
Performance-based specification for the operational and structural road maintenance of communal road networks

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Abstract

Due to the globalization a development towards privatization of infrastructure can be observed nationally and internationally. Worldwide, various investigations show that privately managed public infrastructures show higher cost-efficiency and enable more flexible utilization as well as change of usage. In times of sinking public income, local authorities must prove their efficiency in carrying out public duties. Public Private Partnership (PPP) can be seen as a possible initiative towards increasing efficiency.

Delivering the maintenance of communal road networks in Switzerland through a PPP should not decrease the quality of the infrastructure and its use. Performance-based specification for maintaining the road network give the possibility to affect the quality, because they depend on the output instead of the traditional “input” based specification in road maintenance. In other words, performance-based specifications are not based on quantities of works measured by units for works inputs, but on measured “outputs” reflecting the “service quality levels” of the roads under contract.

This paper outlines the development of performance-based specification as one of the findings of a complex research project in the field of Public Private Partnership (PPP) for operational and structural road maintenance of communal road networks.

Keywords

Public Private Partnership – Communal Road Network – Road Maintenance – Performance-based specification

1. Introduction

The maintenance of urban roads is one of the major duties and responsibilities of the public authorities. In Switzerland the structures of the about 2740 communal agencies in terms of maintenance differ considerably. Major cities manage their maintenance partially or completely by themselves, whereas smaller townships mostly contract out some or every maintenance operation. In Switzerland this procurement of maintenance operations has always used codes and standards with prescriptive criteria.

In times of a sinking public income local authorities as the owner of the different communal road networks have to proof their efficiency. On the other hand the quality of public duties is becoming more and more important. Facing this difficulty, the question arises whether the prescriptive approach yields a solution or not.

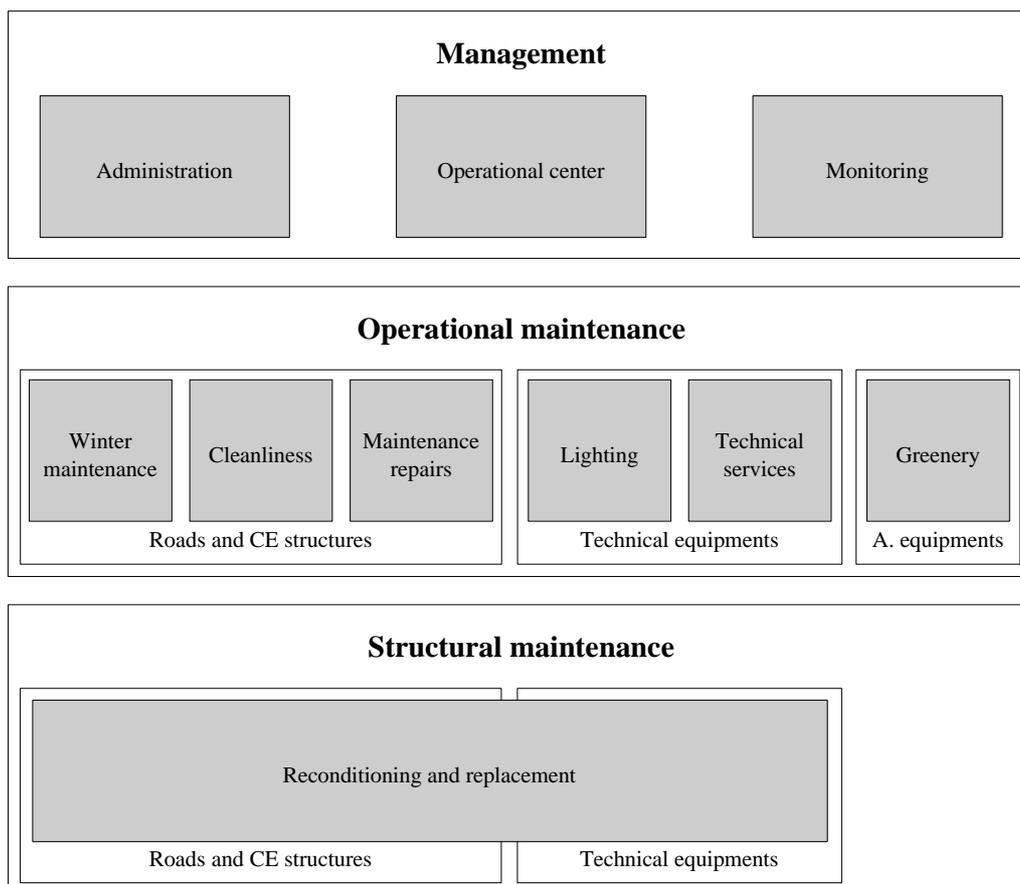
The costs of maintaining a road network are often depending on unpredictable variables, for example weather conditions. This leads to the topic of risk disclosure and allocation. With the prescriptive approach the local authority always bears the risk. Bearing a risk in other words means accepting additional costs. Is it then possible to keep the quality level? A vicious circle of rising costs and sinking quality could be the worst case. The performance-based approach transfers the risks from the local authority to the contractor or enables to share the risks of maintaining a road network. But in order to achieve to a satisfying result, some definitions have to be made and preconditions have to be fulfilled.

