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OPPORTUNITIES AND CHALLENGES OF ARTIFICIAL INTELLIGENCE APPLICATION IN INVESTMENT ARBITRATION

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Abstract: Artificial intelligence (AI) is increasingly advancing, developing, and finding applications in various aspects of life and work. Some of the most significant social areas, such as law and dispute resolution, have not remained immune to the influence of AI. In this sense, both the positive aspects, useful elements, as well as the potential dangers and risks that this technology brings, are being increasingly considered. Arbitration, as a contractual and voluntary method of dispute resolution, presents fertile ground for the application of various technological solutions to accelerate and ease the process. Investment arbitration, which deals with resolving disputes between a host state and a foreign investor, has its specificities that need to be addressed in the context of AI application. Therefore, this paper provides a review of the benefits of AI in arbitration, analyzes its shortcomings and risks, offers an overview of certain smart tools available, and presents a general view on the ethical and legal regulation of AI application in arbitration. The conclusion of the paper is that the possibilities for further development and refinement of AI technology for use in arbitration are numerous, but should be approached cautiously. It will be necessary to devise an optimal, flexible regulation to standardize the rudimentary rules of AI application in order to meet the basic requirement: benefit for humanity and society, while respecting the specific values and principles on which investment arbitration is based.

Keywords: International Investment Arbitration, Artificial Intelligence, Law, Technology.

Introduction

Artificial Intelligence (AI) is becoming an integral part of the functioning of the global economy and is increasingly being applied in everyday life. Its potential, as well as the dangers it brings, are widely discussed in professional and scientific literature. In the field of law, it is considered through the lens of accelerating and facilitating legal work, but there is also concern that many jobs will become redundant due to advancements in generative artificial intelligence tools. Generative artificial intelligence is a type of technology that uses existing data to create new and original texts, images, videos, and audio recordings (Russell & Norvig, 2016: 28-29).

Research analyzing the impact of AI on the labor market has yielded intriguing and potentially concerning results. A study conducted by Hatzius and co-authors (2023) found that a quarter of current jobs in the U.S. are likely to be replaced by automated AI, particularly in administrative roles (46%) and legal professions (44%), while this is far less likely in physically intensive jobs such as construction (6%) maintenance (4%).

Regarding the readiness of lawyers to use AI in their work tasks and their opinions on the future of the legal profession, research provides interesting insights. For example, a study conducted among legal professionals in Serbia concluded that respondents are relatively well-informed about AI and ChatGPT, though these tools are rarely actively used in their work. However, the respondents recognized the potential of these “smart” tools for performing various legal tasks, emphasizing that their use should be limited by legal and ethical regulations (Njegovan & Fišer, 2024).

The subject of this paper is the analysis of the possibilities for applying generative artificial intelligence

in investment arbitration. International investment arbitration is a method of resolving international investment disputes that arise between foreign investors and host states. This method of dispute resolution is highly popular as it is based on the consent of the parties to an international investment agreement for the protection of investments. Through this alternative dispute resolution mechanism, a private legal entity can directly sue a state before an independent international forum, which is considered a more effective means of protection compared to turning to the domestic courts of the host state. Although investment arbitration shares many similarities with commercial and other types of international arbitration, it also has its distinct characteristics. For instance, investment arbitration involves not only legal but also political issues (Dar & Praštalo, 2023). Therefore, this paper analyzes the application of AI specifically in investment arbitration, although many aspects are universal to all types of arbitration.

Although international law and legal scholars increasingly recognize the importance and need to regulate the use of artificial intelligence, international investment law and AI have not yet become the subject of significant scholarly attention. However, certain authors have addressed various aspects of this topic, such as the potential role of artificial intelligence in selecting arbitrators, calculating damages, and predicting the outcomes of investment disputes within the context of investment arbitration (Kryvoi, 2023). McLaughlin (2023) approached the topic from a slightly different perspective, analyzing the interaction between artificial intelligence and international investment agreements. His central thesis posits that the current international foreign investment regime is insufficiently prepared to address the legal and ethical challenges posed by artificial intelligence.

Particularly interesting are writings that consider AI as a potential solution to problems specific to investment arbitration. For example, the system of investment arbitration has long faced criticism for its "lack of consistency, coherence, predictability, and correctness of arbitral decisions by ISDS tribunals" (Knieper, 2021). Moreover, systemic issues existing in investment arbitration between foreign investors and host states have led to a "legitimacy crisis" (Dar & Praštalo, 2023) and discussions within international organizations about directions for its reform. Literature examines the need to regulate AI in arbitration, addressing the ethical, legal, and technological challenges its use entails (Jeeri & Singh, 2024).

In the continuation of this paper, we will review the advantages and disadvantages of applying artificial intelligence in investment arbitration. First, the benefits of using AI tools in investment arbitration will be analyzed, followed by the negative aspects highlighted in the literature. Next, we will present some AI tools already implemented in arbitration practice, as well as an overview of fundamental strategic and legal documents in this field. Finally, the main conclusions of the research will be presented.

Advantages of Applying AI in Investment Arbitration

Artificial intelligence can find its application in various stages of the arbitration process, potentially overcoming some of the problems associated with investment arbitration, which is known for being a lengthy and costly dispute resolution process.

For instance, electronic review and document sorting have numerous advantages over traditional handling methods. However, for this to be implemented, data must be collected and processed before being uploaded onto specific data processing platforms. Furthermore, artificial intelligence can facilitate document creation by identifying relevant sources, anonymizing sensitive data, and sorting confidential documents (Haelser & Visler, 2024).

One of the key applications of AI in arbitration is searching through regulations, doctrinal sources, or arbitral practice. Since AI can process an extremely large volume of data based on various parameters, its scope of sources that can be explored is far greater than that of a human. Additionally, AI's ability to translate

different languages presents a significant advantage and relief in arbitration proceedings between parties from different countries (Jovanović, 2024).

The facilitation of arbitrator selection is also mentioned as one of the positive applications of AI in arbitration. Specifically, searching for potential candidates would be faster and more comprehensive, and the assessment of a candidate's suitability could be made in a quicker and more objective manner, based on a greater number of criteria, not all of which are of equal relevance (Jovanović, 2024).

Another important advantage of AI is predictive analytics, which helps predict the outcome of individual cases based on previous, similar cases. This allows parties to assess the likelihood of success in arbitration and decide whether to continue with the proceedings or turn to alternative methods (AI Fatayri, 2024).

The potentially most significant role of the AI, yet also the most controversial, could be the generation of procedural tools or parts of them, which is a minor issue, or even the creation of arbitral decisions, which could lead to far-reaching consequences. Procedural acts can be divided into those created by the parties and their representatives (e.g., request for arbitration, claim, response to the request for arbitration, response to the claim, submissions on various matters and contents, cost statements...), acts created by arbitrators (e.g., procedural management acts and decisions), and acts in which both the parties and the arbitrators participate (e.g., minutes of oral hearings) (Jovanović, 2024). Since all of these documents vary in complexity, some would be more suitable for creation using AI tools, such as the most routine acts, which typically take up a lot of time but do not require significant creative effort.

Decision-making is certainly the most complex task that could potentially be entrusted to artificial intelligence. However, making an arbitral decision is the result of a creative process that requires human thinking and reasoning. Careless use of AI tools, no matter how advanced, poses a significant risk to the accuracy, reliability, and quality of arbitral decisions. However, certain parts of decisions, which are predominantly template-based, such as decisions on costs and similar matters, could be delegated to AI, which would accelerate and make the process more cost-effective, as well as save time for the arbitrators (Jovanović, 2024). Moreover, determining the amount of damages could be entrusted to AI, especially considering the fact that expert opinions in disputes are often very diverse (Efstathiou & Apostol, 2023), while AI would adhere to objective parameters.

Problems of Applying AI in Investment Arbitration

Despite the numerous potential benefits of AI, the literature also addresses the drawbacks and problems associated with "smart" tools in international arbitration. For instance, in order to "train" AI language models to generate content, significant initial investments and resources are required. Additionally, the data necessary for generating any content, such as previous decisions and submissions, are not always available.

AI is also criticized for its lack of human flexibility and adaptability, as it operates based on pre-set patterns, meaning it cannot independently arrive at innovative solutions for new circumstances that have not yet been encountered in arbitration practice. In other words, AI, at its current level of development, cannot come up with new solutions in practice, nor can it fully adhere to the principle of fairness, which is characteristic of investment arbitration and requires special attention and creativity, qualities that are currently only available to humans (Jovanović, 2024).

It is important to emphasize that AI often makes mistakes. Generating text composed of words that are most likely to appear in a given context does not always provide an accurate and meaningful response (Kucharavy, 2023). If such responses are used without verification and due diligence, they can lead to significant consequences, such as the well-known case of an American lawyer who cited non-existent cases in a court submission, generated by ChatGPT (Weiser, 2023). AI can also create deep fakes, mimicking the style of emails, voices, or even videos of real people. Since it is not easy to distinguish between real and fake

evidence without the appropriate technical tools, this is another risk associated with the use of AI in arbitration.

Generative AI models still cannot process large documents or answer questions based on information located in multiple sections of them (Filippo et al., 2024). Consequently, AI is unable to generate long texts or summarize complex ones. This limits their use in investment arbitration, as proceedings between foreign investors and the host state typically involve large amounts of data and very large documents (Garrido, 2023).

Furthermore, generative language models often do not contain the most up-to-date information, which means that arbitration practitioners must rely on other sources to obtain recent decisions and other necessary information (Garrido, 2023).

Another problem under consideration is bias. Generative language models are trained on vast amounts of data, which undoubtedly contain some biases (Garrido, 2023). Since AI models rely on statistical probability based on existing data, it inevitably results in repeating established choices, such as arbitrators being characterized as male, white, from Western countries (Haelser and Visler, 2024). For example, if a state frequently loses in investment disputes (due to lack of resources for competent representation), AI will conclude that this is the norm and predict that the state is more likely to lose in the future (Kryvoi, 2023).

In addition to the inherent issues of AI technology, the nature of arbitration itself presents challenges for automated decision-making. Specifically, there is no typical investment arbitration case. Decisions are based on broadly defined standards such as fair and equitable treatment, and each case is unique. Moreover, there is no system for reviewing decisions, such as an appeals mechanism, which leads to frequent inconsistent arbitral rulings (Kryvoi, 2023).

The working process of AI is not sufficiently clear. AI is often referred to as a "black box," whose contents are of unknown or difficult-to-ascertain origin. The algorithms that drive AI do not provide enough transparency to understand how they work. Even if there is some transparency, understanding how AI operates is difficult for lawyers who are not technically trained, which in turn undermines confidence in artificial intelligence (Kryvoi, 2023).

