Risk Management with Real Options in Public Private Partnerships

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Abstract

Public Private Partnerships (PPP) have secured a position as an alternative to direct investment in construction projects in the municipal sector. The construction costs of PPP projects are often justified by stating that the quality of construction is better and the overall lifecycle costs are optimized according to the client's needs. Recently a need for flexibility in PPP contracts has emerged. In some cases the client demand for services may vary during the concession period. This generates a need to make flexible contracts between client and provider.

Providers in PPP projects have an increasing need to identify and manage uncertainty and risks related to contract flexibility. In order to do this effectively, the economic feasibility of risk management actions must be evaluated. In this paper real options analysis (ROA) is used to evaluate risk management actions related to PPP projects with long life cycle. A large Finnish healthcare facility PPP project is used as a case in the study. The key performance metrics used in the study is to secure high building occupancy and rental yield.

Three main sources of uncertainty were identified related to the flexible contract and long contract period. Accordingly, the risk management actions for coping with the uncertainties were proposed and examined with the developed ROA procedure. The provider stated to have received several benefits from the ROA analysis such as decision-making information directly applicable to investment decision and guidelines for developing briefing and design management documents; thus, potentially improving project profitability in later life-cycle stages.

The actual monetary values provided by ROA assessment were, for example, 680 000 € for flexibility designed in parking structure compared to the original design. The proposed physical flexibility for coping with the uncertainty in final space demand was found to have a value of 460 000 €. The building integrated on-site energy source production for addressing the uncertainty in raising energy costs was found to have an option value of 440 000 €.

The theoretical implication of the paper is that real options analysis can reveal opportunities and risks inside a PPP project that might remain unnoticed with the traditional investment analysis methods. The identification of separate investments as options can be used for managing risk and value inside a PPP project.

Keywords: Risk management, real options, PPP, life cycle, valuation

1. Introduction

1.1 Background

Public Private Partnerships (PPP) is seen as a mechanism for producing more efficiently real estate services to public organisations. Often PPP projects are so large that the public organisation (client) does not have the necessary resources for implementing the project. This is also tied to financing of the project; the client may not have the necessary initial financing to implement a project of such a large scale. The client may find it more attractive to allocate the costs over the lifecycle of the investment. This mind-set of monthly compensation is also argued to reduce the risk and increase the quality of the investment because the real estate service provider has to optimize the lifecycle costs of the investment. When the provider knows in the design and construction phase that it will stay as an operator in the project, it will have motivation to optimize the maintenance and renovation costs by better design solutions. These arguments are well founded and are used for promoting PPP projects (e.g. Shen et al., 2006; Cumming, 2007).

Recently there has emerged a need for flexibility in PPP contracts. In some cases the client demand for services may vary during the concession period. This generates a need to make flexible contracts between client and provider. For example, the contract may have a claim, which enables the client to increase or decrease the amount of services that it compensates for the provider.

Providers in PPP projects have an emerging need to identify and manage uncertainty related to contract flexibility that can have a great impact in project profits. In order to do this effectively, the economic feasibility of risk management actions must be evaluated. In this paper real options analysis (ROA) is used to evaluate risk management actions in a large Finnish healthcare facility PPP project.

The PPP project has been planned and implemented with a model that aims to maximize the value and flexibility to the client (municipality of Järvenpää). The key target of the provider in the investment project is to secure high building occupancy and rental yield. The concession period is 40 years. The target of the PPP contract is design, construction, operating and financing the healthcare facilities. The contract is highly flexible, as the amount of needed space is not fixed. In contrast, the client will compensate only the costs of the spaces that it currently needs.

The purpose of this paper is to demonstrate how ROA can enhance risk management of a PPP project. ROA is used for identifying and valuating uncertainties from the provider's perspective.

1.2 Real options analysis

Real options analysis is an approach that is often considered to complement the popular traditional discounted cash flow (DCF) analysis when evaluating real capital investments.

