



Aalto University
School of Science

MS-E2177

Seminar on Case Studies in Operations Research

**Modelling the procurement costs of
subcontracted metal parts in
machine manufacturing**

INTERIM REPORT

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Client:

Normet

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1 Changes in objectives and scope

Our original objective was to develop a model that explains the procurement cost for selected metal parts as a function of major cost elements. This model is used for two purposes:

1. Forecast future cost development
2. Identify which parts exhibit abnormal cost development (costs higher than should be expected based on the model)

After our exploratory data analysis, we realized that our potential explanatory variables (from which we have data from) are not explaining well the variation in the item unit prices for most of the suppliers - so we could not build a cost model within the scope of this course for those items. Thus, the objective was changed to build a cost model only for those items whose price variation is explainable with our potential predictors (steel index, labor index, electricity price, ordering quantity, weight). From the original total of 18 suppliers, 4 suppliers were chosen based on our exploratory data analysis. Now we are focusing to build the cost model only for these suppliers.

Besides, it turned out that using the cost model is not the best possible way to identify the parts which exhibit abnormal cost development. Rather, calculating analytical metrics that we used in the exploratory data analysis helped identify suppliers and items whose prices is not behaving as expected. Thus, the second purpose of the cost model was changed to a separate second objective: to develop a method to identify the parts with abnormal cost development. This will come more as a side product of our data analysis and modelling process.

The updated objectives are now two-fold:

1. To develop a model that explains the procurement cost for selected metal parts as a function of major cost elements to forecast future cost development
2. To develop a method to determine parts which exhibit abnormal cost development

As originally planned, the scope is now reduced from the original 18 suppliers and approximately 12 000 unique metal parts to 4 suppliers and 1788 unique metal parts. Besides, as part of our exploratory data analysis, we filtered out items which have been ordered during less than ten different months in our observation period of 46 months, to

ensure enough data points for each of the items included in our modelling. This reduced the number of unique metal parts in our scope as well (to the 1788 unique items). The scope might still be narrowed for the first objective, depending on the progress of our modelling efforts.

2 Project status

Since writing the project plan, we have finished project initiation phase, made significant progress in the data analysis and model formulation phase, as well as some progress in the literature review and documentation of results.

The project initiation phase needed inputs from the exploratory data analysis, as we agreed with Normet to change the objectives as described above. Now we have locked the objectives for the remainder of the project and the scope is set, except some minor narrowing. Besides, we have gathered all data from external sources that we use in our modelling. The project initiation phase has thus been concluded.

In the data analysis and model formulation phase, we have pre-processed the data so that steel and labor index, electricity price data and weight information are combined to the purchase order data. This has enabled us to conduct exploratory data analysis conveniently. Exploratory data analysis has taken longer than expected, partly because we have got new data from Normet during our weekly meetings, based on which we have adjusted our analyses or made completely new analyses. Conducting analyses for such large data set has turned out to be laborious or challenging to automatize with R code for some team members. However, now we have gained the required understanding from the exploratory data analysis to move to fitting models and variables. We have made some initial planning and ideation about the model formulation but we have not yet fitted the models to our data.

Literature review has not been our focus during the last weeks and consequently, we have not yet found much additional literature since writing the project plan. However, we discussed with the teacher of the course about planning the detailed analysis phase. We will focus on finding more literature related to cost modelling and how supply chains work in the steel industry. We will also seek to find literature related to the implementation and diagnostics of the models to the extent what is not common knowledge.

We have started to write the project report already, with the report structure formulated and few pages ready text in the "Introduction" and "Data and methods" sections.

We have had two meetings with our teacher so far and weekly meetings with Normet with some exceptions. Those have guided our project to the right direction as well as enabled to get answers to our questions both on the academic and practical side.

