Asset Management Perspective on the Duration of Public-Private Partnership Contracts: Cost-Control Trade-off?

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Abstract: The risk-incentive model of principal-agent relations and its extensions to infrastructural public-private partnerships outline the efficiency implications of parameters such as contract duration. The predominant focus on individual contracts is of limited use for public agencies that need to allocate their resources efficiently at the level of the entire asset network. This study therefore adopts an asset management perspective on the issue of contract duration in public-private partnership (PPP) contracts. In so doing, this research aims to add to the understanding of asset network level effects of important contractual parameters such as contract duration. Empirical material from the Netherlands illustrates that public professionals tend to think about contract duration in terms of a network cost–network control trade-off. From the data, a hierarchical set of criteria deemed relevant for determination of contract duration is elaborated that ultimately supports network accessibility. Limitations, managerial implications, and suggestions for future research are discussed. **DOI: 10.1061/(ASCE)CO.1943-7862.0000937.**

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Introduction

These days, the development and subsequent utilization of transportation infrastructures such as roads and railroads often involve collaborative efforts of public agencies and private parties (e.g., contractors, financial institutions) in so-called public-private partnerships (PPPs). The involvement of private contractors in infrastructure provision has a long history (Tang et al. 2010). Definitions and typologies of PPPs are numerous, diverse, and arguably to some extent ideological. PPPs are perhaps best loosely characterized as "arrangements whereby private firms are responsible for substantial parts of decision making and finance, with overall responsibility and control exercised by the public sector" (Small 2010).

The trend in PPPs for transportation infrastructure has been toward stronger ties between public agencies and private contractors. Public agencies responsible for infrastructures increasingly rely on, for example, PPP contracts to outsource many important operational activities over the entire life cycle of their assets. Previous studies have examined, for example, when PPPs are useful (e.g., Hart 2003; Martimort and Pouyet 2008; Wibowo and Kochendoerfer 2011), barriers and success factors of PPPs (e.g., Chan et al. 2010; Li et al. 2005; Mahalingam 2010), risks related to PPPs (e.g., Iyer and Sagheer 2010; Li and Zou 2011), and issues of PPP contract design (e.g., Daube et al. 2008; Dewatripont and Legros 2005). This literature is predominantly concerned with contractual and organizational facets at the level of individual projects. However, public agencies are responsible for numerous assets and are ultimately interested in optimizing the use of resources at the level of the transportation network. Contracts for individual projects covering a limited number of assets may not include the proper incentives for PPP contractors when network level optimization is of interest. PPP contractors will mainly optimize their own processes over the contractually determined time frame, leading them to make investments that can be expected to generate money or prevent penalties within that period.

Contractual and organizational issues of PPPs should therefore also be examined from the notion of PPPs as a means to increase the cost-effectiveness of the service delivery for parts of an entire infrastructure network. Such an understanding fits in the asset management approach that many transportation agencies have adopted in recent years.

Asset management is concerned with activities and decisions that optimize expenditures over the entire life cycle of infrastructure assets while ensuring the provision of a specified level of service. It is explicated in internationally recognized standards such as PAS-55 (British Standards Institution 2008) or more recently ISO 55001 (International Organization for Standardization 2014).

This paper explores contract design of PPPs from the perspective of asset management for road infrastructures with a focus on the design issue of contract duration (CD). Generally, the duration of PPP contracts can set incentives to deliver an expected level of service within projects (e.g., E. Iossa, et al., "Contract design in public-private partnerships," working paper, World Bank). However, in this paper it is argued that the CD of a PPP also influences the overall performance of a transportation network. The argument is supported by examining how public professionals in the Netherlands assess the potential impact of CD on the accessibility of road infrastructure networks. This line of research with its focus on the relationship between contract design and network performance contributes to the value-for-money discussion of PPPs (e.g., Grimsey and Lewis 2005).

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Conceptual Background

Contract Design and the Organization of Economic Activity

Modern Western societies characterized by division of labor and specialization, face the task of coordinating the resulting transactions between people. This can be achieved through the price mechanism of markets or through a command-and-control form of organization. Command and control relies on chains of command, and, importantly, contracts.

Until fairly recently, economics had surprisingly little to say about contracts, despite their tremendous importance for modern societies. Neoclassical economics, arguably still the core of modern economics, aims to explain (aggregate) market outcomes such as prices and quantities. In doing so, it makes very specific and strong structural and behavioral assumptions. It takes market structure as a given and ignores potentially important institutional variables.

