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A REVIEW OF PERFORMANCE-BASED CONTRACTING

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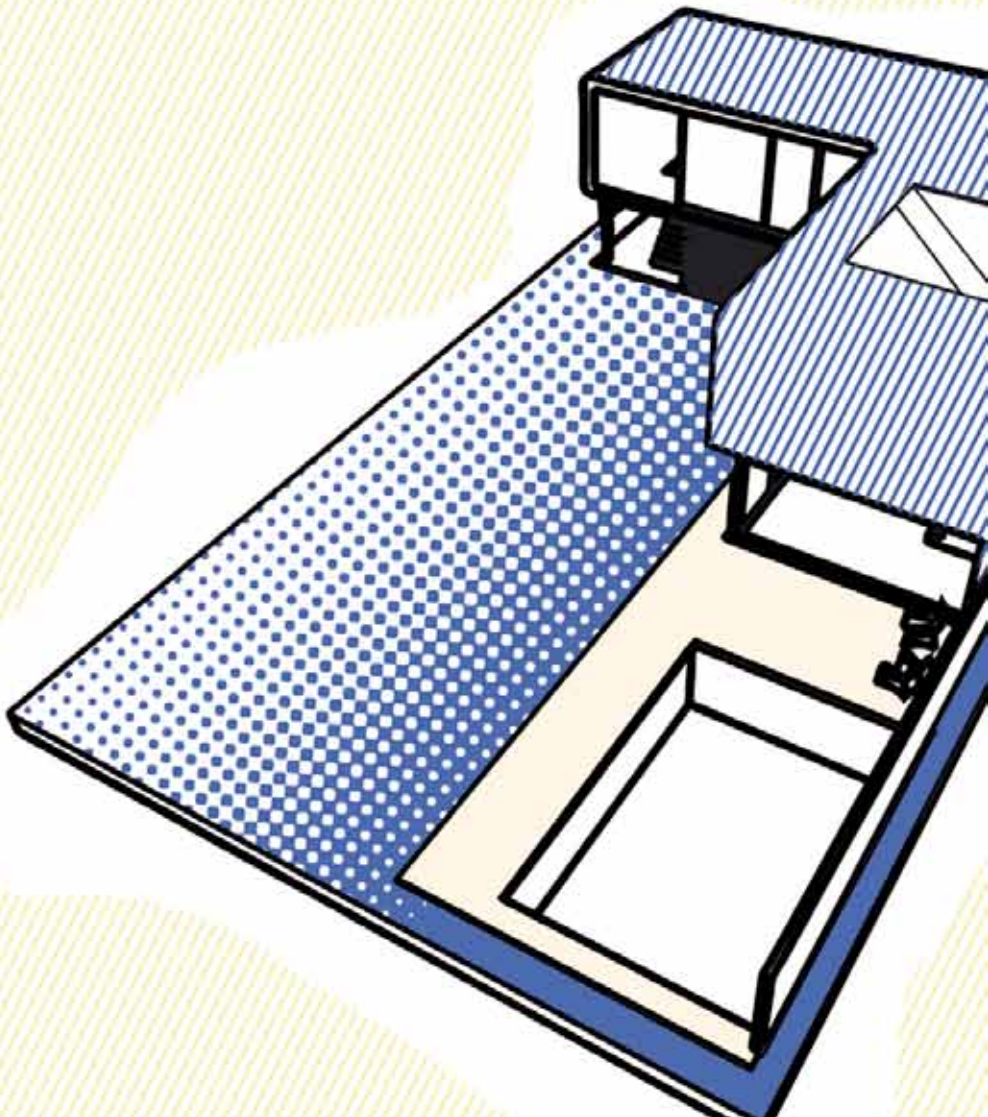

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Summary

Performance-based contracting (PBC) is a method of contracting, which is based on the post-construction performance of a building or structure rather than the cost of materials and labour that produced it. Payments by the client are therefore spread throughout the contract period (beginning on completion) and not as interim payments during construction.

PBC represents a simplification of the Private Finance Initiative as it separates the physical structure from the financial structures. This separation means that negotiations between clients and contractors are less time consuming, expensive and complex. Because the contract is not directly concerned with the details of the building, less paperwork and monitoring of the construction work may be required compared to traditional contracting and procurement methods.

A number of conclusions are drawn from our research and findings. These include:

- performance-based contracts often involve engaging a consortium of firms
- the roles and relationships within consortia are structured around risk. The members of consortia share commercial and reputational risks but otherwise adopt traditional roles within consortia-type arrangements
- the main source of risk and conflict is the reliance on other members of a consortium to deliver
- long term borrowing in construction tends to be lower than the automotive manufacturing and repairs sector, implying relatively less fixed capital investment and longer term commitments. This is reinforced by the ratio of fixed assets to capital employed and fixed assets as a percentage of turnover
- there are many firms in the construction industry whose ratios may well equip them to take on PBC contracts
- the perceived risks of PBC deter most contractors from considering PBC as an option. However, in a survey, carried out as part of this research, 5% of respondents agreed that PBC might be used for minor projects only, where the project represented only a small percentage of total output of the firm and was therefore not a threat to its survival
- PBC represents a service innovation if viewed as an extension of the provision of a product. Alternatively it may be viewed as the introduction of a new service.

To provide some context and a relative perspective, we compared the construction sector to a manufacturing sector. What this revealed was that:

- firms in the construction industry tend to have relatively lower capital to output ratios than firms in the automotive industry. This implies that firms in construction have little spare financial capacity for working capital, long term commitments and contingencies. This is reinforced by the net current assets to turnover ratio
- the argument frequently given that firms in construction experience relatively low profit margins is not supported by the comparison with the automotive industry.

[1] *INSEE*

Glossary

FFP
Fitness for purpose

FM
Facilities management

IPT
Integrated project team

PBC
Performance-based contracting

PBF
Performance-based fees

PBS
Performance-based specification

PFI
Private finance initiative

PI
Professional indemnity

PSS
Product service systems

SPV
Special purpose vehicle

TPO
Total property outsourcing

TPSP
Traditional public sector provision

01 Introduction

Problems of the construction industry concerning timely output, quality output and budget reliability in construction projects are repeatedly raised as issues facing the construction industry. The basic idea underpinning this report is that if contractors were responsible not only for the construction, maintenance and repairs of their output but also their performance, then far more attention would be given to the longer term post-construction phase of projects by contractors. Performance-based contracting (PBC) might offer a new approach, which could help to solve the problems. PBC occurs in practice already, more or less as standard business outside the construction sector, and is widespread within specific parts of the construction sector, and may be appropriate for wider application, particularly in the public sector. With PBC the politics, management and processes of construction procurement change. The politics of PBC concern the desirability and distribution of benefits of procuring buildings using contractors to carry out the increased role of owning and operating completed structures. Such change implies winners and losers.

If construction contractors are not in a position to undertake PBC alone, there may be a need for an intermediary level of organisation, such as consortia. Consortia introduce a level of management to undertake the complex roles and responsibilities involved in PBC. Consortia are often composed of organisations that possess construction management skills, property development and management skills, and finance. The supply chain of specialist contractors and material suppliers is often omitted from membership of a consortium. Nevertheless, because of increasing componentization, manufacturing firms are in a better position to guarantee their elements because:

- supplying firms often have the appropriate capital structure and component cost to total output ratio; and

- self-contained and definable components, such as doors, windows, air-conditioning can be guaranteed as whole functioning parts. This also applies to lifts, escalators, etc.

Therefore, installers might be given an ongoing liability to maintain their installations, though there may still be the issue of payment for the monitoring process. Long term performance contracts would mean that buildings may be maintained until they become obsolete, when the building becomes more expensive to maintain than market rental values would justify. Long term contracts would lock both clients and contractors into arrangements that might no longer be appropriate when market conditions change. Other long term risks involve spillover effects, such as the arrival of a new shopping centre making existing buildings appear unattractive or unlettable or local authority efforts to regenerate an area by improving facilities and amenities in a neighbourhood in order to encourage developers to invest and refurbish their buildings. These changes in a locality may raise a property's value and require refurbishment and maintenance above the maintenance levels agreed in the original maintenance contract. PBC may therefore not be as flexible as other arrangements for maintaining property, in the long run.

It may be useful to assume that the key players in construction are the main or large contractors, as they are in a position to mobilise the plant, labour and materials required. Since they have the technical knowledge to undertake the construction process, they are also in a position to improve the production methods employed. Contractors often argue that they should be involved at the early stages of a project, but instead are only brought in after much planning and design work has already been agreed and decided. It is well known that, once the design has been selected and the construction costs estimated, it is difficult for contractors to influence the outcome either to reduce the cost of construction or influence the running and maintenance costs of a building.

Traditionally, at least since industrialisation, main contractors were taken on only to produce what others selected or designed, which may not have been in the best interests of the contractor and, by implication, the finished building. Moreover, as far as the contractor is concerned it has usually been possible for the contractor to pass on to the client any increases in costs due to changes in the design or problems in the supply chain, not to mention problems further down the line after building completion, provided the contractor had satisfied the terms of the building contract. Indeed, building contracts have evolved this approach to such risks precisely so that contractors do not have to charge a premium in order to build up contingencies and, in many cases, so that contractors are still willing to tender, as contracts that transfer excessive risks to contractors may not achieve economical prices for clients.

Although the most economical price may be achieved by transferring the risk of increased resource costs to clients, public sector clients are often not in a position to take on projects without strict spending limits. Therefore, even though it may lead to higher prices, public sector projects need to be set up so that the contract sum is not inflated during the execution of the contract. In other words, it is better in public sector work for the contractor to take the risk of changes in market prices of labour and materials, i.e. internalise them to the contractor. In order to internalise the costs of contracting and the on-going costs of inappropriate building methods or building design, PFI sought, among other things, to make the contractors and funders responsible for costs throughout the building life cycle. While this may indeed be the case, the increase in transaction costs and the higher costs of finance together with the loss of control over the building has only been compensated for by possible efficiency gains due to the incentivisation of PFI. However it is by no means clear that any improvements in efficiency compensate for the increase in risk premium the public sector must pay in order for PFI projects to proceed.

Among other things, PFI combines finance with life-cycle costs in an attempt to internalize costs and create incentives for innovation and efficiency gains. However, the cost of tendering under PFI became prohibitively high to the point where contractors began to show increasing reluctance to bid for projects. If finance were to be separated from design and operational decisions, the result would be PBC, with a focus on the performance of buildings and the requirements of the client. Under PBC, finance could be procured in the conventional way by issuing bonds or by using public sector assets as collateral. The financial arrangements actually selected are quite separate from (though related to) the operational issues of PBC. Hence, finance does not have to be included in PBC. This separation would release the teams negotiating contracts from a large number of complications and reduce the costs of procurement and tendering. With sufficient profit margins in return for undertaking PBC, there are distinct possibilities for efficiency gains without PFI. In PBC, failure to meet performance standards would incur performance penalties. The penalties would provide incentives for contractors and operators to meet client requirements. The effect would be that buyers would only pay for services when they were being satisfactorily provided, and would not need to invest in infrastructure.

The key to performance is incentives. Those firms that are first to adopt PBC would gain a competitive advantage and expand while those that were slower would lose market share. The incentives would need to motivate firms and show that they could succeed so that others would follow. Because of the lack of contractual incentives to improve, little structural change has taken place in construction. The question is: why do current contractual arrangements not create incentives? There is therefore an opportunity to present a new model of contracting that would provide incentives and innovation, restructuring of the construction market and improvements in productivity.

Performance-based contracting (PBC) may be seen as an extension of the conventional building contract. Conventional building contracts tend to deal with labour and materials, rather than the way a completed facility performs. PBC may be referred to as ‘performance-based building’, ‘performance-based specification’, ‘performance-based serviced building acquisition’ or other terms using ‘performance-based’ as a prefix. In any event, all of these terms imply that it is the output of the building, which is important – not the means by, which it is achieved. This approach to contracting is interesting as it is the way that most things other than buildings are purchased. Indeed, many buildings are already purchased in this way; domestic housing, for example, is purchased in terms of its value, rather than the labour and material content. The emphasis in most discussions that propose and recommend PBC is on client or end-user satisfaction (for example, Ang *et al.,* 2001, Hattis and Becker 2001). A simple way to characterize the essence of a performance-based approach is that the focus is in what a building does, rather than its inputs.

PBC offers a method of procurement, which may be appropriate under certain circumstances. PBC replaces the acquisition of an asset with the purchase of a service. It is a form of service-outsourcing by the client without the need to transfer the property asset at the end of the life of a building or at a given point in the future. PBC enables firms to buy buildings or building components based on reward for performance rather than the materials and labour used in the production of the component at the construction phase alone. Examples of PBC in the USA include the provision of flat roofs, and in the UK the provision of lighting in the University of Bristol for a period of time. Some service agreements to install and maintain plumbing systems in buildings are also based on a PBC approach.

This study of PBC is concerned with the costs of tendering and procurement and improvements in the actual utility of buildings and structures. In contrast performance-based fees (PBF) allow savings of efficient design to be shared between the architects/designers and the clients as part of the contractual arrangements *per se.*

Since PBC is a method of buying services rather than buildings, it allows both private and public sector bodies to pay for the provision of a service without investing any capital. In the private sector this is commonly used to outsource such things as cleaning, catering, advertising, telephone sales and customer relations. In the public sector it may be adopted for health care, accommodation of students or key members of the labour force, provision of public transport, prisons, schools, etc. This contrasts with traditional public sector provision (TPSP), where the public sector owns and uses buildings to provide health care, education and other public services. The public sector also leases buildings, such as offices for the civil service, government agencies and local authorities.

The demand for buildings is a derived demand, derived from the public sector demand for services such as education, health and social welfare. Therefore, it is possible to specify the services required rather than the buildings themselves. The fundamental research question concerns the possibility of conceiving of a construction market paradigm that mirrors the way other markets operate, such as retail markets for consumer goods.

Introduction

PBC expands the role of contractors, property management companies and facilities managers. It may also represent new market opportunities for these firms. In order to take advantage of the new market openings, it is vital for these firms to understand the requirements they would be required to fulfil. This study will go part of the way to providing insights into the new demands of PBC and the responses these firms will need to make to meet them.

PFI offers an alternative model to the TPSP. In PFI the building is procured by the private sector and the services provided either by the public sector or the private sector. Examples of the former include schools and hospitals. Examples of the latter include prisons and infrastructure projects such as the Dartford Bridge and the M6 Birmingham bypass. The key point in PFI is that at some point the assets are transferred to the public sector, and therefore PFI may be construed as a complex means of borrowing capital, repaying it by paying for the service at the point of delivery.

The differences between the three models of public sector provision of mandatory services are summarized in Table 1. In TPSP, government retains ownership, control and management of the assets. In PFI, the assets are built and financed by the private sector (often with the help of payments in kind such as land or buildings already in the public sector) and eventually the new assets are transferred to the public sector. In PBC, as pointed out above, the assets are not necessarily transferred to the public sector. The ultimate risk of failure in the provision of the service in all three systems is carried by the public sector, although in PFI and PBC private sector firms are exposed to losses and the risk of bankruptcy.

Table 1: Features of traditional public sector provision, Private Finance Initiative and Performance-based Contracting

	Traditional public sector provisions	Private finance initiative	Performance-based contracting
Role of public sector	Public sector is provider and client	Public sector is joint provider and client	Public sector is client
Provider of services	Public sector employees	Public and or private sector employees	Private sector employees
Ownership of assets	Owned by public sector	Temporarily owned but later transferred to public sector (land tends to remain a public sector asset throughout)	Owned by private sector, not necessarily transferred to the public sector.
Value of assets	Gains held by the public sector	Gains shared by both public and private sector	Gains held by the private sector
Finance for capital expenditure	Public sector finance	Private sector finance under public sector approval	Private sector finance
Spillover effects	Political interests intervene directly on behalf of third parties especially when unforeseen events arise	Not the concern of the private funders and operators beyond legal and contractual requirements	Not the concern of the private funders and operators beyond legal and contractual requirements
Benefits	Gains returned to public sector. Ownership and control over national assets	Combines capital and revenue concerns in the building	Client can focus on delivery and service allowing management to respond
Disadvantages	Unresponsive service provision	Combines capital and revenue concerns in the building	Client can focus on delivery and service allowing management to respond

Figures 1, 2 and 3 illustrate the monetary flows (solid lines) from government and the private sector into assets and the provision of services, as well as the respective monetary gains. In Figures 2 and 3 the short arrow from government to the private sector represents revenue payments by government for services rendered. It does not represent any payments for capital investment since this is carried out wholly within the private sector in PFI and PBC projects. The broken lines represent non-monetary gains. In TPSP, any monetary gains are retained by the public sector, but there are also non-monetary gains, which consist of hidden subsidies to the private sector, such as low, subsidized fares on public transport that do not cover the cost of the provision, such as bus fares on designated routes.

Similar non-monetary gains may also arise in PFI projects. However, in PFI the monetary gains are shared (not necessarily equally) by both the public and the private sectors. In PBC the monetary gains are retained by the private sector though the public sector still receives indirect gains through taxation on income and profits, where these are declared in the host country. In buying the privately produced services, the public sector may also gain an equivalent of consumer surplus, based on value for money. PBC may also have implications regarding economies of management and different forms of accountability.

The point at which a preferred bidder is selected is known as the financial close. On reaching the financial close the private sector, often in the form of a consortium of firms, moves from an informal arrangement to forming a Special Purpose Vehicle (SPV). In Figure 1 the project is only concerned with the procurement of a building or structure. In Figure 2 the consortium is engaged to provide on-going services through an operating company. This takes the form of a project management company to, which the operating contract is transferred. In Figure 3 under PBC the role of the private sector is further extended to provide the assets and the service provision.

PBC begins by identifying the performance that is required by the client from a constructed facility. The contractor's reward is then tied to the extent that this performance is achieved. Building contractors negotiate directly on their ability to meet performance targets. The focus of the negotiation thus moves from a traditional supplier-led focus to a discussion of customer and user requirements. As well as a series of successful implementations in the USA, a number of modern procurement methods in the UK, e.g. Procure 21, Prime Contracting, involve these principles to varying degrees. Moreover, some European states routinely procure buildings on a functional basis, rather than the cost of the builders' work and materials.

Figure 1: TPSP

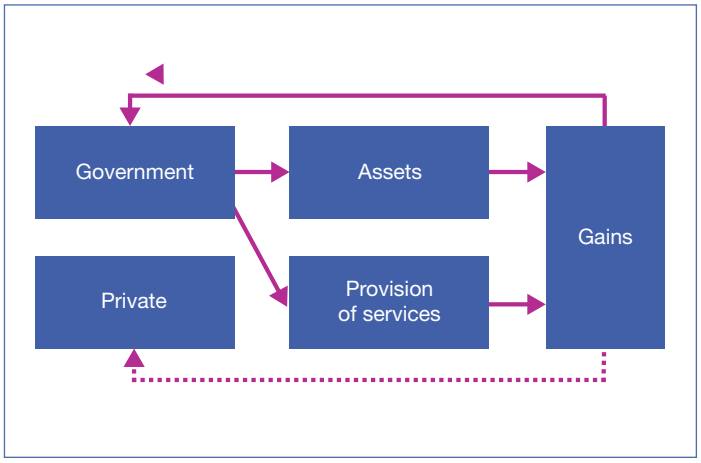


Figure 2: PFI

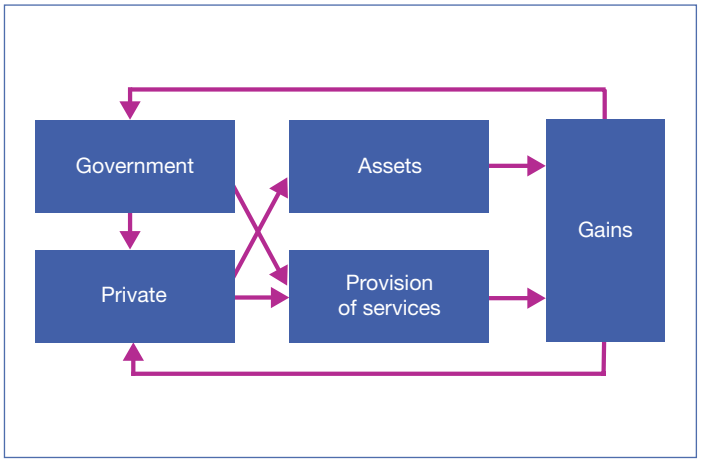
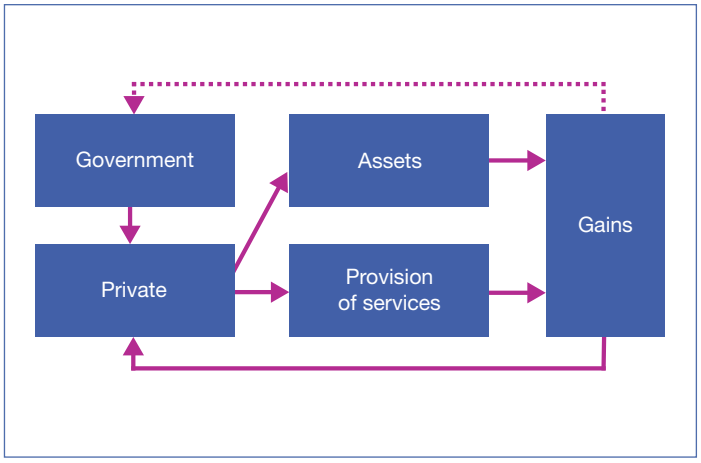


Figure 3: PBC



Introduction

Apart from PBC of whole buildings, facilities and services, there are a number of issues concerning planning and the organization and management of sub-systems in buildings. PBC may also be seen as a response to the calls by Achieving Excellence and nCRISP to discuss the need to adopt performance principles. From a research point of view this study may be seen as a speculative discussion about changing conditions in the property market-place brought about by developments in public procurement policies and technological developments. As such, this research could also be used to inform public sector procurement policies. Indeed, in view of changing current economic conditions, it might be argued that where PBC is used to simply provide services off-balance sheet, such practices might no longer be attractive to lenders.

