

OPINION

by Prof. Dr. Radoslav Yoshinov

Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences

of a dissertation for awarding the educational and scientific degree "Doctor" in doctoral program "Informatics", professional field 4.6. Informatics and Computer Science

by Diellza Shani Berisha

on the topic: "Optimization strategies and algorithms for solving problems of the health system during a pandemic"

By Order No. 176/29.06.2026 of the Director of IICT, I have been appointed as a member of the scientific jury in the procedure for the defense of a dissertation on the topic "Optimization strategies and algorithms for solving problems of the health system during a pandemic" for awarding the educational and scientific degree of "Doctor" in the doctoral program "Informatics", professional field 4.6. Informatics and Computer Science of Diellza Shani Berisha.

As a member of the scientific jury, I have received:

1. Dissertation for awarding the educational and scientific degree "Doctor";
2. Abstract of the dissertation;
3. Copies of the articles included in the dissertation;
4. Reference for the fulfillment of the minimum requirements of IICT-BAS for the acquisition of the educational and scientific degree "Doctor".
5. Other documents accompanying the procedure.

At the first meeting of the scientific jury, I was selected to write an opinion on the procedure.

1. Relevance of the dissertation

Infectious diseases cause millions of cases of starvation each year and are the main cause of human mortality. Mathematical modeling as an applied tool in the field of public health appeared as early as Bernoulli's writings around 1766.

The need for centralized control of epidemic outbreaks can be considered a major driver for the development of modern epidemiology, in particular for the development of a new field using mathematical modeling as an applied tool called Digital and Computational Epidemiology, which is widely used and applied in public health policies.

This dissertation is a contribution to the emerging field of Digital and Computational Epidemiology, focusing on optimization strategies and algorithms for solving problems in health systems during a pandemic. The research is positioned at the intersection between epidemiological modeling, operational research, health resource

allocation, machine learning forecasting and simulation assessment. Its main idea is that the response to a pandemic can be improved when forecasting, optimization and operational simulation are not developed as separate tools, but are integrated into a coherent framework to support decision-making. The subject of the dissertation is new technological solutions and modern tools (models, methods and tools) in the field of computer networks. The subject of the research is the identification of opportunities for the use of a switching field and a control circuit.

The aim of this dissertation is to develop and evaluate an integrated hybrid decision support framework (IHDSF) that combines epidemiological forecasting, optimization-based resource allocation, and simulation of discrete events to improve health system performance during pandemic conditions.

To achieve this goal, the dissertation defines the following eight tasks:

1. To analyze the current state of healthcare modeling during a pandemic.
2. To identify the main methodological and practical gaps in existing approaches.
3. To design an integrated hybrid decision support framework that connects epidemiological modelling based on SEIR.
4. To formulate an optimal allocation of health resources.
5. To build and parameterize a case study of COVID-19 in Kosovo, suitable for computer experiments.
6. To evaluate the proposed framework through experimental scenarios.
7. To assess the value of decision-making for the integrated framework.
8. To demonstrate the effectiveness of the proposed approach to operational decision-making in a pandemic in resource-constrained health environments by proposing an OM model based on a new algorithm.

Guidelines for future research and development are defined. A list of scientific publications on the topic and citations noticed are presented.

In the bibliography of the dissertation, 125 sources are cited, including books, scientific articles and Internet publications. Based on the overview analysis, the PhD student formulates the purpose and objectives of the dissertation.

I find that the goal set and the tasks formulated in this way are relevant, and the content proves the significance of the presented dissertation. I positively assess the topics and the research done in the dissertation.

2. Degree of knowledge of the state of the problem and general characteristics of the work

The main objective of this dissertation is to develop and evaluate an integrated hybrid framework to support operational decision-making in a pandemic from healthcare environments with limited resources. The framework connects SEIR-based epidemiological modeling, adaptation of k-nearest neighbors parameters, linear programming of mixed integers, and simulation of discrete events in a sequential workflow.

The scientific novelty lies in the structured integration of forecasting, prescribing, operational validation, and adaptive feedback. Forecasting results are transformed into

search indicators, demand indicators are used in optimization models, and optimization results are evaluated through simulation-based operational scenarios. This approach supports more evidence-based, adaptive, and operationally feasible pandemic decision-making in resource-constrained health settings.

