Better than you think? Exploring cost and schedule overruns in government IT projects [1]

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Abstract

Information Technology (IT) projects form an essential part of the ongoing transition towards increased digitalization in the public sector. However, many IT projects experience cost and schedule overruns, and some fail altogether. We investigated 54 completed government IT projects, completed from 2011 – 2020. We present a mixed-method inquiry into Danish government IT projects. We used archival data to examine cost and schedule overruns in these projects, using measures established by Flyvbjerg. To further inform our understanding of the various drivers that influence these projects cost and schedule overrun, we conducted a qualitative study using interviews and documents analysis. Our findings show that projects in our sample experience much lower cost and schedule overruns than those reported in previous studies. Our qualitative analysis show that projects are more likely to be completed within time and schedule when project managers actively adopt a set of practices that help these projects to perform positively. These practices are: Building one team, accommodating uncertainty, rigorous project management and capitalizing previous domain knowledge.

Keywords: Government IT projects, IT project performance, Cost overrun, Schedule overrun.

1 Introduction

The public sector is increasingly seeking to digitalize internal and external processes. The goals of these efforts include increased efficiency and effectiveness, higher user satisfaction and adherence to national and international laws [20]. This digitalization mostly occurs in the shape of information technology (IT) projects, which we – following the project management literature – define as temporary organizations established to deliver specific IT-related outcomes (e.g., implementing a new software system) [14]. However, studies show that IT projects in both the public and private sector frequently experience cost and schedule overrun or fail, partially or completely, to deliver their expected benefits [6]. This is deeply problematic, when we consider the importance of the IT projects and the amount of resources that are lost.

Significant work has been published on the empirical distributions of cost and schedule overruns in IT projects [5], but the current scientific knowledge about cost and schedule overrun in government IT projects is limited in three major ways. First, we lack current, valid evidence of government project performance. Although there is substantial evidence stemming from 1990 to 2010, it is possible that IT project performance has changed due to policy changes or to recent developments such as the agile movement. Second, while there is substantial literature on IT project failure, there

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are surprisingly few studies on the reasons for project success or failure in government IT projects. Yet government IT projects face peculiar challenges such as tendering processes and legitimacy pressure, which warrant specific attention on these projects. Third, although the literature has examined distinct performance dimensions such as effectiveness and efficiency [23], few studies have opened the black box of efficiency (i.e., why do projects achieve a particular performance?), seeking to explain why projects meet budget vs. schedule targets. We address these three gaps through the following two research questions:

RQ1: *How do government IT projects perform with regards to cost and schedule?*

RQ2: *Why do government IT projects achieve a particular performance outcome (i.e., over budget and over schedule, under budget and over schedule or under budget and under schedule)?*

We contribute to the knowledge on public sector IT projects with the results of an empirical analysis of 54 completed government IT projects based on a data submitted to the Danish Council for ICT following established guidelines and a mandated IT project model. Our data is current and sourced from reliable sources. We present an analysis of the projects' estimated and realized cost and schedule following established definitions and methods for the calculation of project cost and schedule overrun as presented by Flyvbjerg et al. [10]. In comparison to previous studies [5, 11, 18], our findings show lower average values for both cost overrun and schedule overrun. This could be an indication that organizations are becoming more mature at delivering IT projects. To deepen our understanding of why government IT projects in our sample attain a particular performance outcome, we selected six projects to investigate thoroughly using qualitative methods. The qualitative study helped providing a richer and more informed picture of the phenomena we investigating.

Our contribution extend beyond understanding the cost and schedule performance of the projects in our sample. We identified a set of practices (i.e., table 2) and conditions which influence the projects in our sample to achieve a positive cost and schedule performance. Our qualitative analysis show that building one team, accommodating uncertainty, applying rigorous project management practices, and capitalizing on previous domain knowledge enhance the ability of the projects in our sample to achieve positive cost and schedule performance. This shows focus on implementing the means by which a project can achieve a positive cost and schedule performance.

2 Background & Related Work

2.1 IT project performance

Among the most cited studies on software project performance are the Standish Groups' CHAOS reports, which have received much attention both in and outside of the academic literature. However, the CHAOS reports have been criticized [18]. For example, these critics note that the results are not consistent with other studies and the figures are influenced by political bias [18].

