# PPP in Switzerland - Economic Comparison For Street Maintenance and Rehabilitation Delivery Models



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**Publication date:**
2005

**Permanent link:**
https://doi.org/10.3929/ethz-a-005998035

*Third International Conference on Construction in the 21st Century (CITC-III)*
*"Advancing Engineering, Management and Technology"*
*15-17, September 2005, Athens*

# PPP in Switzerland - Economic Comparison For Street Maintenance and Rehabilitation Delivery Models

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**Abstract**

For performing public works project delivery models such as Public Private Partnerships (PPP) offer opportunities to increase efficiency. However, PPP should only be selected as the project delivery form if the taxpayers can be guaranteed value for money. This necessitates economic comparisons in various phases of the project. In the case of pure street maintenance and rehabilitation works without any investment, qualitative decision-making criteria become more important. In order to be able to include a meaningful and objective consideration of these criteria, the value benefit evaluation is subjected to Monte Carlo simulation within the economic comparison. The use of bandwidths and their simulation reveal comprehensive scenarios that can be used as a decision-making aid by the public decision makers.

**Keywords**
PPP-Model, economic comparison, street maintenance, cooperation, decision-making aid

## 1. Introduction

Communities' advantages of location are based primarily on the quality of the communal infrastructure, especially on the quality of the inner-city street networks. Guaranteeing high levels of street network quality with limited budgets can only be achieved using efficient cost/performance structures. The spectrum of possible delivery models for maintenance and rehabilitation of communal street networks ranges from the public authorities doing all the works themselves, to cooperation projects with private enterprises, to total privatization. Public Private Partnerships offer one possible approach to increasing efficiency. Such partnerships have already resulted in savings potentials of up to 17 % in Great Britain (HM Treasury 2000). To support the decision-making process of the responsible local authorities with regard to an efficient form of delivering street maintenance the Institute for

Construction Engineering and Management at SFIT Zurich is developing a street maintenance delivery model in the form of a public private partnership (PPP) in conjunction with the Federal Transport Ministry. One of the areas of focus of the model is an economic comparison to verify whether a PPP guarantees the taxpayers value for money. In order to evaluate a Public Private Partnership as a model for delivering street maintenance, an economic comparison should be conducted in line with the following steps (acc. to Jacob 2003):

- Project definition and structure;
- Design of the Public Sector Comparator;
- Design of the Public Private Partnership approach;
- Cost calculations and comparison using value benefit evaluation.

Since the PPP Project at SFIT Zurich focuses on pure maintenance and rehabilitation works without any investment, where the public authorities do not gain any benefit from the procurement of private capital to finance public works, target focus is more closely aligned to qualitative target criteria, which aim at cost efficiency by synergies because of partnership, in addition to cost aspects. The aim of the economic comparison must therefore be to suitably evaluate qualitative, synergetic criteria, in addition to the cost aspects, in order to ensure that the price does not represent the sole evaluation criterion. This paper therefore presents a new approach to evaluating quantitative and qualitative criteria in the form of a value benefit evaluation, which involves subjecting the value benefit evaluation to a Monte Carlo simulation.

## 2. Research methodology

The constructivist research approach is suited to developing an economic comparison model since it construes social systems based on an intended input-output effect. The theory-based structure of the model is derived from a constructive-deductive approach based, firstly, on scientific (financial) mathematical methods, such as cost and investment calculation, and, secondly, with regard to the calculation process on the simulation of fuzzy variables. Triangulation is used to ensure validity and reliability, on the one hand by means of the theory-based scientific structure, and on the other hand by the realizability test performed by the communities involved in the research project.

## 3. Economic comparison

### 3.1 Qualitative criteria

Within the framework of the SFIT project, the fundamental qualitative decision-making criteria for a realistically meaningful economic comparison of maintenance and rehabilitation works for communal street networks were defined as follows:

- Risk-distribution in street maintenance and its capturing in cost-terms;
- Evaluation of the new risks arising from the partnership;
- Loss of synergy potential among the local authority's departments;
- Use of synergy potential from partnership cooperation; and
- Efficiency potential from long-term life cycle orientation.

