Integrated procurement and whole life cost: a graphical representation of the relative benefits of alternative procurement methods

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Abstract Title

This paper examines the theoretical relative whole life cost (WLC) efficiencies of alternative forms of serviced infrastructure procurement such as the Private Finance Initiative. Alternatives are considered in terms to levels of contract integration in relation to a facility's design, build and operations (DBO). It uses a production function approach in which contractible output is a function of quantities of two inputs (Capital resource (CAPQ) and Operating resource (OPQ)), with marginal substitution between inputs, and their relative cost, represented graphically with use of isoquant output curves and isocost input lines respectively. Alternative procurement methods are considered in terms of whether they contain constraints on factor inputs, with a specific focus on whether the public sector client faces a constraint on CAPQ resulting from front-end cost aversion rather than pursuit of WLC. Both for realism and for analytical simplicity, it is assumed that the client specifies the same required level and standard of output (FM service quantity and quality) in all procurement options. Therefore subsequent analysis is in terms of WLC minimisation rather than Net Value Maximisation. It is demonstrated that integrated procurement allows for greater allocative efficiency between CAPQ and OPQ to be reached, minimising WLC. This is partly due to reduced waste of separate untendered in-house operations that is decreased x-inefficiency. Furthermore, integrated procurement improves upon separately competitively tendered operations by internalising the incentivised option for higher upfront CAPQ, if anticipated lower OPQ and WLC over the asset life are realised.

Keywords: Integrated contracting, capital resource, operational resource, isocost, isoquant

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1. Introduction

1.1 PFI summary

The Private Finance Initiative (PFI) is a procurement method for the provision of serviced infrastructure that supports essential public services (NAO, 2003). It involves the private sector securing the initial finance required for investment to design, build and operate a facility for the provision of public services. As part of this form of integrated contract, responsibility for on-going facility maintenance (FM) is passed to the private investor under a long-term concession arrangement. In UK PFI contracts, the public sector client normally has the right to take ownership of the facility at the expiry of the contract term. The use of PFI sees the government's role in public service provision change from being the owner and manager of the capital infrastructure, to the purchaser of services on behalf of the public. It is supposed that this type of contract provides the private sector with the incentive and opportunity to minimise the whole life cost (WLC) of the serviced infrastructure (Hart et al., 1997). Another perceived benefit is better value for money through appropriate transfer of various types of risk to the private contractors (construction, operation and technology risk amongst others). Providers of serviced infrastructure under an integrated contract have stronger incentives to control the incidence of risks relating to their provision of services (Hart, 2003). Additionally, the output-based form of specifications associated with these contracts provides incentive and opportunity for the private provider to optimise the net revenue from expenditure on capital and investment in operations, which again, at least in theory, incentivises minimisation of WLC (Rintala, 2004). The private sector manages risk in part by establishing Special Purpose Vehicles (SPVs) for each project. SPVs are independent legal entities in which key project sponsors each potentially invest. These often include construction and FM contractors, private investors including banks, as well as recently a tendency to involve the pubic client (Partnerships UK, 2009). It is the SPV that takes legal responsibility for delivery of the project through sub-contracts with construction, FM and service providers. The public sector pay the SPV for the serviced infrastructure through a unitary charge payment (UCP) paid periodically over the contract tenure, on proviso the specified services are available to contractually agreed standards. This UCP covers payment for the upfront finance and on-going operational expenditure incurred by the SPV. From this the SPV provides for ring-fenced budgets set aside from the beginning of the contract to cover life cycle maintenance of the physical asset.

In Q1 2011, there were 698-signed PFI contracts in the UK, with 632 in the operational phase (HM Treasury, 2011). Based upon analysis of these data, they range in total capital value from under £1m to over £2.65bn throughout the whole contract life (the largest contract being the Military Flight Training Scheme). The average capital value is £76.5m with an associated standard deviation of £161.5m. Normally, the majority of capital expenditure occurs in the initial construction phase, followed by a much lengthier operating phase, together comprising the contract period. Contract periods typically range from around 25 to 35 years, with the average contract length being 26.3 years with an associated standard deviation of 5.2 years. The considerable length of contracts provides potential for transfer of the range of operational risks form the public sector, as well as potential reward for the private sector in terms of recouping investments in operations.

