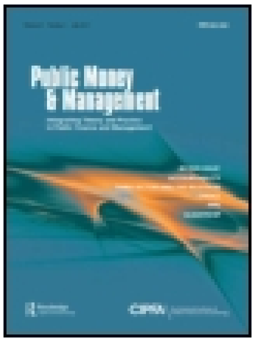

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Do public–private partnerships achieve better time and cost performance than regular contracts?

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ABSTRACT
Infrastructure development with public–private partnership (PPP) contracts has been claimed to lead to better performance compared to regular contracts. However, the empirical evidence for this claim is weak. The authors assessed the difference in the actual performance of Dutch infrastructure PPP projects (design–build–finance–maintain: DBFM) compared to regularly procured projects (design-and-construct: D&C). DBFM projects demonstrated significantly better cost performance.

IMPACT
Public–private partnerships (PPPs) have been widely used for the development and management of transport infrastructure, such as highways, railways, and waterways. However, hard evidence that PPPs perform better than regularly procured projects is lacking. Existing evidence tends to rely on anecdotal and perceptual data. This paper provides policy-makers and managers with real information about the actual performance and benefits of PPPs.

KEYWORDS
Cost performance; design–build–finance–maintain (DBFM); design-and-construct (D&C); principal–agent relationships; public–private partnerships (PPPs); The Netherlands; time performance; transport infrastructure projects

Introduction

Public–private partnerships (PPPs) are popular, particularly for the development and management of transport infrastructure (for example Little, 2011). In Europe, transport is the largest PPP sector in value terms (European PPP Expertise Centre, 2018). Core motivations to opt for PPPs have been off-balance sheet financing of infrastructure projects, the transfer of risks to the private sector, and increasing the efficiency and effectiveness of infrastructure development and management (McQuaid & Scherrer, 2010; European PPP Expertise Centre, 2015). These advantages are claimed to be the result of PPP projects having strong inbuilt mechanisms that reduce principal–agent problems.

However, recent events in the construction sector have fuelled a debate about the future of PPPs, especially that of the long-term infrastructure contracts that are characterized by the transfer of many risks to the private sector, including private financing. For instance, following the bankruptcy of the British construction company Carillion, said to be caused by the complex and inflexible nature of the contracts and the excessive risks for the companies, and resulting in poor value for money, the UK stopped signing new private finance initiative contracts (Davies, 2018; GCR, 2018). In The Netherlands, in the wake of financial problems at the construction company Ballast Nedam, and because of the perceived poor financial health of and disappointing level of innovation from the construction sector (for example Koenen, 2018), the Ministry of Infrastructure and Water Management is working on a new PPP approach (Rijkswaterstaat, 2019).

PPP scholars have observed that the evidence for PPPs performing better than regularly procured projects has been mixed (Hodge & Greve, 2017), arguing that it is important that PPPs are studied and assessed 'away from the policy cheerleaders' (Hodge & Greve, 2007, p. 545). There are several reasons for the weak evidence base:

- PPP research has been dominated by single case studies (Tang et al., 2010; Bovaird, 2010).
- Quantitative research on the impact of contractual forms (or organizational forms) on the performance of PPPs has often been based on surveys among project participants, generally project managers (for example Clifton & Duffield, 2006; Klijn & Koppenjan, 2016; Kort & Klijn, 2011; Steijn et al., 2011; Warsen et al., 2018). Analyses are often based on perceptual performance data and have not included more objective measures of performance, such as financial data or time delays.
- The outcomes of PPP projects are often evaluated ex ante, using methods such as the public sector comparator (for example Boardman & Hellowell, 2017). For instance, the Dutch Ministry of Finance estimates that design–build–finance–maintain–operate (DBFMO) projects (a type of PPP), compared to traditionally procured projects as defined by the public sector comparator, achieve

prospected cost advantages—in terms of value for money—ranging from 10 to 15% (Ministerie van Financiën, 2016). A shortcoming of such studies is, however, that they often tend to focus on forecast outcomes, with the consequence that it remains largely unclear whether the outcomes actually materialize (Boers et al., 2013). For instance, low bids on contracts may evaporate due to contract changes during project construction (Mohamed et al., 2011).

