Case Study

Risk Allocation in the Operational Stage of Private Finance Initiative Projects

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Abstract: A qualitative analysis based on four private finance initiative (PFI) projects during the operational monitoring stage is demonstrated in this paper. The investigation focused on how the design and contractual risks were reflected and handled at the operational stage of the PFI projects. Some unforeseen project risks that occurred during the operational stage were highlighted, and more focus on the risk control of future PFI procurement from the various parties involved is recommended. The research process includes documentation review and a semistructured interview survey. It is found that the public sector still is liable to some unforeseen risks during the operational stage, although the private sector takes most of the risks according to the contract. Recommendations are made for further research and improvements on the PFI project management. **DOI: 10.1061/(ASCE)CF.1943-5509.0000194.**

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Introduction

In 1992, the UK Conservative Government engaged in private finance initiatives (PFI), which is a way of financing and operating public projects. It has been more than a decade since the first PFI project started in the UK. In the PFI procurement, the public sector defines the requirements to meet public needs and ensures delivery of the outputs through the contract, and the private sector is harnessed to deliver better quality of public services (HM Treasury 2006). PFI procurement allows the private sector to finance the capital cost for the projects, which is paid back by the public sector over a period of time—the concession period. The government assesses PFI by its commitment to "efficiency, equity and accountability, and on the Prime Minister's principles of public service reform" (HM Treasury 2006, pp. 295). PFI provides innovative design and delivery of public services and "optimal" risk-sharing between the public and private sectors; therefore, the government claims that PFI can offer better value for money (VfM) than the conventional procurement (HM Treasury 2006, 1997).

The incentive of PFI was to achieve closer partnerships between the private and the public sectors at both central government and local authority levels. The guiding principles of PFI are that risks in PFI procurement should achieve a genuine transfer to the private sector and to secure VfM when using the public resources (Allen 2001).

Until now, PFI has been the first-choice procurement route for public service in the UK, providing most forms of public service provision, such as health, education, defense, residential, information technology, prisons, and roads. The number of signed PFI projects in the UK is 668 until September 2009, with a total capital value of over £55 billion (HM Treasury 2009). The main sectors among the signed PFI projects are the health and transport sectors, which both account for approximately 20% of the total capital value (HM Treasury 2009). The number of PFI projects in the operation stage has exceeded 500 [National Audit Office (NAO) 2007]. Some of the PFI hospital and school projects have been in operation for over 10 years.

The new characteristics of PFI are (1) public services provided by private sector; (2) integrated package of design, build, finance, and operation of the project by the consortium; (3) the contract period is much longer (usually 25–30 years) than the conventional construction contracts; and (4) new concepts, such as whole life costing and VfM, are introduced in the tendering process. The main advantages of PFI are improved efficiency, decreased inflation, reduced public sector expenditure, and expanded private financing of capital projects (Eaton and Akbiyikli 2005; Chang et al. 2010). It is said that PFI projects are mostly delivered on time and within budget compared with traditional procurement (NAO 2003), although some of the early school PFI projects showed high initial cost and poor quality (Audit Commission 2003). Until now, PFI has been introduced to many other countries, for example, mainland Europe, Australia, Canada, Japan, Brazil, and China (Cheng et al. 2007).

Unlike the other conventional construction contracts, the PFI contracts can be as long as 30 years. The contract design and contracting procedures is the key for public-private partnership (PPP) and PFI because well-designed and managed contracts are the mechanism by which risk is transferred to the private sector, and incentives are thereby introduced for good management of service provision (Palmer 2000). The factors to evaluate whether the outcomes represent VfM are (1) the precise terms of the contract, (2) how the contract is awarded, and (3) how it works in practice over the contract period.

The construction industry is considered a risk-based industry, and the PFI projects are even more risky because of their complexity and long contractual period. PFI is a relatively new procurement method: the history of the first few PFI projects in the UK is no more than 20 years. Despite the extremely long tendering stage of the PFI projects, including several rounds of risk analysis, there must be risks and uncertainties that are identified during the tendering stage but that only occur after several years of operation. The commonly accepted definition of project risk is the product of

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probability and consequences caused by risk events (Hertz 1983; Kendrick 2003; Raftery 1994). A large number of studies have contributed to risk analysis in PFI. Allen (2001) stated that the key PFI-specific risks include financial risks and disposal risk, and the public sector also must bear the risk of wrongly specified requirement and the risk of criticism. Bing et al. (2005) categorized PPP/PFI project risk into three levels:

1. Macro level, including political and government policy, macroeconomic, legal, social, and natural;
2. Meso level, including project selection, project finance, residual risk, design, and construction; and
3. Micro level, including relationship, and third party.

