ICAEBT
19 - 20 June 2025 | Baku, Azerbaijan

International Conference on

Interdisciplinary Innovations: Arts, Education, Business and Technology (ICAEBT-2025)

19th-20th June, 2025 | Baku, Azerbaijan

Organized by:

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IFERP Academy

International Conference on Interdisciplinary Innovations: Arts, Education, Business and Technology (ICAEBT-2025)

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Conference Theme

Interdisciplinary Innovations for Sustainable Development: Bridging Arts, Education, Business, and Technology

PREFACE

We cordially invite you to attend the International Conference on Interdisciplinary Innovations: Arts, Education, Business and Technology (ICAEBT-2025) on 19th-20th June, 2025. The main objective of ICAEBT-2025 is to provide a platform for researchers, students, academicians as well as industrial professionals from all over the world to present their research results and development activities in relevant fields of Arts, Education, Business and Technology. This conference will provide opportunities for the delegates to exchange new ideas and experience face to face, to establish business or research relationship and to find global partners for future collaboration.

These proceedings collect the up-to-date, comprehensive and worldwide state-of-art knowledge on cutting edge development of academia as well as industries. All accepted papers were subjected to strict peer-reviewing by a panel of expert referees. The papers have been selected for these proceedings because of their quality and the relevance to the conference. We hope these proceedings will not only provide the readers a broad overview of the latest research results but also will provide the readers a valuable summary and reference in these fields.

The conference is supported by many universities, research institutes and colleges. Many professors played an important role in the successful holding of the conference, so we would like to take this opportunity to express our sincere gratitude and highest respects to them. They have worked very hard in reviewing papers and making valuable suggestions for the authors to improve their work. We also would like to express our gratitude to the external reviewers, for providing extra help in the review process, and to the authors for contributing their research result to the conference.

Since April 2025, the Organizing Committees have received more than 50 manuscript papers, and the papers cover all the aspects in Arts, Education, Business and Technology. Finally, after review, about 15+ papers were included to the proceedings of ICAEBT-2025.

We would like to extend our appreciation to all participants in the conference for their great contribution to the success of ICAEBT-2025. We would like to thank the keynote and individual speakers and all participating authors for their hard work and time. We also sincerely appreciate the work by the technical program committee and all reviewers, whose contributions made this conference possible. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank the organizing committee for their hard work.

ABOUT ICAEBT

The International Conference on Interdisciplinary Innovations: Arts, Education, Business, and Technology (ICAEBT), scheduled for June 19th & 20th, 2025, is an essential platform organized by IFERP that aims to explore the dynamic intersections of arts, education, business, and technology in addressing global challenges. Under the theme "Interdisciplinary Innovations for Sustainable Development: Bridging Arts, Education, Business, and Technology," the conference will gather researchers, educators, practitioners, and policymakers to share innovative ideas, best practices, and collaborative solutions. Participants will engage in insightful discussions and networking opportunities, fostering partnerships that drive sustainable development through interdisciplinary approaches. Join us in shaping the future where creativity, knowledge, and technology converge for a sustainable world.

Multidisciplinary Confluence

- ICAEBT-2025 stands as a melting pot of ideas, where the boundaries between engineering disciplines blur, giving rise to innovative solutions that address global challenges. The conference embraces the multidisciplinary nature of contemporary research, recognizing that true breakthroughs often occur at the intersections of different fields.
- This theme encapsulates the conference's focus on fostering innovation and collaboration across diverse disciplines within engineering and technology. It encourages participants to explore and present cutting-edge solutions that contribute to the sustainable development of industries, addressing challenges and advancing knowledge for a better future. The multidisciplinary perspective highlights the interconnectedness of various fields in creating holistic and impactful solutions.

Benefits of Conference

- Currently, multidisciplinary research has become the most viable and efficient way to solve the problem. In this era of rapidly changing society, many kinds of socio-economic problems, related to other disciplines such as politics, anthropology, psychology, have arisen which require a holistic approach to find their solution.
- When we speak of a multidisciplinary, transdisciplinary or interdisciplinary research team, we imply collaboration between people from different disciplines. Thus, the concept of a multidisciplinary research team can be considered as a subset of the concept of collaborative research.

Objective of the ICAEBT

The objective of ICAEBT is to enhance the quality and impact of interdisciplinary research by integrating innovations in arts, education, business, and technology. The conference aims to foster collaboration, promote skill development, and drive transformative innovation. The following are key objectives that we seek to achieve:

- **Facilitate Knowledge Sharing and Exchange:** To provide a dynamic platform for researchers, educators, and professionals to present their findings, share knowledge, and discuss contemporary trends and advancements across multiple fields.
- **Support Sustainable Development Goals:** To align research and discussions with the United Nations Sustainable Development Goals (SDGs), addressing issues such as quality education, economic growth, technological innovation, and social well-being through interdisciplinary approaches.
- **Enhance Educational Practices and Policies:** To explore new pedagogical methods and educational policies that leverage technology, business acumen, and creative arts to improve learning outcomes and educational systems globally.

- **Encourage Collaborative Partnerships:** To facilitate the formation of collaborative partnerships among academia, industry, and governmental organizations, fostering joint ventures and research initiatives that drive interdisciplinary advancements.
- **Promote Creativity and Technological Integration:** To highlight the role of creativity and technological integration in business and educational practices, encouraging participants to think beyond conventional boundaries and adopt new perspectives.
- **Address Contemporary and Future Challenges:** To identify and address contemporary and future challenges in society, such as digital transformation, cultural shifts, and economic development, through interdisciplinary dialogues and problem-solving strategies.
- **Support Professional Development:** To offer opportunities for professional development by sharing best practices, case studies, and theoretical frameworks that can be applied in academic, business, and technological domains.

These objectives aim to ensure that the ICAEBT - 2025 conference serves as a catalyst for interdisciplinary innovation and transformative research. Let me know if you need any further modifications or additions!

ABOUT IFERP

The IFERP Academy is a professional association devoted to the advancement of the fields of engineering, science, and technology through the funding of research activities, propagation of the latest research insights, furtherance of industry trends, and other related ventures. IFERP aims to digitalize this entire process of innovation, collaboration, and knowledge-sharing through the fostering of a unified virtual scientific community worldwide. Everything from networking and joint ventures to learning, research assistance, publication, and more, will be carried out as part of this objective.

IFERP has established robust scientific, academic, and industry networks throughout Asia, the Middle East, and Europe. Some of the countries that IFERP has its presence in, include Iraq, Maldives, Thailand, Malaysia, Singapore, Philippines, Indonesia, Taiwan, Vietnam, UAE, Australia, Japan, Sri Lanka, Nepal, Ghana, and Africa.

Mission & Vision

Mission : "Upskilling the knowledge hub through technological innovation and excellence for the benefit of humanity"

Vision : "A Digitally equipped robust, dynamic & swift professional community integrating academics & industry for upgraded technical knowledge implementation."

What We Do

IFERP believes that there is always a better way to treat the professionals by providing them a world class stage by organizing conferences. We are committed to doing the following activities:

- We encourage convenient access to academic resources and support for all the aspirants and research scholars in urban and rural areas.
- IFERP organizes Public Education Programs, Workshops, Conferences, Webinars, Seminars, Guest Lectures, Short Term Training Programs, Faculty Development programme in the field of Engineering, Science & Technology.
- IFERP is dedicated to inquisitiveness, innovations and recent trends and developments in the field of Engineering & Technology.
- IFERP believes in knowledge sharing by collaborating with other Universities, organizations/Associations, to bring a better tomorrow.

DIRECTOR'S MESSAGE, IFERP

Mr. A. Siddth Kumar Chhajer

Managing Director & Founder, IFERP
Technoarete Group, India

MESSAGE

On behalf of IFERP & the organizing Committee, I express my hearty gratitude to the Participants, Keynote Speakers, Delegates, Reviewers and Researchers.

The goal of the International Conference on Interdisciplinary Innovations: Arts, Education, Business and Technology (ICAEBT-2025) is to provide knowledge enrichment and innovative technical exchange between international researchers or scholars and practitioners from the academia and industries in various fields of academics. This conference creates solutions in different ways and to share innovative ideas in the field of Arts, Education, Business and Technology. ICAEBT 2025 provides a world class stage to the Researchers, Professionals, Scientists, Academicians, and students to engage in very challenging conversations, assess the current body of research and determine knowledge and capability gaps.

ICAEBT 2025 will explore the new horizons of innovations from distinguished researchers, scientists and eminent authors in academia and industry working for the advancements in Arts, Education, Business and Technology from all over the world. ICAEBT 2025 hopes to set the perfect platform for participants to establish careers as successful and globally renowned specialists in various fields of Academics.

CEO'S MESSAGE, IFERP

Mr. Rudra Bhanu Satpathy

Chief Executive Officer & Founder, IFERP
Technoarete Group, India

MESSAGE

IFERP is hosting the International Conference on Interdisciplinary Innovations: Arts, Education, Business and Technology (ICAEBT-2025) this year in month of June. The main objective of ICAEBT-2025 is to grant the amazing opportunity to learn about groundbreaking developments in modern industry, talk through difficult workplace scenarios with peers who experience the same pain points, and experience enormous growth and development as a professional. There will be no shortage of continuous networking opportunities and informational sessions. The sessions serve as an excellent opportunity to soak up information from widely respected experts. Connecting with fellow professionals and sharing the success stories of your firm is an excellent way to build relations and become known as a thought leader.

I express my hearty gratitude to all my Colleagues, Staff, Professors, Reviewers and Members of organizing committee for their hearty and dedicated support to make this conference successful. I am also thankful to all our delegates for their painstaking effort to make this conference successful.

Keynote Speaker

Ts. Dr. Nur Azaliah BT Abu Bakar

Associate Director
UTM International Kuala Lumpur, Malaysia
Associate Professor
Faculty of Artificial Intelligence,
Universiti Teknologi Malaysia,
Kuala Lumpur, Malaysia

BIOGRAPHY

Assoc. Prof. Ts. Dr. Nur Azaliah Abu Bakar is the Associate Director at UTM International Kuala Lumpur and a faculty member at the Faculty of Artificial Intelligence, Universiti Teknologi Malaysia (UTM). With 25 years of experience spanning academia, government, and industry, she specialises in enterprise architecture, artificial intelligence, business analytics, and cybersecurity. She is a consultant in enterprise architecture and digital transformation initiatives, actively shaping research, policy development, and innovation strategies. A member of the IEEE Society, the Malaysian Board of Technology (MBOT), and several international associations, she is also a sought-after speaker at global forums. Passionate about student engagement and leadership, she drives international collaboration and mobility programs in higher education.

Keynote Speaker

Dr. L. Arun Raj

Associate Director
Department of CSE,
B.S. Crescent Institute of Science and Technology,
Chennai, India

BIOGRAPHY

Dr. L. Arun Raj is an Associate Professor in Department of CSE at B.S. Crescent Institute of Science and Technology, Chennai, India. He has 15 years of experience in teaching, research and administration. He has published more than 50 publications in highly cited Journals and Conferences and 3 book chapters. His research interests are machine Learning, Health Care, Multimedia Applications, Next Gen. of Wireless Networks and IoT. He has delivered several guest lectures, seminars and chaired a session for various International and Conferences. He is serving as a Reviewer and Editorial Board Member of many reputed Journals and acted as Session chair and Technical Program Committee member of National conferences and International Conferences at Thailand, Singapore and China.

Session Speaker

Dr. Md. Sameeruddin Khan

Professor & Dean & Pro Vice Chancellor
Presidency School of Computer Science &
Presidency School of Information Science,
Presidency University, Kolkata,
West Bengal, India

BIOGRAPHY

Dr. Md. Sameeruddin Khan, a beacon of academic brilliance, his illustrious academic trajectory features a Postdoctoral Fellowship at City, University of London, Ph.D. in Computer Science and Engineering from Rayalaseema University, complemented by an M.Tech from Visvesvaraya Technological University and a B.E. from Gulbarga University—each a testament to his unwavering dedication to the pursuit of excellence. As the Pro Vice Chancellor - Engineering and Dean of the School of Computer Science and Engineering and School of Information Science at Presidency University, Dr. Sameer Khan is at the forefront of academic innovation and excellence. His previous leadership roles as Director at Sree Dattha Institutions and Executive Director at Chandigarh University highlight his proficiency in elevating educational standards and championing research excellence. Dr. Sameer Khan's transformative impact includes securing prestigious accreditations and forming strategic partnerships with global tech giants such as Microsoft and Amazon. His visionary leadership in curriculum development and commitment to fostering a culture of inquiry and innovation reflect his deep dedication to advancing education. Beyond his administrative roles, Dr. Khan contributes to the broader academic community as an Advisory Member of the Academic Leadership Council of uLektz, a Senior Member of the Governing Council for Higher Education at IIHT, and a Member of the Academic Advisory Board of Idealabs, Hyderabad. Dr. Sameer Khan's remarkable achievements include receiving the APJ Kalam Excellence Award, the Teaching Excellence Award, the Eminent Educationist Award and the Technology and Innovation in Education Award. Dr. Sameer Khan exemplifies the belief that 'The best way to predict the future is to create it,' demonstrating a commitment to shaping educational excellence and fostering innovation through visionary leadership and collaborative efforts.

Session Speaker

Dr. Nurshahira Ibrahim

Senior Lecturer
Academy of Contemporary Islamic Studies,
Universiti Teknologi MARA,
Pahang, Malaysia

BIOGRAPHY

Nurshahira Ibrahim has a PhD from Universiti Kebangsaan Malaysia. Currently, she serves as a senior lecturer in the Contemporary Islamic Studies Academy, Universiti Teknologi Mara (Pahang campus), Malaysia. She has spent much time in developing Islamic management program, teaching, supervision, research and publication about human resource development, organizational psychology, and community development issues.

