Evaluation of the PhD-Thesis of

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"Mathematical Programs for Dynamic Pricing – Demand Based Management".

1. Basis for the evaluation

A PhD-thesis should be an independent comprehensive scientific work and should contribute to develop new knowledge to the discipline. This thesis aims to analyse the problem of simultaneously determining the ordering quantity and different marketing decisions in a situation with a stochastic demand. It is written as a monograph, though it is based on several papers published in international scientific journals or conference proceedings. The papers are joint work with other authors, and the thesis could in a better way have stated the candidate's own contribution to the research, compared to the contribution from the co-authors.

2. General comments

The thesis focuses on the topic of coordination of marketing, production and logistic decisions. The problem is studied in the context of two well-known demand-based problems; the Newsvendor Problem (NP) and the Transportation Network Design Problem (TNDP). An example on a hub location problem for waste processing is included in addition. All problems have practical relevance and are complex and challenging to solve.

The thesis is well structured and written in proper English. It is divided into seven chapters where the first gives a general introduction and the last states the conclusions and suggestions for further research. The other chapters follow a logical sequence. First, a chapter gives a presentation of the basic versions of the NP and TNDP in question. Then another chapter presents the problems where the aspect of pricing is introduced, and in the succeeding chapter, the NP is analysed with respect to costs of advertising. The next chapter features the pricing and advertising aspect combined in the NP, and then a final chapter presents a model and solution to a waste processing facility location problem where pricing is included. A thorough literature review is given in all the chapters and shows a good overview of the current state of the art within the relevant fields. Several publications by the candidate with co-authors are related to each of the different chapters in the thesis.
3. Specific comments

3.1 Introduction

The purpose of the introduction is to present the problem and methodology, show some related research and tie the different parts of the research together. It gives a short general description and a justification of the need for research within the selected areas. It also gives an outline of the thesis, describing the content of each subsection and links the author’s publications to the different parts of the thesis. In my opinion, the introduction fulfils these criteria even if it could have been more extensive and analysed the research in a broader context.

3.2 Underlying demand based problems

This section presents the basic problems used in this research. It describes the history and basic formulation of the newsvendor problem and shows some modifications to the problems with relevant references on the different variations. The section also contains a detailed description of the transportation network design problem with references to several algorithmic approaches. It shows a mathematical model for the deterministic problem and extensions needed when stochasticity is introduced. The model for the stochastic problem is given both as a Here-and-Now (HN) approach where decisions need to be taken with respect to the uncertainty, and as a Wait-and-See (WS) approach where the decision can be postponed until the final demand is known. Both formulations are scenario-based; for the WS approach, the scenarios are used to examine attributes such as the variance of the variables.

3.3 Pricing

Here we can find a summary of the general ideas for pricing in the context of newsvendor and transportation network design problems. The actual demand in the NP is given as a function of the price, but with some random elements in addition. Thus, the profit function will depend on both the price with the corresponding demand, and some randomness. The randomness could be defined both as additive, i.e. added to the calculated demand with the given price, and multiplicative, i.e. multiplied with the calculated demand with the given price. The riskless problem without the randomness is used for comparison. It is shown that in the additive demand situation with a linear pricing function, the optimal price should be smaller than or equal to the optimal price in a similar riskless situation. Furthermore, while in the multiplicative demand situation with an isoelastic pricing function, the optimal price should be larger than or equal to the optimal price in a similar riskless situation. The pricing aspect is also introduced in the TNDP over a single period for a stochastic price dependent demand. The mathematical model for the WS approach shown in chapter 2 is reformulated both for a linear and for an isoelastic price function.
Due to the complexity of these type of problems, only small instances can be solved to optimality, and thus a hybrid algorithm is developed for obtaining solutions to larger instances. The algorithm combines an exact procedure developed in GAMS with a Genetic Algorithm (GA) coded in C++, where the GA provides a search by changing edges in the network, and the exact algorithm finds the optimal flow in the given network. Computational results show that pricing decisions could improve the objective function, i.e. by reducing the number of customers served with a corresponding reduction of edges used.

3.4 Newsvendor problem with advertising

This chapter concerns an extension of the NP where stocking quantity and advertising expenses are set simultaneously. The problem is analysed with both a concave and an S-shaped demand function with respect to the advertising expenses. It is shown that for the multiplicative demand case, the value for optimal advertising is unique, and will never exceed optimal advertising in the equivalent deterministic model. In the additive case, values are always equal, i.e. optimal advertising is independent of uncertainty. Formulas for determining the optimal advertising are given for the different demand functions, and numerical examples show how variance, profit margin and response functions affect the optimal advertising and profit.

3.5 Newsvendor problem with joint pricing and advertising

The difference from the previous chapters is that now both the price and the advertising expenses are considered as decision variables in addition to the order size. Only the multiplicative demand model is analysed. The thesis could have gained on including a section on the additive case as well.

It is shown that the optimal price is the same when including both pricing and advertising in the problem, as it was when only including pricing. The optimal advertising, however, depends on the optimal price and pricing function. With a concave or S-shaped demand function, the optimal advertising is always less than or equal to the optimal riskless advertising. Similar to the non-advertising problem, with an isoelastic price function, the optimal price is always greater than or equal to the riskless price.

3.6 Waste processing facility location problem with stochastic programming

This section discusses a practical problem of waste collection and transportation to waste processing units with a pricing aspect included. The problem focuses on the location of facilities for waste processing and the corresponding transportation network in a stochastic situation. A mathematical model for the basic problem is presented and an extension where the different cost elements are dependent on the amount processed or transported is given. Then a Genetic Algorithm is implemented in MATLAB with an exact procedure for
determining the routing in the given network. Instances with a size up to 70 nodes are solved with the algorithm. This sections clearly shows the relevance of these types of problems, but could have been linked better to the previous sections on NP and TNDP.

3.7 Conclusions and further research

The last section gives a brief summary of the conclusions from the previous chapters, and suggests focus for further research in the considered areas.

4. Conclusion

In my opinion, the thesis has met the stated objective of analysing the stochastic problem of simultaneously determining the ordering quantity and marketing decisions to an acceptable degree. The scientific contributions presented in this dissertation satisfy the standards that are required for a doctoral thesis. Hence, I recommend that the candidate is permitted to defend the dissertation for the degree of PhD.

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