



COLLECTION OF SCIENTIFIC PAPERS



ISSUE  
№10

2ND INTERNATIONAL SCIENTIFIC  
AND PRACTICAL CONFERENCE

**MODERN SCIENCE,  
ECONOMY AND  
DIGITAL INNOVATION**

MARCH 12-14, 2025  
BUCHAREST, ROMANIA





INTERNATIONAL SCIENTIFIC UNITY

2nd International Scientific and Practical Conference  
**«Modern Science, Economy  
and Digital Innovation»**

Collection of Scientific Papers

March 12-14, 2025  
Bucharest, Romania

UDC 01.1

Modern Science, Economy and Digital Innovation: Collection of Scientific Papers "International Scientific Unity" with Proceedings of the 2<sup>nd</sup> International Scientific and Practical Conference. March 12-14, 2025. Bucharest, Romania. 274 p.

ISBN 979-8-89704-986-8 (series)

DOI 10.70286/ISU-12.03.2025

The conference is included in the Academic Research Index ReserchBib International catalog of scientific conferences.

The collection of scientific papers "International Scientific Unity" presents the materials of the participants of the 2nd International Scientific and Practical Conference "Modern Science, Economy and Digital Innovation" (March 12-14, 2025).

The materials of the collection are presented in the author's edition and printed in the original language. The authors of the published materials bear full responsibility for the authenticity of the given facts, proper names, geographical names, quotations, economic and statistical data, industry terminology, and other information.

The materials of the conference are publicly available under the terms of the CC BY-NC 4.0 International license.

**ISBN 979-8-89704-986-8 (series)**



INTERNATIONAL SCIENTIFIC UNITY

© Participants of the conference, 2025

© Collection of Scientific Papers "International Scientific Unity", 2025

Official site: <https://isu-conference.com/>

## CONTENT

### SECTION: ACCOUNTING AND TAXATION

<b>Кулик Ю.М., Шільвінська О.Л., Погоріла А.Р.</b> ОРГАНІЗАЦІЯ ОБЛІКУ ТА ОПОДАТКУВАННЯ МАРКЕТИНГОВИХ ПОСЛУГ.....	12
--	----

<b>Ненько Б.Є., Задорожний С.В., Яценко Н.М.</b> ХМАРНІ ТЕХНОЛОГІЇ В БУХГАЛТЕРСЬКОМУ ОБЛІКУ УКРАЇНИ: ПЕРЕВАГИ ТА ВИКЛИКИ.....	15
---	----

### SECTION: ARCHITECTURE AND CONSTRUCTION

<b>Мельниченко П.І., Пастухова С.В.</b> 3D-ДРУК В БУДІВНИЦТВІ: МОЖЛИВОСТІ ТА ОБМЕЖЕННЯ.....	19
--	----

### SECTION: ART HISTORY AND LITERATURE

<b>Ковальчук Т.П.</b> ОСОБЛИВОСТІ ВИКЛАДАННЯ ПАПЕРОПЛАСТИКИ В ДЕКОРАТИВНО-ПРИКЛАДНОМУ МИСТЕЦТВІ.....	22
--	----

### SECTION: BIOLOGY AND BIOCHEMISTRY

<b>Магзер В.М.</b> ВИКОРИСТАННЯ ПРИРОДНИХ ІНДИКАТОРІВ ДЛЯ НАВЧАННЯ ТА ЕКСПЕРИМЕНТІВ.....	24
--	----

### SECTION: CHEMISTRY AND PHARMACEUTICALS

<b>Sucayev A., Abdullayev Yu., Mahmudov I., Suleymanli N.</b> REACTION MECHANISM AND SYNTHESIS OF DERIVATIVES FROM THE INTERACTION BETWEEN DICYANDIAMIDE AND ALLANTOIN.....	27
--	----

<b>Гармідер Е., Улізко І.</b> ВДОСКОНАЛЕННЯ МЕТОДІВ ЯКІСНОГО ВИЗНАЧЕННЯ АЦЕКЛОФЕНАКА.....	29
---	----

### SECTION: COMPUTER ENGINEERING

<b>Danyliuk I.</b> MEMORY LEAKS IN C AND C++ PROGRAMMING LANGUAGES: DETECTION METHODS, CAUSE ANALYSIS, AND MITIGATION APPROACHES.....	31
--	----

**SECTION: CULTUROLOGY AND PHILOSOPHY**

**Aliyev R.**

"ECO-TECHNOLOGIES AS A NEW PERSPECTIVE FOR THE DEVELOPMENT OF CIVILIZATION: A PHILOSOPHICAL APPROACH" ..... 35

**Никифоров А.М., Гулей О.В., Нечипоренко А.В., Никифоров А.М.**

ПРО НИКАНОРА ОНАЦЬКОГО В КОНТЕКСТІ ВШАНУВАННЯ 150-РІЧЧЯ ВІД ДНЯ НАРОДЖЕННЯ МИТЦЯ: ІСТОРИОГРАФІЧНИЙ АСПЕКТ..... 37

**Кирилюк О.С.**

УНІВЕРСАЛЬНО-КУЛЬТУРНІ КОМПЛЕКСИ РОМАНУ (МАЙСТЕР-КЛАС СПЕЦКУРСУ «УНІВЕРСАЛІЇ КУЛЬТУРИ»)..... 40

**SECTION: ECONOMY**

**Rozdorozhnyi A.**

SYSTEM NATURE OF ECONOMIC POTENTIAL OF AN ENTERPRISE IN THE CONTEXT OF ANALYSING THE DIRECTIONS OF ITS REPRODUCTION..... 46

