Report on **Bachelor Thesis**

Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague

Student:	**Tadeáš Kopecký**
Advisor:	**RNDr. Michal Červinka, Ph.D.**
Title of the thesis:	**Inventory Control Problem with Random Demand**

OVERALL ASSESSMENT *(provided in English, Czech, or Slovak):*

In his thesis, Tadeáš Kopecký focuses on inventory management based on two basic models (Economic order quantity model and Wagner-Whitin model), four heuristics (Lot-for-lot, Part-period balancing, Silver-Meal and Least-unit-cost) and several means of demand forecasting (Naive forecast, Cumulative mean, Moving average, Exponential smoothing, Brown's double exponential and Seasonal indices) in the context of dental implants business. First, he introduces the methods considered, then he applies them on real data under two order planning scenarios and finally, he compares the cost efficiency of the methods with the actual dental center inventory policy.

In general, the thesis is relatively easy to read and the extent of both the theoretical part and the empirical analysis is, in my opinion, reasonable for a Bachelor thesis. Especially, I appreciate the aim to focus on both the demand forecasting and order planning, including safety stock management, and thus to provide a complete solution directly applicable in practice. On the other hand, there are also some deficiencies, which I have to mention and consider in the assesment. To discuss each evaluation category separately:

Methods: From my point of view, the topic of the thesis is clear, the methods are, in most cases, well described and the analysis of the results is sufficiently detailed. Yet, some things seem to be problematic. First, I would appreciate a more detailed explanation of the inventory management model and accuracy methods choice, including a discussion of the relevant literature. Next, I would suggest a revision of the demand forecasts using weighted average, since the condition on the weights that they can never increase with increasing lag (p.33), seems to be inappropriate, especially in the case of seasonality in the data. Next, I would suggest to provide a more detailed analysis of the safety stock management in both the yearly and the monthly planning scenarios, since I think that the solutions suggested in the work are suboptimal, as far as I understand the explanation provided.

Next, I would suggest to apply the same safety stock policy for both the actual and the forecasted demand scenaros, since else the performance of the methods seems to be hardly comparable and the effect of the demand forecasting on the inventory management costs cannot be correctly assessed. Moreover, separation of the safety stock effect would definitely provide new insights to the optimisation problem, although finding appropriate means of doing so might be nontrivial. On the other hand, I highly appreciate the aim to work with real data, which are, moreover, not easily obtainable.

Contribution: In general, I see the main contribution in the advancement of the authors' knowledge, skills and experience, which he might appreciate in his further studies and/ or in his job. Moreover, the analysis provided, despite some methodological problems, could be considered an incentive for the dental centre in focus to revise its inventory management policies. The only thing that I miss is the advancement of the authors' ability to work with literature, which significantly impairs the overall quality of the thesis.

Literature : In my opinion the use of literature is very poor and I believe that it might even prevent the thesis from being defendable, since the author breaks the official rules for Bachelor thesis writing. Although the list of references seems to be reasonably long and relevant for the thesis, there is a problem with the actual use of the literature in the text and with the compliance between the in-text references and the list of publications presented. Taking a closer look, about one third of the publications (7) in the list is not mentioned in the text, in four cases the year in brackets in the text and in the list of publications are different, so I can just guess that the author refers to these publications, and finally, twice there is a reference in the text, but the respective publications are missing in the list. This makes it problematic for the reader to use the references provided, and, in some cases, it even causes confusion about what is the original idea/ oppinion/ work of the author and what is based purely on the literature.