Trigeorgis and Mason (1987) argued that the DCF cannot properly capture the asymmetric value of managerial flexibility (i.e. *"future managerial decisions can improve upside potential while at the same time limiting downside losses"*) and proposed an options based framework for valuing managerial flexibility. Later Trigeorgis (1988) categorized two option types that can capture managerial flexibility: *"operating flexibility, i.e. collection of options enabling management to make or revise decisions at some future time"* and *"strategic value, i.e. interdependencies with future, follow-up investments and competitive interaction"*. Furthermore, Dixit and Pindyck (1995) stated that the DCF assumes investments are either reversible or now or never decisions, where the decisions regarding future cash flows have to be made at the initial stages of an investment. This was found problematic when future uncertainty may affect the expected cash flows with a much larger impact than in a change in discount rates. Thus, the options approach emphasizes uncertainty rather than adjusting financial variables such as the discount rate that often result in myopic decisions. This was further discussed that by emphasizing the role of risk can encourage to invest in strategic investments that create important opportunities in the future.

To conclude the DCF analysis assesses uncertainty and risk mainly with the discount rate that can be problematic when investment decisions have asymmetric value and when the uncertainty (regarding the value) is not resolved continuously at a constant rate (Trigeorgis, 1988). Additionally uncertainty and risk can be examined with sensitivity analysis that is used for projecting the range of expected cash flows. The sensitivity analysis is an effective tool for demonstrating the range of different values an investment can have. Nevertheless, neither of the uncertainty assessment methods can on their own value embedded options (i.e. possible lines of action during the life cycle of an investment) that are created in investments through initial investments and decision-making. ROA was proposed as a method to address these issues (e.g. Trigeorgis, 1988; Dixit and Pindyck, 1995).

ROA is an application of option pricing theory into real assets, where embedded options in a real capital investment is valued using an option pricing techniques which have been originally used in the financial world. The most widely known techniques are the Black-Scholes equation, binomial option pricing model and the Monte Carlo method (Amram and Kulatilaka, 1999). In all of the methods, the option value is calculated by determining the range the values of the underlying asset. The main component in determining the range is finding out the volatility of the asset that. This has been easy in the original applications of finance where detailed historical data has been available. However, with real assets this is problematic and ROA has received criticism (e.g. Lander and Pinches, 1998; Oppenheimer, 2002) for this exact reason, even though the usability of the approach has been well acknowledged.

Earlier literature on real options in the context of PPP is limited and focused on large infrastructure projects. For example, Alonso-Conde et al. (2007) develop a real options framework for analysing a large toll road project, the Melbourne CityLink Project, as a case study. The authors argue that the project's imposed conditions can be treated as real options. Furthermore, the options affect the incentive to invest and how the public sector may be transferring considerable value to the private sector through government guarantees.

1.3 Research methodology

The research strategy of the study can be described as an embedded single-case study design (Yin, 2002), where the units of analysis are the identified sources of uncertainty. In the case study, ROA is applied to a case study according to real options process developed by Greden et al. (2005). In the process, sources of uncertainty are identified and then the current design is benchmarked against these sources. Then, additional investments which helps coping with the uncertainty are determined and costs are calculated. After that the benefits of these extra investments are quantified with real options valuation. Finally, results are analysed and best lines of actions are suggested.

In this study the selected technique for real options valuation is the fuzzy pay-off method (FPOM) (Collan et al., 2009). FPOM was originally developed on the basis of the Datar-Mathews method (2004), which calculates the real options value from the pay-off distribution of net present values generated by Monte-Carlo simulations. Collan et al., (2009) realized that the probabilistic theory used in the Datar-Mathews method (and in other mainstream ROA methods) to treat for uncertainty can be replaced with fuzzy set theory (Zadeh, 1965). In the fuzzy set theory, different propositions have a degree of membership in a set, i.e. membership is 0 (complete non-membership), 1 (complete membership) or a value between 0 and 1 (an intermediate degree of membership).

This realization allowed a simplification of the projection of uncertainty into three scenarios: minimum, best guess (i.e. the most likely scenario, which is normally drawn up in investment analysis) and maximum. These three scenarios are treated as triangular fuzzy numbers that form a triangular pay-off distribution where the best guess scenario has complete membership, the minimum and maximum scenarios have complete non-membership, and other scenarios between have intermediate degrees of membership. This asymmetrical information is used as the basis to form a triangular pay-off distribution that is *"a graphical presentation of the range of possible future pay-offs the investment can take"* (Collan et al., 2009). For a more detailed description of the method and mathematical formulas, please see Collan et al. (2009) and Collan (2012).