**Ачкасова О.В., Горбунова Ю.С.**

ПЕРСПЕКТИВИ РОЗВИТКУ РИНКУ ПРАЦІ В УКРАЇНІ..... 49

**Ільчов А.І.**

ФІНАНСОВО-ГОСПОДАРСЬКИЙ СТАН КОМУНАЛЬНОГО ПІДПРИЄМСТВА "ДНІПРОВСЬКИЙ МЕТРОПОЛІТЕН"..... 52

**Ачкасова О.В., Кузьменко В.В.**

ПРОБЛЕМИ МОЛОДІ НА РИНКУ ПРАЦІ ТА ШЛЯХИ ЇЇ ПОДОЛАННЯ..... 54

**Podrieza M.**

WAR AND AVIATION ENTERPRISES: HOW ORGANIZATIONAL CULTURE CONTRIBUTES TO SURVIVAL AND DEVELOPMENT.... 57

**Плавкова Д.Д., Саричев В.І.**

КРЕАТИВНА ЕКОНОМІКА ЯК СЕРЕДОВИЩЕ ДЛЯ САМОРЕАЛІЗАЦІЇ ЛЮДСЬКОГО ПОТЕНЦІАЛУ..... 59

**Саламін О.С.**

ФРАНЧАЙЗИНГ ЯК ІННОВАЦІЙНА ФОРМА МІЖНАРОДНОГО БІЗНЕСУ..... 61

**SECTION: FINANCE AND BANKING**

- Нікольчук Ю.М., Ягодзінська А.М.**  
НАПРЯМИ УДОСКОНАЛЕННЯ УПРАВЛІННЯ КРЕДИТНИМИ  
ОПЕРАЦІЯМИ АТ «ОЩАДБАНК»..... 64
- Суздальєва О.С.**  
АНАЛІЗ ФІНАНСОВИХ ІННОВАЦІЙ В ЕКОНОМІЦІ..... 67

**SECTION: INFORMATION TECHNOLOGY & CYBERSECURITY**

- Shmatko O., Antypin I.**  
A SCIENTIFIC STUDY ON FRAUD DETECTION IN ELECTRONIC  
PAYMENTS USING MACHINE LEARNING METHODS..... 70
- Shmatko O., Bunin M.**  
INTELLIGENT CHATBOTS IN HUMAN RESOURCE  
MANAGEMENT: DEVELOPMENT, ARCHITECTURE, AND  
APPLICATIONS..... 73
- Мулеса П., Баник А.**  
ТЕХНІЧНА ОСНОВА ПРОГНОЗУВАННЯ ЗА ДОПОМОГОЮ LSTM  
ТА КОРЕЛЯЦІЙНИЙ АНАЛІЗ НА ЕТАПІ ПІДГОТОВКИ ДАНИХ.... 79
- Гончарова Н.**  
ВНУТРІШНЯ МОТИВАЦІЯ ВИКЛАДАЧІВ ЯК КЛЮЧОВИЙ  
ЧИННИК РОЗВИТКУ ЦИФРОВИХ КОМПЕТЕНТНОСТЕЙ У  
СУЧАСНІЙ ОСВІТІ..... 82
- Деркач Т., Пікалова В.**  
ОГЛЯД ПРОГРАМ ДЛЯ ГРАФІЧНОГО ДИЗАЙНУ: МОЖЛИВОСТІ,  
ПЕРЕВАГИ ТА НЕДОЛІКИ..... 84
- Кісь Я.П., Сироветник Б.Ю.**  
ВИКОРИСТАННЯ ЗГОРТКОВИХ НЕЙРОННИХ МЕРЕЖ (CNN) У  
ФІНАНСОВОМУ АНАЛІЗІ..... 88
- Мулеса П., Скорондяк С.**  
МІНІМІЗАЦІЯ КІБЕРРИЗИКІВ ТА ПІДВИЩЕННЯ РІВНЯ  
ЦИФРОВОЇ БЕЗПЕКИ В СТУДЕНТСЬКОМУ ЖИТТІ ЗА  
ДОПОМОГОЮ ШІ..... 91
- Федорка П.П., Клименко М.В., Повханич В.І.**  
ВПЛИВ НОВІТНІХ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ ТА  
СИСТЕМ ПРИЙНЯТТЯ РІШЕНЬ НА РОЗВИТОК  
ІНФРАСТРУКТУРИ І МОЖЛИВОСТЕЙ «SMART РЕГІОНУ»..... 95

<b>Jiang Peng, Turchenko I.</b> ENHANCING NEURAL NETWORK ROBUSTNESS AGAINST ADVERSARIAL ATTACKS: ANALYSIS AND IMPROVEMENTS OF THE PROPOSED MODEL.....	98
--	----

