

REVIEW

by **Prof. Dr. Maria Petkova Hristova**

of a dissertation submitted for the award of the educational and scientific degree **Doctor (PhD)**

Field of Higher Education: 4. Natural Sciences, Mathematics and Informatics

Professional Field: 4.6 Informatics and Computer Science

Doctoral Programme: Informatics

Author: Stanislav Minchev Dakov

Dissertation Title: *“Tools for Enhanced User Interaction in Electronic Commerce”*

Scientific Supervisor: Assoc. Prof. Dr. Veselin Kyurkchiev, Paisii Hilendarski University of Plovdiv

1. General Description of the Submitted Materials

By Order No. RD-22-1033 dated 19 May 2026 of the Rector of Paisii Hilendarski University of Plovdiv (PU), I was appointed as a member of the Scientific Jury responsible for conducting the procedure for the defense of the dissertation entitled *“Tools for Enhanced User Interaction in Electronic Commerce”* for the award of the educational and scientific degree Doctor (PhD) in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.6 Informatics and Computer Science, doctoral programme Informatics.

The author of the dissertation is Stanislav Minchev Dakov, a full-time doctoral student at the Department of Computer Technologies, Faculty of Mathematics and Informatics, under the supervision of Assoc. Prof. Dr. Veselin Nikolaev Kyurkchiev from Paisii Hilendarski University of Plovdiv.

The set of materials submitted by Stanislav Dakov in both printed and electronic form complies with Article 36(1) of the Regulations for Academic Staff Development of PU and includes the following documents:

- an application to the Rector of PU for opening a dissertation defense procedure;
- a Curriculum Vitae in European format;
- minutes from the preliminary departmental discussion and an opinion from the scientific supervisor regarding the readiness of the dissertation for preliminary discussion;
- an abstract (in Bulgarian and English);
- a list of scientific publications related to the dissertation topic;
- copies of the publications related to the dissertation topic;
- a declaration of originality and authenticity of the submitted documents;
- a report demonstrating compliance with the minimum national requirements.

The doctoral candidate has submitted six publications.

All documents included in the dissertation defense package have been prepared accurately and meticulously in accordance with the requirements of the Regulations for the Implementation of the Academic Staff Development Act in the Republic of Bulgaria and the Regulations for Academic Staff Development of PU.

2. Brief Biographical Information about the Doctoral Candidate

Stanislav Dakov graduated from Paisii Hilendarski University of Plovdiv in 2012 with a Bachelor's degree in Informatics and obtained a Master's degree in the same specialty in 2013.

During the period 2020–2023, he was a full-time doctoral student in Professional Field 4.6 Informatics and Computer Science, Doctoral Programme “Informatics,” at the Department of Computer Technologies, Faculty of Mathematics and Informatics, PU.

He has professional experience in software and website development and maintenance. He has worked at Dazines Web Design and Web Development, Reward Gateway, Programista, and BC Services Europe. During 2011–2012, he conducted PHP laboratory classes at the Faculty of Mathematics and Informatics. He served as Vice-Chairperson of the Student Council of PU and Chairperson of the Faculty Student Council of the Faculty of Mathematics and Informatics.

3. Relevance of the Topic and Appropriateness of the Objectives and Tasks

The dissertation of doctoral candidate Stanislav Dakov is devoted to a current and significant scientific and applied problem related to improving user interaction in electronic commerce through the use of modern information technologies and artificial intelligence methods. The dissertation topic corresponds to contemporary trends in the development of electronic commerce, the digitalization of business processes, and the implementation of artificial intelligence-based technologies. Under conditions of continuously increasing numbers of online commercial platforms and growing consumer demands regarding service quality, personalization, and rapid access to information, the development of tools for improving user interaction is of particular importance.

The relevance of the research is further enhanced by the fact that the doctoral candidate seeks opportunities for integrating different technological approaches to create more effective means of interaction between businesses and consumers. Particular attention is paid to the use of artificial intelligence and automated extraction of information from Internet resources, which represents a modern and promising direction with high practical applicability.

The topic fully corresponds to Professional Field 4.6 “Informatics and Computer Science,” as it includes: modeling of information processes; development of software

systems; integration of AI technologies; data analysis and processing; and design of information architectures.

The objective of the dissertation is clearly and specifically formulated as “Research into opportunities and development of prototype software tools for improving user interaction in electronic commerce” and is fully consistent with the selected topic.