Grimsey and Lewis (2005) excluded socioeconomic costs from their risk analysis for PFI, but included construction, service performance, site use, building standards, revenue, financial conditions, and residual asset value.

The NAO (1999) provide the following risks regarding PFI projects:

- Design and construction risk;
- Commissioning and operating risks;
- Demand risk;
- Political/business risk;
- Project finance risk;
- Regulation risk;
- Residual value risk;
- Risk of contractor default; and
- Technology/obsolescence risk.

Broadbent et al. (2008) state that financial risks, design and construction, service risks, maintenance risks, legal risks, among which are the service and maintenance risks, are difficult to determine until the projects are in the operational stage. Close operational monitoring is necessary to determine these operational-related risks.

There is no lack of literature regarding the tendering and construction stage of PFI projects, such as contractual issues (Coulson 1998), contractual and relational governance (Zheng et al. 2008), bidding decision making (Zitron 2006; Wang and Horner 2007), sustainable design (Wang et al. 2010a, b; Chang et al. 2010) innovative design (Geslera et al. 2004), carbon emission reduction (Wang et al. 2010a; Chang and Wang 2010), and multiple decision making (Wang 2009). However, very little research has been performed at the operational stage of PFI projects. It is necessary to analyze and summarize the advantages and disadvantages of this crucial stage in PFI project management because the design and construction risks have a huge impact on the operational stage. In addition, for the public interests, it is necessary to evaluate the services provided by the private sector during the operational stage of the ongoing PFI projects. Investigation on the operational monitoring process and service performance is crucial to providing valuable feedback to design innovation and to guide the contractual and project management of future PFI projects to provide better public services.

Research Objectives and Methodologies

Because of its flexibility, the case-study method has been widely applied in research (Dubois and Araujo 2004; Beverland and Lindgreen 2010). Easton (2010) stated that case-study research may be the most popular research method adopted by industrial marketing researchers. A case study of a single or a small number of examples can provide significant qualitative data that investigate the true nature of the phenomena (Easton 2010). The operational stage is the longest stage throughout a PFI project; however, there is short of case studies in this area.

The objectives of case-study based research are to (1) investigate contractual relationships and liability of the various parties, (2) identify unexpected risks in PFI projects by examine some existing PFI projects in their operational stages, (3) understand how these outstanding issues are resolved in practice.

Some PFI projects aged between 5 and 11 years were selected as case studies in this research. The methodology of the research includes semistructured interviews with private and public sectors involved in the PFI projects and quantitative analysis based on the contracts and the monthly operational monitoring reports and team meeting notes.

Site visits were executed and interviews with the client, the technical adviser, and the facility manager were arranged to identify and evaluate project risks during the operational stage. The semistructured interview survey focused on the general risks related to the overall projects, excluding the macro environment, in the following areas:

- Design defaults;
- Construction quality issues;
- Financial issues;
- Service performance; and
- Relationships between the public and private sectors.

Despite the general questions, the interview survey also looked into the outstanding issues related to the projects during the operational stages and how problems are being resolved in practice. These issues may have not been expected before the building started but can only be identified during the operational stage. Those unexpected outstanding issues during the operational stage may cause disputes because the liability may not be clearly specified in the contracts. Therefore, it is important to understand how those outstanding issues are resolved in practice.

The documentation review is designed for two purposes: first, to understand the structure of the PFI projects and the relationships and liabilities of parties involved by contract study; and second, to explore outstanding issues and solutions of the issues through monitoring reports and meeting notes.

The data collection stage involves the gathering of the original contracts of the PFI projects signed many years ago, the monthly operational monitoring reports from the technical advisers, and the meeting notes from their regular team meetings. The outstanding issues are selected from the operational monitoring reports and notes for further analysis. The interviewees have been asked to evaluate how serious those issues to their represented parties and classify them into low, medium, and high risks. In this research, low risk is defined as insignificant events during operational stage, whereas medium risk refers to those events that must be reviewed by the key parties in the project. High risks should raise significant concern to the public and private sectors so that immediate action is recommended for consideration.

The key areas in document review address the following aspects, which closely relate to the operational stage of the projects:

- The payment mechanism;
- The service performance;
- The adequacy of the life-cycle cost;
- Utility;
- Snagging;
- Health and safety; and
- Liability allocation.