A potentially significant issue with the use of AI in arbitration proceedings concerns privacy protection. Arbitration is, by default, a confidential process, unlike regular court proceedings (Alternklich and Hossbach, 2024). Smart tools like OpenAI's ChatGPT, in their privacy policies, state that OpenAI collects information about accounts, user content, communication data such as contact information, and similar details. The company also collects technical information such as IP addresses, locations, login data, device access data, and more (OpenAI, 2024). ChatGPT generates information when something is entered into the search bar, which could also be collected as it qualifies as input. In other words, the use of AI models can lead to the identification of parties, cases, and arbitrators who have been collected and analyzed (Efsthathiou and Apostol, 2023).

Finally, in addition to the aforementioned negative aspects of AI at its current level of development, it is important to emphasize that the use of this technology could lead to the disappearance of certain jobs and positions, particularly repetitive ones. Jobs such as reviewing documentation, preparing standardized documents, and similar tasks typically performed by young trainees, technical secretaries, etc., would be at risk or could see a complete decline in demand (Kryvoi, 2023).

Examples of technology that is already in use

Various artificial intelligence-based software are increasingly gaining popularity in international arbitration. Some of the tools used for faster document translation include "DeepL A.I.," "Google Translate," and similar platforms (Gore et al., 2024). There are legal research platforms that have significant impact and use, such as "Wolters Kluwer: International Arbitration & Mediation" and "Jus Mundi." These platforms use

machine learning to collect a broad database of international arbitration cases, agreements, contracts, and more (Gore et al., 2024). The company LexisNexis integrates AI into its platform "Lex Machina" to improve search capabilities, providing predictive analytics to suggest relevant cases, laws, and secondary sources (lexmachina.com).

A smart tool that is claimed to be able to answer questions, draft legal arguments, prepare contracts, client letters, as well as summarize and analyze documents is "Lexis+A.I." There are other tools such as "Westlaw Edge," which is designed to enable analytics on cases, courts, judges, attorney fees, and types of cases. "Jus-AI" uses ChatGPT to answer questions based on the Jus Mundi database (jusmundi.com).

For checking arbitrators and conflicts of interest, the following tools are available: "Arbitrator Intelligence," "Kluwer Arbitration's Profile Navigator & Relationship Indicator," and "Global Arbitration Review's Arbitrator Research Tool (ART)" (Gore et al., 2024).

Thus, smart, AI-powered tools that are currently being used or could be used for various purposes in arbitration procedures already exist. It is certain that this technology is in its early stages, and faster development is expected, with more powerful, precise, and versatile capabilities for legal research, text generation, document translation, case and arbitrator analysis, and advancements in the creation of complex legal documents such as arbitration awards.

Legal and Ethical Framework for the Use of AI in Investment Arbitration

The regulation of AI usage in various aspects of life is still in its early stages. Several organizations are making efforts to create a global AI regulatory framework, which is mostly at the level of guidelines, recommendations, and general frameworks. For example, UNESCO created the "Recommendation on the Ethics of A.I." in 2021, which has been adopted by over 193 countries worldwide (UNESCO, 2023). Other initiatives include the G7 Hiroshima Process International Guiding Principles for Organizations Developing Advanced AI Systems (2023), which aim to create safe, secure, and trustworthy AI, and the US AI Bill of Rights, which aims to provide a framework for protecting civil rights in the age of artificial intelligence (whitehouse.gov).

In terms of legally binding documents, the European Union has enacted the "AI Act," which will regulate AI usage in member states, with implementation expected by mid-2026. The goal is to protect fundamental rights and limit high-risk AI, while setting conditions for the transparent operation of general-purpose AI systems. According to EU regulations, high-risk AI systems include those used in the provision of justice (EU Regulation 2024/1689).

However, the regulation of AI usage in international arbitration, specifically in investment arbitration, has not yet led to the creation of a general framework or centralized mechanism (Jeeri & Singh, 2024). Given the potential significant consequences of using this technology, regulation is needed in investment arbitration as well. However, how this regulation should be implemented is a matter for legal scholars and practitioners to consider. For instance, Fach Gomez (2024) suggests putting efforts into creating both soft and hard laws regarding AI use in arbitration. Ethical guidelines are necessary to ensure that AI tools do not undermine the core values of resolving disputes between foreign investors and states. Jeeri & Singh (2024) argue that regulating AI in arbitration through soft law could be achieved in three ways: first, through an international legal document under which countries would draft their own regulations (model laws); second, by encouraging arbitration tribunals to follow soft law guidelines as best practices; and third, by prompting arbitration institutions and courts to include relevant AI clauses in their procedural rules.

Regarding specific documents that address the regulation of AI in arbitration, a significant initiative has been launched within the Silicon Valley Arbitration and Mediation Center, with the publication of the "Guidelines on the Use of AI in Arbitration" in 2023 (SVAMC, 2024). This guide aims to reflect best practices

and potential risks when applying AI in arbitration proceedings (Friedman et al., 2024). Additionally, the Council of Europe has developed the "Framework Convention on Artificial Intelligence and Human Rights," which discusses AI usage in terms of human rights, democracy, and the rule of law (Committee on Artificial Intelligence).

Therefore, at the international level, there are currently no binding legal regulations regarding the use of AI in international arbitration. However, certain arbitration rules do anticipate the use of technology. For example, Article 14.1 of the LCIA Rules requires arbitrators to ensure the efficiency of the procedure and acknowledges the court's power to "employ technology to enhance the efficiency and expeditious conduct of the arbitration" (LCIA Rules, art. 14.6(iii)). Furthermore, the diversity of national regulations concerning AI use in decision-making, which are important for *lex arbitri*, complicates this issue (Efstathiou & Apostol, 2023). Therefore, the development of soft law is necessary to determine the acceptable and optimal use of existing AI tools. Since the use of AI in arbitration is still unclear, as confirmed by our research, it is crucial to develop guidelines and a sufficiently flexible framework that would standardize AI usage and provide a foundation for future, legally binding regulations (Jeeri & Singh, 2024).

Conclusion

Artificial intelligence is increasingly becoming an integral part of numerous industries and professions, and its future in the field of law is actively being considered. Investment arbitration is a popular method for resolving disputes between foreign investors and host countries, as provided by various international investment agreements. Although it has numerous positive aspects, it has been subject to criticism in recent decades. The application of artificial intelligence is seen as a potential solution to some of the mentioned issues, but the negative aspects of this modern technology are also being considered.

Facilitating the selection of arbitrators, searching for arbitration practice, international and domestic regulations, and other relevant data, translating large volumes of documents, generating legal arguments, and similar tasks represent just some of the examples of the advantages of AI application, which can ease, speed up, and reduce human error in arbitration. However, there are numerous dangers that the use of generative artificial intelligence may bring: mistakes, outdated information, inherent biases, lack of transparency in content creation, threats to privacy and protection of sensitive data, limited ability to create complex legal arguments and decisions due to the absence of a sense of justice, the disappearance of certain legal jobs, and so on.

Despite these limitations and risks, smart tools are increasingly serving lawyers, judges, and arbitrators. With the right balance of technological development, ethics, and law, they can make the field of investment disputes simpler, more efficient, and more predictable. Therefore, this issue should be approached from multiple angles: analyzing existing technology, improving it, working on creating soft and hard law frameworks that would establish ethical and secure use of AI without jeopardizing the core principles and values of arbitration, nor the fundamental ethical imperative of AI development, as stated by UNESCO: it should benefit humanity, society, and the environment.

Conflict of interests

The authors declare no conflict of interest.

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THE ETHICAL DILEMMAS OF THE BLOCKCHAIN TECHNOLOGY USE IN e-HEALTHCARE SYSTEMS

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Abstract: Blockchain technology is increasingly being recognized as a game-changer in healthcare, offering solutions for improved data security, transparency, and interoperability. However, its integration into healthcare systems brings with it a range of ethical challenges that need to be addressed. This paper delves into some of the most pressing issues, such as protecting patient privacy, defining data ownership, obtaining informed consent, and ensuring equitable access. It explores the delicate balance between the transparency that blockchain provides and the potential risks of exposing sensitive health information. The paper also considers the ethical concerns surrounding decentralized governance and the possibility of deepening inequalities due to the digital divide. By addressing these dilemmas, the goal is to offer a thoughtful analysis that can guide policymakers, healthcare professionals, and technologists in leveraging blockchain's potential while upholding ethical principles in healthcare.

Keywords: Blockchain Technology, Healthcare Ethics, Patient Privacy, Data Ownership, Decentralized Governance

Introduction

Blockchain technology has established itself as a disruptive innovation in many sectors in recent years, including healthcare. Due to its ability to provide security, transparency, and decentralized data management, blockchain has the potential to significantly improve various aspects of the healthcare sector. Electronic health records (EHRs), the exchange of medical information, and the authentication of medical licenses are just a few of the aspects of healthcare where blockchain can play an important role. However, while blockchain can bring many benefits, its application in the healthcare sector also raises a number of ethical dilemmas that require careful analysis. This paper aims to explore and analyze the ethical dilemmas of the use of blockchain technology in e-health. The aim of this paper is to explore the basic characteristics of blockchain technology in the context of the health sector, to analyze ethical dilemmas that arise during the application of blockchain technology in e-health, to analyze and systematize literature sources that deal with ethical challenges related to blockchain and e-health, to consider and propose possible potential solutions or guidelines for resolving ethical issues.

We will use the method of systematic literature review, analyzing scientific papers, articles and sources dealing with blockchain technology and its impact on the healthcare sector. The analysis will also include case studies from countries that have implemented blockchain in healthcare, in order to gain insight into practical aspects and ethical implications.

Key features of blockchain technology in the context of the healthcare sector

Blockchain technology provides high security and transparency, making it suitable for medical data management. Patients' medical records can be stored securely, and access to data can be tightly controlled with the ability to track who, when, and under what conditions are using the data. Also, blockchain allows decentralization, which means that no single institution has complete control over the data, while all participants in the chain have insight into the changes. The application of blockchain in healthcare is accompanied by a number of not only technical but also ethical challenges, including data security and privacy, accountability, decentralization, accessibility, digital inequality, interoperability,

efficiency and cost reduction. One of the main ethical issues related to blockchain in e-health relates to data privacy, i.e. to protect the privacy of patients. Health data is extremely sensitive, and blockchain technology, while providing a high level of security, allows for data irreversibility. Once recorded on the blockchain, the data cannot be deleted or changed, which can cause problems if the patient wants to withdraw consent to the use of their information. The decentralized nature of blockchain can make it difficult to remove or anonymize data, which goes against the "right to be forgotten" and the principles of the EU's General Data Protection Regulation (GDPR). These ethical challenges can create tension between technological innovation and patients' right to control their data.

