

REVIEW

by

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on a dissertation for the award of the educational and scientific degree "**Doctor**"

Field of higher education: 4. *"Natural Sciences Mathematics and Informatics"*

Professional field: 4.6. *"Informatics and Computer Sciences"*

Doctoral program: *"Informatics"*

Author: Dielza Shani Berisha

Topic: "Optimization strategies and algorithms for solving health system problems during a pandemic"

Scientific supervisor: Prof. Dr. Vasil Georgiev Gulyashki, Institute of Information and Communication Technologies - BAS

By Order No. 176 of 29.06.2026 of the Director of the Institute of Information and Communication Technologies (IICT), I am approved as a member of the Scientific Jury for conducting the defense of the dissertation. By decision of the Scientific Jury at a meeting held on 30.06.2026, I am appointed as a reviewer of the dissertation.

1. General description of the submitted materials

The author of the dissertation, Dielza Berisha, studied a part-time doctoral program in the Department "Information Processes and Decision-Making Systems" of the IICT – BAS. She was dismissed from doctoral studies with the right to defend her thesis from 01.03.2026. The submitted set of materials includes the following documents:

- dissertation in English for the acquisition of the educational and scientific degree "doctor";
- abstract in English;
- list of publications on the topic of the dissertation;
- copies of the publications on the dissertation;
- declaration of originality of the results obtained;
- reference of fulfillment of the minimum requirements of the IICT for the acquisition of the educational and scientific degree "doctor";
- reference of fulfillment of the minimum requirements for registration in the National Center for Information and Documentation;
- similarity report from the StrikePlagiarizm.co system;
- preliminary opinion by Prof. D.Sc. Daniela Borisova.

The attached documents comply with the regulatory requirements set forth by the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation, as well as the Regulations on the specific conditions for acquiring scientific degrees and for occupying academic positions in the IICT.

2. Relevance of the topic and appropriateness of the set goal and tasks

The dissertation is dedicated to the problems related to the operational management of health systems during pandemic waves. The main goal is the development of an integrated hybrid decision-making support framework that combines epidemiological forecasting, optimal resource allocation and simulation of discrete events to improve the performance of the health system during pandemics. To achieve this goal, research tasks have been appropriately formulated, related to both the analysis of the problems and challenges facing health care in pandemic conditions, and the development, experimental research and evaluation of an integrated approach to support decision-making in these conditions. The relevance of the dissertation research is undeniable, taking into account the complex nature of the problems and the increased requirements for health systems in crisis conditions, as well as the need to implement effective optimization strategies and algorithms to solve these problems. In this regard, the set goal and tasks of the dissertation are well motivated with potential for contributions in scientific and applied terms.

3. Knowledge of the problem

The introduction and literature review made in Chapter 1 of the dissertation are presented on 52 pages. Various optimization and coordination strategies, mathematical models and decision support systems in health systems during pandemics are analyzed. The need for an integrated approach including epidemiological forecasting, health capacity planning, supply chain coordination, economic factors and management mechanisms, and behavioral dynamics is emphasized. Particular attention is paid to the applicability and operational feasibility of this approach in resource-constrained health systems. The conclusions to Chapter 1 justify the goal and objectives of the dissertation research, aimed at developing an integrated, scalable and adaptive hybrid decision support framework in resource-constrained health systems.

The literature review and analysis of the current state, achievements and contemporary trends in the problem area of the dissertation demonstrate in-depth knowledge of the subject and current problems, as well as potential opportunities for solving them.

4. Research Methodology

The methodology of the conducted research includes a phased and systematic implementation of the following main steps: defining the problem in healthcare during a pandemic, analyzing critical gaps and challenges in existing methods and models, designing an integrated hybrid structure to support decision-making, preparing data for an experimental case study on COVID-19 in Kosovo, introducing empirical parameters and research with the modules

for epidemiological forecasting, resource optimization and simulation, analysis and evaluation of the results. The implemented methodological approach fully corresponds to the set general goal and the formulated tasks of the dissertation.

6. Characteristics and evaluation of the dissertation work

The dissertation is 188 pages long and consists of an Introduction, 4 chapters, Conclusion, List of publications on the dissertation work and Bibliography. Two appendices have been added to the main text: Appendix A, containing lists of figures and tables, and Appendix B with additional data, software code and explanations of the results from chapters 3 and 4 of the dissertation. The list of bibliographical sources includes 125 titles by international authors, as well as Internet sites. The list of publications on the dissertation topic contains 4 titles. According to the requirements, a Declaration of originality of the results obtained is attached to the dissertation.

Chapter 1 examines the impact of pandemics and health crises in society, analyzes epidemiological forecasting models, optimization strategies and methods for multi-criteria decision-making in the implementation of healthcare activities. Existing problems and challenges that motivated the dissertation research have been identified.

Chapter 2 develops the methodological basis and architecture of a hybrid framework for supporting decision-making in the healthcare system during a pandemic. The proposed approach integrates epidemiological forecasting, health resource modeling, multi-criteria optimization, discrete event simulation, and adaptive feedback.

Chapter 3 presents the empirical and experimental basis of the dissertation research. Data from the COVID 19 pandemic in Kosovo were used and prepared for experimental research to evaluate the forecasting, optimization, and simulation strategies related to the pandemic.

Chapter 4 contains results from the experimental research of the modules for epidemiological forecasting, resource optimization, and hospital operations simulations based on the data from the COVID 19 pandemic in Kosovo, as well as an overall evaluation of the proposed approach through indicators such as forecast accuracy, hospital and intensive care unit (ICU) demand, transfer feasibility, waiting time, and throughput.

