

OPINION

on the dissertation work of Diellza Shani Berisha
on the topic „Optimization Strategies and Algorithms for Solving Health System Problems
During a Pandemic“, Doctoral program "Informatics", professional field 4.6. "Informatics and
Computer Science"

Scientific Jury member: prof. Daniela Ivanova Borissova, D.Sc. at IICT-BAS

According to Order No. 176/29.06.2026 of the Director of IICT-BAS, I have been appointed as a member of the scientific jury, and according to the minutes of the first meeting, I have been selected to prepare a statement. For this purpose, I have received all the documents submitted by the doctoral student in accordance with the procedure.

1. Relevance of the dissertation research

The research presented in the dissertation examines an interesting and topical topic related to optimization strategies for solving problems in the health system during a pandemic. Pandemic situations simultaneously pose tasks of predicting epidemiological developments, assessing the future load on the hospital system, allocating limited hospital and intensive care resources, managing patient flows, and assessing the sustainability of decisions made in the face of changing demand and capacity. Therefore, health systems must address complex pandemic challenges using dynamic optimization, stochastic programming, and predictive epidemiological algorithms. These methods address key challenges such as resource shortages, hospital capacity constraints, and patient flow logistics through dynamic redistribution of supplies, forecasting infection peaks, and formulating plans for equitable distribution. This gives me reason to believe that the topic of the dissertation research is timely and relevant.

2. Analytical characteristic

The dissertation has a total volume of 188 pages and is structured as follows: title page, table of contents, Acknowledgments, Dissertation Structure, Roadmap of the dissertation, list of abbreviations, introduction, 4 chapters, Conclusion – a summary of the results obtained, thesis contributions, list of publications related to the thesis, declaration of originality, bibliography, and 2 appendices. The structure presented in this way fulfills the requirements of Art. 27, para. (2) of the Regulations for the implementation of the Law on the Development of Academic Staff in the Republic of Bulgaria. The research is supported by 36 figures, 58 tables, and 125 bibliographical sources.

On page 15, the goal of the dissertation research is formulated as *"to develop and evaluate an integrated hybrid decision-support framework that combines epidemiological forecasting, optimization-based resource allocation, and discrete event simulation for improving healthcare-system performance during pandemic conditions"* and 8 tasks for its implementation.

Chapter 1 provides a literature review and theoretical background. The multidimensional impact of pandemics is examined, along with existing approaches in epidemiological forecasting, healthcare operations optimization, supply chain coordination, trade-offs between economics and health, capital-aware optimization, and real-time decision-making. The gaps that motivate the dissertation research are identified here.

In Chapter 2, a proposed integrated hybrid decision support framework is described. It defines the problem scope, modeling assumptions, system architecture, epidemiological component, healthcare resource model, optimization strategy, simulation layer, and adaptive workflow. The chapter presents the methodological basis for linking forecasting, prescription, and operational validation.

Chapter 3 deals with empirical data, parameterization, and experimental design for the COVID-19 case study in Kosovo. Data sources, the logic for including municipalities, robustness checks, derived indicators, preprocessing, normalization, MATLAB input preparation, and scenario design required for the SEIR-kNN, MILP, and DES experiments are presented.

Chapter 4 contains computational results and analysis. The results of SEIR-kNN forecasting and demand estimation, MILP-based hospital allocation results, DES-based hospital operation simulation results, and the integrated evaluation of the SEIR-kNN-MILP-DES framework through metrics such as forecast accuracy, hospital and ICU demand, utilization, transfer feasibility, waiting time, throughput, unmet demand, and sustainability are presented.

3. Compliance of the chosen research methodology with the set goal and objectives of the dissertation work

The methodology used, based on analysis, empirical preparation, forecasting, optimization, and simulation, is appropriately chosen and contributes to achieving the set goal and the formulated tasks in the dissertation.

The main idea is well structured: SEIR-kNN → MILP → DES, i.e., forecasting → optimization → operational verification. The proposed hybrid model combines the interpretability of the SEIR model with local parameter adaptation using kNN. This is a reasonable approach for a small set of municipal data, as it allows avoiding the assumption that all municipalities have identical dynamics. The emphasis on resource constraints, uncertainty, and regional capacity distribution is well placed. The empirical example of Kosovo is logically related to the problem of a resource-constrained health system.

4. Assessment of dissertation publications and assessment of the degree of personal involvement

On the topic of the dissertation, the doctoral student has submitted 4 publications, 1 of which was accepted but without an attached document and therefore is not evaluated. All publications are in English, and for the 3 publications evaluated, the doctoral student is the first author. This gives me reason to believe that the results presented in the dissertation are the personal work of the doctoral student. 2 of the publications are indexed in Scopus, and the third was published in a non-refereed journal with scientific review. One of the publications indexed in Scopus has an SJR. Thus, for group D, the total sum of the indicators is 32 points, which satisfies the criteria of the Bulgarian Academy of Sciences and specific requirement of IICT-BAS and also the minimum national criteria for acquiring the educational and scientific degree “doctor”.

5. Contributions

The main achievements in the dissertation work are of the nature of scientific and applied scientific contributions, which enrich the scientific field with new knowledge and can be summarized as follows:

- (1) An integrated computational framework has been proposed and developed, which connects epidemiological forecasting, resource optimization, and discrete-event simulation in a single architecture of a decision support system.
- (2) A combination of SEIR and kNN has been proposed, which allows adapting epidemiological parameters to different municipal characteristics.
- (3) A MILP approach has been developed for coordinated distribution of patients between hospital structures under capacity and transfer constraints.
- (4) DES verification has been integrated, through which optimization solutions are evaluated under stochastic patient flows, Intensive Care Unit congestion, and staffing constraints.

6. Abstract and author reference

The submitted abstract is 51 pages long, faithfully reflects the content of the dissertation work, and complies with the requirements of the Law on the Research and Development of the Republic of Bulgaria. From the review conducted and the published results on the topic of the dissertation research, it can be established that the doctoral student is well aware of the nature of the issues under study. As additional evidence of the author's results, the plagiarism check performed using iThenticate, which shows a 5% SIMILARITY INDEX.

7. Critical notes, questions, and recommendations

The dissertation is distinguished by a current and socially significant issue; a clearly defined research goal; a logical methodological structure; integration of SEIR-kNN, MILP, and DES; experimental verification through the Kosovo COVID-19 case study; quantitative results; practical applicability; and a critical attitude toward the limitations of the development.

I recommend publishing the results in visible, indexed journals and in world databases.

8. Conclusion

The dissertation research convincingly demonstrates that the doctoral student possesses theoretical knowledge and practical skills in informatics and computer science, as well as proven abilities in independent scientific research. **The presented dissertation work is in accordance with 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 on the Specific Conditions for Acquiring Scientific Degrees and for Holding Academic Positions at the IICT-BAS.** All of these motivate me to give a categorically positive assessment and to propose to the respected Scientific Jury that Diellza Shani Berisha be awarded the educational and scientific degree "Doctor" in the doctoral program "Informatics", professional field 4.6. "Informatics and Computer Sciences".

25 of August 2026

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