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Consistency of state road network master plan development steps☆

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ABSTRACT

By scrutinizing the implementation of a long-range road network plan at the federal state level, the article puts emphasis on the consistency of previously compartmentalized development steps. A recent regional case study of the German state of Thuringia is used to reflect the current planning procedures. Aiming to overcome inconsistencies, an integrated approach to a policy-formation framework is presented, allowing for the systematic identification of a road network improvement project portfolio. Organizational and technological options for the delivery of consistency and a better the usage of the project opportunity space are explored, for example, by transferring the considerations on welfare aspects from the cost-benefit appraisal step to the earlier process stages of construction measure specification and project nomination.

1. Introduction

1.1. Strategic road network planning

The elaboration of a governmental multi-project master plan towards an incremental improvement of interurban road networks is a periodic task of public administration, typically recurring every decade. The evolution of the network, changes of network externalities, of legal requirements, and action needs arising of transport policy goals necessitate updated decisions.

In OECD countries, with an already-existing comprehensive infrastructure as well as a dense framework of technological, social, and ecological standards, the differentiated requirement profiles for road construction projects are demanding. The questions posed to a master plan development processes are correspondingly complex. Requirements placed on the decision-making process include fairness, transparency, reliability, and robustness. Besides budgetary considerations, the state road administration is challenged to assure that all technical standards will be met in the upcoming planning period and the fixed asset erosion will be prevented. Moreover, transport policy goals – such as a balanced regional development and the reduction of external costs of transport – shall be pursued. A realistic impact assessment and monetization, honest cost and implementation time estimates, and the correct combination in cost-benefit analysis (CBA) – proving a project's net economic worth to the society, are key elements for the successful delivery. The international view documents well developed transport infrastructure planning and appraisal practices in this regard (Hull, 2004; May, 1995; Mackie and Worsley, 2013; Douglas and Brooker, 2013). The CBA is generally acknowledged as the most decisive, most sophisticated, and most standardized step. Nonetheless, with budget interdependencies and technical incompatibilities in mind, a positive present value is a necessary, but not sufficient condition (Blauwens et al., 2012).

1.2. Overview of current practice in Germany

The context specific to Germany, a country with a total road transport performance continuing to rise, is marked by

- a functional network classification, mostly adjusted to the tiered responsibilities and inter-authority financial relations
- resource-consuming pre-planning stages and a broad political consensus-building process
- coordination needs of quantity structures modeled, i.e. transport demand scenarios and implicit network master planning
- the high level of commitment of CBAs as legally binding decision/prioritization criterion of proposed projects
- an all-embracing CBA scheme (Gühnemann, 2013), requiring an interdisciplinary, as of 2015 even network-wide assessment of impacts
- master plans with heterogeneous project proposal portfolios in terms of the administration submitting, the project type, scope, and geographic location
- transport mode specific budgeting on the one hand, and consideration of inter-network dependencies on the other
- austerity policies and other preconditions delimiting a proposal's

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chance of being realized − leading to a backlog of projects ready-to-implement, further aggravating the rivalry for scarce investment resources at all administrative tiers.

Note that the revised CBA scheme of Germany's DoT (BMVDI, Federal Ministry of Transport and Digital Infrastructure) is an essential part of the System of Federal Transport Infrastructure Planning (BVWP) of horizon 2030–serves as a guideline for project appraisals at state and regional levels, too. In contrast to the former standard cost valuation approach, the scheme of 2015 uses a Marshallian welfare function with an underlying preference system, expressed by the social groups' willingness to pay for private benefits and public goods.

The revolving workflow of road network development, subdivided into the provision of foundations, the (de-central) project identification by planning bodies, the project appraisal, and the scheduling of approved projects, is depicted in Fig. 1.

Technical standards, the functional classification of network sections mapped to the federal structure's tiers of responsibility, and overarching proactive/reactive transport political goals as well as the project funding options form the statutory framework.

The planning process is initiated by a deficiency analysis of the previous network status under a "business as usual" scenario, i.e., the given maintenance work schedule. If justifiable by a catalogue of requirements, critical road sections revealed will be transformed into improvement measures, then specified as project proposals. In parallel, further projects may be nominated intuitively or from the backlog of unrealized ready-to-implement projects. This step is followed by the assessment of most likely project demand response and predicted cost differences, the cost-benefit appraisal, a subsequent prioritization, scheduling, clearance, construction and operation. The process concludes with a strategic construction schedule.

