Publications:

A matheuristic for transfer synchronization through integrated timetabling and vehicle scheduling

Long transfer times often add unnecessary inconvenience to journeys in public transport systems. Synchronizing relevant arrival and departure times through small timetable modifications could reduce excess transfer times, but may also directly affect the operational costs, as the timetable defines the set of feasible vehicle schedules. Therefore better results in terms of passenger service, operational costs, or both, could be obtained by solving these problems simultaneously.

General information
State: Published
Organisations: Department of Management Engineering, Management Science, Operations Management, Transport DTU
Authors: Fonseca, J. P. (Intern), van der Hurk, E. (Intern), Roberti, R. (Ekstern), Larsen, A. (Intern)
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Electric bus fleet size and mix problem with optimization of charging infrastructure

Battery electric buses are seen as a well-suited technology for the electrification of road-based public transport. However, the transition process from conventional diesel to electric buses faces major hurdles caused by range limitations and required charging times of battery buses. This work addresses these constraints and provides a methodology for the cost-optimized planning of depot charging battery bus fleets and their corresponding charging infrastructure. The defined problem covers the scheduling of battery buses, the fleet composition, and the optimization of charging infrastructure in a joint process. Vehicle schedule adjustments are monetized and evaluated together with the investment and operational costs of the bus system. The resulting total cost of ownership enables a comparison of technical alternatives on a system level, which makes this approach especially promising for feasibility studies comprising a wide range of technical concepts. Two scenarios of European cities are analyzed and discussed in a case study, revealing that the cost structure is influenced significantly by the considered bus type and its technical specifications. For example, the total energy consumption of the considered lightweight bus is up to 32% lower than the total consumption of the high range bus, although the deadheading mileage increases. However, the total costs of ownership for operating both bus types are relatively close, due to the increased fleet size and driver expenses required for the lightweight bus system. The case study furthermore reveals that a mixed fleet of different bus types could be advantageous depending on the operational characteristics of the bus route.
A matheuristic approach for solving the Integrated Timetabling and Vehicle Scheduling Problem

The Integrated Timetabling and Vehicle Scheduling Problem (IT-VSP) is a generalization of the well-known Vehicle Scheduling Problem (VSP). In the IT-VSP the trips in the original timetables may be modified in terms of arrival and departure times in order to minimize a new objective function that considers both operational costs and passenger transfer costs. Starting from a base timetable, the allowed modifications include shifting the departure time from the first station of each trip and also the extension of dwell times at important stops where large flows of passengers are expected to transfer between different trips. We consider transfers between bus trips scheduled by the model, but also transfers to other fixed lines that intersect the lines considered in the IT-VSP. We present a MIP formulation of the IT-VSP able to solve small instances of the problem, and a matheuristic approach that uses the compact MIP to solve larger instances of the problem. The idea is to iteratively solve restricted versions of the MIP selecting at each step a subset of trips where modifications are allowed, while all other trips remain fixed. The performance of the proposed matheuristic is shown on a case study with real-life instances provided by the main service provider in the greater Copenhagen area. The effect of allowing dwell times is compared to previous approaches to the problem where trips are only allowed to be shifted in time.
support for the planning of the railway infrastructure maintenance activities at the strategic planning level. The objective is to achieve better economy, as well as improve cost efficiency.

F-PBPA consists of five main phases: Data Collection, Technical Optimization (TeO), Economic Optimization (EcO), Constrained Optimization (CoO), and Evaluation. In this thesis, two railway planning problems are formulated in Mixed Integer Linear Programming: Railway Preventive Condition-Based Tamping Scheduling Problem (RPCBTSP), which is presented in Papers 1-2, and Railway Track Possession Scheduling Problem (RTPSP), which is presented in Paper 3. The proposed models tested based on the real data collected from two Danish railway corridors. A comparison of the results obtained by using the proposed PDSS with the result obtained from the literature (RPCBTSP) and the current practice (RTPSP), shows a cost reduction for both scheduling problems.

The proposed PDSS (F-PBPA) represents a step forward in solving railway scheduling problems. It can help Infrastructure Managers (IMs) gain a better understanding of the application of optimization in railway planning tasks. There are three optimization phases, TeO, EcO and CoO, that can be performed in sequence. First carries out a technical optimization (EcO), in which the minimal maintenance work can be identified by pure technical conditions. This is followed by an economic optimization (EcO), which results in an economic plan covering the same technically defined maintenance needs while minimizing the costs. Finally, constrained optimization (CoO) includes additional constraints and it allows the railway expert to adjust input parameters, thereby to obtain alternative maintenance plans.

PO-PBPA contains another systematic phase-based process. With a focus on Life Cycle Cost (LCC), PO-PBPA can guide IMs, step by step, to estimate the total project cost for railway projects and to identify the solutions that are economically advantageous. Paper 4 suggests a new LCC framework for IMs to consider costs at the strategic planning level, and Paper 5 considers costs at the project planning level. The case studies show that LCC has influence on the decisions regarding the choice of the track possessions. Similarly, it appears that decisions may change compared to today's practice if other LCC elements are included into the cost estimation, e.g., passenger loss due to delay. A phase-based process such as the proposed PDSS, has great potential to support railway IMs to improve maintenance planning in practice, and reduce the overall costs without affecting railway infrastructure quality.

General information
State: Published
Organisations: Department of Management Engineering, Operations Management, Management Science, Transport DTU, Rambøll Danmark A/S
Authors: Li, R. (Intern), Larsen, A. (Intern), Salling, K. B. (Intern), Landex, A. (Intern), Madsen, S. N. (Ekstern)
Number of pages: 150
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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
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Projects:
Phase-based Planning for Railway Infrastructure Projects
Publication: Research › Ph.D. thesis – Annual report year: 2018

The multi-port berth allocation problem with speed optimization and emission considerations
The container shipping industry faces many interrelated challenges and opportunities, as its role in the global trading system has become increasingly important over the last decades. On the one side, collaboration between port terminals and shipping liners can lead to costs savings and help achieve a sustainable supply chain, and on the other side, the optimization of operations and sailing times leads to reductions in bunker consumption and, thus, to fuel cost and air emissions reductions. To that effect, there is an increasing need to address the integration opportunities and environmental issues related to container shipping through optimization. This paper focuses on the well known Berth Allocation Problem (BAP), an optimization problem assigning berthing times and positions to vessels in container terminals. We introduce a novel mathematical formulation that extends the classical BAP to cover multiple ports in a shipping network under the assumption of strong cooperation between shipping lines and terminals. Speed is optimized on all sailing legs between ports, demonstrating the effect of speed optimization in reducing the total time of the operation, as well as total fuel consumption and emissions. Furthermore, the model implementation shows that an accurate speed discretization can result in far better economic and environmental results.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Management Science, Operations Management, Transport DTU, Liverpool John Moores University
Exact and Heuristic Methods for Integrated Container Terminal Problems

**General information**
State: Published
Organisations: Department of Management Engineering, Management Science, Operations Management, Transport DTU, Operations Research
Authors: Iris, C. (Intern), Larsen, A. (Intern), Røpke, S. (Intern), Pacino, D. (Intern)
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Publication date: May 2016

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An adaptive large neighborhood search heuristic for the Electric Vehicle Scheduling Problem
This paper addresses the Electric Vehicle Scheduling Problem (E-VSP), in which a set of timetabled bus trips, each starting from and ending at specific locations and at specific times, should be carried out by a set of electric buses or vehicles based at a number of depots with limited driving ranges. The electric vehicles are allowed to be recharged fully or partially at any of the given recharging stations. The objective is to firstly minimize the number of vehicles needed to cover all the timetabled trips, and secondly to minimize the total traveling distance, which is equivalent to minimizing the total deadheading distance. A mixed integer programming formulation as well as an Adaptive Large Neighborhood Search (ALNS) heuristic for the E-VSP are presented. ALNS is tested on newly generated E-VSP benchmark instances. Result shows that the proposed heuristic can provide good solutions to large E-VSP instances and optimal or near-optimal solutions to small E-VSP instances.

