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HABILITATION THESIS REVIEWER'S REPORT

Habilitation thesis title:	Dynamical systems in mathematical modeling
Author's name:	RNDr. Zuzana Chladná, Dr.rer.soc.oec.
Habilitation field:	9.1.1. Mathematics
Reviewer's name:	doc. Mgr. Jozef Kiseľák, PhD.
Reviewer's workplace:	Institute of Mathematics, Faculty of Science, Pavol Jozef Šafárik University in Košice

Evaluation

I did this evaluation considering the scientific and educational achievements of the candidate based on a printed thesis titled "Dynamical systems in mathematical modeling" and other informative material, namely the ones related to pedagogical experiences, publications, citations, conferences, and grants. Let us begin with the thesis. It is written as a collection of previously published scholarly works with commentary. From among the relatively rich publishing activities of the author, she selected seven journal papers for this thesis. The habilitation thesis starts with a very short introduction to the theory of dynamical systems. The following chapter deals with key theoretical concepts and solution techniques necessary for mathematical modeling of real-world dynamical systems used in mentioned candidate's papers. This part is written very concisely and nicely lays out the fundamentals and notation for the main part of the thesis. The third chapter involves fields of applications – modeling in mathematical epidemiology and biology and optimization problems in forest management. There are very few typos and spelling mistakes in these parts of the document. The main part consists of a collection of seven published papers, which I will briefly discuss in the next few paragraphs.

- Papers 1 and 4: Based on well-known Bellmann equation, authors developed a real options model given uncertainties in future wood and CO_2 price behavior with detailed sensitivity analysis and determination of optimal rotation period.
  Using real options techniques the level of vaccination rate at which it is optimal to perform intervention was determined and the economic effectiveness of intervention in Slovakia was analyzed.

- Papers 2, 3, 5 and 7: By describing two approaches how to capture incentives to vaccinate authors estimate the epidemiological situation after the abolition of compulsory vaccination, whereas the SIR type model and game theory were used. Based on an age-cohort model incorporating waning immunity, vaccination schedule and demographic structure change, a model that estimates the proportion of

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individuals susceptible to measles in the Slovak population was introduced. Considering a switching prevention strategy in the classical SIR model authors proposed also a new two-dimensional model and studied its global dynamics. Extension of the classical SEIR model by accounting for the presence of asymptomatic individuals and the effect of isolation of infected individuals based on testing was introduced. Moreover, authors suggested two types of quarantine – gradual and abrupt and studied their effect on the epidemic dynamics.

- Paper 6: Authors proved the existence of non-monotone and non-oscillating wavefronts for the Yang and So diffusive version of Nicholson's blowflies evolution delay model (even for arbitrarily small delays).

The topicality of the habilitation thesis is high and its importance will increase in the coming years. The habilitation thesis is neatly written and transparently presented, and shows the author's good insight into the topic of the thesis. A very well elaborated literature review is provided all over the thesis. What is not so clear is the contribution of the author to the topic, namely her own added value in the coauthored papers. Nevertheless, the structuralizing of the papers and thesis itself with theoretical, numerical and simulation approaches and examples show the excellent organization capability of the author to present her work. I have already read papers 2, 5 and 6 before I was asked to write this evaluation, and I considered them mathematically very interesting. Generally, the thesis proves that the candidate has a good record of publications and a strong command in a relevant field of Mathematics – namely Differential equations, Stochasticity or Optimization problems. I noticed, that the majority of the included (published) papers are indeed coauthored by a particular other people, however, this is quite natural in the fields of applied mathematics. Moreover, Dr. Chladná's achievement goes well beyond the mentioned selection, as can be also seen from attached documents and her Google Scholar record. In my opinion, she has sufficiently demonstrated her independence. Furthermore, it is also necessary to point out that she has extensive teaching experience and also the number of citations and the list of conference presentations are impressive. And here I have to emphasize, that sometime in the period 2007 – 2015 had Dr. Chladná a several-year, probably forced, research inactivity. This certainly caused a lower number of her participation in grants.

Comments, remarks and queries

Despite the high appreciation of the Habilitation thesis, the quality of published papers and the personality of the applicant, some remarks, queries, and comments should be inevitable for discussions:

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1. The works lack a general conclusion with the applicant's own scientific contribution. It would be appropriate to mention (not too detailed) the publishing activity of the author in the coauthored papers.
2. We have learned in the recent past due to COVID-19, that predicting hospital admissions and bed occupancy are maybe the most important relevant information. Can this be easily mathematically involved in all your introduced models ?
3. What is your opinion on a multi-agent modeling study of epidemic spreading ?
4. How would you suggest to solve the problem of real and reported data (e.g. in compartmental models) ?
5. Can you shortly explain where can we see mathematical model in your paper 3 [46] ?
6. Why do you mention the Markov property on page 8 ? How do relate it with dynamics ? Or more general, in what sense do you understand the stochastic process as dynamical system ?
7. I don't understant the notation on page 5. E.g. what exactly do you mean by the definition $f(x):=g(x_0,1)$? Is it true for any x from the state space ? It look little bit cumbersome.
8. You wrote that the result in your article 6 [13] is contrary to generally accepted hypothesis in paper [31]. How should we understand it ?

Conclusion and Recommendation

I can conclude that the requirements for habilitation are easily met. Dr. Chladná has undoubtedly realized a remarkable work with a high scientific background and high potentiality of application in practice. The results were published in impacted journals and presented at different national and international conferences. Therefore, I can recommend the submitted habilitation thesis entitled "Dynamical systems in mathematical modeling" to be accepted for the defense pursuant to Decree no. MŠ SR č. 246/2019 Z.z. on the procedure of obtaining scientific-pedagogical titles or artistic-pedagogical titles associate professor. In the case of successful defense of Habilitation thesis before the scientific Jury of "Mathematics" from the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, I recommend RNDr. Zuzana Chladná, Dr.rer.soc.oec. to be awarded Associate Professor (docent/ doc.) title also.

Best regards,

Košice, 22. august 2022

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doc. Mgr. Jozef Kiseľák, PhD.