1.1 Public sector procurement and the construction sector

As PBC is concerned with more than the delivery of a building or a structure, the range of skills, technologies, management strategies and business models that are required call for the use of additional combinations of firms to supply the full needs of the client. One response on the part of the supply side has been the adoption of supply chains and a focus on their management. Another has been the use of construction consortia which combine finance, construction management skills and facilities management services. Construction procurement by the public sector has long been seen as problematic. For example, one recent report published by the Office of the Deputy Prime Minister (ODPM) expressed concern over traditional approaches to procurement by local authorities. According to this report (2003: p12), the traditional interface between clients and contractors and the management of contracts often causes problems, which constrain innovation and inhibit the use of external suppliers.

Firms may often form consortia to provide large and complex public sector projects. These appear to be relatively efficient and effective. Hence, once a public sector client has decided that a major project is needed, it will often engage a consortium with sufficient financial backing and technical expertise in construction to carry out the work.

From the client's point of view the use of a consortium implies that a team could be employed, which would work together to solve problems, reduce costs and lower risks. At the same time, quality issues could be addressed. By forming a consortium it is intended to achieve these objectives in a shorter period than with traditional design, tendering and contracting methods, assuming firms collaborated at an early stage. Moreover, not only could the consortium carry out the building work, the same arrangement could be used to deliver services, including facilities management, after the construction phase.

Special Purpose Vehicles (SPVs) are invariably set up to structure the delivery once a contract has been agreed. Before a contract can be agreed, informal consortia are formed, combining banking, property and construction companies. Only when one of these informal consortia wins a bid is an SPV formally established. Several methods of public procurement have emerged under the umbrella of the PFI, including Prime Contracting for MoD projects, and Framework Agreements for schools and other types of building, and Procure 21 for NHS projects.

These initiatives invariably involve organizational structures that require a supply chain. For example, in Prime Contracting there are clusters of firms supplying the cluster group leader or Prime Contractor. Each of the clusters has clusters of other firms supplying their specialist construction requirements. Under Procure 21, Primary Supply Chain Partnerships (PSCPs) have been set up. These PSCPs are construction consortia, which have prequalified for NHS projects. However, Proverbs and Riley (2003) raise the issue of the extent to which the use of supply chains and clusters are formal rather than effective structures. In a case study of Procure 21 carried out by Proverbs and Riley (*ibid*.), they found little awareness among NHS Trust staff of the supply chain companies and, although NHS Estates advertised Procure 21 widely, individual members of staff were not generally prepared for the new system of procurement when it was launched.

The use of consortia in construction does not necessarily mean that construction firms could not work together outside consortia. In construction there has always been co-operation and a problem-solving ethos; otherwise buildings could never have been built. Nevertheless, the management of risk may be one factor leading to the formation of consortia. It might be argued that one of the main reasons for the formation of a consortium is because it is not possible to parcel up risks. The members of a consortium are forced into the position of trusting others to make commercial decisions on their behalf, which they are going to be held to, because in principle, though not necessarily, they are all jointly and severally liable. In practice, ultimately, the client or individual parties carry the risks at present. PBC may enable clients to reduce some of their risk associated with construction and facilities management by transferring it to contractors instead.

1.2 Objectives of the report

The objectives of this study are to:

- identify the contractual basis of the performance concept in building projects
- devise techniques for measuring the impact of different procurement methods
- learn how various approaches to PBC achieve their aims
- identify the extent to which sustainability needs could be achieved using the principles of PBC
- identify and disseminate how the principles of PBC could best be taken advantage of.

As main or large contractors are in a position to mobilize plant, labour and materials and, as they have the technical knowledge to undertake the construction process, it is apparent they are in a position to improve the production methods employed. Although contractors tend to prefer early involvement in projects, in many cases this does not occur. Once a design has been selected and the construction costs estimated, it is difficult for contractors to influence the outcome to reduce the cost of construction or influence the running and maintenance costs of a building.

Traditionally contractors have been taken on only to produce what others have selected, which may not always be in the best interests of the contractor and, by implication, the finished building. Moreover, as far as contractors are concerned it has always been possible for them to externalize any increases in costs due to changes in design or problems in the supply chain, not to mention problems further down the line after building completion, provided the contractor has satisfied the strict terms of the building contract.

One aim of PFI has been to externalize the costs to the client of contracting and the on-going costs of inappropriate building methods or building design. In PFI projects the public sector clients aim, as far as possible, to make the contractors and funders responsible for costs throughout the building life cycle. This has been done with a view to ensuring adherence to budget in public sector projects. The increase in transaction costs associated with PFI and the higher costs of finance were expected to be compensated for by possible efficiency gains due to the incentivization of PFI. However it is by no means clear that any improvements in efficiency compensate for the increase in risk premium the public sector must pay the private sector in order for PFI projects to proceed.

By combining finance with life-cycle costs in an attempt to internalize costs and create incentives for innovation and efficiency gains, the approach to tendering for PFI projects increased the cost of tendering considerably, to the point where contractors have begun to show increasing reluctance to bid for projects. For this reason, PBC may offer a solution to the high cost of delay caused by protracted negotiations between the public sector and the private sector by separating the discussion of finance from the performance of buildings and the requirements of the client. Public finance could be procured in the conventional way by issuing bonds and paying for service through the public sector revenue account. This would release the teams negotiating contracts from a large number of complications and reduce the costs of procurement and tendering. Naturally risks would still need to be identified and measured. Incentives would be provided by performance penalties even if projects were financed by government. Finance does not necessarily have to be included in PBC negotiations between the supplier and the client. There would still be distinct possibilities for efficiency gains without PFI.

The key to performance is incentivization. If those firms that first adopt PBC gain a competitive advantage and expand they would gain market share at the expense of those that were slower to adapt. Firms require incentives to attract them to new methods of working and demonstrate success, which others might then follow. However, in construction, firms have relatively few incentives or opportunities to innovate. For example, current contractual arrangements do not appear to create such incentives. It is therefore possible that PBC may provide an opportunity to present a new model of contracting that would provide incentives and innovation, leading to a restructuring of the construction market and improvements in productivity.

Much innovation in the construction industry is driven by the client. The public sector client, acting as a model client, may be in a position to create the conditions and terms necessary for contractors to respond by offering PBC. In PBC there is a need to specify performance levels and desirable outcomes. The client would need to give contractors and suppliers a clearly defined project, stating broad outcomes. For example, if the project were a school, which is a well defined use, the number of pupils to be housed with a specific list of functional facilities such as dining room, kitchen, library, gym, staff rooms and toilets form broad outcomes together with environmental and energy use performance specifications.

Contracting firms would then compete to provide the school, and quality would be driven by the contractors' need to protect their reputation and maintain good relations with their clients as well as their desire for repeat business. In this way PBC could be one method used by contractors to compete for market share and pursue growth policies.

In Germany, Hochtief offers clients solutions and costs and then offers to carry out projects but transaction costs remain relatively high. Using this PBC model, contractors demonstrate to the client how to obtain better value out of projects. One major constraint is EU competition law, which may have done much to prevent or limit abuses but at the cost of innovative procurement methods.

1.3 Literature review

Innovation in services

We begin the literature review by presenting a theoretical framework for innovation in general. We then review the literature on PBC in terms of its innovative properties.

The output of contractors consists of buildings and civil engineering structures and work on existing built stock. It might therefore be argued that contractors produce tangible products. However, it could also be argued that they move on to a site and assemble a number of different materials on behalf of their clients, the developers. It is the developers, who own the site and, because of interim payments, own the buildings under construction. The contractors merely provide building services, organizing the labour processes, hiring plant and equipment, and managing the materials and components on behalf of their clients. The contractors use their knowledge, experience and business contacts to provide a service to developers and building owners.

The dichotomy between product and service is being eroded, because PFI projects increase awareness of the life cycle implications of construction projects. Product Service Systems (PSS) in many sectors of the economy are being adopted to focus suppliers on the requirements and needs of customers with a view to improving the service to be provided. This after-sales service can include maintenance, repair and replacement of products and is offered in industries ranging from automobiles to lighting and facilities management.

PBC is an example, as is PFI, of innovation in construction services, where previously attention has focused almost exclusively on delivering a built structure. This innovative thinking can be seen in the context of economic theory concerned with services. In his analysis of the economics of service provision, Galouj (2002: p1) points to three approaches, which can be characterized as a technologist approach, a service-oriented approach and an integrative approach. The first relies on technology for innovation, the second on organization, and the third on convergence between goods and services. This last approach can be seen to account for the kind of innovation in the construction industry discussed in this report.

These three areas of innovation can be viewed in the context of different kinds of production-intensive firm identified by Pavitt (1984). First, innovation can take place in scale-intensive firms, which are engaged in mass production; second, specialized suppliers, such as mechanical engineering; third, science-based firms, such as electronics and chemical industries and supplier-dominated firms such as traditional manufacturing, agriculture and construction.

Of particular relevance here is Pavitt's description of supplier-dominated firms, which tend to be small in terms of numbers employed and have no systematic approach to research and development. They also tend to have difficulty adopting innovative technology based approaches, which forces these firms to rely on alternatives such as marketing. Their clients tend to be concerned with price more than performance, which leads the firms in this category to be focused on cost cutting. Although Pavitt's description is a generalization across a number of industries, it does appear to fit a description of firms in construction. However, Galouj points out that firms are far more heterogeneous than implied in Pavitt's description and later writers have expanded on Pavitt's work. For example, Soete and Miozzo (1990) add to Pavitt's taxonomy by describing service firms that are dominated by their suppliers of technical systems, firms that rely on networks of transport or information, and specialist firms that are science-based and innovative. Examples of all these types of service firm can be found in construction.

Barras (1986) suggests a theory of innovation, which passes through three phases. The first phase occurs as innovations in the process improve efficiency. The second phase is when these processes are used to improve quality of the service, and the third phase is the introduction of new services. Barras (1990) applies these phases to the banking sector. Using a similar approach, similar changes can be seen in construction. In construction, prefabrication and standardization may be viewed in terms of an efficiency improvement phase, whereas PBC may be seen as the introduction of new services made viable by the new technologies such as IT and communications and the resulting ability to integrate the production and service processes involved in the provision of a built structure. Although it is sometimes difficult to define the phases in construction, PBC clearly fits phase 3 in terms of offering a new service. Galouj points out that innovation in services is not the technological change itself but rather the changes in the service, which the technology permits as firms learn, adapt and adopt the new possibilities made available.

This discussion establishes a three dimensional framework, in, which innovative economic activities occur. These dimensions are production intensity, innovation path and phase of innovation. Each economic activity, V, thus comprises three elements. The first concerns production, P, the second is servuction, S, (used to distinguish service production from product production) and the third is the organization of the firm in its business environment. Belleflamme, *et al.,* (1986) summarize this as an equation:

$$V = bP + cS + I$$

The coefficients b and c represent the relative importance of production and servuction in the activity. If $b>c$ then the activity is concentrated on providing a good. If $c>b$ then the activity is largely concerned with providing a service. According to Belleflamme, *et al.,* this formulation can be used to identify a new service or good, a new or improved process of production or a new or improved process of servuction or combination of all three changes.

This can be seen as a framework for identifying the place of PBC in the construction production/servuction process. Perception is also important. PBC may be seen as an extension of the provision of a product or may be viewed as the introduction of a new service. This distinction is difficult to define. As Gallouj (2002: 40) points out, “If the protagonists believe that the product they are paying for and from, which they are benefiting is the immediate act of service delivery, the process and product are virtually one and the same thing.” He therefore suggests that a new service function based on existing processes is considered to be a product innovation. An existing service function drawing on new systems is generally a process innovation. If a completely new service and process is introduced it may be regarded as product innovation, which would not necessarily give full recognition to service innovation.

Gallouj (2002: 45) defines quasi-goods as devices or capacities placed at the user’s disposal, such as automatic cash dispensers, train ticket machines and information points. Car rentals and leasing arrangements would also come under the definition of quasi-goods. However, though different in scale a building or structure may be seen as a quasi-good placed at the disposal of the building users or those wishing to cross a bridge. As Gallouj points out the only difference between quasi-goods and traditional goods is their ownership and mode of use by the recipient. A traditional manufactured good is consumed individually while quasi-goods are used collectively.

Applying the equation from Belleflamme *et al.,* above, services, such as PBC, may be perceived as a set of characteristics comprising goods and services. These characteristics may be defined in terms of human requirements. For example, it may be specified that a building might provide adequate ventilation, light and sound insulation, warmth and security. A service innovation may involve the addition of a new characteristic such as entertainment, aesthetics, food and drink provision. Other specifications might include improved traffic flow within a building, improved rest areas and wash-room facilities, compared to existing facilities.

A further aspect of service innovation involves the participation of the client or recipient. Yet providing a service requires the co-operation of the client and indeed the recipient must have certain competencies in order to participate. Although the theory proposed by Gadrey and Gallouj (1998) is applied more generally to business and the professions, this aspect is particularly relevant to the interface between the supplier of building facilities and the building tenants and users, where both tenants and users must be able to specify their needs and use the building appropriately.

Servicing these specifications can only be accomplished by providing appropriate buildings or building components. As Gallouj (2002: 65) points out “goods produce lasting effects, which are services”. As buildings tend to be one of the more long lasting durables produced, their lasting effects have the potential to provide more services than goods produced in other sectors.

Introduction

Gallouj (2002: 71) identifies six linked and overlapping models of innovation – radical, which creates new characteristics; ameliorative, which improves the quality of characteristics; incremental, which adds or subtracts characteristics; ad hoc, which produces new competencies in individuals often transferring back into technical characteristics of the service; recombinative, which combines or separates groups of service characteristics; and, objectifying innovation, which standardizes service characteristics. Each of these models of innovation can be viewed in terms of PBC, as follows:

- first, PBC represents radical innovation in so far as new competencies are brought into existence that do not occur in traditional contracting. Here we might include PFI projects, where contractors are held responsible for the delivery of a building over a long period of time after completion.

- PBC might also be said to come under ameliorative innovation as it does not change the structure of the system but only alters the weight or importance of certain service characteristics. Again there are elements of incremental innovation as PBC involves both the addition of characteristics such as guaranteed services and usability, and the removal of others such as paper work and accountability for the materials and labour used.

- as ad hoc innovation often involves the interface between the service provider and the client, this form of innovation is relevant where projects are large and the client is a powerful agent such as a government department or public sector body. This may occur over the life of the building as requirements are altered to meet changing circumstances.

- recombinative innovation is also involved with PBC as the bundles of characteristics being combined are the characteristics of construction services and the characteristics of facilities management.

- objectifying or formalization innovation, is also applicable to PBC as this involves standardizing service characteristics, through specification of requirements and the creation of technical criteria. One aspect of formalization is the naming of the service, for example, PBC, Supply Chain Management and Partnering, and then establishing principles by, which the service might be defined. In many cases these models of innovation are responsive to changes in the business environment.

- the evolutionary theory of innovation sees innovation as a problem solving activity, providing new services to meet new or changing circumstances, which may be technical, social, political and organizational. Significant changes in technology and the built environment may be altering the way buildings need to be procured. The increased requirements of clients and the increased complexity of buildings may mean that it is no longer sufficient for firms employing relatively untrained staff to undertake relatively complicated roles and activities. The cost and time needed to acquire the knowledge necessary to design to the level demanded may be beyond the client's limits. Clients may know what they need without necessarily knowing how to achieve it.

This is common in many markets. The automotive, electronics and pharmaceuticals industries all supply goods and services, which are beyond the understanding of their customers and users. Nevertheless, markets for the outputs of these industries function efficiently to a greater or lesser extent. They clearly provide customer satisfaction as measured by the repeat business undertaken, at the same time generating sufficient returns on capital employed and satisfactory shareholder value. They achieve this by a continuous process of innovation.

Performance-based contracting

PBC is based on function rather than the provision of the built asset alone. For example, performance-based fees (PBF) allow savings of efficient design to be shared between the architects/designers and the clients as part of the contractual arrangements. Straub (2007) gives examples of performance measures in social housing in the Netherlands. These performance criteria include: jammed windows and doors, cracking paint and loss of gloss paint. According to Straub, the advantages of performance-based contracting based on such criteria include improved performance, direct and indirect savings, efficient risk allocation and reduced paperwork. Checket-Hanks (2008) gives the increasing cost of energy as a further reason for the interest in adopting PBC for heating and ventilating systems in the USA.

Of course the use of PBC in the public sector extends beyond construction. Boykin (2005) discusses PBC in general across different US government departments. Most Federal government departments and agencies were actively encouraged to adopt PBC by the setting of targets for PBC as a percentage of public sector procurement. This followed the Government Performance and Results Act of 1993, which set "program goals, measuring program performance against those goals" (Office of Management and Budget, 1993). These goals were also linked to departmental strategic plans and Congressional budgets.

However, Kimbler and Rutherford (1993) identified a number of issues regarding outsourcing of service providers including late delivery, non-delivery of promises and reworking, which was often required. Nevertheless, they found that corporate real estate outsourcing (including facilities management) was increasing in the USA. Similarly, in their survey of property-related management functions in Europe and North America, Bon and Luck (1999) found that out of the four services of design management, construction management, facilities management and maintenance management, only construction management shifted towards in-house management between 1993 and 1998. Outsourcing to carry out activities not seen as central by management to the specialist skills, services or products offered by firms appears to be on a rising trend.

Manning, Rodriguez and Roulac (1997) point to the potential benefits of outsourcing of real estate functions, including efficiency gains from economies of scale and scope. However, they point out that although a reduction in transaction costs in outsourcing routine tasks is possible, a premium transaction cost may be paid compared to in-house management to carry out the same tasks. Nevertheless, they, too, conclude that firms have increasingly and successfully outsourced some of their real estate responsibilities, but they point to the need to monitor the cost effectiveness of the transactions involved.

Applying similar methods in the context of the public sector, namely outsourcing routine tasks, could release funds in the short term for service provision. Using PBC, government departments could then concentrate on their core functions and outsource their fixed and current assets. PBC in the public sector could be used to extend the concept of outsourcing by including all labour inputs, buildings and their maintenance. However, there remain a number of practical difficulties. For example, some doubts have recently been expressed concerning outsourced hospital cleaning services. In the private sector outsourcing has usually been restricted to the out-tasking of low-level services such as cleaning, security, catering and reprographics.

Outsourcing can reduce costs if the contractor can take advantage of economies of scale and has greater bargaining strength in its own purchasing markets. This also takes advantage of the knowledge, experience and skills of the contractor, though some of the skills and experience of the client may be lost in the process as outside agencies take over certain functions. Nevertheless, outsourcing may offer benefits for firms and organizations but in order to take systematic decisions and monitor their effectiveness, according to Christensen (2001), three factors are important – a specifiable function, measurable activities and measurable risks.

One issue raised by Gibson and Louargand (2001) is that outsourcing the property portfolio creates a separation of property asset management from the management and strategic planning of the firm or organization. This means that the ability to exploit the property market is impaired and the ability to co-ordinate property requirements with the organization's own plans is reduced. Total property outsourcing (TPO) is concerned with facilities management, (FM), property asset management and property finance. Gibson and Louargand list the functions associated with FM, including security, cleaning, maintenance, reprographics and catering, often carried out by divisions within large construction firms. Asset management includes lease management, acquisitions, disposals, and redevelopment, often carried out by real estate consultancies. Funding includes freehold, leasehold, licences and joint ventures. Outsourcing can involve any or all of these functions.

Using different criteria, buildings can be subdivided in a number of different ways. Gibson and Louargand (*ibid*.) argue that property can be analysed using three criteria. These are the type of asset, the type of use to which the building is put and the type of environmental context of the property. "These categories have been selected because they relate in some way to outsourcing decisions" (Gibson and Louargand, 2001:47, italics inserted). However, Gibson and Louargand do not say how they relate to the outsourcing decision. Nevertheless, we build upon their work.

In more detail they define type of assets as strategic, special or generic. Strategic assets might be R & D facilities; special facilities could be wind farms or theatres, and generic types include offices, distribution and retail buildings. They describe the use of buildings as core, cyclical and casual assets. Core buildings are central to the functioning of the firm or organization, such as head offices. Cyclical buildings are those required in response to changes in demand for the services of the organization. Casual buildings are those only required on an ad hoc basis.

Gibson and Louargand (*ibid.*) see the property market in terms of varying degrees of risk for the property owning firm. Their framework or checklist can be used to identify and analyse risk exposure and the extent of the need for outsourcing different property requirements. They argue that "a key reason for outsourcing is to transfer risks to a third party that can manage the risks more effectively," (Gibson and Louargand, 2001:50). It follows that there is a need to determine which aspects of the workplace to outsource and the nature of the implied contractual arrangement.

Introduction

As PBC involves the purchase of services rather than a specific building, it transfers certain risks to the provider. Nevertheless, the client is still exposed to a number of risks, many of them as a result of PBC. The total risk to the client may even increase, but one of the reasons, and one of the incentives for the client to adopt PBC, is to reduce risk for the purchaser. The problem of risk then shifts to the suppliers and this increase in risk to the suppliers may be greater than the risk they are willing to accept.

The risks to the client are that even a small default by the provider may cost the client a disproportionately large sum, which could not or would not be reimbursed by the provider. The client no longer has direct control over the building or the services that a monopolist provider supplies. The costs of substitution would inhibit the client to the benefit of the provider. Future changes in requirements would depend on the negotiating skills of managers but be dependent on the monopolist supplier's willingness to comply. A further risk is that the business failure of the supplier would not lead to compensation of the client whose services would still be required by the building users.

The shift in procurement method to PBC gives ongoing control to the service provider. The client no longer has direct access to the detailed management of the service being provided. In public sector projects, the motives of the two parties – the public sector client and the private sector service supplier – are different. The aim of the client is to see that quality of service is maintained while the aim of the provider is to generate profits. The purpose of a public sector client is to provide public services whereas firms in the private sector aim to increase shareholder value. These aims are not always compatible. On the other hand, they are not necessarily incompatible.

In projects involving the provision of a building, the private sector is represented by construction contractors, who provide a service on the developer's land using cash flow to manage the building production process. As such, contractors are not willing (or able) to take on any residual risk after the term of a contract expires, the public sector conventionally assumes responsibility for the building at the end of the contract period. This reversion of the asset does not necessarily complicate the transaction. The purchase of buildings is not necessarily any more problematic or complicated in principle than in the housing market where purchasers buy houses with the minimum of inspection.

