Public transportation is recognized as a crucial backbone for sustainable urban development since it enhances mobility by providing infrastructure and services for the efficient movement of people. The primary focus of this thesis is on improving the efficiency of bus services from the perspective of transport companies. Maintenance and fuel consumption of buses and the wages paid to bus drivers are the main factors that contribute to the total operational cost. In particular, the cost of the crew is approximately 60% of the total operational cost. Transport companies are challenged to create cost-effective vehicle and crew schedules for cities with large-scale transport systems. Several practical conditions such as the infrastructure properties and labor regulations that govern the working conditions of bus drivers have to be considered during the operational planning process. The transport companies are also affected by the initiatives taken by the European Union to reduce greenhouse gas emissions.

Providing a bus service involves solving several planning problems such as line planning, timetabling, vehicle scheduling and crew scheduling. These problems are traditionally solved sequentially. However, in recent years, there has been growing research on integrating two or more problems. This thesis studies the impact of integrating the vehicle and crew scheduling problems. Simultaneously handling the vehicle and crew scheduling aspects could potentially improve the operational efficiency of transport systems.

This thesis aims to develop optimization algorithms based on operations research (OR) methods that minimize the total operational cost while handling all practical complexities of a large-scale transport system. One practical complexity that is incorporated in this thesis is the use of staff car by bus drivers. A staff
car is a company-owned car that is used to increase flexibility when scheduling bus drivers. In most cases, staff cars are necessary for transport companies to find a feasible crew schedule. This thesis also incorporates the limited driving range and recharging requirements of electric buses. An integrated approach is proposed that solves the electric vehicle and crew scheduling problems simultaneously. Real-world instances from several Northern European transport companies were obtained to test the developed optimization algorithms. The integrated approach decreases the total operational cost by 1.17-4.37% on average when compared to the traditional sequential approach.

This thesis is carried out in collaboration with industrial partner QAMPO ApS to incorporate the developed algorithms in a decision support system that aids transport companies in implementing cost-effective vehicle and crew schedules. Therefore, this study aims to create a significant positive impact on the transport industry and also adds value to the current state-of-the-art knowledge on utilizing OR-based methods for integrated transport planning problems.