3.68 - 8.36)	1000 – 1199	2015	Project manager
P6	26 - 59 ($3.68 - 8.36)	400 - 599	2014	Project manager
P7	26 - 59 ($3.68 - 8.36)	800 – 999	2015	Project manager
P8	60 - 99 ($8.50 - 14.03)	400 - 599	2018	Section manager
P9	10 - 25 ($1.41 - 3.54)	400 - 599	2017	Project Manager
P10	>$ 100 ($14.17)	400 - 599	2016	Project manager
P11	>$ 100 ($14.172)	1000 – 1199	2015	Project manager, senior stakeholder
P12	26 - 59 ($3.68 - 8.36)	400 - 599	2019	Project manager
P13	26 - 59 ($3.68 - 8.36)	1000 – 1199	2019	Head of department
P14	10 - 25 ($1.41 - 3.54)	1200 - 1399	2019	Project manager
P15	10 - 25 ($1.41 - 3.54)	1000 – 1199	2018	Project manager
P16	10 - 25 ($1.41 - 3.54)	800 – 999	2020	Project manager
P17	10 - 25 ($1.41 - 3.54)	400 - 599	2020	Head of division
P18	10 - 25 ($1.41 - 3.54)	600 – 799	2020	Program manager
P19	26 - 59 ($3.68 - 8.36)	400 - 599	2020	Project manager
P20	10 - 25 ($1.41 - 3.54)	600 – 799	2021	Project manager
P21	10 - 25 ($1.41 - 3.54)	600 – 799	2021	Project manager
P22	10 - 25 ($1.41 - 3.54)	600 – 799	2020	Project manager
P23	10 - 25 ($1.41 - 3.54)	800 – 999	2020	Project manager
P24	10 - 25 ($1.41 - 3.54)	800 – 999	2020	Project owner
P25	60 - 99 ($8.50 - 14.03)	800 – 999	2020	Project manager
P26	60 - 99 ($8.50 - 14.03)	1200 - 1399	2020	Team lead
P27	26 - 59 ($3.68 - 8.36)	1200 - 1399	2020	Project manager
P28	10 - 25 ($1.41 - 3.54)	600 – 799	2019	Head of department, project manager
P29	10 - 25 ($1.41 - 3.54)	400 - 599	2020	Project manager
P30	26 - 59 ($3.68 - 8.36)	600 – 799	2021	Project manager

Table 1. The Study Sample

From these 70 projects, we selected 30 projects that differed in cost and schedule adherence (Ragin 2014), prioritizing projects that were concluded not too many years ago. Table 1 provides an overview of our sample. The fourth column indicates the completion year of the project. The last column lists the study participants from each project. The final sample included 13 projects that adhered to their budget, 6 projects that exceeded the budget by a maximum of 10%, and 11 projects that exceed the budget by more than 10%. 5 projects met their schedule, 5 exceeded it by a maximum of 10%, and 20 exceeded the schedule by more than 10%.

After the selection of cases, we commenced the first iteration of data collection to identify a preliminary set of conditions. We conducted a preliminary analysis of the project documentation and then interviews with project managers and senior stakeholders. While the documents provided a broad understanding of the cases, the interviews facilitated in-depth understanding of the conditions and events that have led to the outcomes of each case. Moreover, the interviews provided us with an opportunity to validate the findings from our document analysis (Blaikie and Priest 2019). Each project in our database had a set of corresponding documents. These documents were business cases, project initiation documents, risks assessment, project completion documents and, in some instances, correspondence letters between the division and the project's teams. Prior to the interviews, we examined the project documentation to familiarize ourselves with the cases and prepare the interviews' questions. After analyzing the interview data, we conducted another iteration of document analysis to identify any further explanations for the projects' cost and schedule outcomes. The aim of the interviews was to collect rich data to explore the conditions leading to cost and schedule outcomes. We approached project managers, senior stakeholders, and team leaders from our selected cases for interviews, recruiting a total of 32 participants. For each project, we interviewed a minimum of one participant and a maximum of three participants. The interviews were conducted in Danish and lasted between 40 to 70 minutes each. With the exception of one face-to-face interview, all interviews were conducted using Microsoft Teams. The interviews generated an average of sixteen pages when transcribed verbatim. The interviews from phase 1 were carried out in 2021 and the follow-up interviews from phase 2 in 2022.