More research is needed, in our view, on the difference in performance between PPP projects and non-PPP projects. This paper addresses this research gap.

We analysed the cost and time performance of 65 Dutch transportation infrastructure projects. Our data concern actual performance in the implementation phases of the projects (i.e. after the shovel has hit the ground). Our analysis focuses on the comparison between projects with a design–build–finance–maintain (DBFM) contract and projects with a design-and-construct (D&C) contract. Although both types involve contract designs where the private partner is integrally responsible for the design and construction of the transport infrastructure, DBFM is generally considered to be a PPP, whereas D&C is not (Yescombe, 2007). The reason is that private project financing, an essential element of PPPs, is present in DBFM but not in D&C. Although a D&C contract can be a subcontract in a DBFM project, they are generally not considered PPPs on their own (Yescombe, 2007).

In the next section, we develop a set of hypotheses, rooted in principal–agent theory, arguing why DBFM should perform better in terms of cost and time performance than D&C. This theory provides a useful lens for the present study, because DBFM projects involve typical principal–agent relationships (Klijn, 2010). The reason is that both principal–agent relationships and public–private relationships in transport infrastructure projects are characterized by a separation of ownership of the infrastructure and the right to maintain and operate it; information asymmetry between the public and private actors; different interests; and uncertainty due to the long life span of the relationship (Liu et al., 2016).

Hypotheses

Background: principal–agent problems

A major motivation to opt for a PPP in the development and management of transport infrastructure is the transfer of project risks to the private sector. The idea is that, by involving the private sector, project risks previously carried by the government are now allocated to a private partner, under the assumption that the private sector is better able to manage those risks. The public and private sectors are governed by different value systems—they have fundamentally different perspectives, interests, goals, and practices (Jacobs, 1992)—and these differences can lead to positive synergies, resulting in increased project quality and efficiency (Huxham & Vangen, 2000).

However, the increased involvement of the private sector also adds risks associated with the contractual arrangement between the public and private partners (De Palma et al., 2009). The differences between the public and private sectors can also lead to negative outcomes when the partners choose to pursue their self-interests at the expense of the shared project interests (De Palma et al., 2009). Whereas the public sector serves the public interest, a private partner strives to maximize its profits (De Bettignies & Ross, 2010). This, then, concerns the principal–agent problem in PPPs: where the involvement of the private sector 'offsets procurer cost burdens, it also puts the private partner in significant control of the whole project, inviting actions that siphon off benefits to themselves at the cost of the procurer, whose interests they are supposed to serve' (Shrestha & Martek, 2015).

The private partner (the agent) is able to serve their self-interests at the expense of the public partner's (the principal) interests because their relationship is characterized by an asymmetry of information, where the agent is better informed than the principal (De Palma et al., 2009; Shrestha & Martek, 2015). First, the private partner has more information about their own competences and skills. This may lead to the problem of 'adverse selection' by the public partner (pre-contract), where an agent that is not the best one for the project is chosen (Shrestha & Martek, 2015). Second, the private partner has more information about the project's internal and external risks (De Palma et al., 2009). This may lead the agent to act opportunistically by deliberately misrepresenting the risks and the measures required to mitigate them (Liu et al., 2016; Fernandez et al., 2018). This is referred to as a 'moral hazard' (Shrestha & Martek, 2015). An example is contractors falsely claiming additional costs after a project has started (Mohamed et al., 2011).

Principal–agent theories explore the governance mechanisms that aim to regulate the self-serving behaviour of the agent (Bovaird, 2010). For PPPs, these mechanisms focus on contract specifications, monitoring the agent's performance, and the performance-dependent payment (De Palma et al., 2009; Leruth, 2012; Reynaers, 2015). First, transaction costs theory states that contracts should be as complete, stable, and fully specified as possible, but that there are limits to this and too much contract complexity may decrease the performance of PPPs