**General information**
State: Published
Organisations: Department of Transport, Department of Management Engineering, Management Science, Transport optimisation and technique, Xi'an Jiaotong–Liverpool University, Arizona State University
Authors: Wen, M. (Ekstern), Linde, E. (Intern), Røpke, S. (Intern), Mirchandani, P. (Ekstern), Larsen, A. (Intern)
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Scopus rating (2014): SJR 2.225 SNIP 2.309 CiteScore 3.12
Web of Science (2014): Indexed yes
Green corridors in freight logistics

The subject of this thesis is ‘green corridors,’ a European concept denoting a concentration of freight traffic between major hubs and by relatively long distances. Since their inception in 2007, green corridors have gained popularity as a policy tool that enhances the overall environmental sustainability of transport through improving the competitiveness of the railway and waterborne modes that exhibit better environmental characteristics than road haulage.

The thesis has three objectives, all related to green corridors. The first one aims to develop a methodology for the quantitative monitoring of the performance of a green corridor in terms of pre-specified Key Performance Indicators (KPIs). The thesis builds on previous own work under the EUfinanced SuperGreen project and applies the new methodology on the GreCOR corridor extending from Oslo to Rotterdam. The scope of the two other objectives relates to environmental indicators viewed in the context of maritime corridors. The second objective seeks to develop a simple and practical framework for classifying the carbon emission reduction measures that have been proposed for the shipping industry, while the third one examines the impacts on modal split and emissions of designating the Mediterranean Sea as a Sulphur Emission Control Area (SECA), where stricter limits on the sulphur content of marine fuels apply.

In relation to the first objective, the thesis reviews the most important EU transport policy documents, discusses the available definitions of green corridors, identifies the characteristics that distinguish a green corridor from any other efficient corridor, and uses these characteristics as criteria to
investigate the relation between the so-called ‘core network corridors’ of the trans-European transport network and the green corridor concept. Once the rationale for a performance monitoring scheme has been established, the thesis critically reviews the SuperGreen methodology which consists of: (i) decomposing the corridor into transport chains, (ii) selecting a sample of typical chains, (iii) assessing these chains through a set of KPIs, and (iv) aggregating the chain-level KPIs to corridor-level ones using proper weights. Unlike SuperGreen that suggests a study-based approach for constructing the corridor sample, the thesis proposes founding the selection of typical chains on the outcome of specialised transport models. The periodic collection of stakeholder data on the selected ‘basket’ of transport services would then enable monitoring progress towards meeting the objectives that corridor management has set.

**General information**

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Organisations: Department of Management Engineering, Management Science, Transport DTU

Authors: Panagakos, G. (Intern), Psaraftis, H. N. (Intern), Larsen, A. (Intern)

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**The Simultaneous Vehicle Scheduling and Passenger Service Problem with Flexible Dwell Times**

In this talk, we deal with a generalization of the well-known Vehicle Scheduling Problem (VSP) that we call Simultaneous Vehicle Scheduling and Passenger Service Problem with Flexible Dwell Times (SVSPSP-FDT). The SVSPSP-FDT generalizes the VSP because the original timetables of the trips can be changed (i.e., shifted and stretched) in order to minimize a new objective function that aims at minimizing the operational costs plus the waiting times of the passengers at transfer points. Contrary to most generalizations of the VSP, the SVSPSP-FDT establishes the possibility of changing trips’ dwell times at important transfer points based on expected passenger flows. We introduce a compact mixed integer linear formulation of the SVSPSP-FDT able to address small instances. We also present a meta-heuristic approach to solve medium/large instances of the problem. The effectiveness of the proposed solution methods is shown on a set of real-life instances provided by the main bus operator on the greater Copenhagen area. The effects of considering exible dwell times on the objective function and on the provided solutions are also analysed.

**General information**

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Organisations: Department of Management Engineering, Management Science, Transport optimisation and technique, Department of Transport, Traffic modelling and planning

Authors: Fonseca, J. F. P. (Intern), Larsen, A. (Intern), van der Hurk, E. (Intern), Roberti, R. (Intern), Røpke, S. (Intern)

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Main Research Area: Technical/natural sciences

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Publication: Research › peer-review › Conference abstract for conference – Annual report year: 2016

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**Integrated Berth Allocation and Quay Crane Assignment Problem: Set partitioning models and computational results**

Most of the operational problems in container terminals are strongly interconnected. In this paper, we study the integrated Berth Allocation and Quay Crane Assignment Problem in seaport container terminals. We will extend the current state-of-the-art by proposing novel set partitioning models. To improve the performance of the set partitioning formulations, a number of variable reduction techniques are proposed. Furthermore, we analyze the effects of different discretization schemes and the impact of using a time-variant/invariant quay crane allocation policy. Computational experiments show that the proposed models significantly improve the benchmark solutions of the current state-of-art optimal approaches.

**General information**

State: Published

Organisations: Department of Transport, Transport optimisation and technique, Department of Management Engineering, Management Science
Transportens Innovationsnetværk og nye tiltag indenfor transportsektoren

General information
State: Published
Organisations: Department of Transport, Transport optimisation and technique, Sektionen for Trafik og Veje, Institut for Miljø- og Erhvervsøkonomi, Institut for Marketing & Management
Authors: Agerholm, N. (Forskerdatabase), Olsen, A. (Intern), Larsen, A. (Intern), Jepsen, L. B. (Forskerdatabase), Reppien Thomsen, L. (Ekstern), Knudsen, M. P. (Forskerdatabase)
Publication date: 2015
Hybrid Heuristic Approaches for Tactical Berth Allocation Problem
Tactical berth allocation problem deals with: the berth allocation (as- signs and schedules vessels to berth-positions), and the quay crane (QC) assignment (finds number of QCs that will serve). In this work, we strengthen the current mathematical models (MM) with novel lower bounds and valid inequalities. And, we propose a hybrid heuristic which combines MM with greedy and search heuristics. Results show that problem can be solved efficiently respect to optimality and computational time.

The Simultaneous Vehicle Scheduling and Passenger Service Problem
Passengers using public transport systems often experience waiting times when transferring between two scheduled services. In this paper we propose a planning approach that seeks to obtain a favourable trade-off between the two contrasting objectives, passenger service and operating cost, by modifying the timetable. The planning approach is referred to as the simultaneous vehicle scheduling and passenger service problem (SVSPSP). The SVSPSP is modelled as an integer programming problem and solved using a large neighborhood search metaheuristic. The proposed framework is tested on data inspired by the express-bus network in the Greater Copenhagen area. The results are encouraging and indicate a potential decrease of passenger transfer waiting times in the network of up to 20%, with the vehicle scheduling costs remaining mostly unaffected.
Timetabling, vehicle scheduling, large neighborhood search heuristics
Improved Models to Integrated Berth Allocation-Quay Crane Assignment Problem: A Computational Comparison and Novel Solution Approaches

Nowadays, over 60% of the world’s deep-sea cargo is being placed in containers and transported by ship via container terminals and seaports. Hence, the need for optimization in container terminal operations has become more and more important in recent years. The productivity of container terminals heavily relies on the efficiency of quay cranes operations, and the usage of the berthing area. Optimizing the allocation of ships to berth and the related assignment of cranes are important problems that are mostly covered as two separate cases in the literature. However, since the handling time of the vessels primarily depends on the number of containers to be handled and the number of cranes deployed, it would be beneficial to consider the integration of those two problems. This work extends the state-of-the-art by strengthening the current best mathematical formulation. Computational experiments are carried out to analyze the performance of the new formulation with respect to solution quality and execution time.