Session Speaker

Dr. Abbas Fadhil Aljuboori

Professor & Head & Deputy Dean
Head of Cyber Security Department,
Deputy Dean for Scientific Affairs
(College of Engineering and Information Technology)
AlShaab University, Baghdad, Iraq

BIOGRAPHY

Prof. Dr. Abbas Fadhil Aljuboori is working currently at College of Engineering and Information Technology- AlShaab University (Deputy Dean for Scientific Affairs and Head of Cyber Security Department). Iraq. He has a Ph.D. in Computer Science from Dongguk University, South Korea. Fulbright Visiting scholar – University of Central Oklahoma – Edmond – USA –2017. International Advisory Board Member for CT University in India. He worked as a Vice President for Administrative Affairs and Head of Smart Cities Center at University of Information Technology and Communications, Baghdad, Iraq. Faculty Staff Member at Al Zahra College for Women, Muscat, Oman. Faculty Staff Member at Media Technology Engineering, College of Engineering, University of Information Technology and Communications, Researcher and Manager in the Advanced Institute of Convergence Information Technology (AICIT) – South Korea, Head of Computer Science Department – University of Kerbala. Vice President of Iraqi Universities Accreditation and Quality Assurance Council for Computer Science and IT. His field of Interest are in Data Mining, Web Applications, Big Data, Data Security, Information Systems, Social Media Analysis, and Smart Applications. He is a Member of several of Academic and Professional Societies. He is an Editor-in-Chief, Editorial Board Member and Reviewer of many eminent International Journals and Conferences worldwide.

Session Speaker

Dr. Aidanazima Abashah

Senior Lecturer and Chairman
Faculty of Business & Communication,
Universiti Malaysia Perlis (UniMAP),
Malaysia

BIOGRAPHY

Dr. Aidanazima Abashah is a Senior Lecturer and Chairman for Industrial Networking & Quality Management at the Faculty of Business & Communication, Universiti Malaysia Perlis (UniMAP). With a distinguished academic career and extensive research expertise, she has made significant contributions in business management, strategic management, quality compliance, entrepreneurship, and social impact studies. Holding a Ph.D. in Business Management from Universiti Utara Malaysia (UUM), Dr. Aidanazima has demonstrated academic excellence, earning accolades such as the Graduate on Time (GOT) recognition award. She is an active researcher with numerous Scopus and Web of Science-indexed publications, contributing valuable insights to global discussions on business strategy, financial literacy, and market feasibility. Beyond academia, Dr. Aidanazima has extensive industry experience in a Multinational Semiconductor Company as an Executive at the Global Service Center Department to serve the global bidding and procurement, bringing practical applications to her research, teaching, and consultation work. She has been an Associate Editor for the International Journal of Business and Technopreneurship. She is also an ISO 9001:2015 Certified Internal Auditor, reinforcing her commitment to quality standards in business operations. Recognised internationally, she has served as a speaker, session chair, and conference committee member for various prestigious events. Today, as the Honorable virtual Session Speaker for ICAEBT-25, she will facilitate an insightful lecture entitled: Strategic Alliances: The Blueprint for Business Success.

Session Speaker

Dr. Pardeep Singh Tiwana

Assistant Professor
Chandigarh Group of Colleges,
Landran Mohali,
India

BIOGRAPHY

Dr. Pardeep Singh Tiwana is an accomplished Assistant Professor with over 8 years of experience in IT education and research. Specializing in Software-Defined Networking (SDN), load optimization, and multimedia applications, he has published over 20 research articles in high-impact journals and conferences. Dr. Tiwana holds a Ph.D. in Computer Science from Chandigarh University, where his thesis focused on load optimization frameworks for multimedia applications in SDN. He is currently associated with Chandigarh Group of Colleges, Landran, where he has been recognized for his excellence in teaching, research, and innovation.

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Abstract's Index

Bio-fabrication of Living Materials for Sustainable Infrastructure

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Abstract

Bio-fabrication, an emerging interdisciplinary field, offers promising strategies for developing sustainable infrastructure by incorporating biological organisms into material production. Living materials - constructed with the help of microbes, fungi, and algae - are capable of dynamic behaviour such as self-growth, repair, and environmental responsiveness. This study explores recent innovations in bio-fabrication methods, including microbial-induced calcite precipitation, mycelium-based composites, and algal-derived bio-polymers, focusing on their mechanical performance, biodegradability, and ecological impact. The integration of these materials into infrastructure supports reduced carbon emissions, energy efficiency, and waste minimization. While the potential of engineered living materials (ELMs) is considerable, challenges such as material consistency, lifespan, and compliance with regulatory standards remain critical. This paper highlights the role of biological systems in redefining building practices and proposes a pathway toward infrastructure that aligns more closely with environmental sustainability.

Keywords

Bio-fabrication, Living Materials, Sustainable Infrastructure, Mycelium, Bio-concrete, Self-Healing Materials.

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Development And Acceptability of Mobile Application eSarakan: A Boarding House Locator for Ilocos Norte

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Abstract

Finding a boarding house is not easy, especially for new boarders who are not familiar with the area, and it requires a lot of effort, money, and time. Searching for the nearest available boarding house in a certain area and the lack of adequate information is still a problem in Ilocos Norte. To give a solution to the problem, the study intended to develop a mobile application eSarakan a boarding house locator for Ilocos Norte and determine the user's acceptability. In the development of the application, Rapid Application Development was used and Android Studio as the platform for development. Maps and navigation features were incorporated utilizing Mapbox API and Firebase as its real-time database. The application was tested by the end-users and answered the questionnaires based on ISO 25010. The application was accepted by the end-users with an overall mean of 4.29 interpreted as Very Satisfactory. The developed application meets the end-user's requirements in finding available boarding houses near the area. With the application's features, it is easier to search for boarding houses and communicate with the owners. The application is a great help to the community, especially to the boarding house seekers and boarding house owners for their business advertisement.

Keywords

Mobile Application, Boarding House, Map, Navigation, Boarders, Lessor, Rent.

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The Impact of Militarization on Democratization in International Relations

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Abstract

Democracy is widely regarded as the most legitimate and stable form of governance. However, its implementation and endurance vary significantly across societies. While Abraham Lincoln famously described democracy as "government of the people, by the people, for the people," modern political realities suggest a more complex picture. Some states successfully establish and maintain democratic institutions, while others struggle with instability, authoritarian tendencies, or incomplete democratization. This raises a fundamental question: What are the key factors influencing the success or failure of democratization?

The process of democratization is shaped by a combination of cultural, economic, and political factors. Culture influences democracy through national identity, religious traditions, and historical experiences, which shape public attitudes toward governance. Economically, some scholars argue that prosperity fosters democracy, while others contend that economic stability must precede political liberalization. In international relations, democratic states are often believed to be more peaceful, yet the process of democratization has sometimes led to conflict, particularly when imposed externally.

This paper examines the multidimensional nature of democratization by exploring its relationship with culture, economic development, and global politics. It also evaluates two major democratic theories—liberal democracy (Locke, Kant) and civil republicanism (Rousseau)—to determine their relevance in contemporary governance. Furthermore, the study incorporates case studies of democratic success and failure, comparing Western democracies, post-Soviet transitions, and non-democratic economic powers such as China and the Gulf states. This paper also argues intersection between democratization and militarization.

By analyzing these diverse influences, this research aims to provide a comprehensive understanding of democracy's development and resilience in different contexts. Ultimately, it seeks to answer whether democracy is a universally adaptable system or whether its success depends on specific cultural and economic conditions and influence of militarization.

Keywords

Democracy, democratization, international relations, militarization.

Exploring Sustainable Finance Practices Toward Building a Resilient Blue Economy in the MENA Region: Opportunities, Challenges, and Policy Recommendations

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Abstract

The Blue Economy is becoming an essential pillar of sustainable economic growth in the Middle East and North Africa (MENA) region, fostering economic diversification, marine resource conservation, and climate resilience. However, the lack of adequate financial instruments, policy coherence, and investment de-risking mechanisms remains a significant challenge in financing sustainable ocean-based industries. This research explores the role of sustainable finance in developing a resilient Blue Economy across the MENA region, with a focus on case studies from the United Arab Emirates, Saudi Arabia, Oman, Kuwait, Bahrain, Egypt, Morocco, and Algeria, showcasing financial mechanisms, policy innovation, and challenges.

Sustainable finance instruments such as blue bonds, green Sukuk, impact investing, and blended finance models have emerged as crucial tools for mobilizing capital toward ocean-related projects. These financial instruments facilitate investments in marine biodiversity conservation, sustainable fisheries, offshore renewable energy, and climate-resilient maritime infrastructure. The findings from the case studies reveal that while some MENA countries have made significant progress in integrating ESG (Environmental, Social, and Governance) principles into Blue Economy financing, there is still a gap in harmonized policy frameworks and regional financial collaboration. Addressing these gaps requires innovative financial structures, stronger public-private partnerships (PPPs), and regulatory reforms to enhance the bankability of Blue Economy projects and attract institutional investors.

This study employs a mixed-method approach, integrating qualitative insights from these case studies and quantitative analysis of investment trends in ocean-based industries. Findings indicate that while sustainable finance policies are evolving, challenges remain in regulatory harmonization, investor confidence, and scaling financial innovation. The research contributes to interdisciplinary discussions by offering policy recommendations aimed at enhancing financial innovation, de-risking investments, and integrating sustainability considerations into regional economic strategies.

Additionally, the study highlights the role of Higher Education Institutions (HEIs) in capacity building and knowledge transfer for sustainable Blue Economy development in MENA. HEIs can play a pivotal role in bridging the gap between academia, industry, and policymakers by fostering research-driven solutions, capacity-building programs, and innovative financial modeling for ocean-based economies. It provides practical insights for policymakers, financial institutions, investors, and academia in leveraging finance for sustainable ocean resource management, thereby strengthening the Blue Economy as a driver of long-term economic stability and ecological balance in the region.

Keywords

Sustainable Finance, Blue Economy, Impact Investing, MENA Region, Climate Resilience, Marine Conservation, Blended Finance, Financial Innovation, ESG Investment, Ocean-Based Industries, Maritime Logistics.

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Enhancing Healthcare Efficiency with a Multi-Persona Platform: Swaasth

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Abstract

One of the challenges healthcare systems faces is their inability to offer efficient, personalized services due to communication silos, inefficient scheduling, and lack of access for patients and/or providers. For example, patients do not find it easy to schedule their appointment, access their health records, or obtain a prescription. Similarly, the provision for doctors to reschedule appointments online and issue electronic prescriptions for the convenience of patients while working on patient records for excellence in healthcare delivery might involve minor issues. For hospital administrators, the strenuous balancing act of supervising staff, monitoring admissions, and operating analytics contributes to the administrative bottleneck, hindering overall operational efficiency.

In addressing these problems, we have proposed a common healthcare application that can provide real-time services for patients, doctors, and administrators. Patients will be able to book appointments, review health records, and manage a prescription in a secure way that is easy to navigate - all on one platform. Doctors are equipped with options to manage appointments, work with their schedules, and write electronic prescriptions quickly to extend patient care. The admins will also have many features around onboarding staff, analytics, and administration capabilities—again, all in one place. With a truly scalable microservices architecture on the serverless backend, the solution will enable seamless data exchanging and secure access control. This will promote the development of truly connected, efficient, responsive healthcare environments.

Keywords

Digital Prescriptions, Serverless Computing, Data privacy, Data Integrity, Security.

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Developing a Risk-Based Work Breakdown Structure for Safety Planning in Change Out Catalyst Projects

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Abstract

The downstream oil and gas sector remains a key contributor to national development in Indonesia. However, the frequency of occupational accidents within these operations remains inconsistent, particularly in high-risk activities such as reactor catalyst replacement. This process poses significant safety risks and calls for the implementation of a structured and sustainable safety management system. This study aims to develop a risk-based safety plan using the Work Breakdown Structure (WBS) framework for reactor catalyst replacement operations. A descriptive qualitative approach was employed through document analysis and structured surveys. The research involved identifying specific work activities, analyzing potential hazards, assessing associated risks, and determining control measures. These elements were integrated into a comprehensive and actionable safety plan. A total of 84 distinct activities were identified, each assessed for its safety implications and corresponding mitigation strategies. By promoting safer work environments and reducing operational risks, this study supports the achievement of Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 12 (Responsible Consumption and Production). The resulting framework is expected to guide service providers in Indonesia's oil and gas sector in aligning operational safety with long-term sustainability objectives.

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Challenges Faced by Ethnic Minority Children in the Educational Process in Georgia

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Imeri Basiladze
Professor, Department of pedagogics, Akaki Tsereteli State University, Georgia

Abstract

This article examines the challenges faced by ethnic minority students in Georgia within the general education system, focusing on the regions of Imereti, Adjara, Kakheti, and Samtskhe-Javakheti. The study investigates the extent to which high-quality education is accessible to non-Georgian-speaking students attending Georgian-language schools. Despite national and international legal frameworks that affirm the right to education for all, including in one's native language, ethnic minority students frequently encounter systemic barriers. These include insufficient Georgian language instruction, lack of adapted teaching materials, poorly translated textbooks, and inadequate training of educators.

Findings indicate that language remains a major obstacle to academic achievement, particularly for students whose families have limited proficiency in Georgian. Many students rely on private tutors or additional classes, underscoring the education system's failure to provide sufficient language support. Furthermore, dropout rates are disproportionately high among minority students due to socioeconomic hardship, early marriage, and limited transport to schools. Teachers report difficulties in adapting curricula to meet the needs of non-Georgian-speaking students, while parents remain largely uninvolved due to a lack of information or resources.

Although some positive examples of integration and peer support were identified, the study concludes that state educational reforms largely overlook non-Georgian sectors within Georgian-language schools. The current "New School" model, which fails to account for ethnolinguistic diversity, further marginalizes these students. The paper recommends the development of inclusive educational policies, reform of language instruction materials, and the establishment of support systems such as student-parent clubs and municipal assistance offices dedicated to ethnic minority students. Addressing these systemic inequities is essential for ensuring equal access to education and fostering social cohesion in Georgia's multiethnic society.

Keywords

Challenges, ethnic minority, child rights, education system, integrity, inclusion, discrimination.