(Klijn & Koppenjan, 2016; Williamson, 2002). Contract stability and specificity decrease uncertainty and project information asymmetry between the partners, thus curtailing the problem of moral hazard. At the same time, a certain extent of 'incompleteness' is unavoidable as actors cannot anticipate everything that will happen (Williamson, 2002). Incompleteness may also be needed, under the assumption that this allows the private partner to fully use their competences and skills to innovate and to plan and design a project (Reynaers, 2015). If the contract is fully specified, these competences and skills are underused. Moreover, a certain degree of contract flexibility may also allow incorporating possible contract changes (Demirel et al., 2017). This can reduce the possibility of moral hazards, resulting in less claims that would otherwise have led to additional costs (Fernandez et al., 2018). Second, however, according to principal–agent theory, contract incompleteness requires monitoring of the agent's behaviour, increasing the public partner's information about the agent's competences, skills, and performance. This can curtail the problem of adverse selection. To this end, it is important that the output indicators in the contract are measurable and that the public partner has access to performance data (De Palma et al., 2009). Because extensive contract monitoring generally leads to increased transaction costs (Carbonara et al., 2016), in PPP projects the principal often 'monitors from a distance' using, for example, system-oriented contract management (Rijkswaterstaat, 2014). Third, performance-dependent payment means that the private partner is financially fined (or rewarded) by the principal based on their performance, which incentivizes them to perform well: 'credible punishment' (De Palma et al., 2009). These mechanisms may be found in both DBFM and D&C contracts: our next two subsections therefore focus on specific differences between the two contract types.

DBFM versus D&C: cost performance

In D&C contracts, the risks associated with designing and building (construction) infrastructures are transferred to the private sector; in DBFM, additionally, the maintenance risks are also transferred (Culp, 2011). It has been argued that transferring as much risk as possible leads to efficiency gains—the bundling of design and build with maintenance leads to better designs that will minimize maintenance costs (Martimort & Pouyet, 2008; Moore et al., 2017). Because improved designs may require learning new procedures for project construction and maintenance that may actually increase costs (Martimort & Pouyet, 2008), we expect to find DBFM contracts mainly in larger projects.

In both D&C and DBFM, the ownership of the infrastructure in the end remains with the public partner who pays for the project design, construction and, in the case of DBFM, maintenance as well. However, in DBFM, the project activities are (at least in part) privately financed (Culp, 2011). A special purpose vehicle (SPV) is set up in which the contractors are the shareholders, sometimes supplemented with infrastructure investors (Grimsey & Lewis, 2004). The SPV uses contracts secondary to the concession contract (i.e. the public–private contract), to finance the project through (short- and long-term) loans with financiers such as banks and with subcontracts for the design, build, and maintenance of the project (Ng & Loosemore, 2007; Demirag et al., 2011).

Because governments have clear financing cost advantages over private consortia (governments can normally borrow money at lower interest rates) (Leruth, 2012; Moore et al., 2017), we expected to find DBFM contracts mainly in larger projects. DBFM requires a certain project size to be a viable option. In The Netherlands, DBFM is thus normally only considered for projects worth over 60 million euro (Ministerie van Financiën, 2013). There are several reasons why the private financing in DBFM is expected to lead to better cost performance.

First, in DBFM, risks related to design, construction, and maintenance are allocated to the private partner (De Palma et al., 2009). Therefore, unplanned additional work may have to be financed by the private partner. The private financing of the additional work increases uncertainty—'will the financiers provide the loan?'—and transaction costs for the private partner. The private partner will therefore try to minimize any additional work that would lead to increased costs. The business model in DBFM focuses on finding innovative and efficient solutions through integrated project designs and processes and life-cycle optimization (Lenferink et al., 2013). In D&C contracts, in contrast, additional work is not privately financed. This means that the uncertainty and transaction costs associated with privately financing additional work are absent. Instead, claiming additional work at the expense of the public partner may increase the private partner's revenue and potentially their profit.

