

OPINION

BY ASSOC. PROF. EMIL HRISTOV DOYCHEV, PHD

on a dissertation for awarding the educational and scientific degree "**doctor**",

field of higher education: *4. Natural sciences, Mathematics, and Informatics*;

professional field: *4.6. Informatics and Computer Science*

doctoral program: *Informatics*

Author: **TODOR ATANASOV TODOROV**

Topic: RISK ANALYSIS IN SMART FARMING CONDITIONS

General presentation of the submitted materials

This opinion has been prepared in accordance with order № ПД-22-1032 of 19.05.2026 of the Rector of the University of Plovdiv "Paisii Hilendarski", by which I have been appointed as a member of the scientific jury to participate in a procedure for the defense of a dissertation on the topic of "***Risk Analysis in Smart Farming Conditions***" for acquiring the educational and scientific degree "doctor" in professional field 4.6. Informatics and Computer Science. The author of the dissertation is Todor Atanasov Todorov, a full-time doctoral student at the Department of Computer Systems at the Faculty of Mathematics and Informatics at the University of Plovdiv, with scientific supervisor Prof. Stanimir Stoyanov, PhD.

The set of presented materials is in accordance with Article 36 (1) of the Rules for the Development of the Academic Staff of the University of Plovdiv "Paisii Hilendarski".

Todor Todorov holds a master's degree in "Computer Technologies" with the professional qualification "Economist - Informatician" from the University of Plovdiv "Paisii Hilendarski" and a master's degree in "International Economic Relations" with the professional qualification "Master of Economics" from the University of National and World Economy (UNWE) in Sofia. He also holds a master's degree in "Pedagogy of Teaching Informatics and Information Technologies" from the University of Plovdiv "Paisii Hilendarski". Since 2018, he has been a full-time doctoral student in the doctoral program "Informatics" at the Department of Computer Systems at FMI of the University of Plovdiv. He has extensive professional experience in the banking sector and, since 2021, works as a chief expert "Corporate Banking in a Regional Center" at Targovska Banka D AD. Since 2019, he has been a part-time lecturer at the Faculty of Mathematics and Informatics of the University of Plovdiv, where he teaches the courses "Banking and Banking Information Systems" and "Internet Banking via Mobile and Online Applications".

Relevance of the developments in the dissertation work on issues in both scientific and scientific-applied aspects

The main focus of the dissertation work is on the identification and analysis of financial risk in the context of smart agriculture, based on the integration of agricultural, climatic, and financial data. The goal of the dissertation is formulated as follows: the development and substantiation of a conceptual, methodological, and architectural model for the identification and analysis of financial risk in the context of smart agriculture. The object of the research is the financial risks in agricultural enterprises, and the subject is the methods, models, and information systems for the identification,

analysis, and management of financial risk, as well as the possibilities for their integration into smart agriculture platforms.

The theme of the dissertation work is undoubtedly relevant. Agriculture is characterized by a high degree of uncertainty, determined by the interaction of natural, economic, and technological factors, and in the context of climate change, increased market volatility, and growing sustainability requirements, financial risk in the agricultural sector acquires a systemic character. The relevance of the research is determined by several key factors: the growing financial vulnerability of agricultural producers as a result of climatic and market shocks; the limited effectiveness of existing risk management instruments, including index-based insurance and traditional financial mechanisms; the need to integrate heterogeneous data (agricultural, financial, and climatic); as well as the increasing role of digitalization and intelligent systems in the management of agribusiness.