These qualitative decision-making criteria can vary from one community to the next, but will generally be assignable to the superior targets of value preservation, securing network quality, availability of the street network and safety of the users. Since the qualitative criteria can be applied variably, each community can adapt the evaluation revealed by the value benefit evaluation to its own situation in line with its prioritized goals.

### 3.2 Suitable approach to incorporating qualitative target criteria

A value benefit evaluation linked to the pure cost comparison is a practical means of incorporating qualitative, synergetic factors in the process to decide a suitable project delivery model. The value benefit evaluation is subjected to a Monte Carlo simulation in order to ensure the objective evaluation of the quantitative and qualitative criteria. A Monte Carlo simulation simulates bandwidths of the target achievement figure specific to the virtual project (stef), which can be used to clearly reveal the quantitative and numerically evaluated qualitative differences between the delivery models. This process objectifies the value benefit evaluation, makes it possible to evaluate project delivery models in scenarios and, in doing so, is an invaluable aid towards reaching a meaningful decision. To date the Monte Carlo Simulation has been used in science for evaluating the risks of a construction project (Busch 2003) and the subsequent choice of a suitable building contract (Girmscheid 2004) respectively of a suitable project delivery model.

### 3.3 Value benefit evaluation process

The value benefit evaluation outlined in Fig. 1 is based, on the one hand, on the cost calculation for performance of the works by the public authorities themselves in the form of a Public Sector Comparator (PSC) and on the costs of a virtual PPP project (Girmscheid, 2005), and, on the other hand, on the pre-defined qualitative decision-making criteria. The value benefit evaluation is a process involving the following three steps:

#### 3.3.1 Initial parameters for a risk-based selection

- Setting up the maintenance and rehabilitation objectives for the local authority (primary and secondary objectives) and their target hierarchies for the specific tasks to be performed by local authorities
- Definition of the various weighting factors (wf), absolute and relative, of the primary and secondary objectives at each level
- Identification and collation of possible opportunities and threats (risks)
- Allocation of opportunities and threats to the individual primary and secondary objectives to evaluate the target achievement figures, irrespective of the virtual project (itaf)
- Therefore a scale of 0-5 is available to determine that target achievement figure, irrespective of the virtual project (itaf), whereby the grades are interpreted as follows: 0: No target achievement possible; 1: Very low level of target achievement; 2: Low level of target achievement; 3: Medium level of target achievement; 4: High level of target achievement; 5: Very high level of target achievement. The target achievement figure, irrespective of the virtual project (itaf) outlines the level at which the secondary objective will generally be achieved by the corresponding project delivery form taking the opportunities and threats (risks) into consideration.