Moløkken and Jørgensen present a literature review of cost and schedule overrun in software projects [18]. They suggest several methodological issues with survey studies' approach to measuring software projects performance, such as "non-random samples, low response rates, and frequent use of data collection techniques (questionnaires) potentially leading to low data quality" [18]. They conclude that "Project overruns are frequent, but most projects do not suffer from major overruns. The average cost overrun reported by Standish Group's Chaos Report (89%) is not supported by other surveys. An average cost overrun of 30-40% seems to be the most common value reported"

[18]. To the best of our knowledge, the most comprehensive peer-reviewed study of IT projects performance is presented by Budzier and Flyvbjerg [5, 6, 11]. They analyzed 1,471 IT projects, of which 92% were conducted in public agencies and 83% were US-based. They found that the average cost overrun was 27%, and the average schedule overrun was 55%. They also found that one in six projects were so-called "Black Swans" with an average cost overrun of 200% and an average schedule overrun of 70%. Although their work presents a very comprehensive empirical investigation, they acknowledge the potential threat of sampling bias given that they sampled projects based on data availability. Our study focuses on process performance (or project efficiency), which is the success of the development process itself (i.e., extent to which the project was delivered on schedule and within budget) [23].

The current literature mainly presents survey, interview-based data or case studies of individual projects. We found only one study includes statistical data on project performance [22]. Taylor [22] examines the relationship between the use of public cloud infrastructure and cost and schedule overrun. Although the paper reports sample characteristics related to cost and schedule overrun, it is difficult to infer population values of cost and schedule overrun from the data due to two difficulties. First, Taylor's sample includes multiple reports on the same project, making it difficult to disentangle the final from intermediate performance of the projects. Second, the study uses metrics of cost and schedule overrun that are difficult to compare with the metrics established by Flyvbjerg and colleagues.

2.2 Factors Contributing to IT projects' performance

Our search shows little work has looked at the factors influencing process performance. But there is vast literature on the topic of "project failure" and "determinants of projects success." This literature, however, used empirical evidence from private sector failures, despite that the likelihood of failure is higher in the public sector [13].

So far, the current literature point to ineffective project management being a significant failure factor [1, 13]. However, Flyvbjerg [9] asserts that "strategic misrepresentation" is a plausible explanation for project under performing in general. He explains that projects strategically overestimate the benefits and underestimate costs when planning projects [9]. Dongus et al. literature review provides a classification of the determinants of information systems (IS) projects performance [8]. They proposed six categories of determinants: Project-related characteristics, IS team characteristics, user-related characteristics, user/IS team-related characteristics, relational processes and formal processes [8]. This review shows that there is a comprehensive understanding of what influence project performance. But we still need empirical evidence of the effectiveness of these determinants. Our work explore the relations between some of these determinants and process performance. Section 6 positions our findings vis-a-vis the literature.

3 Study Design

To investigate our research questions, we opted for a mixed-method, a combination of quantitative and qualitative studies. The underpinning rational behind this choice is to achieve "expansion" and "credibility" [7]. Expansion is a methodological quality that seeks to extend the breadth and range of inquiry and credibility is an enhancement of the integrity of findings [7].

We opted for an "explanatory" mixed-method design. Explanatory sequential studies can be used to explain or to form groups. It is best used when the study is quantitatively oriented, when there

is access to instruments, and there is an ability to reach participants. In this study a quantitative data collection period is followed by a qualitative collection period (QUAN → QUAL), which is then interpreted. A strength of the explanatory sequential study is the two-phase structure, and the straightforward method of study [7].

3.1 Phase I: Quantitative Phase

Our quantitative data is sourced from the Division for central government ICT management (the division) reporting documents. All Danish government IT projects with an estimated budget of at least 10 million DKK, and which include software development are formally required to be risk assessed by the division. These projects must submit reporting documentations, including the project initiation document, a business case, half-yearly status reports and final report upon completion to the ministry's division for Ministerial it-governance.

This data present a unique research opportunity for several reasons. First, the projects reporting documents provide current data, with all projects initiated in the period between 2011 and 2020. Second, relying on this data greatly reduces sampling bias given that reporting is mandatory for all projects above 10 million DKK. This compares favorably to other data collection approaches such as survey or analysis of archival data not stemming from mandatory reporting practices. Flyvbjerg et al. note such a potential sampling bias when acknowledging that "projects that are managed well with respect to data availability may also be managed well in other areas, resulting in better than average (i.e., non representative) performance for such projects" [12]. Third, the use of a consistent project management model and of consistent project status indicators ensure that the figures are comparable between projects. Fourth, the validity of the data is further strengthened by the authoritative character of the projects' documentation, which is compiled and agreed on by a number of stakeholders, involving factual evidence such as project expenses according to time tracking. This leads arguably to more reliable evidence than survey studies asking one key informant per project to recall project performance indicators.