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Authors: Iris, C. (Intern), Pacino, D. (Intern), Repke, S. (Intern), Larsen, A. (Intern)
Number of pages: 3
Publication date: 2013
Main Research Area: Technical/natural sciences
Berth Allocation, Quay Crane Assignment, Valid Inequalities
Links:
Source: dtu
Source-ID: 254939
Publication: Research - peer-review › Journal article – Annual report year: 2013

Integrated Berth Allocation-Quay Crane Assignment Problem: Reformulations, Improved Constraints and Computational Results
Nowadays, large container terminals can process more than 30 million containers a year, and are constantly in search for the best ways to optimize processing time and deliver high quality, and profitable, services. Most of the operational problems on a container terminal are interconnected. The productivity of container terminals heavily relies on the efficiency of quay cranes operations, and the usage of the berthing area. Optimizing the allocation of ships to berth and the related assignment of cranes are important problems that are mostly covered as two separate cases in the literature. However, since the handling time of the vessels primarily depends on the number of containers to be handled and the number of cranes deployed, it would be beneficial to consider the integration of those two problems. In this work we extend the current state of the art by strengthening the current best formulation and by proposing novel set partitioning models. Finally, computational experiments are carried out to analyze the performances of the new formulations with respect to modeling capabilities, solution quality and execution time. Considerable amount of studies have been done on the berth allocation problem (BAP) and the quay crane assignment problem (QCAP). Such integrated problem is known in the literature ([1]) as the Berth Allocation and Crane Assignment Problem (BACP). The state-of-the-art [1] models this problem using two decision variables X_iz and Y_ij, representing respectively the partial order of the time and space dimension of the berth assignment, where i and j are two vessels. Moreover the variables r_iz define the number of cranes q to be assigned to vessel i at time t, and a set of auxiliary variables such as the vessel start time S_i. An optimal solution to the BACP minimizes a number of operational costs, such as the tardiness of the schedule, vessel speedup cost, and crane operation cost. The contribution of this work is twofold. First, we improve the model presented in [1] by proposing a number of valid inequalities. Second, we introduce a novel set partitioning formulation and present preliminary results. We propose an improved version of this model in the form of a set of valid inequalities aimed at improving the LP bound of the formulation. First we focus on the vessel start time. Increasing these bounds will, most likely, increase the lower bound obtained from LP relaxation since start-time variables S_i are integrated into objective function.

Inequality (1) is based on the following two observations. First, if vessel i berths before vessel j (X_iz=1), then the start time of vessel j (S_j) should be larger than the start time of vessel i plus its minimum expected processing time (m_jR_max_i). Second, the start time of j cannot be earlier than the earliest possible time of arrival (EST). Another inequality forces at most one kind of crane assignment plan for each of periods and vessels (2). The berthing time of vessel should be within the interval of minimum and maximum possible processing time (3). Finally, there cannot be any processing before the earliest arrival time of vessels (4). Preliminary results on the first 10 instances of the benchmark in [1] are presented in Table 1. The table compares the model from [1] and our improved version (BACAP+). It is observed that given the time
Table 1. CPLEX Results for BACAP+

<table>
<thead>
<tr>
<th>Ins.ZLB</th>
<th>Obtained LB</th>
<th>Integer Solution</th>
<th>Obtained GAP</th>
<th>CPU Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>184,184</td>
<td>0,00%</td>
<td>53,953.00</td>
<td>0,00%</td>
<td>560.81</td>
</tr>
<tr>
<td>253,953</td>
<td>0,00%</td>
<td>56,076.00</td>
<td>0,00%</td>
<td>314.23</td>
</tr>
<tr>
<td>377,475</td>
<td>22,93%</td>
<td>66,672.00</td>
<td>0,00%</td>
<td>987.35</td>
</tr>
<tr>
<td>476,275</td>
<td>80,52%</td>
<td>10,67%</td>
<td>0,00%</td>
<td>611.38</td>
</tr>
<tr>
<td>556,856</td>
<td>0,00%</td>
<td>56,856.00</td>
<td>0,00%</td>
<td>235.16</td>
</tr>
<tr>
<td>657,657</td>
<td>0,00%</td>
<td>57,657.00</td>
<td>0,00%</td>
<td>561.45</td>
</tr>
</tbody>
</table>

BACAP can also be formulated as Generalized Set Partitioning Problem (GSPP). The model is an extension of the BAP formulation in [2] where we add new set definitions and constraints that relate to the crane assignment. Here each column represents a feasible assignment plan for a vessel (that includes both crane allocation and berth assignment). Let the variable $\lambda_p \in \{0, 1\}$ be the selection of the assignment plans $p \in \omega$. The model minimizes the time dependent costs ($D_p$) and the crane assignment costs ($C_p$). Constraints ensure that each vessel is assigned to one plan, that at a given time $t$ and position $s$ at most one plan can be selected, and that at most one crane amount can be selected in a given plan with the knapsack constraint $\sum_{p \in \omega} D_p^t \lambda_p \leq Q$ $\forall t \in T$, where the number of cranes is captured by the parameter $Q$. The results shown in Table 2 are for fixed number of QC through stay at port.

Table 2. CPLEX Results for GSPP and [1]

<table>
<thead>
<tr>
<th>Ins.ZLB</th>
<th>Obtained LB</th>
<th>Integer Solution</th>
<th>Obtained GAP</th>
<th>CPU Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1X81</td>
<td>14,50%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>56,590.42</td>
</tr>
<tr>
<td>2X56,256</td>
<td>60,00%</td>
<td>56,256.00</td>
<td>0,00%</td>
<td>12,832,76</td>
</tr>
<tr>
<td>3X78,3</td>
<td>14,94%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>18,533,98</td>
</tr>
<tr>
<td>4X61,2</td>
<td>50,72%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>16,121,25</td>
</tr>
<tr>
<td>5X55,6</td>
<td>14,01%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>15,512,15</td>
</tr>
<tr>
<td>6X61,259</td>
<td>38,96%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>92,325,16</td>
</tr>
<tr>
<td>7X78,269</td>
<td>15,81%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>97,561,45</td>
</tr>
<tr>
<td>8X53,6</td>
<td>27,66%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>32,584,23</td>
</tr>
<tr>
<td>9X73,7</td>
<td>22,72%</td>
<td>120,00%</td>
<td>0,00%</td>
<td>56,562,3</td>
</tr>
</tbody>
</table>

Results show that model [1] is not capable to find an integer solution in most cases where number of QC is not changing through the stay of vessel at terminal. However, set partitioning formulation obtains optimum values in reasonable computational time.

General information

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Main Research Area: Technical/natural sciences
Links:
http://iwi.econ.uni-hamburg.de/iccl2013/program.html
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Optimiering af kollektiv transport

Routing of Electric Vehicles: Case Study of City Distribution in Copenhagen

In Copenhagen, Denmark, the preliminary steps of introducing an Urban Consolidation Centre (UCC) in the perimeter of the city centre has been taken. By implementing a UCC, interests of customers and distributors, as well as improvement of the local urban environment are sought considered [1]. The UCC service aims to consolidate urban freight, as well as implement additional aspects such as off-peak delivery and utilisation of alternatively fuelled vehicles.

In the specific case of Copenhagen, a comprehensive traffic survey was conducted in May 2011. The aim of the survey was to estimate freight magnitude and the distribution of goods in the old city centre. Based on the survey, analysis of possible UCC locations was carried out using simulation.

Distribution from the UCC is assumed to be conducted with electric vehicles (EVs) as they are considered suitable for the overall aim. However, compared to conventional distribution vehicles they have a limited driving range and a limited freight capacity. In this work, an Electric Vehicle Routing Problem with Time Windows (EVRPTW) is addressed. The EVs are allowed to recharge at certain customers or replenishment stations in order to continue a tour. Furthermore, intelligent location of these recharging points is considered. The objective is to find a least cost plan for routing and recharging the vehicles so that each customer is serviced by exactly one vehicle within its time windows and the vehicle capacity and driving range constraints are satisfied. The EVRPTW is a new problem that only has received little attention in the literature; see for example [2] and [3]. The costs are compared to distribution conducted by conventional vehicles. A heuristic method is developed and tested on the data generated on the basis of real-life collected data.