To achieve this objective, three tasks have been formulated, which are logically connected to the main objective and lead to its realization. These include:

- analysis of existing technologies and tools;
- design and development of a model of innovative opportunities for improving user interaction in electronic commerce;
- development of a prototype online platform with a set of tools supporting the improvement of user interaction in electronic commerce;
- experimental investigation of the effectiveness of the proposed solutions.

The dissertation topic is undoubtedly relevant and significant both scientifically and practically, while the stated objective and tasks are appropriate, specific, and fully adequate to the subject of the research.

4. Knowledge of the Problem, Style, and Language

Based on the submitted dissertation and its bibliography, it can be concluded that the doctoral candidate has conducted a thorough and careful study of the state of research in the field under consideration. The bibliography contains 206 literary and Internet sources, of which 2 are in Cyrillic and 204 are in English. All references are correctly cited in the text. It is particularly noteworthy that the literature review covers both classical studies and a substantial number of recent scientific publications related to artificial intelligence, machine learning, chatbots, virtual assistants, consumer data analytics, and large language models. This demonstrates the doctoral candidate’s effort to follow and critically evaluate contemporary trends and to position the research within the context of the latest technological advancements.

The rules of proper language usage and academic writing style have been observed. The dissertation text is clear, precise, and analytical.

5. Research Methodology

The methodology employed in the dissertation is comprehensive and appropriate to the stated objective. It combines fundamental theoretical, analytical, experimental, and applied research approaches, including: Literature analysis – for examining existing theories, models, technologies, and scientific publications in the fields of electronic commerce and user interaction; Comparative analysis of existing solutions – for evaluating and comparing different tools, technological solutions, and approaches; Systems approach and modeling – in

the development of a hybrid data extraction model and the design of the overall software architecture; Experimental approach – for developing prototype solutions and conducting tests to evaluate their effectiveness; Quantitative analysis of results – for assessing the accuracy and efficiency of the proposed hybrid model.

Despite the well-organized research process, the dissertation does not explicitly formulate a scientific hypothesis that would link the stated objectives, tasks, and experimental results.

6. Characteristics and Evaluation of the Dissertation

The main body of the dissertation comprises 179 pages and consists of an introduction, three chapters, a conclusion, a list of the author's publications related to the dissertation, citations received, dissemination of results, and references. The graphical component includes 62 figures and 4 tables.

The introduction provides the foundation for the dissertation and justifies the practical significance of the topic. The objective and research tasks are clearly and correctly formulated and logically follow the structure of the presentation.

The first chapter is theoretical and analytical in nature. A comprehensive review is provided of the main concepts, contemporary technologies, and AI-based tools used for interaction between businesses and consumers in electronic commerce, including chatbots, virtual and personal shopping assistants, AI-based predictive analytics, AR/VR solutions, personalized recommendation systems, consumer behavior analytics platforms, omnichannel interaction concepts, computer vision, large language models, and others. The author demonstrates a strong understanding of the practical applications of these technologies and their role in improving customer experience. Particular emphasis is placed on the importance of security and trust as fundamental prerequisites for the effective functioning of electronic commerce. Examples from international practice are presented to illustrate the effective use of e-commerce tools and platforms. This chapter establishes the necessary theoretical foundation for the subsequent research and justifies the need for modern technological tools to enhance customer experience, security, and efficiency in electronic commerce.

The second chapter presents a hybrid model developed by the doctoral candidate for extracting data from the Internet with the aim of improving user interaction in electronic commerce. The model integrates three complementary approaches to data processing: a deterministic symbolic approach (rule-based); sub-symbolic deep learning (deep learning); linguistic-semantic interpretation (large language models). A significant strength of the model is its formalization through a mathematical framework, which provides a foundation for the development of a real software system and lends scientific validity to the proposed solution. The formal functions describing the operation of the components, sets, and theoretical properties of the model establish a clear framework and conceptual architecture for its

functioning. The main technical aspects of the practical implementation in a real e-commerce environment are also described: Module R – a Java-based rule-driven system; Module V – implemented through the YOLOv8 computer vision model and developed using a dataset containing approximately 27,000 images extracted from 28 different websites; Module L – implemented through integration with ChatGPT for data extraction. The architecture enables both autonomous and collaborative operation of the individual components, combining their strengths and compensating for their limitations in order to achieve greater efficiency, accuracy, and speed in data extraction. An experimental validation of the proposed solutions was conducted through tests on 10 real-world websites and comparative analysis among the individual system components. The obtained results demonstrate the potential of the hybrid approach for further development and application not only in electronic commerce but also in other domains requiring automated extraction and structuring of information from dynamic Internet environments.