Although blockchain allows for pseudonymity – whereby the identity of the patient is not directly revealed – the data can still be linked to individuals through other information or metadata. This possibility of identification can compromise the anonymity of patients, especially if there are security flaws or intrusions into the system. The ethical challenge lies in finding a balance between transparency and protecting patient privacy. While blockchain promotes the openness and accessibility of data, patients' personal information must be protected. Private blockchain networks, or the use of off-chain systems to store sensitive information, can be the solution to these problems. Blockchain offers a high level of security thanks to cryptography and the inability to change records. Medical data is sensitive and susceptible to misuse, and it is a key ethical and legal obligation for healthcare institutions to adequately protect it. Blockchain allows data to be encrypted, which ensures that only authorized individuals have access to the information.

Although blockchain is known for its high degree of security, as it provides mechanisms to resist manipulation and data loss, security aspects in the context of health data pose additional ethical dilemmas. Blockchain allows for immutability of records, but this can become problematic when changes or corrections to health data are required due to medical errors or changes in diagnoses (Chen et al., 2019). The irreversibility of blockchain data can have serious consequences on patients' health, raising questions about the responsibility and ethical obligations of healthcare professionals regarding the accuracy of the information entered. Additionally, while blockchain can reduce the risk of unauthorized access to data, cyberattacks still pose a real threat. If attackers manage to compromise the systems used to access the blockchain network, the potential damage can be far-reaching. This ethical dilemma points to the need for continuous improvement of cybersecurity and privacy protection in the context of blockchain applications in e-health (Angraal et al., 2017).

Stakeholders in the application of blockchain technology in e-health

The successful implementation of blockchain technology in e-health depends on the engagement of various stakeholders, including patients, healthcare professionals, regulators, and technology companies. This chapter will analyze key stakeholders, their interests and challenges in the application of blockchain technology in e-health. Patients are one of the most important actors in e-health. Their trust in the system and willingness to share their health data directly affects the success of the implementation of blockchain solutions. Blockchain allows patients to have control over their data, including the right to grant or deny access to that data to healthcare professionals (Kuo et al., 2017). This capability can increase patients' levels of trust in e-health, but at the same time creates a challenge in educating patients about the technology and its benefits. Healthcare professionals, including doctors, nurses and administrative staff, are a key group in e-health. They are responsible for providing services and managing patient data. Blockchain can improve efficiency and accuracy in the exchange of information between healthcare professionals, but it faces challenges such as resistance to change and the need for training. Healthcare workers need to be confident that new technology will make their job easier, not more difficult. Regulatory institutions play a key role in shaping the legal framework for the use of blockchain

technology in e-health. Their task is to ensure that all aspects of the use of technology comply with applicable laws and regulations, especially with regard to data privacy protection (Dagher et al., 2018). The role of regulation is particularly important in the context of blockchain, which can provide a high level of transparency and accountability, but also requires clearly defined guidelines on how data is collected, used, and stored. The regulator's decisions have a direct impact on the ability of healthcare organizations to implement blockchain solutions. Technology companies are key partners in the development and implementation of blockchain solutions in e-health. They provide the necessary technology, infrastructure and expertise. Collaboration between technology companies and healthcare organizations can result in innovative solutions that meet the specific needs of healthcare systems. However, the challenge lies in finding a balance between commercial interests and ethical standards, especially when it comes to sensitive patient data. The community and accrediting organizations also play a significant role in the implementation of blockchain technology in e-health. These organizations can contribute to the creation of standards and guidelines for the ethical use of technology, as well as to educating patients and healthcare professionals about its benefits and risks. Engaging social organizations can improve public trust in blockchain solutions and ensure that the interests of all stakeholders are taken into account when developing and implementing the technology.

Key Aspects of Blockchain Technology

One of the key aspects of blockchain technology is decentralization. Traditionally, health data has been stored centrally, making it vulnerable to attacks or database management errors. Blockchain allows data to be distributed across a network of computers (nodes), eliminating the need for a central authority. Each node in the network has an identical record of transactions, which reduces the possibility of data manipulation and increases the system's resilience to cyberattacks (Yue et al., 2016). Transparency is another important aspect of blockchain. All transactions within the blockchain network are recorded in an immutable manner and available to all participants in the network. This feature is particularly useful in the healthcare sector, as it allows for a secure and transparent exchange of data between different healthcare facilities, patients, and healthcare providers (Agbo et al., 2019). Patients can also monitor how their data is being used and who is accessing it, which increases trust in the system. Blockchain technology decentralizes accountability in the management of health data, which can raise ethical dilemmas regarding accountability. In traditional systems, there are clearly defined responsible institutions, while in a blockchain system, there is no central authority. This can make it difficult to identify the responsible entity in the event of a policy breach or misuse of data (Mettler, 2016). Blockchain technology can increase digital inequality among different patient groups, especially in regions where internet access and technological literacy are underdeveloped. These inequalities can prevent equal access to digital health services (Zheng et al., 2018). The ethics of using blockchain in healthcare requires careful consideration to ensure equitable accessibility and inclusiveness. One of the long-standing problems of the healthcare sector is interoperability – the ability of different systems and institutions to efficiently exchange and use data. Given that health data is often found in different systems and formats, its integration is challenging. Blockchain can provide a standardized way of exchanging information between various entities, such as hospitals, laboratories, pharmaceutical companies, and insurance companies (Zheng et al., 2018). The efficiency of the healthcare system can also be increased through the use of smart contracts, which enable the automatic execution of predefined conditions and actions. For example, smart contracts can automate the processes of reimbursement, dispensing medicines, or processing laboratory results, thereby reducing administrative burden and increasing the speed of services (Zhang et al., 2018). One of the potentially most important aspects of blockchain technology in the healthcare sector is cost reduction. Healthcare is a sector that spends a lot of resources on administration, data processing and compliance with regulatory standards. Blockchain, with its ability to automate many processes and reduce intermediaries, can significantly reduce data management and administration costs (Agbo et al., 2019).

In addition, blockchain can help prevent fraud in the healthcare system. For example, pharmaceutical companies can use blockchain to track drugs in the supply chain, thereby reducing the possibility of drug counterfeiting and guaranteeing product authenticity (Tandon et al., 2020). While blockchain offers significant advantages, its implementation in the healthcare sector is not without its challenges. First of all, there are technical and regulatory challenges, including compliance with legislation, the need for high technical standards, and the adaptation of existing systems to blockchain infrastructure. Also, ethical challenges include issues of privacy, liability, and the possibility of misuse of technology (Jiang et al., 2018). One of the ethical aspects is the issue of accessibility. While blockchain can improve many aspects of the healthcare system, its complexity and infrastructure requirements may limit its implementation in countries with lower levels of development.

Deontological analysis of the application of blockchain technology in e-health

Blockchain technology has become an important factor in the development of modern healthcare systems, especially in terms of data security, decentralization, and transparency. The use of blockchain in e-health raises a number of ethical dilemmas, which can be analyzed through different approaches to ethics. Deontology, as an ethical theory that focuses on moral obligations, rules, and principles, offers a unique perspective for considering the responsibilities and duties associated with the use of blockchain in healthcare. In this chapter, we analyze the deontological approach to the application of blockchain technology in e-health, with a special focus on issues of privacy, transparency, and accountability.

Deontological ethics, most developed by Immanuel Kant, focuses on moral duties and obligations to be followed, regardless of the consequences. According to this theory, certain actions are inherently right or wrong, and moral norms are universal and applicable to all people. In the context of health systems, the deontological approach places a strong emphasis on respect for patients' rights, privacy protection, and accountability in data processing (Shae & Tsai, 2017). One of the key deontological issues regarding blockchain technology in healthcare is the issue of patient privacy. Blockchain allows data to be stored and distributed securely, but its inherent transparency can raise ethical dilemmas. According to the deontological approach, it is the duty of healthcare professionals and organizations to protect patients' confidential information, as privacy is a basic moral right that must be respected regardless of the benefits that transparency may bring (Roehrs et al., 2017). In this context, blockchain technology offers solutions through data encryption and decentralization of control, but the challenge remains in balancing the transparency of the system and patients' right to privacy. Deontologically speaking, respect for privacy should be an absolute obligation, and all technical systems, including blockchain, must be designed to protect patients' rights without compromise. Blockchain is often promoted as a technology that enhances transparency, as it allows all users to access the history of transactions and changes in data. While transparency can contribute to better control and reduce corruption in health systems, deontological analysis requires deeper consideration. According to Kant, accountability for actions must be related to respect for moral principles, and not only to public control. This means that even when transparency is technologically possible, it must not compromise moral obligations to patients, such as the obligation of confidentiality (Azaria et al., 2016). Deontologically speaking, blockchain must be implemented in such a way that the responsibility of healthcare professionals and organizations to patients remains intact. For example, smart contracts, which automate processes on blockchain networks, must be programmed in accordance with ethical standards and the duties of healthcare professionals. These technologies must not replace human responsibility, but must support and strengthen it through respect for moral rules. Decentralization is one of the key attributes of blockchain technology, which allows for the distribution of control over data among network users. From the point of view of deontological ethics, decentralization carries significant ethical value, as it enables patient independence and reduces the risk of misuse of data by centralized institutions. However,

decentralization also raises the question of responsibility — who bears responsibility when something goes wrong? Deontologically, the responsibility for respecting patients' rights still lies with healthcare professionals and institutions, even when data is distributed through a decentralized blockchain network. This moral principle means that decentralization cannot be an excuse for a loss of responsibility or neglect of obligations to patients (Kuo et al., 2019). Decentralized networks must be designed to clearly define who is responsible for data protection and the enforcement of ethical standards. One of the most important features of blockchain is the immutability of data — once data is entered on the blockchain, it cannot be changed or deleted. This feature can be useful in ensuring data integrity, but it can pose an ethical concern when it comes to outdated or inaccurate medical information. According to the deontological approach, healthcare organizations have a moral obligation to ensure that patients have the right to correct or delete inaccurate information (Zyskind & Nathan, 2015). Blockchain technology must be developed in a way that allows data to be updated and corrected, while preserving the immutability of records to ensure accountability and integrity. This balance between immutability and patients' right to correction must be based on moral obligations, not just technical limitations.