Since the 1970s, and especially from the 1990s onward, economic research has turned an eye toward issues of organizational design. New institutional economics (NIE), after all these years still a somewhat heterodox field within economics, picks up where neoclassical economics leaves off. It asks why firms exist in the first place—why bother with command and control and not just leave everything to the market?—and explores social and legal norms in economic activity. Of particular interest is the theory of the firm, or organizational economics, which includes transaction cost economics (TCE) and agency theory (AT). Transaction cost economics and AT try to examine how governance structures emerge as a result of cost minimization by (boundedly) rational and opportunistic actors. Transaction cost economics looks at transactions and posits the notion of transaction costs. These are costs of "drafting, negotiating, and safeguarding an agreement" (Williamson 1985, p. 20) that are mainly driven by transaction frequency, asset specificity of investments, and uncertainty, as well as bounded rationality and opportunistic behavior of the parties involved. Transaction cost economics argues that in attempts to minimize costs, transaction costs give rise to the existence of firms to deal with certain transactions, while other transactions are more efficiently dealt with between firms. Market structure can thus be traced to transaction costs. Agency theory, mostly complementary to TCE (Bergen et al. 1992; Williamson 1988), looks at principal-agent relations and associated agency costs. Agency costs stem from attempts of the principal to deal with informational asymmetries and diverging interests of principal and agent (within the bounds of potential mutual benefit). Agency theory, more specifically its workhorse model the risk-incentive model of principal-agent relations, suggests that efficient contractual arrangements (risk allocation in the form of contractual incentives and penalties as well as allocation of responsibilities) are sought to minimize these costs. Efficient contractual arrangements (Gibbons 1998, 2005; Prendergast 1999) thus depend on the existence and nature of agency costs.

More recently, the behavioral revolution within economics has opened up the field to insights from other social sciences. These insights, especially from the field of judgment and decision making, have refined basic behavioral assumptions of economic theory. These insights alter and supplement the conception of people as boundedly rational beings. Issues like cognitive biases, limits on greed and self-interest, social identity, and fairness are all barely touched upon by traditional organizational economics, yet are important and they shed new light upon the workhorse model of organizational economics (Camerer and Malmendier 2007; Powell et al. 2011).

The contractual issues raised and discussed in the literature on organizational economics naturally extend to contracts used in the construction sector. Of current interest are PPP contracts. A key feature of PPP contracts is a focus on service provision. Construction and maintenance activities are merely a means to provide a service. In the Dutch situation, for example, the authorized Dutch public agency demands road availability for which it then pays an availability fee (subject to availability and performance deductions). Contract clauses are aimed at functional specifications (e.g., availability, road-surface quality, safety) and do not stipulate how the private contractor needs to meet the objectives.

A large body of work on the topic of PPPs has developed that discusses the intricacies of PPPs (e.g., Garvin 2010; Ke et al. 2009). Of particular interest for current purposes are papers (e.g., Nilsson 2006; Small 2010) that discuss contractual efficiency trade-offs resulting from the changing roles of public and private parties as specified by PPP contracts.

A well-known efficiency argument in favor of PPPs concerns life cycle optimization. It is often said (e.g., Evenhuis and Vickerman 2010) that integrating design and construction with maintenance and operation lowers cost over the life cycle of assets compared with separate procurement. The private contractor is induced to think through the implications of investments in the early stages on subsequent maintenance and operation. Specifically, in PPPs private contractors are put in the position where they can optimally balance costs concerns over the entire life cycle and exploit efficiency gains from additional early investments that result in substantial cost savings in the maintenance and operation stage.

Yet, the case for private sector involvement might not be as strong as is sometimes claimed. For example, Small (2010) argues that effective arrangements require extensive public sector immersion and clever fine-tuning of contracts. The net gain, the overall value for money of PPPs, remains a highly debated issue. In two highly cited papers, Grimsey and Lewis (2005, 2002), meticulously list important risks in PPPs (Marques and Berg 2011) and attempt to establish common ground for practitioners and academics by discussing various methods for assessing value for money as used around the globe. Complementary work by Zhang (2005) provides survey results on agreement between practitioners and academics on critical success factors for PPPs.

Importantly, not all PPP contracts are created equally. Whether or not a PPP contract is a superior contractual arrangement depends on its parameters. The overall conclusion from papers on contract design is not very surprising, yet perhaps slightly discouraging: While it is possible to sketch (types of) parameters important in contract design, their relative importance is highly context specific, and there appears to be no straightforward way to flesh out the importance of these parameters across projects.

The relevant literatures typically echo recommendations from the economics of organization literature discussed above. For example, Small (2010) discusses in some detail the incentivizing effects of risk sharing and related efficiency rationales for private involvement such as cost savings and innovation. Related literature on organizational economics highlights payment mechanism as well as all sorts of contingency provisions as important variables in contract design by public agencies. According to the risk-incentive model, incentive setting should be contingent on the respective risk profiles of principal and agent. Given similar degrees of risk aversion, risks should be borne by the party that is responsible or can comparatively better control those risks. Similarly, given similar responsibility or control, risks should be assigned to the less risk-averse party (E. Iossa, et al., "Contract design in public-private partnerships," working paper, World Bank). If one of the partners is both less risk averse and better able to control risk, then it should bear all the risk. However, when the less risk-averse partner (in general, the public partner) is not the one best able to control risk, risks should be shared. Transferring risks to the more risk-averse party

(in general, the private party) entails both gains from incentivizing and costs of bearing risk (Milgrom and Roberts 1992). Often, the incentive motive figures more prominently in this trade-off so that the more risk-averse party should bear a considerable amount of risk and even more so the lower its degree of risk-aversion.