**SECTION: INTERNATIONAL RELATIONS**

<b>Badalov E.</b> EU-RUSSIA ENERGY RELATIONS: TRANSFORMATION FROM RELIANCE TO RESILIENCE.....	102
---	-----

**SECTION: JOURNALISM**

<b>Гусак Н.А.</b> ПРОПАГАНДА У СУЧАСНИХ МЕДІАКОМУНІКАЦІЯХ: ОСОБЛИВОСТІ ЗАСТОСУВАННЯ (НА ПРИКЛАДІ ТЕЛЕКАНАЛУ FREEDOM).....	105
--	-----

**SECTION: JURISPRUDENCE**

<b>Бесєдін І.О.</b> ЄВРОПЕЙСЬКИЙ ГУМАНІТАРНИЙ ФОРУМ (EUROPEAN HUMANITARIAN FORUM, EHF).....	108
---	-----

<b>Мельник А., Авраменко С.</b> ДОМАШНЄ НАСИЛЬСТВО У ФОКУСІ СУДОВОЇ ПРАКТИКИ: ГЕНДЕРНІ АСПЕКТИ ТА ПРАВОВІ ВИКЛИКИ.....	110
--	-----

<b>Sakaly M.</b> SOME ISSUES RELATED TO THE SUBMISSION OF OBJECTIONS BY PARTICIPANTS TO THE PETITION FOR THE APPOINTMENT OF AN EXPERT EXAMINATION BY THE COMMERCIAL AND PROCEDURAL CODE OF UKRAINE.....	113
---	-----

**SECTION: MANAGEMENT AND PUBLIC ADMINISTRATION**

<b>Halhash M.R.</b> ON THE NEED TO FORM A SAFETY-ORIENTED MANAGEMENT SYSTEM FOR ORGANIZATIONS.....	116
--	-----

<b>Kharin S.</b> GERMANY'S ENERGY DEVELOPMENT MODEL.....	118
---	-----

<b>Гльоза І.</b> ЦИФРОВІЗАЦІЯ ЯК КОНЦЕПЦІЯ УПРАВЛІННЯ БІЗНЕСОМ.....	120
--	-----

<b>Жаровська О.П.</b> ОПТИМІЗАЦІЯ УПРАВЛІННЯ ОРГАНІЗАЦІЯМИ І УСТАНОВАМИ ЧЕРЕЗ УДОСКОНАЛЕННЯ ІСНУЮЧИХ ПРОЦЕСІВ.....	123
<b>Козловцева В.А., Фуркаленко А.Л.</b> ДЕРЖАВНА ПОЛІТИКА ТА МЕНЕДЖМЕНТ РЕГІОНАЛЬНОГО РОЗВИТКУ В УМОВАХ “ЗЕЛЕНОЇ” ВІДБУДОВИ.....	127
<b>Оршацький Д.</b> ЗМІСТ, ФОРМУВАННЯ ТА ФАКТОРИ ВПЛИВУ НА СТРАТЕГІЇ РОЗВИТКУ ПІДПРИЄМНИЦЬКИХ СТРУКТУР.....	129
<b>Воіко О., Maksymova Yu.</b> SEMANTIC MODELING USING OWL 2 ONTOLOGY LANGUAGE IN RESEARCHING PUBLIC GOVERNANCE MECHANISMS.....	132
<b>Чукіна І.В.</b> ІННОВАЦІЙНІ ЛОГІСТИЧНІ РІШЕННЯ У МІЖНАРОДНОМУ БІЗНЕСІ: СТРАТЕГІЇ ТА ПЕРСПЕКТИВИ.....	137
<b>SECTION: MARKETING AND ADVERTISING</b>	
<b>Криворучко О., Агапов І.</b> ДОСЛІДЖЕННЯ КОНКУРЕНТНИХ ПЕРЕВАГ ПІДПРИЄМСТВ НА РИНКУ АВТОСЕРВІСНИХ ПОСЛУГ.....	140
<b>Makerska V.O.</b> PROBLEMS OF IMPLEMENTING CRM SYSTEMS IN SMALL AND MEDIUM BUSINESSES.....	142
<b>Харченко О.С.</b> ЕТИЧНІ АСПЕКТИ ПЕРСОНАЛІЗАЦІЇ ТА ВИКОРИСТАННЯ ДАНИХ У МАРКЕТИНГОВИХ КОМУНІКАЦІЯХ.....	145
<b>SECTION: MECHANICS AND ELECTRICAL ENGINEERING</b>	
<b>Левченко Ю., Басова Ю., Проценко О., Качур С.</b> ІННОВАЦІЙНІ ПІДХОДИ ДО УДОСКОНАЛЕННЯ ЕФЕКТИВНОСТІ РОБОТИ ОБЛАДНАННЯ ДЛЯ ТРАНСПОРТУВАННЯ ЗЕРНА.....	148
<b>SECTION: MEDICINE</b>	
<b>Негода Ю.С., Дума А.Б., Мельник Д.П., Кнігавко Д.О., Пономаренко Н.С.</b> ВПЛИВ ІОНІЗУЮЧОГО ВИПРОМІНЮВАННЯ НА БІОЛОГІЧНІ ОБ’ЄКТИ.....	152