Because the public sector is mandated to provide services, there can be no failure due to a supplier being unable to function. For example school buildings have to be safe and weatherproof regardless of the financial problems facing a contractor. If building failure of a school occurs, portakabins may be used as schoolrooms. Until a solution of this nature is found, the school is out of use, and the providing authority is failing in its function – a situation that cannot last for long.

PBC may be a flexible form of procurement. Nevertheless, it could be argued that PBC is no different from conventional outsourcing. Indeed, many buildings are procured speculatively by developers who act as a form of outsourcing as far as their tenants are concerned. According to data referring to type of work in Construction Statistics Annual (ONS 2009) we estimate that 64% of private new work and 48% of all new work is speculative building, built without necessarily having a specific tenant or purchaser, and with a view to selling the capital asset at some point in the future. These percentages are based on the provisional figures for the proportion of private housing, offices, shops and warehouses as a proportion of total new building in 2008. However, not all new-build offices, etc, are necessarily speculative. Very approximately, at least half, i.e. the majority, of all new work is not speculative. Thus PBC may be a useful option, where buildings are built for use rather than speculatively.

Although these estimates assume public sector new work is not speculative, it is invariably outsourced. The Government's Civil Estates use various forms of outsourcing of buildings and services. PBC has already started.

Total property out-sourcing

TPO focuses on the provision of buildings, especially their elements such as air conditioning, lighting, lifts etc., and the facilities management on a day-to-day basis. There are three levels of outsourcing in terms of increasing value added activities: out-tasking, outsourcing and strategic outsourcing. The questions raised by total property outsourcing involve the following issues:

- Who should own the assets?
- Why might a firm outsource its workplaces?
- How can an organization assess the risks involved?

In principle, PFI enables public sector funds to be used to deliver services rather than create assets. It takes advantage of the fact that private sector firms have access to a wider range of funding than that available to the public sector though, of course, the financial crisis of 2008 and its consequences have highlighted the fact that financial market conditions can vary like any other market. The public sector may pay rents for the use of the buildings or the public may pay tolls directly for the use of roads or other public sector provided facilities.

If the fixed assets are no longer in the public sector, this would release funds for revenue spending for service provision. Government departments could then concentrate on their core functions and outsource their fixed assets. Private sector outsourcing has been restricted to the out-tasking of low level services such as cleaning, security, catering and reprographics, though the use of management consultants and PFI has extended the list of tasks.

PBC is a form of outsourcing. Outsourcing takes advantage of the knowledge of contractors using their organizational skills and experience to provide a broader range of services than they have traditionally undertaken. This could in turn lead to innovation in the way buildings are procured, built and managed and therefore add value to the process of service delivery.

There are, however, three areas of risk associated with property management. These risks relate to financial issues, the property market and business management. The financial risk is concerned with the timing of purchases and sale of properties. From the public sector point of view it is a question of managing publicly owned assets in the public interest, taking market conditions into account. For private sector firms, these financial risks are also pertinent, because they continually need to take into account their balance sheet position. Similar financial risks apply when renting or leasing properties when prices are relatively high, which may mean higher costs but this may be one method of managing possibly avoidable or postponable costs. Property market risks include the deterioration of a locality and its effect on property values. Business risks include inflexibility in the buildings, which impair the efficient operation of the organization. This is particularly the case when long contracts are entered into by the public sector. Uncertainty regarding the very long run may lead to ownership rather than outsourcing of property.

Although most TPO deals take more than a year to complete and implement, TPO may be attractive to decision makers. Gibson and Louargand (*ibid*.) point out that strategic outsourcing may be driven by factors that influence the environment that the firm operates in, such as the growth of e-commerce and/or corporate factors, such as a firm's changing property requirements. The decision to outsource may be the result of a number of business imperatives, including reducing the gearing ratio, raising cash and reducing the exposure to risk. Firms may outsource because they have insufficient cash or capital, or they may lack property expertise. They may have an outsourcing champion within the firm, who is a strong advocate for the strategy. Other reasons for outsourcing property may be the perceived relationship between the property portfolio and the organization's core activities or the ratio of annual property costs to total running costs, where this ratio is high. As part of a restructuring of an organization, one strategy open to decision makers is outsourcing.

Introduction

Difficulties in outsourcing property, and therefore obstacles to PBC from the point of view of the client, include the fact that different departments may be responsible for different aspects of the property function. Asset management may be located in a finance department while facilities management is organized separately. This leads to a number of difficulties in costing, pricing and managing outsourcing decisions. The outsourcing contracts may be complex and difficult to negotiate and outsourcing may be seen as a threat by the property managers within a firm or organization.

As assets, buildings vary in their specificity and flexibility of use. Some may be special buildings such as hospitals or theatres, while others are generic, such as offices and dwellings. The characteristics of these niche property markets involve varying degrees of risk for the property owning firm. Based on the type of built asset, if it has a specific use, or a strategic use as part of a corporate plan, or are general in nature. Gibson, V., and M. Louargand, (2001) suggest that these criteria can be used to identify and analyse risk exposure and the extent of the need for outsourcing property requirements.

TPO is concerned with property from the point of view of the developer or property owner. The question raised here concerns extending the role of the building contractor and this involves procuring an ongoing service provided by the contractor to incentivize the contractor in a project with a view to encouraging the contractor to consider the longer term issues of a completed building's use. This may well involve altering the conventional role not only of the building contractor but also of the developer, whose role has been to procure finance and act as a catalyst, bringing the stakeholders together and creating a built structure as an end result. As noted earlier, for service innovation to take place the client also has to be fully engaged in the process.

If particular building contractors do not have the financial structure to support this kind of provision, there may nevertheless be various aspects, i.e. sub-systems, of the provision of a building that may be outsourced effectively and efficiently. PBC at the sub-component level of construction involves specifying what components are required to do and the most efficient means of achieving it. One way of providing suppliers, whether manufacturers, specialist contractors or main contractors, with the appropriate commercial focus is for them to remain responsible for performance of their components after installation is complete. There are therefore three elements to PBC:

- the specifying of output
- the controlling of costs and paying suppliers, during and after construction; and
- the maintenance of service level.

With PBC, the contractor may undertake to maintain the component until it is replaced, or undertake to guarantee that the required functionality will continue to be available. Because of the loss of control and the transfer of risk it is unlikely that the whole service provision would be outsourced.

If PBC is seen as encouraging contractors to be innovative, then any new product or process would need testing before implementation. Unless the innovations had been tested previously, there would be every possibility that the constructor would bear the development costs and time of these innovations without any guarantee of a reduction in the construction cost. The disincentive for contractors to innovate using PBC would therefore remain.

The problems of service innovation can be seen as exaggerated forms of the problems of product innovation. High quality in products and building components is often perceived to arise when they have been tested and awarded a recognized standard from testing bodies such as the International Standards Organization (ISO) or the American Society of Technical Manufacturers (ASTM) or the European Commission (CEN). There is a considerable time lag between testing and implementation. Moreover, internationally, product standards are not always consistent (which is a necessary pre-requisite to establishing a successful trade in building products) (Foliente 2000; Knocke 1993). Poirier *et al.,* (2004) recognize the difficulties of certifying new processes and products and note that it takes time and many experts from many fields to understand the complexities of change approvals. Moreover, product quality is reduced by the practice of working to minimum standards as these may become the norm, rather than the minimum, and as it becomes increasingly uncompetitive to exceed the norm, revised standards are issued to enable the current market players to conform. This is partly brought about by representing the interests of the suppliers on the committees who negotiate standards, and partly through inculcating an attitude in the producer's workforce that quality is someone else's remit, not their own (Kanter, 1983; Dawson 1996). These arguments provide some of the justification for removing a reliance on specifying standardized materials and components and moving towards enabling suppliers to decide for themselves the best and most innovative way to achieve a client's aims.

Foliente (2000) describes the proposed development of performance-based codes. These would describe required performance in terms of quantity and ideally in terms of risk. This, according to Foliente, would then give designers more freedom to provide alternative solutions under their terms of the PBC arrangements. However, designers may prefer to include tried and tested products and processes because they are known, less risky and easier to monitor, especially if they have a delayed-reward contract. The purpose of codes or regulations is to enable designers to prescribe certain performance-based products knowing that they have a minimum standard. All the products in that group would then comply with a particular performance criterion. In the interim, prescriptive bases may be safe and low risk but prone to declining standards and unchallenging solutions.

A key problem in PBC is whether to specify that the building must perform to the client's requirements before the constructors can claim their rewards, or to simply make the builder liable for financial losses that stem from non-performance. Either way, this liability will need underpinning if it is to have any meaning. Financial backing for these liabilities could be provided by a number of mechanisms, most of which are discussed in Hughes, Hillebrandt and Murdoch (1998), an area that mainly lies beyond the scope of this report.

02 Risk

Gibson and Louargand (2001, p50) argue that "a key reason for outsourcing is to transfer risks to a third party that can manage the risks more effectively." From the clients' point of view PBC offers an opportunity to offload some of their risks on to the contractors.

Bramwell (2003) discusses PBC in terms of a contract that focuses on achieving a required outcome rather than a contract to supply a set of prescribed physical specifications. This, according to Bramwell, involves the use of functional terms in the contract to describe how a completed building will operate rather than specifying how a building will be constructed. He provides an example of where this approach was successfully utilized for the procurement of a school in Western Australia. It is clear that performance may be defined at a number of different levels: in terms of the overall building, particular components, systems or sub-systems, specific materials (as in a performance standard), a performance building code or other regulatory document, a performance tender, contract or sub-contract. Similarly, Kashiwagi *et al.,* (2003a) define PBC in terms of the performance required by the owner rather than the methods of performance, such as building specifications or design, thus reducing the need for detailed documentation but at the cost of increasing the contractor's liability and risk.

In PBC, the building itself is viewed as an intermediate output and construction is focused on delivering (or paying for) a finished built facility. With an emphasis on what the final output achieves, rather than what it is made of, the procurement method and period of liability is inevitably extended under PBC. If a supplier has a responsibility for performance, then their contractual liability must extend into the performance period. This has the effect of further increasing the risk to the contractor. As Smith *et al*., (2003) point out in their discussion of a case study of early design development in an apartment project, the identification and allocation of risks partly determine the procurement method and the building process.

PBC clearly alters the nature of risk and its allocation. This raises important questions concerning the identification and management of risk under PBC from a contractor's point of view. To date, little empirical research work has been carried out on the management of risk under PBC, even though a number of projects have been procured in this way.

Risk management involves risk identification and risk allocation. Construction risks have been identified by a number of authorities, including Flanagan and Norman (1999), who list the following areas in the construction process, where problems may arise: design, construction costs, latent defects, faulty materials, safety, completion deadlines and quality. PBC includes these risks for the contractor especially as some of these problem areas may become apparent during the life of the building and not during the construction phase. PBC thus extends the reward structure both in scope and in time. The responsibility for construction and some ongoing performance falls to the contractor. In principle, in return for taking on performance risk, the contractor should be rewarded when the building performs. The corollary of this is that the contractor is not rewarded when the building fails to perform as agreed. This allocation of risk, however, gives rise to some different and differently-weighted risks from those in traditional construction.

Risk is a combination of the three factors of probability, frequency and magnitude. Probability is the likelihood of something going wrong, whereas frequency is the number of times someone engages with a particular risk and magnitude is a measure of the impact of an event. All three aspects influence the way that someone might respond to a risk. Probability of risk is difficult to assess in building projects because each project will have unique characteristics making it impossible to predict with any degree of reliability how likely the risky event is. Buildings are too dissimilar. However, when a series of buildings is repetitive, it becomes possible to assess probabilities to some extent. Inputs and components of a building may stand statistical scrutiny, but most often a building as a whole cannot. This is a problem partly caused by the lack of systematically collected performance data and reliability data. Adams (1995), in his discussion on risks, argues that risk management strategy in the 1990s was more concerned with reducing risk rather than balancing the costs of risk mitigation and the benefits of a reduction in the number of the most adverse events occurring. Lo's (1999) approach to risk management theory is based on a synthesis of research in economics, psychology and the decision sciences. He suggests that total risk management involves price, preferences and probabilities. The intersection of these concepts is the decision point for deciding whether to bear or hedge the risk and this decision would be taken by the individuals involved influenced by their diverse risk preferences.

Risk

PBC may be seen as an attempt to change the way risks are allocated on a construction project by shifting them from client to producer. But this may be a somewhat naïve view, especially when public sector projects are considered. For example, transferring to the private sector the performance risk associated with, say, a prison, may increase the contractor's risk, but if the contractor fails to perform, the public sector client still has to provide the prison: non-performance is not an option. Therefore, there is not a finite amount of risk. In this example, risk to contractors may be arbitrarily increased. By implication, if buildings are the focus of subjective and unmeasurable risk-identification, only those producers who are confident in calculating the subjective risks and reward structures would be willing to accept a PBC project. Bing *et al.,* (2005) researched risk allocation amongst Private Finance Initiative projects (PFI) and came to the conclusion that public sector clients felt that most risks should be passed onto the private sector constructors with appropriate "risk compensation". As PFI is a good example of PBC in practice, it is demonstrable from PFI that PBC more generally also increases the allocation of risk to the producer/ provider, although for reasons mentioned above, there is not necessarily a corresponding reduction in risk for the buyer.

Kashiwagi *et al*., (2003b), note that when contractors carry the risks in PBC, the position of the client is strengthened, because, in principle, the contractor relies on the client for payment after completion when the building is in use. However, if, by the time the building is constructed, clients' financial positions have weakened, contractors may be extremely vulnerable financially as their cash flows remain dependent on their clients. Only the public sector can guarantee contractors' rewards by offering a guaranteed income stream. In any case it is unclear whether clients would choose to be in a position in, which they abdicated all decisions to the building supplier without payment until the building began to 'perform' according to some pre-determined criteria.

The risk of performance failure is real and potentially onerous for contractors and for clients. Most rational responses to an unavoidable increase in risk involve price increases, either to build up a contingency or to pay for some form of hedging of risk. PBC may therefore lead to higher construction costs.

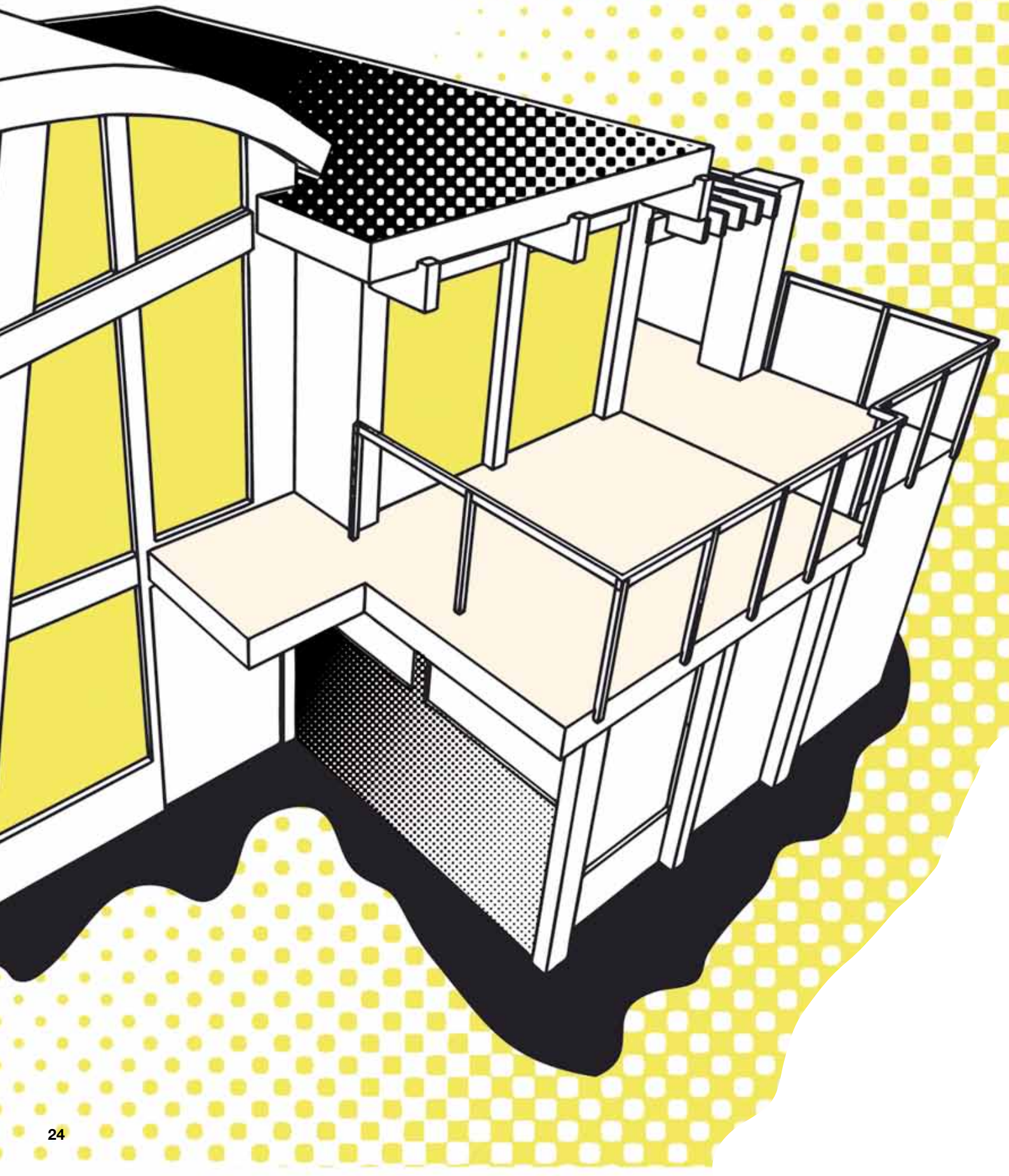
One response of the industry to increased risk is to spread the risk by forming consortia. Hayes *et al.,* (1987) discuss risk management from the contractors' point of view. Although they are not concerned with the issue of consortia they discuss the issue of risk management, arguing that an appropriate contract strategy involves consideration of the organisational structure needed to control both design and construction and the relationship between them. The allocation of risk between the various parties may not be best served by traditional contracting arrangements in undertaking high risk complex projects. When difficulties arise on site or when there are major cost overruns it may be too late to avoid the costs of delay, arbitration or litigation. They advocate "active management of a risk by all parties." (Hayes *et al.,*1987: 24)

Few papers have been published on the practical implications of the way that PBC changes risks, apart from Gruneberg, *et al.,* (2007). Other papers have studied the risk implications of transferring risk from the public to the private sector, including Price *et al.,* 2004. Managing risk is also discussed in Gruneberg and Hughes (2005) who point out that special purpose vehicles (SPVs) are often used as a shell company to operate a PFI agreement. These joint venture companies have few assets and are quite separate from their parent firms, who form consortia in order to undertake large projects.

These consortia form an additional layer of management to manage risk as one of their functions. Consequently they form a barrier between the public sector client and the private sector firms that actually carry out the project work. Indeed, most current examples of PBC are accomplished by the introduction of a third party between builders and procurers, for example in PFI the third party may be an SPV and in leased office space, it may be a developer. Where a contractor acts as a developer, such as in speculative housebuilding or office development, then the contractor takes all the risks of procurement.

SPVs are one method used by the private sector to deal with the risks associated with public sector projects. These SPVs have no assets, except their contracts and some non-recourse financing. SPVs only work because the public sector client has a guaranteed income stream and the companies concerned can price the risks accordingly. In the private sector this does not apply and the risks would be prohibitively large over the long term. Moreover, the proposition that a firm (or an SPV) may take on obligations but have no resources to back them up, appears to be contrary to the whole concept of PBC. Shell companies would not be able to satisfactorily discharge PBC, as they would have no resources to back up their obligations. In PBC, the PBC operator would be required to have a portfolio of projects to be able to cross-subsidize, if necessary, in such a way that their liabilities were not allowed to exceed their assets or some other form of guarantee or insurance. Their liabilities under PBC arrangements must be underpinned by their assets or some form of financial arrangement.

Under PBC, active risk management would suggest that a construction project should begin with an analysis of the main objectives and risks, followed by the identification of roles and responsibilities, and only then the identification of contractual terms, which would bind the parties in legal relationships. This is the opposite of the more usual practice of starting with a standard-form contract and adapting it to suit particular circumstances. Consortia may be viewed as organizational structures, which take risk into account at the earliest stages in a project rather than waiting for problems to arise at a later stage. They are one method of dealing with risk at the inception of projects.



03 Consortia

Banks and property developers with joint contractual financial arrangements may participate in the management and production of projects by being partners in a construction consortium. But they are only part of the management and production of projects. The actual building production is undertaken by a supply chain of a number of firms. The consortium forms a buffer between the public sector clients and the technology and resources used in the process. Yet construction consortia are often used to deliver PFI projects for the public sector. It is therefore worth considering the role of consortia in projects involving PBC.

3.1 Risk management in conosortia

The management of risk through the use of consortia may be viewed as an industry response to demand put to it by the public sector and very large private sector clients, especially where PBC is perceived to increase the risk profile of projects from the point of view of contractors. Demand is put to the industry in the form of project proposals. These projects tend to be very large and complex.

At any one time construction firms hold a portfolio of discrete projects on which they are working. Only firms of a certain capacity can undertake work over a certain size or complexity. When the workload exceeds that size, firms have no option but to seek partners. Otherwise the exposure to risk represented by one large project may threaten the requirement to balance risk in a firm's portfolio of projects. For this reason the relative commitment of any one firm to any particular project is limited. As PBC would entail a far greater financial commitment than other construction-only contracts, it would imply a disproportionate exposure to losses.

An SPV is a formal accounting and contractual arrangement set up by one or more firms to undertake a project or a series of projects separate from the accounts of the firm(s) comprising the special purpose vehicle. Thus, not all SPVs are consortia. However, consortia invariably set up SPVs after being selected to carry out specific work, and the members of the consortium become shareholders of the SPV.

An alternative approach to collaborative working is presented by Egan (1998), who suggests that major public sector building procurers could encourage the industry to integrate the construction process. These teams of firms would not necessarily be consortia, but they would form integrated project teams (IPT). IPTs would consist of all those firms involved with the design, manufacture, assembly, installation, operation and maintenance of the building and they would work closely with the client over the whole process with a view to achieving the customer's business objectives. Furthermore, the Specialist Engineering Contractors Group (2003) advocate that the selection of IPTs should be based on best value rather than lowest price. This would be seen as providing participating firms with opportunities to produce cost-effective solutions, enhance their own profit margins and secure greater continuity of work.