A closely related issue is the delicate balancing act of setting rewards for different activities. The principal must be careful to avoid "rewarding for A, while hoping for B" (Kerr 1975). That is, rewards must reflect the value the principal attaches to the various activities. Activities that are equally valued should thus be rewarded equally (Milgrom and Roberts 1992). See Iossa et al. ("Best practices on contract design in public-private partnerships," working paper, World Bank) for an overview of best practices on risk allocation, Milgrom and Roberts (1992) for a discussion of seven principles that govern the design of optimal incentive contracts, and Ho (2006) for a game-theoretical model of rational (opportunistic) renegotiation behavior of parties in PPPs.

Contract Duration in PPP Contracts of Civil Infrastructures

The literature discussed in the previous section mainly pertains to some of the general trade-offs in contract design for public infrastructure. To the best of the authors' knowledge, the literature on contract parameters such as CD is relatively scarce.

Procurement professionals and researchers are closely familiar with the opposing strategies of achieving short-term gains through squeezing suppliers or seeking similar results through the development of long-term, sustainable relationships with suppliers. Research suggests benefits from developing strong long-term relationships, such as reduced coordination and communication costs (e.g., Ryals and Humphries 2007). At the same time, especially in a harsh economic climate, there are quick results to be had by short-term low-cost sourcing.

How contract negotiations are conducted and how contracts are designed (including the determination of CD) is situation specific but should typically focus on a similar set of criteria. Iossa et al. ("Contract design in public-private partnerships," working paper, World Bank) identify several criteria pertaining to CD of PPPs. Beyond requirements to satisfy given (financial) constraints (e.g., CD must exceed the payback period), Iossa et al. ("Contract design in public-private partnerships," working paper, World Bank) suggest that optimal CD should be chosen by evaluating several factors in a complex trade-off. All else equal, increasing contract length induces the private partner to make more beneficial project-specific investments, because increased CD protects the private partner against holdup that depresses anticipated returns on investment. Moreover, long-term contracts allow partners to capitalize on potential economies of scale (Meduri and Annamalai 2013), stimulate learning by doing, and suffer comparatively less from anticompetitive bidding practices as private competitors interact less frequently.

On the other hand, increased CD partly eliminates market discipline. In addition, long-term contracts suffer to the extent that contract renewal serves as a performance incentive. Finally, long-term contracts reduce flexibility and increase the lock-in effect.

Continuing this line of work, Iossa and Martimort (2008, 2009) develop a (risk-incentive) model of PPP that, among other things, addresses the incentivizing effects of demand risk transfer between partners and choice of CD. It follows from their model that strong incentives in the form of user fee-based payment schemes should be used when risk-aversion and demand risk are low. Instead, weaker incentives in the form of availability fee-based payment schemes are better suited when risk aversion and demand risk are high. Notably, higher risk aversion and demand risk require weaker incentives (i.e., more insurance) obtained through a reduction in contract length. When the PPP contract includes the stipulation that the contractor takes care of financing (as is the case for PPP contracts) and user fees are used, the duration of the contract should be long enough for the contractor to be guaranteed sufficient expected revenue from user fees to cover his initial investment and his risk premium.

Engel et al. (2013), building on earlier work (e.g., Engel et al. 2001; Small 2010), explore the merits of flexible term contracts. They note that since "the economics of PPPs is still imperfectly understood, practice has run ahead of theory." To remedy this situation, they develop a comprehensive model PPP model with implications for the debate on CD. They derive an optimal contract (that takes into account demand risk, user-fee distortions, and the opportunity cost of public funds) with a contingent concession length, minimum income guarantees, and revenue caps, which is implemented through a competitive auction. In this setup, it is argued that public agencies should favor flexible term contracts as they lower demand side risk and therefore reduce demand for guarantees.

Clearly, the literature on contract duration of PPPs, in line with much of the literature on contract design, takes the individual contract as its focal point. This leaves many important questions of network level efficiency unanswered. A study aiming to address this deficiency of the literature was designed.

Research Design

An explorative study consisting of expert interviews and a single case study were conducted to examine CD as a tool for professional public asset managers in optimizing the accessibility of road infrastructure networks. It is principally the underexplored relationship between CD as a contractual design issue in PPP and the performance of infrastructure networks that suggests a qualitative research approach.

The primary objective of this exploratory study was twofold. First, it was designed to determine the problems surrounding CD that asset managers of road infrastructures face and how they deal with them. Of particular interest were the arguments and criteria used in determining CD in order to assess the convergence of theoretical perspectives on CD and current practices (as apparent from the case study). Second, the study aimed to provide recommendations concerning CD for a particular PPP, i.e., the A13/A16 project.

Using a hybrid methodology consisting of expert interviews and a case study made it possible to capture a broad spectrum of criteria for determining CD from an asset management perspective. Interviews with experts generated an initial set of criteria. Expert interviews are considered an efficient and concentrated way of gathering data in explorative research stages as experts possess domain-specific knowledge conducive to structuring and understanding the initial research problem (Bogner et al. 2009). In line with Yin (2008), the subsequent case study A13/A16 at the Dutch Highways and Waterways Agency (RWS) was mainly used for testing and validation purposes. It provided an opportunity to place some of the more abstract responses collected during expert interviews in context and to validate (triangulation) and supplement the initial set of criteria (also see Flyvbjerg 2006, on case study research). Safeguards for reliability included the use of an interview protocol, systematic documentation of results, and the identification of commonalities and discrepancies in the interpretation of the obtained data by the involved researchers yielding the results as presented.