<b>Liashuk R.P.</b> CHARACTERISTICS OF SOME NEW METHODOLOGIES AND TOOLS FOR TEACHING MEDICAL UNIVERSITY STUDENTS.....	155
<b>Zavalna O., Florikian V., Tondiy O.</b> MODERN APPROACHES TO THE TREATMENT OF NON-MOTOR SYMPTOMS IN PARKINSON'S DISEASE.....	159
<b>Данько Ю.С., Кравченко А.В.</b> ВЗАЄМОЗВ'ЯЗОК ПСОРІАЗУ ТА ПСИХІЧНИХ РОЗЛАДІВ: сучасний погляд на основі аналізу зарубіжних джерел.....	163
<b>Стіба А.В., Ставицька О.Ф., Колісник В.О.</b> ДІАГНОСТИКА ТА МЕТОДИ КОРЕКЦІЇ ХАРЧОВОЇ АЛЕРГІЇ У ДІТЕЙ.....	167
<b>Фіщук С.М., Ходак А.С.</b> ФАКТОРИ РИЗИКУ ТА МЕТОДИ ПРОФІЛАКТИКИ МЕЛАНОМИ...	170
<b>Ячменьова Е.С., Кравченко А.В.</b> ДИТЯЧИЙ АТОПІЧНИЙ ДЕРМАТИТ: КОРОТКИЙ ОГЛЯД ПОТОЧНОГО СТАНУ ПРОБЛЕМИ.....	172
<b>SECTION: PEDAGOGY, PHILOLOGY AND LINGUISTICS</b>	
<b>Bobro N.</b> COMPONENTS OF THE PEDAGOGICAL SYSTEM OF FORMING STUDENTS' INFORMATION CULTURE IN A DIGITAL UNIVERSITY.....	176
<b>Shlenova M.</b> FORMATION OF AN INNOVATIVE EDUCATIONAL ENVIRONMENT FOR TRAINING SPECIALISTS IN LIBRARY, INFORMATION, AND ARCHIVAL SCIENCES IN HIGHER TECHNICAL EDUCATION INSTITUTIONS.....	179
<b>Гаєнко І., Сорочинська О.</b> ФОРМУВАННЯ ЦІННІСНОГО СТАВЛЕННЯ ДО ПРИРОДИ У ДІТЕЙ СТАРШОГО ДОШКІЛЬНОГО ВІКУ ЯК СКЛАДОВА СТАЛОГО РОЗВИТКУ СУСПІЛЬСТВА.....	183
<b>Гориленко І.С., Чхетіані Т.Д.</b> ПРАГМАЛІНГВІСТИЧНИЙ АНАЛІЗ МОВЛЕННЄВИХ МЕХАНІЗМІВ ГІПНОТИЧНОГО ВПЛИВУ У МІЖОСОБИСТІСНІЙ КОМУНІКАЦІЇ.....	188

**Данилюк О.І., Шевчук П.Г.**  
МІЖПРЕДМЕТНІ ЗВ'ЯЗКИ ІНФОРМАТИКИ ТА БІОЛОГІЇ У  
РОЗРІЗІ ПОНЯТЬ ПРО НЕЙРОХІМІЧНІ ПРОЦЕСИ ЖИВИХ  
ОРГАНІЗМІВ..... 190

**Kartel T., Maryanko Ya., Stanchyk Ye., Lazarchuk S.**  
SPECIFIC CHARACTER OF THE TECHNOLOGY OF MODULAR  
TRAINING OF FOREIGN LANGUAGE FOR SPECIFIC PURPOSES.... 195

**Омельяненко Г., Парій С., Соколенко Н.**  
ФУНКЦІОНАЛЬНІ МОЖЛИВОСТІ ОСВІТНІХ ІНТЕРНЕТ  
ПЛАТФОРМ В РОБОТІ ВИКЛАДАЧА МУЗИЧНО-ТЕОРЕТИЧНИХ  
ДИСЦИПЛІН..... 197

**Рідка О., Каніболоцька О.**  
ВИКОРИСТАННЯ ІНФОРМАЦІЙНО КОМУНІКАЦІЙНИХ  
ТЕХНОЛОГІЙ НА УРОКАХ АНГЛІЙСЬКОЇ МОВИ..... 199

#### **SECTION: PHYSICAL AND MATHEMATICAL SCIENCES**

**Ковальчук В., Попряга Д.**  
НАНОКЛАСТЕРНА ПІДСИСТЕМА, ЯК СКЛАДОВА  
ТВЕРДОТІЛЬНОГО ГЕТЕРОПЕРЕХОДУ..... 203

**Перцов А.С., Сачовська В.А.**  
АНАЛІЗ ВПЛИВУ ВПРОВАДЖЕННЯ ШІ ТА  
АВТОМАТИЗОВАНИХ ТЕХНОЛОГІЙ У СФЕРІ ІТ НА  
ЗАЙНЯТІСТЬ..... 206

#### **SECTION: PHYSICAL EDUCATION AND SPORT**

**Євтушенко Є.Г.**  
ОПТИМАЛЬНИЙ РІВЕНЬ ТИЖНЕВОГО НАВАНТАЖЕННЯ ПІД  
ЧАС ЗАНЯТЬ СИЛОВИМ ФІТНЕСОМ..... 211

#### **SECTION: PHYSICS AND ASTRONOMY**

**Vidmachenko A.P.**  
PLUTO'S SATELLITE – KERBEROS..... 214

#### **SECTION: POLITICS AND SOCIOLOGY**

**Дідіченко В., Череп В.**  
РОЛЬ НАЦІОНАЛЬНОЇ ІДЕНТИЧНОСТІ ТА ІСТОРИЧНОЇ  
ПАМ'ЯТІ У ФОРМУВАННІ НАЦІОНАЛЬНОГО СПРОТИВУ..... 218

