Collaboration and Harmonization in Creative Systems – Hara (ed.)
© 2005 Taylor & Francis Group, London, ISBN 0 415 39037 0

Risk-based selection of the delivery model for maintenance and rehabilitation of communal street networks in Switzerland

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ABSTRACT: An economic comparison must be conducted before using new improved-efficiency models for delivering public sector services, in order to guarantee that taxpayers get value for money. The aim of such a comparison is to compare the costs of the public sector doing the works itself using a Public Sector Comparator (PSC) with the costs of a Public Private Partnership (PPP). If the economic comparison is conducted in the form of a risk-based cost comparison with subsequent value benefit analysis, the decisive qualitative target criteria of the public sector can be incorporated into the decision-making process. The delivery of services such as the pure maintenance and rehabilitation of communal street networks without any investment, in particular, need to take the unrestricted operational availability, conservation of value, securing the quality of the street network and, above all, the safety of its users into account, and not just the costs.

1 INTRODUCTION

1.1 *Initial situation*

In times of declining public income, local authorities are being forced to sustain or extend their advantages of location to compete for investors and taxpayers. Advantages of location are based primarily on the quality of the communal infrastructure, e.g. supply and waste disposal networks and communication facilities, with the inner-city street network and quality of the same playing a crucial role.

As such, the local authorities are facing the problem of guaranteeing high levels of inner-city street network quality with limited budgets, which can only be achieved using efficient cost and performance structures.

There are various means by which the local authorities can commission street maintenance and rehabilitation works. The spectrum of possible delivery models ranges from the public authorities doing all the works themselves, to cooperation projects with private enterprises, to total privatization (acc. to Girmscheid 2004).

To support the decision-making process on the part 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 PPP in conjunction with the Federal Transport Ministry within the framework of the research project "Communal street networks in Switzerland: New forms of Public Private Partnership (PPP) cooperation for maintenance".

This approach, which is in this vein new in Switzerland, was triggered by the potential improvements in efficiency in the UK of up to 17% compared with internal activities by the public sector, which was determined over nearly 15 years of PFI/PPP experience (HM Treasury 2000).

1.2 *Necessity of an economic comparison for PPP*

The primary objective of the provision of public sector services is to ensure that taxpayers get value for money (Treasury Taskforce Private Finance 2004). As such, new forms of delivering public sector services cannot be applied without first analyzing the cost efficiency. The public sector is obliged to use the taxes paid by its citizens efficiently.

In consequence, the benefits of PPP in street maintenance and rehabilitation need to be examined using an economic comparison.

To prove the economic efficiency of a Public Private Partnership performing the street maintenance works, a cost comparison is being conducted between the conventional approach of a local authority performing

internal activities and a partnering approach with subsequent value benefit analysis.

1.3 *Aims and content of the economic comparison*

This paper presents the structure and sequences of an economic comparison that focuses on the evaluation of life cycle-oriented maintenance and rehabilitations works. It includes a risk-based cost comparison between the conventional approach of the local authority performing internal activities and a partnering approach with subsequent value benefit analysis to street maintenance delivery models, taking particular account of the aspects of conservation of value, securing network quality and availability of the street network, user safety and cost minimization in performing the works.

This economic comparison analyzes the qualitative and quantitative opportunities and risks of the various target expectations and collates these to produce an overall evaluation of the alternative street maintenance delivery forms for the benefit of the public sector decision-makers. The comparison is conducted using a multi-dimensional weighted system to evaluate the achievement of objectives.

The present or net present value method is commonly used to evaluate the costs of investment projects, where combinations of procurement and operating costs in the form of cash flows discounted to the current point in time can be cost-evaluated and therefore compared (Grimsey & Lewis 2004; Treasury Taskforce Private Finance 2004; Jacob & Kochendörfer 2002 etc.).

The cost comparison presented in this paper focuses exclusively on operating costs (rehabilitation and maintenance). A comparison focusing solely on operating costs move qualitative target criteria more into the target focus than when the costs of investment projects are compared where the benefit for the public sector primarily lies in the procurement of private capital to finance public sector services. There is no such a direct benefit in the case of only operating services, which is why qualitative criteria ultimately play a more important role.

A suitable approach is to link the cost comparison to a value benefit analysis. A Monte Carlo Simulation in cost comparison and value benefit analysis offers target achievement bandwidths (expectations) which clearly reveal the quantitative and numerically evaluated qualitative differences between the delivery models.