The third chapter presents an online platform developed by the doctoral candidate for improving user interaction in electronic commerce, implemented on the basis of the hybrid model proposed in Chapter Two. The chapter has a strong practical orientation and demonstrates a real software implementation of the proposed theoretical concepts. The architecture, technologies used, and main functional modules of the system are described. A particularly significant contribution is the developed Internet data extraction module, implemented using a microservices-based architecture and consisting of several components, including: Scraper Service; Controller; Queue Listener; Notifier; Scheduler Service. The module provides automated product monitoring, information extraction, and user notifications regarding price changes. The following technologies were used in its development: Java; Spring Boot; Playwright; Redis; Telegram Bot API. A Telegram bot and a Chrome plugin were also developed for the platform, facilitating access to the system's functionalities and improving the user experience. Integration was achieved between the web platform, the Telegram bot, and the browser extension, creating a unified environment for collecting, processing, and delivering information to users. The system was validated through real-world testing and analysis of the results. The reported indicators - 94% data extraction accuracy, reduced processing time, and high user satisfaction - demonstrate significant improvement compared to baseline approaches and confirm the practical applicability of the proposed model. These results confirm the effectiveness of the proposed solution. The outcomes of the developed tools, including: a parcel tracking tool; a functional personal expense management tool; a real-world implementation of the Telegram bot for monitoring real-estate listings, have been deployed and are operating successfully in real production environments.

The conclusion outlines the main contributions of the dissertation. A table presents the relationship between the contributions, research tasks, dissertation structure, and publications. The doctoral candidate's vision for future development of research in the field makes a particularly positive impression. The dissertation also includes information on the doctoral candidate's participation with four scientific papers in projects funded by the Research Fund of Paisii Hilendarski University of Plovdiv) and the National Science Fund of the Ministry of Education and Science.

The dissertation and all accompanying materials are very well organized and professionally presented.

7. Contributions and Significance of the Research for Science and Practice

The doctoral candidate has identified five main contributions that reflect both the theoretical research and the practical implementation of the developed solutions. The contributions are consistent with the objectives and tasks of the dissertation and may be summarized in two main categories: scientific contributions and scientific-applied contributions.

In the reviewer's opinion, the principal scientific contribution of the dissertation consists in the development of a conceptual and methodological framework for a hybrid model for the automated extraction and structuring of data from Internet environments. The proposed model integrates three different approaches: deterministic, deep learning-based, and linguistic-semantic, thus providing an original solution for increasing the efficiency and reliability of information extraction. The effort to formalize the process and provide opportunities for extending and further developing the model deserves positive recognition.

A significant scientific-applied contribution is the implementation and experimental validation of the proposed hybrid model through the integration of a Java-based tool, YOLOv8, and ChatGPT, which can operate both autonomously and synchronously. The hybrid method has been successfully integrated into a developed online platform containing a set of tools that contribute to improving user interaction in electronic commerce.

Additional scientific-applied contributions include the creation of a specialized module for efficient web scraping and extraction of data regarding new products, current price changes, and user notifications; a Telegram-based integration; and a Chrome plugin that extends the functionality of the platform and demonstrates the applicability of the proposed solutions in a real-world environment.

I consider the claimed contributions to be genuine, well-argued, and substantially validated within the dissertation. They may be classified as contributions that enrich existing scientific knowledge and represent scientific achievements in practice, as well as the creation

of new methods, approaches, and models, and the modification of existing ones for solving the problems addressed in the dissertation.

I believe that the objectives of the doctoral study have been successfully achieved.

Overall, the future development perspectives proposed by the doctoral candidate are realistic, relevant, and demonstrate potential for further enhancement of the achieved scientific and applied results. They include improvement of the theoretical hybrid model, extension of the functionality of the developed platform and its modules, integration of additional data sources, the use of machine learning for process optimization, and expansion of the applicability of the model to other domains.

8. Evaluation of the Publications Related to the Dissertation

Stanislav Dakov has presented a total of six publications related to the dissertation topic, one of which is single-authored, while in the remaining publications he is listed as the first author.

The requirement of a minimum of four publications reviewed and indexed in internationally recognized scientific databases has been fulfilled. One publication is indexed in Web of Science (*International Conference on Innovations in Science and Education (Natural Sciences and ICT), Prague, Czech Republic*), and three publications are indexed in Scopus (*TEM Journal, Engineering Proceedings (Q3)*, and *International Journal of Differential Equations and Applications (Q4)*). The remaining two publications have been published in the proceedings of the *International Scientific Conference IMEA'2023, Pamporovo, Bulgaria*, and in the *Scientific Proceedings of the Union of Scientists – Plovdiv*. All publications are in English.