Phase 1: Expert Interviews

The initial stage consisted of exploratory semistructured interviews with public and private sector employees who had experience

relevant to the question at hand. One of the contract managers of the A13/A16 project provided contact information of RWS employees directly involved in PPP decisions. The listed persons were approached for interviews. Many of them accepted, except those with fully booked schedules in the short term. Semistructured interviews were conducted with the a RWS project director, a stakeholder manager, three asset managers, a technical manager, a procurement consultant (who recently had been assigned a gatekeeper's role within RWS regarding CD), a project manager performance contracts, a legal consultant PPP, and two private sector top-level executives in charge of road exploitation and PPP financing of a Dutch PPP contract (see the Appendix for an overview of persons interviewed).

An interview protocol was formulated with (1) a brief background, objectives, and method of the research, (2) general instructions for the interviewer, (3) questions about the interviewee's background, (4) an optional section containing an opening monologue for the interviewer leading up to (5) core questions clustered around five themes (i.e., general, asset management and PPP, relation contract duration and asset management, relation geographical scope in contract and asset management, and room for closing remarks), and finally (6) concluding questions concerning suggestions about additional written material, important issues that had not been discussed, and persons worth approaching for purposes of the research.

To stimulate responses to the core questions on CD (i.e., in part 5 of the protocol) participants were probed thinking about various CDs (10–30 years) and their possible influence on the management of the PPP contract itself and the connected road network.

Interviews, between 45 and 90 min in length, were recorded (audio), analyzed according to the five themes addressed, and summarized in written form.

Supplementary data was gathered on CD determination in PPP-contracts by the Government Buildings Agency, which is part of the Ministry of Interior and Kingdom Relations. Their task is to manage and develop the State's largest property portfolio (7 million m^2 of floor space of which 1 million m^2 have monument status). These data were collected through document analysis (primarily internal procurement plans) and an interview with a contract manager. The data were used to contrast the findings from the infrastructure sector with the building sector and in so doing to validate and generalize the results.

Phase 2: A13/A16 Case Study

The case is that of the ongoing project A13/A16 implemented through RWS, the executive arm of the Dutch Ministry of Transport. The agency is responsible for managing 4,474 km of carriageways, 90,278 km^2 of surface water, and 2,137 km of canals and rivers in the Netherlands.

The project A13/A16 was initiated mainly to improve accessibility of the Rotterdam region by connecting highways A13 and A16, thereby reducing traffic intensity on the A20. As the projected financial outlay of €1 billion exceeded the €60 million threshold, a public-private comparator was conducted which indicated a surplus value of $3.2 \pm 1.2\%$ for a PPP contract (i.e., *private contract*) relative to a more traditional DC contract in combination with subsequent performance contracts (i.e., *public contract*). Correspondingly, a PPP contract was drafted for the project. In particular, the well-known integrated contract format of design build finance maintenance (DBFM) was used. A DBFM contract assigns responsibility for design, construction, as well as finance and maintenance to the contractor. Determining CD became part of the project team's tasks.

The case study had two stages. The first stage consisted of document analysis (primarily internal memos and project documents about A13/A16), and additional in-depth interviews. Respondents were the aforementioned procurement consultant, three other RWS consultants, and two contract managers (see Appendix). The semistructured interviews focused on determination of CD for the A13/A16 project, but also yielded valuable insights into CD determination in three previous RWS projects, i.e., N31 Wâldwei, N33 Assen-Zuidbroek, and N18 Varsseveld-Enschede.

The second stage entailed a workshop with team members of the A13/A16 project. The aim of the workshop was to test and validate the criteria by applying them to the specific context of the A13/16 project. In addition, the workshop addressed the secondary objective of the study, i.e., to provide recommendations concerning CD for the A13/A16 project. Four RWS employees participated in the workshop, i.e., a contract manager, a risk manager, and the technical and stakeholder managers who were already interviewed in the initial stages of the research. The workshop was facilitated by two researchers. While one researcher took the role of the workshop moderator the other researcher made notes during discussions and recorded workshop results. Participants received handouts with descriptions of the previously identified criteria. These were discussed and applied to the project by means of a multicriteria analysis. Participants were asked to qualitatively assess the impact on each criterion of 10-year deviations (plus or minus) from a default CD (i.e., 20 years). That is, three options of CD were discussed, i.e., 10 years, 20 years, and 30 years. For each criterion the impact relative to the default option of 10 years was cast in terms of a positive or negative change. The workshop moderator continuously updated the results of the discussion using spreadsheets that were projected on a whiteboard. Workshop results were used for recommendations to the A13/A16 project team.

Results

The interviews make clear that RWS is very much in the midst of a transitional period in which issues like CD are getting more attention. For example, over the course of the investigations, one RWS analyst was assigned the centralized responsibility for the determination of PPP contract duration. Below criteria for determining CD are discussed that were most frequently mentioned by the respondents in this period (see Fig. 1 for an overview). The criteria reflect the experiences and perceptions of the respondents and are decompositions of the overall goal of optimizing the accessibility of road infrastructure networks as optimizing the accessibility of road infrastructure networks is a key element of RWS policy and mission statement.