Second, the equity provider in DBFM, who finances the activities of the private consortium, is expected to provide 'an added level of diligence for effective project execution' (Culp, 2011, p. 237). Financiers are risk-averse and they will place high demands on sound, high-quality risk management for them to provide the loans and invest in the project (Demirag et al., 2011). The idea is that this leads to a better identification, allocation, and mitigation of risks. Practitioners sometimes refer to this effect of private financing on risk management as 'the shadow of the banks'. The assumed improved risk management decreases uncertainty and risks, leading to less additional work hence costs. It also means that the private partner is forced to explicate their risk management plan during the tendering phase of the project, explicating its risk management competences and skills, thereby decreasing the problem of adverse selection. The possibility of the effect of the shadow of the banks is absent in projects with a D&C contract. Because of these two reasons elaborated here, our first hypothesis is:

> *H1: DBFM projects have better cost performance (i.e. less additional work costs) than D&C projects.*

DBFM versus D&C: time performance

Performance-dependent payment is an essential element of PPP projects. In many DBFM projects, the private partner finances the project and receives payments from the public partner only when the project is fully constructed (Culp, 2011). However, there can be additional project milestones when the private partner receives a payment. When the construction phase is finished and the transport infrastructure is in full use, the SPV can continue to receive a stream of payments from the public partner for infrastructure maintenance for a period of around 20–30 years (Yescombe, 2007). Importantly, the private partner's revenue structure is highly dependent on the payment stream from the public partner (Ng & Loosemore, 2007). When the private partner fails to comply with the output specifications agreed in the contract, they can be fined and their payments reduced (Demirag et al., 2011). Moreover, when the private partner fails to meet important milestones (deadlines) agreed with the public partner, they can be fined or their payments delayed. Because the project financing consists of multiple short- and long-term loans, the private partner might not be able to meet their debt service obligations. This will have a negative effect on the private partner's credit rating and their profits may decrease (Ng & Loosemore, 2007).

The bundling of the design, build, and operating stages of projects, as well as the transfer of risks, can thus enhance the speed of the project: 'the transfer of construction and operating risks to private contractors incentivizes speedy completion of projects as revenues for the private sector depend on satisfactory completion and ongoing availability of the asset' (O'Shea et al., 2019, p. 250). Although the literature shows that performance-dependent payment is not always consistently applied in Dutch DBFM projects (see Reynaers, 2015), the D&C contracts business model relies to a much lesser extent on meeting deadlines. The evidence may be somewhat mixed, but 'the main theoretical and empirical literature supports the proposition that PPP results in faster delivery of projects' (O'Shea et al., 2019, p. 250). Therefore, our second hypothesis is:

> *H2: DBFM projects have better time performance (i.e. less delay in finishing project construction) than D&C projects.*

Data and method

Data collection

The data were collected between April and July 2018 from the project database of Rijkswaterstaat. Rijkswaterstaat is an executive agency of the Dutch Ministry of Infrastructure and Water Management and it is the major procurer of highway and waterway transport infrastructure in The Netherlands. Access to the data was allowed so long as it was anonymized and that the research results would not be traceable to specific projects or persons. After the analyses were performed, practitioner views on the results were collected during a meeting at the Procurement Centre for Civil Engineering in Rijkswaterstaat, discussing the findings and the implications for public procurers.

The database contained a total of 298 highway projects. After deleting cases that were not infrastructure projects, i.e. projects that did not include infrastructure construction and instead concerned programmes, small measures such as road signage placements or sound barriers, and innovation projects, among other things (173 projects), and that were devoid of data (59 projects), a total of 66 highway projects remained (i.e. construction of roads, tunnel, and bridges). Finally, one project was excluded because it was a 'calamity' project that had not gone through a normal procurement and decision-making process. A total of 65 projects was selected.

Some of the projects were missing some data, leading to a different *N* for different analyses in this paper. Nine projects had a DBFM contract (14%) and 56 projects had a D&C contract (86%). The oldest project by implementation start commenced in February 2008 and the most recent project by implementation start commenced in April 2017. Because DBFM only started to really take off in The Netherlands after 2007 (Eversdijk & Korsten, 2015), because D&C is the standard form of contracting by Rijkswaterstaat (Lenferink et al., 2013), and because DBFM is only considered for large or very large projects, this explains the larger share of D&C contracts in the dataset and the relatively small number of DBFM contracts.