Conditions	Definitions
Prestige project	This condition implies that a particular project had a high status, being perceived to be of significant importance by the project's stakeholders. Consequently, its presence has become notable to a great degree and closer scrutiny was exercised over the project's performance.
Disciplined Budgetary Control	This condition occurred when project managers and their team showed meticulous attention to controlling the project's budget. This has taken place at the process level and by demonstrating accountability towards a rational expenditure by the project team. Process-wise, projects implemented procedures and tools to track the accuracy of spending.
Team-based Organization (high-order construct)	This condition indicates the degree to which project members worked together in a way that is characteristic of teams. It was measured as the average of three binary conditions: whether the project participants (1) were co-located, (2) had been working together before the project, and (3) considered themselves primarily as members of the one team ("one-team mindset"), as opposed to members of respective and potentially different organizations.
Feedback (high-order construct)	This condition indicates the degree to which the project implemented strategies to ensure continuous feedback. It was measured as the average of three binary conditions: whether the project relied on (1) pure agile methods (as opposed to hybrid or plan-based methods), (2) on iterative development or deployment (e.g., to capitalize on the learning during each iteration), (3) and on continuous customer involvement.
Complexity (high-order construct)	This condition indicates to which extent sources of project complexity (defined as the degree to which many information elements interact in dynamic ways) were present. It was measured by aggregating the following conditions: (1) custom development (binary), (2) high requirements uncertainty (binary: at least some major requirements not known at project start), (3) high business complexity (binary: many business rules), (4) high technical complexity (binary: many integrations), (5) high project size (logistic transformation, see the section on calibration), (6) long project duration (logistic transformation, see the section on calibration).
Underestimation	This condition occurred when the budget or the schedule were underestimated due to invalid assumptions about the viability of technical solutions, about internal cost allocation, or about vendor payments.
Descope	This condition occurred when the initially agreed scope was reduced or a subset of the requirements were shifted to be delivered by future projects.

Table 2. Final Conditions Set

The aim of the analysis was to identify a potential set of conditions, i.e., factors that contributed to budget adherence or schedule adherence. We used thematic coding to analyze the interview data (Miles et al. 2014). We approached the analysis inductively, which allowed us to remain open and flexible in order to identify conditions not available in the existing literature. The initial codes were generated using open coding (Miles et al. 2014). We analyzed the raw data systematically line by line to infer meanings and concepts from the

text. In the subsequent phase of the analysis, we categorized the codes into themes by comparing codes to each other and looking for similarities among the list of the initial codes (Miles et al. 2014). Aggregating codes to themes, or higher-order constructs in QCA parlance (Schneider and Wagemann 2010), is a key strategy for keeping the number of conditions at a moderate level. This final step yielded a set of themes which formed our preliminary conditions set.

Phase 2: Finalization of conditions set

In phase 2, we performed eight follow-up interviews to validate the values of conditions we identified in phase 1 and gather data on additional conditions that have emerged during the analysis. For example, it became apparent from phase 1 that team-based organization may influence a particular project's outcome. Hence, we collected missing data and validated our preliminary values during the follow-up interviews. Then, we finalized the set of conditions. Our preliminary conditions set contained 23 candidates. However, after the QCA analysis, some became obsolete, appearing prominently neither among necessary nor among sufficient conditions. Table 2 lists our final conditions set and their respective definitions. We opted to define them inductively to preserve their authenticity, i.e., as they emerged from the qualitative analysis in phases 1 and 2 .

Condition	**Input variable**	**Exclusion threshold**	**Crossover threshold**	**Inclusion threshold**
Budget adherence	Relative cost overrun	0.5	0.1	0
Schedule adherence	Relative schedule overrun	0.5	0.1	0
Project size	Planned budget in million DKK	10	60	110
Project duration	Planned duration in days	360	1080	1800

Table 3. Calibration Thresholds

Phase 3: QCA Analysis

We conducted a fuzzy set Qualitative Comparative Analysis (fsQCA) (Ragin 2014) using RStudio (version 1.0.143) with R version 3.4.1 and the two packages SetMethods and QCA. Our QCA analysis process consisted of four steps: calibration, truth table analysis, necessity and sufficiency analysis, and validation of the results.