Quantitative Data

Our data is comprised of 54 completed central government IT projects. These projects were completed in the period of 2011 – 2020. They have diverse scopes, including custom software development, software package implementations, hardware and software integration, and major enhancements of existing software. The projects in our sample used different project management (PM) methodology to execute the projects. Some projects used either "agile", "waterfall" or a hybrid method (i.e., a combination of "waterfall" and "agile"). We observed two procurement strategies in these projects, fixed-price or time and materials.

RQ1 aims at assessing the current levels of budget and schedule adherence. To this end, we collected the projects' reports from the division and built a database to store these projects' information for the purpose of our empirical investigation. We then surveyed the collected reports to extract the available information of budgets and schedules. For an accurate identification of cost and schedule estimates, we chose the data from the earliest point available in the project's lifecycle, because we wanted the data to be as close as possible to those presented "at the time of decision to build" [10]. Therefore, we collected data from the project's project initiation documents (PID), as first submitted to the Danish Council for ICT, rather than from the business case resubmitted to the division after the projects' risk assessment. We also collected data on the projects' realized cost and schedule from the completed projects' final reports.

We manually transferred the data to a MS Excel spreadsheet. Then, we and a representative from the division validated the data, by referring to the original project documents, the bi-annual status reports, and the division's database. Finally, we adjusted the realized costs to constant prizes, choosing the project's initiation year as a baseline, to allow for the calculation of cost overrun.

Once the raw data collection and authentication were completed,following established definitions in project management literature, we calculated the cost overrun as "actual out-turn cost minus estimated costs in percent of estimated costs" [9]. We measured the project's duration, by converting start and end times to days, and calculated schedule overrun using the same formula as for cost overrun [5]. We then calculated mean and median of cost and schedule overrun and plotted them in a scatter plot.

3.2 Phase II: Qualitative Phase

When quantitative data precedes qualitative data, the aim is to investigate with a quantitative sample and then to explore in more depth with the qualitative phase [7]. We aim at understanding the reasons for projects in our sample end up with an over/under budget and over/under schedule performance. We selected six projects based on performance to achieve a maximum variation of the phenomena in question (i.e., **RQ2**). Then, we interviewed six project managers, the individuals who managed the projects to completion and an IT department manager.

We selected the six projects such that our qualitative sample included two projects with cost and schedule overrun, two with budget and schedule underrun, and two with budget overrun and schedule underrun. There were no projects with budget underrun and schedule overrun in our quantitative sample. Our selection strategy aimed at achieving purposeful sampling [19] to include projects with diverse representation. We selected cases to represent the variety found in the whole sample of projects. For example, for quadrant 2 projects, we selected one project that used "agile" and a second project that used "waterfall model."

Qualitative Data

We opted for semi-structure interview and documents analysis for our qualitative phase. The interviews lasted around 60 minutes and generated an average of 17 pages of text each when transcribed verbatim. The interview guide is available here [2].

We analyzed 20 documents of the six projects; these include business cases, project initiation documents, project closure documents, risk assessments and recommendation letters. These documents provided us with backgrounds and additional context to the projects. This analysis entails thorough examination and interpretation of the documents' content [2]. This is an iterative process consisting of thematic analysis of the content. Two authors conducted the first iteration prior to the interviews. The purpose of this iteration is to inform the questions of our interviews. The second iteration took place after the interviews as a supplementary data to the interviews.

3.2.1 Data Analysis

We used thematic analysis to analyse our qualitative data. Thematic analysis is an analytical technique for identifying, analysing and reporting patterns (themes) within data [3]. Our analytical approach was inductive, our interpretation of the text was not based on existing theory but rather

[2]https://figshare.com/s/e0864b74138f76fe4d34

based on the meaning that emerges from the data. Braun and Clarke suggest six steps to conduct thematic analysis: (1) Familiarizing yourself with your data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes and (6) producing the report [3]. Here, we report the fundamental stages, which are (2) and (3).

To generate the initial codes, we used open coding to analyze the interviews verbatim. We used our RQ2 as a lens to qualify the codes. Using our RQ2 as an analytical lens allowed us a very tightly focused to identify relevant codes in our data. Open coding refers to the interpretive process by which raw data are systematically analyzed line-by-line searching and identifying concepts and finding relations between them. Each of the three authors conducted the initial coding separately. Then, we organized three consecutive sessions to discuss and compare our codes and come up with a final list of codes.