Characteristic Features of Electronic Dictionaries: Proposals for Development and Evaluation of Advantages and Limitations

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Abstract

The rapid evolution of information and communication technologies has significantly influenced the development and functionality of electronic dictionaries. This article explores the advantages, limitations, and future perspectives of electronic lexicography, comparing it with traditional print dictionaries. Drawing upon the ideas and suggestions of several notable scholars including Shriver, L.Bowker, H.Bergenholtz, and A.A.Zalevskaya the study analyzes both the current state and the prospective trajectory of electronic dictionary design. A central focus of the article is the enhancement of search functions within digital dictionaries. Researchers argue that the development of complex, multi-level search systems capable of recognizing spelling errors, implementing wildcard searches, and offering semantic-based results represents a significant leap from the rigid, alphabetical constraints of print dictionaries. Hyperlinks connecting entries and dictionaries further increase productivity, allowing users to explore language in a more interconnected manner. Despite these benefits, electronic dictionaries are not without drawbacks. Several scholars, including L.Bowker and H.Bergenholtz, emphasize issues such as limited content in offline dictionaries, inconsistent user interfaces, and poor integration of lexicographic theory. A/B testing involving students revealed that, while electronic dictionaries allow for quicker look-ups, they often lack the depth and nuance found in comprehensive print resources. Additionally, interface complexity and excessive pop-up windows can distract users and hinder effective use, as noted by Zalevskaya. The article proposes seven key methods to improve future generations of electronic dictionaries. These include: expanding database capacity to accommodate richer linguistic content; customizing dictionaries for different user groups (e.g., translators, learners, professionals); integrating dictionary functions with real-time text analysis tools; offering grammar and orthographic correction features; and designing user-friendly interfaces without compromising functionality. In addition to these methodological proposals, the article provides a detailed classification of the strengths and weaknesses of electronic dictionaries across various dimensions search capabilities, technical features, user interface, and information presentation. It concludes that while current electronic dictionaries exhibit considerable potential, their full capabilities remain underutilized due to technical and design shortcomings. Nevertheless, when properly developed, electronic dictionaries can become indispensable tools for a wide spectrum of users beyond the field of language studies, including engineers, doctors, and travelers. Ultimately, the article advocates for the compilation of a dedicated glossary of terms used in electronic lexicography to standardize terminology and facilitate further research. With appropriate innovation and interdisciplinary collaboration, the next generation of electronic dictionaries may provide enhanced linguistic insight, intuitive usability, and dynamic interaction between users and language data.

Keywords

Softcopy, hardcopy, e-dictionary, lexicography, digital information.

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Introduction

The distinctions between electronic and traditional dictionaries, along with their primary characteristic features, have been outlined by various scholars conducting research in this field. Let us consider the perspectives of several of these researchers. According to V.P. Berkov, the electronic dictionary of the XXI century must meet the following requirements:

- It should be comprehensive in terms of volume;
- It should have a concentric structure;
- It should feature hyperlinked entries;
- Dictionaries should include audio components;
- It should provide complete grammatical information about both headwords and derivatives;
- It should more thoroughly present word combinations and collocations;
- It should contain information about the systemic relationships of words;
- It should incorporate graphical illustrations;
- It should include extensive material on proper names;
- A continuously operating “update service” should be maintained [Berkov, 2000].

Indeed, many of these features are present in most electronic dictionaries currently in use; however, some still exhibit certain shortcomings. Electronic dictionaries deliver information based on users’ specific queries. Such dictionaries can function independently or be integrated as components within larger translation systems and electronic databases.

Q.M. Mandrikova and N.A. Sivakova distinguished electronic dictionaries from traditional ones based on the following features:

- Flexibility – linguistic software tools facilitate easier access to the dictionary and expand its functional capabilities during use;
- Compactness – they allow for the establishment of lexical connections across different languages;
- Bidirectionality – users can select any language as the source language when entering the dictionary;
- Dynamism – the ability to revise dictionary entries and remove obsolete words

In response to the above, S.A. Stroykov commented: "The first three features are also characteristic of traditional dictionaries. The fourth feature, namely dynamism, is actualized solely in electronic dictionaries and constitutes a principal and defining distinction between electronic and traditional formats" [Mandrikova, 1994]. [Stroykov, 2008].

I.I. Zavarueva categorized the strengths and weaknesses of electronic dictionaries as follows:

A) Advantages – larger volume compared to printed dictionaries, fast word search, transcription and audio pronunciation, compactness, and flexibility;

B) Disadvantages – limited social interaction, the need for updates to certain technical functions, and the presence of psychologically affecting factors [Zavarueva, 2013].

P.Sharp, expressing skepticism toward computer-based dictionaries, remarked:

"Simply transferring traditional dictionaries into a digital format is practically the same as using printed dictionaries, and this approach holds little promise" [Sharp, 1995]. N. Forget, on the other hand, reached the following conclusion regarding electronic dictionaries:

"Electronic dictionaries differ from printed ones in terms of usability, presentation, search capabilities, technical aspects, structural composition, and the integration of multimedia elements" [Forget, 1999]. In particular, the author emphasizes the role of hypertext in electronic dictionaries. He further adds: "Every electronic dictionary possesses its own internal structure. As a result, users must dedicate considerable time to understanding the internal navigation of these dictionaries. Both in the structure of the dictionaries and in the presentation of lexical items, different colors and interactive multimedia interfaces are often used to highlight information. Electronic dictionaries function through various types of searches, and although manual searching is significantly slower than automatic search, users may still not always achieve sufficiently satisfactory results".

H.Nesi and E.Schriver, sharing a common viewpoint, point out the limited capabilities of automatic search functions in traditional dictionaries. They argue that, although traditional dictionaries present their entries in alphabetical order, search functionality is restricted by the compiler, and in many cases, even direct and precise word search is not possible. H.Nesi also notes: "People have become accustomed to navigating maps, encyclopedias, and dictionaries in a typical, linear fashion" [Nesi, 1999]. He implies that this behavior may eventually shift as users adapt over time to electronic formats. M. Sanchez, in contrast, argues that searching in electronic dictionaries is significantly faster and more efficient due to the integration of modern search technologies [Sanchez, 2009]. The user's ability to translate and make contextual word choices plays a crucial role here. Selecting contextually appropriate words and demonstrating linguistic agility are key skills required of the user. It is important to remember that the electronic dictionary phenomenon is relatively new, and mastering its use requires time. F.E. Knowles advocates for the use of hyperlinks in electronic dictionaries [Knowles, 1990], while F.R. Abate supports the inclusion of images and graphics in natural language search processes [Abate, 2011].

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Perspectives on Search Functions in Electronic Dictionaries: The views and suggestions of several scholars regarding search types have already been implemented in some electronic dictionaries. For example, in his 2003 article "Lexicographers' Dreams," which is among the contemporary contributions to electronic lexicography, E. Schriver calls upon dictionary compilers to expand the range of complex search functionalities in electronic dictionary design.

Many electronic dictionaries now support search functions even in large-scale volumes, and this functionality is not limited to general-purpose dictionaries but is also present in content-specific ones. Additionally, hyperlinks within electronic dictionaries allow users to navigate to related lexical items. This suggests that creating inter-dictionary hyperlinks can significantly enhance productivity. Even if a user inputs a word incorrectly, the electronic dictionary is often capable of suggesting the correct form. Furthermore, many such dictionaries support wildcard searches (e.g., using symbols such as *, /, !, etc.) and phonetic or pronunciation-based searches. Priority is given to semantically linked and orthographically related search options—features unattainable in traditional printed dictionaries.

L.Bowker identified a common shortcoming in offline electronic dictionaries: insufficient content. In a study, she divided students into two groups—one using only traditional dictionaries and the other using electronic ones (both offline and online) for translation tasks. She concluded that although electronic dictionaries yield faster results, many of them suffer from content deficiencies [Bowker, 1998].

H.Bergenholtz remarked: "If electronic dictionaries are potentially capable of fast searching, whether they achieve this in practice depends on their design. In general, digital media serves as a tool that frees us from various inconveniences" [Bergenholtz,1997]. He also emphasized the need for broader use of such dictionaries. While using an anonymous electronic dictionary, he observed: "There is an incredible lack of lexicographic depth and interest here". Bergenholtz praised The Oxford Guide to Practical Lexicography by S. Atkins and M. Rundell, stating: "This is not just an ordinary book; it is a work of lexicographic theory" [Rundell, 2014]. This book references the work of several well-known lexicographers and introduces a number of specialized terms frequently used in electronic lexicography. Examples include:

- **Copycats** – (conversion of hardcopy to softcopy): the process of digitizing printed dictionaries and uploading them online;
- **Faster horses** – (faster searching): improved search speed in digital environments;
- **Model T Fords** – (first attempts at using what digital media offer): initial efforts to leverage the potential of digital media;
- **Rolls Royces** – (useful distinction between interactive, active, and passive methods for individualization depending on whether the user or the system takes the lead): an effective classification of approaches based on the level of user/system interactivity and control.

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The Future of Electronic Lexicography: Proposals for Development and Evaluation of Advantages and Limitations - From the analysis above, it becomes evident that creating a dictionary of specialized terminology used in the field of electronic lexicography would significantly facilitate the work of researchers and developers alike. Based on the theoretical perspectives collected, five key strategies can be proposed for improving the next generation of electronic dictionaries:

1. Expanded Database Capacity

Future-generation electronic dictionaries will significantly differ from traditional ones in terms of their internal databases. These will include a maximum number of entries and outputs, greater lexical polysemy, and a rich array of examples and idiomatic expressions. Currently, modern electronic dictionaries are limited to approximately 200 MB in size; however, it is expected that the new generation will possess a memory capacity of up to 650 MB or more.

2. Increased Flexibility and User Profiling

The new generation of dictionaries will offer greater linguistic flexibility and personalization based on user categories—such as general users, translators, experts, and language enthusiasts. This differentiation will enable customized interaction and functionality tailored to individual needs.

3. Enhanced Search Interaction and Semantic Comparison

Developers can increase the level of user engagement by integrating more intuitive search features. For example, touching or clicking a word could yield the most contextually relevant meaning. At the same time, alternative meanings of the word can be displayed on the screen to enable semantic comparison—thus enhancing user understanding and lexical learning.

4. Integration with Text Analysis Tools

The integration of electronic dictionaries with text analysis software is also a feasible advancement. This would eliminate the need to consult external dictionaries, allowing direct translation or analysis within the text interface. Moreover, not only orthographic but also grammatical spell-checking tools could be incorporated to aid linguistic precision.

5. User Interface Optimization

Developers can streamline dictionary interfaces for better user experience. However, such modifications should not require fundamental changes in usage behavior; rather, they should enhance usability without compromising existing interaction methods.

The advantages of electronic dictionaries can be classified as follows:

- Large lexical capacity and storage volume;
- High-speed and user-friendly search functions;
- Availability of visual and auditory illustrations of searched items;
- Potential for continuous updating and content expansion;
- Possibility to explore alternative meanings and usages of lexical entries;
- Interactivity, including user comments on entries and the ability to contribute as authors;
- Hypertextual references and external links to source materials and original texts.

Key Findings on Strengths and Weaknesses

1. Functional Advantages during Use

The memory and hypertext functions of electronic dictionaries allow for rapid and easy access. Users can retrieve various types of information and guidance at high speed. Electronic dictionaries allow diverse search options and provide real-time interactivity that enhances the effectiveness of dictionary-based advice.

2. Functional Limitations during Use

Due to the considerable variation in interface design, each electronic dictionary requires a specific learning curve. Users must dedicate time to understanding the navigation and features of individual dictionaries.

3. Presentation Advantages

Multimedia elements help clarify otherwise difficult-to-understand definitions and explanations. These include color-coded visuals, sound files, and short video clips that attract user attention and improve comprehension.

4. Presentation Limitations

One drawback is the interface clutter caused by multiple overlapping windows, which restricts full-view access to dictionary entries. Often, users can only view fragmented information, which necessitates frequent switching between windows. This can distract users from their original objective. A.A. Zalevskaya criticized this aspect of electronic dictionaries, noting: "The overlapping of multiple windows renders the dictionary practically unusable. The psychological impact on users is substantial." [Zalevskaya, 1999].

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5. Advantages of Search Capabilities

One of the most prominent strengths of electronic dictionaries lies in the variety and efficiency of their search functions. Unlike printed dictionaries, electronic versions allow users to search for lexical items with remarkable speed and precision. The flexibility of search parameters—such as wildcard symbols, phonetic input, and partial queries—significantly enhances user experience and retrieval effectiveness.

6. Limitations of Search Capabilities

However, users with limited digital literacy may find it difficult to navigate these features efficiently, potentially resulting in wasted time and inaccurate results. The success of the search process is often contingent on the user's familiarity with digital environments and search strategies, which not all users possess.

7. Technical Functional Advantages

Technical functionality plays a crucial role in the operation of electronic dictionaries. Search requests that arise during usage are essential in shaping the ongoing development of technical features. Hyperlinking—available in most modern dictionaries—enables smooth transitions between related entries or even external dictionary databases. Unlike traditional print dictionaries, electronic versions occupy no physical space, are lightweight, do not degrade over time, and can be accessed through various portable devices. Additionally, while alphabetic arrangement is the main navigational tool in print dictionaries, electronic dictionaries offer far more advanced and dynamic navigation options.

8. Technical Limitations

In some cases, the response to a query may be limited to the specific dictionary in use, with no support for hyperlinking or external references. Furthermore, some dictionaries lack robust technical capabilities or require additional hardware (e.g., storage devices or compatible software platforms). Users often encounter technical issues, such as excessive overlapping of windows or instability in navigation, which can obstruct efficient usage. Additionally, the cost of electronic dictionaries may exceed that of their printed counterparts. A considerable number of users feel that print dictionaries better meet their needs due to the limited search functions or user interface complexities of certain digital versions. Some developers have not yet fully leveraged the technological potential of electronic dictionaries, leaving functionality underdeveloped.