In summary, the defining characteristics of PFI contracts are; their long duration, their scope (to integrate design, construction, operation and finance), their incentives (linking payment to measured availability and performance relation to output specifications), and their ring-fencing of funds intended for maintenance and management of the facility (NAO, 2003).

1.2 Operational PFI commentary

There has been considerable literature produced concerning PFI provision, in part encouraged by the politically sensitive nature of this type of procurement. Authors of the literature range from governments and national auditing bodies, academics (globally based given the international relevance of public procurement practises), industry bodies and trade unions (each with their own interest in the application of PFI).

In the UK the National Audit Office (NAO) have produced numerous case studies of PFI projects (NAO, 2005), as well as two main analyses of the comparative performance of the construction phases of PFI and conventionally procured projects (NAO, 2003 & 2009). Yet only recently has there been any note worthy objective comparisons of the performance of projects within the operational phase that might allow us to comment on WLC considerations (NAO, 2010). This study cites that 'the cost and performance of PFI hotel services[1] are similar to those in Non-PFI hospitals' (NAO, 2010, pg. 6) The need for further analysis is clear in light of the NAO's recent calls:

> "there is a pressing need for better quality evaluation of private finance and other forms of procurement … Government … need particularly to ensure that they can compare the benefits and costs of different procurement routes" (NAO, 2009b, page 4)

and,

> "the systems are not in place to collect comparable data from similar projects using different procurement routes … together with robust evaluation of the overall whole-life costs of alternative forms of procurement" (Ibid, page 8)

Debande (2002) noted that data had yet to be amassed, as there had not been sufficient PFI contracts in the operational phase for data to be available. In 2012 this is no longer the case so there will be increasing opportunities to develop empirical analyses of operations between PFI and non-PFI facilities, providing insight into realities of WLC issues. This paper acknowledges the need for more empirical work in this area, but proposes to undertake a theoretical assessment of the opportunities for integrated contracts to realise WLC savings.

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[1] In this context, hotel services refer to the range of FM services required for the accommodation element of the facility provision.

1.3 Aims and objectives of this paper

The aim of this paper is to examine the context for the selection of the mix of capital and operational resources that deliver the optimal mix of highest operational services against lowest WLC. It does this by applying a common form of graphical representation used in the economics of production theory to the context of alternative forms of serviced infrastructure procurement. The reason for this application to the context of alternative procurement methods is to firstly, enhance understanding of the relative benefits of alternative procurement methods, while secondly seeking to improve the debate concerning what constitutes the optimal point of allocation between investment in the capital asset and operational services for the provision of public serviced infrastructure.

1.4 Term clarification:

CAPQ vs CAPEX: A distinction is made here between capital expenditure (CAPEX) and capital resource (CAPQ) and the operational equivalents of OPEX and OPQ, so as to disentangle price from expenditure to leave physical quantity. To talk about CAPEX may require us to assume that the cost of capital resource for alternative procurement methods is the same, where as this is not necessarily true. PFI projects resort to private finance typically at rates higher than that available to publicly financed projects.

Operations: this refers to the phase of the contract following construction when the serviced infrastructure is in use and where the SPV is in receipt of UCPs.

Contractible output: This refers to the performance of the physical facility as defined by an output specification. The simplest aspects to consider in this are the levels of availability of rooms and spaces that are maintained to a contractually defined quality. This may include, for example, that a hospital ward is maintained within a certain temperature range, lit to a specified standard and achieving defined levels of cleanliness.

Infrastructure: the accepted definition of 'infrastructure' in this investigation aligns with that of Fourie (2006), where a distinction is made within infrastructure, between excludable assets based services and public goods, where there is true non-rivalry and non-excludability. Hirschman (1958) also adds to these concepts highlighting that infrastructure is characterised by its fixed capital nature. Furthermore, we breakdown the general term infrastructure into the two subsets of Social and Economic infrastructure, as laid out by Fourie (2006):

- *Social*: infrastructure which promotes the "health, education and cultural standards" of society and broadly includes schools, hospitals, courts and forms of cultural capital such as museums.