3 Changes to project plan and schedule

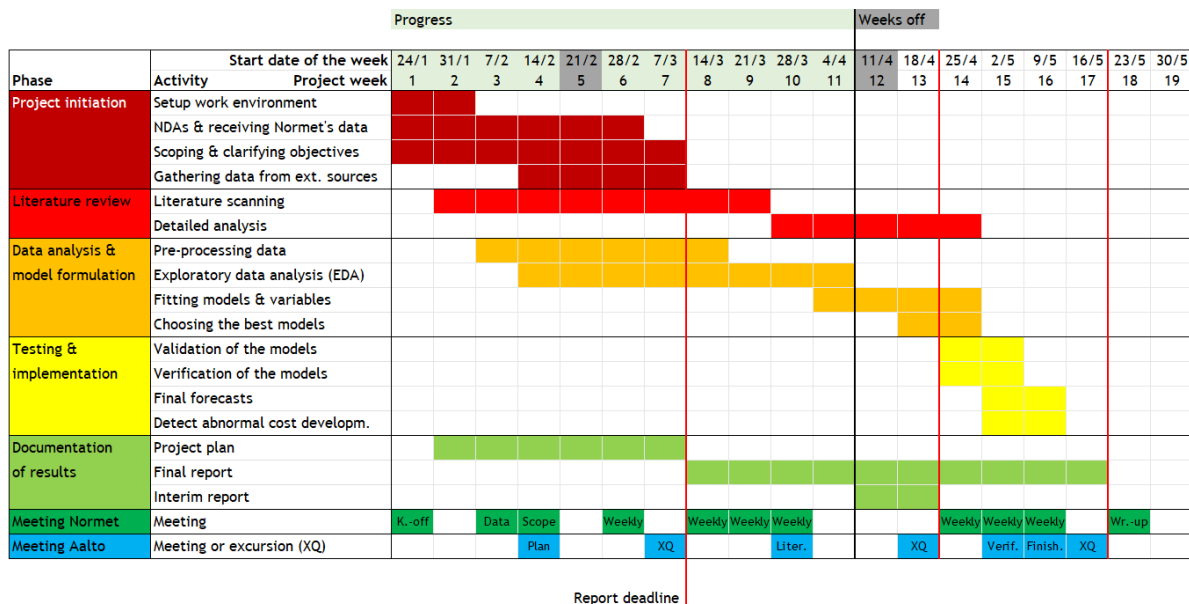


Figure 1: Gantt chart of the project schedule.

Figure 1 shows the updated project schedule. The most important change is the slightly postponed schedule due to the crowded calendars of team members in late March and April. As our team has more time during late April and early May, we will put in more working hours then. Besides, the detection of metal parts with abnormal cost development is changed as we will not use our cost model but other methods to identify those parts.

4 Updated risk management plan

Risk	Prob	Impact	Effects	Measures
Communication issues with the client	Low	Medium	Deliverables are not what the client wanted	Frequent meetings with the client
Team member absence	Medium	Medium	Narrower scope or lower quality, workload not balanced	Frequent meetings and try to make the project work fun
Low information value from data	Medium	Medium	Not able to build model	Focus on suppliers and items whose prices correlate strongly with steel index, provide insights from EDA
Insufficient time to finish implementation	High	Medium	Narrower scope or lower quality	Well-defined roles, reserving early enough time from calendar for the last weeks, prioritizing tasks
Not finding a suitable approach	High	High	Not addressing the objectives	Exploit literature, ask advice with low barrier from teacher

Table 1: Updated risk management plan.

Table 1 presents our updated risk management plan with risks ordered from the lowest to the highest. Each risks are discussed below with the possible updates highlighted.

There have not been communication issues with the client as we are meeting frequently with Normet.

For the risk of team member absence, our risk mitigation actions are the same as they have worked well - everyone is committed to the project.

The risk of low information value from data has partially realized, as we have found out that for most suppliers, our predictors are not able to explain the variation in unit prices. Our updated measure is to focus on suppliers and items whose prices correlate strongly with steel

index. Then we can build model at least for some suppliers and items. Besides, we are documenting insights from exploratory data analysis, particularly for the second objective.

The risk of running out of time is still very probable as we are a bit behind the original schedule. Thus, we added the mitigation measure so that we reserve early enough time from our calendars to ensure that we have enough working hours available.

We have updated the risk of not finding a suitable approach to be the highest, because defining the suitable aggregation level for modelling seems now to be the most challenging task for us. We cannot build the model at too low-level - at the extreme, at individual item level - as our model would be impractical to implement. However, at too high-level, the model will most likely be inaccurate as it overlooks relevant information, such as the mix of individual items ordered. Thus, we have updated our risk mitigation measure to be to exploit more literature and consult our teacher at low barrier, if we should encounter difficulties.