fsQCA allows assigning continuous membership scores ranging from 0 to 1 to each condition in each case. We chose fsQCA because it allowed preserving nuances in the values of conditions, such as the nuance of whether a project ran only slightly or substantially over budget. While some conditions were already coded in binary form (prestige project, disciplined budgetary control, invalid estimation assumptions and descope), other conditions (team-based organization, feedback, and complexity) were higher-order constructs and required adding the lower-order constructs and norming the sum to fit into the range between 0 and 1. Still other conditions (budget adherence, schedule adherence, the two lower-order constructs estimated budget and estimated schedule) were based on continuous variables. We calibrated these raw scores with R's QCA package, using the logistic calibration function. This required us to decide on the threshold for full set exclusion, the crossover threshold, and the threshold for full set inclusion for each of the conditions. Table 3 shows the values that we chose. In line with the recommendations from the QCA literature, we used our substantive knowledge about IT projects in Denmark and our case knowledge to decide upon thresholds (Ragin 2014). The thresholds for budget adherence may help illustrate the meaning of the three thresholds. An exclusion threshold of 0.5 for budget adherence means that we considered projects that had a relative cost overrun of 50% or more to be fully excluded from the set of budget adherence projects. A crossover threshold of 0.1 means that projects with a relative cost overrun between 10% and 50% were considered to be more out than in the set of budget adherence projects, while projects between 0% and 10% were considered to be more in the set of budget adherence projects than out (Ragin 2014). We made this choice because a number of projects exceeded their budget (or schedule) by a few percent and were still considered to have largely met their targets and, hence, to be successful projects (in terms of cost or schedule adherence) by the stakeholders we interviewed. For project size, we used 60 million DKK (≈ $8.50US) as the crossover value because this threshold was used by the Danish State for projects that have extended reporting requirements due to their large size. For project duration, we did not

have any substantive guidance about what constitutes a long versus short project. Hence, we chose the thresholds based on the empirical distribution of project duration which ranged from 1 to 5 years.

After calibration, we examined whether any single condition was a necessary condition for the two outcomes using the QCAfit command (i.e., budget adherence, schedule adherence). Subsequently, we proceed with identifying sufficient conditions by constructing truth tables consisting of all possible combinations of the conditions using the truthTable command. We chose a consistency value threshold of 1.0 to ensure that the resulting configurations had high consistency values. We then calculated the parsimonious solution by using the minimize command. When the parsimonious solution included configurations that were alternatives to each other, we identified the conditions that were shared by all alternatives as core conditions and the conditions that were not present in all alternatives as peripheral conditions. Our interpretations focused on core conditions. Lastly, we validated the results by examining the cases that belonged to the configurations suggested by the QCA algorithm. We assessed whether the logic of the configuration could explain the cost and schedule outcome of the cases based on the insights from the qualitative data.

Results

Identifying necessary conditions

Table 4 presents the results of our analysis of necessary conditions for budget adherence. Columns 2 and 3 show the consistency and coverage values for the presence of conditions (e.g., for projects being prestige projects). Columns 4 and 5 show the values for the absence of conditions (e.g., for projects not being prestige projects). Table 5 shows the results of the same analysis for schedule adherence. Consistency refers to the degree to which a condition is a necessary condition (Mattke et al. 2022). While a value of 1 would indicate perfect consistency, we operated with a threshold of 0.9 in line with the QCA literature (Schneider and Wagemann 2012). Coverage reflects the proportion of observations that exhibit the condition where the outcome is present (Mattke et al. 2022). Hence, low coverage values indicate that only a minor portion of the dataset is explained by the necessary condition. A common threshold for coverage in the analysis of necessary conditions is 0.6 (Mattke et al. 2022).

Condition	Presence of the condition		Absence of the condition	
	Consistency	Coverage	Consistency	Coverage
Prestige project	0.434	0.599	0.566	0.780
Disciplined budgetary control	0.290	0.858	0.710	0.638
Team-based organization	0.588	0.793	0.455	0.642
Feedback	0.664	0.777	0.402	0.674
Complexity	0.469	0.661	0.603	0.813
Underestimation	0.201	0.378	0.799	0.870
Descope	0.290	0.857	0.710	0.638

Table 4. Necessary Conditions for Budget adherence

Condition	Presence of the condition		Absence of the condition	
	Consistency	Coverage	Consistency	Coverage
Prestige project	0.399	0.379	0.601	0.570
Disciplined budgetary control	0.286	0.581	0.714	0.442
Team-based organization	0.640	0.594	0.529	0.513
Feedback	0.743	0.599	0.411	0.474
Complexity	0.544	0.527	0.728	0.676
Underestimation	0.231	0.299	0.769	0.576
Descope	0.233	0.473	0.767	0.475

Table 5. Necessary Conditions for Schedule adherence

As the results show, neither the presence nor the absence of any of the conditions met the consistency threshold of 0.9. Hence, no condition was necessary for budget or schedule adherence. This indicates that explanations for budget or schedule adherence may be more complex than explanations based on a single factor, suggesting that it is important to examine configurations of factors, as done in the subsequent analysis.