- *Economic*: those infrastructures which promote economic activity in terms of facilitating market transactions and related undertakings, and so include roads, rail lines, air and sea ports, electricity generation, transmission and distribution networks, telecommunications and water.

Whole life cost: An effective definition of WLC includes: “the systematic consideration of all relevant cost and revenues associated with the ownership of an asset” as developed by the UK Construction Research and Innovation Strategy Panel (Constructing Excellence, 2004).

2. Theoretical framework

The theoretical framework to be applied is based on the notion of incomplete contracts and private information (Hart et al. 1997; Hart, 2003). Under a PFI contract, specified standards of operational performance must be achieved for the SPV providing the service to avoid financial penalties being imposed. A specified standard of output implies a certain level of expenditure on inputs. It is proposed that this expenditure can take one of three forms, the first being upfront CAPEX, the later two being subsets of OPEX:

- Upfront CAPEX – leading to a better-built or higher specification physical asset.
- Annual maintenance – frequent planned and responsive non-capital upkeep expenditure.
- Life cycle replacement – periodic infrequent renewal of capital elements of the asset.

There is an option of substitution between the three expenditures above with, in theory, an associated optimum lowest level of total expenditure (in present value terms) able to provide the contracted standards. This optimisation can be considered as the internalisation of a positive externality (Bennett & Iossa, 2006). This externality is the potential for WLC savings when there are separate contracts for the design, build and operation, which in the UK has been the default position in recent economic history. Furthermore, it is not just the bundling of the contract that is relevant, but the ownership and stewardship of the asset. This matters especially when investment cannot be verified or measured (Hart et al., 1997). Placing asset ownership within the SPV would be expected to incentivise optimal WLC investment to ensure the asset value (in terms of meeting contractual standards and the resulting revenue stream) is maintained. On contracts and incentives Grout comments:

> “If contracts can always be written to replicate any reward scheme, then it should not matter whether we have the same entity building, owning, and providing services, or have different entities with public ownership. The difficulty with this argument is that it assumes that contracts can always be complete in the sense that every eventuality can be covered and, therefore, incentives are not a problem.”
>
> *Grout, pg. 63, 1997.*

In that study, Grout goes on to concede the reality of incomplete contracting commenting:

> “In a world of efficient capital markets, full information, and complete contracts, the ownership transfer between the public and private sectors should have no economic effect. In practise, contracts cannot be complete and capital markets may not be perfect, so there is considerable scope for economic impact to

arise as a result of the specific ownership and contractual structure."

Grout, pg. 56, ibid.

On the completeness of contracts, Hart (2003) asserts that no contract can account for every possible eventuality. Furthermore, he suggests the lack of vertical integration between the client and provider incentivises innovation during operations, as savings can be realised for the providers' benefit in terms of increased profit for the SPV. When innovations are pre-envisioned during the tendering, some of the benefits will be passed on to the client in the context of a competitive tendering environment. When innovations are not envisioned, the provider is more likely to reap more of the reward of cost savings. Furthermore, Leiringer (2006) suggests innovation is more likely to occur if it has scope for application elsewhere, by reducing risk exposure to an uncertain single 'investment in operation'. Hart (1997) concedes that the freedom and incentive to innovate comes at a cost in terms of opportunity to shade on quality, as the provider's investments are non-verifiable.

In providing the SPV with a certain enough context in which to realise minimised WLC throughout an assumed 25 plus year contract, there is, however, a trade off in the flexibility of scope and standard in the operational services provided (HM Treasury, 2008; NAO, 2008). Some question the ability of PFI to deliver efficiency gains in sectors where the quality of the infrastructure cannot so directly reduce operational cost (including cost of provision of final services), such as in forms of social infrastructure, as opposed to say transport and water (Iossa & Martimort, 2008).

Given the output-based nature of the PFI contract, this study proposes:

A) SPVs will trade-off capital resource on design quality for contractible build quality, resulting in higher levels of the latter (than in Non-PFI facilities) per unit of CAPQ. This will tend to reduce OPQ of both forms, annual maintenance and life cycle replacement.

B) The relatively high discount rate SPVs will use in investment decisions, taken together with their ability to commit to levels of maintenance and replacement expenditure, will lead them to spend more on OPQ relative to CAPQ.