Final Remarks

Therefore, electronic dictionaries should be designed in such a way that they serve not only language learners but also a wide range of users—including tourists, engineers, and medical professionals. The ideal electronic dictionary should provide automatic spelling correction, audio pronunciation, voice-enabled and fast search options, and various advanced interactive features. It is anticipated that such advanced dictionaries will become available in the near future. Despite existing technical shortcomings, electronic dictionaries continue to offer significant advantages to users, and some already partially fulfill the practical needs of translators.

Outcomes - This study has led to the following key findings regarding the current state and future development of electronic dictionaries:

1. Advantages of Electronic Dictionaries:

Compared to traditional paper-based dictionaries, electronic dictionaries offer faster search functions, a broader and more interactive database, and multimodal content delivery through audio, graphic, and video illustrations. Hyperlinks, real-time updates, and user-oriented customization significantly improve accessibility and usability, especially for translators, language learners, and linguistic researchers.

2. Flexibility of Search Functions:

Advanced search mechanisms such as wildcard queries, orthographic correction, phonetic search, and semantically linked entries provide greater flexibility and precision in information retrieval. These features allow users to explore word meanings, usage examples, and related expressions efficiently, even if there are spelling errors or incomplete input.

3. User Differentiation and Personalization:

Next-generation electronic dictionaries are expected to serve diverse user groups — including language learners, professional translators, experts in various fields, and casual users — by offering adaptive content, simplified interfaces, and context-specific suggestions. This differentiation enhances the user experience and supports individualized learning or reference needs.

4. Integration with Text Analysis Tools:

Future dictionaries will likely be integrated with text editors and translation platforms, enabling real-time word analysis, grammatical correction, and automatic suggestion features without requiring users to switch platforms. This will contribute to more seamless and efficient workflows in academic and professional environments.

5. Terminological Development:

The emergence of specialized terminology within electronic lexicography (e.g., "copycats," "faster horses," "Rolls Royces") signals the need for a dedicated glossary of electronic dictionary-related terms. This would support researchers and developers in navigating and advancing the field more effectively.

6. Technical Functionality and Limitations:

Although electronic dictionaries offer portability, large data capacity, and multimedia features, there remain notable technical challenges. These include interface complexity, overload of pop-up windows, lack of cross-linking in some versions, high cost,

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and user difficulties stemming from insufficient digital literacy. These factors can hinder user efficiency and satisfaction.

In the context of the education process, this article can be highly valuable on several levels — both theoretically and practically. This study offers conceptual and analytical insights that help learners and educators understand:

- What electronic dictionaries are.
- How they have evolved compared to traditional paper dictionaries.
- The strengths, weaknesses, and structures of different types of electronic lexicographic resources.
- Key terminology and theoretical approaches to electronic lexicography.

It helps learners and educators use, evaluate, and even design better digital resources for language learning, research, and communication. It improves digital literacy and applied skills — which are highly relevant in today's education systems.

1. Content Analysis

- Analyzing the structure, definitions, and classifications of electronic dictionaries discussed in the article. Helps identify trends or patterns.

2. Survey Research

- Gathering quantitative data from students, educators, or translators about their use and perception of electronic dictionaries in education.

3. Interviews / Focus Groups

- Conducting qualitative research through interviews or group discussions to explore user experiences with electronic dictionaries.

4. Case Study

- In-depth exploration of the application of electronic dictionaries in a specific educational setting (classroom, online course, etc.).

5. Experimental Research

- Conducting controlled experiments to measure the impact of electronic dictionaries on students' learning outcomes, such as vocabulary acquisition.

6. Usability Testing

- Evaluating the effectiveness and ease of use of electronic dictionaries through user testing to improve the design and functionality.

7. Corpus-Based Analysis

- Analyzing language data from the dictionaries' corpora to assess their linguistic quality, coverage, and accuracy.

These methodologies offer different lenses through which you can investigate the role and impact of electronic dictionaries in education.

Conclusion

In conclusion, electronic dictionaries have undeniably revolutionized the way people access and process language data. Their advantages over traditional print dictionaries are numerous, and their continued evolution signals a bright future for the field of lexicography. These electronic tools have transformed from simple word collections into dynamic, interactive resources, offering not only definitions but also multimedia elements such as audio pronunciations, video demonstrations, and graphic representations. The integration of hyperlinks and semantic relationships between entries further enhances the depth and usability of the information provided.

One of the most significant advantages of electronic dictionaries is the speed and flexibility of search functions. Unlike traditional paper dictionaries, where users must manually scan through pages to find a word, electronic dictionaries enable rapid retrieval of information through advanced search mechanisms. Features such as wildcard searches, spelling correction, phonetic search, and contextualized results provide users with a more comprehensive and accurate understanding of words and their meanings. The ability to search for related expressions or synonyms directly also improves the user's ability to understand subtle variations in word usage, which is crucial for language learners, translators, and researchers.

Moreover, the future of electronic dictionaries will involve increasingly sophisticated systems capable of personalizing content for specific user needs. By recognizing user preferences, expertise, and previous search patterns, these systems can offer tailored suggestions, improving the overall learning experience. This adaptability is especially beneficial for diverse groups of users, ranging from professional translators to casual learners, as well as specialists in various fields such as medicine, law, or engineering, who require specialized lexicons and terminology. Therefore, the future development of electronic dictionaries will likely focus on creating customizable user interfaces and interfaces that cater to the specific demands of these different groups.

Another exciting prospect for the future of electronic dictionaries is their integration with other digital tools, such as translation software, text editors, and educational platforms. By merging dictionary features with other language-related technologies, users will have access to seamless workflows. For example, a translator working within a text editor might receive real-time suggestions from an integrated electronic dictionary, eliminating the need to switch between multiple programs or applications. This interconnectedness not only enhances user efficiency but also fosters a more cohesive and productive digital ecosystem for language professionals.

Despite their many benefits, electronic dictionaries still face certain challenges and limitations. One major issue is the

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technical complexity of these tools. While they offer numerous functionalities, the user interfaces can sometimes be overwhelming or unintuitive, especially for users unfamiliar with digital platforms. Overloading the user with pop-up windows, excessive options, or fragmented layouts can disrupt the overall experience and deter users from fully utilizing the tool. Additionally, while many electronic dictionaries now boast vast amounts of content, not all of them are fully comprehensive or up-to-date. Many still lack certain lexical entries or relevant contextual information, limiting their usefulness for advanced or specialized users.

Furthermore, some users may encounter technical limitations related to device compatibility, software crashes, or insufficient processing power. In some cases, the cost of electronic dictionaries can also be a barrier, especially for students or professionals in lower-income regions. As these dictionaries often require advanced technical infrastructures, they are not always as accessible or affordable as traditional print versions.

Nevertheless, despite these challenges, the potential of electronic dictionaries is vast. Moving forward, the development of these tools will likely focus on addressing the technical limitations while enhancing their strengths. This could include improving the user interface for easier navigation, adding more specialized and niche vocabulary for professional use, and integrating dictionaries more deeply into educational and translation ecosystems. The creation of a unified lexicographic terminology glossary could further streamline the development process, providing a shared understanding of key concepts and innovations in the field.

In summary, the future of electronic dictionaries holds tremendous promise, with advancements that will continue to expand their capabilities and improve their effectiveness as language tools. By addressing existing limitations, especially in terms of usability, accessibility, and content richness, electronic dictionaries will become even more integral to our digital lives. With continued technological and conceptual developments, these dictionaries will not only serve as essential reference tools but also become more interactive, user-driven, and indispensable components of modern communication, learning, and professional practice.

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A Secure Cloud-Based Academic File Verification System Using EdDSA Cryptography

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Abstract

In the digital transformation of academic institutions, the secure transmission and verification of documents over cloud-based environments has become paramount. With increased dependency on online platforms for exchanging confidential academic records, ensuring file authenticity is critical. This paper proposes a secure cloud-based academic file verification system leveraging the Edwards-curve Digital Signature Algorithm (EdDSA). The proposed system aims to protect university-generated documents from tampering and unauthorized access by integrating cryptographic principles with digital signature schemes. EdDSA is known for its robust security and efficiency, particularly in key and signature generation, making it an ideal choice for resource-constrained environments such as university intranets. Each authorized user is issued a private key while their corresponding public keys are securely stored in a centralized database. Uploaded files are signed using the user's private key, and recipients can verify authenticity using the associated public key. The implementation includes SHA-256 hashing for generating document digests and integrates seamlessly with cloud infrastructure, specifically Amazon Web Services (AWS), for deployment. The system design ensures resistance against common cryptographic attacks, including side-channel, Pollard's rho, and MOV supersingular attacks. A web-based front end is also presented for ease of use. The result is a lightweight, efficient, and scalable system suitable for academic institutions aiming to adopt secure file sharing practices.

Keywords

EdDSA, Elliptic Curve Cryptography, University Cloud Storage, SHA-256, Digital Signature, Authentication, File Integrity, AWS Deployment, Cryptographic Security.

Optimizing DNS Response Delay in Distributed Cluster Architectures

Kanagalakshmi Murugan

Abstract

The Domain Name System (DNS) is a foundational component of the Internet, translating human-readable domain names into IP addresses necessary for communication between devices. As DNS is a critical path in nearly all internet transactions, its performance directly affects overall network efficiency and user experience. However, standard DNS lacks built-in security, making it vulnerable to threats such as cache poisoning, spoofing, and man-in-the-middle attacks. To address these issues, DNS Security Extensions (DNSSEC) were introduced, which provide data origin authentication and integrity verification through digital signatures. While DNSSEC significantly strengthens DNS security, it also introduces performance implications that must be carefully evaluated in distributed systems, especially those relying on low-latency name resolution. DNSSEC adds cryptographic signatures (RRSIG records) and key management records (DNSKEY, DS) to DNS responses. These additional records increase the size of DNS messages and require extra computational effort for signature verification and validation, particularly on the resolver side. This results in increased query processing time and network overhead. This scaling delay is due to the additional cryptographic operations and the need for consistent key validation across nodes. These delays, while seemingly minor on a per-query basis, can significantly affect systems that perform a large volume of DNS lookups or operate in real-time environments. Furthermore, DNSSEC-related performance impact is not only limited to lookup latency but also includes increased memory usage, CPU consumption, and network bandwidth due to larger response sizes. These factors must be taken into account when deploying DNSSEC in high-availability or performance-critical infrastructures. Despite these challenges, DNSSEC remains a vital mechanism for securing DNS infrastructure, and ongoing research continues to explore ways to optimize its implementation to minimize performance trade-offs while maintaining robust security guarantees. Thus, a careful balance must be maintained between enhancing DNS security and preserving efficient system performance, particularly in distributed cluster systems. In communication between nodes within the cluster. DNS is facing performance issues using DNSSEC. This paper addresses this issue by using access control mechanism.

Keywords

DNS, DNSSEC, delay, latency, performance, cryptography, distributed, clusters, query, resolver, signature, validation, overhead, scalability, lookup.

Introduction

The Domain Name System (DNS) is a critical part of modern networking infrastructure, responsible for translating human-readable domain names into machine-readable IP addresses [1]. This process, known as name resolution, allows users and applications to connect to websites and services without having to remember numerical addresses. When a client initiates a DNS query, it follows a resolution path that may involve recursive resolvers, authoritative servers [2], and various levels of caching, depending on the network configuration and the availability of prior query results. Host-based resolution is another method used primarily in local environments. It relies on a static file, typically named `hosts` in Unix-based systems or `hosts.txt` in older network architectures, to manually map hostnames to IP addresses. When configured, the system will check this local file before querying DNS servers [3], effectively bypassing external lookups for entries listed in the file. This method is beneficial for environments where speed and control are prioritized, as it avoids the network latency associated with DNS queries. Delay in DNS resolution can arise from several sources. In a standard DNS lookup, if the resolver does not have the answer cached, it must contact multiple servers to obtain the correct record, starting from the root server and moving through the TLD (Top-Level Domain) and eventually to the authoritative server. Each of these steps introduces latency [4], typically measured in milliseconds, and the total delay accumulates based on network conditions, server responsiveness, and geographic distance. However, its static nature also makes it less scalable and harder to manage in large, dynamic systems. In distributed systems, where clusters of nodes frequently communicate, the speed of name resolution becomes crucial. Delays in resolving hostnames can cascade into application-level performance issues [5], especially when hundreds or thousands of requests are made per second. As a result, choosing the appropriate name resolution strategy—whether relying on DNS, host tables, or a combination of both—requires careful consideration of system size, update frequency, and performance requirements. Ultimately, minimizing DNS and hostname resolution delay is essential for maintaining low-latency, high-availability [6] networked applications, particularly in environments where speed and consistency are operational priorities.

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Literature Review

The Domain Name System (DNS) is the cornerstone of human-friendly networking. It enables the translation of domain names—such as www.example.com—into IP addresses, which are essential for routing data over the internet or internal networks. Without DNS [7], users would need to memorize numerical IP addresses to access websites or services, which would severely impact usability. Beyond the internet, DNS plays a critical role in private networks, microservices architectures, and large-scale distributed systems where thousands of hostname lookups may be performed every second. When a DNS query is made, the resolution process begins either at a local cache or by querying recursive resolvers. If the answer is not cached, the resolver begins by contacting the root server, then proceeds to query the top-level domain (TLD) servers, and finally the authoritative name server for the domain. This hierarchical querying structure [8], while scalable and efficient in design, introduces inherent latency, particularly when queries are not cached or when there are network delays between resolver and authoritative servers.

The total delay for DNS resolution varies depending on factors such as network path quality, server load, DNS software efficiency, and system hardware. In contrast to DNS, host-based resolution is a much simpler and more localized method of name resolution [9]. It uses a static file, commonly named hosts, which resides in the operating system's file system (e.g., /etc/hosts in Unix/Linux systems or C:\Windows\System32\drivers\etc\hosts in Windows). Entries in this file map specific hostnames directly to IP addresses. When an application requests resolution of a hostname, the system checks this file before invoking external DNS services. If a matching entry is found, the lookup is resolved instantly from the file, bypassing any need for network interaction. The main performance advantage of host-based resolution is that it avoids round-trip network time entirely. Lookup from a local file typically completes within a fraction of a millisecond. In benchmark tests, host resolution can be as fast as 0.1 to 0.3 milliseconds, depending on the file size and operating system.