The open coding exercise yield a set of codes. Subsequently, we categorized the codes into categories by comparing codes to each other. This method enables us to organize and group similarly coded data into categories or families when they share similar characteristic and attributes.

4 Findings

4.0.1 Quantitative Phase

Table 1 presents descriptive statistics. The statistics on realized costs and realized duration give insights into the characteristics of our sample. Realized costs varied from 8.3 million DKK (or $1.3 million) to 138.7 million DKK ($22.0 million), with a mean of 39.6 million DKK (or $6.3 million). Realized duration varied from 1.08 to 6.25 years, with a mean of 2.29 years.

The statistics on cost and schedule overrun address **RQ1**. Cost overrun ranged from -52.3% to 168.7%, with a mean of 9.3% and a median of -1.3%. Schedule overrun ranged from -15.0% to 214.0%, with a mean of 31.1% and a median of 14.6%. The differences between mean and median are due to positive schew, which was 1.73 for cost overrun and 2.27 for schedule overrun.

Table 1: Descriptive Statistics

Variable	**Mean**	**Median**	**Std. Dev.**	**[Min; Max]**	**Skewness**
Realized costs (in million DKK)	39.6	31.8	30.0	[8.3; 138.7]	1.67
Realized duration (in years)	2.29	2.52	1.37	[1.08; 6.25]	0.64
Cost overrun (in %)	9.3	-1.3	45.4	[-52.3; 168.7]	1.73
Schedule over-run (in %)	31.1	14.6	43.9	[-15.0; 214.0]	2.27

Figure 1 visualizes cost and schedule overrun by means of a scatter plot, which is divided into four quadrants based on positive versus negative cost and schedule overrun. Twenty-four projects had positive budget and schedule overruns (Quadrant 1), with a few projects exceeding the planned budget and schedule by more than 100%. Twenty projects went under budget but over schedule (Quadrant 2). Three projects remained both under budget and under schedule (Quadrant 3). No project in our sample went over budget but under schedule. Seven projects do not fit into any of the quadrants because they were exactly on schedule.

4.0.2 Qualitative Phase

Recall that, for **RQ2**, we asked why the projects in our sample end up in a particular quadrant. In response to this question, our analysis indicates that the main drivers, experienced by our

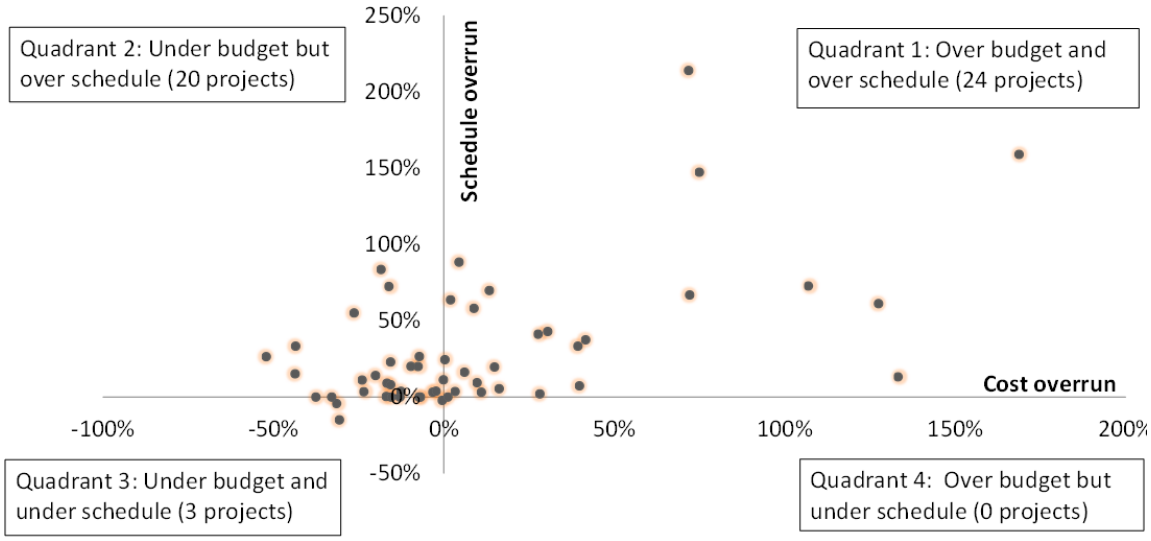

Figure 1: Scatter plot of cost and schedule overrun

participants, for projects in our sample to conclude with a positive efficiency (quadrant 2 or 3) is the adoption and implementation of some project management practices. These practices sway the projects toward a positive efficiency when adopted and fostered. Projects in quadrant 1 did not achieve a positive efficiency not for lack of trying, but mostly because they lacked the application of these practices and experienced conditions that influenced the efficiency negatively. Table 2 list the practices and the conditions we observed in our data. The plus sign (+) indicates the adoption of the practice by the projects in the relevant quadrant. The minus sign (-) shows either the practice was not adopted or simply it was not possible due to project's circumstances. We also observed a condition which is an occurrence of something, mainly scope change that either influence the performance positively (when the scope is reduced) or negatively (when the scope increases).