3.2 Types of consortia

Although some construction consortia may appear to include contractors, many PFI bids are assembled by developers and financiers, using a contractor only to present a technical input to the client. In practice, the construction contractors are kept at arm's length and are not full participating members of the consortium. There is no one form that defines construction consortia. On the contrary there are several types of consortia: developer-financial consortia, developer-financial-contractor consortia, client-developer consortia and single-type-organization consortia. Some are involved in the essential commercial risk-taking of projects while others are involved in the building production process and some combine commercial risk, construction and service provision. Variants of the consortium concept also depend on the relative size, skills and financial inputs of the various parties needed to meet the specific demands of each project, building or service requirement.

3.3 Relationships between firms in consortia

In their paper discussing a survey of supply chains, Akintoye, *et al.,* (2000) point out that although they found improvements in planning and purchasing, a number of barriers remained, which inhibited collaborative working. They found a hostile culture in the industry amongst senior managers in the top construction contractors they interviewed, and a lack of commitment to supply chain management (a form of IPT in which specialist subcontractors are engaged in a close working relationship with the main contractor). They also found organizational structures, which failed to encourage collaboration. This collaboration could be achieved through incentivization and this in turn could be achieved through PBC.

However, it remains to be seen if incentives could be devised that would overcome the consortium nature of construction, which, according to Pearce (2003: 23), creates major difficulties between the various participants in the building process and adds to the transaction costs of delivering "consistent work patterns and effective communication".

04 Research issues

PBC may be seen as a potential development of PFI, which overcomes some of the difficulties of PFI. PBC may alter the perception of privately procured services for the public sector, given that privatization has transformed ownership patterns in the UK. A number of issues emerge.

- Because the ownership of buildings comes outside the contractual arrangements in PBC, does PBC simplify public sector procurement? It may enable the public sector to concentrate on performance outcomes, standards of service and monitoring rather than the micro-management of large diverse organizations such as the NHS.
- How can PBC be implemented and what are the steps that need to be taken?
- What, if any, are the implications of PBC for the construction industry?
- Would the construction industry need to re-organize and adapt or would new agencies emerge, which undertake construction processes as well as service provision on behalf of government? For example, property development may be combined with facilities management and service provision.

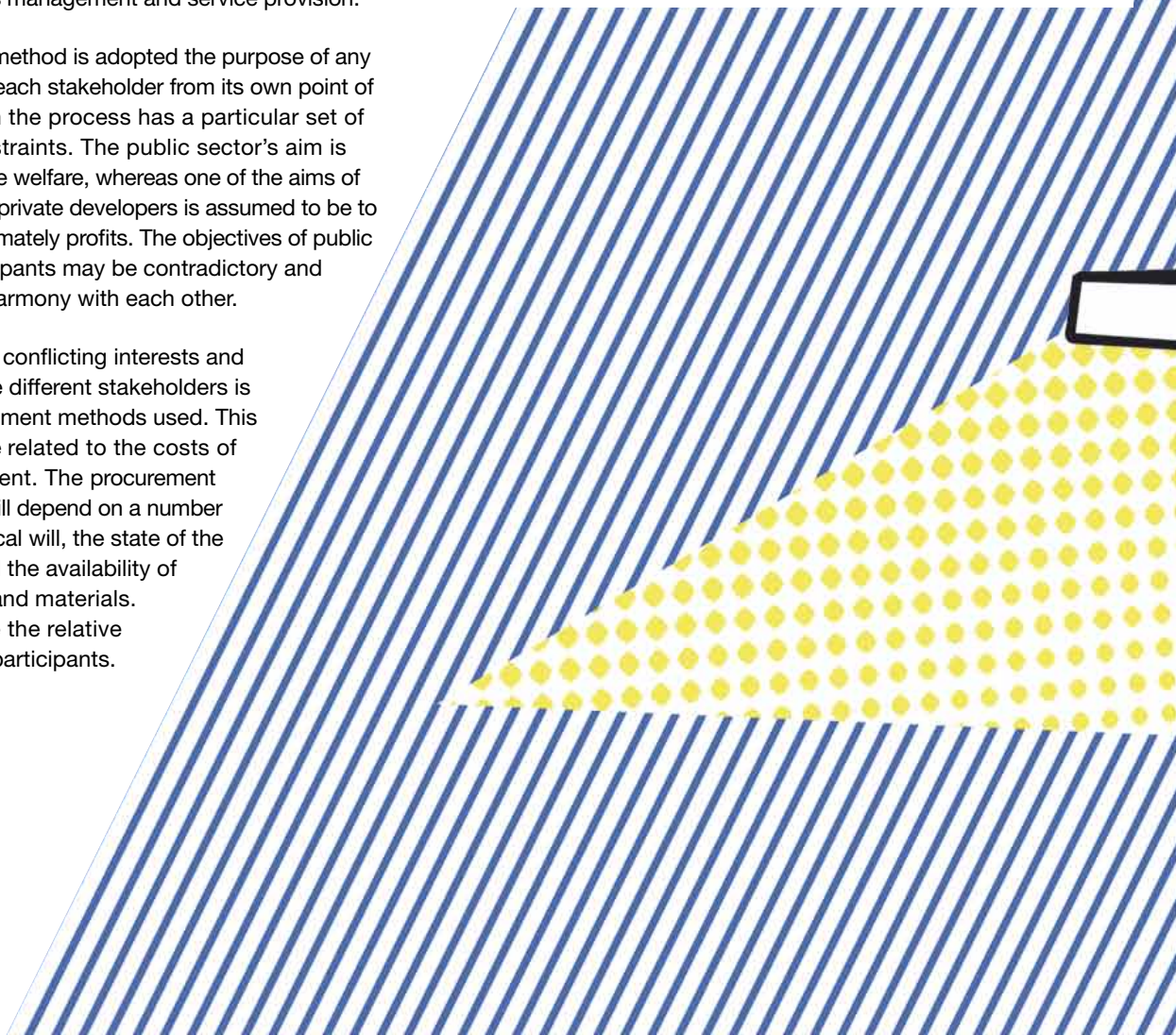
Whichever procurement method is adopted the purpose of any project is determined by each stakeholder from its own point of view. Each participant in the process has a particular set of interests, aims and constraints. The public sector's aim is assumed to be to increase welfare, whereas one of the aims of contractors, consultants, private developers is assumed to be to increase turnover and ultimately profits. The objectives of public and private sector participants may be contradictory and therefore not always in harmony with each other.

One manifestation of the conflicting interests and objectives of some of the different stakeholders is played out in the procurement methods used. This study of PBC is therefore related to the costs of tendering and procurement. The procurement method finally selected will depend on a number of factors including political will, the state of the construction market, and the availability of resources in manpower and materials. These factors determine the relative economic power of the participants.

This investigation considers questions regarding the characteristics of construction contractors that emerge in discussions on PBC including:

- organizational structure
- financial structure
- bargaining power
- integration with suppliers
- market position
- contractor's role (merchant or professional); and
- liability for performance.

This research also discusses some of the contractual principles that would be needed to underpin developments in procurement and contracting methods in the UK to facilitate PBC, and the impact of PBC on the way in which firms are structured and projects are managed.



05 Method

Partly because of the risks to the client and partly because of the difficulties faced by suppliers, it is unlikely that PBC for whole building provision will always be viable or appropriate. However, it may be possible to offer PBC at sub-system levels such as M&E services, furnishings and building maintenance. To investigate this, it was decided to conduct a number of interviews with decision makers engaged in different aspects of the development and construction processes. Diverse responses were anticipated, each appropriate to different kinds of building, different kinds of building components, different kinds of deal and different firms.

Contractors are not an homogeneous group. The Standard Industrial Classification (SIC) divides the construction industry into five 3-digit classifications and these form the basis of our analysis of the business ratios of contractors. If their financial structures differ widely these differences may partly account for differences in approach to PBC between the various classifications. Our investigation focuses on detailed issues regarding the kind of construction contractor that would emerge in terms of organizational structure, financial structure, bargaining power, integration with suppliers, market position, contractor's role (merchant or professional), liability for performance, and so on.

Contract terms are considered in terms of ownership of assets, the acquisition of building sub-systems and the liabilities associated with the operation and performance of completed structures.

The move towards PBC for procuring parts of buildings requires an understanding of the needs of the client. The person who specifies what is to be bought should be the one with most knowledge of the client's programme. This suggests that the way that projects are managed should be expected to change. The construction industry may provide general construction project managers, but it may be more appropriate for clients to develop their own project management skills in-house.

In order to carry out an assessment of contractors' attitudes towards risk management of PBC, a telephone survey was conducted. The survey was targeted at the top 50 UK construction companies, ranked by turnover, (Building Magazine, 2004). The measurement of size by turnover was preferred to operating profit because profit is related to management expertise and for this particular research, contractor turnover was a better measure of the work undertaken by firms. The questionnaire (see Appendix A) was targeted at senior managers or directors with responsibility for strategic decisions.

Forty-five companies were contacted and 22 responses received. Most questions (Appendix A) were open-ended. For example, respondents were invited to suggest what they considered to be the risks associated with PBC (see Appendix C) and subsequent questions related to the risks they identified.

Respondents to the survey included marketing directors, commercial directors, managing directors, risk managers, regional directors, business development managers, directors of risk, finance directors, chief estimators, and quality and standards executives. From these responses, it was possible to conclude that some had board-level responsibilities; others were middle-managers and others office clerks.

Senior managers in large construction firms, many of whom are involved in PFI projects, might be expected to understand PBC concepts. However, when asked to define performance-based contracting, only 23% of respondents claimed to be aware of it. This may be because of unfamiliarity with the terminology. An operational definition of PBC was therefore provided for the purposes of securing consistent answers in the survey.

Another aspect of this research has been the study of consortia in construction. As PBC of whole buildings requires the collaboration of a number of firms, the study of consortia is based on a literature review reinforced with interviews with a number of leading practitioners. Interviews with selected practitioners from the demand side and the supply side of consortia have enabled us to develop clear explanations and answers to the research questions. The interviewees represent a public sector client, a developer, a bank, a financial consultancy, an independent project manager, a construction industry consultant, two main contractors, a specialist subcontractor and a legal advisor. The size of firms approached ranged from small consultancies to relatively large firms, such as Bovis Lend Lease, Symonds and EMCOR Drake and Scull. Only one contractor's responses are included in Tables 10 to 13 below to maintain a balance of the different perspectives.

The interviews were divided into an open discussion of construction consortia and a series of specific questions designed to highlight particular issues. The questions covered two areas of interest; first, the setting up and operation of consortia and second, the management of risk and decision-making.

Eight structured interviews were conducted, based on the questions shown in Appendix B. In addition, two further interviews were carried out for the purposes of dealing with some specific outstanding issues. While these additional interviews are reported, they are not included in the tabular analysis.

Method

Analysis of specialist contractors was carried out using Financial Analysis Made Simple (FAME) published by Bureau van Dijk Electronic Publishing. The Standard Industrial Classification (SIC 95) 3-digit codes covering all parts of the construction industry were used to find the median values of a number of ratios. These construction sub-sectors were also compared to the equivalent ratios of firms in the auto repair and maintenance and auto manufacturing industries, in order to test the widespread assumption that construction is not like manufacturing. These were analysed to view the extent of variation in profit margins and capital structures of the firms in different specialisms. Table 2 defines the SIC codes used and the number of firms' accounts analysed in the study. The predominant types of firm in construction are in SIC 45.2, SIC 45.3 and SIC 45.4, which together constitute approximately 97% of all firms studied. SIC 45.1 and 45.5 are therefore omitted from our discussion, though they are included in the tables.

It can be noted that the variance within each subdivision is greater than the variation of the ratios between different sub-classes within the construction sector. Though inter-quartile ranges provide insights, to simplify the analysis in this report only medians are compared. Tables 3 to 9 summarize the full set of tables given in Appendix D. The annual median ratio for each year between 1996 and 2004 in each 3-digit class was found. The summary tables only show the highest and lowest annual median ratio found for each classification regardless of when it occurred between 1996 and 2004.

This analysis relates to the hypothesis that only those firms with capital assets and relatively high profit margins are in a position to undertake PBC as their resources would be needed to finance the long term commitments and cash flow requirements. Medians were used. These were calculated for each ratio in each year in each 3-digit SIC code. It should be noted that the medians of each ratio of each SIC in each year relate to different firms and therefore do not indicate the profile of a theoretical median firm, even if such a concept could be defined.

The FAME data base is designed for current enquiries concerning existing firms. As a result the data base does not hold data on firms that no longer exist in the year of the latest version of FAME. Time series of the FAME data base are therefore biased in favour of those firms that survived. The population of firms in any past year declines the earlier the year. Indeed there are so few firms that appear in every year of the FAME data since 1996 that using a cohort of firms in 1996 produces such small numbers that the result would not be meaningful or useful in any comparison of different SIC codes in this report. As a result it is not possible to aggregate the accounts for each year to form a time series of aggregate output. The approach adopted here is to use ratio analysis taking the median values for each ratio. This does not build a picture of an average firm overall as the different median ratios refer to different firms.

As many specialist firms in construction undertake work in a number of different areas, it is not possible to analyse Companies House data in terms of specialisms or markets. Instead it is only possible to discuss the firms that carry out specialist work. The focus is therefore on the firms rather than the specialism.

In looking at a given year of data, the tax year is used. As some company year-ends occur shortly after the start of the year their accounts are mainly concerned with the preceding year. There is therefore a built in time lag in the data that should be noted.

Table 2: SIC codes and number of firms*

SIC 95 3-digit codes	Description	Number of firms	Percentage of firms
45.1	***Site preparation*** 45.11 Demolition and wrecking of buildings; earth moving 45.12 Test drilling and boring	1301	1
45.2	***Building of complete constructions or parts thereof: civil engineering*** 45.21 General construction of buildings and civil engineering works 45.22 Erection of roof covering and frames 45.23 Construction of highways, roads, airfields and sport facilities 45.24 Construction of water projects 45.25 Other construction work involving special trades	64 601	53
45.3	***Building installation*** 45.31 Installation of electrical wiring and fittings 45.32 Insulation work activities 45.33 Plumbing 45.34 Other building installation	29 733	24
45.4	***Building completion*** 45.41 Plastering 45.42 Joinery installation 45.43 Floor and wall covering 45.44 Painting and glazing 45.45 Other building completion	24 925	20
45.5	***Renting of construction or demolition equipment with operator*** 45.50 Renting of construction or demolition equipment with operator	2036	2
	Totals	122 596	100
34	Manufacture of motor vehicles, trailers and semi-trailers	1447	5
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	25 297	95
	Totals	26 744	100

*Omitting firms with no account

06 Findings

6.1 Analysis of accounting data

One view expressed in a number of discussions held with contractors during the research process was that builders were not in a financial position to carry out work under PBC. While it might be argued that contractors do not have the capital to undertake PBC, and that the risks of PBC are too great and too long term for contractors, it does not follow that firms in the construction industry could not build up the expertise to undertake the life cycle commitments necessary for PBC. The financial ability or capacity of firms in the construction industry to undertake the long term commitments implied in PBC is shown by a study of the accounts of construction firms.

One of the key financial performance indicators of firms is the return on capital employed (ROCE). In Table 3, the median rate of return of firms in SIC 45.2 (Building of complete constructions or parts thereof; civil engineering) the ROCE varies from 18.3% in 1996 to 44.5% in 2004. In 45.3 (Building installation) the ROCE was 30.5% in 1997 rising to 100% in 2004. SIC 45.4 also displays returns on capital employed of 27.6% in 1996 to 104% in 2004. These figures compare to 9.9% in 2001 to 18.5% in 1996 in auto manufacture and to 15% in 2000 and 23.5% in 2004 in auto repair and maintenance.

The relatively high ratios in construction indicate that ROCE is not necessarily a useful measure of performance in the construction sector. These high rates of return occur because the business model of firms in the construction industry is based on the use of very little of their own capital and a negative cash flow.

The higher ROCE ratios in construction compared to the auto industry are due to the tendency of construction firms to employ relatively little capital by relying more on credit from suppliers (including plant hirers) and interim payments from clients, unlike firms in the automobile industry. This is an important distinction to draw as it implies that construction firms tend to be relatively insubstantial, in terms of capital employed, and highly geared. This can also be seen directly in the comparison below of the capital to output ratios, fixed asset ratios and gearing ratios of firms in construction compared to the auto industry.

Table 3: Median percentage ROCE in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	303.4	412
45.2	Building of complete constructions or parts thereof; civil engineering	18.3	44.5
45.3	Building installation	30.5	100
45.4	Building completion	27.6	103.7
45.5	Renting of construction or demolition equipment with operator	13.2	17.6
34	Auto manufacture	9.9	18.5
50	Auto maintenance	15	23.5

The hypothesis is that the capital to output ratio shows that firms in construction are able to generate a far higher turnover per £100 of capital employed than firms in the auto industry. If this is found to be the case, it would confirm the relatively high level of capital utilization in construction compared to auto manufacturing and automotive repair. A low capital to output ratio implies a high level of capital utilization.

The evidence to support the low capital to output ratio is given in Table 4 by the ratio of capital employed per £100 of turnover. In SIC 45.2 the capital employed per £100 of turnover tended to be between £12.60 in 2003 and £14.40 in 1997. In SIC 45.3 it was £9.47 in 2003 to £11.42 in 1997. In SIC 45.4 it was £7.70 in 2003 and £10.80 in 1996. These figures are compared to the auto industry where the capital to output ratio of manufacturers was as high as £29 in 2003 and £41.30 in 1997, approximately 3 to 4 times more capital per £100 of output than in construction. This demonstrates the relatively low level of capital construction firms employ to undertake work and the low level of capital investment by contractors. Their utilization of capital is considerably greater than in the automotive industry. This leaves little capital or capacity for contractors to guarantee their output. To measure the ability of firms to guarantee output, the proportion of capital available can be seen in terms of net current assets as a percentage of turnover.

The ratio of net current assets to turnover indicates the financial capacity and flexibility of construction firms to deal with the short term liabilities that arise in the course of PBC from year to year. In Table 5, the median net current assets to turnover in SIC 45.2, 45.3 and 45.4 range from as low as 1.6% to 5.5%. These figures are only slightly below the auto industry at 1.7% to 7.3%, with a large overlap between the two industries. This implies that firms in the construction sector are no less able to meet short term obligations that might arise under PBC than firms in the auto industry.

Table 4: Median percentage capital employed to annual turnover ratio in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	21.8	30.8
45.2	Building of complete constructions or parts thereof; civil engineering	12.6	14.4
45.3	Building installation	9.5	11.4
45.4	Building completion	7.7	10.8
45.5	Renting of construction or demolition equipment with operator	48.2	62.8
34	Auto manufacture	29	41.3
50	Auto maintenance	10.1	12.6

Table 5: Net current assets as a percentage of turnover in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	0.4	3.6
45.2	Building of complete constructions or parts thereof; civil engineering	4.3	5.5
45.3	Building installation	3.0	5.1
45.4	Building completion	1.6	3.3
45.5	Renting of construction or demolition equipment with operator	-10.9	-3.2
34	Auto manufacture	2.9	7.3
50	Auto maintenance	1.7	2.5

Findings

If the availability of net current assets is not a good reason for contractors to avoid the commitments and liabilities of PBC, then another objection to contractors undertaking PBC might be based on the low profit margins found in the construction industry compared to the auto industry. Low profit margins do not permit firms to take on additional risks. There is evidence of relatively low profit margins in construction in Table 6.

In SIC 45.2 the profit margins ranged from 3.71% in 1996 rising to 7.5% in 2004. In SIC 45.3 the profit margin was 4.0% in 1997 and 11.3% in 2004. In SIC 45.4 the lowest median profit margin was 3.1% in 1996 and the highest was 13.7% in 2004. However, the auto manufacturers' median profit margins in the same period only ranged from 2.2% to 5.8% and auto maintenance was even lower at 1.8% to 2.3% in the same period. The low profit margins in the auto industry do not prevent these firms from making good their faulty output albeit for a shorter period of time than implied under PBC and for a smaller percentage of turnover represented by each individual unit of output. The argument may therefore still be valid that the relative size of each unit of output in construction is too great for firms to give long term commitments on the profit margins found in construction.

Table 6 Median percentage profit margins in construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	5.8	8.9
45.2	Building of complete constructions or parts thereof; civil engineering	3.7	7.5
45.3	Building installation	4.0	11.3
45.4	Building completion	3.1	13.7
45.5	Renting of construction or demolition equipment with operator	6.5	10.3
34	Auto manufacture	2.2	5.8
50	Auto maintenance	1.8	2.3

In order to operate a building with sufficient financial flexibility to meet the physical obligations and contingencies of PBC, contractors require a certain level of liquidity in reserve. It may be argued that as profit margins in construction are low, generating reserves out of profits is not generally an option open to firms. One alternative is long term borrowing since PBC requires long term finance. However, long term borrowing is not exploited in construction because firms do not tend to have sufficient fixed assets to act as collateral for the amounts needed to finance production. This results in relatively low long term borrowing, which may appear to offer a sound financial base but in practice reflects the relatively high risk of lending to building contractors. This might well be reflected in higher rates of interest charged to building contractors, (assuming they are able to borrow long term finance in the first place to finance production rather than the purchase of fixed assets), compared to firms in other industries, not to mention public sector organizations.

The lower level of long term borrowing of construction firms compared to the auto industry is shown in Table 7, which gives the gearing ratio of long term borrowing to net assets. The gearing of firms in SIC 45.2 varies from 13% in 2002 to 17% in 1996; SIC 45.3 varies from 12% in 2002 to 15% in 1999; SIC 45.4 varies from 14% in 2004 to 18% in 1998. In the auto industry the median ratios ranged from 18.5% to 24% in those years, far higher than the equivalent in construction.

Table 7 Gearing in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	21	25
45.2	Building of complete constructions or parts thereof; civil engineering	13	17
45.3	Building installation	12	15
45.4	Building completion	14	18
45.5	Renting of construction or demolition equipment with operator	25	30
34	Auto manufacture	18.5	23.4
50	Auto maintenance	19	24

Findings

PBC assumes a long term commitment on the part of the contractor. Investment in fixed assets is a measure of a firm's commitment to its future workload. Fixed assets may be financed out of long term debt and represent additional liabilities. Loans may have been fully repaid, in, which case the fixed assets are a measure of their net worth to the capital base. In any case, the ratio of fixed assets as a percentage of turnover indicates one of the overheads borne by sales, which can be seen as a level of risk for the contractor and therefore a commitment.