| primary objectives | target hierarchie (absolute) | secondary objectives | weighing factors (wf) | | delivery forms | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PSC | | | PPP | | |
| | | | (absolute) | (relative) | itaf | staf | stef | itaf | staf | stef |
| costs of the virtual project | 65.00% | costs of the periodical routine measures | 2.50% | 1.63% | 2 | 1.00 | 0.03 | 4 | 1.0 | 0.07 |
| | | costs of the unscheduled ad hoc measures | 2.50% | 1.63% | 2 | 1.00 | 0.03 | 4 | 1.0 | 0.07 |
| | | hourly wages | 2.50% | 1.63% | 3 | 1.00 | 0.05 | 4 | 1.0 | 0.07 |
| | | wages of project costs | 2.50% | 1.63% | 3 | 1.00 | 0.05 | 4 | 1.0 | 0.07 |
| | | total costs | 60.00% | 39.00% | 3 | 1.00 | 1.17 | 4 | 1.0 | 1.56 |
| | | minimisation of failings in execution | 5.00% | 3.25% | 4 | 1.00 | 0.13 | 3 | 1.0 | 0.10 |
| | | minimisation of supplementary amendments | 5.00% | 3.25% | 2 | 1.00 | 0.07 | 4 | 1.0 | 0.13 |
| | | risks for the community | 5.00% | 3.25% | 2 | 1.00 | 0.07 | 4 | 1.0 | 0.13 |
| | | synergy potential from partnership cooperation | 5.00% | 3.25% | 0 | 1.00 | 0.00 | 4 | 1.0 | 0.13 |
| | | synergy potential among the local authority's departements | 5.00% | 3.25% | 3 | 1.00 | 0.10 | 0 | 1.0 | 0.00 |
| | | efficiency potential from long-term life cycle orientation | 5.00% | 3.25% | 2 | 1.00 | 0.07 | 4 | 1.0 | 0.13 |
| | | | sum = 100 % | | | | | | | |
| organisation / process of decision | 15.00% | flexibility in sercive perfomance | 20.00% | 3.00% | 5 | 1.0 | 0.15 | 2 | 1.0 | 0.06 |
| | | response time of service performance | 20.00% | 3.00% | 5 | 1.0 | 0.15 | 2 | 1.0 | 0.06 |
| | | coordination of performance to a long-term life cycle orientation | 40.00% | 6.00% | 2 | 1.0 | 0.12 | 5 | 1.0 | 0.30 |
| | | audit | 20.00% | 3.00% | 2 | 1.0 | 0.06 | 4 | 1.0 | 0.12 |
| | | | sum = 100 % | | | | | | | |
| operational availability / users' safety | 10.00% | unrestricted operational availibility | 50.00% | 5.00% | 3 | 1.0 | 0.15 | 4 | 1.0 | 0.20 |
| | | guanrantee of users' safety | 50.00% | 5.00% | 4 | 1.0 | 0.20 | 3 | 1.0 | 0.15 |
| | | | sum = 100 % | | | | | | | |
| quality of street network | 10.00% | quality of the periodical routine measures | 30.00% | 3.00% | 4 | 1.0 | 0.12 | 3 | 1.0 | 0.09 |
| | | quality of the unscheduled ad hoc measures | 30.00% | 3.00% | 4 | 1.0 | 0.12 | 3 | 1.0 | 0.09 |
| | | quality of rehabilitation | 30.00% | 3.00% | 3 | 1.0 | 0.09 | 4 | 1.0 | 0.12 |
| | | QM-system existing | 10.00% | 1.00% | 1 | 1.0 | 0.01 | 4 | 1.0 | 0.04 |
| | | | sum = 100 % | sum = 100 % | total stef PSC: | | 2.93 | total stef PPP: | | 3.67 |

itaf = target achievement figure, irrespective of the virtual project
staf = target achievement figure, specific to the virtual project
stef = target expactancy, specific to the virtual project
total stef = total target expactancy, specific to the virtual project

the higher the total swtef, the better the community's demands are achieved

PSC = Public Sector Comparator
PPP = Public Private Partnership

**Figure 1: Value benefit evaluation matrix PSC and PPP**

- Creation of a target achievement figure specific to the virtual project (staf). The target achievement figure specific to the virtual project (staf) estimates the extent of target achievement situatively for the virtual project being calculated, e.g. using the Delphi method or an estimate by an individual expert. It (staf) serves to adjust the specified target achievements figures, irrespective of the virtual project (itaf), independently of the virtual project for the project delivery models being studied, to the specific circumstances of the virtual project and can vary from zero to one. If the target achievement figure specific to the virtual project (staf) is achieved in full in the virtual project, then the target achievement figure, irrespective of the virtual project (itaf) is equal to one. If staf is not achieved, itaf is equal to zero. Decimal points can be used to achieve possible nuances, especially for the input values for the Monte Carlo simulation (section 3.3.2)

### 3.3.2 Risk-based evaluation process

The specific target expectancy figures (stef) of each secondary objective are evaluated by multiplying the target achievement figure, irrespective of the virtual project (itaf) with the target achievement figure specific to the virtual project (staf) and the relative weighting factor (rel. wf). An aggregation of the target expectancy figures for all the secondary objectives produces the total target expectancy figure of each delivery model (traditionally or PPP) as a deterministic value. To evaluate the variation of the total target expectancy figure (total stef) and the related sensibility in regard to changes or variation of the specific target achievement figure for each secondary objective (staf), each staf must be defined by three values (min staf, $staf^{EP}$, max staf) and a discontinuous or continuous distribution function. During the Monte Carlo simulation "j" random numbers are generated for each secondary objective and aggregated in each simulation run (Fig. 2). The Monte Carlo simulation simulates

different cases "j" where the staf factor and their different characteristic of combination with all the secondary objectives will be analysed in relation to the total stef$^j$ per simulation run..