The difference between practices and conditions, in our data, is that practices are the application or use of ideas or methods to enhance the ability of the project to achieve a positive efficiency. We observed that project managers are actively taking the necessary actions to implement these practices. Conversely, conditions are the occurrence of something not within the control of the project. In this section, we will report and discuss these practices and conditions.

Table 2: Overview of the practices and conditions influencing project's performance

Practices & conditions influencing performance	**Quadrant #1**	**Quadrant #2**	**Quadrant #3**
Practices			
Building One Team	-	+	+
Accommodating Uncertainty	-	+	+
Rigorous Project Management	-	+	+
Capitalizing previous domain knowledge	-		+
Condition			
Scope change	-	+	

Building One Team The focus on building an effective team and creating an environment that stimulate collaboration is highly visible in our interviews data. Projects, in quadrant 1 & 2, invested

in building a team, which eventually has paid off. While various characteristics can lead to effective teams, we observed an emphasis on establishing a unified and consolidated team from the inception of the project. Project managers have taken effective actions to create collaborative teams.

Collaboration enhanced the chances of the projects' teams in quadrant 2 and 3 to achieve a positive efficiency. These projects demonstrated high levels of collaborative behavior despite their complexity. Some of these projects have taken the extra step to collocate with the vendor to create a unified team atmosphere and a feeling of togetherness. This project manager explains: *"So quite specifically on this project, at [the name of the project] we have a supplier, it is [the name of the supplier] at this time, we sit with them physically, we can, have the opportunity to sit with them, so that is, where we sit and can work with them, as one now works with colleagues, and it does with such a project, especially when it becomes intensive, that it becomes incredibly effective, because clarifications can be made a lot quickly."* When team's members work together openly, processes and goals become more aligned, leading the team towards achieving positive efficiency.

We also observed that lack of collaboration undermine achieving positive efficiency. Projects in quadrant 1 struggled to create a highly collaborative environment. For example, one project in quadrant 1 experienced a troubled relationship with the vendor. Eventually, they were unable to establish a one team environment. The project manager described it as being *"two very very different cultures."* The project selected an American vendor for a niche product. During the project execution, the relationship unfolded with problems and difficulties. The parties were not able to establish trust and each one deployed a rather divergent method to run their respective side of the project. While the American vendor used an "agile" method, the Danish counterpart had preference for a sequential and gated phases approach, described by the project manager as "waterfall." The project manager explains: *"So you have such a totally agile secret organization that does projects that way and then you get that complete waterfall model in the other side, and they do not fold together very well, you could say. There are a lot of problems in it."* These conditions were unfavorable for swaying the project to achieve a positive performance. The project manager concludes: *"So, well, it [cultural and PM methodologies differences] do not provide completely optimal conditions."*

Collocating the project team in the same physical location is a measure taken by some project managers to enhance the collaborative aspects of the one team approach. A project manager explains: *"In general, I think it is our experience, it is that sitting together works really well, because you can just make these clarifications quite quickly, which would otherwise require some writing or you have to time that one can meet at certain times."*

Accommodating uncertainty All six projects, have experienced some level of uncertainty at the time of estimation and planning. But, those who managed to accommodated it in their planning where successful at achieving a positive efficiency. Our data shows that these projects faced uncertainty in the level of business needs. We define uncertainty of business needs, as it appears in our data, as a potential deficiency in business needs at the time of the estimation has taken place, which can be characterised as inaccurate, unknown or unreliable. This condition triggers a behavior to safeguard the project from going over budget and over schedule. This takes place by generously estimating the budget and schedule. This project manager stated: *"We had an expectation that it would be quite expensive. So therefore it has been budgeted quite high."*