Case Studies

Basic Information about the PFI Projects in the Case Studies

The case studies include four life PFI projects, which were all in the postconstruction stage. Basic information about the PFI projects is listed in Table 1.

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Table 1. Basic Information on the Case Studies

Project details	Case 1	Case 2	Case 3	Case 4
Type of project	PFI hospital	PFI hospital	PFI secondary school	PFI primary school
Floor area (m^2)	8,000	11,800	10,600	2,140
Location	Greater London	East England	West coast	Southwest England
Contract signed year	1999	2004	2005	2004
Type of building	New build	New build and existing	New build	New build
Stories	3	3	2	1
Structure	Steel and concrete	Concrete and bricks	Concrete	Concrete

The overall processes of the four PFI projects are quite similar, as shown in Fig. 1. The whole life of a PFI project consists of four stages: tendering, construction, operation, and hand over. The average period for the tendering stage is approximately 2 years, similar to the construction period. However, the operational stage alone cover a 25-year period, much longer than any other stage in PFI. The final hand-over period is 5 years. Unfortunately, none of the projects reached that period, therefore the investigation on the hand-over period is excluded from this research. It is obvious that the operational stage is the longest during the PFI contract period.

The special purpose vehicle (SPV) raises private investments to fund the construction stage in a PFI project, whereas the client only pays back the initial investment through unitary charges after the construction is complete. The unitary charge is composed of the initial investment of construction, the interest of their capital investment (the cost of borrowing money), the facility management (FM) cost, and the life-cycle cost, among which the FM and life-cycle costs only occur in the operational stage. The FM cost, including the soft and hard FM, is directly related to the service performance of the service provider, whereas the life-cycle cost is the fund for planned replacement works for building elements.

Parties Involved in the Operational Stage of PFI

The operational stage of a typical PFI project in the UK is 25–30 years. The key parties involved in the long period include the client, the technical adviser of the client, the FM company, and the SPV. At this stage, the authority starts paying off the initial capital investment of the SPV together with the public services they provide, according to the quality of their services. Based on the contracts of PFI projects, the relationships between the key parties during the operational stage are summarized in Fig. 2.

The project agreement is the legal contract to bond the public and private sectors, i.e., the authority and the SPV. The SPV organizes the financing, design, construction, and operation works throughout the whole life of the project according to the service requirements of the client. The various parties within the SPV are tied by subcontracts; for example, the construction contract for the contractor, the FM contract for the FM company, and so on. The client only pays back, in a form of unitary charge, the SPV's investment and operational costs after the assets start to provide public services. The FM company, forming part of the SPV, provides services to the public. Their service performance is monitored by an independent party (the technical adviser) who is directly responsible for the client. Although the contractor has completed the construction works, they still have liability for latent defects during the operational stage.

The key indicators to measure the service performance provided by the FM company are the availability and service failure. Availability means whether a unit space, for example a classroom, is available for use. Service failure constitutes (1) quality failure deductions and (2) failure event deductions. The indicators are used to calculate deductions on unitary charge, which is paid by the client. The calculations are defined in payment mechanisms in the project agreement, which varies slightly between projects. If there are neither service failure nor availability deductions in a month, the unitary charge of the month will be fully paid to the SPV. Otherwise, if the services failed the minimum requirements in the contract, there will be a deduction from the monthly unitary charge. All the service failures must be rectified by the FM company within said period in the contract or service deductions will apply to the unitary charge. The service failures reported by the users of the facilities are recorded by call-logging system, and the building maintenance works are stored in an asset database. The data in the data recording system are summarized each month in the FM reports and are used as the input to the pay mechanism for payment calculation.

According to the project agreement, for the purpose of optimizing service delivery, the technical adviser of the client executes operational monitoring on a regular basis. The operational monitoring review measures their services and decides how much the public sector should pay to the services provided by the SPV. The SPV's income (unitary charge) depends on the quality of their service performance. According to the contracts, the client is entitled to make a deduction from the unitary charge once a service failure occurs and is not rectified on time during the operational period. In this way the service performance is directly linked to the monthly payment to the SPV; therefore, the quality of the services provided by the private sector is properly controlled. The liabilities regulated in the contracts within PFI projects are listed in the Table 2.