Despite the availability of various digital solutions, in both scientific and applied practice there is a lack of an integrated approach for the joint use of agronomic, climatic, and financial data for the purpose of systematic financial risk management. This necessitates the development of new conceptual and technological solutions, such as the one proposed in the dissertation work. The work is also thematically connected with the research of the Department of Computer Systems in the field of intelligent agricultural systems and the ZEMELA platform, which the doctoral student extends with a new module for the identification and analysis of financial risk. *I consider the subject matter under consideration to be highly relevant in both scientific and scientific-applied aspects.*

Knowledge of the research problem

The clearly defined aim of the dissertation, the well-motivated and specifically formulated eight main tasks to achieve the aim, the literature review, analysis, and conclusions demonstrate a very good knowledge of the problem area on the part of the doctoral student. The first two chapters of the dissertation are devoted to an analytical review of financial risks and electronic systems in agriculture, as well as to the theoretical foundations and classifications of financial and agricultural risks, examining both the nature and types of risks (market, credit, operational, climatic, basis, and systemic risk) and the modern digital technologies for their management. From the dissertation and its bibliography, containing 102 literature sources, it can be concluded that the doctoral student has deeply and thoroughly researched the state of research in the area under consideration, including official guidelines, international institutional frameworks, and recent empirical studies. The dissertation text is clear, precise, and analytical.

Research methodology

I believe that the chosen methodology of the study follows the usual developments in the field. The doctoral student first carries out an analytical review of financial and agricultural risks and of the existing electronic systems for their management, after which he proposes a conceptual event-oriented model for the identification of financial risks, in which financial-risk events are represented formally (through the triple $\langle \text{eid}, \text{etype}, \text{epar} \rangle$) and are composed by means of causal, logical, and temporal operators. This model is developed as an adaptation of the event model of the smart agriculture platform ZEMELA and serves as the theoretical basis of the proposed architecture.

At the next level, the doctoral student develops a formal mathematical model for the quantitative identification of risk, which is built sequentially in four steps - the creation of a parametric space (13 primary indicators of the enterprise's financial condition), its reduction to an

index space (8 risk indices), then to a finite interval space, and finally the specification of the five characteristic points corresponding to the types of risk (minimal, low, moderate, high, and critical). This approach is methodologically sound, since through successive reductions the problem of the infinite solution space is overcome and a finite set is reached, suitable for implementation in a knowledge-based system.

The proposed models are implemented in software as a prototype of an expert system (FIRA), composed of a dialogue component, an explanatory component, a knowledge base, and an inference engine, implemented through production rules and frames in the Flex environment. Finally, the methodology is validated through five representative test examples of real agricultural enterprises – one for each type of risk – in which the system's results correspond to the expected assessments. *I consider the chosen methodology to be adequate to the stated aim and objectives.*

Characteristics and evaluation of the dissertation work and contributions

The dissertation is 131 pages long and consists of an introduction, four chapters, a conclusion with future development, a list of the scientific and scientific-applied results, a list of the publications cited in the dissertation, and a bibliography. The work contains 16 figures, 8 tables, and 102 literature sources.

The research work is structured into several logical components, which are dealt with in the individual chapters of the dissertation:

The introduction substantiates the relevance of the research and formulates the aim, object, subject, and tasks of the work. Chapter 1 - Financial Risk and Electronic Systems in Agriculture: this section provides an analytical review of the scientific research and practices related to financial risk and electronic systems in agriculture, examining the main types of financial risks, the role of digitalization, index-based and satellite insurance and the problem of basis risk, FMIS and ERP systems, fintech and blockchain solutions, as well as the existing gaps and challenges; the ZEMELA platform is also presented here as a basis for integration. Chapter 2 - Financial and Agricultural Risks - Nature and Management: the definitions, characteristics, and numerous classifications of financial and agricultural risks are examined (by source, by time of occurrence, by degree of predictability, by possibility of insurance coverage, etc.), as well as the main objectives and principles in the management of financial risk. Chapter 3 - Mathematical Model for the Identification of Financial Risk: in this section a formal mathematical model is developed, built in four steps - a parametric space (13 primary indicators), an index space (8 risk indices), an interval space, and the specification of the five characteristic points corresponding to the types of risk (minimal, low, moderate, high, and critical). Chapter 4 - Software Implementation of a System for the Study of Financial Risk: here the FIRA prototype is presented, implemented in the Flex environment and integrated into the event-oriented architecture of the ZEMELA platform; the general architecture is described (dialogue component, explanatory component, knowledge base, and inference engine), along with the development environment, the software implementation, and the testing of the prototype through five representative examples of real agricultural enterprises. The conclusion summarizes the results of the work carried out and outlines directions for future development.