Thus, a project proposal can only 'survive' until implementation, if it successfully passes the entire chain of filtering stages of project identification, project appraisal, and project scheduling. Whether and to what extent the procedure allows to realize the preconceived benefits at the end does not only depend on the action needs of the infrastructure status and the legal/political framework.

Compared to the concisely detailed CBA, the other 'filtering stages' generally provide a disproportionate degree of clarity – despite of their criticality for the outcome in the light of distinct rivalry between project proposals – and/or do not necessarily reflects the compromise between different stakeholders or social groups.

With regards to the reality of planning procedures, this raises the non-trivial question of how the decision rules de facto/ideally interact in the interest of the transport policy goals, observing the boundary conditions set by civil engineering and capital budgeting. The *meta*-level problem of guiding the process stakeholders to successfully capture the decision leeway in allocating road construction funds – from regular maintenance to new constructions – sets the scene for this paper: The assurance of consistency among the development steps as well as between the steps and the conditioning policy goals, standards, and requirements in road network master planning.

1.3. Research problems, paper objectives and organization

The overarching research problem is the possibility of goal conflicts (i.e. inconsistencies) arising *between*, not just *within* the de-central decision-making steps, such as project identification and CBA, possibly leading to a lack of efficiency of both the planning process (=wasted resources for improvement measured without imminent chances being implemented) and the final outcome (=a globally sub-optimal portfolio of projects). A constraint-consistent approach is considered as way of avoiding or at least mitigating such consequences. In particular, the aim of research underlying this article is to

- investigate consistency issues by embracing real-world road network planning processes
- use new evidence from a case study based on a complex planning project on federal state level in Germany
- systematize the notion of consistency in the context of road transport infrastructural planning steps
- point to consistency needs and to detect the types of inconsistencies occurring so far
- explore the technological options of delivering consistency and the opportunity space of projects throughout the strategic and operative road network planning, also acknowledging the limitation on resources
- provide a mathematical representation of an arc-consistent network of planning items
- identify useful approaches and further research needs to effectively manage consistency.

The remaining article is organized as follows:

Section 2 lays the foundations with a definition of consistency, a review of the current planning methodology and arising consistency issues as-is-situation descriptions of the as- situation, and solution approaches, as provided by the related literature.

Section 3 summarizes the recent study of the State Road Master Plan (acronym: *LStrBPl*) of the German Federal State of Thuringia. This multi-year project, conducted in cooperation with research partners and engineering firms, was chosen to gain practical experiences with increased emphasis on the assertion of consistency. Technical details illustrate the dimensions, resulting computational effort of a systematized approach, and also reveal the mutual influences between the process of deriving road construction projects from requirement analyses, the subsequent shortlisting, CBA, and investment staging.

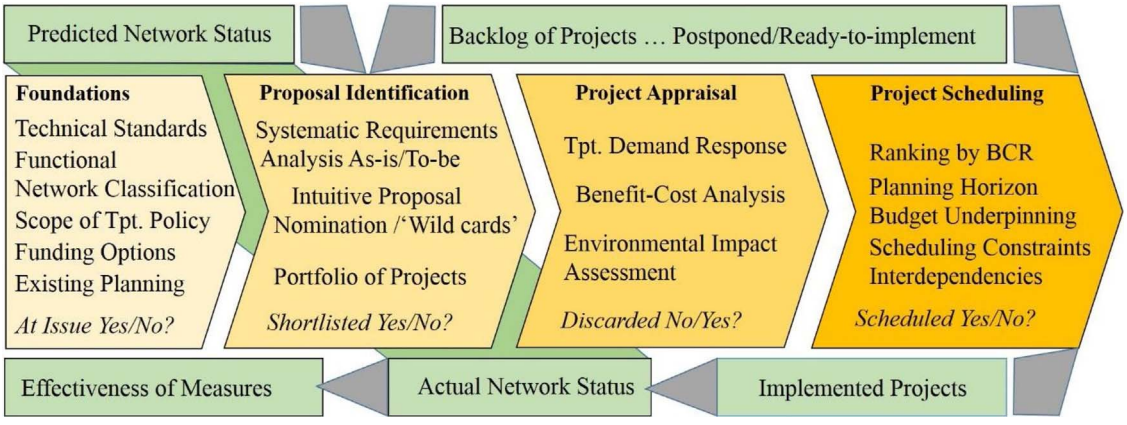

Fig. 1. Framework of Road Network Development and Emerging Consistency Issues (Source: Own Representation).