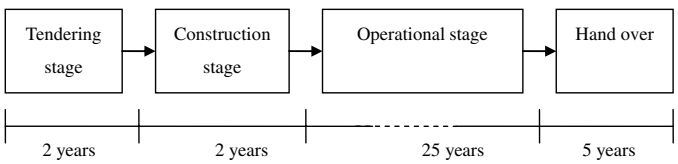

Fig. 1. Procedure and time frame of PFI projects

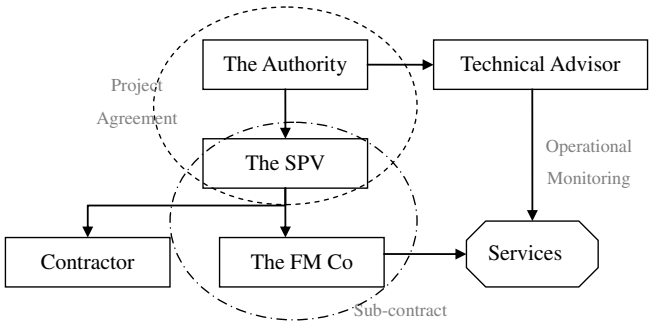

Fig. 2. Key parties in PFI operational stage

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Table 2. Liabilities Allocation in the Project Agreement

Risk area	Description	Liability	Impact on building operation
Design	Design defects	SPV	Usability and maintainability
	Unforeseen site condition	Contractor	Delay of operation
Construction	Snagging	SPV	Reactive maintenance
	Latent defects	Contractor	Early life-cycle failure
	Cost overrun	SPV	—
	Failure of delivery	Contractor	Termination of subcontract
Service performance	Unavailability	FM company	Availability deduction on unitary charge
	Service failure	FM company	Service deduction on unitary charge
	Inefficient energy performance	SPV	Loss of energy allowance
	Failure points exceed contract requirement	FM company	Termination of FM contract
	Cost overrun	SPV	—
	Unitary charge—fix amount	Client	Potential savings on life-cycle cost
Relationship	Communication failure	SPV	Delay of unitary charge payment
	Relationship breakdown	SPV	Termination of the contract

The contract review shows the client is allocated least risk during the whole process of the projects. The project managers' role of the SPV requires them to take most of the risks during the whole process of the PFI project. The majority of the liabilities are allocated to the SPV, with some being transferred to the subcontractors of the SPV, such as the FM company and contractor, by subcontracts. The client takes less responsibility during the operational stage, except for the financial payment to the services provided by the private sector.

Interview Surveys with Key Parties

The various parties involved in the operational stage of the PFI projects comprised the facility manager, the technical adviser, and the client (i.e., the public sector), who were invited to semi-structured interviews. Interview surveys were carried out in conjunction with site visits to each project in the case studies. On a high level, the interviewees were asked about their general opinion on the design, construction, finance, and relationship issues. They were also asked to point out the risk events and unforeseen issues that occurred in the operational stage. During the research process, a total of 16 people were invited to interview survey.

1. *The users' opinions*. On the public sector side, the users of the facilities, such as teachers, doctors, and nurses, were generally satisfied with the built assets and the maintenance services by the private sector in the case studies. The PFI hospitals and schools in the case studies were designed in modern styles and with high specifications in comparison to hospitals and schools built by conventional arrangements. The improvement of usability can be shown in several aspects from the viewpoint of the users; for example, sufficient car parking spaces for future expansion, improved hygiene standards, quicker response to reactive maintenance works, and better maintenance of exterior and site works. The schools were satisfied at the high-quality sport pitches and enlarged outdoor spaces for students. The construction processes of the four projects were remarkably efficient because all of them were completed on time and within budget. The services provided by the facility management team were prompt and efficient. The quality of services was generally higher than hospitals and schools built by conventional arrangements.
2. *The facility managers' opinions*. The facility mangers in the four case studies were satisfied with the overall maintainability of the designs. This is mainly attributable to the participation of the facility managers in the design stages of the PFI projects, which is impossible in conventional procurements. The facility managers particularly drew attention to the advantages of the PFI design mechanism that provides adequate cleaning facilities for cleaners, appropriate storage space for building maintenance works, and adoption of long-life building elements to reduce the minor refurbishment works. The facility managers' opinions were reflected in the design innovation of the PFI projects, which increased the maintainability of the buildings in return. The whole life costing decision making newly adopted in the PFI tendering stage also guided the design team to work toward a long-life target rather than a construction-oriented scheme. The energy efficiency has been remarkably improved by better design of building insulation and the energy management policy within the PFI contracts.