We observed that neglecting this type of uncertainty undermines achieving a positive efficiency for projects in quadrant 1. Projects in quadrant 1 did not know how to accommodate uncertainty or it was simply not possible. Uncertainty of business needs, in both cases, stemmed from the newness and originality of what was wanted by the business stakeholders. Subsequently, this condition

has affected the project's ability to accurately estimate the budget, which inherently led to an over budget performance when it is not accommodated and an under budget performance when accommodated. This project manager explains: *"So the deviation [from estimated budget] is not because we estimated poorly, it was because it was not possible."* Another project manager described the state of business need at the start of the project as *"totally unknown."*

Rigorous project management Projects in quadrant 2 and 3 had high commitment to rigorous project management practices. These are mainly tracking the budget and the schedule rigorously. This has taken place in the procedures put in place and also by assuming accountability for the budget and schedule expectations by the project managers. This project manager explains that the organization had a robust tracking mechanisms in place, which have helped the project. He said: *"I was very much on the financial management of it ... We kept track of the supplier and the finances and that things, the schedules ... So it has been a lot of finances, supplier management, following up that things were reached on time."* Another project manager implied accountability, when he was asked about the project perspective on budget. He said: *"... Of course we should look at the budget and in particular the Ministry of Finance, there is rarely enough money ... which is such a stricter duty, that we must try to stay within the framework, so of course there was focus on the budget."* We also observed that projects in quadrant 2 and 3 had better stakeholders engagement. This project manager stated that he invested rigorous effort to ensure the involvement of key stakeholders. He said: *"We fought hard for our [name of department] and our [name of a second department] to take responsibility for coming and saying that what we were now trying to propose, also it was what they want, tried to get them involved in these projects."*

Capitalizing previous domain knowledge Some project managers capitalized on their teams' knowledge and experience of the business domain, from previous projects, to get a positive outcome. This is the only practice that we observe present in quadrant 3 but not in 2. However, we do not contribute the positive performance in quadrant 3 solely to this practice. It is the combination of establishing and fostering a one team approach, accommodating uncertainty, and adopting rigorous project management practices.

Domain knowledge, as talked about in our interviews, points to the comprehension and understanding of the inner workings, processes, procedures and other key aspects of a business. Both projects in quadrant 3 have shown intimate knowledge of the business domain. Both teams have worked previously with the same organizations to deliver similar projects. They became effective at learning the business domains and able to translate that knowledge to understand business needs. This project manager explains: *"So there we had quite of dirt under our nails and knowledge of what is being demanded at institutions, where are the issues, what is what can be difficult, so there we were flagged into the team that owns the systems and had to run the re-tender, where we helped to specify requirements, and part of the requirements specification then runs over to make or have discussed, how to make an implementation plan..."*

Scope change Scope change can have either a favorable or unfavorable effect on efficiency. When a project in our sample experienced a scope increase, then the effect on its efficiency was negative. However, a scope reduction has helped a project in quadrant 2 to achieve a positive efficiency.

One project in quadrant 2 has benefited from this condition, which was translated to a lower expenditure and eventually to an under budget performance. Projects in quadrant 1 have experienced a scope increase. This unfavorable condition is a manifestation of the uncertainty of the business

needs. When the business needs exhibit unknowns, it is anticipated for the project to experience scope increases. This project manager explains: *"I would think that the scope changes are the primary ones. We have taken in things that we did not have in the beginning. And then there are also in some areas that we have been surprised at how much storage [storage requirements for the data]."*

In conclusion, the projects in our sample ended up in **quadrant 1**, mainly for their inability to handle the uncertainty of the business needs at the time of estimation. This condition had a subsequent effect on increasing the scope. Quadrant 1 projects also failed to create a highly collaborative environment, which has created sub-optimal conditions to achieve a positive efficiency. Projects in **quadrant 2 & 3** have invested on establishing a one team approach and had strong awareness of the uncertainty of the business needs, which they accommodated for. In addition, these projects followed rigorous project management practices. The distinguishing practice, that helped projects ending up in **quadrant 3**, is the teams ability to capitalize previous knowledge of the business domain. This quality has helped the teams to understand the business needs and mitigate potential uncertainties.

5 Limitations & Threats to Validity

We acknowledge the limitation presented by the size of our qualitative phase sample. We selected only six projects for the qualitative phase. However, our objective is not to reach saturation of coding but to explore and support our quantitative results. This limitation may have led to the identification of fewer practices than it should be or what is universally used in the broader spectrum of IT projects in order to achieve a positive performance.