Network Cost Criteria

Of major concern according to most respondents are the various network costs (and underlying cost drivers) across the entire life cycle of assets. Two broad categories of network costs are distinguished.

Life cycle costs: *Life cycle costs* constitute the first category. These are costs incurred in the initial PPP contract period, and in the period afterwards.

Increasing CD—ideally so that is coincides with the duration of the entire life cycle of assets—forces the private contractor to think through the implications of development choices during the design and construction stage on later maintenance operations. This is expected to lead to costs savings through innovations in the early stages of a PPP. However, such a CD can be extreme (approximately 100 years or so) and is believed to be politically infeasible.

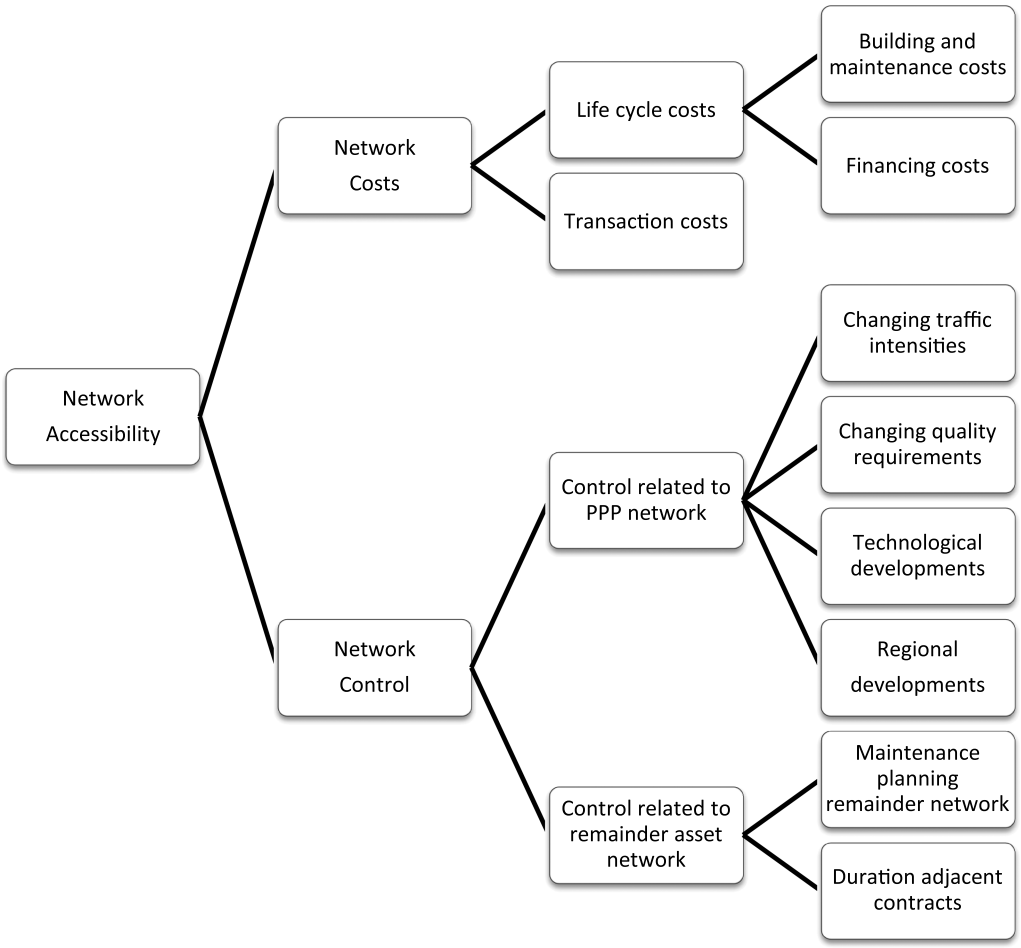

Fig. 1. Overview of criteria for determination of contract duration

The second-best alternative would be to let CD include at least one cycle of major maintenance of the main cost-driving asset (typically the road pavement). To see this, the contractual obligations of the contractor and the behavior this induces must be considered. A PPP contract stipulates a minimum required quality level for the condition of the assets when they are transferred back to the public agency at the end of the PPP contract. This requirement induces a profit-maximizing contractor to cap their expenditure at a level that just satisfies this contractual lower limit. In other words, the contractor is encouraged to extent the lifespan of assets just enough to be able to transfer the assets at the required minimum level of quality. The subsequent contractor will then start with major maintenance interventions so that, again, the contractor has to take into account the implications of early choices on later maintenance activities. A shorter duration than outlined above would effectively wipe out any expected benefits, as contractors would not be confronted with the effects of their own design choices. Interviews clearly reflect life cycle costing to be a dominant mindset for the practitioner. RWS uses life cycle costing since their first PPP project, N31. Many involved in the A13/A16 project explicitly relate rules of thumb for CD (e.g., 25 years) to the expected date for first major maintenance interventions on major subsystems. The life cycle costing paradigm favors the 30-year contract over the 20-year contract, let alone the 10-year contract.

An analysis of life cycle costs arguably includes potential efficiency effects through learning by doing. Increasing CD generates opportunities to learn from past mistakes and therefore allows contractors to improve the efficiency of their operation. Although mentioned, the expected benefits from learning by doing are deemed moderate.