Identifying sufficient conditions for budget adherence

Table 6 shows the results of our sufficiency analysis for budget adherence. We identified four core configurations for budget adherence: Prestigious feedback-based projects, lucky projects, disciplined projects, and team-based projects. Prestigious feedback-based projects and lucky projects had variants (i.e., configurations that slightly differed in peripheral conditions), which we refer to as C_1a, C_1b and C_2a, C_2b, C_2c(see Table 6). The overall solution had a high consistency of 0.986, indicating that these configurational statements match the data very well. A high coverage value of 0.779 shows that a substantial amount of the projects in our sample are captured and predicted by these configurations.

	Prestigious Feedback-based Projects		**Lucky Projects**			**Disciplined Projects**	**Team-Based Projects**
	C_{1a}	C_{1b}	C_{2a}	C_{2b}	C_{2c}	C_3	C_4
Prestige project	●	●	•			⊗	
Disciplined budgetary control						●	
Team-based Organization				⊗			●
Feedback	●	●			⊗		
Complexity	⊗						
Underestimation		⊗					⊗
Descope			●	●	●		
Cases	20, 28, 30	7, 17, 20, 25, 30	1, 7, 25, 30	1, 7	1, 3, 4	3, 5, 9, 23, 24	2, 3, 4, 5, 10, 12, 14, 17, 25, 30
Consistency	0.860	0.975	1	0.857	0.900	0.980	0.988
Coverage	0.197	0.220	0.193	0.097	0.145	0.237	0.494
Overall Solution Consistency	0.986						
Overall Solution Coverage	0.779						
● core condition present, • peripheral condition present, ⊗ core condition absent, ⊗ peripheral condition absent							

Table 6: Sufficient Conditions for Budget Adherence

C_1: Prestigious Feedback-based Projects

The first configuration for budget adherence includes six projects that met two core conditions: Prestige projects and feedback. Feedback is a higher-order condition that combines several project management elements associated with agile software development: an iterative development approach, continuous customer involvement, and an agile project management approach (see Table 1 for detailed definitions). Feedback helped the projects to continuously improve their understanding of user requirements and viable designs while allowing the project to strongly involve users and other stakeholders. Prestige project implies that a project has a high status and significant attention from its stakeholders, making it easier for project to obtain resources and ensure the commitment of involved actors.

One of the projects in this configuration was P28, which comprised the implementation of a new software application across all subsidiaries of a major organization in Denmark. The project initiation document highlights the prestige character of the project by emphasizing its aim *"to be a fusion-culture-creating project and to create common ground and work structures for both management and employees across previous organizations"*, which required the project team *"to involve all stakeholders"* (P28 Project Initiation Document). While the system was developed and configured in sprints, the project manager placed importance on "the involvement of the employees (…) to (…) get everyone involved because in reality, this was a fusion project." (Interview, P28) Interestingly, the project managers also mentioned that P28 was a prestige project not only for the pubic-sector organization but also for the supplier who wanted to retain a large customer:

It think it was because primarily it was a well-known supplier, that knew [us] and professionally also knew everyone else … (…) It was probably also a prestige project for the supplier. … They were really interested in not losing a large customer (…) Because everyone expected that other [organizations like us] would follow [our] choice. So, for the supplier, it was clearly of high business interest to make this implementation a success. (Interview, P28)

In sum, prestigious feedback-based projects were characterized by a high amount of energy and a strong focus on learning and stakeholder involvement, which enabled the projects to reach their goals within the given budgets.

C_2: Lucky projects

Six projects in our sample (two of which also belong to C1) belong to a configuration that we term lucky projects. These projects benefited from descoping, i.e., from a situation where key deliverables from the project charter were not required to be delivered. Not surprisingly, descoping made it easier for projects to remain on budget. Interestingly, we found different types of descoping in our empirical data. In project 30, the project manager explained that the major cause of cost underrun was that one of the main deliveries was removed from the project:

"And the reduction of 15 million DKK [≈ $2.06], do you know the reason for this?" (Interviewer) - "Yes, it was because we canceled [mentions specific delivery] Meaning that was the part that was taken out." (Interview, P30)

A different case also involved descoping. This case involved collaboration across different governance levels, both national and municipal. Here, descoping occurred in the project at the national level because one of the municipal organizations ended up developing – and paying for – the deliverable in question.