2. Case study

2.1 Sources of uncertainty

Finnish municipality of Järvenpää (client) with a population of nearly 40 000 inhabitants recognized the need for a new healthcare facilities in 2008. The need was imminent due to three major reasons. First, the demand for healthcare services is increasing due to the rapidly ageing population. For example, the number of people over 75 years of age is expected to triple by 2030. Second, the existing healthcare facilities were in relatively poor condition. Third, a new agile, low cost and high impact process for delivering healthcare and social services was urgently needed as local healthcare costs and budget deficit were projected to rise substantially by 2020.

In this situation, the city decided that new facilities should be procured with a PPP model. The concession and contract period was selected to be 40 years and the scope of the contract was set flexible as the amount of space the client uses, and thus the compensation for provider, should change according the client needs. In essence, the target of the PPP contract was design, construction, operating and financing the healthcare facilities. The provider was selected in 2010 and the aim is to complete the building in autumn 2016.

The key target of the provider in the investment project is to secure high building occupancy and rental yield. The provider had to start the design of the new building under high uncertainty. Three main sources of uncertainty to the building investment were identified:

1. The need of parking space was strongly linked with the development of the surrounding urban area of the building and there were no decisions of the schedule of development actions.

2. The client space need correlates strongly with the future population growth, which was not unambiguous because there were different forecasts for the growth, and the healthcare processes were under development.

3. The raising volatile energy costs for heating was identified as a major risk that could radically decrease the profit of the provider during the contract period.

Three extra investments were identified for coping with these uncertainties: a phased parking garage solution, physical flexibility and on-site energy source. Two of the first investments are related to the population growth and the latter investment is related to the raising costs of energy prices.

The role of population growth is very important when planning new long-term public investments. Often there are different projections for population growths that can complicate the decision-making for the stakeholders in an investment project. In this case there are three main projections for the population of Järvenpää in 2030. The municipality itself estimated it as 54 514 persons (Järvenpää, 2011). The Statistics Finland's (Statistics Finland, 2013) official estimation is 43 928. A healthcare consultant nominated for the project estimated it as 50 000 that was regarded as the most likely scenario. Since the other two estimates are also well founded, they should be taken into consideration as well because we want to assess the uncertainty regarding the space and parking demand which are closely tied to the population growth in the area. Therefore, these three estimates are set as the maximum, minimum and best guess estimates for FPOM, respectively.

2.2 Parking garage

The first step of the investment analysis for the parking garage was to model the local demand of parking lots in three population scenarios. Following that, four potential parking investment alternatives were analysed and valuated.

The new healthcare facilities were estimated to require 182 parking spaces. A dedicated lot next to the facilities allows for building 185 spaces in one level. However, the lot has also been dedicated as a parking space for other new developments in the area. These are two apartment buildings with a need of 30 and 48 parking spaces as well as other planned healthcare related buildings with a requirement for 250 parking spaces. Thus, when the area is fully developed the total demand is 510 parking spaces. This demand can be supplied by constructing a four-story parking garage. However, there is uncertainty how the demand is actually realized in time. In Figure 1 is presented the demand for parking spaces in the three different population growth scenarios