References

Routing of Electric Vehicles: City Distribution in Copenhagen

In this work, a Vehicle Routing Problem with Time Windows considering EV constraints of limited driving range and freight capacity is addressed (EVRPTW). The EVs are allowed to recharge at certain locations, and aspects of intelligent location of these recharging points are considered. The objective is to find the least cost plan for EV routing and compare this to conventional routing. A heuristic method is developed and tested on data based on real-life collected data on distribution vehicles in central Copenhagen, Denmark. The EVRPTW has so far received little attention in the literature.

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Organisations: Department of Transport, Transport optimisation and technique, Department of Management Engineering, Management Science
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Number of pages: 1
Publication date: 2013
Event: Abstract from 26th European Conference on Operational Research, Rome, Italy.
Main Research Area: Technical/natural sciences
Links: http://euro2013.org/
Source: dtu
Source-ID: u::9533

The waste collection vehicle routing problem with time windows in a city logistics context

Collection of waste is an important logistic activity within any city. In this paper we study how to collect waste in an efficient way. We study the Waste Collection Vehicle Routing Problem with Time Window which is concerned with finding cost optimal routes for garbage trucks such that all garbage bins are emptied and the waste is driven to disposal sites while respecting customer time windows and ensuring that drivers are given the breaks that the law requires. We propose an adaptive large neighborhood search algorithm for solving the problem and illustrate the usefulness of the algorithm by showing that the algorithm can improve the objective of a set of instances from the literature as well as for instances provided by a Danish garbage collection company.

General information
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Organisations: Department of Transport, Transport optimisation and technique
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Scopus rating (2014): SJR 0.156 SNIP 0.461
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.151 SNIP 0.408
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.222 SNIP 0.23
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.164 SNIP 0.162
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.142 SNIP 0.124
Original language: English
Waste collection, Vehicle routing, Reverse logistics, Optimisation, Case study
DOI: 10.1016/j.sbspro.2012.03.105
Solving a Vehicle Routing Problem with a non-linear load dependant cost function

General information
State: Published
Organisations: Department of Management Engineering, Operations Research, Department of Transport, Logistics & ITS
Authors: Spoorendonk, S. (Intern), Larsen, A. (Intern), Pisinger, D. (Intern), Røpke, S. (Intern)
Publication date: 2011
Main Research Area: Technical/natural sciences
Links:
http://www.uv.es/route2011/

Truende mangel på trafikplanlæggere og vejingeniører

General information
State: Published
Organisations: Logistics & ITS, Department of Transport, Section for Geotechnics and Geology, Department of Civil Engineering
Authors: Larsen, A. (Intern), Hansen, C. B. (Intern), Jørgensen, A. S. (Intern)
Pages: 18-21
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Trafik og Veje
Issue number: 8
ISSN (Print): 1903-7384
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
Original language: English
Links:
http://www.trafikogveje.dk/site/

Disruption Management - Foreword

General information
Disruption management in the airline industry—Concepts, models and methods

This paper provides a thorough review of the current state-of-the-art within airline disruption management of resources, including aircraft, crew, passenger and integrated recovery. An overview of model formulations of the aircraft and crew scheduling problems is presented in order to emphasize similarities between solution approaches applied to the planning and recovery problems. A brief overview of research within schedule robustness in airline scheduling is included in the review, since this proactive measure is a natural complement to disruption management.

General information
State: Published
Organisations: Operations Research, Department of Management Engineering, Logistics & ITS, Department of Transport
Authors: Clausen, J. (Intern), Larsen, A. (Intern), Larsen, J. (Intern), Rezanova, N. J. (Intern)
Pages: 809-821
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Computers & Operations Research
Volume: 37
Issue number: 5
ISSN (Print): 0305-0548
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.75 SJR 1.916 SNIP 2.094
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.77 SJR 2.299 SNIP 2.192
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.924 SNIP 2.048 CiteScore 3.09
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.225 SNIP 2.309 CiteScore 3.12
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.527 SNIP 2.93 CiteScore 3.62
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.727 SNIP 2.775 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.41 SNIP 2.449 CiteScore 3.05
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.316 SNIP 2.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.28 SNIP 2.389
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.199 SNIP 2.287
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.976 SNIP 2.523
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.157 SNIP 2.009
Scopus rating (2004): SJR 1.003 SNIP 1.706
Scopus rating (2003): SJR 1.058 SNIP 1.677
Scopus rating (2002): SJR 0.85 SNIP 1.441
Scopus rating (2001): SJR 1.069 SNIP 1.095
Scopus rating (2000): SJR 0.931 SNIP 0.878
Scopus rating (1999): SJR 0.862 SNIP 0.879
Original language: English
disruption management, network models, airline optimization, crew recovery, passenger recovery, integrated recovery, aircraft recovery
DOIs:
10.1016/j.cor.2009.03.027
Links:
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VC5-4W15KX6-2&_user=10&_coverDate=04%2F07%2F2009&_alid=928155809&_rdoc=4&_fmt=high&_orig=search&_cdi=5945&_sort=d&_docanchor=&view=c&_ct=44&_acct=C000050221&_version=1&_userid=10&md5=302788af6f52502e860927da355036b51
Source: orbit
Source-ID: 242560
Publication: Research - peer-review › Journal article – Annual report year: 2010

The Simultaneous Vehicle Scheduling and Passenger Service Problem

General information
State: Published
Organisations: Logistics & ITS, Department of Transport
Authors: Petersen, H. L. (Intern), Larsen, A. (Intern), Madsen, O. B. (Intern), Røpke, S. (Intern)
Publication date: 2010
Event: Abstract from Tristan VII : Triennial Symposium on Transportation Analysis, Tromsø, Norway, .
Main Research Area: Technical/natural sciences
Electronic versions:
abstract.pdf
Source: orbit
Source-ID: 264180
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

Intelligent Freight Transport Systems: Visions for real-time distribution planning
The Danish innovation project entitled “Intelligent Freight Transport Systems” aims at developing prototype systems integrating public intelligent transport systems (ITS) with the technology in vehicles and equipment as well as the IT-systems at various transport companies. The objective is to enhance the efficiency and lower the environmental impact in freight transport. In this paper, a pilot project involving real-time waste collection at a Danish waste collection company is described, and a solution approach is proposed. The problem corresponds to the dynamic version of the waste collection problem which can be formulated as a dynamic version of the vehicle routing problem with time windows (VRPTW).

General information
State: Published
Organisations: Department of Transport
Authors: Overø, H. M. (Intern), Larsen, A. (Intern), Røpke, S. (Intern)
Publication date: 2009
A Data Set for the Simultaneous Vehicle Scheduling and Passenger Service Problem

General information
State: Published
Organisations: Operations Research, Department of Management Engineering, Logistics & ITS, Department of Transport
Authors: Petersen, H. L. (Intern), Larsen, A. (Intern), Madsen, O. B. (Intern), Røpke, S. (Intern)
Publication date: 2008

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark, Transport
Edition: 1
Original language: English
Series: DTU Transport Technical Reports
Number: 2008-8
Main Research Area: Technical/natural sciences
vehicle scheduling, data set, passenger service
Source: orbit
Source-ID: 232361
Publication: Research › Report – Annual report year: 2008

Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

We present a Dynamic Airline Scheduling (DAS) technique which is able to change departure times and reassign aircraft types during the booking process to meet fluctuating passenger demands. The procedure is tested on several different days before departure, resulting in a significant profit increase for a major European airline. The results also indicate that applying DAS close to departure yields the largest potential.

General information
State: Published
Organisations: Department of Transport, Logistics & ITS, Jeppesen System AB, Scandinavian Airlines Sweden
Authors: Warburg, V. (Intern), Hansen, T. G. (Ekstern), Larsen, A. (Intern), Norman, H. (Ekstern), Andersson, E. (Ekstern)
Pages: 163-167
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Air Transport Management
Volume: 14
Issue number: 4
ISSN (Print): 0969-6997
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.373 SJR 0.981 CiteScore 2.38
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.101 SNIP 1.414 CiteScore 2.61
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.853 SNIP 1.074 CiteScore 1.41
Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

We present a Dynamic Airline Scheduling (DAS) technique which is able to change departure times and reassign aircraft types during the booking process to meet fluctuating passenger demands. The procedure is tested on several different days before departure, resulting in a significant profit increase for a major European airline. The results also indicate that applying DAS close to departure yields the largest potential.