CD is also thought to affect financing costs of the private contractor and, in effect, costs for the public agency. To the extent that increasing CD reduces risks for banks (e.g., if it improves the viability of the project), interest rates will be lower on bank loans. Typically, banks try to secure future payments from contractors by requiring a minimum level of investment. These investments lead to acceptable future failure rates and therefore low deductions on the availability fees that contractors receive from RWS. For the A13/A16 project, innovative ways to attract funds at attractive rates, e.g., through major pension funds or other nontypical investors, are currently being examined.

Transaction costs: The second category consists of *transaction costs*. The (substantial) costs of drafting and negotiating contracts are dependent on the number of contracts needed to cover the entire life cycle of infrastructure assets. All else equal, increases in CD of the initial PPP contract will decrease the number of subsequent contracts needed and are thus expected to reduce transaction costs. Typically, as PPP contracts will not cover the entire life cycle of assets, RWS uses performance contracts (for small and regular maintenance) and DC contracts (for larger rehabilitation projects) for the remainder of the life cycle. The transition from contract to contract generates risks. After all, new contractors will not have perfect information about the assets that are transferred to them. Importantly, there are transaction costs attached to the preparation and closing of these new contracts. These may include fees to cover preparation costs of potential contractors, and costs of negotiation

and evaluating contractor's proposals. Transaction costs can be substantial. Recent experience in other PPP projects shows that contractors sometimes struggle to flesh out a well-functioning organization within the short timeframe they face. This results in unforeseen, frequent, and costly interactions between the contractor and the public agency to streamline the start-up stage. It is also apparent that a transfer of activities (from public agency to contractor) in the start-up stages creates confusion for stakeholders about respective responsibilities to the extent that the contractor has already managed to become visible to stakeholders at all. Managing this process, e.g., through closer collaboration in the start-up stages in which the contractor establishes ties to external stakeholders, is costly. Respondents from the A13/A16 project appreciate the transaction cost effect, but do not expect major benefits on this point from increases in CD. It is clear, however, that a 10-year (30-year) CD of the A13/A16 PPP contract will increase (decrease) transaction costs relative to the default case of 20 years.

Network Control Criteria

Employees at RWS also stress the importance of the flexibility of the RWS operation at the network level to be able to deal with changing circumstances. Again, two broad categories of criteria can be distinguished.

Control criteria related to the PPP network: First, there are *control criteria related to the PPP network*. Four frequently mentioned criteria are (the likelihood of) changing contract requirements due to (1) changing traffic intensities (e.g., as a result of policy change), (2) changing quality requirements (e.g., as a result of policy change), (3) impact of technological developments, and (4) impact of developments in the regional surroundings of the network. The general reasoning is that increasing CD renders changing contract requirements more likely and thus stifles the opportunity for adequate, independent response by RWS.

Changes in e.g., policies related to mobility can clearly affect traffic intensity. One can arguably generate accurate short-term traffic intensity projections, but this becomes problematic for the longer term. If, for example, a road adjacent to the network covered by the PPP contract is, at some future point in time, designated a toll road, traffic flows on the PPP network will change accordingly. Long-term PPP contracts will make it harder to accommodate such a future policy change. These contracts will consequently have to be renegotiated. Although demand risk is a key concern in PPP design, respondents indicate that potential future changes in traffic intensity are not a major consideration for the A13/A16 project. Traffic intensity in the Rotterdam area is already very high and possible fluctuations are believed to be sufficiently addressed.

Similar reasoning applies to changing quality requirements. A PPP contractor is required to meet specified minimum quality standards that are contractually agreed upon. Now suppose that, at some future point in time, newly formulated policy includes lower quality requirements aiming to generate savings for the public agency. Without renegotiations, long-term PPP contracts will prevent these savings to materialize. Again, from the data, it seems that changing quality requirements are of no great concern for the A13/A16 project, as they are deemed unlikely.

Long-term PPP contracts also make it harder to accommodate future technological developments, and thus to reap the benefits of technological progress across the entire network of asset. Technological developments are hard to predict, and even more so the longer the timeframe under consideration. Long-term PPP contracts are typically not well suited to anticipate these changes. The CD for N18 was determined with this consideration in mind. For example, limited foresight notwithstanding, RWS expects that systems situated alongside the road (e.g., dynamic traffic management systems) in time will be replaced by functionally equivalent systems in cars. Of the four mentioned criteria, RWS professionals of the A13/A16 project worry most about the impact of technological change.

The case of the N18 also offers some perspective on the impact of changes in the external environment. A consideration was that of local governments requiring changes on the PPP network in the exploitation phase of the contract that would necessitate corresponding changes of the contract. Demographical changes, for example, might require bicycle bridges or additional road exits. For the A13/A16 project this is of little concern. The burden of changes in the external environment contractually falls on the party that wishes to implement these changes. These changes therefore do not greatly affect RWS' maneuverability.