   The facility managers also mentioned the existence of the latent defects caused by poor construction; for example, a small area of water leakage caused by the inappropriate installation of waterproofing. Those items were then corrected by the contractor because they were still liable for the defaults caused by poor construction in the first 1–2 years after the completion of construction. Other smaller-scale snagging items were rectified by the FM company through building reactive maintenance works in practice.
3. *The technical advisers' opinions*. The technical adviser's works are to investigate the service performance of the FM company, the relationship between the client and the SPV, and the adequacy of the finance aspect with regard to the operational stage. Interviews with the technical advisers revealed some common issues within the four PFI projects. First, the reactive and preventive FM maintenance were generally prompt and efficient. The interior and exterior of the buildings were in good maintenance condition. Second, because of the good maintenance condition mentioned, the lives of the building elements have been prolonged in the PFI projects. The original life-cycle cost plan was estimated based on the average life spans of building elements under an average maintenance condition. Because of improved maintenance conditions in the PFI environment, the real life-cycle replacement costs were less than the expected life-cycle fund agreed to in the project agreement years ago. Almost all of the PFI projects in the case studies have not experienced any drawdown from their life-cycle funds in the first 5 years. However, the contract states

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the clients have no control of the life-cycle fund during the operational stage of the PFI projects. As a result, the savings in life-cycle fund becomes a pure bonus for the SPV.

There is an energy policy in the project agreement, which encourages improvement on energy efficiency of the building in operation. The energy consumption of the project was closely monitored during the operational stage to measure the energy efficiency each year. An allowance is preserved as an award to the FM team for any energy savings below the agreed target during the operational period. It works as a good incentive mechanism for the facility management to improve energy efficiency. The newly built buildings in the case studies showed good energy performance in their operational stage.

All the interviewees showed no concern about the financial issues. It may be because the financial issues have been properly regulated in the PFI contract. There were no financial issues reported in any of the projects in the case studies.

4. *Client and SPV's opinions*. Both the client and the SPV in the interview survey are satisfied with the relationships between the public and private sectors. Because the contract period of the PFI projects lasts a lifetime, both parties are exerting great effort to maintain good relationships. Communications between the private and public sectors are regular and prompt, which assists a sustainable development of the PFI projects. Monthly meetings were held between the FM company, the authority, and SPV, with project updates provided and discussed each time. The services provided by the FM company were reviewed, and the clients' feedback was received in these regular project meetings.

Outstanding Issues in the Case Studies

The preceding section summarized a general survey of the four PFI projects. They have some minor issues in common, but the outstanding issues in each of the projects are unique. During the site visits and interview survey, some outstanding issues of the four projects were discovered. The opinions of different parties toward these issues are similar.

Case Study 1

This PFI hospital is the oldest among all the projects in the case studies: the building was completed nearly 10 years ago. The three-story hospital building contains three wards of approximately 200 beds. The FM company based on-site is responsible for the day-to-day maintenance and management of the hospital building and external works. The semistructured interviews with different parties and documentation review in this case study uncovered some outstanding issues that occurred in the operational stage of the hospital.

The corridors connecting one wing and the canteen experienced heavy traffic of metal push trolleys. The original design did not consider installing wall protection, such as metal corner protections and handrails along the corridor walls. The plasterboards at the corridor areas were damaged, and repair and repainting were needed. After discussion in the monthly team meeting with the client, the FM company took prompt reactive maintenance action, including installation of wall protections and repair of the damaged plasterboards. Therefore, the SPV has to bear the extra cost caused by the design defect. The remedy cost is relatively small compared to the overall FM fee. This kind of extra FM cost caused by design defects can certainly be avoided if preventive actions had been considered in the original design. Because the FM company has taken reactive maintenance works to rectify the design default, the risk of this outstanding issue is considered low to the SPV.

Some issues related to the life-cycle cost fund were also revealed in the investigation. The original life-cycle cost plan of the building was estimated on the basis of the life span of building elements under an average maintenance condition. It assumed each building element would be replaced in the year when it reached the end life. That is why the life-cycle cost plan appears to spike in certain years over the 25-year concession period. However, that is not how the life-cycle cost is spent in reality. For example, all the ironmongery of internal doors were planned to be replaced after 8 years, as noted by the life-cycle cost plan in the contract. However, some of the ironmongery on frequently used doors failed much earlier than the others; therefore, they were replaced much earlier than the planned replacement year. Therefore, the replacement of ironmongery became a reactive maintenance tasks that was finally excluded from the life-cycle cost drawdown in operating the PFI hospital. Another example is the replacement of the vinyl floor finishes within the wards. Although the life-cycle cost plan suggests replacing the vinyl floor finishes at the same year, that is not achievable in reality. The wards were fully occupied by patients most of the days during the year, which made renovation works difficult to arrange. The replacement of vinyl floor finishes is normally separated into many small areas and constructed in different stages in line with the availability and working time of each unit of the hospital. The construction period of replacing the floor finishes of the whole building may take several years to complete. The more suitable way for life-cycle replacement cost planning of a building element is to spread replacement cost into a several-year period rather than a single expense at one year during the life of the building.