The results of the value benefit analysis become objective when the Monte Carlo Simulation takes the qualitative targets in the system of objectives into account, alongside the costs. To date this method (Monte Carlo Simulation) is used in science for evaluating the risks of a construction project (Busch 2003) and the subsequent choice of a suitable building contract (Cadez 1998) respectively of a suitable project delivery model.

When calculating the Public Sector Comparator (compilation of all costs connected with the public sector's internal activities (Jacob 2003)), this economic comparison offers a new approach to local authorities. Two alternative versions for local authorities to calculate the PSC are being developed.

- Community-specific Public Sector Comparator
- Public Sector Comparator using reference data.

2 MAIN PART

2.1 *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 realisability test performed by the communities involved.

The current maintenance concepts of the ten local authorities involved in the project were first captured qualitatively empirically in order to evaluate the potential for improving efficiency from the services being performed privately and, as such, to design a cost approach for a PPP.

In a second step, the street maintenance costs of the ten local authorities are being captured using the cost capturing method especially developed by SFIT Zurich. This quantitative empirical study reveals the cost benchmarks (reference data) for designing the Public Sector Comparator.

The choice of communities focused on the (restricted) representative distribution in terms of size, street network length and cross-cantonal inclusion of the communities in line with empirical principles (Yin 1994).

The economic comparison is given further scientific support by the realisability test comprising a test run in the ten local authorities involved in the project, which simultaneously represents the close of the triangulation.

2.2 *Structure and sequence of the economic comparison*

Fig. 1 shows the principal street maintenance cost structures when the public sector performs internal activities compared with a PPP performing the works.