A possible external threat to validity is the coverage of our sample. Our sample is limited to Danish government IT projects, with a minimum budget of 10 million DKK, completed in the period 2011 – 2020, and which have been reported to the Division for central government ICT management. This implies that we can not generalize our findings beyond our sample. This does not undermine our findings by all means. We contribute to IT projects performance literature by using a reliable and valid data.

This study's threats to internal validity is the budget size of the projects in our sample and the representation of Danish government IT projects in our sample. Our sample represent large projects. Smaller IT projects tend to perform slightly better than larger IT projects [8]. This may have influenced the quantitative analysis toward a higher cost and schedule overruns. Another threat to internal validity is the projects in our sample are not a true representation of Danish public sector IT projects. The Division for central government ICT management itself has acknowledged the problem that not all eligible IT projects are reported to them. For instance, a government organization might split an IT project into several smaller projects with a budget below 10 million DKK to avoid reporting to the Danish Council for ICT.

6 Discussion & Conclusions

The conclusion we draw from these findings is that when comparing our results to previous studies [5, 11, 18], we find that our sample show lower average values for both cost overrun and schedule overrun. This finding demonstrates a positive shift in IT projects performance. Informed by the observations we made in the qualitative phase of this study, we can safely conclude that at least the

projects in our sample have shown a noticeable maturity in delivering IT projects. Project managers have actively taken actions to implement practices to help them achieve a positive efficiency.

We also find that our sample defies the long held claim that cost and schedule overrun are mutually inclusive. This mutuality is not always true. Our analysis shows that projects in our sample managed to achieve a budget underrun but not a schedule overrun. Studies have often suggested close correlations between schedule and cost overruns. Few studies (e.g., [16]) advise that this correlation does not necessarily mean causality. Various factors may contribute to driving the schedule overrun, but not always mean a cost overrun. This relationship is underexplored in IT projects management. Our finding suggests that the assumed mutuality is questionable and the relation between the the cost and schedule outcomes warrant further investigation.

Traditionally, the literature of project management has been preoccupied with project performance as an end state without providing the context, i.e., why projects end up with a budget and schedule overrun or underrun. Our qualitative analysis indicates that when projects actively adopt practices (Tbl. 2) to strengthen their delivery capability, they may achieve a positive efficiency. Except for rigorous project management, the other practices fit within the broader grouping of human factors. This has been pointed out previously by Mohagheghi and Jørgensen [17]. They studied the success factors in Norwegian public IT projects and they suggest that "success factors tend to focus on human factors, e.g., involvement, competence and collaboration." In the remaining of this section we discuss the practices, we identified in our study, in light of previous literature on the topics and we draw conclusions.

It is interesting to see project managers paying attention to building one team to achieve a positive efficiency. This quality has been accentuated in previous work in many occasions (e.g., [15]). There is significant work available on the topic of building a successful team. Several "determinants" have been proposed to build a successful team, such as communication, empowerment, commitment, cohesiveness, etc. The particularity of our finding is the unified team approach adopted by the studied projects. Government IT projects rely on outsourcing procurement models to deliver the business needs. This usually implies engaging a party outside the public sector to perform services and create products. Sometimes both parties have no prior history of working together. To mitigate the unfamiliarity and the unknown state of each other's, project managers take actions to unify the parties involved to create one team atmosphere to deliver the project. Collaboration does not imply only working closely with the supplier but also engaging and involving closely the business stakeholders. Mohagheghi and Jørgensen [**?**] report that "involving stakeholders" was an important success factor in their sample.

Our findings show that the projects we investigated experienced uncertainty on the business needs at the time of estimation and planning. Managing requirements uncertainty has received attention from researchers in the software engineering research (e.g., [21]). However, this literature still lacking concrete advice and strategies for project managers to accommodate requirements uncertainty during the estimation of the budget. For budget estimation at the planning phase, Flyvbjerg and colleagues [10, 9] suggest strategies for accommodating uncertainty by allowing for risk buffers, but there is little empirical evidence about the use of these strategies. Our data show that these strategies can indeed help to avoid cost overrun. Our finding suggests that project managers provide estimate that is more than its actual estimate of completion because they include some allowances for uncertainties of business needs.

The literature of projects failure has pointed out project management issues as a key factors for decades (e.g., [1]). Some of the issues we found in the literature are underestimate of timeline; weak definitions of requirements and scope; inefficient risk analysis and management; unsuccessful

monitoring and measurement. Our findings show that rigorous project management practices help projects to achieve a positive performance. But, more specifically the strong awareness of the need to monitor the budget and being accountable for it.

