ROAD ASSET EVALUATION MODELS, CASE STUDY

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Abstract
This article is dedicated to the problem of modelling for the technical-economic value of roads, as public assets. Carrying out asset valuation helps us to fulfil the legal requirements, for an effective financing of infrastructure and the improvement of management through the provision of technical data and financial perspective. Addressing the problem of their evaluation requires a careful treatment, but also the introduction of other disciplines. It is very important that road authorities and specialists involved in the evaluation process understand the nuances of modelling and, most important, the interpretation of the results. In this article, we guarantee a discussion of the problem of evaluation of road assets, we show the properties, which through a "Typical-example-ideal" model can give some relevant instructions to the implementers. This article concludes with a discussion of three examples of real-life assessments conducted in Albania.

Keywords: Road assets, model, evaluation, assessment

1 Introduction

The proposed model for effective maintenance management in the road infrastructure system, consisting of three main components: (i) the model of prioritization of activities and roads in the inclusion of performance-based maintenance, (ii) the optimization model of maintenance management based on the required output, and (iii) the evaluation model of effective maintenance application cases. Within the framework of the combined research methodology used in the study, this chapter presents the results of the qualitative analysis from the data collected in the three cases studied:1) Performance-based maintenance and rehabilitation of the national axis Vorë - Brick Factory for a contract in four years 2) Maminas road - the old road part of the completion of the performance-based rehabilitation and maintenance contract, 3) Performance-based rehabilitation of urban and local roads of Devoll Municipality [1, 2].

2 The model analysis

The collection of qualitative data was carried out through the review of documentation, structured interviews, and observations, aiming at complementing and supporting converging the quantitative results. Thus, the study of the documentation mainly aimed to identify the phases and procedures of the application of the performance-based maintenance contract. The semi-structured interviews aimed to identify the main indicators encountered, their distribution and treatment measures to guarantee a high level of service [5].
The selected roads are national, regional, and local roads. What they have in common is that they are all paved roads. The Figure 1 indicate the locations of the roads in the Republic of

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Albania we are studying. The selected roads are very important roads and they have been invested in recent years. The maintenance management plan for these roads, due to lack of funds, were not possible to be activated exactly a year after the first year of completion. The constructions of different typology have different packages of layers. Their technical design were calculated based on the terrain, since these roads pass through different ground conditions and some of them have different level of maintenance [8].

Figure 1 Presentation of the network covered by the four contract codes: Contract A; Contract B; Contract C; and Contract D

- Contract A = 275.99 km, value 17,671,487.66 € cost per km = 64,029.44 €/ 4 years = 16,007 €/year: the red colour roadway
- Contract B = 286.0 km, value 16,004,667.09 € cost per km = 55,960.37 €/ 4 years = 13,990 €/year; the green colour roadway
- Contract C = 419.42 km, value 11,276,531.70 € cost per km = 26,886.13 €/ 4 years = 6,721 €/year; the purple colour roadway
- Contract D = 350.66 km, value 13,786,125.17€ cost per km = 39,315 €/ 4 years = 9829 €/ year; the light blue colour roadway

According to the contract for performance-based maintenance, there is estimated 58.86 months related to routine maintenance. Within 25 months the contractor will complete the contract specifications for the completion of the periodic of rehabilitation of works and the improvements of asset's conditions. This is very important part of the contract, since the assets have an impact on the level of service to the users. These contracts contain, a) design and implementation of rehabilitation works of road layers, b) design and implementation of other rehabilitation works, c) design and implementation of improvement works, d) periodic network performance maintenance service, e) emergency works, f) management, monitoring and control of activities [2, 7].

3 Functional contracts, functional criteria

Functional contracts refer to contracts specified by criteria from a user perspective, according to [11, 12] exemplify by expressing a road as a transportation corridor defined with height, length, width and flow characteristics. The recipe of the pavement should be left to the contractor to design.