This makes it ideal for latency-sensitive applications, local testing, and private networks where the IP addresses of critical hosts are static and known in advance. This method also eliminates reliance on external DNS services, which is useful in isolated environments or during network outages. .However, host-based resolution does not scale well. As the number of nodes or services increases, maintaining and distributing consistent host files across multiple systems becomes operationally challenging. Manual updates are prone to errors, and inconsistency across nodes can lead to resolution failures or misrouting. Additionally, the lack of centralized management and automation limits [10] its practicality in large or frequently changing environments. Despite its limitations, host-based resolution continues to be useful in specific contexts. In clustered computing environments, such as container orchestration platforms or microservices deployments, developers often use host files during development to hardcode service endpoints. This provides consistent, deterministic resolution behavior without relying on dynamic discovery or third-party infrastructure. It's particularly effective during early-stage testing or when debugging issues that may be influenced by DNS propagation delays. On the other hand, DNS—particularly when supported by recursive caching resolvers—provides a scalable and manageable solution for dynamic environments. Caching plays a significant role in improving DNS performance. When a resolver receives a DNS response, it caches the result for the duration specified by the time-to-live (TTL) value. Subsequent queries for the same hostname are served directly from the cache [11], significantly reducing the resolution time to sub-millisecond levels. In high-performance systems, intelligent cache management is essential to maintain low-latency resolution while keeping data up-to-date. DNS performance can be influenced by resolver location, cache freshness, server responsiveness, and TTL values.

For example, placing resolvers closer to the application or enabling DNS caching at the application layer (e.g., using internal DNS caching libraries or services like nscd or systemd-resolved) can reduce overall lookup time. However, stale cache entries can lead to failed connections if services change IP addresses without timely propagation [12]. Clustered systems often exhibit patterns of DNS usage that differ from typical end-user web browsing. In these systems, nodes frequently resolve service names for database endpoints, API gateways, or peer nodes in real-time. As cluster size grows—from 3 to 5, 7, or more nodes—the number of inter-node communications increases significantly. Every node may resolve the hostname of every other node repeatedly, particularly in service discovery, health checks, and distributed coordination mechanisms. Even modest delays in DNS resolution, when multiplied across thousands of lookups per second, can create performance bottlenecks or increase transaction latency. For example, in a system where each DNS lookup takes 0.8 milliseconds and nodes perform 10,000 lookups per minute, the cumulative delay becomes nontrivial—amounting to 8 seconds of lookup time per minute per node.

In multi-node clusters, this delay multiplies, potentially impacting application response times, especially under load or during peak usage. As a result, optimization strategies such as caching, resolver tuning, or local resolution (via host files or internal DNS servers) become critical. Operating system-level DNS settings can also influence resolution speed. Parameters such as timeout intervals [13], retry counts, and search domains (as defined in /etc/resolv.conf or equivalent

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configurations) can affect how quickly the system reacts to failures or misconfigured domains. Reducing timeout thresholds or eliminating unnecessary search paths can improve average resolution time. Another factor contributing to DNS delay is the use of load balancers and service discovery layers. Many modern applications use DNS-based service discovery mechanisms, such as those in Kubernetes, Consul, or Eureka. These often resolve names dynamically using internal DNS servers that map services to pods or instances. While highly dynamic and scalable, these internal DNS layers can introduce additional latency if not properly optimized. Monitoring DNS query latency, response time, and cache hit ratios becomes essential in these systems to ensure optimal performance. When evaluating DNS performance in a distributed system, it's important to consider not only individual query latency but also the cumulative effect of DNS lookups on transaction paths. In many web and microservices applications, a single user request may involve multiple backend service calls, each requiring separate name resolutions. Even small delays in each lookup can add up to a noticeable lag in the end-user experience. To minimize DNS-related delays, systems can implement layered caching, distribute resolvers locally on each node, or tune TTL values for appropriate balance between freshness and performance.

Logging and analyzing DNS performance metrics—such as average lookup time, failed queries, and cache hit/miss ratios—also help identify resolution bottlenecks [14]. In summary, DNS and host-based resolution are both essential tools for translating names to IPs, each with strengths and trade-offs. DNS offers scalability, manageability, and dynamic updates, making it the standard for large and evolving infrastructures. Host-based resolution delivers minimal latency and reliability in static or isolated environments. Understanding the performance characteristics of both, particularly the delay each introduces in various contexts, is key to building fast, resilient, and efficient distributed systems. DNS Security Extensions (DNSSEC) were developed to address serious security vulnerabilities in the traditional Domain Name System (DNS), such as cache poisoning and spoofing. By adding cryptographic signatures to DNS records, DNSSEC ensures that the data returned in a DNS query has not been tampered with and is authentically provided by the authoritative source. While DNSSEC is critical for improving the trustworthiness and integrity of DNS responses, its adoption introduces several performance challenges that can impact the efficiency of DNS operations.

One of the most significant performance issues associated with DNSSEC is increased latency in DNS query resolution. This delay arises from the need to perform additional cryptographic operations, such as signature verification and validation of the trust chain using DNSKEY and DS records. Each DNSSEC-enabled query may require multiple lookups to obtain all necessary security records before the final response can be considered valid. These extra steps increase the total time required to resolve a domain, especially in systems that perform a high volume of lookups. DNSSEC also results in larger DNS response sizes due to the inclusion of RRSIG [15] records and associated keys. Larger responses increase the likelihood of fragmentation over UDP, which can degrade performance or cause resolution failures if intermediate network devices do not properly handle fragmented packets. In some cases, queries must fall back to TCP, which introduces additional overhead and further increases resolution time. Another factor affecting DNS performance under DNSSEC is the added computational load on resolvers and authoritative servers. Signature generation on the server side and verification on the client side both consume CPU resources.

In environments with limited processing capacity or high traffic volume, this can lead to slower response times or increased server load, impacting scalability and responsiveness. Additionally, DNSSEC validation requires strict clock synchronization and proper key management, including regular key rollovers. Mismanagement or failure in validation procedures can cause resolution failures, leading to service disruptions even when network connectivity and DNS infrastructure are otherwise functioning correctly. In summary, while DNSSEC enhances security by ensuring data authenticity [16] and integrity, it introduces measurable performance drawbacks. These include increased query latency, larger packet sizes, higher CPU usage, and operational complexity, all of which must be accounted for when deploying DNSSEC in performance-sensitive environments.

```
package main
import (
        "fmt"
        "github.com/miekg/dns"
        "os"
    )
func queryDNS(name string, qtype uint16, server string) *dns.
Msg  {
        client := new(dns.Client)
        client.Net = "udp"
        msg := new(dns.Msg)
        msg.SetQuestion(dns.Fqdn(name), qtype)
        msg.SetEdns0(4096, true)
.       resp, _, err := client.Exchange(msg, server)
        if err != nil {
                fmt.Println("DNS query error:", err)
                os.Exit(1)
        }
```


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```
        return resp
    }
func main() {
    server := "8.8.8.8:53"
    domain := "example.com."
    aResp := queryDNS(domain, dns.TypeA, server)
    fmt.Println("A Record Response:")
    for _, ans := range aResp.Answer {
        fmt.Println(ans)
    }
    fmt.Println("Authenticated Data (AD bit):", aResp.AuthenticatedData)
    fmt.Println("\nRequesting DNSKEY Record with DNSSEC:")
    dnskeyResp := queryDNS(domain, dns.TypeDNSKEY, server)
    for _, rr := range dnskeyResp.Answer {
        fmt.Println(rr)
    }
    fmt.Println("\nRequesting RRSIG Record for A Record:")
    rrsigResp := queryDNS(domain, dns.TypeRRSIG, server)
    for _, rr := range rrsigResp.Answer {
        fmt.Println(rr)
    }
}
```

This Go program performs DNS queries with DNSSEC enabled, allowing it to request and receive DNSSEC-related records such as DNSKEY and RRSIG. The core functionality is built around the `queryDNS` function, which takes a domain name, query type, and DNS server address as input. It constructs a DNS query message, sets the question section with the requested record type, and enables DNSSEC by setting the DO bit via EDNS0 options. The function then sends the query using UDP to the specified DNS server and returns the response message. In the `main` function, the program queries the DNS server (Google's public DNS at 8.8.8.8) for three types of DNS records: A records, DNSKEY records, and RRSIG records, all for the domain `example.com.`. First, it requests the A record, which contains the IP address for the domain, and prints all answers received. It also checks and displays the Authenticated Data (AD) bit, which indicates whether the DNS resolver has verified the response's DNSSEC signatures.

Next, the program queries for DNSKEY records, which hold the public keys used to validate DNSSEC signatures for the domain. These keys are essential for establishing trust in DNS data authenticity. The retrieved DNSKEY records are printed to the console. Finally, the program requests RRSIG records that correspond to the A records. RRSIG records contain the cryptographic signatures that validate the integrity and origin of DNS data, and printing them allows the user to inspect the DNSSEC signatures associated with the queried records. Overall, the program demonstrates how to perform DNSSEC-aware queries, retrieve security-related DNS records, and check if the response is authenticated. However, it does not perform cryptographic verification of signatures locally; it relies on the DNS server to do this and indicate validation through the AD bit. The program is useful for learning about DNSSEC and inspecting DNSSEC records but would require additional logic to fully validate DNSSEC trust chains.

Table 1: DNSSEC Delay Impact

Cluster Size (nodes)	DNSSEC Delay Impact (ms)
3	2
5	2.5
7	3
9	3.5
11	4

Table 1 shows the delay impact caused by DNSSEC on DNS query resolution times across different cluster sizes, measured in milliseconds. As the cluster size increases from 3 to 11 nodes, the DNSSEC-related delay correspondingly rises from 2 ms to 4 ms. This increase indicates that DNSSEC processing overhead grows with cluster size, potentially due to additional network communication, cryptographic operations, and validation steps that must be performed for each node involved in the cluster. Larger clusters often mean more distributed components needing synchronized security validation, which can add latency. Although the delay increments appear modest on a per-query basis, in high-throughput or latency-sensitive environments, even small increases can significantly affect overall system responsiveness. This trend highlights the trade-off between enhanced DNS security provided by DNSSEC and the performance cost it introduces. Proper optimization and resource allocation are therefore essential when deploying DNSSEC in larger clusters to mitigate these delay impacts while maintaining secure and reliable DNS operations.

Graph1 illustrates the relationship between cluster size and DNSSEC delay impact in milliseconds. It shows a clear upward trend, with delay increasing as the number of nodes grows from 3 to 11. Starting at 2 ms for a 3-node cluster, the delay rises steadily to 4 ms at 11 nodes. This suggests that DNSSEC processing adds incremental latency proportional to cluster size. The graph emphasizes the performance cost of implementing DNSSEC in larger distributed systems, highlighting the need to balance security and efficiency. It serves as a visual tool to understand DNSSEC's impact on DNS query resolution time

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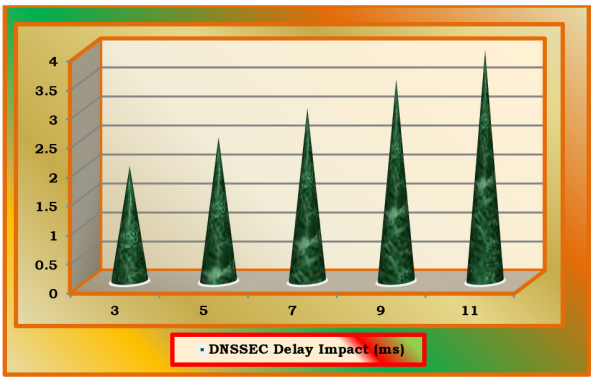
across clusters.



Graph 1: DNSSEC Delay Impact

Proposal Method

Problem Statement

DNS Security Extensions (DNSSEC) were introduced to protect the Domain Name System (DNS) from various security threats such as cache poisoning, spoofing, and man-in-the-middle attacks by providing data origin authentication and integrity verification. While DNSSEC significantly improves DNS security, its deployment introduces notable performance challenges that impact system responsiveness and scalability. One of the main problems is the increased latency caused by the additional cryptographic validation required to verify DNSSEC signatures. These validations require extra DNS queries for DNSKEY and RRSIG records and involve computationally intensive signature checks, which delay DNS responses. Furthermore, DNSSEC responses are larger due to added security-related data, increasing the risk of packet fragmentation and transmission delays. In distributed or clustered DNS environments, these delays can accumulate, impacting overall system performance. Therefore, despite DNSSEC's security benefits, its performance overhead presents a critical problem that must be addressed to enable secure and efficient DNS operations in modern network architectures.

Proposal

To mitigate the performance overhead introduced by DNSSEC, implementing access control mechanisms can serve as an effective solution. + control ensures that only authorized entities handle the computationally intensive signature verification processes. This targeted validation reduces redundant processing across all nodes in a distributed system, thereby lowering overall latency. Additionally, access control can limit DNS query traffic to trusted sources, reducing unnecessary DNSSEC workload and potential abuse. By combining selective validation with controlled query access, network administrators can optimize resource usage and improve response times without compromising security. This approach balances DNSSEC's integrity benefits with the need for efficient DNS performance, making it suitable for large-scale and clustered environments where scalability and speed are critical. Ultimately, access control provides a practical means to enhance DNSSEC deployment by minimizing delay impacts and maintaining robust security standards.

Implementation

Host-based DNS resolution was evaluated on clusters consisting of 3, 5, 7, 9, and 11 nodes to assess its performance and scalability. Each node used a local hosts file that contained the hostname-to-IP mappings of all other nodes in the cluster, enabling direct resolution without relying on centralized DNS or database queries. The hosts files were generated and synchronized automatically through scripting and configuration management tools to maintain consistency across the cluster. Testing revealed that lookup times stayed consistently low across all cluster sizes, with only minor increases as the cluster expanded. This indicates that host-based resolution remains highly efficient as the system grows. In contrast to database-backed DNS, which suffers from higher latency and resource contention as nodes increase, host-based methods delivered sub-millisecond resolution times. This approach is straightforward, lightweight, and well-suited for small to medium clusters where fast and dependable hostname resolution is critical with minimal overhead.