Control criteria related to the remainder of the asset network: The second category consists of *control criteria related to the remainder of the asset network*. One criterion is maintenance planning on the remainder of the asset network. Increasing CD includes a longer term of independent maintenance planning by the private contractor, which necessitates adjusting maintenance planning on the remainder of the asset network accordingly, in effect reducing the independence of the RWS operation. The A13/A16 project team simply determined that network maintenance planning has a horizon of merely five years, which is shorter than any reasonable CD for the PPP contract. For the A13/A16 project, this criterion is therefore of no relevance.

An additional criterion that is sometimes mentioned is the (de) synchronizing effect of increasing CD of a single contract relative to contracts that cover adjacent parts of the asset network. The effect of a CD increase of a single contract on RWS' flexibility is ambiguous. Increasing CD of a contract may, or may not, more closely align ending dates of (geographically) adjacent contracts.

Discussion

The results indicate a fair amount of convergence of (scarcely available) theory as discussed in section "Conceptual Background" (e.g., E. Iossa, et al., "Contract design in public-private partnerships," working paper, World Bank) and practice as apparent from the previous section. The importance of decision criteria such as transaction costs and learning-by-doing effects is clearly well recognized by professionals in the field. Even more apparent is the influence of the life cycle costing mindset. Practitioners, however, tend to focus on a subset of criteria identified in the literature. For example, the relation between CD and anticompetitive bidding practices was never discussed.

Practitioners stress the uncertainties surrounding new contracting practices as these practices are still in its infancy. Consequently, several network control criteria were identified that have not been extensively discussed in the literature, such as the likelihood of changing contract requirements due to changing traffic intensities, changing quality requirements, technological developments, and developments in the regional surroundings.

The results, at least in part, illustrate a relative neglect of current literature to incorporate the interdependencies of individual PPP contracts on the level of the entire asset network. Moreover, existing (predominantly economic) literature on contract design typically addresses relatively simple settings as reflected by the (many) simplifying assumptions in well-known theories on contract design. Contracts underlying the development and subsequent utilization of civil infrastructures, however, involve complexities beyond the scope of the relatively simple and well-known settings.

The contribution of the current exploratory research lies in its insistence to assess the effects of choices in contract design at the overarching network level. This research shows that many professionals, adopting an asset management perspective, (explicitly or implicitly) think of CD in terms of a network costs versus network control trade-off. One the one hand, increasing CD is expected to bring down network costs. On the other hand, doing so supposedly sets limits on the maneuverability of an agency in the face of changing circumstances. One way to conceive of this trade-off and its underlying cost drivers is in terms of expected net present value (NPV). Expected NPV provides a risk- and time-adjusted measure of projected net benefits (costs) over a specified timeframe. Arguably, expected NPV can be viewed as a formalization of the intuitive understanding of the respondents concerning network costs. Continuing with this analogy, respondents' worry about network control constitutes the outcome of a mental sensitivity analysis indicating a significant responsiveness of expected NPV to unforeseen circumstances.

Political discourse often highlights the expected cost savings, yet possibly fails to adequately address the issue of impaired flexibility. This may yield a distorted view of the alleged efficiency gains that are usually advanced as the rationale for private party contracting in infrastructure development and management. It is commonly argued, or rather assumed, that contracting out is more efficient than public sector maintenance, if not in the short run, then at least in the long run as contracting out stimulates private contractors to develop and employ innovative solutions to maintenance problems. This is the well-known argument concerning life cycle optimization favoring PPP. In other words, it is argued that contracting out is dynamically efficient (although perhaps not always statically efficient due to e.g., start-up problems). This reasoning is reminiscent of the practice of granting patents to product innovations or embracing similar anti-competitive measures. Patents, although reducing market efficiency in the short run (since patents create monopolists and inventions that are not freely available), are believed to increase dynamic efficiency in terms of an increased rate of innovations that often outweigh short-term losses (see e.g., Gallini 2002, on the conventional view of patents and its failings).

It is imperative to assess whether the supposed efficiency gains of contracts outweigh efficiency losses due to inflexibility to legitimize the use of these contracts. Work on value for money of PPP contracts alluded to earlier is pertinent to this assessment. Moreover, in designing PPP contract in construction, experiences in other sectors and with other long-term contracts should be considered. For example, García-Herrera and Llorca-Vivero (2010) present a model and empirical data that suggests that CD of franchise contracts varies with fixed investment, price-cost margin of the franchise, a time discount factor, and strength of "brand name." Importantly, the authors link the strength of the *brand name* to franchise experience as examined by Brickley et al. (2006). Brickley et al. (2006) find that CD of franchise contracts increases with the size and experience of the franchisor, presumably because of reduced uncertainty about optimal contract design relative to smaller, less established franchisors. Moreover, learning from experience takes place within, as well as across organizational boundaries. New franchisors in sectors with mature contracting practices typically adopt longer-term contracts from the start than their counterparts in sectors with less established contracting practices. Perhaps then, in construction, we might witness eroding apprehension with truly long-term PPP contracts due to inflexibility concerns as experience with them increases.

