

DTU Management

Department of Technology, Management, and Economics

Project Definition Report

Optimizing the train clearing for DSB using integer programming

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Kongens Lyngby 2023



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Project Description

1.1 Background

This project will be based on a real problem given to us by DSB, Danske statsbaner (Danish state railways), which is a company that operates the public trains in all of Denmark. They have asked for ideas for a way to optimize the way they schedule their interior train cleanings. This should be done in a way that ensures that all trains are about equally clean all the time, according to DSB's standards. The cleaning schedule is currently manually handled, and it would therefore be a great advantage for DSB to have a way of automatizing the process.

We received a data set from DSB of a normal week in 2023 of the train scheduling including their solution for the cleaning scheduling. A *Normal week* refers to an standard week and the train schedule for this one week can therefore later be used for every other week. This will not take any scheduling changes and seasonal changes into consideration, but can be used as a general solution.

This project will focus on modelling the problem and solving it using methods of integer programming. This will be based on a function minimizing the time, and money, spend on cleaning, while ensuring the cleaning standard of DSB is upheld.

1.2 Research Question / Hypothesis / Thesis /Problem Statement

We intend to model the problem in different ways to schedule the cleaning to some standards given by DSB, while minimizing the cost of the cleaning. This will be done by several models to compare between and by analyzing the data given by DSB and comparing to our own solutions and results. Our problems involve how to describe how dirty the trains get, how to ensure that they are equally clean all the time, how to best model the problem, and what constraints give the best solutions. By doing this project, and for DSB to automatize their scheduling, they can save a lot of money and time, by not have workers doing the scheduling manually every week.

1.3 Research Goals and methods

Problems:

- DSB's cleaning schedule is manually done and need to be automatized with a mathematical model
- It is undetermined how to best model the problem

Goals:

- Create a mathematical model using mixed integer programming
- Create a solution for the cleaning schedule with our model
- Create several models and compare their results with each other and the given solution
- set up a way to "quantify dirtiness"

Methods:

- Mixed integer programming

1.4 Empirical Considerations

A big data set has been given to us from DSB containing 13.852 train departures in a *normal week*. Each train is given with lots of information including departure station, destination station, departure time, arrival time, train wagon type, train number, kilometers travelled on current trip and kilometers travelled total by the train wagon. This data set, we intend to change a bit to fit our needs. This will be done by removing columns of information that we don't need and adding several other columns needed, like the stoptime on each station. We have been asked by DSB to deliver an idea for a way to model and implement the data and get a solution.

CHAPTER 2

Intended Learning Objectives

The intended learning objectives (ILO) of this Thesis are:

- Can build several mathematical models using mixed integer programming
- Can analyze the given data and our own results
- Can understand a real life problem and describe it in mathematics
- describe and analyze DSB's train cleaning problem
- Perform a data analysis of our solution and compare it to their given solution
- Find a way to quantify dirtiness to use in a mathematical model

CHAPTER 3

Plan

3.1 Plan and activities for project

Plan for 18 weeks project	
Week numbers	To do
Week 1, 2 and 3	Model 1: Implement and chapter
Week 4,5 and 6	Model 2: Implement and chapter
Week 7,8 and 9	Data analysis
Week 10,11 and 12	Model 3 + (maybe) Model 4: Implement and chapter
Week 13,14 and 15	Results and discussion
Week 16,17 and 18	Checking formalia + writing up final project, Conclusion, Proof-reading and handing in

3.2 Milestones

- Project description report
- Mathematical model 1:
the simple model only on one train
- Mathematical model 2:
the expanded model that can take in several trains and take into consideration that the wagons can unite
- Data analysis:
Analysis of their solution and ours
- Mathematical model 3 and optionally 4:
Based on the data analysis we will create the final model
- Data analysis and discussion of results:
Analysis of final solution and discussion of this compared to their solution - Is it better? and how to determine this is discussed
- Finish report