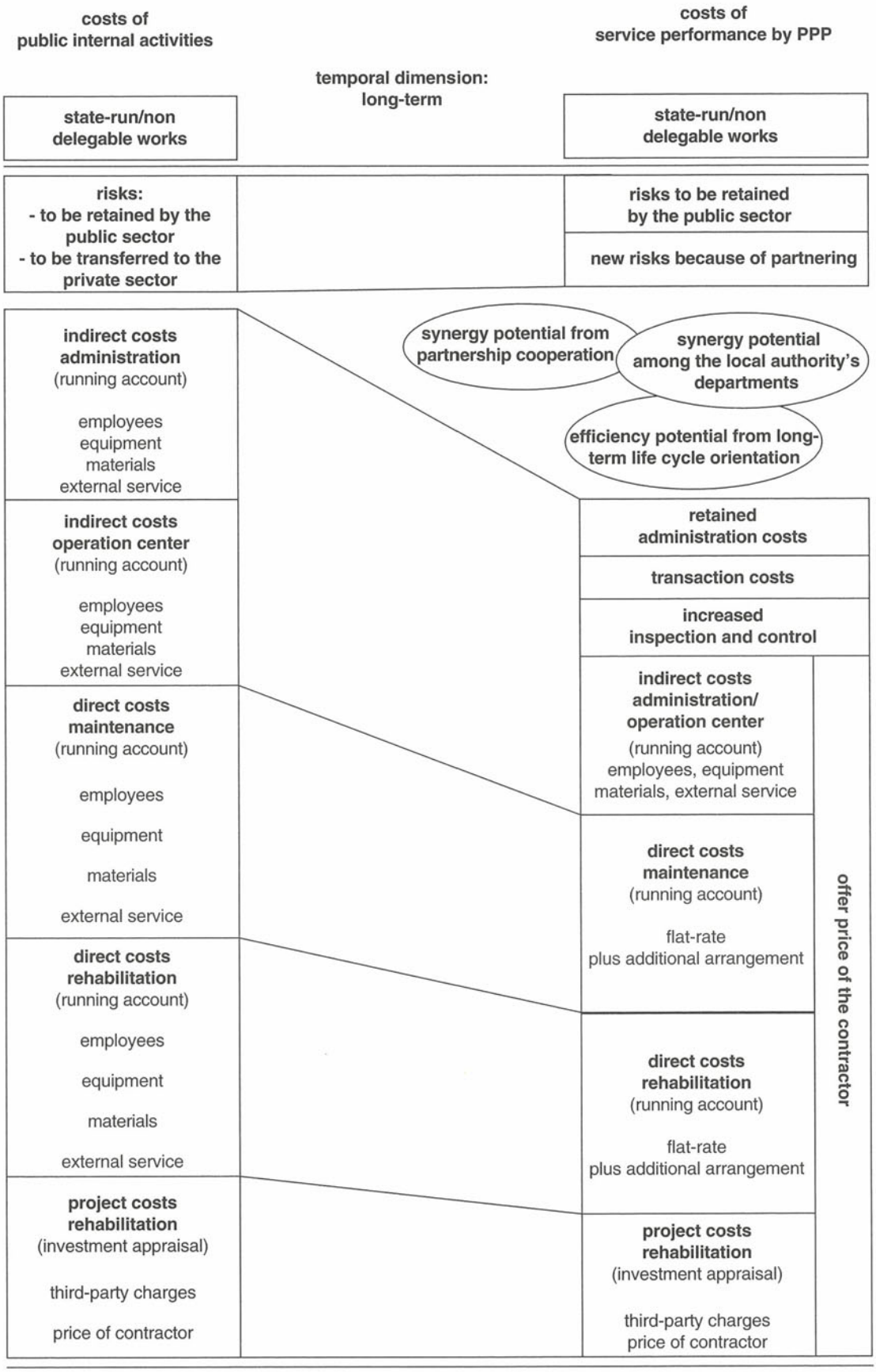

Figure 1. Economic comparison of works performed by the public sector (PSC) and by a Public Private Partnership (PPP).

The Public Sector Comparator may be defined as a hypothetical risk-adjusted costing, by the public sector as a supplier, to an output specification produced as part of a PPP procurement exercise (Treasury Taskforce Private Finance 2004). Or as the compilation of all costs involved in the public sector performing internal activities (Jacob 2003). A comparison on full cost basis is essential to gain a meaningful comparison. The PSC is represented by the left-hand column in Fig. 1.

The aim of a Public Sector Comparator is to give the public sector reference values for assigning services which can be used to evaluate the value for money, i.e. efficiency of the capital invested (acc. to Merna & Owen 1998).

The Public Sector Comparator (Treasury Taskforce Private Finance 2004):

- is expressed in net present value terms;
- is based on the recent actual public sector method of providing that defined output (including any reasonable foreseeable efficiencies the public sector could make); and
- takes full account of the risks which would be encountered by that style of procurement.

The right-hand column in Fig. 1 represents the costs of a PPP performing services (temporal dimension: long-term).

Within the partnership, the private partner assumes responsibility for the majority of executive and coordinating street maintenance works (work performance and support processes). In addition to the contractor's costs, a certain degree of administrative costs remains with the local authority, in addition to increased costs for supervision and control and transaction costs for initiating and executing a PPP.

The economic comparison must examine whether the assumptions made in Fig. 1 in terms of reduced costs for services performed by a PPP are actually justified.

A PPP only offers value for money if the execution by the PPP costs less than if the services were to be performed by the private sector itself.

In addition to the purely cost-based comparison, however, further aspects, so-called soft skills, need to be taken into account when drawing up a cost comparison in order to enable a realistically meaningful comparison.

These five soft skills are:

- 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.

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 phases (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; and
- Value benefit analysis.

2.3 *Project definition and structure*

The definition of the scope of works to be compared is the central point of focus for obtaining a meaningful economic comparison. As such, a first step focuses on defining the type and scope of street maintenance works, with particular attention being paid to the system definition. It must be clear which works on which parts of the street network systems can be performed by private suppliers.

The aim should be to pass as many works as possible over to the private suppliers within the framework of the partnership in order to increase partnering efficiency.

Within the framework of this research project, the system is defined as illustrated in Fig. 2. The grey boxes represent the individual street maintenance work sections. The surrounding white boxes indicate to which partial system of the street network system the relevant work section refers.

2.4 *Public Sector Comparator*

Once the system and works have been defined, the costs of the public sector performing the works itself need to be quantified. The method developed during the research project offers two possibilities:

- Community-specific Public Sector Comparator; and
- Public Sector Comparator using reference data.

For the first alternative, each local authority can base the cost comparison on the actual costs of their performing the street maintenance works themselves, whereby the advance outlay for the local authority is higher. This method offers precise, community-specific data for an economic comparison.