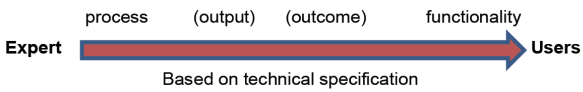
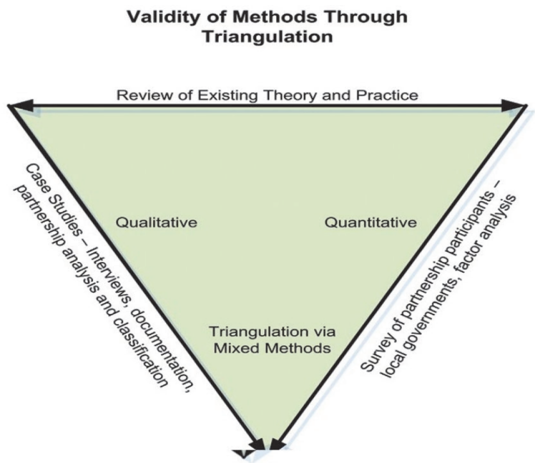


Figure 2 Chart based on technical specification at every level of performance

3.1 Triangular method

Triangulation is the geodetic technique of determining the position of an object in space by taking directions for at least three known points, Fig. 2. The position of the object is assumed to be at the point of gravity of the error triangle or polygon. The distances between the gravity point and the edges of the polygon provide estimates of accuracy, i.e. possible error of position. Analogously, the Triangulation Method refers to the study of phenomena with several independent methods to reduce error and obtain accuracy estimates [4, 9].

Figure 3 Validity of methods through the Triangulation used in that survey



The classification is used to determine ownership, drawing standards according to traffic and according to the prioritization of funds. The principle of roads in prioritisation of fund are those that:

- Where there is significant cross-state or interstate travel.
- Urban service areas with a population density of more than 50,000 or large areas with a majority population of more than 25,000
- Providing an integrated network

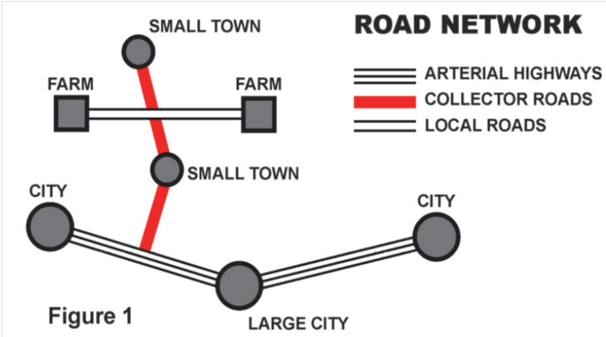


Figure 4 The classification for road financing prioritisation

Table 1 Hierarchy of prioritisation

National roads	Urban/Regional roads	Small urban/local roads
Main artery	Main artery	Main artery
Small arterial passages	Small arterial passages	Small arterial passages
Collective road	Collective road	Collective road
Local road	Local road	Local road

According to AASHTO Functional classification is used to categorize roads according to their predominant role in the highway network and also based on their physical location. The AASHTO functional classification distinguishes between arterial, collective, and local roads [3, 10]:

- Arteries serve those corridor movements that have long travel lengths and high volumes.
- Collectors serve traffic function generators, while local roads provide similar access to movement in local roundabouts.
- The road is defined as an urban or local area, with the destination based on the density of the general population.

Classifies roads over a fairly wide geographical area and does not respond to localized changes such as those encountered when moving from open fields to small villages. The classification of systems should be:

- Simple
- Easily adaptable to the road network in the future
- Accept all types of administration levels
- Stable

3.2 “PROFIT” approach

This method is usually applied to the evaluation of capital investment projects, since these activities usually contain a large investment associated with a significant forecast and where the cost of each alternative is the same. Therefore, it is quite difficult to assess the exact benefits. It is also usually difficult to define measures of effectiveness for such projects and rather complex to describe due to the long duration of activities and the convolution of effects [10, 13]. Much research work has been conducted over the past two decades to describe measures for evaluating capital improvement benefits. Some benefits include: liability for work done insurance, reduced travel time, improved vehicle comfort and safety, reduced or deferred capital expenditures through conservation of capital, vehicle operating and maintenance costs, and reduced level of deterioration of the road. Cost-benefit analysis can be done when costs and benefits are measurable in monetary terms. Cost reduction is the benefit. In the management of the road network, the actual value of the life cycle cost and benefit has been applied. The equation below reflects the application of net present value considered as an economic calculation used:

$$\text{NPV} = \text{Initial construction cost} + \sum_{k=1}^{N} \frac{future\ \cos t\, k}{(1+i)n_k} \text{-}saving\ road\ value \cdot 1/\left(1+i\right)n$$

Where:
N – is the cost in the future against the analysed period
i – percentage [%] of the interest rate
n_k – the number of years from the initial construction to the expenses in the year k
n – analysis in years of the period.