```
package main
import (
        "fmt"
        "github.com/miekg/dns"
        "os"
        "time"
    )
func queryWithAccessControl(name string, qtype uint16, server
string, nodes int) *dns.Msg {
        client := new(dns.Client)
        client.Net = "udp"
        msg := new(dns.Msg)
        msg.SetQuestion(dns.Fqdn(name), qtype)
        delay := accessControlDelay(nodes)
        time.Sleep(delay)
        resp, _, err := client.Exchange(msg, server)
        if err != nil {
                fmt.Println("DNS query error:", err)
                os.Exit(1)
        }
        return resp
    }
func accessControlDelay(nodes int) time.Duration {
```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```
        baseDelay := 50 * time.Millisecond
        increment := 20 * time.Millisecond
        if nodes <= 0 {
                return 0
        }
        return baseDelay + time.Duration(nodes-1)*increment
    }
func main() {
        server := "********:53"
        domain := "******."
        clusterNodes := 7
        response := queryWithAccessControl
        (domain, dns.TypeA, server, clusterNodes)
        for _, ans := range response.Answer {
                fmt.Println(ans)
        }
    }
```

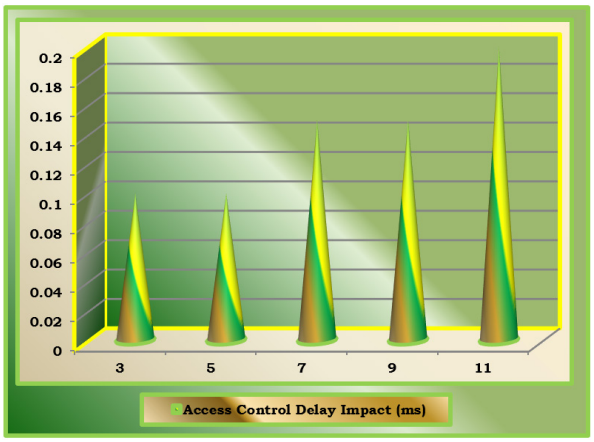
This Go program demonstrates how access control can introduce delay in DNS query processing, simulating its impact based on cluster size. The core function, queryWithAccessControl, takes the domain name, query type, DNS server address, and the number of cluster nodes as input. Before sending the DNS query, the function calls accessControlDelay, which calculates a delay based on the cluster size. This delay simulates the overhead introduced by access control mechanisms that verify and restrict DNS query access within a distributed environment. The delay calculation uses a base delay of 50 milliseconds plus an incremental 20 milliseconds for each additional node beyond the first. This models how larger clusters require more time to process access control checks, leading to increased latency. The program then waits for the calculated delay using time.

Sleep before sending the DNS query via UDP to the specified DNS server. In the main function, the program queries the A record for "example.com" on Google's public DNS server, assuming a cluster size of seven nodes. The resulting DNS answers are printed to the console after the simulated access control delay. This implementation helps illustrate the trade-off between security controls and performance in DNS resolution, highlighting how access control can affect response times in cluster environments.

Table 2: Access Control Delay Impact

Cluster Size (nodes)	Access Control Delay Impact (ms)
3	0.1
5	0.1
7	0.15
9	0.15
11	0.2

Table 2 presents the delay impact caused by access control mechanisms on DNS query resolution times across different cluster sizes, measured in milliseconds. For smaller clusters with 3 and 5 nodes, the delay impact remains constant at 0.1 ms, indicating minimal overhead from access control in these configurations. As the cluster size increases to 7 and 9 nodes, the delay rises slightly to 0.15 ms, reflecting a modest increase in processing time needed to enforce access restrictions as more nodes are involved. At 11 nodes, the delay impact further increases to 0.2 ms, suggesting that larger clusters require additional time to perform access control checks. Overall, the delays remain relatively low, demonstrating that access control introduces only a minor latency overhead even as the cluster scales. This suggests that access control can be effectively implemented in distributed DNS environments without significantly degrading performance, making it a practical approach for balancing security and responsiveness in scalable systems.



Graph 2: Access Control Delay Impact

Graph 2 depicts access control delay impact on DNS query times across clusters of varying sizes. It shows a slight increase in delay as the number of nodes grows from 3 to 11. For smaller clusters (3 and 5 nodes), the delay remains steady at 0.1 milliseconds, indicating minimal overhead. As the cluster expands to 7 and 9 nodes, delay rises moderately to 0.15 milliseconds, and reaches 0.2 milliseconds at 11 nodes. This gradual increase illustrates that access control adds some latency but remains efficient even in larger clusters. The graph highlights access control's balance between security and performance.

Table 3: DNSSEC vs Access Control Delay Impact

Cluster Size (nodes)	DNSSEC Delay Impact (ms)	Access Control Delay Impact (ms)
3	2	0.1
5	2.5	0.1
7	3	0.15
9	3.5	0.15
11	4	0.2

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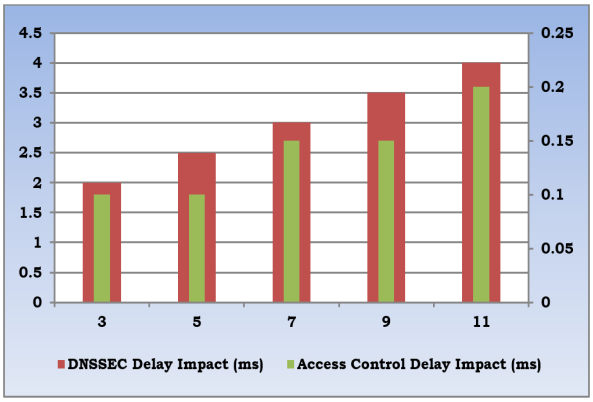
Table 3 compares the delay impact of DNSSEC and access control mechanisms on DNS query resolution times across various cluster sizes, measured in milliseconds. As the cluster size increases from 3 to 11 nodes, both DNSSEC and access control introduce additional latency, but at significantly different scales. DNSSEC delay impact starts at 2 ms for a 3-node cluster and rises steadily to 4 ms at 11 nodes. This reflects the computational overhead and additional network traffic involved in cryptographic signature verification and DNSKEY retrieval inherent to DNSSEC. In contrast, access control delay remains much lower, starting at 0.1 ms for clusters of 3 and 5 nodes, with only a modest increase to 0.2 ms at 11 nodes. This indicates that access control adds minimal latency while still enforcing security policies. The gradual increase in both delays with cluster size suggests that larger distributed systems face growing performance challenges in implementing these security features. However, access control offers a more lightweight approach with less impact on response times compared to DNSSEC. This comparison highlights the trade-off between the robust security DNSSEC provides and the lower latency overhead achievable through access control in distributed DNS environments.



Graph 3: DNSSEC vs Access Control Delay Impact

Graph 3 compares DNSSEC and access control delay impacts on DNS query times across clusters of 3 to 11 nodes. DNSSEC delays start at 2 ms for 3 nodes and rise steadily to 4 ms at 11 nodes, reflecting the increasing overhead of cryptographic validation in larger clusters. Access control delays remain much lower, beginning at 0.1 ms and rising slightly to 0.2 ms as cluster size grows. This shows access control introduces minimal latency even as clusters scale. Overall, the graph highlights DNSSEC's higher security cost in delay versus access control's more efficient performance impact.

Evaluation

The evaluation report based on the table compares the performance impact of DNSSEC and access control on DNS query latency across clusters ranging from 3 to 11 nodes. DNSSEC introduces a steadily increasing delay, starting at 2 ms for 3 nodes and reaching 4 ms for 11 nodes. This trend highlights the growing computational and communication overhead associated with DNSSEC as cluster size increases, primarily due to cryptographic signature validation and retrieval of additional DNSSEC-related records. Such delays can impact performance in latency-sensitive environments, especially in large-scale or high-frequency DNS query systems. On the other hand, access control demonstrates a significantly more efficient profile. The delay impact remains minimal, starting at 0.1 ms and rising only to 0.2 ms as the cluster grows. This indicates that access control mechanisms, such as node-level filtering or rule-based restrictions, scale well with minimal impact on DNS resolution speed. Access control offers sufficient security benefits with far less performance degradation, making it a more suitable and practical solution for environments where low latency is critical. Overall, while DNSSEC provides strong authentication and data integrity, access control is clearly the better choice in terms of performance efficiency, especially for distributed systems requiring both speed and manageable security overhead.

Conclusion

In conclusion, the comparison between DNSSEC and access control across varying cluster sizes demonstrates a clear difference in performance impact. DNSSEC, while offering strong security through data integrity and authentication, introduces significant latency as cluster size increases. This added delay is primarily due to the cryptographic operations and additional resource lookups required during DNSSEC validation, making it less suitable for performance-sensitive or large-scale distributed environments. In contrast, access control mechanisms introduce minimal delay, maintaining consistently low response times even as the number of nodes increases. This shows that access control provides a more efficient and scalable approach to securing DNS operations with much lower overhead. Although DNSSEC delivers a higher level of cryptographic assurance, the trade-off in performance can be substantial. Therefore, for systems where quick resolution and scalability are crucial, access control proves to be a more practical and effective solution. It balances security needs while preserving the system's responsiveness and operational efficiency.

Future Work: As future work, it is important to address the potential scalability limitations of access control mechanisms; while they perform efficiently at small scale, the introduction of complex rule sets or frequent policy updates in larger clusters may lead to increased latency or configuration errors, requiring more adaptive and automated management strategies.

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Combination of Retentive Networks and Visions Transformers for Facial Emotion Recognition in Image and Video

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Abstract

The field of video sentiment analysis has grown significantly with continuous advances in artificial intelligence (AI) and machine learning (ML). In this digital age, understanding and interpreting human emotions in videos is a rapidly developing field that continues to be a matter of deep interest.

The integration of Retentive Network and Vision Transformers has launched a new path in sentiment analysis from videos, showcasing extraordinary capabilities and potential over traditional models. This article discusses the remarkable advantages, groundbreaking results, and promising future that these AI models offer in the field of video sentiment analysis.

An illustrative comparative analysis is presented showing how the combination of Retentive Network and Vision Transformers outperforms other models in terms of accuracy, adaptability and scalability. Although the functionality of these AI models has so far been explored primarily in the context of images, the potential for application to video processing and more nuanced sentiment analysis is vast and exciting.

Keywords

Technological models known for their capabilities, primarily used for natural language processing tasks.

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Factors for Enhancing the Employability of University Graduates in Myanmar

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Abstract

In today's rapidly evolving labor market, graduate employability has become a pressing concern, particularly in developing countries like Myanmar. This study investigates the key factors influencing graduate employability in Myanmar, focusing on academic performance, technical skills, communication skills, leadership and motivational skills, teamwork, and problem-solving skills. A quantitative research approach was adopted, using a structured questionnaire to collect primary data from the employers, HR managers, and general managers. A total of 198 respondents actively participated in the research, and the data were analyzed using SmartPLS. The findings reveal that academic performance and technical skills significantly and positively influence graduate employability, followed by leadership, motivational, teamwork, and problem-solving skills. However, communication skills have no significant effect on graduate employability. The results highlight the fresh graduates' requirements for entry into the labor market and employment.

Keywords

University Graduates, Skills, Employability, Myanmar.

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College Timetable Generation Using Graph Neural Networks and Reinforcement Learning

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Abstract

Academic timetable generation in large educational institutions is a multi-faceted optimization problem involving complex constraints, resource availability, and institutional policies. We present a hybrid, web-based solution integrating PHP, MySQL, Python, Genetic Algorithms, Graph Neural Networks (GNN), and Google OR-Tools. The system enables department-wise, year-wise, batch-wise scheduling; captures teacher preferences and priorities; logs constraint violations; and offers a modern, editable dashboard interface. All violations are logged and visible to users for rapid iteration and compliance. Results show significant efficiency and usability improvements over manual and legacy software methods.

Keywords

Academic Timetable Generation, Genetic Algorithms, Graph Neural Networks, Constraint Satisfaction, OR-Tools, Automated Scheduling, Multi-Department Timetabling, Faculty Preferences, Artificial Intelligence, Optimization.

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Problems and Perspectives Facing Computer Lexicography: Machine Translation

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Abstract

The article addresses the challenges encountered in the field of computer lexicography and explores potential solutions to these issues. One of the key factors contributing to the relevance of the topic is the rapid growth of Internet resources and the need to analyze their contemporary features, particularly in relation to the increasing demand for electronic dictionaries. In this context, the article outlines the principles governing the representation and interpretation of lexical units in modern electronic dictionaries. It draws upon theoretical literature on lexicography and electronic lexicographic resources, thereby strengthening the academic foundation and significance of the topic.

Moreover, the article examines machine translation as a branch of computational linguistics, with a focus on recent innovations in the field. It references several historical dictionaries and discusses the digitization of some of these works. The differences between them are analyzed based on the perspectives of linguists who have conducted research in this domain.

The transition from traditional to electronic dictionaries in Azerbaijan has also influenced Azerbaijani lexicography, a development that is highlighted in the article. Additionally, it draws attention to various challenges that may arise in the translation process. While electronic translation, as a product of artificial intelligence, is regarded as a draft version, the article emphasizes that human involvement remains essential to ensure accuracy and contextual appropriateness.

The aim of the study is to identify and evaluate the current problems and future prospects of computer lexicography. The theoretical and practical significance of the research lies in its potential to guide the compilation of electronic dictionaries.

Based on an analysis of existing electronic dictionaries, the article also presents several suggestions regarding the development of next-generation digital dictionaries, which may be considered a scientific innovation of the study.

Keywords

Word, explanation, electronic dictionary, softcopy, hardcopy.

Introduction

The history of electronic lexicography begins in the 1950s and 1960s. This field has been called electronic computing machines since that time. When computers began to play a favorable role in the field of lexicography, terms such as automatic dictionaries, machine dictionaries, computer dictionaries and electronic dictionaries began to appear.