The users of the building, such as nurses and doctors, reported the availability failure and the service failures through a call-logging system. The reports were stored in a database and reviewed by the authority and the FM company at the end of each month. The data-recording system was found adequate and prompt. There was no availability failure reported in the previous operational monitoring reports. The service failures in the past mainly related to mechanical failures of electrical appliances and functional failures of small building components. The rectification times of those reported service failures were all within the remedy period written on the FM contract; therefore, there were no service deductions on monthly unitary charge in the past. The private sector in this case study provided good-quality services to the public sector, and they also kept an excellent relationship with the public sector.

Case Study 2

The PFI hospital project in Case Study 2 is the largest in scale among the four projects in the case studies. The central asset of the project is a newly built community hospital, including an emergency and accident center, reception, and wards of nearly 400 beds. There is also an existing Victorian building functioning as an office building for the hospital staff.

The biggest issue in this hospital project lies in its design because it has been oversized. In the first few years in operation, only half of the hospital beds were occupied. The FM company only executes minor preventive maintenance and annual inspection works to those unoccupied parts of the building, but not soft FM services. According to the contract, the authority only pays the services provided by the FM company to those occupied wards. Although the authority does not need to pay for the soft FM cost of the unused wards, their payments still include the SPV's initial capital investment, the capital interests of their borrowed money from the private funder, the life-cycle replacement cost, and the hard FM cost of the whole building, which include both the occupied and unused wards. In this case study, overestimated service

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requirements of the client caused overdesign of the hospital. Although the private sector paid for the initial construction cost, the public money has to finally pay back the unnecessary spending in construction during the operational stage.

Snagging from construction has been gradually rectified by the FM company through reactive maintenance works. The outstanding issues of this PFI project are mostly related to the refurbishment works of the existing staff office on-site, which is a poorly insulated two-story Victorian building.

The key issue addressed in the operational monitoring reports was the damp caused by inadequate waterproof to the external walls, windows, and doors of the building. The reason for the defect is that during the tendering stage the design team was not given enough time to carry out an in-depth site survey for the existing building. The poor waterproof condition of the building was not identified early enough; therefore, no allowance for new waterproof to the external wall was made in the original design. The damp condition was worsening in the operational stage, causing damp patches and mold growth on the inner face of the walls. Because it is the early stage of operation, the risk relating to this issue was of low risk to the client and the FM company. However, if no remedy actions are undertaken, this situation can lead to unavailability and health and safety issues, which are classified as medium to high risks. After a few months of discussion, an agreement has been made between the client and the FM company that waterproof will be installed to the external walls without changing the appearance of the exterior of the building, and rain shields will be installed on top of the external doors and windows. The SPV will fund this remedy work from the life-cycle budget rather than the FM fees.

The newly built part of the project has adopted new design solutions to improve energy efficiency, such as lighting control, building management system, and meter facilities. The energy consumption appears below the target during recent years of operation. However, the existing office building is a backlog for the energy efficiency of the overall project. It was found that the energy consumption of the office building exceeded the target in every year of the operation. The Victorian building is listed as a heritage building by the local government; therefore, the exterior, such as the external windows, doors, and walls are not replicable. The maintenance solutions suggested by the technical adviser include installation of thick curtains to the windows and adding sealant to the external windows and doors to improve the overall insulation condition of the aged building.

The life-cycle models do not envisage expenditure until year five of the concession period. This expenditure includes items such as roof, external walls, windows and external doors, and internal redecoration. The building was well maintained; therefore, there is neither major replacement required nor any drawdown from the life-cycle fund at the current stage.