The ratio of fixed assets as a percentage of capital employed indicates the degree of the asset specificity of firms with assets in the form of buildings, plant and vehicles and can be taken as one measure of longer term planning and commitment. In Table 8, the ratio of fixed assets over capital employed in SIC 45.2 ranges from 39% in 2002 to 45.6% in 1997. In SIC 45.3 it ranges from 42.1% in 2001 to 53.8% in 2004 and in SIC 45.4 it ranges from 45% in 2001 to 60.8% in 2003. These figures tend to be below the ranges found in auto manufacturing (53.2% in 2004 to 69.9% in 1997) and in auto maintenance (from 56.5% in 2002 to 68.6% in 1996).

Table 8: Fixed assets as a percentage of capital employed in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	77.1	101.4
45.2	Building of complete constructions or parts thereof; civil engineering	39.0	45.6
45.3	Building installation	42.1	53.8
45.4	Building completion	45	60.8
45.5	Renting of construction or demolition equipment with operator	100	110
34	Auto manufacture	53.2	69.9
50	Auto maintenance	56.5	68.6

A further measure of the physical commitment of firms to the projects they undertake is their investment in specific plant and equipment needed to carry out the work. Although actual plant and equipment expenditure is not always available, the ratio of fixed assets to turnover is indicative of construction firms' commitment to their clients compared to for example, auto manufacturing. However, this ratio is only one element in the equation. The study of consortia revealed that commitment on the part of a firm is also a function of its total financial commitment, its reputation, relationships between different suppliers and between the contractors and their clients.

The ratio combines the cost of fixed assets, which may be paid for over a number of years (and can in principle be large) and turnover, which is always an annual figure (and therefore limited). Nevertheless the ratio of fixed assets to turnover in construction tends to be very low. In Table 9 the ranges of the ratio of fixed assets to turnover were as follows: for SIC 45.2, it varied between 5.4% in 2002 to 6.6% in 1997; SIC 45.3 it was 4.9% in 2001 to 5.7% in 2004; and in SIC 45.4 5.1% in 1997 to 5.9% in 2004. Fixed assets therefore represented only a small proportion of the value of annual turnover compared to auto manufacturing, which ranged from 23.3% in 2003 to 36.7% in 1999. The equivalent ratios in auto maintenance were 7.2% in 2004 to 8.6%, which are similar to construction. The figures in auto maintenance reflect the nature of maintenance compared to manufacture. It is simply not necessary to employ as much plant in maintenance compared to production facilities. It may well be the case that it is in the nature of construction production that less plant is required as a percentage of output than in manufacturing. This means that construction firms do not need the same volume of investment for production and this enables them to be more independent of their client base than in other sectors of the economy, even before legislation obliged manufacturers to guarantee their products. One aspect of this weaker relationship with their clients is that contractors in general may be less concerned with the performance of their output than manufacturers.

Table 9 Fixed assets as a percentage of turnover in the construction and automotive sectors, 1996–2004

SIC	Definition	Low %	High %
45.1	Site preparation	17.1	27.95
45.2	Building of complete constructions or parts thereof; civil engineering	5.4	6.6
45.3	Building installation	4.9	5.7
45.4	Building completion	5.1	5.9
45.5	Renting of construction or demolition equipment with operator	55.5	70.0
34	Auto manufacture	23.3	36.7
50	Auto maintenance	7.2	8.6

*Omitting firms with no account

Findings

This ratio analysis of construction firms indicates that construction firms in general may not be financially strong and therefore may not be capable of taking on work based on the performance of their constructed output. However, the use of medians to summarize the ratio analysis does not necessarily show that some firms in each sub-division of the construction industry could not take on the longer term commitments implicit in PBC.

The evidence of the analysis of the accounts of firms supports the argument that none of the major subdivisions of firms in the construction industry (SIC 45) is as well placed as the subdivisions of the auto industry to undertake post-completion long term responsibilities for the performance of output. Firms in the construction industry have inferior ratios for the purpose of PBC compared to the auto industry, especially considering the relative size of the units of output as a percentage of total output of the firm. Nor do firms in the construction industry tend to have the necessary asset structure to accommodate the additional risks of PBC. For this reason, they require either developers or banks to provide the necessary financial underpinning needed to ensure that expenditures can be met for the construction phase prior to payment by the client as required under PBC.

However, it should be emphatically noted that specific construction firms may well be able to accommodate the additional burdens imposed by PBC. It may be the case that the largest firms in all construction sub-sectors are capable of having the necessary financial reserves to enable them to undertake contracts based on performance. While it might be argued that contractors do not have the capital to undertake PBC, and that the risks of PBC are too great and too long term for contractors, it does not follow that they could not build up the expertise to undertake the life cycle commitments necessary for PBC.

Like so much innovation in the construction industry the change may well have to come from clients and be driven by them. The public sector client, acting as a 'best-practice client' may be in a position to create the conditions and terms necessary for contractors to respond with PBC. There is a need to decide what the performance levels should be and what outcomes are desirable. The client would need to give contractors a clearly defined project stating a building's or structure's function and broad outcomes e.g. the project could be a school, which is a well defined use, and the number of pupils to be housed with a number of facilities such as dining room, kitchen, library, gym, staff rooms and toilets may be broad outcomes together with environmental and energy use performance specifications.

Contracting firms would then compete to construct and maintain the school and quality would be driven by the contractors' need to protect their reputation and maintain good relations with their clients as well as their desire for repeat business. Moreover market principles would also shape their behaviour as contractors compete for market share and pursue growth policies.

6.2 Risk associated with performance-based contracting

This section considers risk management and the use of consortia as a method of managing, spreading and sharing risk with other firms due to undercapitalization in the construction sector. In a survey of senior managers in large construction firms, it was found that responsibility for risk management is not usually allocated to any one person or department in particular and it was rarely straightforward to ascertain the responsible person. Respondents were invited to describe risks they associated with PBC. From the results of the enquiry, seven key risk groups emerged from the use of common terms by respondents. These are ranked in Table 10, according to the frequency they were mentioned by respondents.

Table 10: Frequency of respondent-suggested key risks

Area of risk	Percentage of respondents
FFP and associated insurance issues	36
Costs	16
Measurement (performance and indicators)	12
Briefing/specification	10
Contractual issues	10
Resource issues	8
Creativity issues	6
Communication	1
Safety	1
Total	**100**

Clearly fitness for purpose (FFP) and associated insurance issues are the most frequently perceived risks for contractors. Many contractors explained that they would consider accepting only 'reasonable skill and care' as this is an insurable risk. But FFP is apparently a problem for insurers and is usually excluded in professional indemnity (PI) policies because of the allocation of strict liability, a point, which could render PI an unhelpful safeguard for clients. The problem lies in the nature of a guarantee, which is, in general, uninsurable and, therefore, dependent on resources that lie behind the risk-taker, in relation to their liability. According to the respondents, many clients would want to pass FFP obligations on to contractors as well as risks associated with 'skill and care'. Responsibility for FFP may also make the contractor vulnerable to any late change in the client's purpose.

Table 11 shows how respondents said they would manage the risks they had previously named. Not having had any experience of managing PBC risks, most respondents tended to mention that they would manage them as they would manage their existing arrangements. In dealing with the first risk, product quality, their management strategy involved ensuring that suppliers retained liability, and that they themselves obtained appropriate sourcing of components, used only proven, inspected and tested products, and ensured defects liability periods were stated. Second, the risk associated with FFP was found to be unacceptable to contractors. They stated they were not prepared to take on FFP conditions. As far as contractors were concerned, responsibility for their output only extended to reasonable skill and care in the construction and maintenance phases. The third type of risk, contractual risk, could be dealt with by adopting a formal risk register as part of the contract to identify the allocation of risk to the different parties involved.

Table 11: Risk management strategy of PBC risk

Type of risk	Percentage of respondents*
Product quality	32
FFP	20
Contractual issues	12
Other	16
No comment	20
Total	**100**

NB: Some respondants listed more than one stratagy.

FFP was considered by one respondent to be too onerous to be included in any contract. One reason for considering FFP to be too onerous was given by a number of interviewees, who commented that it was not always possible to arrive at a consensus on the definition of functionality and therefore the contractor might not be paid. Obtaining the client's complete specification was seen as an obstacle, particularly during the bidding phase.

Contractors were asked, which of the PBC risks they identified they would be prepared to absorb and, which they would pass on to clients. Their preferences are shown in Table 12. The majority of respondents (63%) who answered this question did not express a particular preference; which may have been the result of lack of experience of PBC and its potential for risk management. PBC could be perceived as either an opportunity or a threat, depending on whether one was client or producer.

Table 12: Contractors' preferences for risk allocation

Risk allocation	Percentage of respondents
Clients	11
Shared between clients/component suppliers	11
Contractors	7
Shared between contractors/clients	4
Suppliers	4
Don't know	63
Total	**100**

A number of respondents felt that suppliers were required to take the risk for new products but they also commented that suppliers generally did not return to take responsibility if their products failed. In general these answers were inconsistent with their responses to the management of risk, where the contractors sought to offload all risks either to their suppliers or their clients.

Risk absorption through the contract in the United Kingdom (UK) was felt to be inadequate as standard contracts do not cover all risks. Clients were perceived as attempting to place risks onto the contractor either through the job or through the contract. Contractors stated that they would prefer to be involved in the contract negotiations at the inception stages of projects. They also noted that risks are currently shuffled between the contracting parties as the project progresses – even on PFI projects – rather than being fixed allocations throughout the entire project.

In view of the difficulties in identifying and managing risk under PBC, respondents were asked under what conditions or circumstances (if any) they would be prepared to use PBC. Their responses are given in Table 13.

Table 13: Potential use of PBC

Circumstances	Percentage of respondents
Under PFI arrangements	9
Criteria must be properly expressed	5
Risk assessment favourable	5
Company policy	5
If the contractor were also the developer	5
Only on minor projects	5
Would not accept PBC	66
Total	**100**

One of the most significant results from this survey is that most contractors (66%) felt that they would not accept a PBC contract, although under PFI contracts, it might be acceptable. Once again, FFP was often given as a reason while others noted that risk decisions were made on a job-by-job basis, which did not take into account any long term obligations beyond the construction phase of a contract. Five percent of respondents said that PBC might be acceptable on minor projects only, reinforcing the point made in the ratio analysis above, that firms in the auto industry produce and sell units of production that only represent a relatively small percentage of output compared to construction, where each project tends to represent a significant share of a firm's annual production and is therefore a greater threat to the firm's survival should something go wrong.

To some extent the issues of post-construction liabilities were recognized by contractors. They managed this risk by offloading it onto their suppliers. If contractors were not prepared to take on long term liabilities beyond completion, many of them nevertheless considered that their suppliers or subcontractors should. They were asked if they required their suppliers or sub-contractors to be responsible for their inputs beyond building completion. Of the respondents, 38% required their suppliers to accept responsibility beyond completion, 21% required it from their sub-contractors and 25% did not know.

6.3 Consortia as a method of dealing with risk

As pointed out above, the use of consortia is one method that may appear to spread the burden of risk and in so doing it may be argued that consortia reduce risk to individual participating firms. Moreover, different firms working together with different specialist skills, and more diverse management expertise than any single firm, appear to offer lower risk solutions. However, far from reducing uncertainty, consortia can also be seen as increasing some firms' exposure to risk. This apparent paradox can be resolved by thinking in terms of overall risk reduction and individual firms' risk exposure. While each firm may experience additional risk factors, many of these risks are part of a zero sum game, in, which the total risk to the client is reduced. For example, value engineering implies that solutions can be found, which reduce the total cost of construction. At the same time, design changes brought about by the value engineering exercise may mean that one or more members of the consortium may find their services are no longer required.

The major group of identified risks is concerned with the implications of working very closely with other firms or organizations. This area of risk associated with consortia may be called reputational risk. Reputational risk is not limited. In any case all respondents stated that limited liability makes no difference where large projects are concerned. In effect any firm that fails to perform to the satisfaction of its public sector clients will find it extremely difficult to continue to supply services to public sector organizations. Indeed if any firm consistently underperformed, it would find it difficult to win more work, especially in the public sector. This reduces demand for the firm's output, depending on the ratio of public to private sector work the firm carries out. Even private sector clients may be deterred by a firm's tainted reputation.

The interdependence of firms in consortia has the potential to break up working relationships between members, leading to a significant loss in a firm's turnover. As consortia often work closely with local authorities, an additional risk facing firms is the lack of understanding of commercial risk by many in the public sector. Indeed political disputes between different local authorities (where projects overlap into neighbouring council territories) and between local authorities and central government can also lead to difficulties for consortia members.

A further risk for firms in consortia is the changing capacity of fellow firms to fulfil their obligations to the consortium. Given that each firm is engaged on a number of projects outside the consortium and because of the lumpiness of demand facing any one firm in property and construction, each member firm's capacity available to the consortium can vary widely over the life of a consortium.

There are other soft issues, for example the tying up of resources, such as expensive senior management, which interferes with the smooth running of the organization, especially as there is no guarantee of success. This would also apply where no consortium is formed but selection for many public sector projects is not based on a single firm's strengths or offer, but on the combined strengths and merits of the consortium as a whole. Success, for example from a consortium funder's point of view, is also dependent on the selection process, which may be based on design or facilities management features and not just the banking aspects of the bid.

Risks within consortia may be classed as attributable and non-attributable risks. Attributable risks may be taken by members according to their skills and roles within the consortium. Non-attributable risks may be taken by the consortium leader or the funder.

Although property developers may argue that it is they, who accept responsibility for projects, risks are borne by those in the weakest negotiating position, because they can be most easily replaced. Therefore those who offer non-differentiated services are in the most vulnerable position. The firms in the weakest negotiating position are the contractors and their sub-contractors. Perceived risk is taken by the developers and constructional risk is taken by the contractors. Perceived risk, which may be speculative or commercial risk, is rewarded with the profits (net of construction costs). The constructional risk is therefore left to contractors to price correctly and profitably (while still winning the auction for work). Risks are thus identified and allocated to the firm best able to manage them. That firm then owns the risk. Construction is seen as a high risk, high volume and low-margin business.

The contractor is usually responsible for cost overruns as construction contracts are usually fixed price unless design changes are delivered late. If the design changes originate in the consortium, the consortium would then be responsible for the delay and additional costs. Otherwise, the bank, according to one banker, still carries the main responsibility for costs because it is the bank that provides 90% of the funding. However, the bank usually holds collateral security and manages actual cash flow and, hence, controls the contractual arrangements of the constructor or facility manager. Risks other than construction risks may be seen as residual risks. Residual risks are taken or assumed in proportion to the consortium shareholdings of partners, or by the lead bidder. Alternatively, the client may carry the risk rather than waste or lose time.

Nevertheless, several interviewees pointed out a number of factors relating to consortia, which actually reduce the level of risk, because they reduce uncertainty in the process. This is partly achieved by making use of a broader knowledge base than could be afforded by one organization working alone. Risks are also reduced because consortia can make use of the experience of the different partners who may have worked on similar projects.

The sharing of bidding costs and the spreading of financial risk over a number of firms and organizations also reduce risks faced by members of a consortium. The larger the asset base the easier and cheaper it is to raise finance, assuming all else remains the same. As a number of firms combine to form a consortium the asset base may be enlarged to allow for greater access to funding at lower rates of interest and therefore lower risk. Consortia allow members additional exit routes if they wish to leave a project by finding a suitable and acceptable replacement without necessitating the abandonment of the project.

Consortia tend to be formed only when firms have little alternative. Indeed, one interviewee stated it was not his firm's strategy to enter into consortia agreements. Consortia are not seen as vehicles for improving collaborative working. Again, it was stated that best practice in construction does not depend on consortia. This is not to say that consortia inhibit best practice. Firms rely on their bargaining strengths even within consortia arrangements.

Findings

Influence and control within consortia are based on financial commitment and equity share. Even where contractors may be deemed to lead consortia, further enquiry may reveal that the contractor's financial input and control is provided by a property, investment or development arm of the same company. The examples or case studies given by interviewees tended to support the view that consortia are marketing and financially driven arrangements, which take on commercial and reputational risks. A separate supply chain of contractors takes on the production risk which may extend to the provision of services after completion of construction. In some cases a contractor may be a member of both the consortium and the supply chain, in which case it is possible for the contractor to be sued by the consortium of, which it is a shareholder.

The public sector client saw the aim of a consortium as a group of companies brought together for a particular purpose (for example constructing a building), because of the expertise of the different firms. In joint ventures, the partners take equal liability. In consortia the consortium takes the financial risk and manages the supply chain.

As a public sector client, one interviewee would have welcomed the opportunity to establish long term relationships with construction consortia. But this did not arise, partly because many in the public sector have a fear and distrust of the profit motive. Nevertheless, public-private partnerships enable the public and private sectors to share problems and develop closer working relationships. This enables the public and private sectors to play-off each other to their mutual benefit. Longer-term partnerships with the private sector could be developed in return for local authority sites. This arrangement takes advantage of the private sector skills of managing procurement, while the government sector remains accountable to the public.

Because many civil servants tend to have little direct knowledge or experience of commerce, the public sector does not always have the necessary skills in managing procurement. The public sector is more concerned with non-commercial issues, such as public service provision and accountability, than commercial considerations. It is, therefore, relatively poor at making commercial decisions. The public sector cannot take on financial risks such as cost overruns, late delivery and unresolved disputes. As a result the public sector is willing to pay for the private sector to take the risks associated with projects. Nevertheless the private sector tries to put the financial risks back on to the public sector. Consortium decisions were often not conveyed to the client, but were informally communicated by chance in meetings between the client and the consortium. Distrust is played on by advisors. In spite of these difficulties in public-private sector collaboration, there is a need for a leap of trust.

These issues indicate that far from being an open method of procuring a building or structure, it is possible for members of a consortium to obscure important details of a project from the client. This highlights the self-interested behaviour of the parties in the construction process, allowing for predictable opportunistic transaction costs and game theory outcomes of the hawk dove variety.

Developers are prepared to take commercial risk only provided they are in a position to hire or dismiss the other members of the team. Indeed although the relationship with other members of the consortium may be closer than in non-joint ventures, joint venture organizations work best when there are several projects to be undertaken. With the developer in a position to remove partners from the team, the developer has a sanction if things go wrong. At the same time there is less chance of contractors behaving opportunistically if they are at risk of losing further participation in the joint venture. This applies similarly to subcontractors.

These comments illustrate the divisions that exist within consortia, showing the level of distrust of developers towards contractors, their relative negotiating strengths and their attitudes towards risk.

Funders view consortia as business opportunities but not ones to be carried out by a single firm or funder. From the point of view of the partners in a consortium, the main aim of setting up a consortium is to win the bid. Once this has been achieved each member of the consortium receives a contract and the bank funds the project. Consortia represent the integration of the vertical value chain by working together in collaborative teams. The consortium whole is greater than the sum of its parts. It can be argued that one of the benefits of working as a consortium on a construction project is that it improves value management. It also increases the reliability of the bid price compared to many recent public sector directly commissioned works, though this may not necessarily always be the case.

Contractors may see participating in consortia as a construction market segment. Consortia bidding for NHS and local authorities' projects may be contractor-led but usually contractors are brought in at a later stage. Perhaps as much as 70% of consortia are not led by contractors. However there may be a trend towards contractors becoming more involved. There is no incentive for contractors to invest in consortia for the long term, if they only have a construction contract. Therefore, where contractors lead, the contractor member is often a facilities management firm, which may be a subsidiary of a building contractor. The facilities manager then has an on-going interest in the operating phase of the project.

As far as funders are concerned, the distinction between developers and contractors is blurred in practice. The developer accepts responsibility for the delivery of the project, which is then undertaken by building and/or facilities management contractors. Consequently the contractors are responsible if they do not deliver as required. To the funder, the risk of poor performance is passed on to the other parties in the consortium, regardless of their particular roles in the process.

In financial consortia the developer acts as fund manager and a bank as funder. However, funders are often brought in far too late, because funders are usually involved only after the tender stage, which follows the initial proposal stage.

In a delivery-plus model consortium, such as implied by PBC, there is a developer, a funder and a facilities manager. Together they form an SPV. Construction contractors are only on the supply chain and have a client-supplier relationship with the SPV. The construction side is kept at arm's length by the SPV, although the SPV may insist on an open book condition in the contract allowing the SPV to monitor the construction phase closely.

One of the problems for lenders, and a limit on their willingness to form an SPV with a contractor or a developer, is that there are no credit ratings in the construction industry or property sector. The reasons for the lack of credit ratings are:

1. Property companies' valuations depend on the value of their land banks. This means their asset base is difficult to value and varies over time.

2. There is no tradition of joint ventures between lenders and developers. There appears to be an innate conservatism on the part of lenders to form partnerships with developers.

3. SPVs tend to be relatively static contractual arrangements whereas developers are essentially opportunistic firms requiring flexibility to respond to changing circumstances and market conditions.

Construction contractors have traditionally been even more difficult to value than property companies. However, Standard and Poor (2004) have recently recognized the changes brought about by the PFI undertakings of contractors, which produce income streams. These income streams create capital values and form an asset base, which can be identified and associated with construction firms. Nevertheless, from a financial point of view, significant fragmentation within consortia remains between the financial inputs and the commercial and speculative functions and the industrial processes of constructing buildings.

In the early to mid 1990s the recession in the construction industry pushed firms towards working in consortia, further encouraged by PFI projects for the public sector. Contractors decided to lead consortia in order to protect their business. For one contractor, Bovis Lend Lease, working within a consortium represented an investment interest as well as providing construction work and facilities management. Winning construction work was the major driver for contractors in consortia because construction provided the earliest returns. Government also wanted operators to run the built facilities. However, the returns on facilities management are too long term and contractors were not geared to taking on long term investments. This is a major issue and we return to this point later. Nevertheless, a number of major contractors also provide facilities management in addition to their construction work, while at least one firm, Amey plc, has tended to concentrate on facilities management.

The current building recession, at the end of the first decade of the century, comes at a time when many contractors were showing signs of reluctance to participate in PFI projects. It remains to be seen what trends will emerge as a result of the current downturn in the construction market.