General information
State: Published
Organisations: Department of Transport, Logistics & ITS, Scandinavian Airlines Sweden, Jeppesen System AB
Authors: Warburg, V. (Intern), Hansen, T. G. (Ekstern), Larsen, A. (Intern), Normann, H. (Ekstern), Andersson, E. (Ekstern)
Publication date: 2008
Recent developments in dynamic vehicle routing systems

General information
State: Published
Organisations: Logistics & ITS, Department of Transport, Northeastern University
Authors: Madsen, O. B. (Intern), Larsen, A. (Intern), Solomon, M. M. (Ekstern)
Number of pages: 590
Pages: 199-220
Publication date: 2008

Host publication information
Title of host publication: The Vehicle Routing Problem : Latest Advances and New Challenges
Volume: 43
Publisher: Springer
Editors: Golden, B., Raghavan, S., Wasil, E.
Edition: 1
ISBN (Print): 978-0-387-77777-1
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 232763
Publication: Research - peer-review › Book chapter – Annual report year: 2008

The Simultaneous Vehicle Scheduling and Passenger Service Problem

General information
State: Published
Organisations: Operations Research, Department of Management Engineering, Logistics & ITS, Department of Transport
Authors: Petersen, H. L. (Intern), Larsen, A. (Intern), Petersen, B. (Intern)
Publication date: 2008

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark, Transport
Edition: 1
Original language: English
Series: DTU Transport Technical Reports
Number: 2008-7
Main Research Area: Technical/natural sciences
vehicle scheduling, passenger service
Source: orbit
Source-ID: 232360
Publication: Research › Report – Annual report year: 2008

Airline Disruption Management - Perspectives, Experiences and Outlook
Over the past decade, airlines have become more concerned with developing an optimal flight schedule, with very little slack left to accommodate for any form of variation from the optimal solution. During operation the planned schedules often have to be revised due to disruptions caused by for example severe weather, technical problems and crew sickness. Thus, the field of Airline Disruption Management has emerged within the past few years. The increased focus on cutting cost at the major airlines has intensified the interest in the development of new and cost efficient methods to handle airline disruptions. The purpose of this paper is twofold. In the first part it offers an introduction to airline disruption management provides the readers with a description of the planning processes and delivers a detailed overview of the numerous aspects of airline disruption management. In the second part we report on experiences from a large research and development project on airline disruption management. Within the project the first prototype of a multiple resource decision support system at the operations control center in a major airline, has been implemented.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Logistics & ITS, Department of Transport, Operations Research, British Airways, Carmen System A.B.
Authors: Kohl, N. (Intern), Larsen, A. (Intern), Larsen, J. (Intern), Ross, A. (Ekstern), Tiourine, S. (Ekstern)
Publication information
Journal: Journal of Air Transport Management
Volume: 13
Issue number: 3
ISSN (Print): 0969-6997
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.373 SJR 0.981 CiteScore 2.38
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.101 SNIP 1.414 CiteScore 2.61
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.853 SNIP 1.074 CiteScore 1.41
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.801 SNIP 1.279 CiteScore 1.31
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.818 SNIP 1.035 CiteScore 1.22
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.89 SNIP 1.348 CiteScore 1.19
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.729 SNIP 1.39 CiteScore 1.35
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.905 SNIP 1.612
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.72 SNIP 1.38
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.707 SNIP 1.355
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.554 SNIP 0.919
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.573 SNIP 1.297
Scopus rating (2005): SJR 0.464 SNIP 1.279
Scopus rating (2004): SJR 0.54 SNIP 1.122
Scopus rating (2003): SJR 0.479 SNIP 0.808
Scopus rating (2002): SJR 0.334 SNIP 1.008
Scopus rating (2001): SJR 0.224 SNIP 0.475
Scopus rating (2000): SJR 0.273 SNIP 0.815
Scopus rating (1999): SJR 0.408 SNIP 0.355
Original language: English
airline operation, real-time decision support, irregular operations
DOIs:
10.1016/j.jairtraman.2007.01.001
Source: orbit
Source-ID: 159048
Publication: Research - peer-review › Journal article – Annual report year: 2007
Classification of Dynamic Vehicle Routing Systems

This chapter discusses important characteristics seen within dynamic vehicle routing problems. We discuss the differences between the traditional static vehicle routing problems and its dynamic counterparts. We give an in-depth introduction to the degree of dynamism measure which can be used to classify dynamic vehicle routing systems. Methods for evaluation of the performance of algorithms that solve on-line routing problems are discussed and we list some of the most important issues to include in the system objective. Finally, we provide a three-echelon classification of dynamic vehicle routing systems based on their degree of dynamism and the system objective.

Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

We present a Dynamic Airline Scheduling (DAS) technique which is able to change departure times and reassign aircraft types during the booking process to meet fluctuating passenger demands. The procedure is tested on several different days before departure, resulting in a significant profit increase for a major European airline. The results also indicate that applying DAS close to departure yields the largest potential.
Analysis and Comparison of Typical Models within Distribution Network Design
Efficient and cost effective transportation and logistics plays a vital role in the supply chains of the modern world’s manufacturers. Global distribution of goods is a very complicated matter as it involves many different distinct planning problems. The focus of this presentation is to demonstrate a number of important issues which have been identified when addressing the Distribution Network Design problem from a modelling angle. More specifically, we present an analysis of the research which has been performed in utilizing operational research in developing and optimising distribution systems.

General information
State: Published
Organisations: Traffic Modelling, Department of Transport, Logistics & ITS
Authors: Jørgensen, H. J. (Intern), Larsen, A. (Intern), Madsen, O. B. (Intern)
Number of pages: 4
Publication date: 2006
Main Research Area: Technical/natural sciences
Electronic versions:
SCM_paper_Odysseus_140306.pdf
Source: orbit
Source-ID: 195488
Publication: Research - peer-review › Paper – Annual report year: 2006

Analysis and Comparison of Typical Models within Distribution Network Design
This paper investigates the characteristics of typical optimisation models within Distribution Network Design. During the paper fourteen models known from the literature will be thoroughly analysed. Through this analysis a schematic approach to categorisation of distribution network design models on a tabular form is introduced. The analysis provides a framework for a categorisation of models based on their structure. The models which are analyzed cover both strategic as well as tactical planning issues, as the categorisation framework seeks to avoid making this distinction. The features which are covered in the categorisation include fixed vs. general networks, specialised vs. general nodes, linear vs. nonlinear costs, single vs. multi commodity, uncapacitated vs. capacitated activities, single vs. multi modal and static vs. dynamic. The models examined address both strategic and tactical planning issues but do include considerations on the operational level. The paper should prove to be useful to both theoretically well-founded and experienced readers as well as to inexperienced readers as it provides a broad but easy accessible literature survey. This also makes this paper ideal for educational purposes. Furthermore, the paper can be seen as a practical introduction to network design modelling as well as a being an art manual or recipe when constructing such a model.