Manuscript Form: Although the thesis is well structured and relatively easy to read, there are several deficiencies in the form. First, in the introduction, I miss a clear summary of what is the author going to do in the rest of the work, including a brief summary of the main results. Second, I miss a literature review section that would support the relevance of the thesis in terms of the methods applied. This is closely related to the missing explanation of why only the basic models from 1910s and 1930s are assumed, although there are many improved versions available, as mentioned by the author. In general, the work with literature is poor, which affects both the content and the formal aspect of the thesis. Third, I would suggest to describe the methodology, including all general practical aspects, in the theoretical part only. Next, numbering of all equations would make the orientation

Report on **Bachelor Thesis**

Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague

Student:	**Tadeáš Kopecký**
Advisor:	**RNDr. Michal Červinka, Ph.D.**
Title of the thesis:	**Inventory Control Problem with Random Demand**

in the text easier and a correct use of literature would enable to see the thesis in a broader context. Finally, I would not include the textbook-style academic examples in chapter 2.

Suggested technical questions for the defense are:
- Why should the lead time (in the economic order quantity model) fall between two cycles?

- What is the advantage of using the symmetric mean absolute percentage error (sMAPE) instead of the mean absolute percentage error and/or the (root) mean squared error, in the case of the data in focus?

- Why are the parameters in the demand forecasting models estimated based on MSE and then the models are compared using sMAPE?

- Why, in the weighted average, why should all weights satisfy a ≥ b ≥ c ≥ ... ≥ l, where a is the weight for the most recent period, b is the weight for the second most recent period, etc., even though there is a clear seasonality in the data and the constraint prevents weights such as (a=0,b>0,c=0,d>0,...)? This might explain the "optimal" weights in the table with results and the respective MSE (p.53).

- The safety stock suggested seems to be excessive. Is the use of normal distribution for the safety stock calculation appropriate? Should there be the same safety stock for all months even though the demand in July and August is based on all past data below average? Moreover, should the safety stock be the same no matter the frequency of the replenishment and no matter the planning revision (yearly/ monthly) pattern? Could the author explain in more detail the safety stock management for both the yearly and the monthly planning setting?

- Why the safety stock is not applied in the case of actual demand (equivalent to a perfect forecasting model)? The costs of the inventory policy are then hardly comparable.. Moreover, since some underestimation of the demand decreases the costs due to the desirable depletion of the safety stock, the comparison of the methods seems to be problematic when the safety stock is assumed.

-

Suggested question for a general discussion:
- What are the main weaknesses of the new inventory management policy suggested by the author and what could be done to get rid of them?

In the case of successful defense, I recommend the grade **" good " ("velmi dobře" , 2)**

SUMMARY OF POINTS AWARDED (for details, see below):

CATEGORY		POINTS
Literature	*(max. 20 points)*	10
Methods	*(max. 30 points)*	23
Contribution	*(max. 30 points)*	25
Manuscript Form	*(max. 20 points)*	12
TOTAL POINTS	*(max. 100 points)*	**70**
GRADE	(1 – 2 – 3 – 4)	**2**

NAME OF THE REFEREE: **Lucie Kraicová**
DATE OF EVALUATION: **29.08.2014**

_____
Referee Signature

EXPLANATION OF CATEGORIES AND SCALE:

LITERATURE REVIEW: *The thesis demonstrates author's full understanding and command of recent literature. The author quotes relevant literature in a proper way.*

Strong	Average	Weak
20	10	0

METHODS: *The tools used are relevant to the research question being investigated, and adequate to the author's level of studies. The thesis topic is comprehensively analyzed.*

Strong	Average	Weak
30	15	0

CONTRIBUTION: *The author presents original ideas on the topic demonstrating critical thinking and ability to draw conclusions based on the knowledge of relevant theory and empirics. There is a distinct value added of the thesis.*

Strong	Average	Weak
30	15	0

MANUSCRIPT FORM: *The thesis is well structured. The student uses appropriate language and style, including academic format for graphs and tables. The text effectively refers to graphs and tables and disposes with a complete bibliography.*

Strong	Average	Weak
20	10	0

Overall grading:

TOTAL POINTS	GRADE		
81 – 100	**1**	= excellent	= výborně
61 – 80	**2**	= good	= velmi dobře
41 – 60	**3**	= satisfactory	= dobře
0 – 40	**4**	= fail	= nedoporučuji k obhajobě