Conclusions

Blockchain technology offers revolutionary opportunities to improve the healthcare sector, especially in terms of decentralization, security, efficiency, and cost reduction. However, there are challenges that need to be addressed, including issues of privacy, regulation, and ethical implications. Stakeholders in the application of blockchain technology in e-health play a key role in shaping its success. Collaboration between patients, healthcare professionals, regulators, technology companies, and the community can enable the creation of sustainable and ethically acceptable solutions. As blockchain continues to evolve, it is imperative to identify and address the interests and challenges of all stakeholders in order to achieve successful implementation and benefit for the entire healthcare system. The healthcare sector must carefully consider how to make the most of this technology, while ensuring that its benefits are implemented in a way that protects patients and their data. The effective implementation of blockchain solutions in e-health requires the alignment of the interests of all stakeholders in order to achieve an optimal balance between individual benefits and the wider societal good. Ethical regulations and technological solutions must be adapted so that blockchain can fully respect and protect the moral rights of individuals in the healthcare sector. These dilemmas require careful consideration and development of ethical and legal frameworks to ensure that blockchain technology benefits patients without compromising their rights and safety. The future of blockchain in healthcare will depend on how these ethical dilemmas are addressed in practice. A deontological analysis of the application of blockchain technology in e-health reveals a number of moral duties that healthcare professionals and organizations must uphold. The duty to protect privacy, the responsibility for transparency and decentralization, as well as the right of patients to rectify data, are key aspects that blockchain technology must respect in order to be ethically justified. The deontological approach requires that blockchain be implemented in accordance with moral principles, where patients' rights remain at the center of any technological solution.

Conflict of interests

The authors declare no conflict of interest.

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SCIENCE, ETHICS AND NEW EMERGING TECHNOLOGIES

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Abstract: In this paper, we will examine the relationship between science, ethics, and emerging technologies, with a particular focus on nanoscience and nanotechnology. Our goal is to demonstrate that all sciences, including these most recent ones, originate from philosophy, which has always strived to maintain an integral, holistic approach to reality. In contrast to philosophy, individual sciences gradually lose interest in philosophical views of a higher level of generality and a holistic approach to reality. As a result, sciences often neglect ethics and value judgments that assess the consequences of their activities and outcomes. Nanotechnology, along with other convergent technologies such as biotechnology, information technology, artificial intelligence, and neurotechnology, differs from other technologies in its ability to operate at the atomic and molecular levels. This enables its impact on the natural environment and the human organism to often remain beyond public awareness. Such a situation raises legitimate concerns and calls for addressing the issue of responsibility for the development of these technologies. Strict and organized action by the broadest possible public is needed to ensure the responsible development and application of nanotechnology. In this paper, we will consider potential coalitions for overseeing these technologies, as well as some key questions that must be answered before these technologies "slip" beyond our control. In this context, special attention will be given to promoting a multidisciplinary approach and involving various stakeholders from the fields of science, philosophy, ethics, and representatives of civil society in the decision-making processes related to the development and regulation of nanotechnology.

Keywords: philosophy, society, ethical capacity, responsibility, nanotechnology,, coalition, collaboration, multidisciplinary.

Introduction: The Evolution of Sciences from Philosophy: A Historical Perspective

All contemporary natural and social sciences have emerged from philosophy, which represents humanity's first attempt to rationalize and understand the reality that surrounds it. Philosophy arose from a sense of "wonder" at the magnificence, perfection, and even inscrutability of the world, the universe, and particularly life in all its diversity and richness. Philosophy seeks to provide a comprehensive picture of the world, its perspective, value, and the meaning of human existence within it. There is a saying that "philosophy knows a little about many things," while "science knows a lot about a few things." In the initial stages of humanity's reflective efforts to understand the world, philosophy was the "science" that dealt with all aspects of knowledge about reality. However, from the Renaissance period (15th century onward), specific sciences gradually emerged from philosophy, focusing on smaller parts of reality in order to achieve a deeper understanding of as many aspects of that reality as possible.

The relationship between science and philosophy in modern times was most vividly described over a century ago by the renowned German philosopher Friedrich Nietzsche, who stated:

"Today, science is flourishing and its face clearly reflects a tranquil conscience, while what the entirety of modern philosophy has gradually sunk into—a remnant of today's philosophy—elicits distrust and ill will, if not mockery and pity..."

For a discipline to be distinguished from philosophy and established as a separate science, it is essential to have a defined subject of study, a categorical-conceptual apparatus employed, and a method of investigation suited to that defined subject. Thus, science becomes an activity through which humans acquire knowledge about the world around them. It is a method of approaching the empirical world accessible to human experience, founded on principles of objectivity, reliability, precision, verifiability,

systematicity, and so forth. However, despite this distinction, every scientist, whether engaged in the natural, technical-technological, or social sciences, is consciously or unconsciously also a philosopher. In the course of their work and study, they inevitably grapple with ontological, epistemological, ethical, and even aesthetic questions, which are fundamentally philosophical disciplines.

Why ethic is important for the further development of nanoscale science

Ethics is, in the simplest terms, a philosophical discipline that systematically examines human values and the distinction between good and evil. It seeks to resolve questions of human morality by defining concepts such as good and evil, right and wrong, virtue and vice. While science deals with factual judgments, ethics employs value judgments that incorporate not only attempts at rational, objective assessment of situational facts but also the subjective, personal perspective of the one making these judgments.

Morality is a historical category and its content changes from one epoch to another. Each era strives to “re-evaluate” established values and moral norms in accordance with the reality it constructs, and history has shown that it generally succeeds in doing so. Thus, we can distinguish between ancient morality, Christian morality, bourgeois morality, communist morality, and so on.

Emerging technologies, such as biotechnologies, nanotechnologies, and complementary technologies, bring with them new moral dilemmas. As a result, many authors argue for the legitimacy of entirely new and independent fields of ethics, such as bioethics and nanoethics.

Unlike other emerging technologies that have also reached a high level of development, nanotechnologies are particularly unique due to their ability to precisely characterize, design, and control matter at the atomic, molecular, and supramolecular levels (on a scale of approximately 1–100 nm). They have already found extensive applications across various fields, including industry, agriculture, and medicine. Given that fundamental processes in the human body occur on the nanoscale, this discussion gains even greater significance not only for the scientific community but also for the general public.

The Socio-Historical Context of Technological Development – Science, Technology, and Morality

To engage in rational, argumentative, and meaningful discussions about the impact of new technologies on society today and the changes they bring, it is necessary to establish the broadest socio-historical context of human development. It is crucial to define a universal ontological framework through which human society, and consequently science, has existed and developed from its inception to the present day.

According to this ontological framework, humans, through labor—an active, productive, creative, sensory-material, conscious, and purposeful activity—use their natural organs, and later tools and technology as extensions of these organs, to transform nature, their *locus standi*, and adapt it to their needs, thereby creating their own history.

This seemingly simple and self-evident relationship between humans, labor, technology, nature, and history provides a foundational basis for any further analysis of the impact of technological development on society, including the influence of nanotechnologies on the reality we live in today and the perspectives of social development in the immediate and distant future.

Since the 17th century, modern science has sought to portray itself at all costs as an autonomous and (self-)sufficient means of representing the world. It has established a new concept of reality based on a strong bond between logic and experimentation. When scientific truth became equated with technical effectiveness, the rationalization and scientification of human culture reached its peak.

Technology is a fully social phenomenon. It arises from society, which enables and encourages it. It shapes us as much as we shape it. Technology influences every aspect of our lives—the places we live, the ways we communicate, how we perform our jobs, our forms of recreation, our institutional

arrangements, and how we organize our time and lives (Ronald (Sandler 2009). When science and technology, united in this way, are put in the service of the economy and business, the meaning of human existence acquires a purely materialistic concept.

Science, Technology, and Ideology

The rapid development of nanoscale technologies brings new moral dilemmas and controversies. These arise from genuine concerns about their potential impact on the environment, human health, the human genome (and thus human nature), human rights, freedoms, democracy, societal surveillance and control, and the concentration of social, political, and economic power. Such power structures are increasingly controlled by those who oversee the development, commercialization, and application of these technologies globally.

Humankind has found in technology a substitute for its own strength, but humans remain irreplaceable in determining the purposes of this multiplied power.

Today, as nanotechnologies and their complementary technologies can influence human lives and even the entirety of human civilization in much more subtle and pervasive ways, the level of concern and attention must be higher than ever before (e.g., risks of bioterrorism, technoterrorism, or even nanoterrorism).

According to Klaus Schwab, the Fourth Industrial Revolution is characterized by a range of new technologies that merge the physical, digital, and biological worlds, affecting all disciplines, economies, and industries, while challenging fundamental ideas about what it means to be human (Schwab, 2016).

Every new technology offers an opportunity to engage stakeholders in social and ethical debates to achieve the broadest possible societal consensus regarding its application. The nanotechnological revolution is still in its early stages, providing a window for open public discourse on both its intended and unintended consequences. It is imperative to establish the widest coalition of stakeholders and achieve the greatest possible public consensus on critical issues related to the development, commercialization, and application of nanotechnologies.

To initiate this process, the following questions may be considered:

- Who comprises the coalition of key stakeholders in this debate?
- How can they be connected and motivated to participate in the discussion?
- How can public attention on the importance of these issues be maintained?

This groundwork aims to find answers and consensus on fundamental questions, such as:

- What are the boundaries of nanotechnology development?
- How far is it permissible and wise to go?
- What are the later-stage implications (currently unknown) of these technologies?

Moreover, as new questions arise over time, answers will need to be sought, ensuring these revolutionary technologies serve humanity responsibly and ethically (Ferreira and Filipe, 2022).

The Role of Ethics in the Responsible Development of Nanotechnologies

Ethical reflection can clarify what constitutes a fair development process and how nanotechnologies can promote human flourishing and prosperity while ensuring the sustainability of their progress (e.g., extending lifespan, enhancing cognitive abilities, food production). The goal-means dilemma is ever-present—some means are not ethically acceptable, even if the goals they serve are worthwhile. Ethical analysis helps identify boundaries regarding how goals should be pursued (e.g., the use of stem cells and chimeras in medical research, synthetic biology). There is a saying: “The worst things are done with the best intentions.” A laudable goal does not always guarantee ethically acceptable practices (Sandler, 2009).

Ethical and socio-scientific research not only identifies opportunities for nanotechnology to achieve its aims but also predicts non-technical barriers to realizing these goals (e.g., religious beliefs and prejudices, experiences with prior technological innovations, resistance to change, and the political and strategic interests of specific states, organizations, and groups).

The ethical capacity of society is critical for the responsible development of nanotechnologies. This encompasses tools and resources that assist governments, individuals, and organizations in making decisions based on ethical considerations. These include:

- An informed public opinion
- A developed non-governmental sector and civil society
- Professional associations and adopted codes of conduct
- Case studies based on prior experiences and historical precedents

Ethical observations also aim to overcome misconceptions and prejudices related to the development and application of nanotechnologies. The first misconception suggests that there is nothing socially or ethically problematic in the practice of nanoscale science and engineering (Sandler, 2009). Arguments here often highlight that nanotechnology has not yet "taken off" on a large scale, with relatively few products containing nanoscale particles, processes, or devices that are not yet commercially effective.

The second misconception is rooted in the familiar phrase: "Science creates, industry applies, and society adapts." (Sandler, 2009). This techno-optimism assumes that technological innovations are unstoppable, driven by their internal logic, and inherently welcome and positive. Thus, raising social and ethical questions about nanotechnological innovations is seen as futile, if not harmful, as it could slow the exponential development of nanotechnology, which is deemed inevitable.