**SECTION: PSYCHOLOGY**

<b>Бужина І., Волченко В.</b> ВДОСКОНАЛЕННЯ УПРАВЛІННЯ ПЕРСОНАЛОМ ПІДПРИЄМСТВ В УМОВАХ ВОЄННОГО СТАНУ.....	223
<b>Вінник Н., Кутішенко В.</b> РОЛЬ ДУХОВНИХ РЕСУРСІВ ПЕДАГОГА ПІД ЧАС ВОЄННОГО СТАНУ.....	226
<b>Весперіс С.З., Тарасова Т.Б.</b> ПРОБЛЕМА ПЕРФЕКЦІОНІЗМУ ПЕДАГОГІЧНИХ ПРАЦІВНИКІВ.....	228
<b>Грабовська Т.В., Стахова О.О.</b> ОСОБЛИВОСТІ ЕМОЦІЙНОЇ СФЕРИ МОЛОДШИХ ШКОЛЯРІВ ІЗ ПОРУШЕННЯМИ МОВЛЕННЯ.....	232

**SECTION: TECHNICAL SCIENCES**

<b>Tuzenko O., Sidun N.</b> MATHEMATICAL MODELING OF EXCHANGE RATE FORECASTING BASED ON TIME SERIES ANALYSIS.....	235
<b>Корчак М.М.</b> ОГЛЯД КОМБІНОВАНИХ МАШИН ДЛЯ ОБРОБІТКУ ҐРУНТУ.....	238
<b>Arutiunian T., Arutiunian D.</b> DETERMINATION OF TECHNOLOGICAL CONDITIONS FOR THE PRODUCTION OF A STABILISER FOR WATER-FAT FOOD EMULSIONS.....	243
<b>Капитанова Л., Рябков В., Крыштафович І.</b> ENSURING AIRCRAFT FLIGHT SAFETY DURING LANDING BY CHANGING ITS WING AND CHASSIS CONFIGURATION.....	245
<b>Markolenko T., Tingayev Ye.</b> IMPROVEMENT OF THE MATHEMATICAL MODEL OF GASEOUS FUEL COMBUSTION IN A BOILER CONSIDERING THE VARIABLE COMPOSITION OF THE FUEL MIXTURE AND ITS IMPACT ON THE THERMAL REGIME.....	248
<b>Yurych L., Pytak D.</b> THE INFLUENCE OF CARBOXYMETHYLCEL CELLULOSE ON THE PROPERTIES OF CEMENTING SLURRY AND STONE.....	254

**SECTION: TOURISM AND HOTEL AND RESTAURANT BUSINESS**

**Radionova O.**

AGRITOURISM AS A TOOL FOR AGRICULTURAL  
DIVERSIFICATION AND SOCIO-ECONOMIC DEVELOPMENT..... 257

**Obolentseva L.**

THE POTENTIAL FOR DEVELOPMENT OF THE SLOW FOOD  
CONCEPT IN FORMING MODERN GASTRONOMIC CULTURE..... 260

**Чухрай Л.О., Кіріченко С.Я.**

ТЕХНІЧНІ МУЗЕЇ: СУЧАСНІ ТЕХНОЛОГІЇ ТА ПЕРСПЕКТИВИ  
РОЗВИТКУ..... 262

**Лояк Л., Загнибіда Р., Бурчак С.**

ГУЦУЛЬСЬКА КУХНЯ ЯК СКЛАДОВА КУЛЬТУРНОЇ  
СПАДЩИНИ РЕГІОНУ..... 265

**SECTION: TRANSPORT TECHNOLOGIES AND LOGISTICS**

**Цера Ю., Чорний Б., Криворучко А., Стринадко М.**

ОПТИЧНІ ТЕХНОЛОГІЇ МОНІТОРИНГУ ЗАЛІЗНИЧНИХ РЕЙОК... 269

# **INTELLIGENT CHATBOTS IN HUMAN RESOURCE MANAGEMENT: DEVELOPMENT, ARCHITECTURE, AND APPLICATIONS**

**Shmatko Oleksandr**

Ph.D., Associate Professor

Technical University “Metinvest Polytechnic” LLC, Ukraine

**Bunin Maksym**

Master Degree student

Department of Software Engineering and Management Intelligence Technology

National Technical University “Kharkiv Polytechnic Institute”, Ukraine

**Introduction.** Artificial intelligence (AI) has become a crucial component in modern HRM systems, improving decision-making and employee satisfaction. AI-driven chatbots are designed to automate HR functions, facilitate employee interactions, and enhance recruitment processes. These virtual assistants simulate human communication, enabling organizations to optimize HR workflows efficiently.

The integration of AI in HR systems is particularly relevant in the context of Industry 4.0, where automation and data-driven decision-making play a crucial role in business transformation.

This paper examines the development of AI-powered chatbots for HRM, focusing on their design, architecture, and implementation. The study investigates various NLP methods for understanding human language, AI-driven decision-making models, and the selection of suitable development tools. The research also explores chatbot performance through experimental evaluation, demonstrating its effectiveness in HR automation.