Interviewer: (…) Then there is a subsequent reduction, where (…) those elements are taken out. Is that correct? Participant: No, they are not taken out. Interviewer: Because these tasks are made at the municipal level? Participant: Yes, that's right. [Mentions two specific features] are made as a joint project with [other organization] but not by us, it was built by [municipal supplier].

We refer to these and four other projects as "lucky projects" because the key reason for budget adherence did not lie in the application of specific project management practices. Instead, the projects benefited from events that were outside of the project managers' control and made it easier for the projects to remain on budget.

C_3: Disciplined Projects

Five projects in our sample fall into a configuration that we term disciplined projects. The project managers of these projects paid strong attention to meeting budget goals. Moreover, these projects were not prestige projects. These projects followed a rather traditional approach to project management, emphasizing rigorous control of expenses and activities against a plan. It seemed that such a traditional approach worked well especially for non-prestige projects, where it was feasible to keep the scope at an agreed or minimal level. Interestingly, different project managers exercised disciplined budgetary control for different reasons. In some cases, the motivation was internal and came from the project manager's own organization. In other cases, the motivation came from an external organization. One project manager explained that they were new and "green" at the time and that their management paid close attention to them:

Participant: Yes, I think I was very attentive to time and budget (…) There's a lot of attention from management when you're in it [the project]. Now you've got that lump of money, public money, so you cannot spend any more. And for God's sake, you should not spend less either, because that is almost worse, right? So it was important to balance that pool of money. And again, I was new and green, so I was almost overfocused on these things working out [keeping within budget and schedule], because these [IT projects] always end up too expensive or run over time or such. I really feel like, this is the order I've been given, and it's what I must deliver, right? (Interview P20)

Another project manager explained that the attention from the ICT council (which oversaw all projects in our sample, irrespective of whether they were prestige projects) motivated them to stay within budget. The project manager meticulously tracked every expense to avoid their project being singled out for being over budget.

So, I must get a handle on all the expenses in this project, I'm out with the magnifying glass and look for all the expenses (…). So it's all about the expenses, I think we stopped working on the benefits. (…) I said, if we are to avoid going in red or yellow in the half-yearly reports and be slapped by the ICT council (…) then we must include all expenses, I do not want to say we have over-budgeted, but if I should answer why we went under budget, I tracked all possible expenses, and if some of those expenses don't materialize, then one goes under budget. While [mentions colleagues] were focused on the features, [I said] there is no money for this, it must be delayed to a later project. (Interview P9)

C_4: Team-Based Projects

With ten projects, the fourth configuration—team-based projects—was the most important configuration in our sample. Several project managers we interviewed sought to create high-performing teams to deliver the project as efficiently as possible. We identified three conditions that were present in these projects. The teams were often collocated, which avoided miscommunication and saved time by reducing the need for writing back and forth. The project team members often identified themselves as belonging to the project team rather than working for their respective employer (e.g., a vendor in the project). Moreover, some projects relied on project teams with employees that had previously worked together. One project manager explained the benefits of working with the same team members:

We had a development team which had been on [a similar project] before (…) And that meant they had worked together for more than a year, so they were becoming the high-performance team that you read about in agile development. We also knew each other's strengths and weaknesses. (P12)

Another project manager explained the benefits of being co-located and knowing each other on beforehand, and how this contributed to the project's success:

So there are several benefits. (…) I think what is special about this project is that the idea comes from the team, which at the project start has a very strong culture already. There is a strong sense of unity, and we already work well together. And that is part of the project's success. So there is this strong culture. There is (…) a responsibility to each other in relation to getting the job done. And there is a joy in doing the job. We have fun too while working. And this is something that is almost never written in reports. But we're having fun, and that's crucial. (…) Our architect ended up moving into our office because it's fun and a nice place to be.

Although a team-based organization helped many projects to adhere to their budget, this occurred only in projects that did not suffer from underestimation issues, as indicated by the second core category of this configuration, the absence of underestimation.

Identifying sufficient conditions for schedule adherence

Table 7 shows the results of our sufficiency analysis for schedule adherence. The QCA algorithm produced four core configurations. Since the core conditions of these configurations overlapped to a strong, though not perfect, extent with the core categories of the four categories for schedule adherence, we decided to use the same names as for the categories explaining budget adherence. The conditions are uniquely identified by the abbreviations D through D . The overall solution had an excellent consistency value of 0.914, while the coverage value of 0.514 was below the value for budget adherence. This implies that, although our configurations for schedule adherence make predictions that are highly consistent with the data, a smaller fraction of the projects (as compared to the analysis of budget adherence) is covered by these predictions.