C) Banks will want as much as possible of the total expenditure to be CAPEX, so that when the riskiest period of the project is complete, i.e. construction, the cost risk can be minimised (and so costly monitoring activity reduced).

3. Research method

The research method of this paper is based on standard economic production theory. Specifically, the form of graphical representation of the available factor inputs facing a producer with a given budget (isocost), as well as the potential output of various combinations of those factor inputs (isoquant):

- Isocost: a line representing a varying maximum combination of units of factor inputs available with a given budget

- Isoquant: a curve representing equal levels of outputs within a 2 dimensional space defined by quantities of alternative factor inputs

In this paper isoquants represent a consistent level of contractible output of serviced infrastructure facilities, which is assumed to be the same between alternative forms of procurement to allow focus on consideration of WLC. The graph below illustrates these graphical forms of factor input cost (isocost) and performance output (isoquant). The efficient point is found where the isoquant is tangential to the isocost (shown at point A below). At this point WLC is minimised subject to a fixed level of contractible output. This point also tells us the optimal mix of factor inputs required at this efficient point of production.

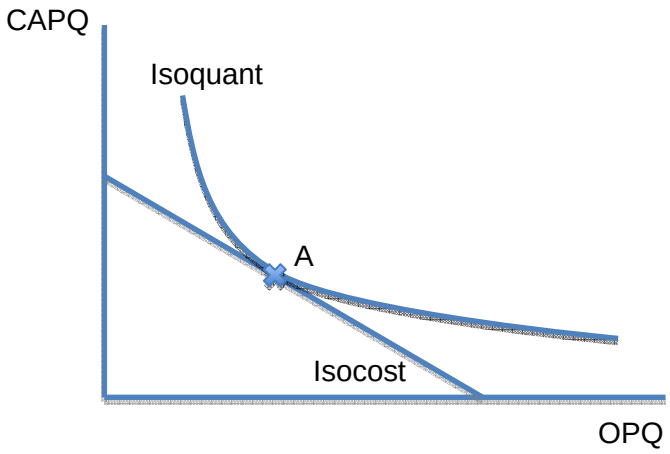

Figure 1. Isocost and isoquant diagram within a 2 dimensional space representing differing amount of the determinants of WLC, namely CAPQ and OPQ

4. Findings and discussion

4.1 Findings

4.1.1 CAPQ constraint

The first consideration of comparing where integrated and non-integrated forms of procurement are within our graph considers the notion that procurement method may impact on the ultimate freedom in choice between quantities of factor inputs. This is not necessarily due to a lower budget (lower isocost line would represent a reduction in WLC at given output). It could be a potential lack of knowledge about the relative productivities of the factor inputs in terms of whole life provision, or simply an aversion to CAPQ resulting from the inherent bias of the NPV method against upfront expenditure. Conventional procurement in the public sector has a reputation for failing to acknowledge the role of capital expenditure in WLC, so is thought to underspend on CAPQ generally. If this were the case, we would have a situation as below (Fig 2, point A), where there would be a conventional design and build construction contract with operational services provided in-house or separately procured via outsourcing. This scenario would restrict the ability to optimise the allocation of CAPQ and OPQ, resulting in a higher WLC represented by the dashed Isocost 1.

Fig. 2 below demonstrates the relevance of integrated contracts in helping to minimise WLC. Assuming there is some level of waste in the provision of in-house services resulting from a lack of competitive forces acting to improve provision, the move from point A to B represents the potential reduction of x-inefficiency through the introduction of competition for outsourced service contracts. However, any outsourced service supplier will be unable to make significant changes to the capital asset, so is restrained as to how much they can 'invest in operations'. Further, contract length will likely not be sufficient to allow them to recoup any significant investment in operations. The introduction of integrated contracts allows the provider to consider minimisation of WLC from the project outset as a constrained optimisation. This is defined by the relative cost and productivity of CAPQ and OPQ, allowing the move from a semi-optimised position 'B' to the optimal point C.