The purpose of a consortium is to meet the total needs of the client. In principle forming a consortium allows communication of clients' needs to subcontractors, which improves client satisfaction. Most consortia are put together for the public sector or in some cases a large private sector client such as British Airports Authority. A consortium is usually set up in conjunction with an open and transparent partnering agreement. To achieve this, the consortium requires partners to have common aims and objectives. All the constituent parts should make up a coherent whole. Although the arrangements can be loose or formal, there should be a culture embodying a belief in the aims of the project and a belief in the other members of the team and the value they bring. Moreover, there are three elements that form or glue a consortium. They are mutual risk, trust and money. But these elements can also create major friction within consortia.

Findings

The builder and the operator may or may not be part of an SPV but the client often assumes builders and operators are part of the consortium. The main contractor and the mechanical and electrical (M&E) contractor may have a good relationship, but the M&E is not usually part of the consortium. The M&E contractors, therefore, have no direct access to, or relationship with, the funders or financiers. The specialist firm is in the supply chain but not in the consortium. The client liaises with the SPV, which assumes responsibility for legal and financial aspects. The SPV then commissions a contractor for the construction phase and a facilities manager or operator (if required) during the building-in-use phase. Both the contractor and the operator are seen as leading their supply chains to the SPV. The supply chains extend to the subcontractors and material and component suppliers. In this model, the SPV acts as a client of both the contractor and the facilities manager, even though both may be shareholders in the SPV. The SPV therefore comes between the client and the supply chains, which actually undertake the work.

Specialist sub-contractors can, therefore, experience the same difficulties encountered in many construction projects whether they involve consortia or not. The early stages are based on trust with builders, but after winning a tender the main contractor may ask for a price reduction. In one instance, the interviewee was asked for a £3m reduction on an £18m tender and this concession was followed with very late payments by the main contractor. Consequently the firm, which is a subsidiary, is no longer allowed by its parent company to join consortia on the basis of trust alone. The extent of reliance on good faith forms part of the risk analysis of any given project.

From a legal perspective, there is no single definition of the term ‘consortium’. A consortium may or may not be formed of like organizations, such as all-architect members or all-contractor members, and it may or may not be jointly or severally liable. The formation of a consortium would be unnecessary, if a client did not want any involvement in the construction process.

A consortium, which is separate from the client, can lead to distrust. One measure to overcome this distrust is a single open contract for all team members. This pre-contract requirement would not only reduce the inherent distrust, which arises when a number of firms are needed to work together on construction projects, but it would also reduce the time spent on negotiations. If a client participates in the building team, the arrangement may be seen as conventional partnering or a consortium, which included the client-developer.

6.4 Procurement issues

Standard forms for construction contracts tend to deal exhaustively with the obligations and rights of the partners to the contract. Not all of these issues are of importance regarding the PBC approach. The four essential issues are the following:

- Specification of Performance: In traditional construction contracts (general contracting) the client provides the contractor with the design. The contractor is being paid for the labour and materials necessary to construct the building in accordance with the design (Murdoch and Hughes 2000: 25, 35). However, under the PBC approach the client does not provide the contractor with the design but with a set of requirements defining the functions of the projected building (Performance Based Specification, PBS). In this the PBC approach is consistent with design and build contracts.

- Retained Ownership: In the PBC approach, the acquisition of an asset is replaced by the purchase of a service. This must be reflected in the contract. In UK construction projects the land is regularly owned by the client (Emden 2003: Part I, Ch. 1, Para. 36) and the materials are regularly supplied by the contractor (Chitty 2003: Vol. 2, Para. 37-003; Jansen 1998: 245). In the absence of a special provision, the materials become the property of the employer as soon as they are incorporated into the building (Sims v. London Co [1885] 1 TLR 584; Murdoch and Hughes: 155). Given this context, there must be a special provision in a PBC contract that all the materials used by contractors remain in their ownership, which may be perfectly feasible under English law.

- Payment: The payment issue needs to be addressed in a PBC contract. One method is a service charge whereby the contractor is paid over a long period of time depending on the performance of the building. Another is the payment of a lump-sum on completion before use, as in a contract for the supply of goods, e.g. cars. If the latter is chosen, the ability of the contractor to provide maintenance should be underpinned by a bond as a security.

- Guarantees: The most important issue concerns the obligations of the contractor. Under English law, the contractor's obligations are defined by three terms, which become part of every construction contract by implication of law if they are not expressly excluded. These terms, "the usual threefold implication" (Wilson and Rutherford 1994), are laid down in sections 4 (2), 4 (5) and 13 Supply of Goods and Services Act 1982. They provide that the goods supplied are of satisfactory quality, that the goods supplied are reasonably fit for the purpose and that the supplier will carry out the service with reasonable care and skill. The common standard forms such as JCT's Standard Building Contract echo these obligations in their clauses. For contracts to be considered as PBC construction contracts another obligation must be included. According to that obligation the contractor guarantees that the completed building as a whole is fit for its purpose. English case law provides that such a term is implied in every design and build construction contract, cf. Smith and Snipes Hall Farm Ltd v. River Douglas Catchment Board [1949] 2 K.B. 500, 513; Lynch v. Thorne [1956] 1 W.L.R. 303; Greaves & Co. Ltd v. Baynham Meikle [1975] 1 W.L.R. 1095, 1098; National Coal Board v. Neill [1985] Q.B. 300, 317; see also Furst and Ramsley 2001: Para 3-58; Murdoch and Hughes 2000: 150. In practice, however, standard forms for design and build contracts exclude this implied term, cf. clause 2.17.1 of JCT's Design and Build Contract 2005 (Millett 1994: Para. 2033, with regard to the identical clause 2.5.1 JCT Design and Build Contract 1981). Therefore, such an exclusion must not be expressed in a PBC contract. Moreover, the limitation period (indicating the spell of time in, which the client is able to sue the contractor for breach of contract) must persist for the lifetime of the building. That means an appropriate express term must be included in the contract, because the usual limitation period lasts only six years (section 5 Limitation Act 1980).

07 Discussion

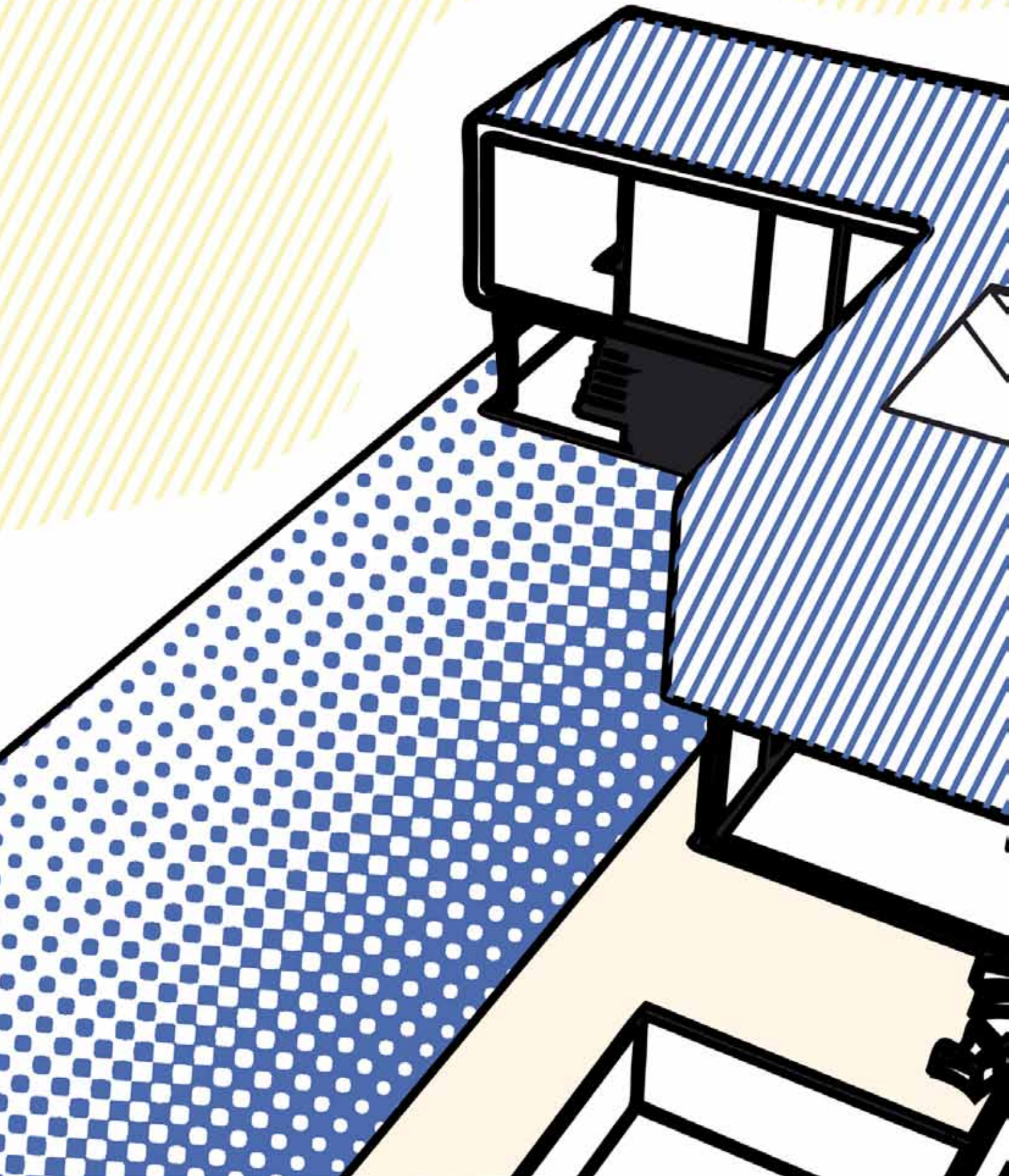
It is generally assumed that the key players in construction, especially in major projects, are the main or large general builders or management contractors. They mobilize plant, labour and materials usually by subcontracting and have the technical knowledge to undertake the organization of the construction process. It is apparent they are in a position to improve the production methods employed. Yet research and development expenditure in the construction industry lags behind other industries because contractors have little opportunity to put costly innovations into practice.

Contractors are often reported as saying they would prefer to be involved at an early stage in their projects, preferably before designs have been finalized. Otherwise, once a design has been selected and the construction costs estimated, it is difficult for contractors to influence the outcome either to reduce the cost of construction or influence the running and maintenance costs of a building.

Because they have so little design input, it is often possible for contractors to externalize increases in costs due to changes in the design. Provided the management contractors have satisfied the terms of their building contracts, they cannot be held responsible for problems upstream in the supply chain.

In order to limit the escalation of costs PFI places responsibility for costs throughout the building life cycle with contractors and funders. As a result contractors and funders internalize the costs of contracting and the on-going costs of inappropriate building methods or building design. In terms of cash flow it is the building that takes up most money at the beginning of most projects. This bunching of the cash flow remains regardless of whether the payer is the public or the private sector. In common with PFI projects, PBC alters the cash flow. For example, under PBC specifying a building in health care in terms of infection rate reduction or monthly functionality of the building, and only making payments on fulfilment of these performance specifications may be a way of spreading the cash flow evenly and over a long period.

However, the high transaction costs associated with PFI and the higher costs of finance of private firms compared to public sector borrowing may only be compensated for by possible efficiency gains due to the incentivization created by PFI. However, it is by no means clear that any improvements in efficiency compensate for the increase in risk premium the public sector must pay in order to enable PFI projects to proceed or compensate for the public sector's loss of direct control over the finished building.



Discussion

The complexities of PFI mean that the private sector has a dual role. It is engaged to supply the public sector with buildings and structures and it is also expected to finance the project. This dual role of the private sector under the PFI has led to costly and often lengthy negotiations. The cost of procurement alone has become prohibitively high, especially for contractors, to the point where contractors have begun to show increasing reluctance to bid for projects, as pointed out earlier.

If financial issues and discussions could be separated from delivery, it would be possible for the transactors to focus on the performance of buildings and the requirements of the client. This would release the teams negotiating contracts from a large number of complications and reduce the costs of procurement and tendering. Naturally risks would still need to be identified and measured by both parties but these would be assessed by the purchaser quite separately from the supplier. The emphasis becomes one of building performance rather than the components and materials used in construction. This arrangement can be seen as an example of PBC. In PBC payments are not made during the construction phase. The client only pays suppliers once buildings are in use and payments are based on meeting performance requirements.

PBC is a logical extension of PFI or Public Private Partnerships (PPP). Both PFI and PPP adopt a whole life cycle approach insofar as post construction use of buildings and structures are built into the contract. In PFI and PPP the finance for both the construction and post-construction phases are sourced in the private sector. If the public sector were only required to pay for a project over an agreed period of use once its construction is completed and the building is in operation, then suppliers such as developers and contractors would concentrate on ensuring the performance of buildings and structures was satisfactory. Using the PBC model, contractors would be able to demonstrate to clients how to improve the value of their projects. There are distinct possibilities for efficiency gains. PBC potentially offers an opportunity to present a new model of contracting that would provide incentives and innovation, restructuring of the construction market and improvements in productivity.

The key to improving performance is giving firms incentives both positive and negative. The first firms to adopt PBC would gain a competitive advantage and expand while those that were slower would lose market share. Positive incentives would need to motivate firms and demonstrate to their competitors in the construction industry that firms, which adopted PBC for at least some of their work, found such projects profitable. This would encourage others to follow. Negative incentives would be provided by performance penalties.

It cannot be claimed that PBC is revolutionary in itself. Like most developments in construction, the concept of PBC is already widely in use in other industrial sectors. It is merely the next logical step in construction and service procurement based on PFI principles but without the private finance discussion necessary in PFI. This new mode of working is not even new to construction. For example, similar arrangements are in use in the German construction industry, and in the UK many firms already undertake PBC-type work when installing and servicing building components.

Traditional contracts are based on the specification of client requirements in terms of time, cost and quality, with teams of experts helping clients to specify targets for each of these objectives. A contractor who achieves what was required will have fulfilled contractual obligations and will rightly expect to be paid, regardless of whether the client is satisfied with the result.

Egan (1998) proposed an agenda for radical change and improvement in the way that the construction industry organizes projects. The industry was urged to replace competitive tendering with long term relationships based on clear measurements of performance and sustained improvements in quality and efficiency. Although there has been much work implementing the changes called for by Egan, very little attention has been paid to the contractual issues that would arise as a result of moving away from competitive tendering.

One radical approach would therefore be to depart from the traditional focus of documenting physical building elements and building component requirements. These are the documents used by contractors to compete on price. Instead, an innovative approach would be to specify what performance is required from a completed building, or sub-system, and to choose a contractor based upon that contractor's past performance in achieving client performance requirements, and a promise of future performance that would form the basis of a deal that is negotiated. The mix between selection based on reputation and selection based on promises is a challenge for clients.

We have suggested that the providers of construction services may be left to decide how to achieve the ends, instead of being instructed in great detail about what, precisely, should be built. This would require payment to be linked to the performance achieved, rather than the quantity of building work undertaken and materials supplied. One consequence of this approach may be to reduce the documentation and project management overhead required by clients.

Until recently, when the Office of Fair Trading (OFT, 2008) reported on collusive tendering, the UK's traditional focus on lowest price bidding appeared to have helped to avoid the worst excesses of collusion and corrupt practices, and there were naturally very real fears about losing the accountability that came from traditional practice. This is not to say there were no problems with the construction tendering process as practiced in the UK. If contractors' performance data were to be made freely available in the public domain, then this problem would at least be recognized. These ideas raise some serious questions for research, especially following the Statement of Objections published by the OFT (*ibid*.) on collusion in the construction industry. The emphasis on price competition clearly did not prevent certain collusive practices from emerging, at least in the view of the OFT.

In our study we found a lack of awareness of PBC combined with fears over the long term implications for FFP. Furthermore, the uninsurable risks arising from FFP are major obstacles to contractors accepting PBC. This would imply that PBC is not a risk that non-PFI contractors have been exploring. This is not surprising as few innovations in procurement methodology have been made other than by clients. Nevertheless, the lack of workload and the state of the market may influence contractors to take on risks associated with PBC.

Many existing contractors do not have sufficient resources and capital to undertake PBC obligations. Without sufficient capital they would be merely managers of the construction process rather than financial stakeholders and would be surplus to requirements.

Under PFI contracting the client accepts some risks, the contractor accepts others. FFP requirements are clearly stated in the specifications. In PBC contractors would be expected to accept liability for a building's function to ensure that it matches the client's FFP requirements (Ang *et al.,* 2001; Hattis and Becker, 2001). One major risk identified in this study was that clients' requirements may change over time (and even the building production phase can extend over a considerable period). Such changes would alter the objectives of FFP. The contractor would be uninsured for such changes of use, even if they were reasonable and negotiable, without incurring major additional insurance expenses.

Discussion

In traditional construction contracts, contractors would be able to take advantage of changes because they would be in a position to negotiate a new price and extra time. Having agreed a fixed price for a particular service, under PBC the contractor may be exposed to a major risk, if the detailed definition of what is needed to achieve a given level of service develops or changes at some point in the future, unless there is an opportunity for renegotiation of the contract terms. In the event of such changes, contractors may fear they would not receive the agreed rewards if the client is not satisfied. Since contract enforcement through the courts is costly, the producer is vulnerable in a deal, which invariably requires considerable up-front investment from the supply side. The worst case scenario is:

- the clients have a building, which has been procured for the original purpose but is no longer suitable

- the producers are unable either to receive their post-construction reward or dispose of the building profitably and quickly to reduce their financial exposure.

Furthermore, if the FFP changed over the longer term (during client occupation), contractors might fear that they would be in danger of not being paid the on-going rewards. This could be considered an unacceptable risk, even for the largest firms.

Using innovative products (an integral part of PBC) was also seen as 'risky' as many products had not been available for sufficiently long periods of time to ensure their durability. This contradicts the innovative aspects of PBC as described by Poirier *et al.,* (2004), Foliente (2000) and Bramwell, (2003). Although, in principle, contractors could require suppliers to take responsibility for individual products to perform over time as a prerequisite of PBC, contractors appeared to be reluctant to take responsibility for buildings as a whole.

In the majority of industrial production processes the producer is responsible for securing finance for the production process. If contractors found they had insufficient capital to fund production, under PBC the contractor/developer would be able to use the contract and the promise of a future cash flow as collateral to finance the construction phase.

Some contractors might object that the risks of PBC are too great and too long term for contractors. However, it does not follow that contractors could not build up the expertise to undertake the life cycle commitments necessary for PBC. There is nothing necessarily insurmountable that prevents building producers acquiring the expertise and resources needed for PBC, given the will and the necessary incentives.

Like so much innovation in the construction industry the change may well have to be initiated on the client side. Although PBC may be relevant to private sector clients, the public sector client, acting as a good client, is in a strong position to create the conditions and terms necessary for contractors to accept PBC. Specifying performance levels and desirable outcomes, and measuring and monitoring them form the core of a performance-based contract. As with any contract, both sides must be able to agree on their expectations for payments to be met.

Private sector firms would then compete to provide the building, and quality would be driven by contractors' needs to protect their reputation and maintain good relations with their clients. Contractors would have the incentive of being considered for repeat business. Market principles would also shape their behaviour as firms competed for market share and pursued company-growth policies.

The introduction of PBC in the current UK construction market takes advantage of the cultural changes in the construction industry brought about by PFI, namely the increased awareness of post-construction considerations. It combines this change in public sector construction procurement with the more traditional methods of financing projects, without passing additional costs back on to the public sector or private sector client.

PBC fits in to the range of contractual arrangements operating in the construction sector. Indeed it is possible to conceive of a systematic method for defining appropriate structures for procuring buildings and building services including PBC. We propose a new innovative paradigm based on a decision tree method for evaluating appropriate procurement types. The position of PBC in relation to alternative methods of procument can be readily defined using only a few direct questions. These questions can be used to show the nature of any construction contract relationship, the role of the contractor and the type of contract used. The answers to these questions also indicate the reasons for different contract approaches. The resulting contract may be seen as a response to the circumstances of its use. We consider this decision tree to be of considerably wider significance than only determining PBC as it can be applied equally to establish the appropriateness of different types of procurement depending on a limited number of conditions.

The questions are:

1. Does the client pay for contractor's work in progress?

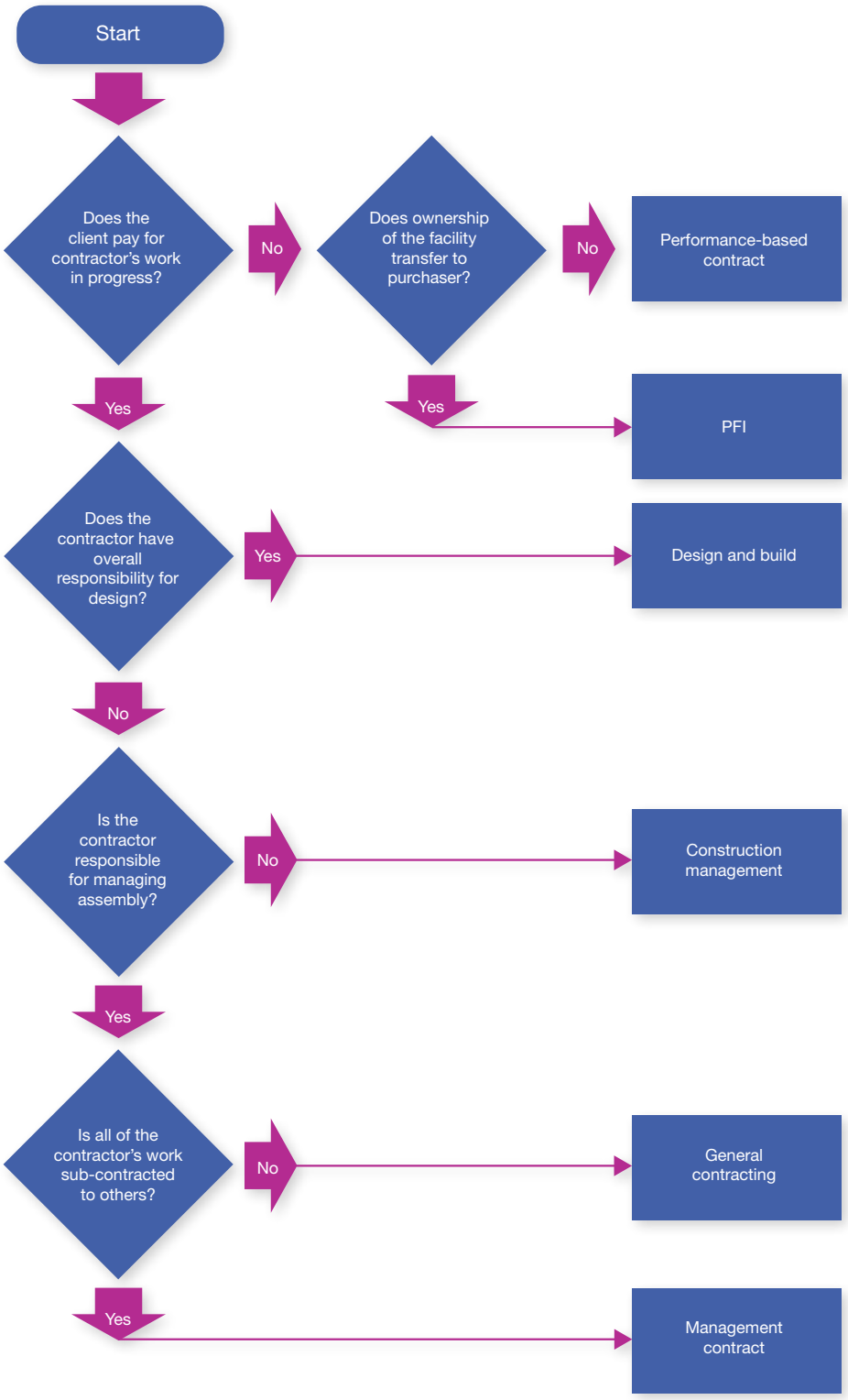
2. Does ownership of the facility transfer to purchaser?