Data measurement and analysis

The analyses focused on four variables: cost performance in euro, time performance, contract type, and project size. *Cost performance* was measured as: the value in euro of the sum of the additional work costs after the end of the D&C/DBFM contract(s), divided by the value of the contract(s), resulting in a percentage. Some projects involved multiple contracts (hence the plural). As an example, one project with a contract value of approximately 1.4 billion euro and additional work with costs of approximately 170 million euro had a cost performance of 12.14%. Higher percentages indicate higher additional work costs and thus a lower cost performance.

Time performance was measured as the number of days between the start of the implementation phase and the full recommissioning of the infrastructure after completion of the construction works (i.e. the infrastructure is back in full use). For D&C contracts, the start of the implementation phase was marked by the milestone 'shovel in the ground' in the project database. For DBFM contracts, it was marked by the 'date of commencement', i.e. when the private partner received their starting certification. By subtracting the actual length from the planned length of the implementation phase, we found the implementation delay in terms of days. As an example, one project's implementation started on 25 April 2011 and the infrastructure was fully recommissioned on 29 April 2016. The actual length of the implementation phase was therefore 1804 days. Because the recommissioning was planned on 1 December 2015 (i.e. a planned implementation phase of 1656 days), the delay was 148 days. Dividing this delay by the planned implementation duration (i.e. 148/1656), gives a time performance of 8.94%. Higher percentages express higher time overruns and thus a lower performance.

We calculated the relative time performance for different moments in time. First, we calculated the time performance for the recommissioning date as planned when the contract was awarded. We called this the 'relative time performance T = 0'. Over the duration of implementation, however, scope changes can lead to an adjustment of the planned recommissioning date (Verweij et al., 2015). Second, we calculated the time performance for the recommissioning date in March 2018: 'relative time performance 2018-T1'.

Contract type was a nominal variable: D&C or DBFM. DBFM contracts are mainly found in larger projects; therefore we also included project size as a variable. Project size was measured as the value of the contract(s) of the project at the moment of contract closure, i.e. the initial contract value of the project. We performed analyses for three different sets. In the first 'all-inclusive set', project size was not accounted for and the full group of 56 D&C projects was compared to the full group of nine DBFM projects. In the second 'Rijkswaterstaat policy set', only projects above 60 million euro were compared. The logic behind this set was that DBFM is normally only considered for projects over 60 million euro (Ministerie van Financiën, 2013). Therefore, it made sense to compare D&C projects above 60 million euro with DBFM projects (which are always above 60 million euro). The third 'empirically-informed set' started with the clusters as defined by Cantarelli et al. (2012; see also Verweij et al., 2015) in their analysis of cost overruns in Dutch transport infrastructure projects: small projects under 50 million euro, medium projects (50–112.5 million euro), large projects (112.5–225 million euro), and very large projects (above 225 million euro). Then, since we empirically observed DBFM projects only within the large and very large groups (i.e. above 112.5 million euro), we decided to run the analysis for this set only for projects above 112.5 million euro, in order to compare projects which are, based on their actual size, more equal.

Table 1. Descriptive statistics for all DBFM and D&C projects (N ranging from 37 to 65 depending on data availability).

Contract type	DBFM	D&C	Total
Project size (k€)	*N* = 9	*N* = 49	*N* = 58
Mean	631,427.67	75,900.45	162,102.95
SD	576,336.89	92,262.55	308,147.03
Absolute cost performance (k€)	*N* = 9	*N* = 49	*N* = 58
Mean	60,480.33	17,100.41	23,831.78
SD	87,646.23	24,199.96	42,688.97
Relative cost performance (%)	*N* = 9	*N* = 49	*N* = 58
Mean	6.24	24.72	21.85
SD	5.80	24.32	23.42
Absolute time performance T = 0 (days)	*N* = 6	*N* = 31	*N* = 37
Mean	-164.67	12.35	-16.35
SD	547.95	320.93	363.19
Absolute time performance 2018-T1 (days)	*N* = 7	*N* = 33	*N* = 40
Mean	-151.71	-59.55	-75.68
SD	99.59	225.12	210.64
Relative time performance T = 0 (%)	*N* = 6	*N* = 31	*N* = 37
Mean	-11.79	1.20	-.09
SD	30.77	57.34	53.8
Relative time performance 2018-T1 (%)	*N* = 7	*N* = 34	*N* = 41
Mean	-16.67	-6.02	-7.83
SD	11.31	52.63	48.17
Project completeness (%)	*N* = 9	*N* = 56	*N* = 65
Mean	86.74	96.62	95.25
SD	27.24	14.59	16.95