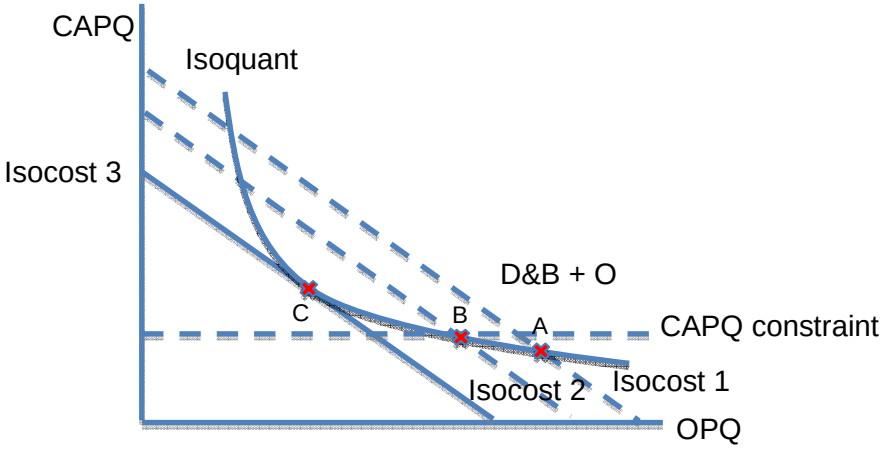

Figure 2: WLC minimisation with integrated procurement vs CAPQ constrained conventional procurement

4.1.2 Cost of CAPQ

One of the overarching criticisms of PFI in the UK is the generalised fact that as it must make recourse to private finance (as opposed to cheaper public debt) it will inevitably have a higher cost of capital. This capital in PFI projects is a blend of debt finance and equity investment typically in a 90:10 ratio. In the context of our analysis, we can illustrate this by a reduction in the ability to afford higher levels of CAPQ against a fixed WLC budget, shown below if Fig. 3 by the shift from Isocost 1 to Isocost 2. This finding suggests the increase in the relative price of CAPQ to OPQ will force a lower level of contractible output, illustrated via a move from point A to point B. Privately financed integrated contracts may be unable to meet the same level of contractible output as conventional procurement with a given WLC. This deficit may be compensated for by benefits of innovations in operations reducing WLC.

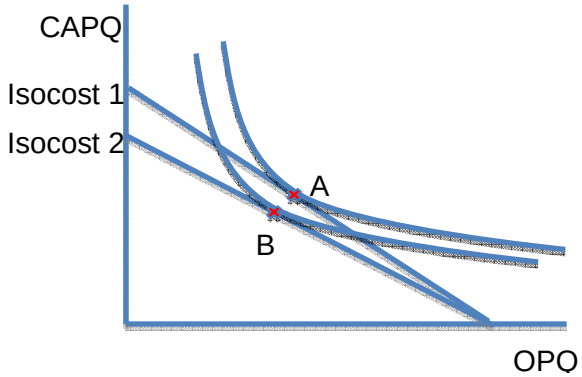

Figure 3: Illustration of the impact of higher cost of capital increasing relative cost of CAPQ to OPQ resulting in potentially lower levels of performance

4.1.3 Marginal productivities of factor inputs

The presence of financial incentives for maintaining or improving performance in PFI contracts stimulates increased pressure to seek efficiency gains during operations. The combination of integration and the long-term nature of the contract provide opportunities for these. Further, it could be argued there is greater potential for innovation during operations than there is for innovation in design and construction. In the context of our analysis we can represent this change in the productivity of OPQ as below in Fig. 4 with the shift from point A to B. We see an increase in productivity of OPQ meaning the same level of output can be achieved with lower amounts of OPQ input. This allows a reduction in the expenditure on quantity of factor inputs, represented by the new lower Isocost 2, with no associated decrease in output (both isoquants represent the same level of contractible output as shown by their convergence at low amounts of CAPQ). In the context of UK PFI, a reduction in OPQ may reduce the real WLC for the facility, but not necessarily the cost to the public sector as the UCP may remain the same. It is the SPV that would benefit from such an increase in the productivity of factor inputs, via anticipated reduced expenditure on factor inputs and hence higher residual profits.