	Prestigious Feedback-Based Projects	**Lucky Projects**	**Disciplined Projects**		**Team-Based Projects**
	D_1	D_2	D_{3a}	D_{3b}	D_4
Prestige project	●				⊗
Disciplined budgetary control		⊗	●	●	⊗
Team-based Organization					●
Feedback	●	⊗	•		
Complexity					
Underestimation	⊗		⊗	⊗	●
Descope	⊗	●		⊗	⊗
Cases	17, 20, 28	1, 4	5, 9, 20, 23	5, 9, 20, 23	16
Consistency	0.944	0.773	1	0.949	0.975
Coverage	0.155	0.127	0.211	0.267	0.068
Overall Solution Consistency	0.914*				
Overall Solution Coverage	0.514*				

● core condition present, • peripheral condition present, ⊗ core condition absent, ⊗ peripheral condition absent

Table 7: Sufficient Conditions for Schedule Adherence

D_1: Prestigious Feedback-based Projects

We identified three projects that were prestigious, relied on feedback processes, did not have issues with underestimation and descoping, and thus managed to adhere to the schedule. Like in C_1, project prestige and feedback processes allowed these projects to energize project team members and stakeholders and promote continuous learning. For example, the project managers of P17 and P28 ensured active engagement of their stakeholders throughout the project. The interviewees explained: *"the project approach has made it possible to have an ongoing dialogue with stakeholders and (…) the user groups regarding the design of the final solution"* (P17) and *"the strategy is to involve all stakeholders, ensure transparency and responsiveness"* (P28). The early and ongoing engagement of stakeholders facilitated better alignment of expectations and understanding of the requirements, which reduced complexity and enabled informed decision making and "responsiveness." These conditions enabled the project teams to recognize problems early and avoid delays.

While this configuration includes the core conditions of C_1 (prestige project, feedback processes), it seems that, in addition to these conditions, the absence of estimation issues and descoping is important for achieving schedule targets. Although it may appear counterintuitive that the absence of descoping should make it easier to meet the schedule targets, a possible explanation for this finding may lie in the use of agile practices. If projects rely on feedback-related agile practices such as iterative development and continuous stakeholder involvement, the scope of such projects is managed through a flexible, dynamic backlog. With such flexible and dynamic scope management, issues related to estimation and descoping might not always be salient.

D_2: Lucky projects

Two of the six projects that were subject to descope and adhered to the budget also adhered to the schedule. Both projects were characterized by traditional project management techniques, which is captured by the core condition of not relying on feedback processes. Moreover, both projects had critical schedule goals, which may have led the project manager to pay less attention to disciplined budgetary control. This may explain the core condition of no disciplined budgetary control.

Interestingly, our qualitative data also provide some insights into why cost and schedule adherence are not always related. One of the projects in this category concerned the implementation of EU legislation. Due to their stakeholder responsibilities, the organization was forced to embark on the project before the legislation was completely agreed upon by the EU. During the project, some of the schemes in the legislation were dropped, and these elements were removed from the project. Thus, we find an element of descoping here. The project consequently ended up approximately 40% under budget. However, it was not completed 40% before the deadline. The project manager and the deputy director explained that descoping did not affect the schedule because the descoped activities were planned to be conducted in parallel to other activities:

Interviewer: The project is about 40% below budget, but it's still on schedule, is that because there are some other dependencies, so the schedule is not shortened by 40% correspondingly? IT director: No but for these things there are some specific dates when we need it and it's built by then. So [deliveries] be done by certain time. Project leader: Yes, so there was another delivery in this project that we had to spend the time on. Interviewer: Well, it was just because when you look at it the outside (…) you could have an assumption that time and budget go hand in hand, but it does not necessarily. It director: They are not made in a specific order these deliveries, they are built simultaneously, so we could build [specific delivery] while we set up [mentions another delivery].

