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# Quantitative Assessment of Intelligent Transport Systems for Road Freight Transport

Gideon Mbiydzenyuy

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**Blekinge Institute of Technology**
School of Computing
Blekinge Institute of Technology
SE-374 24 Karlshamn, Sweden

Handledare:
Paul Davidsson, Professor, Sektionen för datavetenskap och kommunikation, BTH, Sverige
Jan A. Persson, Docent, Sektionen för datavetenskap och kommunikation, BTH, Sverige

Fakultetsopponent:
Professor Khaled El-Araby, Ain Shams University, Cairo, Egypt
Betygsnämnd:
Dr. Susan Grant-Muller, University of Leeds, United Kingdom
Prof. Risto Kulmala, Finnish Transport Agency, Finland
Dr. Clas Rydergren, Linköping University, Sweden

## Abstract

In this thesis, methods for using computer-based models as support tools for assessing Transport Telematic Services (TTSs) are studied. Such assessments provide one way to understand how TTSs can address problems caused by transportation, such as accidents, emissions, and energy consumption. TTSs are services based on telematic systems which are Intelligent Transport Systems (ITS) involving the integrated use of information and communication technologies in transport. The focus is on TTSs that are relevant for road freight transport, even though the suggested methods can easily be adapted for TTSs in other areas. We characterize TTSs, e.g., in terms of their functionalities, and apply computer-based modeling for pre-deployment assessment of various TTSs (from an ex-ante perspective). By analyzing information provided by the suggested computer-based models, it is possible to make an informed decision whether to (or not to) deploy a given TTS.

A review of previous studies reveals information about relevant TTSs for freight transport in areas such as driver support, administration, safety, traffic management, parking, and goods handling. A hierarchical clustering algorithm and a k-minimum spanning tree algorithm were employed to analyze synergies of TTSs. Synergies can enable identification of sets of TTSs that can lead to cost savings if deployed on a common platform (cf. Multi-Service Architectures). An analytical model inspired by the net present value concept is used to estimate quantified societal benefits of TTSs. An optimization model is formulated and solved using a branch and bound method to determine an optimal combination of TTSs taking into consideration societal benefits, costs, dependencies, and synergies. The optimization model also addresses possible system architectures for achieving multiple TTSs. Dominance rough set approach is used to assess and compare benefit areas for TTSs specific to truck parking. The benefit areas are suggested with the help of conceptual modeling, which describes functional models of a system in terms of states, transitions among states, and actions performed in states.

The main scientific contributions of the thesis are in suggesting new quantitative models, extending and applying existing models in the assessments of TTSs, and obtaining results that can help decision-makers select TTSs for medium-to long-term investments. Researchers can employ and build on the proposed methods when addressing different scenarios (geographic or organizational) involving similar TTSs. By studying a range of TTSs and possible Multi-Service Architecture concepts for such TTSs, the thesis contributes to achieving convergence of TTSs in a Multi-Service Architecture environment that will improve cost efficiency, minimize redundancies, and encourage the establishment of standards in the deployment of TTSs in road freight transport. TTSs implemented in such an environment can contribute to optimizing available capacity, accuracy, speed, and efficiency of road freight transport systems.

**Keywords**
Transport Telematic Services, Assessment, Freight Transport, Quantitative, Modeling, Decision Support Systems.