A very good impression is made by the finalization of the individual chapters, where the main conclusions, generalizations, and results are synthesized.

The doctoral student has pointed out concrete possibilities for the future development of the work: empirical validation of the proposed model through the deployment of the financial risk module in a real or pilot environment; expansion of the set of risk analysis models through the integration of more complex econometric and machine-learning approaches (deep neural networks, Bayesian and ensemble methods); standardization and interoperability between different FMIS, ERP, and financial platforms; improvement of the index-based insurance models to reduce basis risk; as well as the integration of regulatory and ESG indicators to support public policies.

The results achieved in the dissertation work are original and correspond to the stated aim and objectives. I accept the scientific and scientific-applied results summarized at the end of the dissertation, which, in my judgment, can be systematized as scientific, scientific-applied, and applied. Among the scientific contributions, the following stand out: the development of a formal event-oriented model for the identification of financial risks in agriculture, in which risks are represented as compositions of agronomic, climatic, and financial events; the demonstration of the applicability of event-oriented architectures for modeling financial risk; the formulation of an integration framework for combining heterogeneous data; as well as the substantiation of the possibility of reducing basis risk through local calibration of indices. To the scientific-applied and applied contributions I assign the designed architecture of a module for the identification and analysis of financial risks, the early-warning methodology, the developed mechanism for supporting management decisions through visualization and interpretation of the results, as well as the implemented FIRA prototype, demonstrating the practical applicability of the proposed approach. The contributions relate to the areas of financial risk management in the agricultural sector, event-oriented architectures, and intelligent information systems. ***I believe that the goal of the PhD has been achieved.***

Evaluation of the dissertation publications and personal contribution of the PhD student

Todor Todorov has submitted two publications related to the dissertation work, both co-authored and reported as refereed and indexed in world-renowned databases of scientific information (Web of Science and Scopus). One was presented at the International Conference on Information Technologies (InfoTech-2025), and the other was presented at the 13th International Conference on Intelligent Systems (IS'26) and is directly devoted to the modeling of financial risks in smart agriculture. I accept that the main results of the dissertation are presented to the scientific community. ***I have no doubts that the dissertation and the results obtained are the personal work of the doctoral student. I have not noticed or detected any plagiarism.***

The minimum national requirements for acquiring the educational and scientific degree "doctor" in professional field 4.6. Informatics and Computer Science have been met, according to which a minimum of 30 points under group G indicators must be available, while the doctoral student has 36 points.

Abstract

The abstract is of a volume that meets the requirements and correctly reflects the structure, aim, and tasks of the dissertation work. It has been prepared in accordance with the requirements of the ADASRB and the Rules of the University of Plovdiv "Paisii Hilendarski" and gives an accurate impression of the content of the dissertation.

Critical remarks and recommendations

I recommend the doctoral student to continue the research undertaken, as the topic has a high degree of applicability and wide perspectives for development, including through the validation of the proposed models in a real environment. I would encourage his future publications to be concentrated around the central theme of the research.

CONCLUSION

The dissertation work contains scientific, scientific-applied, and applied results, which represent an original contribution to science and meet the requirements of the Act for the Development of the Academic Staff in the Republic of Bulgaria, the Rules for the Implementation of the ADASRB, and the Rules for the Development of the Academic Staff of the University of Plovdiv "Paisii Hilendarski".

I believe that the doctoral student Todor Todorov possesses in-depth theoretical knowledge in the specialty "Informatics" and the ability to conduct independent scientific research. All of this gives me grounds for an entirely **positive assessment of the dissertation work**. I propose to the honorable scientific jury to award the educational and scientific degree "**doctor**" to **Todor Atanasov Todorov** in field of higher education: 4. Natural sciences, Mathematics, and Informatics, professional field 4.6. Informatics and Computer Science, doctoral program "**Informatics**".

07.06.2026

Plovdiv

Signature:

/Assoc. Prof. Emil Doychev, PhD/