The dissertation is structured in an introduction, four chapters, general conclusions about the results achieved, thesis contributions, a list of publications related to the dissertation, a declaration of originality, prospects for future development, approbation, bibliography and appendices. The dissertation has a total of 186 pages, 36 figures, 58 tables and 125 bibliographic sources. The Conclusion summarizes the results obtained by the tasks, indicates the main scientific and scientific-applied contributions of the dissertation, and formulates prospects for future development

By solving these problems, the main goal of the dissertation is achieved. A list of scientific publications on the topic.

All this proves that the PhD student has in-depth knowledge of the topics of the research carried out.

3. Correspondence of the proposed research methodology and the set goals and objectives of the dissertation

The dissertation examines how epidemiological forecasting, healthcare resource optimization, and hospital operations simulation can be integrated into a scalable and uncertainty-aware framework to support decision-making under pandemic conditions.

The chosen methods and tools, based on analysis, empirical preparation, forecasting, optimization, and simulation, align with the main goal and tasks assigned to the doctoral student. I have not noticed any errors in either the concrete or conceptual models. I also find the proposed strategies to be well-founded.

4. Contributions of the dissertation

The more significant results obtained in the dissertation are summarized in the author's claims for the following scientific and applied scientific contributions.

1. Integrated Hybrid Solution Support Framework:
2. SEIR-kNN Context-Aware Approach to Demand Estimation:
3. Hospital allocation model based on MILP.
4. Development of an operational validation layer based on DES.
5. Development of the scenario and empirical case study for COVID-19 in Kosovo.
6. Creation of an integrated assessment methodology based on KPIs.
7. Evidence of coordinated management of health networks. DES,
8. Sustainability, sensitivity and contribution to supporting fair-oriented solutions:
9. Implementation based on a structured computational path.
10. Practical Contributions to Health Systems with Limited Resources:

The reviewer accepts contributions from 1 to 4 as scientific. The reviewer accepts contributions 5, 6 and 9 as scientifically applied. The reviewer does not accept contributions 7, 8 and 10.

5. Degree of personal participation of the dissertation student in the contributions

I judge the personal participation of the PhD student by the publication activity of the PhD student reflected in the materials published on the dissertation. The PhD student convincingly presents the results achieved, with very good and in-depth argumentation, as well as uses a professional graphic layout of the materials.

The nature of the research presupposes a very good and broad preparation in the field of innovative methods and applications. A positive assessment was given to the doctoral student, emphasizing the overfulfillment of the required criteria for admission to defense. I have not noticed the presence of plagiarism.

I believe that the PhD student has done well, and I do not question her personal participation in the development of the dissertation material.

6. Evaluation of the publications of the dissertation

The attached list of publications contains 4 titles. Three of the publications are co-authored with the supervisor, and one is independent. All publications are in English in specialized journals and international conferences. Two of the publications are indexed in international databases Scopus, Web of Science, and one of them is published in an edition with SJR. This shows the ability of the PhD student to conduct research in a team, as well as independently.

The publications reflect the more significant results achieved in the dissertation. They have been reported on reputable scientific forums, which I accept for approbation in scientific circles.

7. Compliance of the abstract with the requirements for its preparation and adequacy of reflecting the main points and contributions of the dissertation

The presented abstract is in accordance with the Regulations for the preparation of abstracts on dissertations, indicated on the website of IICT-BAS. The abstract in the volume of 52 pages reflects the essence and the results achieved, as well as the contributions of the author. Graphically, it is very well formatted and includes the necessary information describing in a summary the dissertation.

8. Opinions, recommendations and comments

The dissertation examines a very complex, dynamically developing and promising field. Significant results have been achieved. The work of a well-established scientist is visible. I have no critical notes on the dissertation, except for spelling mistakes that do not detract from its value.

9. CONCLUSION

The content and contributions of the dissertation of Diellza Shani Berisha fully meet the requirements of the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for its implementation and the Regulations on the terms and conditions for acquiring scientific degrees at IICT-BAS. Considerable research

work has been carried out. There is a sufficient number of scientific, applied and applied contributions. A sufficient number of publications on the dissertation published on prestigious scientific forums are presented. The educational minimum of doctoral students set out in the individual plan is covered. The personal participation of the PhD student in the development and the contributions received is indisputable. Expressing my categorical positive attitude to the submitted materials, this gives me grounds to recommend to the Honorable Scientific Jury to award Diellza Shani Berisha the educational and scientific degree of **"Doctor"** in the professional field 4.6 "Informatics and Computer Science", specialty "Informatics"

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