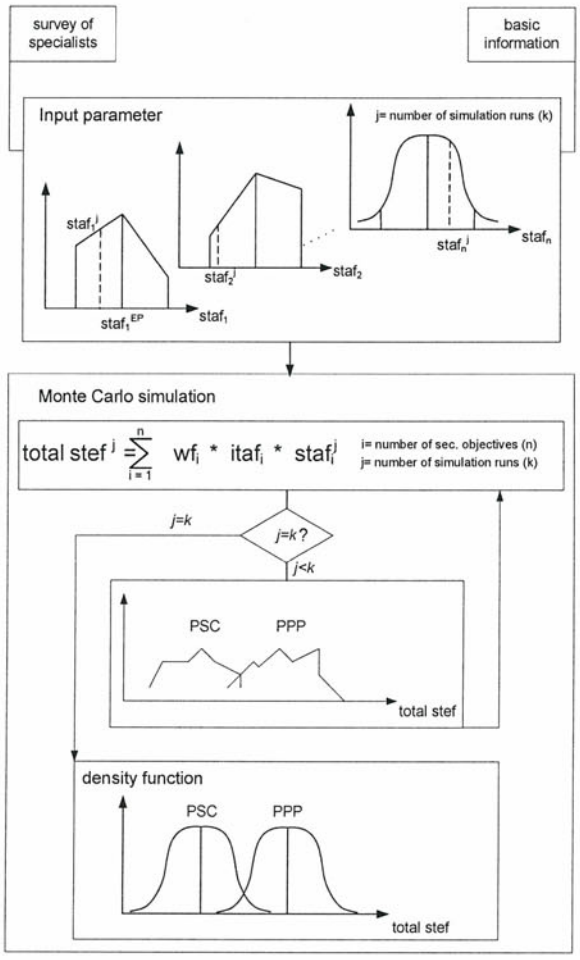


**Figure 2: Monte Carlo Simulation**

The bandwidth of possible value benefits can be illustrated by the Monte Carlo simulation by simulating the project-specific target achievement levels of a project delivery model. Each simulation run produces a possible scenario. 10000 runs produce 10000 scenarios, whose probability distribution can be illustrated using a density function.

### 3.3.3 Information provided by risk-based evaluation

The risk-based evaluation supplies three statements. It generates information on the choice of the most efficient delivery model for street maintenance and rehabilitation of the relevant community on the basis of the various primary and secondary objectives to aid the decision-making process. Using Monte-Carlo simulation the entire probable bandwidth of possible target achievement levels and their likelihood of occurrence can be revealed. The total target expectancy figure for each street maintenance delivery form (total stef) produces a risk-oriented

objectified decision-making basis for the selection of the most efficient delivery model for street maintenance and rehabilitation .

## 4. Conclusion

By using Monte Carlo simulations in the value benefit evaluation, communal decision makers achieve a basis for evaluating their decisions with possible bandwidths (function) for the total target expectancy figure for each street maintenance delivery model (total stef) in order to be able to select a delivery form offering the most efficient cost/performance structure. Within the framework of the multi-level decision-making process for or against the use of a PPP, the method presented in this paper can be used, both prior to the PPP for initial rough analysis of cost efficiencies, and as proof of the actual cost efficiency, based on the bids submitted by the contractors. The economic comparison resulting from this research project is being developed directly for practical use. It can be flexibly applied to other areas of public sector works, e.g. building maintenance. The method can also be used for the cantonal and federal road networks in Switzerland since, by examining the communal street network, the most complex form of road infrastructure in both technical and organizational terms was analyzed.

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