In general, the dissertation work is characterized by a thorough knowledge of the current state and issues in the field of healthcare and the functioning of healthcare systems in the context of pandemics and health crises, as well as the possibilities for finding modern and effective solutions in this area. The dissertation is structured logically and consistently, the results obtained in the individual chapters are presented and analyzed in detail and convincingly. The developed integrated approach to supporting decision-making in the operational management of healthcare systems has been experimentally studied with real empirical data, its effectiveness and practical applicability have been assessed. The author's solutions and results obtained fully meet the set goals and objectives of the dissertation. The final part lists the contributions of the dissertation

research, which are defined as scientific, methodological and practical. The appendices added to the dissertation complement the main text and contribute to the overall and complete appearance of the dissertation research.

7. Contributions and significance of the work for science and practice

I accept and positively evaluate the contributions of the dissertation. The doctoral student has classified them as scientific, methodological, empirical and practical. According to Art. 27 (1) of the Regulations for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria "The dissertation must contain scientific or scientifically applied results that represent an original contribution to science". In accordance with this provision, I accept that in general the contributions of the dissertation are of a scientific and scientifically applied nature, among which the following results can be highlighted.

- An integrated hybrid framework for supporting decision-making in healthcare management is proposed, which contributes to overcoming the fragmentation of existing methods and approaches for response during a pandemic.

- A model with adapted parameters (SEIR-kNN) has been developed for assessing hospital demand and in intensive care units under conditions of limited and heterogeneous data.

- A model using mixed-integer linear programming (MILP) has been developed to optimize the allocation of hospitals and health resources depending on demand, capacity, utilization and feasibility of transfer.

- A simulation model of health operations (admission, bed allocation, deterioration, transfer to intensive care unit, recovery, discharge, etc.) has been proposed in order to assess the performance of health facilities under stochastic conditions of hospital activity.

- An experimental study has been conducted based on data from the COVID 19 pandemic in Kosovo, a methodology for integrated assessment of health activities in hospitals has been proposed, and the possibilities for practical application of the results under limited capacity of health systems have been indicated.

The listed contributions relate to the development of new and improvement of existing models, methods and approaches in the field of health care and hospital activity in the context of pandemics and health crises. They also have the potential for development and improvement in cases where health system capacity, data availability, and analytical infrastructure may be limited.

8. Assessment of publications on the dissertation work

Four publications on the dissertation topic are presented, which are in English and were published in 2025. One of the publications is self-authored, the other three are co-authored, with the doctoral student as the first co-author. Three of the publications are indexed in the Scopus and IEEE databases, one of them is published by Springer with SJR: 0.166. The presented

publications reflect essential parts and main results of the dissertation, which have become known to the scientific community in the subject under consideration. They also demonstrate the developed qualities of the doctoral student for working both in a team and for conducting scientific research independently.

9. Personal involvement of the doctoral student

I do not know the doctoral student personally and have no direct impressions of her research activities. My acquaintance with the dissertation, the abstract and the publications made gives me reason to believe that the dissertation work and its contributions are the personal work of the doctoral student, obtained under the direct supervision of his scientific supervisor.

10. Abstract

An abstract of the dissertation in English is presented in a volume of 51 pages. The abstract meets the requirements for its design, its content corresponds to the content of the dissertation and accurately presents the main results of the dissertation.

11. Assessment of the fulfillment of the minimum national requirements

According to the Regulations for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria, to obtain the educational and scientific degree "doctor" in professional field 4.6. "Informatics and computer sciences", a minimum of 50 points is required for indicator A and 30 points for group of indicators Г. The same number of points is also required by the Regulations on the specific conditions for acquiring scientific degrees and occupying academic positions at IICT-BAS. From the submitted reports on the fulfillment of the requirements for obtaining the educational and scientific degree "doctor" it is evident that the requirements for both indicators are met.

12. Critical remarks and recommendations

I have no critical remarks on the substance of the dissertation and the presented results. Of an editorial and technical nature, I have the following remarks.

- The contributions of the dissertation could be formulated in a more compact and synthesized manner, emphasizing the most significant results of the dissertation research. For example, in the current formulation, contributions from 7 to 10 on page 158 rather contain conclusions and analysis of the results obtained. Also, there is some repetition of the texts in the sections "Scientific Novelty and Contributions" on page 16 and "Thesis Contributions" on page 157.

- Inaccuracies have been made in the numbering of the figures and tables in Chapter 1 of the dissertation, as well as inconsistencies in their citation and explanation in the text of the chapter.

These remarks are not on the substance of the work and do not reduce the value of the contributions in the dissertation work.

My recommendation to the doctoral student is to continue and expand the research activity for further development and improvement of the proposed models, as well as practical application of the developed integrated approach to managing the health system in the context of a pandemic.

CONCLUSION

I positively assess the work done and the results obtained in the dissertation. The dissertation work contains original scientific and scientifically applied results that meet all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation and the Regulations for the specific conditions for acquiring scientific degrees and for occupying academic positions at IICT-BAS. The doctoral student possesses in-depth theoretical knowledge and professional skills in the specialty "Informatics", demonstrating qualities and skills for independent conduct of scientific research.

In view of the above, I confidently propose to the esteemed Scientific Jury to award the educational and scientific degree "doctor" to Dielza Shani Berisha in the field of higher education: 4. "Natural Sciences Mathematics and Informatics", professional direction 4.6. "Informatics and Computer Sciences".

Sofia,
21.08.2026