The importance of knowledge retention and transfer in project-based environment has been emphasised in the literature (e.g., [4]). Knowledge management in IT projects has some challenges, this is mainly because of the one-off nature of the work and the discontinuities in methods of organisation and flows of personnel, materials and information [4]. Our findings show that project managers have become aware of this problem. Some of the projects we investigated have taken actions to re-use teams from previous projects within the same organization to capitalize on their accumulated knowledge.

Overall, the analysis of our sample data does not show a gloomy picture of the state of Danish public IT projects performance. Our descriptive statistics values for both cost overrun and schedule overrun are relatively lower than what has been reported previously in the literature. Our qualitative analysis demonstrates that project managers are actively pursuing the implementation of particular practices to achieve positive efficiency.

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References

[1] L. Anthopoulos, C. G. Reddick, I. Giannakidou, and N. Mavridis. Why e-government projects fail? an analysis of the healthcare. gov website. *Government Information Quarterly*, 33(1):1, 2016.

[2] G. A. Bowen. Document analysis as a qualitative research method. *Qualitative research journal*, 2009.

[3] V. Braun and V. Clarke. Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 2006.

[4] M. Bresnen, L. Edelman, S. Newell, H. Scarbrough, and J. Swan. Social practices and the management of knowledge in project environments. *International journal of project management*, 21(3), 2003.

[5] A. Budzier. *Theorizing outliers: explaining variation in IT project performance*. PhD thesis, Oxford University, UK, 2014.

[6] A. Budzier and B. Flyvbjerg. Double whammy–how ict projects are fooled by randomness and screwed by political intent. 2011.

[7] J. W. Creswell and V. L. P. Clark. *Designing and conducting mixed methods research*. Sage publications, 2017.

[8] K. Dongus, S. Ebert, M. Schermann, and H. Krcmar. What determines information systems project performance? a narrative review and meta-analysis. In *2015 48th Hawaii International Conference on System Sciences*. IEEE, 2015.

[9] B. Flyvbjerg. Policy and planning for large-infrastructure projects: problems, causes, cures. *Environment and Planning B: planning and design*, 34(4), 2007.

[10] B. Flyvbjerg, A. Ansar, A. Budzier, S. Buhl, C. Cantarelli, M. Garbuio, C. Glenting, M. S. Holm, D. Lovallo, D. Lunn, et al. Five things you should know about cost overrun. *Transportation Research Part A: Policy and Practice*, 118, 2018.

[11] B. Flyvbjerg and A. Budzier. Why your it project might be riskier than you think. *Harvard Business Review*, 2013.

[12] B. Flyvbjerg, M. S. Holm, and S. Buhl. Underestimating costs in public works projects: Error or lie? *Journal of the American planning association*, 68(3), 2002.

[13] R. Gauld. Public sector information system project failures: Lessons from a new zealand hospital organization. *Government information quarterly*, 24(1), 2007.

[14] S. Jenner. *Transforming government and public services: realising benefits through project portfolio management*. CRC Press, 2016.

[15] F. T. Jetu and R. Riedl. Determinants of information systems and information technology project team success: A literature review and a conceptual model. *Communications of the Association for Information Systems*, 30(1), 2012.

[16] W. Majerowicz and S. A. Shinn. Schedule matters: Understanding the relationship between schedule delays and costs on overruns. In *Aerospace Conference*. IEEE, 2016.

[17] P. Mohagheghi and M. Jørgensen. What contributes to the success of it projects? success factors, challenges and lessons learned from an empirical study of software projects in the norwegian public sector. In *2017 IEEE/ACM 39th International Conference on Software Engineering Companion*. IEEE, 2017.

[18] K. Moløkken and M. Jørgensen. A review of software surveys on software effort estimation. In *ESEM*. IEEE, 2003.

[19] L. A. Palinkas, S. M. Horwitz, C. A. Green, J. P. Wisdom, N. Duan, and K. Hoagwood. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research*, 42(5), 2015.

[20] J. Rose, J. S. Persson, L. T. Heeager, and Z. Irani. Managing e-government: value positions and relationships. *Information Systems Journal*, 25(5), 2015.

[21] A. Sillitti, M. Ceschi, B. Russo, and G. Succi. Managing uncertainty in requirements: a survey in documentation-driven and agile companies. In *11th International Software Metrics Symposium*. IEEE, 2005.

[22] J. Taylor. Going public: Using the cloud to improve project delivery. *Information Systems Management*, 34(2), 2017.

[23] L. Wallace, M. Keil, and A. Rai. How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model. *Decision sciences*, 35(2), 2004.