Results

Descriptive statistics

Table 1 presents the means and standard deviations for project size, cost performance (in absolute and relative values), time performance (in absolute days and relative delays), and project completeness for the 'all-inclusive set'. DBFM projects performed better in terms of both cost and time performance. The average relative cost performance was 6.24% in DBFM projects and 24.72% in D&C projects. This means that DBFM projects have, on average, additional work costs of 6.24% of the initial contract value, whereas the average relative increase in costs due to additional work in D&C projects was almost four times higher. Regarding the time performance for the recommissioning date as planned at the time of the contract award (T = 0), we observed that DBFM projects had, on average, a delay of -11.79% of the planned duration of the implementation phase, i.e. an acceleration of the implementation phase. The average time performance was even better, at 16.67%, when changed planned dates for the recommissioning of the infrastructure, due to scope changes, were taken into account (2018-T1). Table 1 shows that the time performance for D&C projects was lower.

Finally, project completeness expresses the percentage of completion of the implementation phase at the moment of data collection. There were five projects which had not fully finished the construction phase: two DBFM projects and three D&C projects. Since the differences, regarding the relative cost performance, between the projects with 100% completeness and the projects with a lower completeness were not significant, we decided to include them in the analysis. Concerning time performance, these projects are of course missing cases.

The descriptive statistics show that the standard deviations in both sets (DBFM and D&C) were generally high. Hence, there was some variation within both sets. This holds especially for the set with D&C projects regarding the relative cost performance (compared to the DBFM projects).

Table 2. Comparative group analyses (Mann-Whitney U test) for relative cost performance (%).

Contract type	DBFM	D&C	Mann-Whitney U	Significance difference (two-tailed)? (*p* value*)
Set 1: All-inclusive set	N = 9	N = 49	95.00	*Yes (0.007)*
Mean	*6.24*	*24.72*		
SD	*5.80*	*24.32*		
Mean Rank	*15.56*	*32.06*		
Set 2: Rijkswaterstaat policy set	N = 9	N = 18	28.00	*Yes (0.005)*
Mean	*6.24*	*27.19*		
SD	*5.80*	*23.73*		
Mean Rank	*8.11*	*16.94*		
Set 3: Empirically-informed set	N = 9	N = 11	15.00	*Yes (0.007)*
Mean	*6.24*	*24.27*		
SD	*5.80*	*20.59*		
Mean Rank	*6.67*	*13.64*		

*Sig two-tailed: $p \leq 0.05$.

Cost performance

For a more nuanced comparison between the DBFM projects and the D&C projects, we constructed the three different sets—see Table 2. The data were not normally distributed: in the 'all-inclusive set', the Shapiro-Wilk test was not significant for the DBFM group (0.14), but it was for the D&C group (0.00). We therefore used the non-parametric Mann-Whitney U test. This test has the advantage that it neither assumes equal variance within groups nor equal sample sizes.

The difference between the DBFM projects and the D&C projects for relative cost performance for all three sets was statistically significant. In fact, the mean scores across the three analyses with different project sizes for the D&C contracts did not differ much. We performed a Pearson correlation analysis to check whether project size and project completeness had a relationship with cost performance, which was not the case (non-significant values of -0.16 and 0.16, respectively). Hence, although both DBFM projects and D&C projects had additional work costs, DBFM projects performed better than D&C projects. We therefore confirmed our first hypothesis (H1).

Time performance

Table 3 shows the results for the differences in time performance (both for T = 0 and 2018-T1). Again, we

Table 3. Comparative group analyses (Mann-Whitney U test) for relative time performance (%).