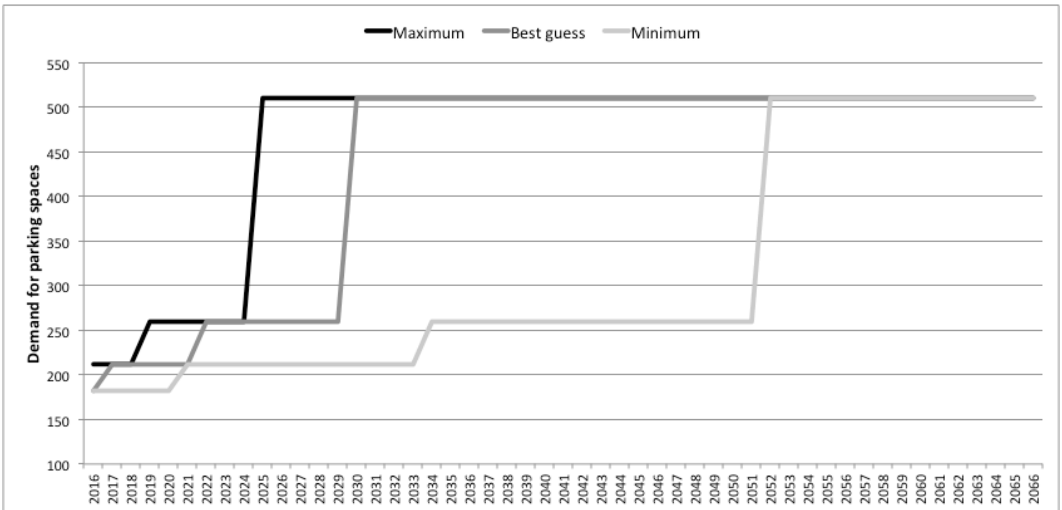

Figure 1: Demand of parking spaces in different scenarios

The smaller jumps in the demand in the figure are due to construction of the two apartment buildings. It was estimated, based in Järvenpää statistics that 3.5% of the annual population growth is focused in the district where the lot is. From this could be derived the demand for new housing in the district and eventually determining the approximations when the new apartment buildings are constructed in the different population growth scenarios. The larger jump of 250 spaces is due to the extension of the healthcare campus. The extension will be developed when the population of the area reaches a level that cannot be handled only with the new healthcare facilities.

Originally the provider was given three alternatives for developing the lot. All of them included the eventual construction of a four-story parking garage with 460 spaces (115 per story) and a ground level parking of 50 spaces. However, a fourth alternative of staged construction was presented to provider as a new alternative. The idea of this alternative was based on de Neufville's (2006) real options paper where the flexibility (i.e. the upfront costs of the footings and columns) allowing the garage to be built in stages (i.e. additional levels could be built on top of the initial structure at a later date) rather than all at once reduces the risk and increases the expected value of the investment. Table 1 presents the alternatives for developing the lot.

Table 1: Alternatives for developing the parking lot

Alternative	*Investment costs per parking space (€)*	*Maintenance costs (€/space/a)*	*Rental income (€/space/a)**
1) Temporary gravel field with a life cycle of 2 years	*500*	*180*	*602*
2) Temporary plated field with a life cycle of 10 years	*2 000*	*180*	*1 203*
3) Parking garage with a life cycle of 50 years	*15 000*	*300*	*2 407*
4) Parking garage constructed in stages with a life cycle of 50 years	*17 130 (1st floor), 14 870 (2nd to 4th floors)*	*300*	*2 407*

** Assuming parking garage is open 12 hours a day, 70 % occupancy rate during the weekdays, 20 % during the weekend, and a parking fee of 0.25 €/h, 0.5 €/h and 1.0 €/h for the alternatives 1, 2 and 3/4, respectively.*

In the 1st and 2nd alternatives it is assumed that the temporary fields are continuously constructed until the demand requires construction of the parking garage. In the 3rd alternative, the parking garage is constructed immediately. In the 4th alternative, the construction starts with the first and second floors (the first floor is more expensive due to the staged construction process), then when the demand is high enough, first the 50 ground level spaces (5 000 € per space for a lifecycle of 50 years) are constructed and after that the 3rd and 4th floors of the parking garage are constructed.

Since we know the timing of construction (demand), construction costs and net rental income, we can use FPOM for calculating the option values for the different alternatives. In the calculations have been assumed that discount rate is 3.0 % (lending rate for the provider), annual rise of construction costs is 2.5 %, annual inflation (rental appreciation) is 2.0 %, and annual rise of maintenance costs is 3.5 %. The calculated real option values for different alternatives are 1) 21 430 000 €, 2) 21 400 000 €, 3) 21 800 000€ and 4) 22 480 000 €. From the values we can see that the staged construction has the best net present value for the project. The value difference is mainly due to the potential gain in the minimum demand scenario where downside losses are limited but upside gain is not. This observation is in line with the one found in de Neufville's (2006) paper: flexibility of the staged construction limits downside losses while retaining the advantage of upside potential.