2. Definition of road maintenance

Road maintenance covers all work on roads. This includes operational (routine) and structural maintenance and of course the management of road works. These three levels can be subdivided into the different maintenance operations. These operations are more or less structured by the costing in each community. The Swiss Community Association defined a standard for local authorities to structure their costing in order to make it possible to compare the costs in the communal road maintenance. Unfortunately these standards are not adopted in all communities yet.

Figure 1 shows the three levels classifying the road maintenance operation according to the structure of costing.

Figure 1 Levels classifying road maintenance operation



As opposed to the road maintenance of trunk roads and highways the scale of the operational and structural maintenance of urban roads differs very much and is depending on the different demands of the various areas in a communal road network. This makes it difficult to describe

the maintenance operation in the traditional prescriptive way. In one place the operation includes rather manual labour, in others just machine-made work. A striking example here is the comparison of an inner-city junction to a highway in winter maintenance. With highways it makes sense to refer to their length. In the inner-city area it is not even possible to refer to the square meter because of the different expansions.

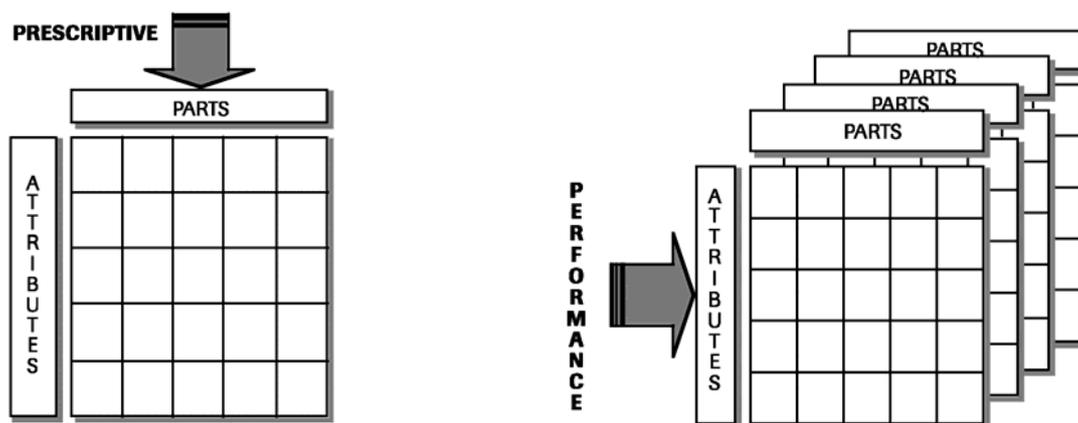
In the different maintenance operation in a community firstly the level of service and the set objectives are taking centre stage. In other words, the result or the quality of the maintenance operation is of importance. An advantage of the performance based approach is to link directly the aims and quality needs in the different areas of the communal road network with the maintenance operation.

3. History of the Performance-based approach

The first application of a performance-based approach took place in the field of bridge engineering in the 1960s in order to enable the contractor to offer special technical solutions. In the 1970s the performance concept became of importance in the turnkey construction. In 1977 the U.S. Department of Commerce published a project report for the development of performance standards for special and innovative construction. In 2001 for Europe a network was established for continuing the development of performance based building. The performance-based approach creates potentials for more innovation and gives the possibility to optimize construction engineering in technical and economical matters. It is a efficient method for contracting and transfers the risk from the client to the contractor.

As opposed to the traditional prescriptive approach the performance-based approach describes the demands on quality by standards and codes instead of specifying for example materials or methods of construction. Hence it does not obstruct innovation. Figure 2 exemplifies the difference between both approaches by means of a building viewed as a matrix of building parts and attributes. In the traditional prescriptive approach the description of specific building parts leads to a building with an implicit set of attributes. The performance-based approach with a specification of building attributes brings forth many combinations of different building parts.

Figure 2 Difference between the prescriptive and the performance-based approach



Source: Foliente, G. C. (2000) Developments in Performance-Based Building Codes and Standards, Forest Products Journal Vol. 50, No. 7/8, Madison USA, July/August 2000

The first implementation of performance-based specifications in road maintenance took place as a pilot project in Canada in 1988. Among others, Argentina, Uruguay, Brazil, Chile, and

Colombia followed in the 1990s. In 1995 Sydney started a performance-based contract for the road maintenance of about 450 km urban roads. In the USA Virginia started a pilot project in maintaining the highway network in 1996. Ever since the performance-based approach is applied to maintaining highways, bridges, tunnels, rest areas and urban roads in other federal states of the USA. In Europe contracts are based of performance-based and output oriented approaches for the maintenance of road networks in different pilot projects in the United Kingdom, Sweden, Finland, Netherlands, Norway, France, Estonia, Serbia, and Montenegro.