Contract type	DBFM	D&C	Mann-Whitney U	Significance difference (two-tailed)? (*p* value*)
Set 1: All-inclusive set Time overrun (%) [T = 0]	*N = 6*	*N = 31*	67.00	No (.302)
Mean	*-11.79*	*1.20*		
SD	*30.77*	*57.34*		
Mean rank	*14.67*	*19.84*		
Set 1: All-inclusive set Time overrun (%) [2018-T1]	*N = 7*	*N = 34*	80.50	No (0.186)
Mean	*-16.67*	*-6.02*		
SD	*11.31*	*52.63*		
Mean rank	*15.50*	*22.13*		
Set 2: Rijkswaterstaat policy set [T = 0]	*N = 6*	*N = 12*	19.00	No (0.125)
Mean	*-11.79*	*10.36*		
SD	*30.77*	*31.36*		
Mean rank	*6.67*	*10.92*		
Set 2: Rijkswaterstaat policy set [2018-T1]	*N = 7*	*N = 12*	20.00	No (0.068)
Mean	*-16.67*	*0.74*		
SD	*11.31*	*22.46*		
Mean Rank	*6.86*	*11.83*		
Set 3: Empirically-informed set [T = 0]	*N = 6*	*N = 7*	11.00	No (0.181)
Mean	*-11.79*	*13.57*		
SD	*30.77*	*34.32*		
Mean rank	*5.33*	*8.43*		
Set 3: Empirically-informed set [2018-T1]	*N = 7*	*N = 7*	10.00	No (0.073)
Mean	*-16.67*	*6.26*		
SD	*11.31*	*26.13*		
Mean rank	*5.43*	*9.57*		

* Sig two-tailed: $p \leq 0.05$.

opted for the non-parametric Mann-Whitney U test because the data on this variable were not normally distributed. This holds in particular for the D&C group, for which the Shapiro-Wilk test was significant for both T = 0 and 2018-T1 (0.00/0.00), while it was not significant for the DBFM group in the all-inclusive set (.24/.51).

The differences between the DBFM projects and the D&C projects for relative time performance (for both T = 0 and 2018-T1) for all three sets were not statistically significant. Although the DBFM projects had, on average, better time performance, the difference in ranked distributions with the D&C projects was not statistically significant based on the Mann-Whitney U test. We have to note here that we are dealing with a relatively small sample and relatively large standard deviations, partly explaining why the difference in time performance between the two groups was not found significant, although the mean scores of the two groups varied considerably. We therefore could not confirm our second hypothesis (H2). The differences between DBFM and D&C in the 'Rijkswaterstaat policy set' and the 'empirically-informed set' did, however, approximated significance, particularly for the 2018-T1 values. Furthermore, we performed a Pearson correlation analysis to check whether project size showed a relationship with time performance, which was not the case (non-significant values of 0.01 and 0.02 for T = 0 and 2018-T1, respectively).

Conclusions and discussion

Cost and time performance

At the beginning of this paper, we asked whether the widely-claimed advantages of developing and managing transport infrastructure through PPPs actually materialize. We therefore looked for empirical evidence about the advantages of DBFM over D&C, in terms of cost and time performance. With respect to time performance, we cannot conclude that DBFM contracts perform significantly better than projects with a D&C contract, although there were indications of differences in our data in favour of DBFM projects. Based on our analyses, we conclude that DBFM projects performed significantly better than D&C projects with respect to costs (cf. Verweij et al., 2015). It could be argued that this effect of contract type on cost performance is explained by the fact that the D&C contracts we studied had a much smaller project size (see Table 1). However, when we compared only the large projects, the results produced the same picture—DBFM projects performed better. Furthermore, no relationship was found between project size and cost performance. This is an important finding. Whereas recent studies have suggested that contract characteristics explain PPP performance to only a limited extent (for example Klijn & Koppenjan, 2016) or not at all (for example Kort & Klijn, 2011), our findings show that contract type does matter for cost performance.

Contribution of the study

Some studies have shown that relational aspects and process management seem to be more important for PPP performance (Kort & Klijn, 2011). However, those studies did not systematically compare different contract types (but instead focused on contract characteristics). Moreover, they were based on perceptual data and did not include hard performance data (such as costs and time as in the present paper). Much of the existing public administration literature on the relationship between the contract characteristics of PPPs and performance is based on interviews or survey data, involving the measuring of managers' perceptions about the contracts and their impact on performance. Hard project data can add to this. However, hard project data (on costs and time performance) are often hard to come by, because the data are not publicly available and because of confidentiality issues. We were able to collect and analyse real project data; so this paper is an important contribution to the academic literature on PPP performance. Clearly, more studies that analyse actual PPP performance data are needed. A promising avenue for future research would be to combine different types of data, using a mixed method design including both quantitative hard performance data and qualitative experience-based judgments of project participants.