Most earlier technological innovations (from the Industrial Revolution to the present) have proven unsustainable. These innovations facilitated production systems and consumption patterns that treated Earth's natural capital merely as a resource, negatively impacting living systems, biodiversity, and their regenerative capacities (e.g., pollution, toxicity, climate change, food insecurity, and species extinction) (Sandler, 2009). While some argue that further technological advances, particularly in nano- and biotechnologies, might rectify these issues, such beliefs are currently rooted more in faith than in evidence-based knowledge.

Moreover, these technological changes have not been accompanied by significant shifts in value systems, consumption habits, or economic models. Specifically, the capitalist economy—focused on maximizing utility rather than optimizing the balance between natural, technical, and human resources—remains dominant. As a result, there is no inherent guarantee that nanotechnologies and their applications will inevitably lead to societal flourishing or a more sustainable relationship with natural resources.

Historically, our perception of nature has become increasingly mediated by technology, leading to the marginalization of natural values. Risk assessments for new technologies often rely on quantitative methods (which are sometimes questionable) instead of inclusive approaches that involve a broader range of stakeholders. Furthermore, the precautionary principle is frequently overlooked in favor of an unwarranted belief that technology will resolve all adverse side effects of technological innovations. This overconfidence also reflects an overestimation of our ability to predict and control technologies, especially in complex and dynamic biological systems.

Additionally, the practice has shown that developed nations often externalize the negative consequences of new technologies onto less developed countries and regions to capitalize on the benefits for themselves. A current example is the exploitation of lithium resources to revitalize the struggling automotive industries of Western European manufacturers, particularly Germany's. Given the global socio-economic context, nanotechnology and nanoengineering are likely to perpetuate or even deepen environmental injustice. Thus, the responsible development of nanotechnology is incomplete

without addressing ecological justice.

Example: Prejudices Around Artificial Intelligence (AI)

There is a pervasive belief that the latest technologies are "clean technologies," implying they do not rely on the exploitation of natural resources or human labor. However, this belief is misleading, as AI systems are inherently materialistic, built from natural resources, energy, human effort, infrastructure, and logistics. The term "artificial intelligence" may evoke images of algorithms, data, and cloud architectures, but these technologies cannot function without the minerals and resources that make up their essential components, such as rare earth elements like cobalt, lithium, and neodymium (Krawford, 2021).

AI's massive ecosystem depends on various forms of extraction, from data collection sourced from our everyday activities without consent, to the depletion of natural resources and the exploitation of labor globally to maintain and develop this extensive planetary network (Krawford, 2021). These practices give rise to numerous ethical and ecological issues not immediately apparent to average users.

For example, Amazon's Mechanical Turk platform originated from an unsuccessful attempt to automate retail tasks effectively. As a corrective measure, an army of workers—mainly from developing countries—are employed to carry out micro-tasks to enhance AI systems. These workers compete for tasks at meager wages, often receiving only gift vouchers that are redeemable exclusively through Amazon. Jeff Bezos has openly described this system as "artificial artificial intelligence (Krawford, 2021)."

Nanotechnology - Between Hype and Reality

New technologies, including nanotechnology, have undeniably become a topic of discussion not only in scientific and professional circles but also in the media and public debates concerning their potential impacts on nature and humanity. Several reasons contribute to the proliferation of hype surrounding nanotechnology.

First, the general public often lacks understanding of the current state of nanotechnology development, existing applications, real benefits, and potential risks. This gap in knowledge can be exploited by those who exaggerate or even construct negative and catastrophic forecasts regarding their future implications (so call "conspiracy theorists"). On the other hand, there are groups that uncritically or even deliberately emphasize the positive aspects of nanotechnology, ranging from techno-optimists and transhumanists to research institutions seeking financial support for various projects, and corporate interests aiming for profit maximization.

Moreover, strictly speaking there is no such thing as 'nanotechnology', so to be in favour of or against it as a whole makes little sense (José Manuel de Cózar-Escalante, 2021). Nanotechnology, along with other converging disruptive technologies, undoubtedly represents both our future and present. It has found applications in areas such as materials science, medicine, pharmacology, and electronics. However, there are still many technical limitations, particularly in the realm of nanotechnology engineering. Concepts like nanobots remain within the realm of science fiction, with limited near-term prospects.

Promising applications of nanotechnology include water purification technologies, medical advancements, and new materials that could provide basic goods to a significant portion of the world's population currently deprived of them. However, the history of previous technologies that were expected to fulfill similar roles, only to be co-opted by the interests of the wealthy and powerful, raises concerns about the equitable distribution of these advancements. Without a strong social movement mobilizing critical stakeholders, the decisions surrounding the development and application of nanotechnology are likely to favor those with economic and political power.

The Question of "Coalition"

Ethics can provide standards for evaluating the impact of nanotechnologies. Since nanoscale science and technology encompass various fields and applications, such as energy, agriculture, computing, medicine, weapons, materials, and the environment, ethical assessments must be context-specific (Sandler, 2009). These evaluations depend on individual cases and should focus on specific research, technologies, and their applications. Only through such evaluations can more informed decisions be made, minimizing negative public reactions that may hinder the development or commercialization of socially desirable nanotechnologies. This includes government policy adoption, allocation of public resources, legislation, regulations, and oversight of corporate policies, research, commercialization, and applications of nanotechnologies across various sectors like pharmaceuticals, agriculture, and healthcare.

While most nanotechnology research occurs within academic settings, such as universities and institutes, the commercialization of ideas is often driven by corporate interests. In these cases, researchers have limited influence over how the results of their work are applied. Although researchers engage in revolutionary scientific advancements, their initial intentions may be detached from how their work is later used in practical applications. Consequently, it is unreasonable to expect individual researchers to bear the entire responsibility or to manage the technological pathways that result from their work (Spruit and Hoople, 2015).

Thus, while the ad-hoc nature of scientific research, particularly in the context of nanoscience and nanotechnology, creates challenges, it does not absolve scientists and engineers of ethical responsibility. (Spruit and Hoople, 2015)

They must share this responsibility with others involved in the research and development process, forming coalitions of stakeholders who can collectively oversee and guide nanotechnology development for the betterment of society as a whole.

Regarding "specialized" NGOs and other civil society organizations that see themselves as representatives of specific social groups, they can play a role as partners in dialogues concerning the development of new technologies. Traditional participatory forms of political representation should simultaneously be complemented by other types of networking, such as community-based research¹ and science shops², 'creative appropriation' of scientific findings and innovations, different kinds of activism, etc. (José Manuel de Cózar-Escalante, 2021).

However, their role should not be limited to merely identifying those who may be affected by nanotechnology applications without immediate visibility, such as patients, consumers of food products, farmers, etc. There should be more comprehensive involvement.

Higher educational institutions, colleges, and universities should integrate interdisciplinary courses into their curricula that place specialized knowledge in a broader societal and ethical context (e.g., Sociology of Technology, Philosophy of Technology, Ethics and Science, Digital Ethics, Nano-bioethics, etc.). Research institutions and specialized scientific bodies, which possess unique expertise and in-depth insights into possible applications of their work, must include sessions dedicated to social and ethical considerations in their projects. These sessions should result in project documentation that includes thorough discussions of social and ethical implications.

Collaboration with academic communities, including social science and philosophy faculties and institutes, and organizing public conferences and open debates, are essential for fostering an inclusive dialogue. Additionally, considering the institutionalization of employing social science scholars in technical institutions could facilitate a more ethical and socially responsible approach to technological

¹ Community-based research is defined as an approach to public health research that emphasizes active participation of community members, collaborative partnerships, and the integration of knowledge and action to address shared needs and health determinants.

² Science shop: "a unit that provides independent, participatory research support in response to civil society's concerns about scientific or other technological innovations and their social applications."

development, ensuring that technical advancements contribute positively to the community.

To expand the coalition and strengthen the ethical capacities of society for controlling the development of nanotechnology, the following initiatives should also be considered:

- Creating more science-shops and strengthening community-based research in general.
- Combining conventional, formal, representative procedures with existing participatory methods, while also including activism and social movements. However, the integration of these various elements should not be forced into a supposedly all-purpose problem-solving method
- Creating hybrid forums, an organisational methodology designed to manage scientific and technological controversies in which diverse (human) actors participate (José Manuel de Cózar-Escalante. 2021).

Therefore, we can conclude that there is no predefined coalition or public that can be engaged in all cases and situations. Instead, the public must be sought anew, depending on the specific issue at hand.

Additionally, the question of a critical public or coalition is not merely a technical issue of organization and interaction, but touches on fundamental questions related to how our societies function.

Conclusion

New emerging technologies and the Future of Human Society: Technologies have always influenced social forms, structures, standards, production practices, institutions, and lifestyles. Karl Marx noted that capitalism and the Industrial Revolution transformed people's lives from the rhythm of the seasons (associated with agricultural societies tied to farming and seasonal changes) to the rhythm dictated by machines and factory work organization. New emerging technologies, including nanotechnologies, are likely to reshape this situation, establishing new rhythms of human life.

Technological and social transitions once occurred more slowly, allowing societies more time to adapt. Today, multiple technological transitions can occur within a single human lifespan. Information technologies have redefined social interaction, production organization, education, lifestyles, and even philosophical systems of values over just a few decades.

Nano and biotechnologies, along with convergent technologies, have the potential to deeply transform society and human lives. For example, advancements in nanomedicine could redefine human progress, enhancing longevity and expectations regarding health. This extends to environmental protection and sustainability, with new material sciences creating synthetic alternatives to previously exploited natural resources.

In synergy with other convergent technologies, nanotechnologies may influence the concept of human nature, psychological identity, and even metaphysical questions about life's meaning. This raises new ethical landscapes that require reevaluation and redefinition. The boundaries of nanotechnology are still largely unknown, but they introduce paradoxical possibilities in science and ethics, particularly in areas such as neurotechnology, which could alter moral capacities (Bensaude and Vincent, 2010) and transform humans into utilitarian biomachines.

Alongside the development of nanoscience and its transformative potential, transhumanism has emerged as a new ideology, often starting from unsubstantiated premises and lacking clear criteria for evaluating its impact on humans and society. Given the growing public scrutiny of technological advancements and diminishing trust in science's self-regulation, establishing a new social contract between science and society is becoming increasingly necessary. Nano-bio-neuro technologies require an interdisciplinary approach and a coalition including anthropologists, sociologists, philosophers, and ethicists, always guided by the principle of precaution (Ferreira and Filipe, 2022).