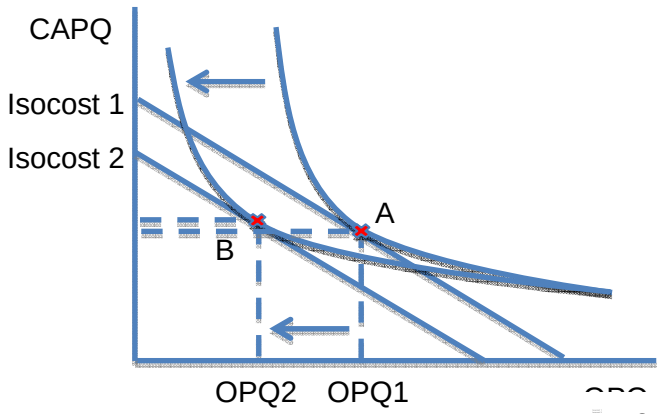

Figure 4: Illustration of an increase in the productivity of OPQ in terms of a static level of serviced infrastructure output

4.2 Discussion

The relatively high discount rate SPVs will use in investment decisions resulting from the margins paid on private commercial debt and dividend seeking, taken together with their ability to commit to annual maintenance and life cycle expenditure, will lead them to spend more on OPEX relative to CAPEX than a socially benevolent far-seeing planner would. However, the more relevant comparison is with the public sector ‘as it actually is’, where capital and operating budgets are often set separately and are the responsibility of different managers, and where construction expenditure decisions have therefore tended to disregard (and not merely discount) impacts on operating cost and resulting WLC.

Even if opportunities do exist for SPVs to reduce WLC through investment in operations and innovation, some comment that financiers of PFI serviced infrastructure, and specifically the providers of bank debt are sufficiently risk averse that any novel design solutions or high cost CAPQ investment in operations will either be excluded, on their demand due to their risk aversion to unproven technologies, or excessively priced (Rintala, 2004). The overall affect of this is likely detrimental for WLC if innovations cause the WACC to increase significantly through higher priced debt. A further barrier to reduction in WLC is the fact the SPV often re-fragments the integrated scope of the PFI contract into separate sub-contracts for construction and operations (Rintala, 2004). The result being incentives for realising capital investment in saving operational costs are reduced by suboptimal co-ordination between those that may benefit from reduced WLC, and those that will not, such as fixed price construction contractors. However, as a counter to this Rintala (2004) supposes:

> 'The client's use of PFI procurement and, thus, task integration improves the ProjectCo's opportunity to minimise *C*WLC*P*. This is because the fragmented and sequential traditional procurement creates contractual and organisational barriers between the private sector actors, which come under a single DBFO contract in PFI procurement. In addition, some of the private sector actors that are involved from the inception of PFI project development are only introduced to traditional service provision at a stage when the functionality and the quality of the building has already been determined.'

The economic efficiency of accommodation service PFI projects, Rintala, 2004, pg 44.

5. Conclusions and further research

5.1 Conclusions

Representation of the interplay between capital and operational resources can be represented through use of standard diagrams used in Economic theory of production. As a means of communicating the concept of potential for 'investment in operations' this could prove to be a powerful teaching tool, and further, a potentially valuable framework for the exploration of the relative benefits of alternative procurement routes for means of achieving minimised WLC.

While it was demonstrated graphically that integrated procurement may allow for WLC reduction (Fig. 2), it must be conceded that this could be restricted by the higher cost of capital resource maintaining the same level of output (Fig. 3). Further, based on this analysis, there seems no particular reason why non-integrated forms of procurement cannot seek to minimise WLC, if there were better knowledge about the relative pay-offs of CAPQ and OPQ and co-ordination in the budgeting for whole life provision.

5.2 Further research

This method of analysis will be applied more extensively to more scenarios within the context of alternative procurement methods, specifically with respect to potential changes in

the productivity of factor inputs. It is hoped in time to use this method of analysis to isolate the competing effects of differing factor costs and productivities, to develop a better understanding of when integrated procurement is more appropriate. Further, it is hoped this method can be developed to provide a more easily interpretable model for understanding the relative benefits of alternative procurement methods varying the level of integration between CAPQ and OPQ. There is scope to relax the assumption of an equal level of contractible output, as reflected in empirical studies produced recently (Ive et al., 2010) that show there is evidence to suggest some PFI projects may perform better than more conventionally procured facilities.

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