3. Does the contractor have overall responsibility for design?

4. Is the contractor responsible for managing assembly?

5. Is all of the contractor's work sub-contracted to others?

Figure 4: Methods of Procuring Contractors' Work



Discussion

The answers to these questions are shown in Figure 4, which shows the methods for procuring contractor's work, not the buildings as such. Using the questions in Figure 4 shows clearly that PBC occurs when the client does not pay for contractor's work in progress and ownership of the facility does not transfer to purchaser.

As the private sector does not take on any residual risk after the term of a contract, it is reasonable to take over the buildings once the construction phase contractual arrangements have been completed, though this may be extended under PFI contracts or PBC. The reversion of the asset does not necessarily complicate the transaction. Indeed the purchase of buildings is not necessarily problematic or complicated. In the housing market people buy houses with the minimum of inspection.

There are market risks associated with PBC transactions from the point of view of public sector clients. PBC transactions take place in a market context over an extended period of time. One of these risks is that during the tendering and negotiating stages there is an element of competition but as soon as a project has been agreed the supplier becomes a monopolist. Moreover, there is a public sector duty to provide so that there can be no failure due to the supplier being unable to function. For example, safe and weather-proof school buildings are required, regardless of the financial problems facing a contractor. The reality of failure means that porta-cabins are often used as school rooms. If a health service project fails the costs can be much greater than the project. The whole health infrastructure of an area could be threatened with collapse.

It can be argued that PBC is no different from conventional outsourcing of services. If money follows the service requirements, there is a shift in capital requirements for health care from built structures to actual health provision. In the public sector this in turn creates an issue in terms of capital and revenue accounts in the Health Service.

A further issue, arising out of the emphasis on outsourced services rather than buildings and direct employment, is that corporate commitment and long term stability are essential. Firms need to be prepared to undertake long term contracts. This does not mean that the ownership of organizations is immutable. Where ownership transfer takes place there is a requirement to protect and maintain continuity of service levels. Even where the same organization remains in charge, where there is fluid staff turnover individual members of staff may not be as motivated as much as permanently employed people. In fact in PFI projects the initial developer often sells on the contract and its cash flow to provide an agreed post construction phase service as soon as the project has been built, set up or is running smoothly.

At present there is usually a split in responsibilities. For example, the public sector employs nurses and doctors while the private sector provides the buildings. The private sector may have different priorities in running a building. For example, the air conditioning used to control temperatures may be in conflict with the needs of the nurses and doctors. Objective criteria and methods of resolving disputes are needed to arbitrate in such conflicts. Political disputes may arise, for example, where hospitals are widely seen as failing to meet the requirements of the building users, (including cleaning, maintenance and the presence of MRSA and other bacterial infections), and the present situation may not be allowed to continue.

A distinction needs to be drawn between long term issues and short run requirements. In the long term built assets are not always appropriate for the demands placed upon them, because they are static, fixed and durable, whereas needs are dynamic and often volatile, depending on changes in numbers as a result of shifts of population, economic conditions and technology developments. The long term may need a different contract to that needed to meet short term requirements. Contradictions between long and short term requirements could lead to no-win situations for contractors, as they attempt to meet short term changes in demand by lowering maintenance standards with long term implications. This can often occur as managers within an organization act in their own personal interests on the assumption that succeeding managers will have to deal with the consequences of deteriorating under-maintained buildings and structures.

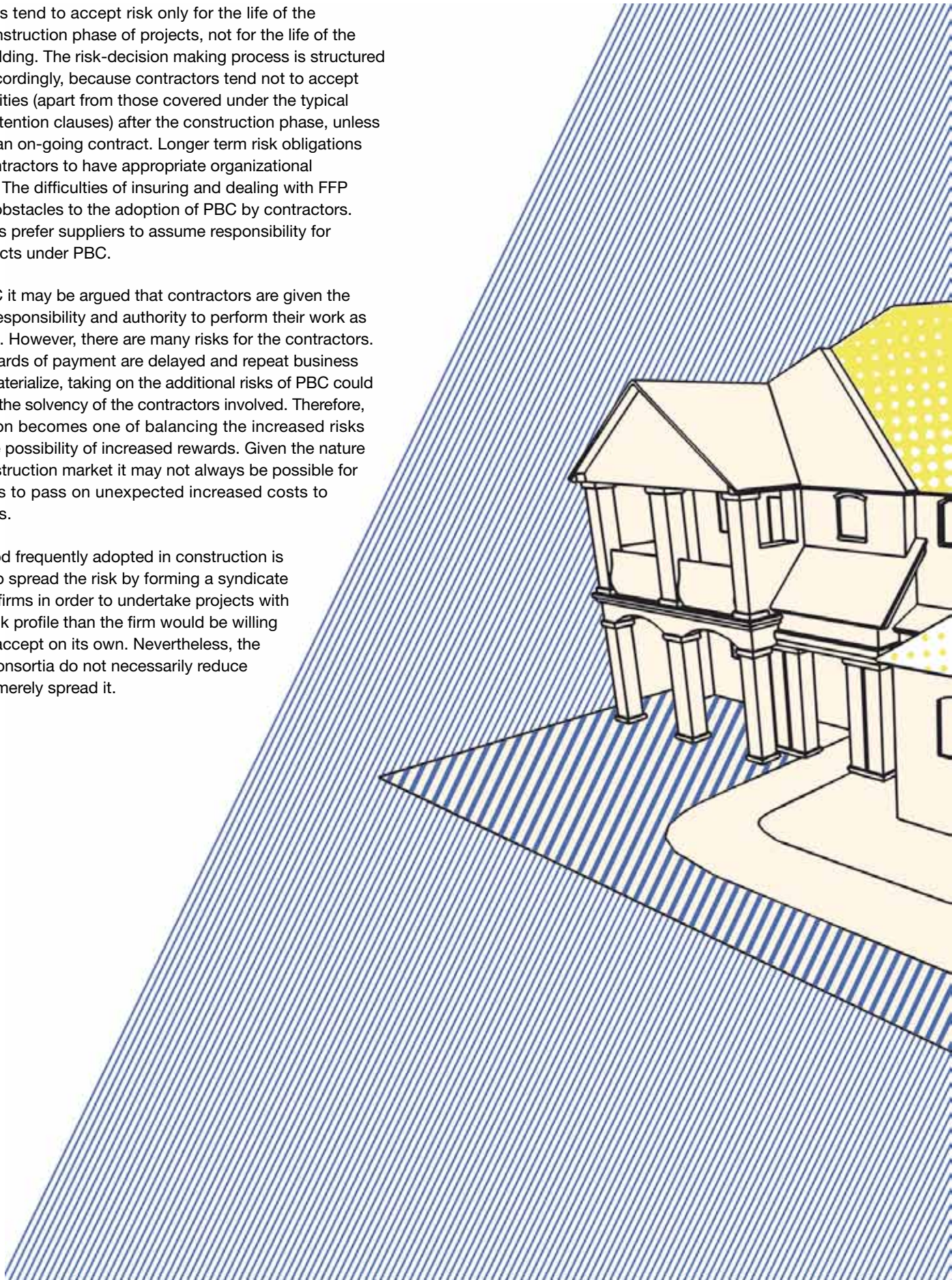
PFI represents an alternative to traditional government procurement. PBC is a new challenge. PFI imposes penalties for non-performance, which the traditional method does not. PFI provides incentives to repair and maintain the asset. Another benefit of PFI is the discipline it brings to a project but its disadvantage is its complexity. PBC may offer a simpler alternative than PFI. It would appear that a more responsive approach to public sector procurement is required and the more flexible the procurement method the better. PBC offers a more flexible form of procurement than conventional PFI projects, which are highly inflexible.

08 Conclusions

Firms tend to accept risk only for the life of the construction phase of projects, not for the life of the building. The risk-decision making process is structured accordingly, because contractors tend not to accept responsibilities (apart from those covered under the typical terms of retention clauses) after the construction phase, unless they have an on-going contract. Longer term risk obligations require contractors to have appropriate organizational structures. The difficulties of insuring and dealing with FFP are major obstacles to the adoption of PBC by contractors. Contractors prefer suppliers to assume responsibility for their products under PBC.

Under PBC it may be argued that contractors are given the freedom, responsibility and authority to perform their work as they see fit. However, there are many risks for the contractors. As the rewards of payment are delayed and repeat business may not materialize, taking on the additional risks of PBC could jeopardize the solvency of the contractors involved. Therefore, the question becomes one of balancing the increased risks against the possibility of increased rewards. Given the nature of the construction market it may not always be possible for contractors to pass on unexpected increased costs to their clients.

One method frequently adopted in construction is therefore to spread the risk by forming a syndicate with other firms in order to undertake projects with a higher risk profile than the firm would be willing or able to accept on its own. Nevertheless, the resulting consortia do not necessarily reduce risk. They merely spread it.



We conclude that:

- the roles and relationships within consortia are structured around risk. The members of consortia share commercial and reputational risks but otherwise adopt traditional roles within consortia-type arrangements
- the main source of risk and conflict is the reliance on other members of the consortium to deliver
- firms in the construction industry tend to have relatively lower capital to output ratios than firms in the automotive industry. This implies that firms in construction have little spare financial capacity for working capital, long term commitments and contingencies. This is reinforced by the net current assets to turnover ratio
- the argument frequently given that firms in construction experience relatively low profit margins is not supported by the comparison with the automotive industry
- long term borrowing in construction tends to be lower than auto manufacturing and repairs implying relatively less fixed capital investment and longer term commitments. This is reinforced by the ratio of fixed assets to capital employed and fixed assets as a percentage of turnover
- there are many firms in the construction industry whose ratios may well equip them to take on PBC contracts
- the perceived risks of PBC deter most contractors from considering PBC as an option. However, 5% of respondents agreed that PBC might be used for minor projects only, where the project represented only a small percentage of total output of the firm and was therefore not a threat to its survival
- PBC represents a service innovation if viewed as an extension of the provision of a product. Alternatively it may be viewed as the introduction of a new service.

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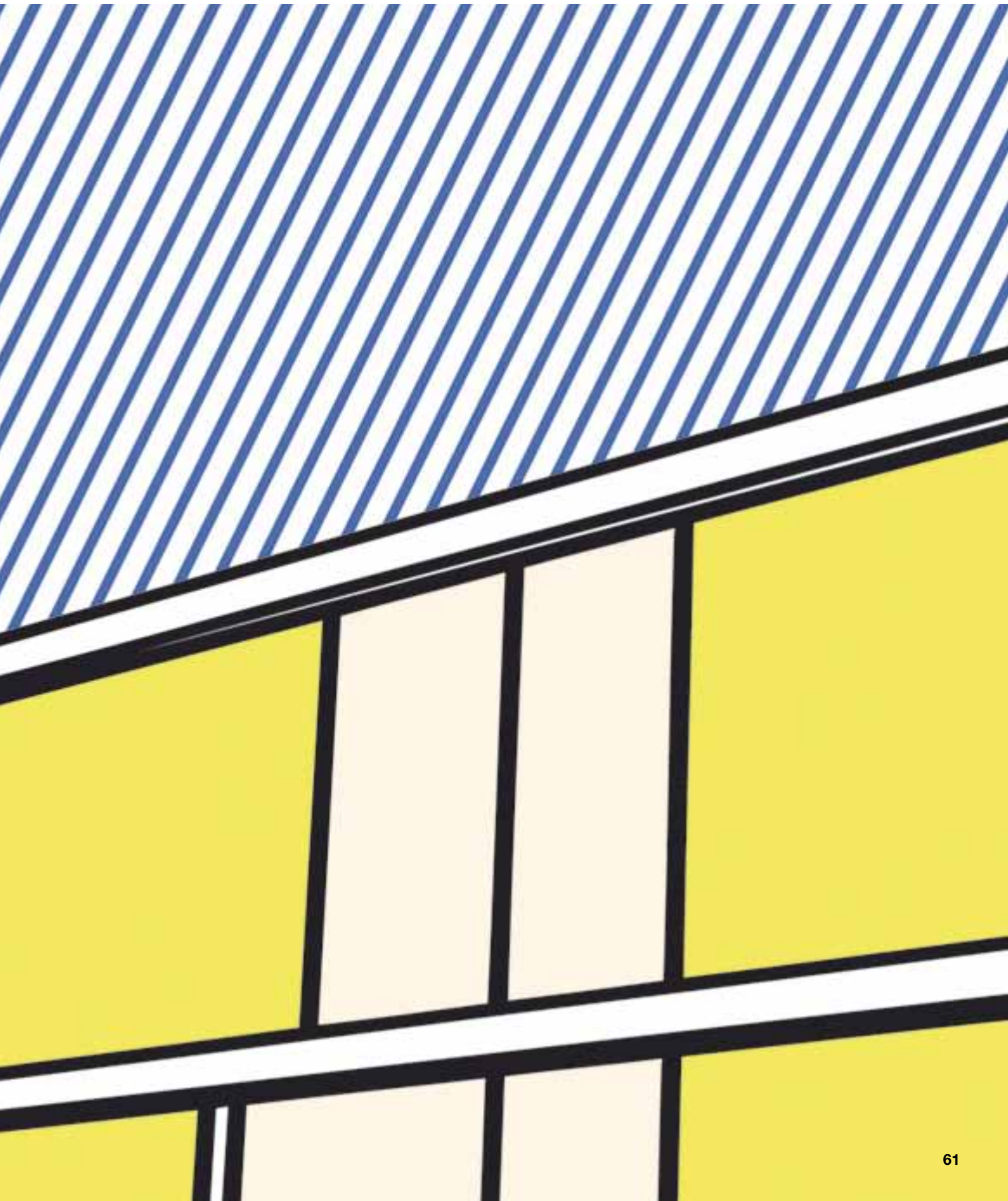
Appendices



Appendix A: Interview questions

Main business activity of firm and role in construction process

Personal role in construction process

Approximately how many people engaged directly by the firm

Approximate turnover of firm

1. Do you have any long term consortium arrangements? (Yes/no.)

2. Why do you enter into these agreements?

3. Under what circumstances do you form a consortium?

4. Do you have a standard partnering agreement? (Yes/no.)

5. Which members of the consortium are responsible for
   - Financial provision
   - Design
   - Actual construction
   - Management
   - Financial control
   - Other roles

6. Are there terms and conditions you seek in the negotiations before entering a consortium?

7. What are the additional risks of being in a consortium?

8. What risks are reduced by the use of consortia?

9. Which parties in a consortium should carry these respective risks?
   - Cost overruns
   - Late delivery
   - Design changes
   - Unresolved disputes
   - Other

10. Why should they carry these risks?

11. Who carries these respective risks at present?

12. What difference does limited liability have on the behaviour of firms in consortia compared to firms outside and do you have any examples of firms taking advantage of their limited liability to avoid financial difficulties?

13. What disputes if any have arisen?

14. How are decisions taken?
    - Jointly following discussion at regular meetings
    - By one party (developer, bank, contractor, architect, other decides)
    - Consultation with all parties concerned
    - Ad hoc discussion.
    - Other

15. How open are the decisions – is the client informed? (Yes/no) If so, rough percentage.

16. How open are the decisions – are decisions circulated in any form? (Yes/no.) If so how?

Appendix B: Questions used in the risk assessment survey

1. Do you know what performance-based contracting is?

2. Bearing in mind the definition* above, what would you consider to be the risks in performance-based contracting?

3. How do you deal with these risks?

4. Which of these risks do you absorb and which do you think should be taken by your suppliers, yourselves or your clients?

5. Under what circumstances (if any) would you be prepared to use performance-based construction?

6. Do you require suppliers or sub-contractors to be responsible for their inputs beyond building completion/retention?

6a. If yes, please give an example.

7. Do you accept responsibility for your output (building) beyond building completion/retention period/warranty period?

8. If you do accept responsibility, how is this effected and under what circumstances?

*the definition supplied to respondents was “the building is procured, based on its fitness for purpose, not the method of construction or the building components used.”

Appendix C: Risks of PBC as suggested by respondents

Table 13: Potential use of PBC

Circumstances	Percentage of respondents
Fitness for purpose (FFP)	7
Lack of insurance for FFP	6
Lifetime costs (including responsibility for lifetime maintenance)	4
Price (capital cost)	3
Inadequate client specification	3
Changing the mindset of clients, consultants, designers and contractors	2
Setting the key indicators	2
Measurements of key indicators over time	2
"Wouldn't touch it!"	2
The "fitness for purpose" changing after completion	2
Too risky for a contractor	2
Client may not get what he perceived	1
Not truly understanding what "fitness for purpose" means	1
Delivery to a price and a programme	1
Consultants cannot get insurance	1
Type of contract	1
Type of specification	1
PBC may not promote creative design	1
Measurement of project indicators	1
Third party intervention for key indicator measurement	1
Poor communication	1
Inadequate materials	1
Inadequate staffing levels	1
Considerable rework	1
Minimum quantity	1
PBC would give minimal safety	1
Client may not like input, which contractor identifies as "fit for purpose"	1
Total	**51**

Appendix D: Accounting ratios – D1

Table D1: Accounting ratios of firms in SIC 45.1 – site preparation 1996–2004

Table D1.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	40	40	56	65	62	65	65	77	72
Median	0.285	0.308	0.259	0.218	0.229	0.241	0.265	0.219	0.247
First quartile	0.125	0.173	0.083	0.089	0.078	0.095	0.133	0.073	0.062
Third quartile	0.540	0.536	0.448	0.398	0.397	0.442	0.479	0.476	0.461

Table D1.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	197	207	267	360	401	467	543	671	760
Median	1.014	0.973	0.844	0.842	0.811	0.771	0.746	0.857	0.818
First quartile	0.473	0.536	0.403	0.354	0.333	0.298	0.3199	0.335	0.352
Third quartile	1.491	1.386	1.309	1.340	1.272	1.246	1.260	1.443	1.394

Table D1.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	37	37	53	61	61	64	64	73	67
Median	0.207	0.272	0.195	0.224	0.171	0.279	0.226	0.196	0.194
First quartile	0.082	0.083	0.047	0.061	0.055	0.073	0.070	0.069	0.077
Third quartile	0.409	0.566	0.449	0.398	0.452	0.446	0.373	0.443	0.379

Table D1.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	141	156	193	242	268	300	363	430	494
Median	0.243	0.247	0.248	0.231	0.250	0.238	0.214	0.242	0.254
First quartile	0.068	0.096	0.094	0.088	0.068	0.065	0.061	0.076	0.073
Third quartile	0.464	0.465	0.493	0.501	0.457	0.430	0.407	0.478	0.601

Appendix D: Accounting ratios – D1

Table D1: Accounting ratios of firms in SIC 45.1 – site preparation (continued)

Table D1.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	40	40	56	65	62	65	65	77	72
Median	0.036	0.030	0.015	0.033	0.015	0.004	0.027	0.026	0.050
First quartile	-0.072	-0.089	-0.077	-0.111	-0.071	-0.077	-0.050	-0.072	-0.036
Third quartile	0.177	0.130	0.137	0.098	0.112	0.136	0.122	0.093	0.151

Table D1.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	40	40	56	65	63	65	65	77	72
Median	0.089	0.075	0.066	0.068	0.058	0.080	0.067	0.061	0.082
First quartile	0.025	-0.003	0.011	0.014	0.028	0.025	0.039	0.0238	0.032
Third quartile	0.145	0.119	0.122	0.105	0.118	0.167	0.187	0.158	0.187

Table D1.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	40	40	56	65	62	65	65	77	72
Median	3.259	3.034	3.602	3.331	4.212	3.467	3.210	3.864	3.638
First quartile	1.562	1.374	2.144	2.280	2.224	2.087	1.940	1.959	2.015
Third quartile	5.875	4.677	9.348	9.535	10.098	7.629	6.385	9.170	14.778

Appendix D: Accounting ratios – D2

Table D2: Accounting ratios for firms in SIC 45.2 – building of complete constructions or parts thereof: civil engineering, 1996–2004

Table D2.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2759	2833	3421	3916	4039	4107	4153	4462	4427
Median	0.137	0.144	0.133	0.130	0.129	0.129	0.135	0.126	0.127
First quartile	0.047	0.053	0.046	0.039	0.044	0.043	0.043	0.036	0.037
Third quartile	0.379	0.392	0.355	0.327	0.338	0.348	0.349	0.333	0.351

Table D2.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	13078	13527	17929	22386	24438	26735	29771	35752	40587
Median	0.454	0.456	0.444	0.444	0.432	0.414	0.390	0.438	0.427
First quartile	0.118	0.123	0.106	0.105	0.104	0.099	0.090	0.095	0.092
Third quartile	0.945	0.934	0.941	0.976	0.972	0.964	0.960	1.090	1.086