Conflict of interests

The authors declare no conflict of interest

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EVALUATING THE IMPACT OF SUSTAINABLE LANDSCAPE PLANNING ON STUDENT WELL-BEING AND ACADEMIC PERFORMANCE: A Case Study of the University of Ibadan

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Abstract: This study investigates the impact of sustainable landscape planning on the well-being and academic performance of students at the University of Ibadan. Utilizing survey data, the research highlights the positive effects of well-maintained green spaces on students' mental health, stress reduction, physical health, and connection to nature. The findings indicate that a significant proportion of students perceive sustainable landscape planning as beneficial to their overall well-being and academic experience. Hypothesis testing results further confirm the substantial positive impact, underscoring the importance of incorporating sustainable landscape practices in educational institutions. These results advocate for increased investment in sustainable landscaping to foster a healthier and more conducive learning environment.

Keywords: Sustainable landscape planning, Student well-being, Academic performance, University of Ibadan, Green spaces

Introduction

The initial impression an individual forms upon arriving at a new location is often shaped by the landscape practice in that environment. This is because the landscape, encompassing the visible features of an area including its landforms and their integration with natural or man-made elements, significantly influences the self-image of the inhabitants (Bondarenko *et al.*, 2020). A campus landscape, therefore, holds substantial weight in students' decision-making processes when selecting an institution for admission, embodying both cultural and aesthetic values. The landscape is the front door and welcome page of an institution, revealing more about a college, polytechnic, or university than promotional materials or speeches by recruiters and administrators (Olu *et al.*, 2018). The local environment and landscape are crucial for future sustainability (Lovett *et al.*, 2011). Increased knowledge and awareness of the local environment promote environmental stewardship. An attractive school landscape inspires students, teachers, school employees, and parents. The function of the landscape extends beyond beautification and providing shade; it should also aid students' learning processes and foster an appreciation for the environment (Ali *et al.*, 2020).

The campus landscape, akin to its buildings, is the physical embodiment of an institution's values. It plays a vital role in campus life by providing spaces for study, play, outdoor events, aesthetic appreciation, and even food production, while serving as a "living lab" for research. The perception of the campus landscape can influence the extent and rate of naturalization efforts (Wu & Yan, 2019). Natural landscaping offers numerous environmental benefits. The reduced use of fertilizers, pesticides, and lawnmowers can positively impact plants, water, and land use, preventing ecosystem degradation (Wu & Yan, 2019). Natural landscapes, with native plant materials, reduce the need for synthetic fertilizers, minimizing contamination

and eutrophication of surface water (Lerman *et al.*, 2018). Additionally, reducing lawn mowing and relying more on natural flora utilizing native species can decrease fossil fuel consumption (Lerman *et al.*, 2018).

Landscapes are perceived by individuals as areas that appeal to the human sense of beauty, combining natural and man-made features. Designers play a crucial role in shaping our living environment by thinking critically and visualizing innovative solutions related to usability, form, and ergonomics. The

benefits of natural landscapes are diverse, including environmental, social, and economic factors. Natural landscapes help people recover from stress more effectively than urban environments, improving physiological indicators such as blood pressure and muscle relaxation in as little as 400 milliseconds (Ulrich *et al.*, 1991). People living in areas with abundant green space experience better general health and immunity, and hospital patients recover faster with views of natural environments (Mitchell & Popham, 2007)

The primary issue is the lack of understanding of the true importance of sustainable landscape planning in a university setting. Recognizing the importance of sustainable landscapes is crucial for creating and designing environments that benefit both students and the university at large. Poorly planned or unsustainable landscapes negatively affect a university's image, while well-planned landscapes enhance aesthetics, improve air quality, and support student learning and assimilation. Poor landscaping can lead to unappealing environments, poor air quality, and increased vulnerability to natural disasters such as erosion.

The aim of this study is to investigate, examine, and understand how sustainable landscape planning can impact the University of Ibadan and improve the lives of its students. The specific objectives are to assess the impact of sustainable landscape planning on the well-being of students at the University of Ibadan and to determine the effects of sustainable landscape planning on student learning and assimilation.

The study focuses on exploring sustainable landscape planning specifically within the University of Ibadan, encompassing various dimensions. It concentrates on the University of Ibadan campus and its immediate surroundings, analyzing the existing landscape and potential areas for sustainable interventions. It considers the student population of approximately 41,743 as of 2023, including both undergraduate and postgraduate students, to understand how it affects sustainable landscape planning. The study examines the influence of sustainable landscapes within the University of Ibadan, evaluating their impact. Spanning from the past decade to the present, the study examines the evolution of the university's landscape and changes over time affecting sustainability efforts. It explores students' perceptions and experiences of the landscape environment, gathering feedback on air quality, aesthetics, and general impressions to identify areas for improvement. Based on the findings, the study provides insights and recommendations for optimizing and sustaining the landscape environment, including architectural modifications, proper waste management, resource management, and student involvement.

The justifications for this study on sustainable landscape planning at the University of Ibadan are multifaceted. Examining the landscape can enhance students' well-being by providing more relaxation and recreation areas. Understanding sustainable landscapes helps identify areas for improvement and informs efforts to enhance the university's overall landscape. Sustainable landscape planning aids in adapting to climate change impacts, supporting the campus's long-term sustainability. Promoting sustainable practices enhances biodiversity, conserves resources, and reduces the university's ecological footprint. As a leading academic institution in Nigeria, the University of Ibadan can serve as a model for sustainable practices, influencing other educational institutions and the wider community. Sustainable landscape planning reduces resource consumption, leading to cost savings and efficient use of limited resources. Furthermore, the study fosters innovative research opportunities in sustainable landscape planning, encouraging interdisciplinary collaborations within the university.

The study area is the University of Ibadan, located in Ibadan, Oyo State, Nigeria. It lies approximately between longitude N07° 26'850" and N07° 27'087" and latitude E003° 53'899" to E003° 53'552", with an

elevation ranging from 205 to 227 meters above sea level in the sub-humid tropics. Established in 1948, the

University of Ibadan is one of Nigeria's oldest and most prestigious institutions, known for its academic excellence and contributions to research, teaching, and cultural development.

The university campus spans approximately 224 hectares and includes 92 academic departments organized into 17 faculties: Arts, Science, Basic Medical Sciences, Clinical Sciences, Agriculture, Social

Sciences, Education, Veterinary Medicine, Pharmacy, Technology, Law, Public Health, Dentistry, Economics and Management Sciences, Renewable Natural Resources, Environmental Design and Management, and Multidisciplinary Studies.

The University of Ibadan offers accommodation through 15 halls of residence, housing about 30% of its students. Notable halls include Lord Tedder Hall, Kenneth Mellanby Hall, and Obafemi Awolowo Hall. The university employs 5,339 staff members and provides 1,212 housing units for senior and junior staff. The campus is equipped with residential, sports facilities, and separate botanical and zoological gardens.

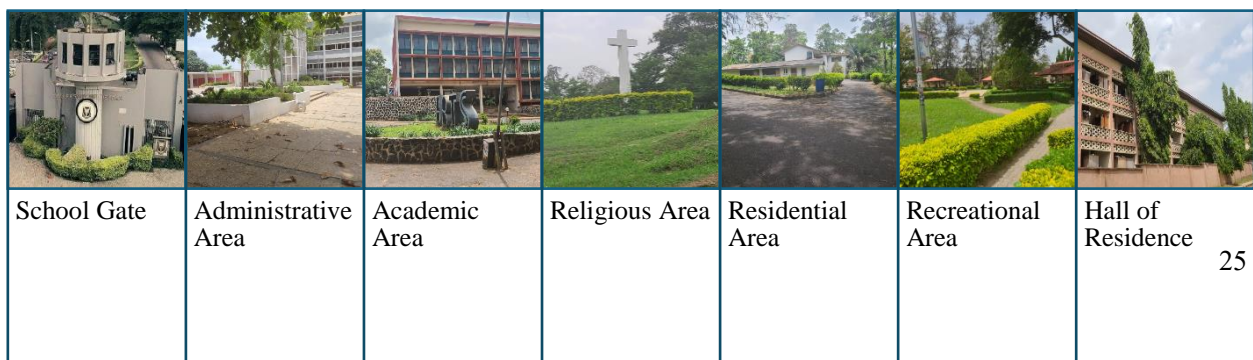
As a leading educational and cultural center in southwestern Nigeria, the University of Ibadan is recognized for its beautiful landscape, diverse student body, and significant role in Nigerian higher education.

Methodology

Landscape Character Assessment

The landscape character assessment of the University of Ibadan was systematically divided into seven distinct areas:

1. School Gate: This includes the university's main entrance and surrounding environs. Photographic documentation was used to capture the landscape characteristics of this area.
2. Administrative Area: This encompasses the University Senate building, the university bookshop, the senate chambers, and the student affairs building.
3. Academic Area: Defined by all faculty buildings within the campus, this area includes lecture halls and offices of academic staff, such as those in the Faculty of Science, Faculty of Social Sciences, and Faculty of Education.
4. Religious Area: This area includes religious buildings such as the central mosque, the school chapel, and the Catholic Church.
5. Residential Area: This includes both junior and senior staff quarters where university staff reside.
6. Halls of Residence: This includes student housing areas such as Lord Tedder Hall, Mellanby Hall,
7. and Queen Elizabeth II Hall
8. Recreational Area: This includes areas designated for leisure and recreation, such as Gamaliel Onasode Park, Heritage Park, and the Student Union Building (SUB).



Methods of Data Collection

The data collection methodology for this study involved the use of a questionnaire, a quantitative research method. A structured set of questions was designed to gather standardized data from a targeted sample of respondents, ensuring that all participants answered the same questions. The collected data were then analyzed using hypothesis testing methods and statistical techniques to identify patterns, trends, and associations among variables.

Questionnaire Administration

For this research, 50 questionnaires were randomly distributed to students and staff of the University of Ibadan. The questionnaire was divided into two sections:

Section 1 assessed the impact of sustainable landscape planning on the well-being of students at the University of Ibadan while Section 2 determined the effects of sustainable landscape planning on the learning and assimilation of students at the University of Ibadan. Thereafter, the data collected were analyzed using hypothesis testing method. Hypotheses were formulated based on the described survey outcomes and statistical methods were used to test them. The key aspects of the data include student well-being, academic performance, mental health, stress levels, physical health, and connection to nature, as well as the overall impact of sustainable landscape planning on their learning experiences.

Results and Discussion

Hypotheses Formulation

Hypothesis 1: Impact on Well-being

Null Hypothesis (H_0): Sustainable landscape planning has no significant impact on the well-being of students at the University of Ibadan.

Alternative Hypothesis (H_1): Sustainable landscape planning has a significant positive impact on the well-being of students at the University of Ibadan.

Hypothesis 2: Impact on Academic Performance

Null Hypothesis (H_0): Sustainable landscape planning has no significant impact on the academic performance of students at the University of Ibadan.