2.3 Physical flexibility

The investment costs for the healthcare building is estimated as 38 500 000 € including everything, i.e. construction costs, furnishings and project reservations. The building size is approximately 13 500 gross sqm with an operative area of 8 000 sqm. Nearly all social and healthcare operations of Järvenpää will move in to occupy this area. This operative area is designed in accordance with the best guess scenario of 50 000 persons in the year 2030. Since the hospital building is constructed according to the population of the year 2030, the building will not have a 100 % utilization rate in the beginning. Figure 2 presents empty consulting rooms in different growth scenarios.

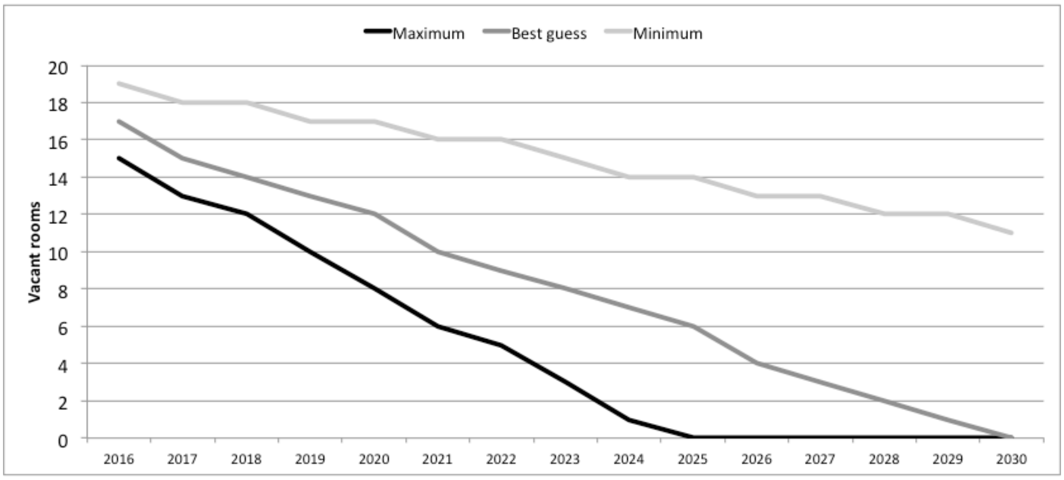

Figure 2: Vacant rooms in different population growth scenarios

These vacant rooms can be regarded as unnecessary space costs to the provider if the contract only requires the client to pay for the rooms it needs (or they would be unnecessary space costs to the client if the client would have to pay for them). However, these unnecessary space costs could be transformed into rental income, if they could be rented to an outside operator (e.g. a private practitioner) for the years they are not needed by the client. This real option is acquired by investing into physical flexibility. The extra investments is only 50 000 € because the investment is executed at a very early-stage of design process so that it involves just incremental improvements into locking, passage functionality, etc.

The real option value is tied to the potential rental income generated from the rooms. The average room size (including hallways) is 22 sqm, annual net rent is 240 €/sqm, discount rate is 3 % and occupancy rate is 85 %. This information can transform the empty rooms into net present values of rental income. These cumulative net present values (for years 2016-2030) are 304 000 €, 482 000 € and 845 000 € the minimum, best guess and maximum scenarios. Applying these numbers into FPOM calculates the real option value of 510 000 €, which is 460 000 € more than the extra investment.

2.4 On-site energy source

The provider has a possibility to invest in a ground heat system that removes a large portion of energy price risk. Additionally, on-site energy source enables provider to gain a LEED Gold certificate, which may have a positive impact for the property value, occupancy and rental yield (Wiley et al, 2010). The proposed ground heat system is calculated to remove 80 % of the need for district heating. This saving is attained with an electricity usage equivalent to 26 % of the district heating energy. The investment costs for the system is 750 000 € with a lifecycle of 20 years.

Three scenarios were formed for the real option valuation. In the best guess scenario, the electricity and district heating prices were expected to have an annual increase of 4.0 % and 5.0 %, respectively (expert estimation). The following numbers for the maximum and minimum scenarios were 6.0 % and 8.0 % (Statistics Finland, 2013), and 2.5 % and 3.0 % (expert estimation), respectively. The starting amount of energy needed for heating the building was calculated (using the most widely used construction cost software in Finland i.e., Haahtela) as 1 031 404 kWh with a cost of 0.083 €/kWh. The same numbers for electricity were 777 104 kWh with a cost of 0.101 €/kWh. Figure 3 presents the cumulative savings from the ground heating system in three scenarios.