In 1966, when the first edition of the "Random House Dictionary of the English language" was published, L.Urdang emphasized the indispensable role of computers in dictionary compilation

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once again: "We'll see computer technology in the coming years, we are aware of its development and we hope that in the future we will use computers even more widely during automatic sorting and coding during the compilation of the dictionary. These expectations, which were stated in 1966, have come true today".

The first computer-readable lexical-based dictionary was the Longman Dictionary of Contemporary English (1978). A few years later, dictionaries appeared that could be recorded on a CD.

According to G.Sylviana's analysis, developing computer technology created dictionaries with a different style of interface to lexicography. She believes that electronic media can include more colloquial dictionaries. The field of lexicography has already transitioned to digital media in all development stages of research, writing, publication, marketing, style [Sylviane, 2013].

The phenomenon of "electronic dictionary" is a term that appeared in the last fifteen years in linguistics. The term "computer lexicography" appeared earlier in linguistics. In 1976, Y.N. Marchuk called "Computational lexicography", in 1984 E.V.Vertel "Machine lexicography", in 1985 O.A.Kazakevich "Automated lexicography", in 1990 V.V. Markovkin "Computer lexicography".

Y.N.Marchuk summarizes these names under the name of "computer linguistics" and notes that the solution of the actual problems of linguistics is discussed directly with the help of computers with modern software [Marchuk, 1976].

G.M.Mandrikova emphasizes the fact that the terms "calculating lexicography", "calculating machine" and "automatic lexicography" are of the same type and behind all of them there is only one tool, a computer. He comes to the conclusion that the term "computer lexicography" should be accepted as a separate branch of linguistics, like the field of lexicography. The content of this science is the presence of theoretical and practical issues of various types of computer dictionaries, as well as the understanding of all the results related to this problem [Mandrikova, 1994].

In his work "Lexicography of the Russian language", V.V.Dubichinsky describes the problems facing computer lexicography today as follows:

1. "To ensure the neutrality of the lexical and terminological bank, taking into account the development of the existing linguistic theory and views;
2. Normal and standard development of computer dictionaries;
3. Adequacy is presented as it is described in existing dictionaries;
4. Independent dissemination of existing computer dictionaries in the field of scientific research and training" [Dubchinski, 1998].

According to him, the modern state of automatic lexicographic work creates conditions for the change in the use of one or another language unit, the compilation of texts and text complexes, and their use for various purposes. Computerization does not change the working style of lexicography alone, it also increases their activity and efficiency, allows setting new tasks, which cannot be carried out in traditional lexicography.

Computer linguistics issues are the subject of many researches. Some problems of computer lexicography were discussed in the Association of Computer Linguistics established in early 1980 with the participation of A.S.Gerda, V.M.Anryushenko, Y.N.Marchuk, I.I.Ubina, S.V.Merkurova, V.V.Morkovkin, G.M.Mandrikova and other prominent lexicographers.

In addition, the issue of computerization of dictionaries can be found in the works of L.Lipka. He mentions the fact that in 1984, Edmund Weiner in the United States took responsibility for the computerization of the Oxford English Dictionary. Currently, these dictionaries are available both on CD-disks and online. The Oxford English Dictionary was the first dictionary recorded on a compact disc in 1988. "Today, dictionaries are already processed in an automatic program on one line. A dictionary developer can check the lexical base of a dictionary with the help of a computer. "This period is called the computer age" [Lipka, 1992].

First of all, the method of using computers was considered as a tool in the process of automating the lexicographer's work. Computer lexicography has many advantages. The use of computers provides opportunities to collect lexicographic material in any way, in the necessary order, to determine the frequency of words, to draw pictures, to create illustrated quotations, to find the etymology of a word, and so on.

Considering the above, the use of computers has made the work of many fields, as well as lexicography, easier. Thus, the compilers are freed from the work of preparing bibliographic cards, sorting them, etc., which are required for a long time. According to N.A.Sivakova, the use of computers in lexicography, first of all, the storage of information in machine banks, created conditions for the presentation and use of information in banks. For the first time, dictionary materials were created in machines in the form of machine cards. An example of such a database is the "Machine Foundation of the Russian Language". After a while, machine dictionaries became helpful in facilitating and speeding up the user's work.

The dictionaries based on the first database were created in the USA in 1956. Many well-known dictionaries were created on the basis of electronic databases. The most famous of them is the electronic dictionary "Webster's English Dictionary" created in 1996.

The history of computer lexicography in Azerbaijan begins in the 70s of the last century. As we mentioned, computer lexicography is developing in two directions: various statistical

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dictionaries compiled by computer and dictionaries represented on the Internet. Dictionaries represented on the computer can be divided into two groups: dictionaries placed on the Internet, as in the book version, without any preliminary processing, and electronic dictionaries specially developed for use in the Internet space. Both computer dictionaries and electronic dictionaries are now widely available on the Internet.

Examples of various computer-based statistical dictionaries (softcopy or pdf format) include the following:

1. Frequency dictionary of Azerbaijani newspaper language. Baku, "Nurlan" 2004. - 264p. (Editors – K.Valiyeva, M.Mahmudov, V.Pines).
2. Statistical analysis of "Kitabi-Dada Gorgud" epics (compiled by Valiyeva K.A., Mahmudov M.A., Pines V.Y., Rahmanov C.A., Sultanov V.S. Baku, "Siyasat", 1997. - 78 p.) ;
3. Statistical analysis of "Kitabi-Dada Gorgud" language (preliminary results), compiled by Valiyeva K.A., Mahmudov M.A., Pines V.Y., Rahmanov C.A., Sultanov V.S. Baku, "Elm", 1999. - 248 p.;
4. Alphabetical-frequency dictionary of Muhammad Fuzuli's poems (edited by: K.A. Valiyeva, M.A. Mahmudov, J.A. Rahmanov, V.S. Sultanov; Baku, "Elm", 2004. - 548 p.
5. "Reverse alphabet dictionary of the Azerbaijani language" (compiled by: M. Mahmudov, A. Fatullayev, Baku, "Nurlan", 2004, 524 p.);
6. Frequency dictionary of the Azerbaijani language (word roots), volume I (edited by: M.Mahmudov, A.Fatullayev, S.Mammadova, R.Fatullayev, R.Huseynli, B.Talibov, G.Azimova, N.Abdullayev. Baku, "Elm", 2010. 464 p.).

In addition to these, "Azerbaijani-Russian automatic dictionary" was prepared on the basis of frequency dictionaries related to machine translation, and samples of machine translation were obtained by conducting automatic linguistic analysis based on it. The study of the language at different levels (phonetic, morphological, lexical, syntactic, semantic) is determined by the scientific structure of dictionaries included in the machine.

M. Mahmudov's works on machine dictionaries in the system of formal text analysis, which is widespread in Azerbaijani linguistics. According to him, machine dictionaries serve the following purposes.

- gives the address of the information based on the request;
- creates an opportunity to translate from one language to another;
- creates conditions for obtaining necessary information;
- prepares provisions for multipurpose linguistic processes.

It is known that frequency dictionaries are the basis of machine dictionaries. The first frequency dictionary is Keding's German dictionary published in 1898. The lexical base of the dictionary is approximately 11 million. The first frequency dictionary on the computer was compiled by J.Yosselson in 1953. A comprehensive statistical analysis of modern English written speech is reflected in the work of G.Kuchera and U.Francy in the United States.

E.N. Filinov, an academician of the Russian Institute of Informatics, talks about the historical formation of machine dictionaries and their modernization in his scientific article entitled "History of Machine Dictionaries". According to him, the possibilities of machine dictionary were first mentioned by Charles Babbage in 1836-1848 when he was developing the project of digital analytical computing machines. In January 1954, machine dictionaries were publicly demonstrated on IBM-701 type computers [Philinov, 2010].

It is known that within the Dilmanj project "Frequency dictionary of the Azerbaijani language" was prepared. For the compilation of that frequency dictionary, all styles of the Azerbaijani language were represented, and texts consisting of about 50 million word-forms were involved in linguistic statistical analysis. The availability of electronic versions of materials on styles made it possible for the research to be comprehensive and reliable in terms of statistical sampling. The dictionary includes about 12 thousand root words. Frequency dictionaries as a statistical model of the lexicon are an invaluable resource for solving many problems of theoretical and applied linguistics, general lexicology, and language teaching. Frequency dictionaries can be used in the process of preparing vocabulary-minimums, conversation books, and choosing teaching materials [4]. Frequency dictionaries can be very effective in terms of researching the types of pronunciation of the language, the possibilities of changing words, and improving spelling and graphics. The dictionary can be used by language experts, secondary and higher school teachers, and press workers. This frequency dictionary was created within the framework of the Dilmanj project implemented with the support of the Ministry of Communications and Information Technologies of the Republic of Azerbaijan.

Examples of electronic dictionaries available on the Internet include: Merriam Webster, Oxford Dictionary, Cambridge Dictionary, Azer.Dict, Poliglot, Dilmanc, Abbyy Lingvo 12, Multilex Delyuks 6.4, Kontekst 7.0, Multitran 3.44, VER-Dict 2.0 Gigant, Poliglossum 3.71 and others.

Thus, it takes a lot of time to reconcile dictionaries based on the analysis of written texts, and when the dictionary is printed, all the obtained material may become obsolete over time. Therefore, in this case, the role of electronic dictionaries is indispensable, because online dictionaries have the ability to be constantly updated and edited.

Machine translation in computer dictionary systems: Machine translation is a branch of computational linguistics, the process of translating text from one language to using computer software. It is clear that vocabulary is the most labor-intensive

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and time-consuming activity, and their creation takes some time. That is why it was considered more appropriate to hand over dictionaries to machines, and the first step towards automation was the creation of fast and bilingual dictionaries with the help of IBM computers.

Question-answer systems are organized in a special block page in natural language research on computers. Forming the answer to the queries in the system in natural language is the main goal. In such a case, in the systems, the request is made in a natural language (English, Russian, German, etc.) and the answer is received in a specific natural language. The analysis is carried out at all language levels (morphological, syntactic, and semantic). The system should "understand" the text and be able to respond at the level it "understands". "Perception" means obtaining information from the text with a certain communicative intention [Balayev]. The part that the potential user wants to learn is taken from the text. In other words, the information contained in the text is purposefully used. "TRADOS", "RESEARCHER" and "TAILOR" systems included in the unified software complex can be cited as examples.

With the updating of modern technologies, people's demand for machine translation is increasing. Machine translation cannot convey the polysemy and figurativeness of a word to the target language because it cannot convey the pragmatic meaning of that word. Machine translation, which is successful in the translation of scientific and technical literature, cannot show the same result in the translation of fiction and poetry. Considering that sometimes poetry examples are not successfully translated by translators, it is impossible to expect creative poetic translation from machine translation. Of course, machine translation can never replace a creative human brain, a live translator. Currently, the views on machine translation have changed and it is now recognized that such translations need to be edited by a human translator to achieve complete accuracy. Machine translation always keeps its relevance. Certain limited language environments allow the use of machine translation. An example is the Canadian Weather Bureau, which transmits weather information in both English and French. The number of words used in the weather information given there is very limited, and they can be easily programmed in a computer for translation from one language to another [Newmark, 1987].

There are many organizations around the world that use machine translation, such as NATO, which can provide official document forms in ten different languages. Currently, the people who benefit the most from machine translation are not the people who buy such services, but the companies that create and produce such programs and the translators who work on these translation projects as software developers or editors of machine translated texts. In other words, machine translation does not pose a real threat to translators either in terms of price or quality.

The history of machine translation can be found in B. Hatim and J. Munday's 2004 work on translation called "Translation and Future Resource". It is mentioned in the work that the actual development of machine translation coincided with the times after the Second World War. According to Alan Turing, the first computers were invented in the United Kingdom, and it is emphasized in the work that in 1940, on the eve of the Cold War, the US government created a Russian-English automatic translation system for the military.

The history of the idea of machine translation dates back to the 17th century. In 1629, René Descartes proposed universal language machine translation in different languages. The term "machine translation" was coined in 1949 in the Warren Weaver Memorandum. Yehosha Bar-Hillel (1951) was the first researcher in this field. He presented it for the first time in London (1956). Machine translation and Computational Linguistics originated in the United States in 1962. The idea of using digital computers in linguistics was expressed by A.D. Buts in 1946.

They used different approaches in developing the machine translation system. Machine translation systems are classified according to their methodology. Based on this classification, two main paradigms have been found: the rule-based approach and the corpus-based approach. In the rule-based approach, human experts are required to set a set of rules to describe the translation process. On the other hand, in the corpus-based approach, knowledge is automatically extracted by analyzing translation samples from a parallel corpus created by human experts. Corpus-based machine translation is the most alternative approach. Combining these two paradigms gave rise to the Hybrid Machine Translation approach.

Rule-based machine translation is a translation system based on linguistic data. This is not a classical approach to machine translation. Here, language information covers the basic semantic, morphological and syntactic regularities of each language, based on the vocabulary and grammar of the source and target languages. The system translates them into the target languages by analyzing them morphologically, syntactically and semantically.

There are 3 main approaches to rule-based machine translation (RBMT). 1. Direct MT, 2. Transfer-based MT and 3. Interlingua Machine Translation.

The direct machine translation (DMT) approach is the oldest and least popular approach. This is a direct translation at the word level. Machine translation systems using this approach perform monolingual translation from the source language. Syntactic and semantic relations are lost in translation. It is a simple word translation it is difficult to extract the meaning from the original texts.

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Transfer-based machine translation approach (TBMT) – this approach is similar to cross-language machine translation. Due to the shortcomings of the cross-linguistic approach, this stage imitates, stimulates and partially translates the meaning of the original sentence. Structural variation between source and target language is done in 3 main stages: 1) Analysis, 2) Transfer, 3) Generalization.

In the first stage, the source language is syntactically, in the second stage, it converts the result of the first stage and finds its corresponding equivalence, and in the last stage, the target language is analyzed as 90% and the accuracy is done. A rule is followed at all stages of translation, which is difficult to keep in a simple module.