D_3: Disciplined projects

The four projects in D_3 applied disciplined budgetary control and met schedule targets. This separates them from the "Lucky projects" in D_2, which managed to stay within the schedule without applying disciplinary budgetary control. In contrast to configuration C_3, we also find the absence of underestimation in D_3. This suggests that disciplined budgetary control helps to counterbalance the effects of flawed estimation assumptions on budget but not on schedule. The absence of underestimation also suggests that the projects in D_3 are both realistically planned and rigorously managed. The project managers in these four projects all explain how they were mindful of both budget and schedule adherence. One project manager told us that they listened to the advice of the developers and cut features to stay on track:

So we kept a close eye on staying within the schedule. (…) And we also kept a close eye on the budget. And we did that by estimating every single function. Then you could see, if we want this function included, it will cost this much. Then we could remove some functions which were actually not important, so we'll settle for this. So we also played a part in cutting it down. (P9)

Similarly, the project manager in P23 told us: *It was a clear wish from management that we should finish on time and that we should not go over budget. So that was what I was very focused on. And it was also at the expense of, to the frustration of our product owner, that I had to say that we can't [include that feature]. (…) We must prioritize and we must deliver the most important.*

The participants for the projects in D_3 also provide other reasons for why they exercised disciplined control. In P9, the organization had already laid off employees that were administering the old IT system. Therefore, the new system, which did not require as many employees, had to be ready on time. In P20, the project manager did not want their project to be yet another public IT project that went over budget and schedule.

D_4: Team-Based Projects

This final configuration only contained one project. This is in stark contrast to the Team-based configuration C_4, which contained 10 projects. We decided to retain this configuration despite its small empirical basis because configurations with only one datapoint are not uncommon for small sample sizes and because retaining the configuration allows empirically contrasting the team-based approaches in our sample that were associated with budget versus schedule adherence in our sample. At the same time, we caution about the potentially limited generalizability of D_4.

Project 16, the project making up D4, had a team-based organization (prior shared experience of project members, co-location, all members of the project considering themselves to be one team) but was also underestimated. The project managed to deliver the project within the schedule without descoping, but the project went over budget. It was a technically complicated project, and the project participants were external consultants who were technically skilled but also expensive. The project manager we interviewed was hired as an external consultant to get the project back on track. They explained that their primary goal was to establish a new economic baseline for the project and to reestablish top management's trust in the project. The project manager explained: *The technical delivery itself went really well. But everything around it was out of control. So my primary task was to establish a new baseline (…) and figure out if some change requests were needed. And then shortly after, I was offered to complete the project. So, the technical part ran really, really well (…). But you know, technicians cannot walk around freely by themselves. (…) There was the distrust from the steering group, from the management layer, that things were out of control. That why I was brought in.*

From these observations, it is clear that the project relied on a team-based approach and that bringing in competent consultants and a competent project manager helped save the schedule but not the budget of the project. This suggests that the absence of disciplined budgetary control and a team approach can help increase the speed of troubled projects.

Discussion

Although the literature on IT project management has produced an impressive body of knowledge, the dominant approach in the literature remains to identify and discuss how budget and schedule adherence is caused by single factors in isolation (Lindsjørn et al. 2016) or, at most, by the interplay of two factors (Krancher 2020). We proposed that IT projects are marked by equifinality, conjunctural causation, and causal asymmetry, which do not align well with research designs that focus on single factors in isolation. Our results support these ideas in a number of ways. In line with the notion of equifinality, we find that four alternative configurations (prestigious feedback-based projects, lucky projects, disciplined projects, team-based projects) lead to budget and schedule adherence. Consistent with the notion of conjunctural causation, none of these configurations was about the effect of a single condition only. Consistent with causal asymmetry, we found that some conditions needed to be present in some configurations but absent in others. For instance, prestige projects were associated with budget and schedule adherence if accompanied by feedback processes typical for agile development. Conversely, not being a prestige project was associated with budget and schedule adherence if accompanied by disciplined budgetary control.

Hence, a key contribution of our study lies in demonstrating the configurational nature of IT projects, calling thus for future research to expand the use of configurational methods.

We also noted that most of the literature focusing on IT project efficiency does not distinguish between budget and schedule adherence (Gopal and Gosain 2010; Krancher 2020). We performed separate analyses for cost versus schedule adherence. Although the configurations predicting cost versus schedule adherence were not identical, we found similar configurations predicting both outcomes. This provides some support for the current practice of subsuming these two outcomes under project efficiency. However, we also found some interesting differences in regard to the two outcomes. In line with prior research (Nelson and Morris 2014), we found more cases of budget adherence than of schedule adherence, suggesting that it is easier for projects to be in budget than to be on time. Moreover, while we found 10 projects using a team-based strategy to achieve budget adherence, we found only one project using a team-based strategy to achieve schedule adherence. This may suggest that team-based strategies do not work well for schedule adherence.