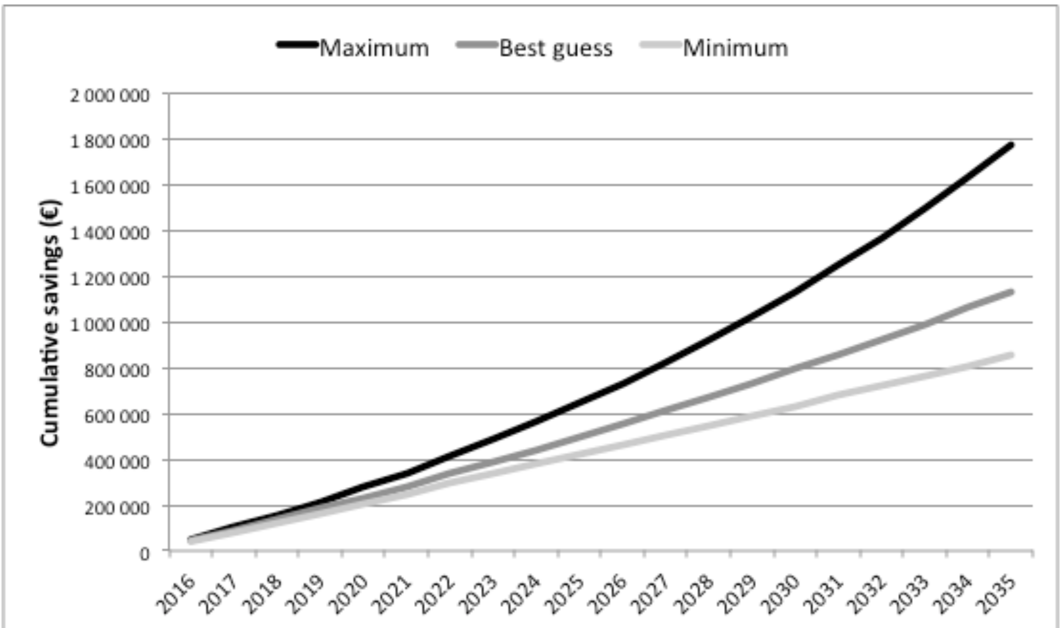

Figure 3: Cumulative savings from ground heating in different energy scenarios

When FPOM is applied to the cumulative savings, the real option value of 1 190 000 € is calculated. This is 440 000 € more than the investment cost. From the figure can be seen that even the minimum scenario the investment is profitable. Additionally it is easier to plan maintenance costs when a large portion of them is fixed to the on-site energy source.

3. Conclusion

Providers in PPP projects have an emerging need to identify and manage uncertainty related to contract flexibility that can have a great impact in project profits. In order to do this effectively, the economical feasibility of risk management actions must be evaluated. In this paper real options analysis (ROA) was used for evaluating risk management actions in a Finnish healthcare project.

Three main sources of uncertainty were identified and risk management actions for coping with the uncertainties were proposed and examined with ROA. As a result, the provider may radically improve the profitability of the project. The staged construction alternative for addressing the uncertainty in parking space demand was found to have a value premium of 680 000 € compared to the second best alternative. The physical flexibility for coping with the client's uncertain space need was found to have a value of 460 000 €. The on-site energy source for addressing the uncertainty in raising energy costs was found to have a value of 440 000 €.

This paper illustrates that real options have practical applications in managing risks in PPP projects. In fact, the provider of the project has already received benefits from the analysis. For example, the output of the analysis presented in this study was used as an investment analysis document in the actual investment decision-making process by the provider's board of directors. Later on the building briefing process and design team selection were partly based on the results from the analysis.

The findings of the research are in line with real options literature suggesting that embedded options inside projects can help managing the downside risk without abandoning the upside potential. The application presented in this paper manages risk by projecting uncertainty according to the best available information using a novel real options valuation method which can be easily constructed to supplement the dominant DCF method. The values calculated using the method are transparent and are easily connectable to the uncertainty sources used for the calculus.

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