Alternative Hypothesis (H_1): Sustainable landscape planning has a significant positive impact on the academic performance of students at the University of Ibadan.

Data Summary

1. Well-being:

- 76% rate the importance of landscape as 4 or 5.
- 94.7% affirm the positive impact on academic experience.
- 81.3% note improved mood or mental health.
- 88% state a decrease in stress levels.
- 80.7% agree that access to outdoor spaces positively influences physical health.

2. Learning and Assimilation:

- 85.3% believe green spaces positively impact their learning experience.
- 64.7% perceive the campus as conducive for learning.
- 72.6% believe incorporating sustainable landscaping is important for universities.

Hypothesis Testing

A one-sample proportion test was used to determine if the observed proportions are significantly greater than a baseline (e.g., 50% which indicates a neutral effect).

Test 1: Impact on Well-being

Using the data, the Z-score for the proportion test was calculated and compared with the critical value for a given significance level ($\alpha = 0.05$).

$$Z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

Where:

- \hat{p} is the sample proportion.
- p_0 is the null hypothesis proportion (0.5).
- n is the sample size.

Data for Well-being:

1. Improved mood or mental health: 81.3% (0.813)
2. Sample size: 50

Calculations:

$$Z = \frac{0.813 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{50}}}$$

```
python

import math

# Given values
p_hat = 0.813
p_0 = 0.5
n = 50

# Z-score calculation
z_score = (p_hat - p_0) / math.sqrt((p_0 * (1 - p_0)) / n)
z_score
```

Test 2: Impact on Academic Performance

Data for Academic Performance:

1. Positive impact on learning: 85.3% (0.853)
2. Sample size: 50

$$Z = \frac{0.853 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{50}}}$$

```
python

# Given values for academic performance
p_hat_academic = 0.853

# Z-score calculation for academic performance
z_score_academic = (p_hat_academic - p_0) / math.sqrt((p_0 * (1 - p_0)) / n)
z_score_academic
```

The Z-scores were interpreted by comparing them with the critical value from the Z-table for $\alpha = 0.05$ ($Z = 1.645$ for a one-tailed test).

Summary of Results

- a. If $Z > 1.645$, we reject the null hypothesis in favor of the alternative hypothesis, indicating a significant positive impact.
- b. If $Z \leq 1.645$, we fail to reject the null hypothesis, indicating no significant impact.

To calculate the Z-scores for both hypotheses testing,

Well-being:

$$Z = \frac{0.813 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{50}}}$$

$$Z = \frac{0.813 - 0.5}{\sqrt{\frac{0.25}{50}}}$$

$$Z = \frac{0.313}{\sqrt{0.005}}$$

$$Z = \frac{0.313}{0.0707}$$

$$Z \approx 4.43$$

Academic Performance:

$$Z = \frac{0.853 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{50}}}$$

$$Z = \frac{0.853 - 0.5}{\sqrt{\frac{0.25}{50}}}$$

$$Z = \frac{0.353}{\sqrt{0.005}}$$

$$Z = \frac{0.353}{0.0707}$$

$$Z \approx 4.99$$

- a. For Well-being: $Z \approx 4.43$
- b. For Academic Performance: $Z \approx 4.99$

Both Z-scores are significantly greater than 1.645, so we reject the null hypothesis for both hypotheses, indicating a significant positive impact of sustainable landscape planning on the well-being and academic performance of students at the University of Ibadan.

Conclusion

The statistical analysis highlights the positive perceptions and significant impacts of sustainable landscape planning on students' learning experiences at the University of Ibadan. The data suggests that enhancing green spaces and sustainable landscape features could further improve student well-being, academic performance, and overall campus satisfaction. The findings advocate for increased investment in sustainable landscaping to foster a conducive and productive educational environment.

Conflict of interests

The authors declare no conflict of interest.

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AI IN WEALTH MANAGEMENT AND WELTHTECH

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Abstract: The main idea of the paper is researching AI and other technologies for Wealth Management. Implementation of the AI in WealthTech helps in giving the best investment advises. Wealth Management includes retirement planning, inheritance tax, estate planning, and other activities according to investment preferences. WealthTech aims to manage investment funds and assets more efficiently, accessible, and personalized through data-driven insights and smart automation. Besides improving their efficiency, WealthTech aims to automate investment and wealth management services. WealthTech utilizes innovations like blockchain, artificial intelligence, and machine learning to improve investment decisions combining technologies for fund transformation and asset handling. These technologies include a wide range of solutions and include robo-advisors, social trading, robot-retirement, quant advisors, and micro-investing. This approach use the best technology solutions more advanced than typical analysis used in financial institutions. WealthTech AI applications are developed to create wealth data dashboards tailored to the clients needs. The applications enable clients to see full and transparent picture of their entire wealth and visualise wealth maps and data-driven analytics to uncover valuable investment insights. The aim of the applications is to convert diversified investment portfolio in clear reports and graphs. Because of the advancements in AI, the programs provide personalized advice concerning wealth management and business strategies. The Manuscript will present WealthTech solutions on the practical example and recommend the most attractive investment opportunities on the global market.

Keywords: Blockchain Technology, Healthcare Ethics, Patient Privacy, Data Ownership, Decentralized Governance

Introduction

Wealthtech refers to providing digital solutions that facilitate the wealth management process and automate wealth management services using AI and other technologies for improving their efficiency.

The wide range of solutions under this umbrella term includes robo-advisors, social trading, robo retirement, quant advisors, and micro investing. A key difference between this concept and fintech is that the latter involves catering to a diverse client base.

Theoretical Background

Information-based investments are rapidly growing, especially in the financial and banking sectors [1] For high-tech companies, competitiveness among firms may lead to diversified innovation for a single product, which in turn, may make patent portfolios more complex and difficult to understand by investors [2]

With the deepening integration of internet technology and the financial industry, FinTech has offered the public innovative financial services [3] such as online payment, peer-to-peer lending, budgeting and financial planning, crowdfunding, and savings and investments. [4]

Financial inclusion encompasses various efforts aimed at guaranteeing that individuals and businesses can obtain cost-effective and appropriate financial products and services. This encompasses the

provision of savings accounts, credit facilities, insurance coverage, and payment services, along with other financial instruments that facilitate individuals in effectively managing their finances and enhancing their economic welfare. FinTech can positively impact overall traditional financial inclusion because it enables banks to easily reach populations with limited access to banking services or without bank accounts through the use of digital platforms [5]. The rapid growth in cryptocurrencies has led them to garner investors' interest as a popular diversification choice [6,7,8, 9].

WealthTech is recognized as a specialized subset of FinTech. It focuses on utilizing digital technologies to enhance investment and client portfolio management, providing customized products and services tailored to individual needs [10, 11].

FinTech is being used to attract traditional banking clients, optimize commercial transactions, improve credit granting, and simplify banking operations. Financial services are thus being automated, resulting in a correspondingly necessary and accelerated process of transformation. Among the technologies used in this process are big data, blockchain, artificial intelligence, machine learning and cryptocurrencies [12].

The issue of financial exclusion continues to be an important barrier to equitable development in the global financial landscape, even with all the economic progress we are seeing around the world. [13]

Individuals can now do their financial transactions anytime, anywhere, thanks to FinTech platforms [14]. FinTech relates to the usage of technology to deliver better financial services [15, 16, 17].

FinTech studies mainly concentrate on the implication of FinTech for bank performance [18, 19] or risk-taking [20]. FinTech is a term that has arisen in recent years; it refers to innovative technologies designed to enhance and automate the provision and utilization of financial services [21].

The term FinTech refers to the convergence of finance and technology, with an emphasis on the development of new and improved financial solutions [22,23]. FinTech tools provides consumers with easy access to financial services, fast and easy confirmation of financial transactions, and reduced operational costs [24].

The rapid growth of FinTech adoption and usage has introduced innovative solutions that offer convenience, efficiency, and accessibility [25, 26]. FinTech refers to innovative financial services that use technology to create disruptive new trends in services or rewrite financial services to make them more valuable, reasonable, and secure [27,28, 29].

WealthTech is recognized as a specialized subset of FinTech. It focuses on utilizing digital technologies to enhance investment and client portfolio management, providing customized products and services tailored to individual needs [10, 11].

Artificial intelligence is a pivotal technological advancement that seeks to replicate human cognitive functions through machines and data analysis [30]. Using artificial intelligence in finance means that it can identify, analyze and adjust changes in data patterns on its own.

AI-driven platforms facilitate trade finance access by analyzing non-traditional data points, supply chain data, and payment histories. These platforms provide more inclusive and accurate credit assessments, benefiting underrepresented businesses such as SMEs and closing the financing gap [31].

WealthTech

WealthTech combines wealth management and technology to transform how funds and assets are handled. It utilizes innovations like artificial intelligence, machine learning, and blockchain to improve personal finance and investing. WealthTech developers build applications that automate manual wealth management processes and provide customized financial recommendations powered by AI.

Wealthtech refers to the delivery of an extensive range of financial services for wealth management via digital means. This technology improves investors' decision-making and enables people to manage their finances efficiently in a manner that is different from how conventional financial institutions work. Because of

the advancements in software as a service (SaaS), big data, AI, machine learning, etc., software programs can now provide personalized advice concerning wealth management. Image 1 shows example of Wealth Management application.

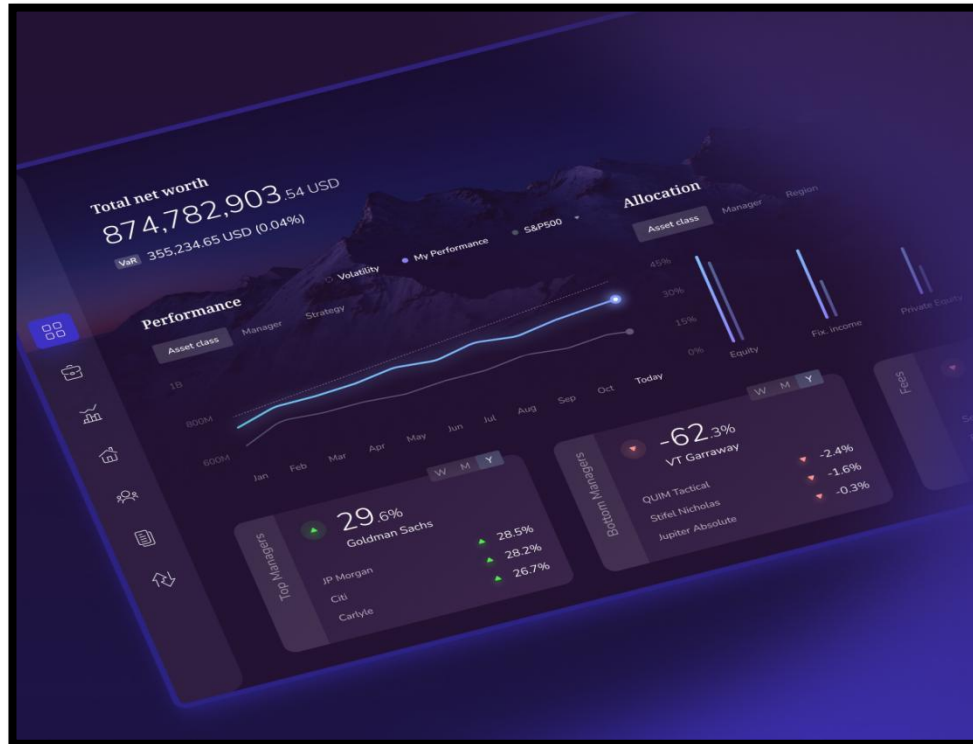


Image 1: Wealth Management application (Source: theuxda.com)

Some noteworthy wealthtech solutions and services are as follows:

Robo-Advisors: These are digital tools often utilizing machine-learning-based techniques to carry out operations for the client or the user. Such software can automatically allocate funds to different financial instruments based on how a user configures it.