**Main part.**

The design and development of chatbots involve a variety of methodologies aimed at optimizing functionality, efficiency, and user experience [1]. Understanding the intended role and classification of a chatbot helps developers select appropriate algorithms, platforms, and tools for its creation. Simultaneously, this classification aids end users in setting realistic expectations for chatbot interactions [2].

The key requirements for chatbot development include accurate knowledge representation, an efficient response generation strategy, and a predefined set of neutral responses for handling ambiguous user inputs [3]. The initial step in designing any system is its decomposition into modular components based on standardized principles, enabling a structured development approach [4]. Figure 1 illustrates the general architecture of a chatbot.

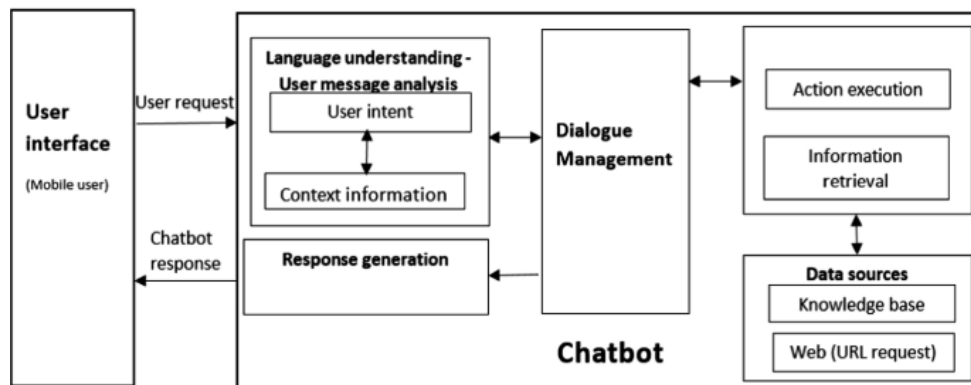


Figure 1. General Architecture of AI chatbot.

A chatbot can be integrated with various messaging platforms such as Facebook, Slack, WhatsApp, WeChat, and Skype or voice-enabled applications like Amazon Echo [5]. The interaction begins when a user submits a query, for instance, "What does 'environment' mean?" The chatbot processes this query using a natural language understanding (NLU) component that determines user intent and extracts relevant information (e.g., intent: "translate"; entity: ["word: environment"]) [6].

Once the chatbot identifies the most appropriate interpretation of the query, it determines the next course of action [7]. The chatbot may:

- Respond directly based on available data.
- Retain the interpreted information for future reference.
- Request additional contextual details or clarification from the user.

When a query is fully understood, the chatbot executes necessary actions or retrieves relevant information. It extracts data from its knowledge base or external sources via API calls [8].

The response generation component employs Natural Language Generation (NLG) to convert structured data into human-like responses [9]. Depending on the chatbot model, responses are generated using one of three approaches [10]:

- Rule-based models – Follow predefined response patterns.
- Retrieval-based models – Fetch responses from a knowledge base.
- Generative models – Use deep learning to generate responses dynamically.

The dialogue management system maintains and updates the conversational context, tracking user intent, identified entities, and missing information required for request execution. Additionally, it requests missing details, processes clarifications, and asks follow-up questions. For example, after providing a definition, the chatbot may ask, "Would you like an example sentence using the word 'environment'?"

The architecture of an AI-powered chatbot follows a 4+1 model, incorporating logical, developmental, process, and physical representations of the system [7].

Figure 2 presents the different levels of the 4+1 architectural model, originally proposed by Kruchten.

The proposed chatbot system is based on three core abstractions: Idea, Action, and Tracker.

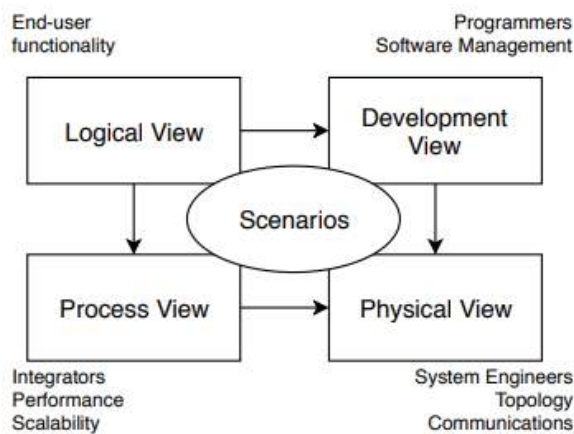


Figure 2. Different Views of the 4+1 Architectural Model

The core chatbot architecture is implemented using object-oriented design principles. Figure 3 illustrates the UML component diagram, detailing the relationships between Dialogue Manager, Idea, Action, and Tracker modules.