Table D2.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2517	2595	3088	3477	3611	3636	3642	3869	3767
Median	0.063	0.066	0.062	0.060	0.060	0.057	0.054	0.058	0.055
First quartile	0.024	0.025	0.023	0.022	0.022	0.021	0.019	0.018	0.019
Third quartile	0.182	0.192	0.176	0.167	0.165	0.160	0.159	0.159	0.159

Table D2.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	8237	8519	10248	11897	12722	13797	15893	18702	20973
Median	0.174	0.162	0.170	0.169	0.160	0.149	0.128	0.134	0.136
First quartile	0.036	0.037	0.036	0.037	0.033	0.028	0.022	0.020	0.019
Third quartile	0.472	0.449	0.474	0.494	0.490	0.474	0.453	0.507	0.516

Appendix D: Accounting ratios – D2

Table D2: Accounting ratios of firms in SIC 45.2 – building of complete constructions or parts thereof: civil engineering (continued)

Table D2.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2758	2832	3420	3916	4040	4105	4153	4462	4427
Median	0.046	0.052	0.047	0.043	0.048	0.051	0.055	0.048	0.050
First quartile	-0.019	-0.013	-0.017	-0.017	-0.014	-0.012	-0.008	-0.016	-0.016
Third quartile	0.174	0.187	0.168	0.158	0.166	0.176	0.182	0.179	0.193

Table D2.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2753	2819	3403	3895	4011	4080	4116	4430	4388
Median	0.037	0.042	0.0469	0.0497	0.049	0.057	0.057	0.065	0.075
First quartile	0.008	0.011	0.011	0.011	0.011	0.015	0.015	0.015	0.016
Third quartile	0.096	0.105	0.125	0.142	0.155	0.163	0.174	0.209	0.236

Table D2.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	6779	6886	8682	10491	11027	11622	12398	13718	14078
Median	0.183	0.203	0.230	0.261	0.268	0.299	0.324	0.383	0.445
First quartile	0.026	0.035	0.037	0.042	0.047	0.056	0.064	0.072	0.080
Third quartile	0.528	0.545	0.690	0.869	0.903	0.992	1.022	1.236	1.407

Appendix D: Accounting ratios – D3

Table D3: Accounting ratios for firms in SIC 45.3 – building installation, 1996–2004

Table D3.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	565	626	866	1135	1256	1302	1367	1572	1705
Median	0.104	0.114	0.111	0.109	0.104	0.113	0.106	0.095	0.101
First quartile	0.052	0.053	0.052	0.042	0.041	0.036	0.031	0.027	0.029
Third quartile	0.210	0.236	0.237	0.216	0.218	0.221	0.209	0.202	0.211

Table D3.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	3506	3633	5335	7593	8776	10155	12037	16828	21070
Median	0.469	0.466	0.457	0.464	0.439	0.421	0.424	0.537	0.538
First quartile	0.207	0.212	0.183	0.168	0.155	0.144	0.140	0.163	0.158
Third quartile	0.897	0.873	0.908	0.967	0.964	0.951	1.002	1.537	1.417

Table D3.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	542	596	816	1051	1166	1207	1251	1444	1555
Median	0.050	0.055	0.052	0.056	0.052	0.049	0.050	0.053	0.057
First quartile	0.023	0.027	0.026	0.026	0.023	0.022	0.022	0.023	0.022
Third quartile	0.104	0.111	0.111	0.115	0.100	0.103	0.112	0.118	0.124

Table D3.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2258	2355	3055	3936	4421	5018	6136	8109	10018
Median	0.141	0.136	0.144	0.148	0.141	0.129	0.116	0.132	0.134
First quartile	0.036	0.035	0.033	0.034	0.030	0.025	0.022	0.021	0.020
Third quartile	0.375	0.364	0.396	0.429	0.431	0.425	0.409	0.516	0.514

Appendix D: Accounting ratios – D3

Table D3: Accounting ratios for firms in SIC 45.3 – building installation (continued)

Table D3.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	565	626	865	1135	1256	1302	1367	1571	1705
Median	0.045	0.047	0.047	0.042	0.046	0.051	0.045	0.036	0.030
First quartile	-0.001	-0.003	-0.008	-0.015	-0.013	-0.012	-0.018	-0.036	-0.041
Third quartile	0.115	0.132	0.123	0.128	0.133	0.139	0.133	0.123	0.121

Table D3.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	564	625	865	1133	1250	1298	1360	1571	1702
Median	0.040	0.040	0.047	0.050	0.061	0.060	0.065	0.088	0.113
First quartile	0.011	0.012	0.012	0.012	0.013	0.014	0.014	0.023	0.029
Third quartile	0.085	0.091	0.121	0.138	0.159	0.169	0.194	0.243	0.287

Table D3.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1406	1433	2108	2968	3332	3717	4143	5214	5807
Median	0.315	0.305	0.405	0.509	0.553	0.595	0.632	0.962	1.000
First quartile	0.091	0.106	0.113	0.148	0.140	0.151	0.143	0.203	0.249
Third quartile	0.790	0.739	1.089	1.409	1.416	1.554	1.649	3.226	2.736

Appendix D: Accounting ratios – D4

Table D4: Accounting ratios for firms in SIC 45.4 – building completion, 1996–2004

Table D4.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	360	388	528	711	796	839	916	1151	1290
Median	0.108	0.104	0.097	0.098	0.087	0.101	0.098	0.077	0.095
First quartile	0.039	0.043	0.028	0.018	0.018	0.024	0.025	0.010	0.020
Third quartile	0.215	0.229	0.221	0.208	0.207	0.218	0.217	0.197	0.220

Table D4.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	2270	2340	3473	4958	5834	6833	8462	12912	16712
Median	0.555	0.532	0.523	0.477	0.468	0.450	0.457	0.608	0.605
First quartile	0.243	0.218	0.189	0.159	0.145	0.137	0.132	0.168	0.161
Third quartile	0.997	0.969	0.999	1.008	1.035	1.025	1.092	1.810	1.623

Table D4.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	344	372	480	634	710	748	809	1018	1136
Median	0.056	0.051	0.055	0.057	0.053	0.057	0.054	0.054	0.059
First quartile	0.028	0.024	0.026	0.025	0.024	0.024	0.022	0.022	0.023
Third quartile	0.129	0.137	0.130	0.118	0.122	0.134	0.120	0.143	0.152

Table D4.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1520	1542	2083	2605	3004	3447	4301	5883	7336
Median	0.187	0.168	0.182	0.172	0.166	0.159	0.136	0.159	0.158
First quartile	0.049	0.047	0.041	0.038	0.037	0.032	0.023	0.023	0.022
Third quartile	0.464	0.411	0.456	0.456	0.492	0.471	0.486	0.611	0.601

Appendix D: Accounting ratios – D4

Table D4: Accounting ratios for firms in SIC 45.4 – building completion (continued)

Table D4.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	360	388	528	711	796	839	916	1151	1290
Median	0.024	0.032	0.033	0.032	0.027	0.030	0.033	0.016	0.023
First quartile	-0.023	-0.015	-0.024	-0.032	-0.038	-0.035	-0.029	-0.051	-0.042
Third quartile	0.089	0.096	0.110	0.116	0.107	0.113	0.120	0.103	0.112

Table D4.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	360	387	527	709	793	837	912	1150	1288
Median	0.030	0.038	0.050	0.060	0.060	0.068	0.080	0.107	0.137
First quartile	0.009	0.013	0.017	0.016	0.018	0.015	0.022	0.029	0.034
Third quartile	0.073	0.078	0.120	0.167	0.176	0.183	0.207	0.275	0.319

Table D4.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	931	964	1410	1948	2284	2536	2950	4076	4794
Median	0.276	0.321	0.391	0.476	0.549	0.606	0.722	1.001	1.037
First quartile	0.062	0.098	0.109	0.099	0.131	0.139	0.164	0.234	0.291
Third quartile	0.731	0.729	1.032	1.271	1.428	1.520	1.957	3.808	3.535

Appendix D: Accounting ratios – D5

Table D5: Accounting ratios for firms in SIC 45.5 – renting of construction or demolition equipment with operator, 1996–2004

Table D5.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	140	147	168	184	183	188	184	177	159
Median	0.482	0.590	0.628	0.547	0.523	0.535	0.538	0.543	0.506
First quartile	0.262	0.296	0.267	0.293	0.240	0.252	0.229	0.220	0.239
Third quartile	0.837	0.952	0.891	0.849	0.833	0.858	0.831	0.900	0.851

Table D5.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	827	848	995	1133	1194	1240	1288	1437	1533
Median	1.100	1.075	1.042	1.045	1.025	1.008	1.002	1.021	1.000
First quartile	0.755	0.752	0.698	0.653	0.648	0.620	0.611	0.605	0.590
Third quartile	1.433	1.359	1.368	1.393	1.376	1.351	1.383	1.436	1.391

Table D5.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	136	144	164	178	177	183	179	173	152
Median	0.644	0.700	0.718	0.683	0.606	0.585	0.555	0.591	0.630
First quartile	0.276	0.327	0.345	0.379	0.312	0.297	0.244	0.291	0.342
Third quartile	0.984	1.168	1.029	1.050	0.989	0.954	0.925	1.040	1.017

Table D5.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	665	690	777	878	887	945	1009	1108	1183
Median	0.256	0.274	0.287	0.283	0.287	0.289	0.270	0.301	0.300
First quartile	0.108	0.100	0.105	0.112	0.108	0.108	0.095	0.091	0.097
Third quartile	0.520	0.506	0.503	0.525	0.538	0.553	0.539	0.547	0.562

Appendix D: Accounting ratios – D5

Table D5: Accounting ratios for firms in SIC 45.5 – renting of construction or demolition equipment with operator (continued)

Table D5.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	140	147	168	184	183	188	184	177	159
Median	-0.073	-0.048	-0.064	-0.109	-0.064	-0.069	-0.032	-0.087	-0.065
First quartile	-0.243	-0.284	-0.236	-0.274	-0.251	-0.278	-0.214	-0.324	-0.280
Third quartile	0.067	0.085	0.087	0.042	0.075	0.092	0.127	0.070	0.122

Table D5.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	140	147	168	184	183	188	184	177	159
Median	0.079	0.083	0.096	0.070	0.065	0.086	0.090	0.080	0.103
First quartile	0.035	0.034	0.035	0.018	0.010	0.035	0.042	0.030	0.031
Third quartile	0.142	0.154	0.163	0.152	0.133	0.166	0.171	0.181	0.186

Table D5.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	349	346	417	471	477	471	488	496	457
Median	0.143	0.150	0.176	0.146	0.132	0.158	0.157	0.140	0.168
First quartile	0.062	0.071	0.079	0.059	0.028	0.063	0.051	0.052	0.053
Third quartile	0.296	0.301	0.317	0.325	0.282	0.323	0.306	0.372	0.364

Appendix D: Accounting ratios – D6

Table D6: Accounting ratios for firms in SIC 50 – sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, 1996–2004

Table D6.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1618	1695	1855	2044	2101	2131	2195	2348	2303
Median	0.126	0.121	0.123	0.121	0.118	0.113	0.112	0.104	0.101
First quartile	0.063	0.059	0.057	0.052	0.051	0.045	0.044	0.037	0.035
Third quartile	0.246	0.243	0.248	0.251	0.250	0.243	0.241	0.227	0.222

Table D6.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	6799	7036	8438	10001	10921	11847	13039	15929	18283
Median	0.686	0.655	0.641	0.618	0.609	0.577	0.565	0.622	0.612
First quartile	0.271	0.260	0.227	0.193	0.174	0.151	0.135	0.142	0.132
Third quartile	1.094	1.063	1.066	1.074	1.085	1.071	1.085	1.245	1.242

Table D6.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1581	1652	1805	1970	2015	2049	2101	2233	2173
Median	0.086	0.081	0.086	0.086	0.086	0.077	0.075	0.074	0.072
First quartile	0.032	0.030	0.031	0.030	0.028	0.024	0.023	0.025	0.022
Third quartile	0.181	0.175	0.178	0.182	0.182	0.176	0.164	0.174	0.175

Table D6.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	4930	5066	5733	6429	6680	7098	7944	9175	10159
Median	0.227	0.225	0.234	0.240	0.237	0.215	0.190	0.200	0.196
First quartile	0.047	0.045	0.043	0.044	0.041	0.033	0.025	0.024	0.022
Third quartile	0.525	0.502	0.518	0.544	0.551	0.543	0.540	0.588	0.595

Appendix D: Accounting ratios – D6

Table D6: Accounting ratios for firms in SIC 50 – sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (continued)

Table D6.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1618	1695	1855	2042	2101	2131	2195	2347	2303
Median	0.024	0.025	0.023	0.021	0.023	0.022	0.021	0.017	0.018
First quartile	-0.014	-0.011	-0.015	-0.019	-0.025	-0.022	-0.021	-0.026	-0.030
Third quartile	0.080	0.083	0.085	0.086	0.093	0.089	0.092	0.085	0.087

Table D6.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1619	1693	1853	2041	2098	2130	2192	2346	2300
Median	0.021	0.023	0.022	0.020	0.018	0.019	0.021	0.021	0.022
First quartile	0.009	0.012	0.010	0.007	0.003	0.007	0.007	0.007	0.006
Third quartile	0.045	0.045	0.047	0.044	0.045	0.048	0.053	0.064	0.067

Table D6.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	3642	3706	4167	4655	4970	5197	5488	5978	6014
Median	0.162	0.177	0.174	0.157	0.150	0.180	0.185	0.217	0.235
First quartile	0.066	0.074	0.067	0.052	0.034	0.057	0.055	0.066	0.061
Third quartile	0.342	0.361	0.372	0.380	0.413	0.449	0.493	0.748	0.902

Appendix D: Accounting ratios – D7

Table D7: Accounting ratios for firms in SIC 34 – manufacture of motor vehicles, trailers and semi-trailers, 1996–2004

Table D7.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	172	181	202	221	230	242	241	250	235
Median	0.359	0.413	0.410	0.385	0.378	0.322	0.331	0.290	0.309
First quartile	0.171	0.174	0.156	0.169	0.139	0.114	0.090	0.100	0.101
Third quartile	0.686	0.690	0.781	0.893	0.953	0.858	0.937	0.720	0.734

Table D7.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	408	430	532	656	704	755	831	898	982
Median	0.666	0.699	0.678	0.682	0.668	0.620	0.602	0.572	0.532
First quartile	0.346	0.380	0.346	0.295	0.267	0.218	0.201	0.176	0.109
Third quartile	0.983	1.000	1.034	1.051	1.119	1.112	1.050	1.031	1.002

Table D7.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	169	179	197	216	223	234	229	240	225
Median	0.277	0.318	0.358	0.367	0.332	0.345	0.339	0.240	0.233
First quartile	0.113	0.135	0.148	0.132	0.130	0.116	0.117	0.089	0.080
Third quartile	0.552	0.654	0.773	0.850	0.780	0.786	0.802	0.697	0.573

Table D7.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	320	334	398	464	484	517	569	607	620
Median	0.214	0.219	0.212	0.234	0.211	0.211	0.185	0.200	0.186
First quartile	0.044	0.047	0.051	0.049	0.041	0.037	0.041	0.036	0.027
Third quartile	0.486	0.479	0.489	0.565	0.583	0.648	0.622	0.643	0.587

Appendix D: Accounting ratios – D7

Table D7: Accounting ratios for firms in SIC 34 – manufacture of motor vehicles, trailers and semi-trailers (continued)

Table D7.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	172	181	202	221	230	242	240	250	235
Median	0.071	0.073	0.051	0.066	0.039	0.029	0.064	0.048	0.065
First quartile	-0.037	-0.022	-0.095	-0.086	-0.113	-0.160	-0.113	-0.069	-0.048
Third quartile	0.203	0.196	0.175	0.216	0.284	0.247	0.342	0.298	0.297

Table D7.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	172	181	202	221	230	242	241	250	235
Median	0.058	0.053	0.048	0.038	0.029	0.022	0.026	0.030	0.036
First quartile	0.009	0.017	-0.032	-0.028	-0.083	-0.062	-0.043	-0.020	-0.024
Third quartile	0.121	0.110	0.108	0.095	0.115	0.102	0.093	0.093	0.109

Table D7.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	283	290	355	417	441	455	483	496	469
Median	0.185	0.163	0.169	0.135	0.122	0.099	0.112	0.107	0.133
First quartile	0.061	0.038	0.003	0.010	-0.032	-0.053	-0.020	-0.027	-0.015
Third quartile	0.381	0.351	0.343	0.345	0.378	0.361	0.361	0.389	0.479

Appendix D: Accounting ratios – D8

Table D8: Accounting ratios for firms in SIC 34 and SIC 50 combined – manufacture of motor vehicles, trailers and semi-trailers and sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, 1996–2004

Table D8.1: Capital employed over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1789	1875	2055	2264	2329	2372	2434	2598	2538
Median	0.135	0.134	0.131	0.131	0.128	0.121	0.118	0.112	0.108
First quartile	0.066	0.063	0.059	0.056	0.053	0.048	0.047	0.041	0.037
Third quartile	0.280	0.278	0.289	0.297	0.298	0.284	0.280	0.257	0.252

Table D8.2: Fixed assets over capital employed

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	7197	7455	8953	10633	11599	12575	13842	16795	19232
Median	0.685	0.657	0.643	0.624	0.614	0.580	0.567	0.620	0.607
First quartile	0.275	0.265	0.233	0.199	0.179	0.155	0.138	0.144	0.132
Third quartile	1.089	1.060	1.065	1.073	1.089	1.073	1.084	1.231	1.227

Table D8.3: Fixed assets over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1749	1830	2000	2185	2236	2282	2329	2473	2398
Median	0.097	0.091	0.096	0.094	0.096	0.086	0.083	0.081	0.079
First quartile	0.034	0.033	0.034	0.034	0.030	0.027	0.026	0.027	0.024
Third quartile	0.209	0.208	0.218	0.219	0.217	0.208	0.196	0.201	0.198

Table D8.4: Gearing, defined as long term liabilities over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	5242	5392	6119	6876	7148	7596	8492	9763	10759
Median	0.226	0.225	0.232	0.240	0.235	0.215	0.190	0.201	0.196
First quartile	0.047	0.046	0.044	0.045	0.041	0.034	0.026	0.025	0.022
Third quartile	0.523	0.502	0.516	0.545	0.552	0.548	0.545	0.591	0.595

Appendix D: Accounting ratios – D8

Table D8: Accounting ratios for firms in SIC 34 and SIC 50 combined – manufacture of motor vehicles, trailers and semi-trailers and sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (continued)

Table D8.5: Net current assets to turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1789	1875	2055	2262	2329	2372	2433	2597	2538
Median	0.025	0.027	0.024	0.023	0.024	0.022	0.021	0.018	0.019
First quartile	-0.014	-0.012	-0.017	-0.021	-0.028	-0.026	-0.024	-0.029	-0.032
Third quartile	0.087	0.094	0.093	0.098	0.100	0.098	0.104	0.093	0.095

Table D8.6: Profit margin, defined as earnings before interest and tax over turnover

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	1790	1873	2053	2261	2326	2371	2431	2596	2535
Median	0.022	0.024	0.022	0.020	0.018	0.019	0.021	0.022	0.023
First quartile	0.009	0.012	0.009	0.007	0.002	0.005	0.006	0.006	0.005
Third quartile	0.050	0.052	0.052	0.047	0.048	0.051	0.057	0.067	0.071

Table D8.7: Return on capital employed, defined as earnings before interest and tax over fixed assets and current assets less current liabilities

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of firms	3922	3992	4516	5068	5402	5644	5962	6465	6478
Median	0.164	0.177	0.174	0.156	0.147	0.174	0.179	0.210	0.228
First quartile	0.066	0.072	0.064	0.049	0.029	0.050	0.049	0.059	0.057
Third quartile	0.345	0.361	0.371	0.378	0.411	0.442	0.480	0.719	0.853

Table D8: Summary tables 2004

Capital employed over turnover 2004

SIC	1st quartile	Median	3rd quartile
451	.062	.247	.461
452	.037	.127	.351
453	.029	.101	.211
454	.020	.095	.220
455	.239	.506	.851
34	.101	.309	.734
50	.035	.101	.222
34 and 50	.037	.108	.252

Fixed assets over capital employed 2004

SIC	1st quartile	Median	3rd quartile
451	.352	.818	1.394
452	.092	.427	1.086
453	.158	.538	1.417
454	.161	.605	1.623
455	.590	1.000	1.391
34	.109	.532	1.002
50	.132	.612	1.242
34 and 50	.132	.607	1.227

Fixed assets over turnover 2004

SIC	1st quartile	Median	3rd quartile
451	.077	.194	.379
452	.019	.055	.159
453	.022	.057	.124
454	.023	.059	.152
455	.342	.630	1.017
34	.080	.233	.573
50	.022	.072	.175
34 and 50	.024	.079	.198

Gearing 2004

SIC	1st quartile	Median	3rd quartile
451	.073	.254	.601
452	.019	.136	.516
453	.020	.134	.514
454	.022	.158	.601
455	.097	.300	.562
34	.027	.186	.587
50	.022	.196	.595
34 and 50	.022	.196	.595

Appendix D: Accounting ratios – D8

Table D8: Summary tables 2004 (continued)

Net current assets over turnover 2004

SIC	1st quartile	Median	3rd quartile
451	-.036	.050	.151
452	-.016	.050	.193
453	-.041	.030	.121
454	-.042	.023	.112
455	-.280	-.065	.122
34	-.048	.065	.297
50	-.030	.018	.087
34 and 50	-.032	.019	.095

Profit margin 2004

SIC	1st quartile	Median	3rd quartile
451	.032	.082	.187
452	.016	.075	.236
453	.029	.113	.287
454	.034	.137	.319
455	.031	.103	.186
34	-.024	.036	.109
50	.006	.022	.067
34 and 50	.005	.023	.071

Return on capital employed 2004

SIC	1st quartile	Median	3rd quartile
451	2.015	3.638	14.778
452	.080	.445	1.407
453	.249	1.000	2.736
454	.291	1.037	3.535
455	.053	.168	.364
34	-.015	.133	.479
50	.061	.235	.902
34 and 50	.057	.228	.853

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