Our research also offers implications for specific streams of IT project management research. Our findings on underestimation corroborate Flyvbjerg et al.'s assertion that estimation issues are a key source of budget overrun (Flyvbjerg et al. 2002). Our findings on prestige projects highlight that managerial behavior may depend on the prestige associated with a project (Flyvbjerg et al. 2002; Keil et al. 2000). However, going beyond existing research, we find that being a prestige project is not only a handicap. In conjunction with feedback processes, prestige projects can energize learning processes among participants and stakeholders with positive impact on both budget and schedule adherence. Our findings on disciplined budgetary control are in line with perspectives in IS project control research (Wiener et al. 2016; Wiener et al. 2019) that identify formal controls as a potential way to ensure positive project outcomes while also highlighting potentially harmful effects of disciplined budgetary control, which may not always work well together with a team-based strategy and which may detract attention from alternative performance outcomes (e.g., schedule adherence). The key role of feedback and team-based strategies in our findings speaks to the potential benefits of agile methods, which strongly rely on feedback and team structures (Baham and Hirschheim 2022; Krancher 2020) and to existing research that highlights the key role of relational processes (Dongus et al. 2015; Jørgensen 2019). Nonetheless, our results show that a more traditional project management approach centered on disciplined budgetary control can also be successful. Interestingly, while one might suspect that agile methods are more viable in the absence of disciplined project management and vice-versa, our results do not demonstrate such negative interactions. For example, our disciplined projects configurations do not make any requirements for the presence or absence of feedback and team processes. This is in line with a study finding that detailed planning and detailed requirements (a more traditional approach), when combined with agile practices, do not increase performance (Jørgensen 2019). Interestingly, although existing work suggests that the suitability of agile methods depends on the uncertainty or complexity of a project (Boehm and Turner 2003; Krancher 2020) and although we included complexity as a condition, complexity was largely absent from the configurations produced by the QCA algorithm. Specifically, our configurations do not imply that feedback-based and team-based strategies (i.e., agile strategies) are more suitable for uncertain or complex environments. In our data, it appeared that even relatively simple projects still involved sufficient challenges (e.g., due to integration, data modeling, user involvement) to benefit from agile methods. Last but not least, we note that few studies have measured descope. Although it might not surprise that descoping eases budget and schedule adherence (as implied in the traditional project triangle of time, budget, and scope), our analysis shows that it is important to include descoping as a condition. Indeed, alternative models without descoping had substantially weaker consistency values. This suggests that quantitative project management research, which rarely controls for descoping in empirical analyses (Gopal and Gosain 2010; Krancher 2020; Tiwana and Keil 2009), can strengthen its validity by controlling for descoping.

Not only these implications but also some limitations of our study provide avenues for future research. An important boundary condition of our empirical work is its public-sector context. Since the public sector has specific institutional requirements, not all findings may necessarily translate to the private sector, calling for investigations beyond public-sector settings. Another limitation lies in our configuration D_4, which included many conditions but only one case. Clearly, a higher sample size could help increase the robustness of our configurations, as it could allow reducing logical remainders in our analysis. Yet we faced a trade-off between the depth in understanding each project and the breadth of cases allowing a more robust QCA analysis. Moreover, our study limits its attention to project and schedule adherence. Future research could examine how other outcomes such as quality or business impact relate to the configurations presented here

or to other configuration. To validate and refine the configurations proposed here, future research could use some of our conditions as boundary conditions (e.g., no descoping).

Implications for practice

Our study offers at least three implications for practice. First, business or public-sector authorities are often tempted to prescribe particular practices, assuming that they are necessary for project success. However, as implied in the notion of equifinality, our study shows that there are several alternative strategies leading to budget or schedule adherence. Hence, prescribing a particular practice for all projects may not necessarily be helpful. Second, even though it is often recommended to choose between plan-based approaches and agile approaches based on the complexity or uncertainty associated with a project (Boehm and Turner 2003; Jørgensen 2019; Krancher 2020), our results indicate that the prestige associated with a project can be another important contingency factor. According to our results, managers of prestige projects are well advised to capitalize on feedback processes through short iterations and continuous customer involvement to energize learning and adjustment processes. In contrast, managers of less prestigious projects can well consider a more traditional approach focused on disciplined budgetary control, which allows projects to meet budget and schedule goals without the benefits of the attention that prestige projects receive. Third, following our results, project managers are well advised to capitalize on team-based strategies (e.g., making attempts to build high-performing teams) if budget adherence is critical, while the same approach may not work well for schedule adherence.

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