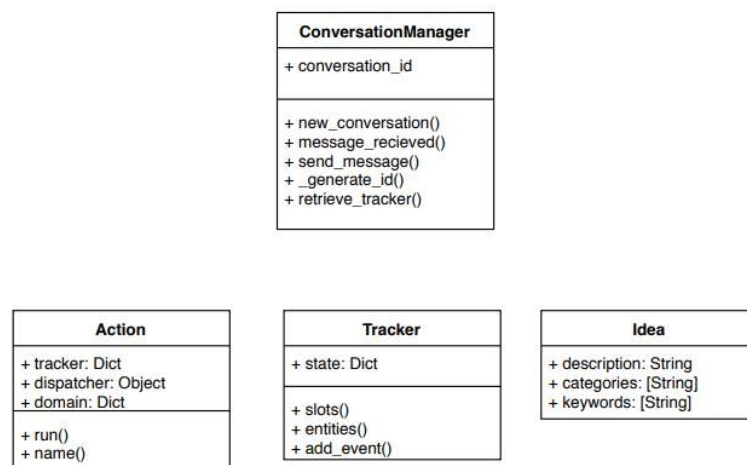


Figure 3 – Component Diagram of the Chatbot System

### Analysis of the Obtained Results

The evaluation involved 52 participants, who answered questions related to five different scenarios and provided feedback on the ease of information retrieval. Additionally, participants assessed their overall experience with the chatbot. The evaluation was conducted in two stages, with the first stage involving 30 participants and the second stage 22 participants.

During the first stage, a preliminary evaluation identified key aspects requiring improvement. This section presents the final evaluation results, comparing them with the initial assessment to measure improvements in chatbot performance. The percentage of errors for each scenario, based on the total number of questions posed, is illustrated in Figure 4.

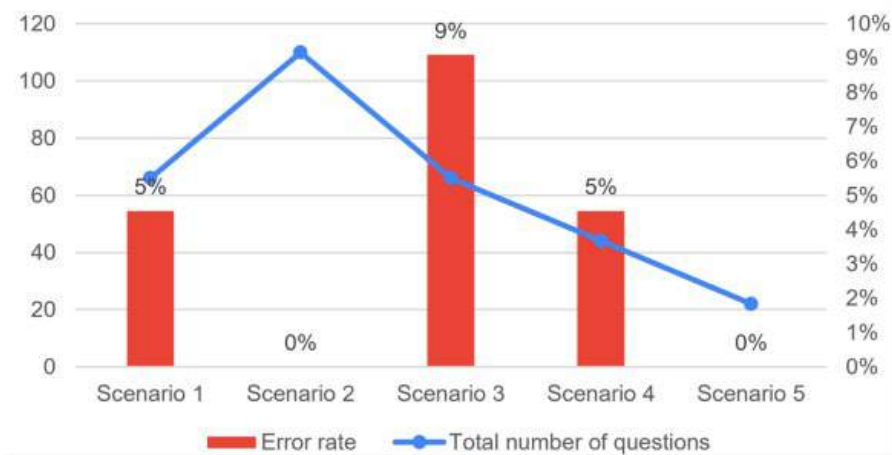


Figure 4 – Error Rate in Each Scenario. Source: Author’s Development

The percentage of errors was calculated by analyzing incorrect responses in each scenario. For instance, in Scenario 1, each participant answered three questions, totaling 66 responses across 22 participants. Of these responses, only three contained incorrect information, resulting in a 5% error rate relative to the total number of questions posed.

Regarding user experience evaluation, 31.8% of participants found the chatbot easy to use, while 27.3% considered it very simple to operate. A neutral response was given by 36.4% of users, indicating that chatbot usage was neither difficult nor easy. Finally, 4.5% of participants reported that interacting with the chatbot was very challenging.

It is worth noting that 100% of expert evaluators agreed that the chatbot was an effective tool for information retrieval. Additionally, 72.7% of participants preferred using the chatbot to obtain information over other communication methods. However, 18.2% preferred making phone inquiries, while 9.1% opted for web-based information retrieval. Furthermore, 72.7% of chatbot users experienced no issues during the evaluation, whereas 27.3% encountered some difficulties.

In terms of performance analysis, system logs were examined to assess chatbot efficiency during interactions. Each user attempt was recorded and analyzed using the "History" section in the Rasa Core web interface, which documents all chatbot conversations chronologically.

Figure 5 illustrates the average number of activated intents, failed intents, and completed intents, along with their corresponding standard deviations. This visualization enables an assessment of data deviation from mean values. By analyzing the standard deviation bars, the degree of variation in chatbot responses can be observed, offering insights into improvements from the preliminary to the final evaluation. The overall chatbot performance score was calculated as the ratio of completed intents to activated intents. The comparison with the first evaluation phase is also depicted in Figure 5, providing a quantitative measure of improvement in the chatbot's final version. The average overall score in the final evaluation was 93.83, with a standard deviation of 0.06, compared to 86.58 in the initial evaluation, which had a standard deviation of 0.09.