The second approach is not community-specific in terms of evaluating the possible savings from using a PPP since it is based on the cost benchmarks calculated during this research project and, as such, reflects cost bandwidths for works performed by the public sector. However, this second approach is much easier to handle and can be executed by any local authority without considerable time expenditure.

2.4.1 *Community-specific Public Sector Comparator*

This method captures the actual direct and individual costs incurred by the local authority performing the street maintenance works itself.

The costs are captured on two levels as outlined in Fig. 2 using SFIT's cost specification forms. One level covers the operational and construction maintenance, whilst the other focuses on the fixed costs for coordinating street maintenance works. It is important that all works relating to street maintenance, i.e. including the coordinating activities that incur fixed costs, are fully included to enable a meaningful cost comparison.

In consequence, the direct and indirect costs must be reported separately since the cost comparison is full cost-based.

2.4.2 *Public Sector Comparator using reference data*

This method evaluates the reference data (benchmarks) drawn up during the research project and offers local authorities indications for the cost bandwidths involved in performing the works themselves.

2.5 *Public Private Partnership*

There is no database available in Switzerland for assessing the costs of services performed by a PPP.

The research project therefore estimated the corresponding figures for a Public Private Partnership using efficiency advantages measured in percentage terms drawn up on the basis of the current maintenance concepts in the communities. Moreover, the self-performance of the works was examined to identify any potential economies of scale and scope for a more efficient performance of the services by private suppliers, e.g. by using equipment in several communities in the form of a maintenance association, by awarding partial works to subcontractors and by changing periodic works to output-oriented works. When performing the economic comparison in practice, the prices offered by PPP suppliers will be used (cf. virtual pricing model, Girmscheid 2005).

A major Swiss total service contractor is involved as a potential supplier to verify the plausibility of the assumptions, and empirical values from comparable projects within Europe are being drawn upon.