There were several similar types of incidents reported regarding waste management services, which slightly affected the relationship between the hospital staff and the FM team. To classify wastes, the FM company provided colored waste bins for different types of waste disposal, including recyclable, general, and contaminated wastes. The hospital staff members were asked to dispose of waste into the appropriate waste bins according to the nature of the waste. However, the nurses often dispose the contaminated waste, such as used needles and chemicals, into the wrong bins. The careless actions of the nurses caused several incidents in which the cleaners suffered skin damage and wounds. These kinds of incidents occurred three times in the monthly reports, of which one involved the absence of a FM staff member for several days. In accordance with the project agreement, the client should be responsible for any financial loss of the SPV if it is caused by misuse of the users of the building facility. The issue was reported on the monthly project meetings, and it drew the attention of the client, who finally agreed to reeducate their staff to reduce the health and safety risks of the FM company.

Another conflict between the client side and the FM company was related to the room temperature control. The FM was required to provide a minimum room temperature of 20°C in winter. There were some calls logged in regards to room temperature failures in winter. Some nurses were accustomed to heating rooms to as high as 26°; therefore, they sometimes claimed service failure because they considered the temperature too low. The FM company argued the nurses should not have the expectation of indoor temperature high enough that they can even wear summer clothes. Overheating the hospital rooms made it difficult to reduce energy consumption to under the initial target. After team discussion, the hospital and the FM company agreed that the nurses should wear warmer clothes in winter and the room temperature should be kept at 20–25°C.

Similar to the preceding case study, the data recording and management system was satisfactory in this project. The overall service performance of the FM company in this project was considered adequate, and the relationship between the authority and the SPV is satisfactory.

Case Study 3

In this case study, a newly built secondary school PFI project was investigated through site visit and document review. The interview surveys with both the public and private sectors were carried out during the site visit. The number of pupils in this school is 1,300, and the location of the school is on the coast of west England.

The designed external windows for this school are aluminum frame with double-glazed windows. The windows were given 30 years replacement cycle in accordance with the original life-cycle cost plan in the contract. However, the special salty condition of the school shortened the life of the window frames, and some frames show signs of oxidization. It was recommended by the technical adviser to replace the frames within 3 years, which is significantly sooner than the estimated life of this type of frame. In this project, the early life-cycle failure of the window frames was deemed as a latent defect rather than life-cycle deduction, therefore the risk is liable to the contractor rather than the FM company. In addition, a more suitable alternative material should be installed to replace the current type of window frames. The replacement cost of windows is a large expenditure in the operational stage; therefore, this event is classified as medium risk to the contractor.

The client side thought the relationship between the SPV and the schools remained reasonable, although improvement could be made through better communication between the various parties involved in the operational stage.

In service performance measurement, the biggest issue in this project is unavailability of the outdoor sport pitch. The total deduction on the availability failure is nearly £300,000 from the monthly unitary charge. This project is the only one experiencing a large amount of availability deductions among all four projects in the case studies.

The overall management and service provided by the FM company was considered inadequate at the earliest years of the operational stage. The FM management team was considered poor at the beginning of the operational stage. Although the overall evaluations on the client-SPV relationship were good, the school and the representative of the authority in the interview survey addressed that the client's changes and issue resolutions were not efficient. The variations took too long to process, and the process was not clear or smooth. The inadequately effective system to manage

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client variations can result in poor customer satisfaction and even cause relationship breakdown; therefore, it is a high risk to the SPV.

Unlike the other projects in these case studies, there was a lack of detailed preventive maintenance program or monitoring system, which were required by the project agreement. The ineffective help desk operation was not compliant with the service requirement of the contract. Additionally, there is no detailed asset database to record the reactive maintenance works. Once the services cannot be closely monitored, the service deduction will not be correctly calculated to reflect the service performance in the payment term. As a result, there was a medium risk to the authority that the service performance of the FM company was not fully monitored because of the lack of a recording system, and the school assets may not be adequately managed.

The SPV gradually took actions to improve the previous situations that occurred in the early stage of the operation, such as sending extra resources to contract management and establishing new management software. A new call-logging system was planned to solve the help desk problem, so that the school can trace their calls with job numbers and request follow up information. The later monitoring reports showed signs of improved service performance by the FM company.

Case Study 4

The project in Case Study 4 is a primary school that serves 350 pupils. Because of its small size, the FM company did not set up an on-site office but rather created a remote office to manage the FM services.

Some outstanding issues related to communication were discovered in this project. Team meetings were only taking place when there was a problem reported in operating the school, and there were no scheduled monthly meetings, as in most of the other PFI projects. The client claimed that the employees of the FM company lacked a good knowledge of the contract, which might be a result of several personnel changes within the FM team. The new staff members were not given enough background knowledge before they took the management role.