A report documenting seven citations of the doctoral candidate's publication: Dakov, S., Malinova, A., *A Survey of e-Commerce Security Threats and Solutions*, CBU International Conference Innovation in Science and Education, March 17, 2021, Prague, Czech Republic, Vol. 2 (2021): Proceedings of CBU in Natural Sciences and ICT, pp. 1–9. ISSN: 2695-0758, has been submitted, including three citations indexed in Scopus. This confirms the relevance of the dissertation topic, the significance of the achieved results, and their applicability. I accept that the results of the dissertation have been adequately disseminated to the scientific community.

The Minimum National Requirements under Article 2b, paragraphs 2 and 3, respectively the requirements under Article 2b, paragraph 5 of the Academic Staff Development Act of the Republic of Bulgaria, as specified in the Regulations for its Implementation for obtaining the educational and scientific degree "Doctor" in Professional Field 4.6, have been fulfilled. According to these requirements, at least 30 points must be

accumulated under indicator group G, whereas the doctoral candidate has achieved 90 points, representing 300% fulfillment of the requirement.

The doctoral candidate has submitted a declaration of originality and authenticity. There is no evidence of plagiarism established in accordance with the legally prescribed procedures concerning the submitted dissertation or scientific publications.

9. Personal Contribution of the Doctoral Candidate

The personal contribution of the doctoral candidate is evident from the submitted research and his ability to define tasks, solve problems, and derive logically justified conclusions. I have no doubt that the dissertation and the obtained results are the work of the doctoral candidate, or, where they have been achieved within collaborative research projects, that the doctoral candidate's contribution is clearly distinguishable.

10. Abstract

The abstract complies with the requirements of the Regulations for the Implementation of the Academic Staff Development Act in the Republic of Bulgaria. It consists of 32 pages, is very well structured, and accurately reflects the content of the dissertation, the main aspects of the research, and the achieved results.

11. Critical Remarks and Questions

The dissertation is characterized by the relevance of its topic, a strong practical orientation, and a substantial volume of research and scientific-applied work.

Alongside its unquestionable merits, the following remarks may be made:

- The dissertation does not formulate a scientific research hypothesis.
- The criteria and indicators used to evaluate the effect of the proposed approach on user interaction are not sufficiently clearly defined and justified.
- The experimental evaluation is based on a relatively limited set of websites.
- The scientific contributions and the scientific novelty of the proposed solutions should be more clearly highlighted.

The following questions may be raised:

- What are the prospects for the development of the proposed model with the emergence of new multimodal AI models?
- What numerical metrics were used to measure the improvement in user interaction?
- How were the reported 94% data extraction accuracy and 38% reduction in processing time calculated, and on what volume of data was the experiment conducted?

12. Recommendations for the Future Use of the Dissertation Contributions and Results

I recommend that the doctoral candidate continue the initiated research, as the topic has a high degree of applicability and broad prospects for future development. In future work, it

would be beneficial to place greater emphasis on research aspects related to improving the accuracy, adaptability, and intelligence of the hybrid model, as well as on the development of objective criteria for evaluating its effectiveness under different application conditions. Greater emphasis could also be placed on the universality of the architectural approach rather than on dependence on specific technologies or external services.

The remarks and recommendations made above do not diminish the scientific value of the achieved results; rather, they outline opportunities for further development and improvement of the research.

13. Personal Impressions

I do not know the doctoral candidate personally.

CONCLUSION

The dissertation addresses a relevant and practically significant scientific problem, demonstrates a high level of scientific-applied implementation, and exhibits strong applicability in the field of electronic commerce. The stated objective and tasks have been successfully accomplished. The obtained results possess scientific, scientific-applied, and practical significance and comply with the requirements of the Academic Staff Development Act of the Republic of Bulgaria, the Regulations for its Implementation, and the corresponding Regulations of Paisii Hilendarski University of Plovdiv. Stanislav Dakov possesses profound theoretical knowledge in the field of Informatics and demonstrates the ability to conduct independent scientific research.

All of the above provides sufficient grounds for a positive evaluation of the dissertation. Therefore, I propose that the esteemed Scientific Jury award the educational and scientific degree **Doctor (PhD)** to **Stanislav Minchev Dakov** in the field of higher education **4. Natural Sciences, Mathematics and Informatics**, professional field **4.6 Informatics and Computer Science**, doctoral programme **Informatics**.

06 June 2026

Reviewer:

/Prof. Dr. Maria Hristova/