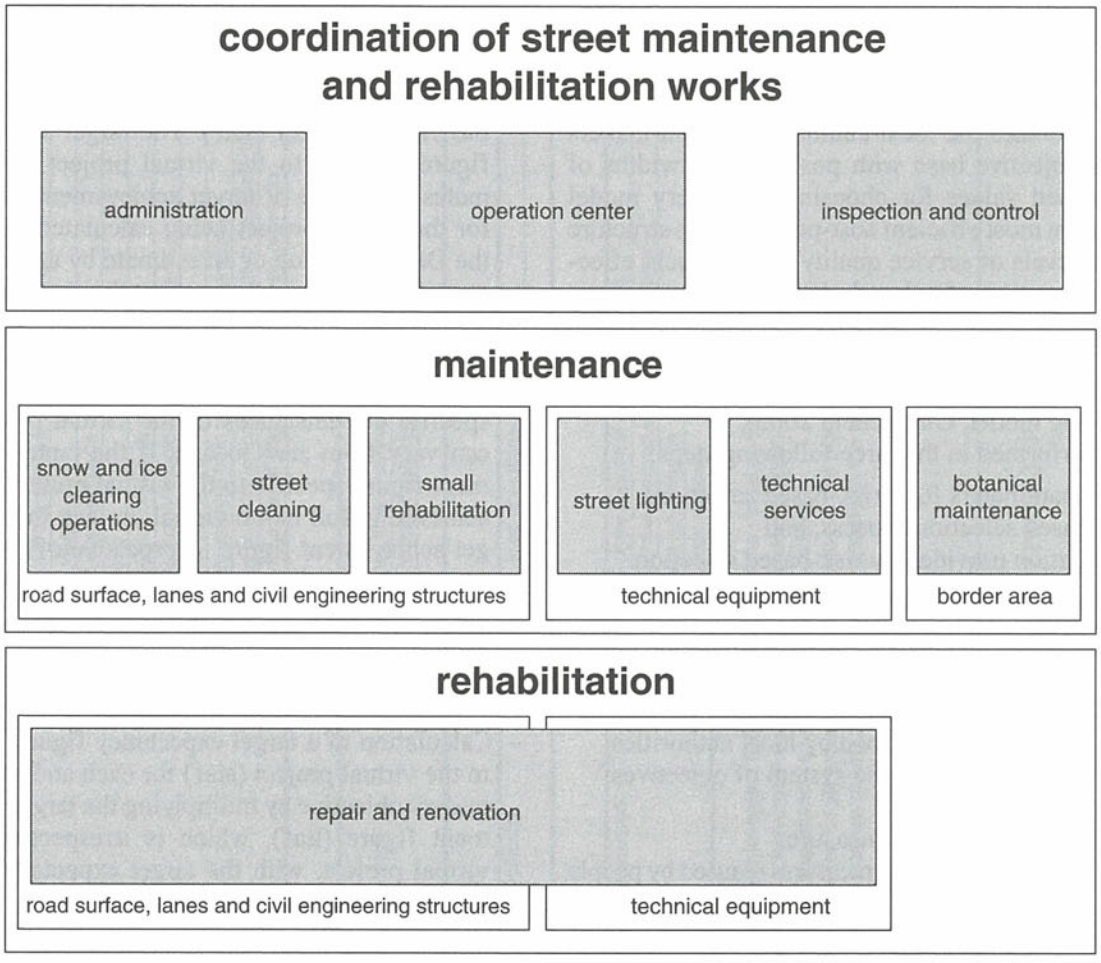

Figure 2. System definition.

2.6 *Cost comparison*

The costs of a PSC and PPP determined in Sections 2.4 and 2.5 must be compared with each other. The costs of the PSC and PPP works are indicated as bandwidths with expected, minimum and maximum values.

Monte Carlo Simulation is used to identify the spread and total expected value of both alternatives.

Special attention needs to be paid to the five soft skills mentioned in Section 2.2.

These are estimated based on their likelihood of occurrence and included, e.g. as surcharges or discounts, in the costs.

2.7 *Value benefit analysis*

In addition to the cost factor, local authorities also need to define qualitative objectives before agreeing a PPP. These can vary from one local authority to the next, but will generally include the superordinated objectives of conservation of value, securing network quality, street network availability and user safety. Accordingly, the PSC-PCC value benefit evaluation matrix can be drawn up to reflect the prioritized goals of each individual community. A possible system of objectives and evaluations is illustrated in Fig. 3.

Using the risk-oriented decision-making method, all qualitative and quantitative factors are evaluated and subjected to a systematically comparative analysis (Fig. 3).

This provides the local authority decision-makers with an objective base with possible bandwidths of the expected values for choosing a delivery model offering the most efficient cost-performance structure for high levels of service quality and, as such, effective conservation of value during the entire contract performance phase.

The value benefit analysis outlined in Fig. 3 is based on the calculation of costs for a virtual project (cf. virtual pricing model, Girmscheid 2005).

It is performed in the three following steps:

- Initial parameters for a risk-based selection;
- Risk-based selection process; and
- Information provided by risk-based selection.

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
- Further subdivision of the system of objectives:
  - for maintenance:
    - periodical routine measures
    - unscheduled ad hoc measures (caused by people and nature)
  - for rehabilitation:
    - scheduled project works
    - ad hoc measures – actual damage
- Definition of the various weighting factors (wf) of the primary and secondary objectives at each level and of original target achievement figures, irrespective of delivery form, of the various street maintenance delivery models for the target criteria
- 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
- Evaluation of the original target achievement figures, irrespective of the virtual project (itaf), of the secondary objectives depending on the allocated opportunities and threats. 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
- A scale of 0–5 is available to determine the 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
- 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.

Risk-based selection process

- Calculation of a target expectancy figure, specific to the virtual project (stef) for each and every secondary objective by multiplying the target achievement figure (itaf), which is irrespective of the virtual project, with the target expectancy figure specific to the virtual project (staf)
- Calculation of the weighted target expectancy figure specific to the virtual project (swtef) for each and every secondary objective by multiplying the target