General information
State: Published
Organisations: Department of Transport
Authors: Jørgensen, H. J. (Intern), Larsen, A. (Intern), Madsen, O. B. (Intern)
Publication date: 2006

Publication information
Publisher: Technical University of Denmark, Centre for Traffic and Transport
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 210400
Publication: Research › Report – Annual report year: 2006

Disruption Management in the Airline Industry - Concepts, Models and Methods

General information
State: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling
Authors: Clausen, J. (Intern), Larsen, A. (Intern), Larsen, J. (Intern)
Publication date: 2005

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
imm3763.pdf
Over the past decade, airlines have become more concerned with developing an optimal flight schedule, with very little slack left to accommodate for any form of variation from the optimal solution. During operation the planned schedules often have to be revised due to disruptions caused by for example severe weather, technical problems and crew sickness. Thus, the field of Airline Disruption Management has emerged within the past few years. The increased focus on cutting cost at the major airlines has intensified the interest in the development of new and cost efficient methods to handle airline disruptions. The purpose of this paper is twofold. In the first part it offers an introduction to airline disruption management, provides the readers with a description of the planning processes and delivers a detailed overview of the numerous aspects of airline disruption management. In the second part we report on experiences from a large research and development project on airline disruption management. Within the project the first prototype of a multiple resource decision support system at the operations control center in a major airline, has been implemented.
The A-priori Dynamic Traveling Salesman Problem with Time Windows

In this paper we examine the traveling salesman problem with time windows for various degrees of dynamism. In contrast to the static problem, where the dispatcher can plan ahead, in the dynamic version, part or all of the necessary information becomes available only during the day of operation. We seek to minimize lateness and examine the impact of this criterion choice on the distance traveled. Our focus on lateness is motivated by the problem faced by overnight mail service providers. We propose a real-time solution method that requires the vehicle, when idle, to wait at the current customer location until it can service another customer without being early. In addition, we develop several enhanced versions of this method that may reposition the vehicle at a location different from that of the current customer based on a priori information on future requests. The results we obtained on both randomly generated data and on a real-world case study indicate that all policies proved capable of significantly reducing lateness. Our results also show that this can be accomplished with only small distance increases. The basic policy outperformed the other methods primarily when lateness and distance were equally minimized and proved very robust in all environments studied. When only lateness was considered, the policy to reposition the vehicle at a location near the current customer generally provided the largest reductions in average lateness and the number of late customers. It also produced the least extra distance to be traveled among the relocation policies.

General information
State: Published
Organisations: Logistics & ITS, Department of Transport, Northeastern University
Authors: Larsen, A. (Intern), Madsen, O. B. (Intern), Solomon, M. M. (Ekstern)
Publication date: 2004
Main Research Area: Technical/natural sciences
Publishing information
Journal: Transportation Science
Volume: 38
Issue number: 4
ISSN (Print): 0041-1655
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.27 SJR 3.312 SNIP 2.56
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.69 SJR 2.564 SNIP 2.345
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.65 SNIP 2.532 CiteScore 3.9
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
The a-priory dynamic traveling salesman problem with time windows

General information
State: Published
Organisations: Logistics & ITS, Department of Transport, Department of Informatics and Mathematical Modeling, Northeastern University
Authors: Madsen, O. B. (Intern), Larsen, A. (Intern), Solomon, M. M. (Ekstern)
Pages: 459-472
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Transportation Science
Volume: 38
Issue number: 4
ISSN (Print): 0041-1655
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.27 SJR 3.312 SNIP 2.56
The A-priori Dynamic Traveling Salesman Problem with Time Windows

General information
State: Published
Organisations: Logistics & ITS, Department of Transport, Northeastern University
Authors: Larsen, A. (Intern), Madsen, O. G. (Intern), Solomon, M. (Ekstern)
Publication date: 2003

Publication information
Place of publication: Lyngby
Publisher: Center for Traffic and Transport, Technical University of Denmark
Original language: English
Partially dynamic vehicle routing - models and algorithms

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. (Intern), Solomon, M. (Ekstern)
Pages: 637-646
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the Operational Research Society
Volume: 53
Issue number: 6
Original language: English
Links:

Staff Scheduling within the Retail Business in Denmark

General information
State: Published
Authors: Leedgaard, J. (Ekstern), Mortensen, K. H. (Ekstern), Larsen, A. (Intern), Larsen, J. (Intern)
Publication date: 2002

Host publication information
Title of host publication: Proceedings of Nordic MPS 2002
Main Research Area: Technical/natural sciences
Conference: Nordic MPS ’02, Bergen, Norway, 01/01/2002
Links:

Bibliographical note
ISSN 0333-3590
Source: orbit
Source-ID: 58242
Publication: Research › Article in proceedings – Annual report year: 2002

Disruption management

General information
State: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling, Department of Transport
Authors: Clausen, J. (Intern), Hansen, J. (Intern), Larsen, J. (Intern), Larsen, A. (Intern)
Pages: 40-43
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: OR/MS Today
Volume: 28
Disruption management - operations research between planning and execution

General information
State: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling, Department of Transport
Authors: Clausen, J. (Intern), Larsen, J. (Intern), Larsen, A. (Intern), Hansen, J. (Intern)
Publication date: 2001

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
imm144.pdf
Links:
Source: orbit
Source-ID: 58014
Publication: Research › Report – Annual report year: 2001

The dynamic vehicle routing problem

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. (Intern)
Number of pages: 183
Publication date: Dec 2000

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: IMM-PHD
Number: 2000-73
Main Research Area: Technical/natural sciences
IMM-PHD-2000-73
Electronic versions:
imm143.pdf
Source: orbit
Source-ID: 274540
Publication: Research › Ph.D. thesis – Annual report year: 2000

Partially Dynamic Vehicle Routing-Models and Algorithms

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. G. (Intern), Solomon, M. M. (Ekstern)
Publication date: 1999
The A-Priori Dynamic Travelling Salesman Problem with Time Windows

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Northeastern University
Authors: Madsen, O. B. G. (Intern), Larsen, A. (Intern), Solomon, M. (Ekstern)
Number of pages: 25
Publication date: 1999

Dynamic Vehicle Routing - An Overview of Systems with Varying Degree of Dynamism

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Madsen, O. B. G. (Intern), Larsen, A. (Intern)
Publication date: 1998

Host publication information
Title of host publication: Proceeding of Tristan III
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172681
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Solving the multiple depot vehicle scheduling problem in a major Scandinavian city

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. G. (Intern)
Number of pages: 18
Publication date: 1997

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 168623
Publication: Research - peer-review › Report – Annual report year: 1997

Solving the multiple depot vehicle scheduling problem in a major Scandinavian city

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. G. (Intern)
An Evaluation of the Strategy for Calling in Vehicles for Inspection.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. G. (Intern), Rygaard, J. M. (Intern)
Number of pages: 40
Publication date: 1996

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 164791
Publication: Research - peer-review › Report – Annual report year: 1996

Computer based crew rostering (in Danish).

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Larsen, A. (Intern), Madsen, O. B. G. (Intern)
Publication date: 1996

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 164796
Publication: Research - peer-review › Report – Annual report year: 1996

Projects:

Electric Urban Freight And Logistics
Department of Management Engineering
Management Science
Transport DTU
Operations Research
Operations Management
MT Højgaard A/S
Region Hovedstaden
Period: 01/01/2018 → …
Number of participants: 5
Acronym: EUFAL
Project ID: 7064-00007B
Project participant:
Pacino, Dario (Intern)
Christensen, Jonas Mark (Intern)
Larsen, Allan (Intern)
Malladi, Satya Sarvani (Intern)
Barfod, Michael Bruhn (Intern)

**Project**

**Machine Learning and Mobility**
Department of Management Engineering
Period: 15/12/2015 → 14/12/2018
Number of participants: 3
Phd Student: Markou, Ioulia (Intern)
Supervisor: Larsen, Allan (Intern)
Main Supervisor: Pereira, Francisco Camara (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

**Optimization of operations in public transportation**
Department of Management Engineering
Period: 01/10/2015 → 30/11/2018
Number of participants: 4
Phd Student: Farina, Federico (Intern)
Supervisor: Larsen, Allan (Intern)
Main Supervisor: Røpke, Stefan (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