Uniform annual equivalent cost (UEC) is calculated according to the formula that parks current and future expenses converted into a uniform annual cost [5, 6]. The model for identification, prioritization and evaluation is proposed through the combination approach of Activity Prioritization and Effective Maintenance Prioritization Structure of many criteria. This template is designed for a model performance-based maintenance contract project, which can be used as a basis for further extensions and updates.

4 Analysis of the condition of national, regional and local roads

In order to plan and implement maintenance in the right way, it is necessary to define maintenance. Maintenance Objectives may be defined as the need to achieve a certain service level and may have corresponding Maintenance Standards.
Level of Service (LSL) is a qualitative measure of what the user expects or what the existing road can offer. The Maintenance Standard is a quantitative measure that defines the required activities, their scope and frequency in order to provide a certain LSL.
The LSL must be set at a level that is economical and reasonable to achieve. For a given road with a given level of traffic there will be an optimal LSL determined by the relationship between maintenance expenditure and user cost.
For roads with low traffic, the justification for maintenance will rely more on social than economic criteria. Generally, in this case, LSL will be the socially acceptable minimum, and may amount to no more than a commitment to keep the road open and provide a basic level of vehicular access [1, 10].
The graph below shows the level of road expenditures as a result of road conditions. The green graph represents agency costs as a result of road agency maintenance, the blue graph represents user costs, and the red graph represents the sum of user and agency costs. When agencies have budgets to fund maintenance according to the required level of service, transportation costs are reduced.
The following table graphs show the NPV and other economic indicators together with IRI values at the end of the contract (5 years) and the reference period (20 years).

Table 2 Annual Investment levels as precent of property maintenance of the roads

Organization	**New construction** [%]	**Maintenance and repair** [%]	**Total** [%]
Departament of Maintenance	1.6	1.4	3
Public works intrastructure			4.5

Table 3 Economic Indicators/IRI values [11, 12].

Budget Scenario (pavements only)		Capital Exp. Years 1 to 5 (M€ per year) 5 years	Financial Cost (mln €)		Discounte Financial Cost (mln €)		NPV (mln €)		NPV/ Cost		IRR (%)		IRI (m/km)	
			20 years	5 years	20 years	5 years	20 years	5 years	20 years	5 years	20 years	5 years	20 years	5 years
Scenario 1	Unconstrained Scenario	Average 45	229.6	544.3	219.55	385.85	252.6	4,452.62	34,855	34,855	62.3	82.1	2.22	2.73
Scenario 2	30 mln €/year	30	141.8	504.8	179.15	373.49	131.7	4,200.90	34,855	2,967	63.3	89.5	4.54	3.52
Scenario 3 (Vore- Brick Factory)	20 mln €/year only	20	97.8	394.1	88.11	255.02	130.3	4,124.46	34,855	43.72	64.8	90.7	4.91	3.49
Scenario 4 (Maminas old town)	15 mln €/year	15	71.5	294.4	64.42	184.59	115.7	4,073.00	14,756	2,967	62	89.7	5.34	3.49
Scenario 5 (Devoll Municipality roads)	5 mln €/year	5	21.2	290.8	19.12	164.1	93.3	3,692.29	43,148	43,148	58.4	85.5	6.23	3.53

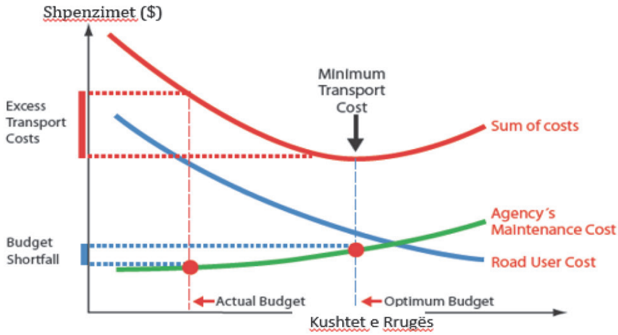


Figure 5 Conditional road, based on expenses and budget

The outcome in terms of surface condition and road user comfort relating to these alternative budget scenarios are highlighted in the following graphs. Pavement quality trends are highlighted in the next two graphs (period 2015-2019).

