Maintenance of material infrastructure in Germany considering the forecast of the future investment costs in early project phases

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Significance and status quo of infrastructure  
Infrastructure and the associated mobility are of significant importance as a foundation for growth, prosperity and employment. Transport connects people and countries and enables the exchange of goods. Improved mobility with shorter and faster connections at the same time is a feature of high quality of life. Growth and function of a spatially differentiated economy that is based on the division of labour strongly depends on an efficient infrastructure. The infrastructure is therefore an important factor for the attractiveness of a location.

Maintenance as a business economic task  
Infrastructure objects have high maintenance costs during the operating phase. In his dissertation Kornblum identified a factor of 2.2 for the maintenance costs relating to the production costs. The whole life cycle costs consist of the initial investment costs (production costs), the future investment costs and the operating costs. The maintenance costs, which occur during the operating phase, are part of the future investment costs. In order to draw up a reliable and meaningful planning of the future investment costs of an object, it is necessary to know the duration and the amount of costs incurred. This requires knowledge of the lifetimes of each component. During the process of decisions on realization, the focus is still to a large extent on production costs and not on the total life cycle costs, although the operating and maintenance costs can exceed the production costs significantly. Empirical values are often used as life time parameters to determine the future investment costs, but these values can't be used for all projects without checking.

DIN 31051 defines the term maintenance as "a combination of all technical and administrative measures taken by management during the lifecycle of a unit which serves to maintain or restore its functional condition so that it can fulfil the required function" and divide it into four basic measures: maintenance, inspection, repair and improvement (see Fig. 1).
According to Zimmermann the Measures “Wartung” and “Inspektion” are not part of the future investment costs but part of the operating costs and will not be examined during this dissertation.

Furthermore, it defines wear and tear as the reduction of the wear margin caused by chemical and/or physical processes. The wear margin refers to “the stock of possible functional fulfillment under specified conditions which is inherent in a unit due to manufacture, repair or improvement” (see Fig. 2).

**Research methodology**

The methodology developed by Greitemann and Kornblum of Standardraumstrukturen for building construction will be further developed for the material infrastructure. Therefor Standardräume are built for tunnel constructions, bridge construction and road construction. The cost key values are obtained by an empirical data collection from real projects and from databases. Furthermore, the influencing factors on wear and tear and on the lifespan of the individual components are identified. A cross-impact analysis is carried out to investigate the roles and influences of the identified factors. On this basis, a service life analysis is carried out using stochastic models and the derivation of a cost function according to the life cycle.

**Aim of the task**

The aim of this work is to create a guideline or a forecast model which can be used in early project phases for predicting the future investment costs. This model is based on the method of Standardraumstrukturen by Greitemann and Kornblum and follows the approach of a preventive maintenance. The future investment costs are determined by assigning the lifespans to the individual components. The total price is determined by the product of the unit price and the corresponding reference amount.

**References**


Kornblum, Florian: Bestimmung von Herstellungs- und Instandsetzungskosten sowie dem Verbrauch von Grauer Energie bei der Realisierung und dem Betrieb von Immobilien

Greitemann, Peter: Bestimmung der Bauzeit von Bauprojekten zum Zeitpunkt der Realisierungsentscheidung Stand: 08.01.2018