**Optimization of timetables in integrated public transport planning**
Department of Management Engineering
Period: 01/10/2015 → 30/09/2018
Number of participants: 4
Phd Student: Fonseca, Joao Filipe Paiva (Intern)
Supervisor: Roberti, Roberto (Intern)
Main Supervisor: Røpke, Stefan (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD
Cargo-mix optimisation
Department of Management Engineering
Period: 01/09/2014 → 01/02/2018
Number of participants: 6
Phd Student: Christensen, Jonas Mark (Intern)
Supervisor: Psaraftis, Harilaos N. (Intern)
Main Supervisor: Pacino, Dario (Intern)
Examiner: Larsen, Allan (Intern)
Alvarez-Valdés, Ramón (Ekstern)
Andersson, Henrik (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Green corridors in freight logistics
Department of Management Engineering
Number of participants: 6
Phd Student: Panagakos, George (Intern)
Supervisor: Larsen, Allan (Intern)
Main Supervisor: Psaraftis, Harilaos N. (Intern)
Examiner: Rich, Jeppe (Intern)
Cullinane, Kevin (Ekstern)
Ojala, Lauri (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Efficient Algorithms for integrated Container Terminal Activities
Department of Transport
Period: 01/02/2013 → 04/07/2016
Number of participants: 7
Phd Student: Iris, Cagatay (Intern)
Supervisor: Pacino, Dario (Intern)
Rapke, Stefan (Intern)
Main Supervisor: Larsen, Allan (Intern)
Examiner: Psaraftis, Harilaos N. (Intern)
Meisel, Frank (Ekstern)
Vis, Iris F. A. (Ekstern)

Financing sources
Source: Internal funding (public)
The Framework of phase-based planning of railway

Department of Management Engineering
Period: 15/01/2013 → 21/09/2017
Number of participants: 8
Phd Student:
Li, Rui (Intern)
Supervisor:
Landex, Alex (Intern)
Landex, Alex (Intern)
Salling, Kim Bang (Intern)
Main Supervisor:
Larsen, Allan (Intern)
Examiner:
Psaraftis, Harilaos N. (Intern)
Preston, John (Ekstern)
Vicencio, Alfredo Antonio Núñez (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

Relations
Publications:
Phase-based Planning for Railway Infrastructure Projects
Project: PhD

ConCoord
The project focuses on the important area of city logistics. It investigates an integrated urban freight simulation environment, a unique measurement framework for the environmental footprint of transport and logistics, and the performance measurement of new innovative urban transport and logistics concepts. Specifically dealing with the different and important considerations of new transportation solutions, new mechanisms for execution and control of city logistics, and research on the urban distribution of goods reducing urban freight movements and its impact on residents and the environment.

The fundamental idea is to stop considering each shipment, actor (e.g. shippers, Logistics Service Providers, etc.) and vehicle in isolation, but as components of an integrated logistics system to be optimized. The keywords are CONsolidation and COORDination (CONCOORD) of the urban distribution flows that are currently fragmented. CONCOORD involves key players in the urban transportation field, both from leading European universities and world-class Europe-based companies, who have expertise and experience in city distribution and who have the willingness to explore this issue for the benefit of all those in Europe.

Department of Transport

Transport optimisation and technique
Period: 01/01/2013 → 01/06/2016
Number of participants: 5
Acronym: ConCoord
Project participant:
Larsen, Rune (Intern)
Wen, Min (Intern)
Project Manager, organisational:
Olsen, Allan (Intern)
Project Manager, academic:
Psaraftis, Harilaos N. (Intern)
Project applicant:
Larsen, Allan (Intern)
Potential of Intelligent Electric Vehicles for Commercial Use

Department of Transport
Period: 15/12/2012 → 31/08/2014
Number of participants: 4
Phd Student:
Linde, Esben (Intern)
Supervisor:
Røpke, Stefan (Intern)
Wen, Min (Intern)
Main Supervisor:
Larsen, Allan (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Network Effects within Railway Networks

Department of Transport
Period: 01/10/2012 → 07/04/2016
Number of participants: 6
Phd Student:
Jensen, Lars Wittrup (Intern)
Supervisor:
Landex, Alex (Intern)
Main Supervisor:
Nielsen, Otto Anker (Intern)
Examiner:
Larsen, Allan (Intern)
Goverde, Rob M. P. (Ekstern)
Preston, John (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Green Corridor in the North Sea Region
GreCOR – Green Corridor in the North Sea Region – is an Interreg IVB North Sea Region project that started the 1st of January 2012. GreCOR will promote the development of a co-modal transport corridor in the North Sea Region. Important in this collaborative approach, is the focus on secondary networks and the hubs, and the regional hinterland around the Green transport corridor Oslo-Randstad from a co-modal perspective.

GreCOR has 14 partners and a total budget of 3.7 M€. It started the 1 January 2012 and will be finalized 31 December 2014. The Swedish Transport Administration is the responsible lead partner for GreCOR

GreCOR works in close collaboration with public and private stakeholders, and its overall aim is to improve knowledge about the logistic needs and conditions and develop and implement the first green corridor in the North Sea Region in a strategic policy setting.

The main idea of the project is to influence the green corridor consisting of infrastructure and transport development in the area. Furthermore, GreCOR aims to:
- Improve knowledge about the logistics needs and conditions in the corridor
- Test innovative logistics solutions through the development of pilot projects
- Promote the development of sustainable transport in the North Sea Region
- Focus on the role of the hubs and the regional hinterland
- Understand and develop the logistics utility creation in a green corridor taking a co-modal perspective.
- One very important tool for reaching the goals of corridor development is a liaison group to which we invite all relevant organizations, stakeholders and companies to join.
Department of Transport

Transport optimisation and technique
Period: 01/01/2012 → 31/12/2014
Number of participants: 4
Acronym: GreCOR
Project participant:
Farina, Federico (Intern)
Larsen, Rune (Intern)
Project Manager, academic:
Olsen, Allan (Intern)
Project applicant:
Larsen, Allan (Intern)

Disaggregate activity-based traffic assignment modelling
Department of Transport
Period: 01/05/2011 → 23/02/2015
Number of participants: 7
Phd Student:
Rasmussen, Thomas Kjær (Intern)
Supervisor:
Frederiksen, Rasmus Dyhr (Intern)
Prato, Carlo Giacomo (Intern)
Main Supervisor:
Nielsen, Otto Anker (Intern)
Examiner:
Larsen, Allan (Intern)
Bekhar, Shlomo (Ekstern)
Cantarella, Giulio Erberto (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Optimal Aircraft Gate Assignment on a Strategic, Tactical and Operational Level
Department of Management Engineering
Period: 01/10/2010 → 26/05/2014
Number of participants: 7
Phd Student:
Justesen, Tor Fog (Intern)
Supervisor:
Dohn, Anders Heeg (Intern)
Meincke, Dan (Ekstern)
Main Supervisor:
Larsen, Jesper (Intern)
Examiner:
Larsen, Allan (Intern)
Cohn, Amy Ellen Mainville (Ekstern)
Vaaben, Bo Valdemar (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD
Effekive løsningsmetoder til real-tids distributionssystemer

Department of Transport
Period: 01/05/2010 → 31/03/2011
Number of participants: 3
Phd Student:
Buhrkal, Katja Frederik (Intern)
Supervisor:
Røpke, Stefan (Intern)
Main Supervisor:
Larsen, Allan (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Sustainable Disruption Management

Department of Management Engineering
Period: 01/11/2009 → 04/04/2013
Number of participants: 7
Phd Student:
Vaaben, Bo Valdemar (Intern)
Supervisor:
Altus, Stephen (Ekstern)
Hansen, Jesper (Intern)
Main Supervisor:
Larsen, Jesper (Intern)
Examiner:
Larsen, Allan (Intern)
Cohn, Amy E. M. (Ekstern)
Granberg, Tobias A. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD

Cable Aerodynamic Control

Department of Civil Engineering
Period: 01/10/2009 → 27/08/2013
Number of participants: 6
Phd Student:
Kleissl, Kenneth (Intern)
Supervisor:
Koss, Holger (Intern)
Main Supervisor:
Georgakis, Christos T. (Intern)
Examiner:
Fischer, Gregor (Intern)
Larose, Guy (Intern)
Larsen, Allan (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD
Solving Recovery Problems using Optimisation Methods

Department of Management Engineering
Period: 01/05/2008 → 28/09/2011
Number of participants: 6
PhD Student:
Rasmussen, Matias Sevel (Intern)
Supervisor:
Ryan, David (Ekstern)
Main Supervisor:
Larsen, Jesper (Intern)
Examiner:
Larsen, Allan (Intern)
Gustafsson, Tomas (Ekstern)
Rönnqvist, Mikael (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Models and Algorithms for the Vehicle Routing Problem with Cross Docking

Department of Management Engineering
Period: 01/02/2006 → 24/03/2010
Number of participants: 6
PhD Student:
Wen, Min (Intern)
Supervisor:
Clausen, Jens (Intern)
Main Supervisor:
Larsen, Jesper (Intern)
Examiner:
Larsen, Allan (Intern)
Hasle, Geir (Ekstern)
Nielsen, Jakob Birkedal (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Simultaneous Optimisation of Operating Costs and Passenger Service in Public Transit

In the Greater Copenhagen area approximately 200,000 hours are lost every day when passengers are waiting for a connecting bus or train. Hence, an enormous socio-economic potential lies within the development of new methods that
can be used to generate timetables which have better temporal correspondences. Naturally, this can be achieved by assigning more resources to cover the timetables. However, the public transit companies are faced with administrative claims for cutting operating costs which renders improvements of the service intractable. Hence, efficient and near-optimal use of the resources is of paramount importance for the public transit companies.