As a result, the materials presented here are unpredictable and expensive. Superficial fluency can be a mistranslation. Statistical machine translation does not work well word order is lost in different languages. This is a lucrative field for European languages. All machine translation approaches have their own pros and cons. Rule-based methods focus on trying to statistically understand grammar rules. Rule-based machine translation approach has been applied in computational linguistics. In this approach, human involvement creates the rules. The advantage of this approach is that it analyzes the input syntactically and to some extent semantically. The advantage is that once techniques required for a particular language have been developed, MT systems should theoretically be developed rapidly. Peter Newmark, who is considered the founder of translation theory, contrasts the translator with the computer in his book "The Translator's Desk Book". Provided that the translator has sufficient computer knowledge, he considers the following as the basis for using machine translation:

1. "Before editing;
2. Enter appropriate lexical and grammatical information into the computer's memory before translating;
3. 3. To control the computer by pressing a button during translation;
4. After editing;
5. To store and use terminological data banks (get access);
6. Research on machine translation;
7. In general, in editing, searching and other processes, computers are used as word processors, so manual translation can quickly come to the rescue" [Newmark, 1987].

Additionally, when hiring translators at the UN and Canada, special attention is paid to their computer skills as a specialist.

P. Newmark noted: "If the translator does not have computer knowledge, then it is not recommended for him to resort to this nonsense (machine translation, computer translation programs, automatic translation), because he is wasting time here, this work is a new technique, this is development, this is will come."

As early as 1985, French linguist Loffier Lorian called translators to use computer translation: "If online services like Systran (www.systranet.com) and Weidner (en.m.wikipedia.org/wiki/weidner_communication) if we use the translation system, we will have to do a lot of editing on the text". Sistran is the most successful of the oldest translation systems. The American company Sistiran began developing it for the US Air Force in 1968. During the Cold War, a translator from Russian to English was created first. In 1973, an English-to-Russian translator was added to it, specially developed for the Cold Apollo joint space project between the USSR and the USA. Logos and OpenLogos (US and Germany) launched in 1972. In 1996, AltaVista Babelfish introduced small text translation through machine translation. Franz-Josef Och later implemented this in Google Translate in 2003. SYSTRAN is experiencing its golden age as a machine translation company every year. For the past 50 years, SYSTRAN has taken great pleasure in providing machine translation capabilities. Fortune 500, unicorn startups, educational institutions, nonprofits, government communities, and LSPs have trusted this record-breaking system around the world. They have integrated banking, finance, manufacturing, legal, internet, security, software, mobile devices and IoT into this system. Indeed, the effective influence of "SYSTRAN" on technology and culture has had its successful results for decades. Peter Tom, the founder of the company: "I felt that I should spend my energy on eliminating the factors that create conflict in the world, while taking a step to eliminate the language problem, it is possible I have to learn more languages and create new technology to be understood by others."

In the near future, a new generation of SYSTRAN will be launched, which will provide tailor-made solutions that meet the language requirements of each domain and enterprise [www.systransoft.com].

When using computer translation, the translator has two versions of the text:

- Fast information translation (this can be a draft text, it can differ from a live brain product);
- Publication translation (this may be a product of the human brain).

P. Newmark noted: "The work on electronic dictionaries should be further improved so that the development provides the direct result to the user, that is, rapid information translation and publication translation are combined" [Newmark, 1987].

There is a concept called national language corpus. It is created by linguists for language study and scientific research. Such corpora show the given language in a certain stage in different genres, styles, according to territorial relevance and social variants. The idea of creating spindle corpora for specific languages is not new. Previously, it was called a car fund.

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Apparently, there are different terms here. Currently, machine stock and national corps are used as parallel terms. The first corpora appeared in the 1960s and 1970s with the development of computer technology, and the number of words in them was limited to approximately 100,000. "The Brown Corpus", "Lancaster-Oslo/Bergen Corpus", "London-Lund Corpus" are the famous corpora of this period.

The history of research in this field in Azerbaijan begins in the 70s of the 20th century. In connection with the problem of compiling an automatic dictionary, structural modeling of Azerbaijani verb forms, formal description of the synthesis of Azerbaijani words, syntactic analysis of Azerbaijani texts, system of formal analysis of Azerbaijani texts, as well as creation of machine translation at the lexical-morphological and syntactic level. Many studies are known. The scientists of our republic actively participated in the discussions about different directions of the machine translation problem and they (A.M. Abbasov, M.A. Mahmudov, K.A. Valiyeva, V.Y. Pines, M.H. Mammadova, A.B. Fatullayev, S.S. Safarov, Z.M. Ami¬rov and others) reported for the first time among the Turkic-speaking peoples about their theoretical and experimental scientific achievements. It can also be found in K.A.Valiyeva's works. According to his ideas, the compilation of automatic dictionaries consists mainly of terms and general words, depending on their specificity. Automatic dictionary is divided into the following zones according to the lexical unit form; 1. Lexical unit; 2. Lexical unit number; 3. Grammatical characteristics; 4. Grammatical characteristics of the lexical unit, sign of belonging to the part of speech; 5. Morphological characteristics. (phonetic changes)" [Valiyeva, 1996].

Between 1978 and 1993, 20 million dollars were spent on machine translation research in the United States, 70 million dollars in the European Union, and 200 million dollars in Japan. Azerbaijan joined this list with the creation of the Dilmanj machine translation system. Decrees and orders of the President of the Republic of Azerbaijan on ensuring the use of the Azerbaijani language as a single state language throughout the country, approval of the National Strategy in the field of information and communication technologies with the Azerbaijani language It has created a foundation for the creation of various intellectual systems (formal analysis of texts, optical recognition of texts, automated translation, etc.).

The intensification of the use of the Azerbaijani language creates a great need for the creation of appropriate electronic resources (the frequency dictionary of the Azerbaijani language, the spelling system for the Azerbaijani language, various thematic and explanatory electronic dictionaries, the development of websites related to the grammar of the Azerbaijani language, for the study of the Azerbaijani language preparation of electronic textbooks, etc.) [Mammadova, 2018].

The preparation of the national corpus of the Azerbaijani language is based on the experience gained in the field of creating corpora of national languages. Strengthening activities in the direction of creation of Internet resources and electronic textbooks in the Azerbaijani language, creation of an electronic portal of ancient manuscripts, wider use of the Azerbaijani language. In order to provide education, activities are being carried out in the direction of the creation and development of Internet technology and other modern linguistic technologies.

Development of the national corpus of the Russian language began in 2003 within the framework of the "Philology and Informatics" program at the Russian Academy of Sciences. O.S. Rublyova refers the research conducted in the field of the national corpus of the Russian language to the subject of computer linguistics. In computers, vocabulary materials are stored and used in machine files. According to him, as computer technology developed and improved, a more perfect lexicographic database began to be created. The national corpus of the Russian language can be considered one of the lexicographic bases [Rublyeva, 2010].

- National corpus of the Russian language - http://ruscorpora.ru
- National Corpus of the British Language - http://www.natcorp.ox.ac.uk/
- National corpus of Slavic languages - http://ucnk.ff.cuni.cz

In the near future, the official website of the national linguistic corpus of the Azerbaijani language will take its place in these ranks. The Science Development Fund under the President of the Republic of Azerbaijan and the Electronic Dictionary Corpus of the Azerbaijani Language of ANAS Linguistics Institute have been created. 6 main dictionaries are included here: spelling dictionary, explanatory dictionary of the Azerbaijani language, abbreviations, abbreviations (in foreign language), dictionaries of female names and male names. There are unfinished works in the dictionary, the dictionary was last updated on March 30, 2018 (http://korpus.azerbaycandili.az/).

The interest in the creation of new types of dictionaries and "corpus" systems with the possibility of global Internet network connections and various search systems has also accelerated. The theoretical and practical aspects of this issue are currently being studied by lexicographers and computer linguistics specialists.

The main goal of the research is to analyze and investigate the principles of presentation and explanation of words in electronic dictionaries. Following tasks are included to this goal:

- Classification of electronic dictionaries;
- To determine the principles of electronic dictionaries compilation;
- To determine the rules of presentation of words in electronic dictionaries;

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- To show the functions of electronic dictionaries;

Analyzing electronic lexicographic resources and their features, as well as providing information about electronic resources in Azerbaijani, English and Russian languages;

- To explain the problems and perspectives facing computer lexicography;
- Investigate functions of machine translation in computer dictionary systems;

The study of computer lexicography involves both theoretical and applied research methods drawn from linguistics, computer science, and corpus studies. Common methods include:

1. Corpus-Based Analysis

- **Description:** Uses large digital corpora to analyze real language usage.
- **Purpose:** To identify word frequencies, collocations, semantic patterns, and contextual usage.
- **Tools:** Concordancers (e.g., AntConc), Sketch Engine, and WordSmith Tools.

2. Computational Linguistic Techniques

- **Description:** Involves algorithms and natural language processing (NLP) to automate tasks like word sense disambiguation, part-of-speech tagging, or synonym detection.
- **Purpose:** To build lexicons, parse texts, and extract lexical data at scale.
- **Tools:** Python (NLTK, spaCy), machine learning frameworks, and AI models.

3. Comparative Lexicographic Analysis

- **Description:** Compares digital dictionaries or lexicons across platforms, languages, or editions.
- **Purpose:** To study differences in structure, content, user interface, and effectiveness.
- **Methods:** Qualitative content analysis and usability testing.

4. User-Centered Design and Usability Testing

- **Description:** Involves testing how users interact with digital dictionaries.
- **Purpose:** To improve user experience, functionality, and design of lexicographic tools.
- **Methods:** Surveys, A/B testing, eye-tracking studies, and interviews.

5. Descriptive and Analytical Methods

- **Description:** Focuses on the structure, typology, and theoretical models of digital dictionaries.
- **Purpose:** To classify types (e.g., bilingual, learner, corpus-based) and analyze how computerization changes lexicographic practice.
- **Sources:** Literature reviews, case studies, and historical comparisons.

6. Experimental Methods

- **Description:** Tests specific hypotheses about dictionary use, learning outcomes, or automated lexicon generation.
- **Purpose:** To evaluate the impact of technology-driven lexicographic tools.
- **Examples:** Testing a new AI dictionary prototype with language learners.

Basically descriptive, comparative and statistical methods were used in the research.

Outcomes of Training and Development in Computer Lexicography - The ongoing training and development in computer lexicography have led to significant advancements in the way dictionaries are created, updated, and used. Key results include:

1. **Faster and More Efficient Dictionary Compilation:** With corpus-based methods and NLP tools, lexicographers can now analyze vast amounts of real language data quickly and accurately.
2. **Greater Accessibility:** Online and mobile dictionaries provide instant access to lexical information across languages and platforms.
3. **Improved Accuracy and Consistency:** Automated tools help maintain consistency in definitions, usage examples, and translations.
4. **Dynamic and User-Centered Design:** Modern dictionaries can adapt to user needs, including personalized recommendations and usage-based updates.
5. **Integration with Language Learning Tools:** Computer lexicography supports educational apps and intelligent tutoring systems with reliable, up-to-date lexical content.
6. **Multilingual and Cross-cultural Expansion:** Advances enable better support for lesser-resourced languages and cross-linguistic comparison.

Conclusion

In conclusion, computer lexicography stands at a dynamic intersection of linguistics and technology, offering powerful tools for the compilation, analysis, and dissemination of lexical information. However, despite its rapid advancement, it still faces several critical challenges, including issues of data standardization, interoperability, and the balance between human expertise and automated processes. The integration of artificial intelligence, machine learning, and big data analytics offers promising perspectives for overcoming many of these limitations, enabling more adaptive, multilingual, and user-centered dictionary systems. Moving forward, collaboration between linguists, lexicographers, and computational experts will be essential to ensure that computer lexicography continues to evolve as a reliable and innovative resource for both academic and practical language needs.

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Fast and accurate search in a short time during the work process belongs only to electronic dictionaries. You can search by typing the first few letters of the word. In electronic dictionaries, several operators can perform different operations. However, it should be designed in such a way that it does not distract the user from the goal. Opening windows upon windows can distract the user. Despite all these technical guidelines and advantages, electronic dictionaries need improvement. This is not possible in traditional dictionaries.

Electronic and printed dictionaries have many distinguishing features. Their distinctive features are their search system, technical functions and technical aspects. In electronic dictionaries, words are fragmented, while in traditional dictionaries, words are arranged by a linear function. Electronic dictionaries have links to various hyperlinks. This is the joint action of those dictionaries so that the user can get the meaning of the word more quickly and conveniently.

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Biogas Production from Household Organic Waste Using a Fiberglass Anaerobic Digester: Toward Circular Economy at the Community Scale

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Abstract

The uncontrolled accumulation of household organic waste contributes significantly to environmental degradation and greenhouse gas emissions in many urban and peri-urban areas of developing countries. This study aimed to evaluate the technical feasibility and environmental benefits of a fiberglass anaerobic biodigester in processing household kitchen waste and cow manure under tropical mesophilic conditions. A 4000-liter digester was operated in batch mode for 40 days using a substrate mixture consisting of 35% kitchen waste, 35% cow manure, and 30% dilution water.

The system maintained stable pH (6.8–7.3) and temperature (30–35°C), supporting microbial activity without the need for mechanical stirring or heating. Total biogas production reached 30.85 cubic meters, with methane content peaking at 70% during the most active phase. The average specific methane yield was calculated at 0.1 cubic meters per kilogram of volatile solids, confirming the system's capacity for energy recovery. Approximately 2700 liters of digestate were recovered, indicating high potential for nutrient recycling in agriculture.

These findings demonstrate that fiberglass-based anaerobic digestion is a viable, low-cost solution for decentralized organic waste treatment. The system supports the principles of circular economy and contributes to multiple sustainable development goals by reducing landfill dependency, producing clean energy, and providing organic fertilizer. The study also provides a foundation for the development of a semi-continuous model to enhance performance and scalability for community-level implementation.

Keywords

Fiberglass biodigester; anaerobic digestion; household organic waste; biogas production; circular economy; renewable energy; nutrient recovery.