Experiences in other sectors, notably the health care sector, may also provide valuable clues as to whether long-term contracts and inflexibility concerns are inevitably linked. Torchia et al. (2013) review articles from peer-reviewed journals published between 1990 and 2011 and provide a discussion of main findings organized according to research domain (i.e., effectiveness, benefits, public interest, country overview, efficiency, and partners). The authors acknowledge the popularity of PPP arrangements but note that questions about their effectiveness, efficiency and convenience are far from settled, which includes questions about PPP flexibility. Blanken and Dewulf (2010), for example, emphasize the importance of flexibility for hospital PPPs. They distinguish different forms of flexibility and assess flexibility empirically using data from the U.K. and Australia. The results suggest that there is ample room for improving the adaptability of PPPs. Importantly, their case studies indicate that "there are hardly any provisions to be found in hospital PFI-PPP contracts for dealing with adaptability needs" (p. S45). There are, however, several ways—contractual and noncontractual—to deal with the lack of adaptability which the authors outline in their paper.

It could be taken from this that truly long-term PPPs do not necessarily stifle flexibility and may hold promise for the construction sector. On the other hand, there is perhaps a very fundamental reason to use relatively short CDs in order to retain at least some flexibility and that concerns the level at which public agencies try to optimize. At present, CD is often discussed at the level of specific projects. However, the asset management philosophy stresses optimization at the level of the entire asset network. Current practice thus, at best, promotes optimization at the project level that may not coincide with optimization at the network level. Indeed, a possible result of current practice—a frightening outlook for many public professionals—is a quilt patchwork of good (private contracting) and bad (remaining public) road sections. Whatever else there might be on the horizon, flexible term contracts, as outlined in Engel et al. (2013), are an appealing option; one that fosters efficiency, yet also mitigates several concerns about flexibility.

Conclusion

For public agencies, the issue of contract design in asset management is profoundly complex, yet at its core incredibly simple: establish which of all feasible ways to set incentives yields the highest net contribution to the overall objective. In short, it is a basic question of economic efficiency (*doing things right*), presuming one is already clear on effectiveness (*doing the right things*). An important tool that is used by the Dutch Highways and Waterways Agency RWS to judge efficiency of contracts is the public-private comparator. At present, the comparator uses default values for CD to compare the efficiency of alternative contracts (e.g., PPP versus DC with subsequent performance contracts). CD is not systematically varied to examine how efficiency of contracts changes as a result.

This research addressed the efficiency implications of varying CD for PPP contracts at the level of the entire asset network. The contribution of this research derives from the change in focus from the level of individual contracts to the asset network level, as the network level is of ultimate importance to public agencies trying to allocate their limited resources. Present research highlights several important criteria for setting CD. Empirically, the main identified trade-off is a network cost-network control trade-off. Extending CD is expected to reduce costs over the lifecycle of assets, but reduces the public agency's ability to deal with unforeseen circumstances (e.g., changes in policy and resulting maintenance budgets) potentially resulting in additional financial pressure.

This research has revealed a distinct set of criteria relevant to setting CD from an asset management perspective. There are, however, reasons to believe this set to be incomplete. First, the interviews were conducted almost exclusively with RWS managers rather

than private sector managers. The listed criteria could therefore, for example, to some extent overemphasize the now dominant preconceptions of public professionals. It should be noted, however, that a conceivable remedy of interviewing private sector managers in order to get insight into the effects of CD variations is not likely to be very fruitful, as they can be expected (as was overtly admitted in an interview) to simply take CD as given and optimize their operations on that basis.

Further, some of the policy constraints that RWS managers face make it harder to consider, or even conceive of, possibilities excluded by these constraints. For example, directives at RWS limit the scope for managers to use build contracts for more than 25% of the total asset network. In addition, there is some reluctance to consider extreme CDs. Discussions about more extreme forms of outsourcing, including very long-term contracts, are therefore relatively theoretical and uninteresting.

Moreover, experience with PPP contracts of Dutch managers in both the public as well as the private sector is limited, especially concerning their effects in the long term. Currently, only four Dutch PPP contracts are in the exploitation phase. The effects of variations in contract parameters, such as CD, are therefore hard to assess.

The objections above notwithstanding, the mentioned criteria have already proven valuable in the exploratory, mostly qualitative, MCA that was conducted for the project A13/A16. The criteria were transformed into value trees, which are MCA standard format (Department for Communities and Local Government 2009). This analysis has resulted in preliminary CD recommendations. A more extensive follow-up analysis is suggested that would involve quantifying scores for choice alternatives on the various criteria and assigning weights to these criteria.

Future research should be aimed at substantiating claims made by respondents of this study. In addition, future research should take into account a host of well-established findings in behavioral economics, such as biases in risk perception, the planning fallacy, the overconfidence effect, and hyperbolic discounting, which are relevant to construction management in general and the issue of contract duration in PPP contracts in particular (De Palma et al. 2009; Van Buiten and Hartmann 2013). The way risks and time are assessed by partners affects the costs and benefits of transferring risks between partners and potentially has important implications for CD determination.

Appendix. List of Persons Interviewed in Phase 1 (Expert Interviews) and Phase 2 (Case Study)

Phase 1: 11 interviews	Phase 2: Six interviews
RWS project director	Procurement consultant[a]
Stakeholder manager	Three RWS consultants
Three asset managers	Two contract managers
Technical manager	
Procurement consultant[a]	
Project manager performance contracts	
Legal consultant PPP	
Two private sector executives in charge of road exploitation and PPP financing of a Dutch PPP contract	

[a]Refers to the same person being interviewed at different occasions.

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