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REVIEW OF A HABILITATION THESIS

Thesis title: Determining the value of information as a tool for prioritizing the diagnosis of road network sections (Slovak: Stanovenie hodnoty informácie ako nástroj určovania priorít diagnostiky úsekov cestnej siete)

Author: Ing. Štefan Šedivý, PhD.,
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1. Relevance of the Chosen Scientific Topic

The selected scientific topic is highly relevant from both theoretical and applied perspectives, addressing the continuing need to improve road infrastructure management under long-term budgetary constraints. The habilitation thesis contributes new knowledge supporting the objectification of decision-making processes in road asset management systems.

The research focuses on an information-driven optimization model for identifying road sections where diagnostic activities provide the highest informational benefit, while respecting budgetary limitations and minimum inspection requirements. The author addresses the frequent subjectivity and inefficient use of data in engineering practice by promoting transparent, data-driven and analytically justified decision-making.

The importance of the topic is underscored by the essential role of accurate and timely road condition data in modern asset management, maintenance optimization and effective use of public funds. The scientific relevance is strengthened by the interdisciplinary integration of technical diagnostics with the economic concept of information value and multi-criteria optimization under uncertainty. Diagnostics is thus redefined as a measurable decision-making asset rather than a purely technical or cost-related activity.

Given the international relevance of information-driven asset management and optimization methods, the thematic focus of the thesis clearly exceeds a national context and can be regarded as highly relevant, socially necessary and promising for further research and practice.

2. Methods Applied in the Habilitation Thesis

The habilitation thesis applies a coherent set of theoretical, analytical and optimization methods consistent with standard scientific procedures. The research process includes problem identification, systematic literature review, formulation of theoretical foundations, model development, verification and interpretation of results.

An extensive review of scientific and professional sources enabled the identification of research gaps in current diagnostic prioritization practices. The analytical framework builds on uncertainty modelling and the expected value of information, with Jensen–Shannon divergence applied as an innovative probabilistic measure of informational benefit.

The core methodological contribution is an optimization model based on combinatorial optimization in the form of a knapsack problem, enabling the selection of road sections that maximize informational benefit under technical and budgetary constraints. The experimental procedure consists of data selection, computational modelling and prioritization of diagnostic activities. The applied methods are appropriate and well matched to the research problem.

3. Achieved Results and Novel Contributions of the Habilitation Thesis

The principal result of the thesis is an original methodological and optimization framework for prioritizing diagnostics of road network sections under operational and financial constraints. The author demonstrates that road diagnostics should be regarded not only as a technical assessment tool, but as a decision-support asset with measurable informational value.

A further contribution lies in the integration of information value theory, multi-criteria decision-making and optimization algorithms into a unified analytical framework. The methodology shifts the focus from maximizing diagnostic coverage to targeting sections where obtained information has the greatest value for subsequent decision-making.

Experimental verification confirms the practical applicability of the proposed model and extends modern asset management approaches by incorporating explicit quantification of information value. The results provide a solid foundation for further development, particularly in dynamic modelling and integration with digital asset management systems.

Contribution to the Advancement of Science and Technology

The thesis makes a significant contribution by transforming traditional road diagnostics into an information-oriented, analytically grounded decision-making process. The introduction of metrics based on expected information value and Jensen–Shannon divergence enables mathematical quantification of diagnostic benefits and their use as objective decision criteria.

This methodological foundation supports the development of advanced decision-support tools and expert systems and aligns with global trends in intelligent and digitalized infrastructure management.

4. Comments and Observations on the Habilitation Thesis

The habilitation thesis is professionally relevant, methodologically sound and valuable for further research in road infrastructure management. Its main strength is the original integration of information valuation, uncertainty modelling, multi-criteria decision-making and optimization within a single functional framework.

Model verification is limited to selected Class I–III road sections in the districts of Bytča and Žilina, justified by their representativeness. Broader territorial validation would further strengthen follow-up research, a limitation acknowledged by the author.

Further refinement could focus on sensitivity analyses with respect to weighting factors, diagnostic costs and segmentation strategies. These remarks are developmental in nature and do not reduce the scientific value of the thesis, which opens a new research direction and provides a strong basis for further methodological and empirical extension.

5. Questions Related to the Subject Matter

• What do you consider the principal scientific contribution of this habilitation thesis compared to existing approaches to prioritizing road diagnostics?

• How could the proposed model be integrated into current road management systems, and would this require changes in data collection or data management structures?

• Which research direction would you consider most important for the further development of this work?

6. Achievement of the Objectives of the Habilitation Thesis

Based on a detailed evaluation, all objectives of the habilitation thesis were fully achieved. The primary goal of developing an objective mechanism for prioritizing road diagnostics was met through the proposed information-driven model.

The successful integration of theoretical foundations with practical application represents a meaningful methodological extension to traditional road management systems and is consistent with contemporary asset management principles. Research questions were clearly answered and hypotheses satisfactorily verified, as summarized in Chapter 6.1.

7. Overall Evaluation and Concluding Remarks

Overall, the habilitation thesis is thematically current, methodologically rigorous and scientifically valuable. It addresses a highly relevant problem in road infrastructure management, focusing on objective decision-making, efficient allocation of limited resources and reduction of uncertainty.

The author proposes original solution methods rather than merely extending existing approaches, giving the work the character of a genuine scientific contribution. The thesis is well structured, concise and consistent with its stated objectives.

Final comment:

The submitted habilitation thesis demonstrates the author's scientific maturity and ability to provide innovative and systemic solutions for the modernization of transport infrastructure management. It meets all requirements for a habilitation thesis in the field of construction and is fully recommended for presentation.

Reviewer

Elżbieta Radziszewska-Zielina