Discussion and further research

Several important comments have to be made in relation to our findings. First, the average relative cost performance of the DBFM projects in our dataset was 6.24%. This means that additional work that occurred after the contract was concluded led to increased project costs for the public partner of 6.24% of the initial contact value. Although the cost advantages of DBFM over D&C certainly speak in favour of developing and managing transport infrastructure through PPPs, the cost increase in DBFM may be a reason for continued concern. It is therefore imperative that the search for improved design and management of DBFM contracts continues.

Second, fully specified and complete contracts may cancel out the opportunistic behaviour of the private partner (Hart, 2003). However, contracts are incomplete by definition (Badenfelt, 2011); after the contract is fixed, events can occur that could not have been predicted and, naturally, private partners may respond to events in a way that protects or serves their interests. Increasing the private partner's proportion of the benefits generated in the PPP can decrease their incentive to act opportunistically (Liu et al., 2016). In Dutch DBFM projects, however, this may be difficult to achieve because the revenue is rooted in availability-based payments instead of usage-based payments (for example toll fees) (Yescombe, 2007).

Third, our analysis did not include the reasons behind the costs associated with the additional work. For instance, in the current debate on the future of PPPs, the effects and therefore the desirability of private financing as part of a PPP contract has been called into question, because it can lead to unfair contracts (in Dutch: *wurgcontracten)* that place too much risk on the construction companies instead of leading to improved risk management (Koenen, 2019a; 2019b). However, we could not assess the actual effect of private financing on the quality of risk management (Culp, 2011) as an explanation for cost performance. Also, we did not analyse different cost categories. A previous study indicated, for instance, that scope changes are the most common reason for additional work in the implementation phase and that smaller projects are particularly subject to additional costs due to contract omissions (Verweij et al., 2015). That study, though, did not distinguish between DBFM and D&C contracts. The question therefore remains what exactly explains the occurrence of additional work in DBFM projects.

Our study has some limitations. Although our empirical basis was not particularly small in comparison with other studies that compared the performance of PPP projects with that of non-PPP projects (for example Atmo et al., 2017; O'Shea et al., 2019; Chasey et al., 2012), our dataset included only nine DBFM projects. Second, although the project completeness was high, and although projects with full completeness were not significantly different from the projects that were incomplete, future analyses should be performed on the data when all the projects have concluded their implementation phases to further strengthen the results.

Conclusions

In this paper, we investigated the cost and time performance of projects. Do PPPs achieve better results when it comes to additional work costs and time overruns than regularly procured projects? We found that DBFM projects had better cost performance than D&C projects. DBFM projects also seemed to perform better regarding time overruns, although the difference was not statistically significant. Our findings are in line with some recent studies into the cost and time performance of PPP projects versus that of traditionally or regularly procured projects. Atmo et al. (2017) statistically analysed 56 power plants in Indonesia and found that the DBFM(O) projects had better time performance. O'Shea et al. (2019), studying the procurement of schools in Ireland, found that, although tendering took longer in the DBFM cases, the construction time for DBFM schools was shorter than for schools under traditional procurement. Finally, Chasey et al. (2012) compared DBFM(O) contracts with design–build procurement (i.e. D&C) in road projects in North America and found that the PPP projects had both better time performance and better cost performance. These studies, together with this one, speak in favour of DBFM procurement. It is too early, however, to conclude that DBFM by definition performs better; the literature continues to show mixed results regarding PPP performance. Moreover, focusing on costs and time might be considered rather narrow. Current policy debates stress the value of PPPs in achieving, for example, innovative and sustainable transport solutions by capitalizing on the innovative capacities of the private sector. Are some time delays and additional project costs acceptable if the result is increased project quality, sustainability, innovation, or other perhaps unforeseen social benefits? We should not blindly focus on cost and time performance—PPPs may prove to be valuable vehicles for other reasons too.

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