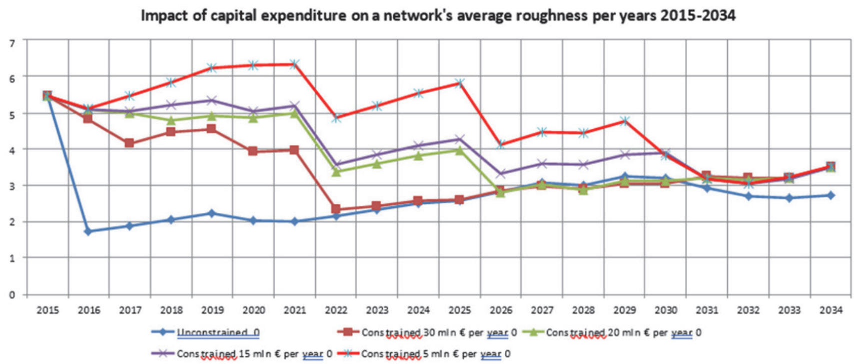


Figure 6 Constrained and Unconstrained Scenario: HDM-4 output (Source: the Consultant)

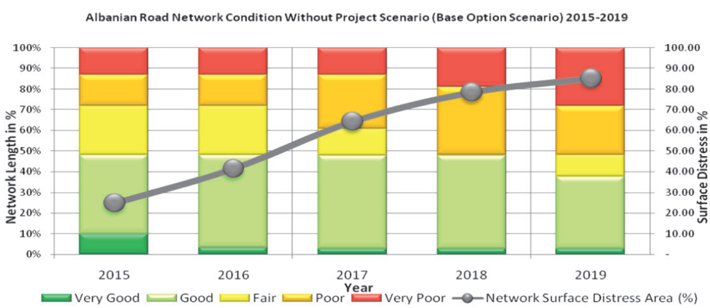


Figure 7 Base Option Scenario: HDM-4 output (Source: the Consultant)

This item includes all works required to bring the road to pre-defined standards (other than pavement works which are dealt with the HDM-4 analysis). For sake of clarity, all rehabilitation works other than pavement works are also referred to as road restoration works. A list of the main restoration works considered is reported at the abastruct, “Definition and cost estimates of the project elements”. The method for estimating the cost of rehabilitation (restoration) road works utilises a set of unit rates factored by the quantities determined during the data collection stage.

Specific unit rates were developed for the proposed rehabilitation 'BoQ' items, while the quantities were a result of substantial processing activity made by the Consultant on data extracted from the Contractors' Road Condition Survey templates and Contractors' BoQ templates. All road restoration costs are reported in figure 1 summarized in "Total estimated project cost". This overlay performance model was chosen from a number of current models implemented in several Maintenance Management Systems because it has been widely used and tested. However, pavement performance models can also be used, such as the deterioration models developed for roads managed by local authorities as referenced in [10, 13] or deterioration models developed for use [11, 14].

5 Conclusion

Since it was found that the current ARA database regarding required maintenance interventions was incomplete and not updated, a detailed survey was deemed necessary to assess the present qualitative condition of the network. Under these circumstances, the opportunity represented by the availability of ARA staff and Contactors' co-operation was exploited beyond the scope originally suggested by the ToR (collection of additional data), as the workshops and the following activities in fact originated an actual full condition survey of almost the entire national road network. During the workshop three templates for the collection of additional data were forwarded to the Contractors and ARA Regional Departments:
- Priority Data Template (PDT)
- Road Condition Survey Template (RCST)
- Bill of Quantities for Rehabilitation Works Template (BoQsT)

The PDT regards basic data, used as the necessary input to implement the HDM-4 analysis of the network (traffic volumes and composition, geometrical data, pavement condition). As clarified in the relevant chapter, the estimation of the budget for pavement maintenance is based on the analysis performed usingas an input the information contained in the PDT.RCS and BoQs Templates were also developed. They refer to the condition survey the Consultant has proposed to implement with the assistance of the ARA's personnel, the Regional Departments engineers and the maintenance contractors' staff.

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