The project addresses the multiple objective planning problem of generating timetables that on the one side is economically feasible for the transport companies and on the other hand also offers high-quality service to the passengers by minimising the unproductive time spent on waiting between one or more shifts.

Department of Transport
Period: 01/09/2005 → 31/05/2008
Number of participants: 4
Project participant:
Larsen, Allan (Intern)
Pedersen, Michael Berliner (Intern)
Petersen, Bjørn (Intern)
Project Manager, organisational:
Madsen, Oli B.G. (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Forskningsrådene - Andre
Amount: 840,000.00 Danish Kroner

Traffic Plan for Greenland: Decision Support Tool TGB
Department of Transport
Period: 06/06/2005 → 31/12/2005
Number of participants: 8
Acronym: TGB
Project ID: 35105
Project participant:
Jensen, Anders Vestergaard (Intern)
Salling, Kim Bang (Intern)
Nielsen, Otto Anker (Intern)
Hansen, Stephen (Intern)
Larsen, Allan (Intern)
Knudsen, Mette Aagaard (Intern)
Project Manager, organisational:
Leleur, Steen (Intern)
Rich, Jeppe (Intern)

Financing sources
Source: Indtægtsdækket virksomhed UK 90
Name of research programme: Indtægtsdækket virksomhed UK 90
Amount: 1,500,000.00 Danish Kroner

Centre for Logistics and Freight Transport
The Centre for Logistics and Freight Transport (CLG) is a multi-disciplinary research centre on logistics and freight transport. The Centre is headed by CTT. CLG is a cooperation between a number of Danish and international universities and companies. CLG is funded by The Danish Technical Research Council (STVF). The objective of the Centre is to strengthen the Danish research on logistics and transport. This is achieved through specific research projects and through networking activities within the center. A number of the research projects are multi-disciplinary. The scope of the Centre is to obtain an increased knowledge about the various stakeholders within the logistics and transport sector and to develop new methods and concepts which are applicable to the stakeholders. This includes organisatorial and management concepts as well as methods based on mathematical models in order to support the various stakeholders which briefly can be characterized as follows: Manufacturers and consumers of goods (transport users). Transporters (operators, forwarders, etc.). Transport infrastructure owner (public authorities, ports, airports, etc.). Public authorities (political means and control). National economics (derivated effects of the transport system and the external influences).
Period: 25/06/2001 → 31/12/2006
Number of participants: 13
Acronym: CLG
Project ID: 421-35044
Project participant:
Madsen, Oli B.G. (Intern)
Leleur, Steen (Intern)
Overgård, Christian Hansen (Intern)
Rich, Jeppe (Intern)
Jørgensen, Rene Munk (Intern)
Larsen, Allan (Intern)
Pedersen, Michael Berliner (Intern)
Salling, Kim Bang (Intern)
Jensen, Anders Vestergaard (Intern)
Sørensen, Majken Vildrik (Intern)
Landex, Alex (Intern)
Holvad, Torben (Intern)
Project Manager, organisational:
Nielsen, Otto Anker (Intern)

Financing sources
Source: Forskningsrådene - STVF
Name of research programme: Forskningsrådene - STVF
Amount: 15,723,006.00 Danish Kroner

The dynamic vehicle routing problem
Department of Transport
Period: 01/01/1997 → 17/04/2001
Number of participants: 5
Phd Student:
Larsen, Allan (Intern)
Main Supervisor:
Madsen, Oli B.G. (Intern)
Examiner:
Clausen, Jens (Intern)
Gendreau, Michel (Ekstern)
Pisinger, David (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Anden Sektorministeriel Fin-SU
Project: PhD

Crew and vehicle scheduling.
The objective of the project is to develop methods for finding the optimal or near optimal scheduling of crews and vehicles. Rules concerning e.g. working periods and union regulations have to be taken into consideration. In 1996 a system ACROS has been developed for computer based crew rostering, in particular applicable for medium term planning for allocation of bus drivers. ACROS was developed in cooperation with the company TR-Partners. Furthermore a system concerning the scheduling of duties for nurses has been developed. The system is based on set partitioning and constrained branch and bound, and it was developed in cooperation with Hovedstadens Sygehusselskab and Andersen Consulting.

Department of Informatics and Mathematical Modeling
TR Partner
Period: 01/01/1996 → 31/12/1998
Number of participants: 2
Project participant:
Larsen, Allan (Intern)
Calling in vehicles for inspection.

In 1998 and the following years all cars which are more than three years old must be inspected by the Danish Car Inspection (Statens Bilinspektion) every second year. Therefore the Danish Car Inspection needed to know how, when and where should the cars be called in for inspection and which capacity was necessary. To answer these questions we developed a large aggregated optimization model. The results from the model was used by the management of the Danish Car Inspection to make decisions concerning the overall structure of the future process for car inspection.

Department of Informatics and Mathematical Modeling

Statens Bilinspektion
Period: 01/11/1995 → 31/05/1996
Number of participants: 3
Project participant:
Larsen, Allan (Intern)
Rygaard, Jens Moberg (Intern)
Project Manager, organisational:
Madsen, Oli B.G. (Intern)

Dynamic vehicle routing.

Dynamic vehicle routing is dealing with vehicle routing problems in which not all information is available at the start of the planning period. Vehicles are dispatched to satisfy service requests, that evolve in real time. In 1996 a simulator was developed. The simulator generated problem instances which were solved by a static algorithm. The purpose was to analyze how the degree of dynamism influenced the quality of the static solution procedure. Furthermore an algorithm has been developed for dispatching medical doctors serving patients in there homes at night. The algorithm was combined with a very fast shortest route algorithm and a road network database.

Department of Informatics and Mathematical Modeling

COWI A/S
Period: 01/09/1994 → …
Number of participants: 4
Project participant:
Rygaard, Jens Moberg (Intern)
Lund, Karsten (Intern)
Larsen, Allan (Intern)
Project Manager, organisational:
Madsen, Oli B.G. (Intern)

Activities:
A matheuristic approach for Integrated Timetabling and Vehicle Scheduling Problem

Period: 17 May 2017
Joao Filipe Paiva Fonseca (Speaker)
Roberto Roberti (Other)
Evelien van der Hurk (Other)
Allan Larsen (Guest lecturer)

Department of Management Engineering
Management Science
Operations Management
Operations Research

Degree of recognition: International

Documents:
Abstract_JoaoFonseca

Related event

Mini-Workshop on Integrated Timetabling
15/05/2017 → 17/05/2017
Goettingen, Germany
Activity: Talks and presentations › Conference presentations

City Logistics – constraints and opportunities. E-mobility and city logistics – for citizens, goods and business
Period: 2 Feb 2017
Allan Larsen (Guest lecturer)

Department of Management Engineering
Management Science
Transport DTU

Operations Management
Degree of recognition: National

Related event

E-MOBILITY & CITY LOGISTICS - for citizens, goods, and business: Region Hovedstaden seminar om E-mobility
02/02/2017 → …
København, Denmark
Activity: Talks and presentations › Conference presentations