primary objectives	target hierarchie (absolute)	secondary objectives	weighing factors (wf)		delivery forms							
					PSC				PPP			
			(absolute)	(relative)	itaf	staf	stef	swtef	itaf	staf	stef	swtef
costs of the virtual project	65.00%	costs of the periodical routine measures	2.50%	1.63%	2	1.0	2.00	0.03	4	1.0	4.00	0.07
		costs of the unscheduled ad hoc measures	2.50%	1.63%	2	1.0	2.00	0.03	4	1.0	4.00	0.07
		hourly wages	2.50%	1.63%	3	1.0	3.00	0.05	4	1.0	4.00	0.07
		wages of project costs	2.50%	1.63%	3	1.0	3.00	0.05	4	1.0	4.00	0.07
		total costs	60.00%	39.00%	3	1.0	3.00	1.17	4	1.0	4.00	1.56
		minimisation of failings in execution	5.00%	3.25%	4	1.0	4.00	0.13	3	1.0	3.00	0.10
		minimisation of supplementary amendments	5.00%	3.25%	2	1.0	2.00	0.07	4	1.0	4.00	0.13
		risks for the community	5.00%	3.25%	2	1.0	2.00	0.07	4	1.0	4.00	0.13
		synergy potential from partnership cooperation	5.00%	3.25%	0	1.0	0.00	0.00	4	1.0	4.00	0.13
		synergy potential among the local authority's departments	5.00%	3.25%	3	1.0	3.00	0.10	0	1.0	0.00	0.00
		efficiency potential from long-term life cycle orientation	5.00%	3.25%	2	1.0	2.00	0.07	4	1.0	4.00	0.13
			sum = 100%									
organisation/ process of decision	15.00%	flexibility in service performance	20.00%	3.00%	5	1.0	5.00	0.15	2	1.0	2.00	0.06
		response time of service performance	20.00%	3.00%	5	1.0	5.00	0.15	2	1.0	2.00	0.06
		coordination of performance to a long-term life cycle orientation	40.00%	6.00%	2	1.0	2.00	0.12	5	1.0	5.00	0.30
		audit	20.00%	3.00%	2	1.0	2.00	0.06	4	1.0	4.00	0.12
			sum = 100%									
operational availability/ users' safety	10.00%	unrestricted operational availability	50.00%	5.00%	3	1.0	3.00	0.15	4	1.0	4.00	0.20
		guarantee of users' safety	50.00%	5.00%	4	1.0	4.00	0.20	3	1.0	3.00	0.15
			sum = 100%									
quality of street network	10.00%	quality of the periodical routine measures	30.00%	3.00%	4	1.0	4.00	0.12	3	1.0	3.00	0.09
		quality of the unscheduled ad hoc measures	30.00%	3.00%	4	1.0	4.00	0.12	3	1.0	3.00	0.09
		quality of rehabilitation	30.00%	3.00%	3	1.0	3.00	0.09	4	1.0	4.00	0.12
		QM-system existing	10.00%	1.00%	1	1.0	1.00	0.01	4	1.0	4.00	0.04
			sum = 100%	sum = 100%			total swtef PSC:	2.93			total swtef PPP:	3.67

itaf = target achievement figure, irrespective of the virtual project
staf = target achievement figure, specific to the virtual project
stef = target expectancy, specific to the virtual project
swtef = weighted target expectancy, specific to the virtual project
total swtef = total weighted target expectancy, 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 3. Value benefit evaluation matrix PSC and PPP.

expectancy figure specific to the virtual project (stef) with the relevant relative weighting factor (wf)
- An aggregation of the weighted target expectancy figures for the secondary objectives produces the weighted target expectancy figure of the relevant primary objective
- The total weighted target expectancy figure for each street maintenance delivery form (total swtef) is calculated by Monte Carlo simulation using the target expectancy figures, specific to the virtual project (stef), of the primary objectives.

Information provided by risk-based selection

- 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 of the different systems of objectives to aid the decision-making process
- The entire probable bandwidth of possible target achievement levels and their likelihood of occurrence can be revealed using Monte Carlo simulation
- A risk-oriented, objective basis for the decision-making process when choosing the most efficient street maintenance delivery model is produced by the total weighted target expectancy (total swtef) levels of the street maintenance delivery models and their variance.

3 CONCLUSION

The economic comparison as one result of the research project is being developed for direct use in practice. Its substantiated relevance for practical application is proven, on the one hand, by the increased inclusion of qualitative objectives in street maintenance. On the other hand, the comparison method is flexibly applicable to all communities, since it can be performed on the basis both of precise proprietary PSC costs or of cost estimations of the local authorities performing internal activities using cost bandwidths.

As far as this partial result of the research project is concerned, the realizability is proven by verifying the functionality of the economic comparison in the ten communities involved in the project.

Using precise cost capturing, the economic comparison can be flexibly applied to other areas of public sector responsibility, e.g. park maintenance, building maintenance. But this method can also be used for maintaining cantonal and national street networks in Switzerland, since the community street networks that were examined are the technically and organizationally most complex street network system of the communal, cantonal and national street network systems.

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