4. Preconditions for the performance-based approach in road maintenance

Performance-based specifications contain characteristics of the maintenance operation and define the demands on its performance. Hence no process of realization is described but the expected output or result of the maintenance. Performance-based specifications include basically the following information:

- Qualitative demands (indicators)
- Quantifiable expected outputs (standards)
- Verification procedures
- Assessment procedures

The demands have to be clear on a level which is quantifiable and for which verification and assessment procedures exist. To reach this point advance contributions have to be made by contractor and client. The following facts are very important:

- Classification of the road network
- Definition and quantification of the objectives of maintaining the network
- Definition of related verification and assessment procedures

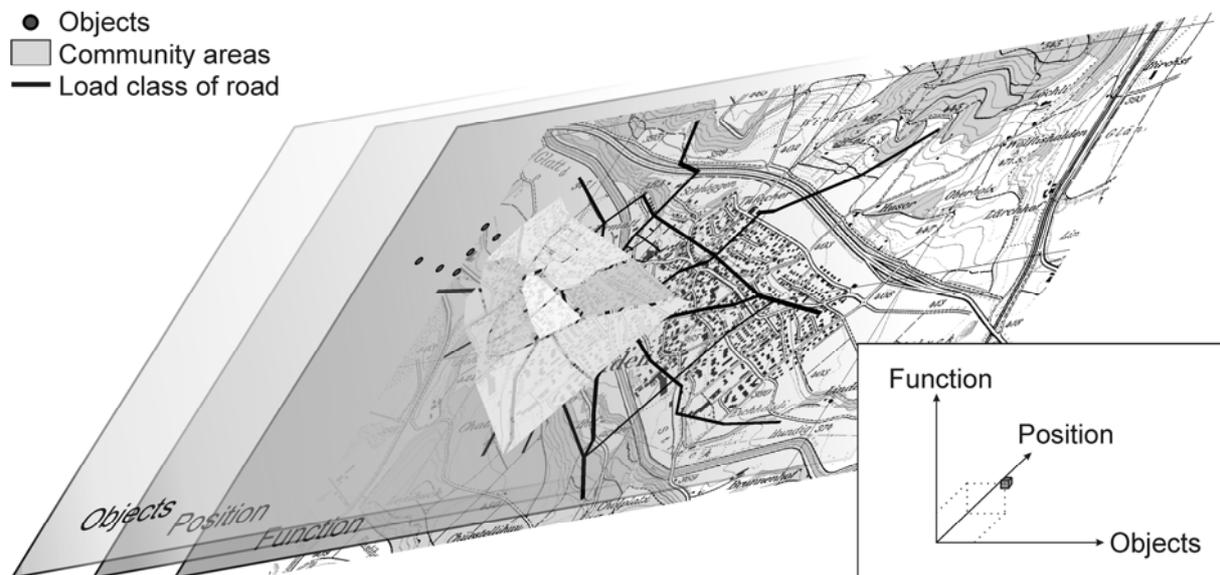
It has to be defined what, has to be maintained why and in which extent. One positive development at local authorities has already begun – the focus on quality of the performed maintenance in the road network.

4.1 Classification of the road network

The road network of a community has to be divided into areas of different use and demands on quality. Hence it is appropriate to split into different objects or groups of objects in consideration of the various characteristics of maintenance operations, the use of the areas and the different demands. This enables the comparison of objectives and outputs of each single defined object by determination of the target score. This enables for managing maintenance in a methodical way.

Figure 3 shows a 3-dimensional classification of the road network into objects, communal areas (position) and the functions in terms of importance.