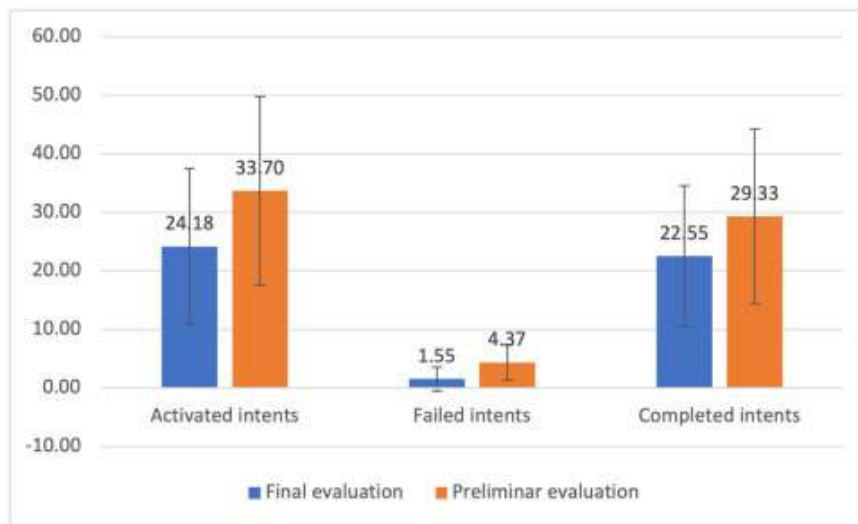


Figure 5 – Comparison of Average and Standard Deviation Between Two Evaluations Based on Logarithmic System Metrics. Source: Author’s Development

The findings suggest that the chatbot is a valuable tool that could benefit a wide range of users. The chatbot demonstrated a high level of accuracy, with minimal incorrect responses recorded. Scenarios 2 and 5 received excellent ratings from expert evaluators, whereas Scenarios 1 and 4 exhibited a 5% error rate, likely due to the increased complexity of these scenarios compared to the others. Scenario 3 recorded the highest error rate, suggesting it presented the greatest challenge to users.

During the evaluation process, it was observed that users adapted to the chatbot's functionality over time, ultimately comprehending its responses and instructions. However, the analysis also identified areas for improvement, such as expanding the chatbot's training dataset, incorporating additional synonyms, common misspellings, and abbreviations frequently used in user interactions.

A manual analysis of interactions revealed that users who followed the chatbot’s instructions precisely were able to find the desired information more efficiently. Nearly all participants acknowledged the value and benefits of using chatbot technology. While further training and refinements are necessary before deployment, the chatbot already demonstrates strong potential as a prototype or proof-of-concept system.

### Conclusion.

The development of AI-driven chatbots involves structured methodologies, ranging from intent recognition to response generation. The 4+1 architecture model

provides a scalable and modular framework for chatbot design, ensuring seamless NLP processing, conversation tracking, and backend integration.

In conclusion, the developed chatbot demonstrates strong potential for deployment as a functional and user-friendly tool. While refinements are necessary to address remaining limitations, the chatbot serves as a solid prototype for future advancements in AI-driven conversational agents. Further research should explore multi-lingual support, integration with external knowledge bases, and adaptive learning mechanisms to enhance chatbot capabilities and ensure more intuitive and human-like interactions.

### References

1. Lin, C. C., Huang, A. Y., & Yang, S. J. (2023). A review of ai-driven conversational chatbots implementation methodologies and challenges (1999–2022). *Sustainability*, 15(5), 4012.
2. Wahbi, A., Khaddouj, K., & Lahlimi, N. (2023). Study of the relationship between chatbot technology and customer experience and satisfaction. *International Journal of Accounting, Finance, Auditing, Management and Economics*, 4(6-1), 758-771.
3. Han, X., Zhou, M., Turner, M. J., & Yeh, T. (2021, May). Designing effective interview chatbots: Automatic chatbot profiling and design suggestion generation for chatbot debugging. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-15).
4. Stirgwort, B. W., Mazzuchi, T. A., & Sarkani, S. (2022). A model-based systems engineering approach for developing modular system architectures. *Journal of Engineering Design*, 33(2), 95-119.
5. McTear, M. (2022). *Conversational ai: Dialogue systems, conversational agents, and chatbots*. Springer Nature.
6. Omarov, B., Narynov, S., & Zhumanov, Z. (2023). Artificial intelligence-enabled chatbots in mental health: A systematic review. *Computers, Materials & Continua*, 74(3).
7. Luo, B., Lau, R. Y., Li, C., & Si, Y. W. (2022). A critical review of state-of-the-art chatbot designs and applications. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 12(1), e1434.
8. Guo, L., Yan, F., Li, T., Yang, T., & Lu, Y. (2022). An automatic method for constructing machining process knowledge base from knowledge graph. *Robotics and Computer-Integrated Manufacturing*, 73, 102222.
9. Dong, C., Li, Y., Gong, H., Chen, M., Li, J., Shen, Y., & Yang, M. (2022). A survey of natural language generation. *ACM Computing Surveys*, 55(8), 1-38.
10. Luo, B., Lau, R. Y., Li, C., & Si, Y. W. (2022). A critical review of state-of-the-art chatbot designs and applications. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 12(1), e1434.

Collection of Scientific Papers  
with Proceedings of the 2nd International Scientific and Practical Conference  
«**Modern Science, Economy and Digital Innovation**»  
March 12-14, 2025  
Bucharest, Romania

Organizing committee may not agree with the authors' point of view.  
Authors are responsible for the correctness of the papers' text.

Contact details of the organizing committee:  
Sole Proprietor Viktoriia Tsiundyk  
E-mail: [info@isu-conference.com](mailto:info@isu-conference.com)  
URL: <https://isu-conference.com/>

Certificate of the subject of the publishing business: ДК №7980 of 03.11.2023.



INTERNATIONAL SCIENTIFIC UNITY