Another issue in this project is inadequate health and safety management. After discovering the structural changes of the FM team, a further investigation on the staff training was carried out. The findings showed there was a lack of up-to-date health and safety training records for the new staff. The lack of knowledge of the FM staff may bring dangers to the school pupils in special situations. The health, safety, and environmental inspection reports were not up to date. There was a lack of a health and safety plan under severe weather conditions for the school, which was a major concern to the school because it may lead to school closure.

The building defects discovered in the operational stage of this project were considered minor, such as hair cracks on the wall, unclean gutters, and small areas of water leakage from the roof. The reactive maintenance works have been taken to remedy the damage according to the monitoring reports.

The head teacher was happy with the school built under the PFI scheme, but he expected the FM services could be significantly improved.

This project is relatively small compared to the other projects in the case studies; therefore, it should be easier for the FM team to manage. However, the service performance of the FM company was not considered better than the other larger PFI projects. The reason may be the management team was based in the remote office instead of on-site. There was no service failure reported during the operational stage of this PFI project.

Discussion and Recommendations

The initial review of the project agreement showed almost all the liabilities were allocated to the private party in the PFI. However, the further documentation review, site visit, and interview survey revealed some unexpected risks occurred in the operational stage that were actually borne by the public sector.

The client predicted most of the risks and allocated the liabilities mostly to the private sector in the project agreement. For these expected risk events, the private sector, such as the SPV, the contractor, and FM company, are the responsible parties. The liability of design defects, snagging, latent defects, performance failure, energy efficiency failure, and communication failures were allocated to the private parties during the operational stage of the PFI projects, as regulated in the contracts. In the four PFI projects, the liabilities of each party and risk allocations were generally in line with the contracts.

Because the PFI projects developed to the operational stage, many unexpected risk events occurred that were not covered in the contract. In this case, the client became the aggrieved party in the projects. For example, although the hospital in Case Study 2 has been overdesigned, the client was still liable to pay back the capital investment and its interests of the SPV and the life-cycle replacement cost and preventive maintenance cost for the whole building, including the unoccupied part of the building. This was classified as high risk because overdesigned PFI projects can cause an unnecessary financial burden on the local authority.

Because of the higher quality of building maintenance in comparison with conventional projects, the building elements in the PFI projects appeared to have longer life replacement cycles. There should be huge potential savings on the life-cycle fund during the whole operational stage of the projects. However, the client did not have total control of the life-cycle fund and therefore would not benefit from the savings on life-cycle expenditures. The client still must pay the planned life-cycle fund, as agreed in the original project agreement.

The public sector, especially the users of the facilities, was the victim of poor management of the FM services. Inefficient communication was classified as high risk because it can lead to user dissatisfaction, even relationship breakdown. The ineffective data recording system led to inaccurate calculation of deductions and client loss, which was also a high risk. The health and safety issue is crucial for public organizations, such as hospitals and schools. Poorly managed health and safety service can be a high risk to the client. Unfortunately, there was a lack of strict regulations to control the management quality of the FM team in the project agreement of the PFI projects in the case studies. For example, the efficiency of the data recording system and communication were not directly linked to the service deductions.

Compared with the project manager of the conventional construction procurements, the SPV took more risks when managing a long-life PFI project. The design defects not only affect the construction cost, but also can cause FM cost overrun during the operational stage of the projects. These kinds of risks can be medium to high depending on the characters of the design defects.

Conclusions

This research investigated four PFI projects in their operational stage. In general, the PFI projects were considered efficient and satisfactory with some exceptions. The public-private relationships were found to be well developed during the operational stage.

The analysis of some of the outstanding issues of the PFI projects in the case studies identified unexpected risks for both the

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private and public sectors. There were issues not included in the original contract that should be taken into consideration in future PFI procurements.

Some recommendations for better management of risks in the PFI projects are as follows:

1. The client should carefully design their service requirements to avoid overdesign of the project;
2. The architects should pay more attention to maintainability and usability in design to reduce the impact of design defects on the operation of the building;
3. Stricter quality control can reduce latent defects and snagging during construction and reduce FM costs;
4. Include FM management efficiency into payment mechanism to ensure the management capability of the FM team can be directly linked to their payment;
5. Project meetings attended by the authority, FM, and SPV should be held on a regular basis; and
6. The FM team should be site-based regardless of the size of the project so that the reactive maintenance can be executed more efficiently.

This research only focused on the operational stage monitoring of the PFI projects in the case studies. Because PFI is relatively new procurement method, few projects have reached their hand-over stage. It is therefore recommended that future research in 5–10 years should include hand overs in their investigations.

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