Figure 3 3-dimensional classification of the road network



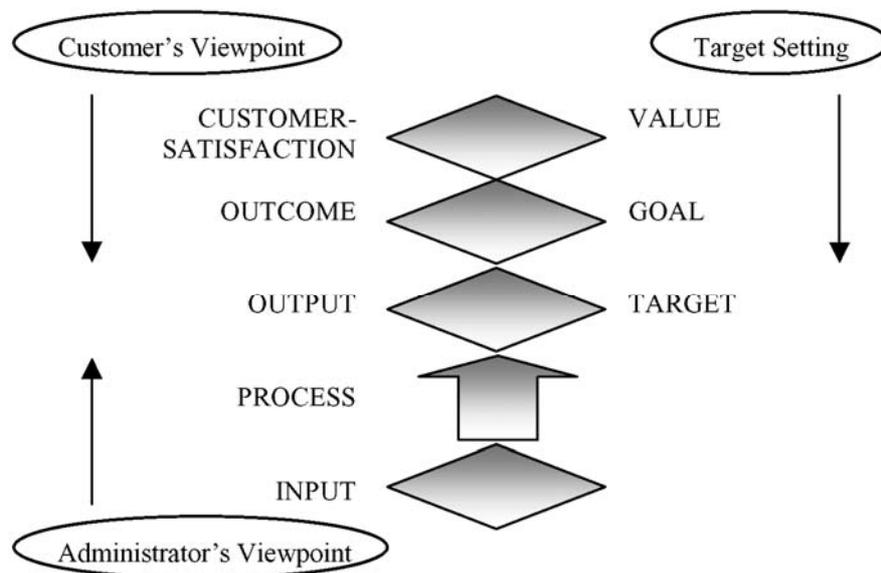
Each community uses its own classification of the road network in terms of functions and areas. That is why each authority has to classify all three dimensions by themselves to keep the already existing information.

Once this is done for each maintenance operation, a documentation of the actual condition has to be made. The actual condition in comparison to the target score gives an overview about the long time period performance in maintenance quality.

4.2 Definition and quantification of the objectives of maintaining the network

One of the most important things is to define objectives for maintaining the road network. These objectives have to be quantified for the sake of controllability. The aims in the maintenance of communal road networks are more and more user oriented. Basically with a minimum of cost a maximum of satisfaction of the user (benefit) should be reached. But clients and users have different expectations for maintenance which can be seen in Figure 4.

Figure 4 Administrator's viewpoint and customer's viewpoint



Source: Yoshida, T. Performance-based specification as a Stepp to performance-based management and maintenance of pavement in Japan, Public Works Research Institute, Tokyo/Japan, 2001

The SMART approach can be applied in defining objectives for performance-based specification:

- S pecific
- M easurable
- A chievable
- R ealistic
- T imely

4.3 Definition of related verification and assessment procedures

For appointing performance-based specification in a contract objectives have to be defined including verification and assessment procedures. These procedures provide the base for monitoring the maintenance not only for the client but also for the contractor and its own quality management. Verification and assessment procedures have to be defined as mandatory in the contract.

5. Development of performance-based specification

Performance-based specifications for the road maintenance should include the following information:

- Indicators
- Standards
- Percentage of the network
- Indices
- Quantities
- Response time

Ideally, descriptions are made of all aspects for the high standard of expectation concerning the road maintenance. The consideration for specific user criteria guarantees the securing of the service level in maintaining the communal road network. User criteria includes capacity, safety and reliability as well as the demand on structure and a quality-oriented management in maintenance. To cover all different duties and responsibilities, routine work, initial rehabilitation work, improvement works and emergency work have to be considered.

Table 1 gives an example of a performance-based specification for winter maintenance. It contains the 3-dimensional classification in objects, load category and land use. Thus the object, for example a transect within a street of 50 m is identified clearly and gets indicators depending on its demand to the winter maintenance. Each indicator is allocated by a standard, in this case a parameter or a percentage of the network. For every standard the verification and assessment procedures are defined and an indication of the response time is given. This has to be made for every combination of requirements in the road network.

Table 1 Example of performance-based specification in winter maintenance

WINTER MAINTENANCE				
Transect No.:		0000015		
Name:		Example Road		
Object:	Load category:	Land use:		
Transect within a street	BK WIA	Higher Density Housing		
				
Indicator	Description	Standard	Verification and assessment procedures	Response time
Slip resistance of sidewalk	Guarantee of slip resistance by providing skid resistance	$\mu = 0.2$	Skid Resistance Tester (SRT)	No response time
Snow depth	Guarantee a max. snow depth h_S on the sidewalk in a width of 1m, this incl. to keep free passes to roads every 20m	$h_S < 10 \text{ cm}$	Visual inspection with ruler	No response time
Snow removal	Snow removal on the sidewalk in a width of 1m, this incl. to keep free passes to roads every 20 m	$> 80 \%$ of road network	Visual inspection with ruler	3 hours after occurrence
Snow removal	Snow removal on the sidewalk in a width of 1m, this incl. to keep free passes to roads every 20 m	100 % of road network	Visual inspection with ruler	5 hours after occurrence

6. Perspective

As shown the performance-based approach can be easily adopted for specifications of communal road maintenance instead of the prescriptive approach. However, the performance based approach is only one part of a complex research project titled Public Private Partnership which is to be completed until the end of 2007.

The PPP project which also describes the contractual applications sets the foundation to properly apply the performance-based approach on procurements of maintenance services in the communal road network.

In Switzerland in the field of maintenance, performance-based specifications have not been used yet. Due to lack of experience it is necessary to introduce this performance-based approach by the means of pilot projects.

According research projects are already drafted and likely to be pursued further.

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