Quant Advisors: These are extensions of robo-advisors. Such systems actively utilize AI for managing investment strategies.

Robo Retirement: These are a version of robo-advisors and are quite popular. Robo retirement services involve creating retirement portfolios, managing assets, recommending computer system-generated plans, and providing strategies.

Micro Investing: These solutions enable investing via small credits or microcredits. They provide a more interactive experience compared to robo-advisors.

Social Trading: It allows investors to share their own trading experience. It combines the concept of social media with that of trading platforms. In this case, traders are able to mimic the investment models of traders who share their opinions. Hence, novice traders can learn from traders who have more experience.

This subcategory of fintech covers more solutions and services, such as the following: Digital brokers, Algorithmic trading, B2B software services, Online marketplaces, Portfolio management tools and Risks.

WealthTech AI

A recent Gartner report projects the global AI in wealth management market to grow at a CAGR of 23.8% from 2022 to 2027, highlighting the significant rise of these technologies. Image 2 presents US WealthTech Market with prediction until 2030.

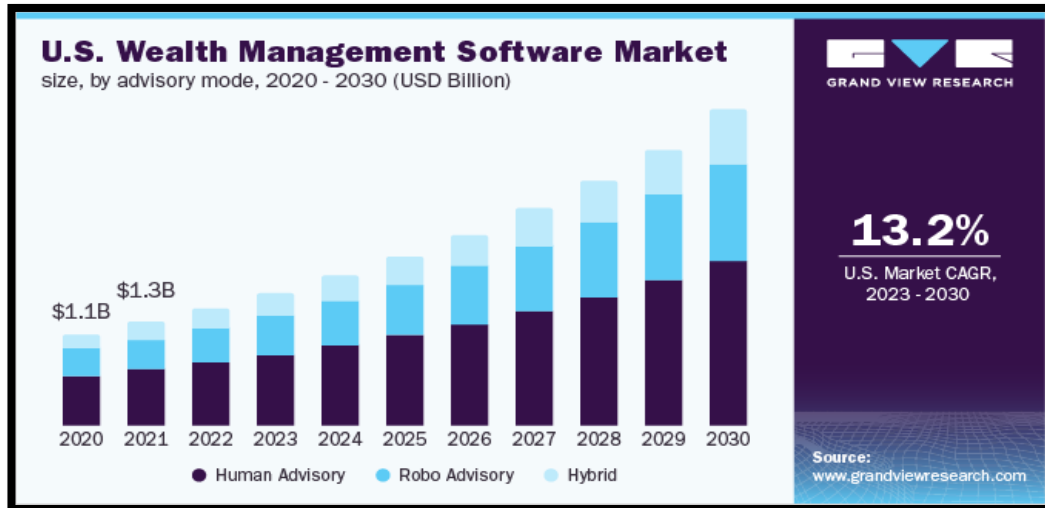


Image 2: US WealthTech Market (Source: www.sphereinc.com)

WealthTech AI solutions are tailored for businesses, specializing in translating technological trends into practical and commercially viable applications. Our expertise spans large language models, intelligent automation, time-series forecasting, predictive analytics, search technology, and sophisticated data strategy, architecture, and management. WealthTech mobile application is presented on Image 3.

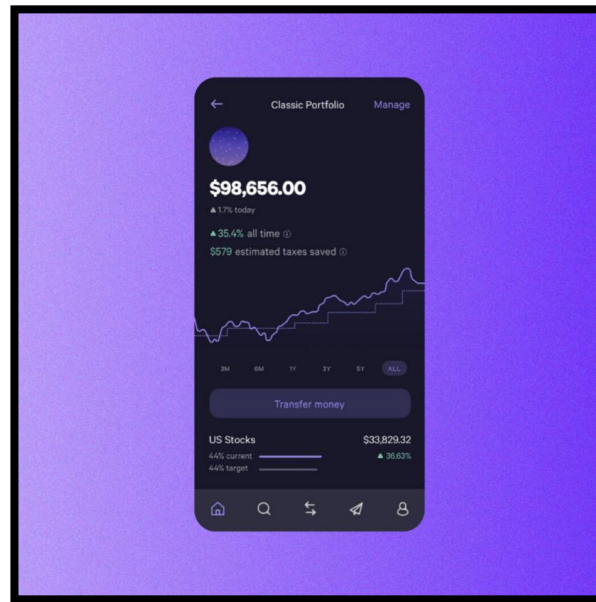


Image 3: WealthTech Mobile Application (Source: Wealthfront)

The future AI-powered landscape for wealth management companies could shape up as follows:

1. **Personalized Financial Planning:** By analyzing a client's financial history, spending habits, and investment preferences, genAI can help advisors create highly personalized financial plans that evolve as the AI continues to learn from the client's financial behavior and changing market conditions.

2. **Risk Assessment and Management:** Financial advisors can recommend tailored strategies for risk management based on the client's specific situation, helping to safeguard their investments and financial health.

3. **Real-time Market Insights:** GenAI can process market data in real-time, providing financial advisors with up-to-the-minute insights to advise clients on immediate actions, such as buying, selling, or holding assets based on current market conditions.

4. **Predictive Analytics for Financial Products:** GenAI can predict which financial products or services a client might need in the future, based on a comprehensive understanding of the client's financial journey and goals, as well as their past interactions with financial products.

5. **Automated Portfolio Management:** Machine learning models can build and manage investment portfolios using predefined rules and objectives, automatically rebalancing portfolios to optimize performance and manage risk based on real-time market conditions.

6. **AI-powered Customer Interactions:** AI-powered chatbots can handle routine customer inquiries and assist with account management, allowing financial advisors to focus on more complex or strategic tasks and improving overall customer experience.

7. **Regulatory Compliance:** AI systems can monitor real-time data and communications, flagging potential compliance issues and alerting financial advisors to investigate or take action, helping to mitigate risks and ensure regulatory compliance.

8. **Reducing Back-Office Tasks:** AI can significantly reduce the workload of back-office tasks such as data processing, document management, and administrative support, thereby increasing operational efficiencies and allowing staff to focus on higher-value activities.

Share and Maintain Corporate Knowledge: Corporate knowledge agents use AI to manage and optimize the flow of information within the company, ensuring that decision-makers have quick and easy access to accurate and relevant data. This enables more informed decision-making and improves overall corporate governance. (Source: www.sphereinc.com). Image 4 presents AI Driven WealthTech Solutions.

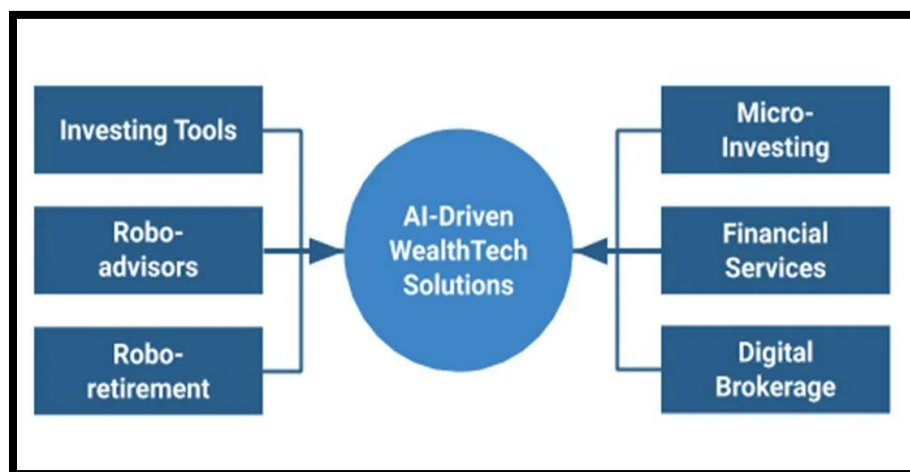


Image 4: AI Driven WealthTech Solutions (Source: longevity.technology)

Conclusions

By adopting these technologies, both managers and clients benefit from enhanced services and better outcomes. WealthTech marks an exciting shift towards more user-friendly, effective wealth management software development.

Conflict of interests

The authors declare no conflict of interest.

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ONTOGENESIS OF CLEAR IMAGE: CONTEMPORARY TELEVISION AND FILM PROGRAMMING ON RADIO TELEVISION OF SERBIA IN THE DIGITAL AGE FROM AN EDITORIAL PERSPECTIVE

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Abstract: This paper examines the transformation of television production, specifically focusing on film programming within the digital environment from an editorial perspective at Radio Television of Serbia (RTS). The study delves into the transition from traditional analog broadcasting, where a single film was aired once a week, often a western, to the complexities of modern digital television production, which incorporates advanced organizational and technical skills, as well as the integration of contemporary technologies in program realization. The research highlights the increasing importance of editorial work in creating diverse and engaging content that caters to various demographic groups, with a special focus on the responsibilities of editors in shaping program quality and audience engagement. As television production has evolved into a leading creative sector, it now encompasses a wide range of genres, multimedia content, and interactive media, reflecting significant changes in both cultural and organizational strategies within the media landscape. The paper also explores the impact of globalization, technological advancements, and changing cultural policies on the development of national public service broadcasters like RTS. It discusses how these institutions have adapted to the challenges posed by a rapidly changing media environment, such as the increasing demand for efficiency, the expansion of content, and the inclusion of marginalized social groups in the programming. Through the examination of editorial practices in contemporary film programming, this work aims to offer insights into the evolving role of editorial decisions in shaping television content, as well as their contribution to the broader cultural and educational objectives of public broadcasting in the digital age.

Keywords: Television production, editorial work, digital environment, film programming, organizational development, cultural policy, public service broadcasting, audience engagement, multimedia content, digital broadcasting, media evolution, programming strategy, editorial creativity, technological advancements.

Introduction

Radio Televizija Srbije (RTS), as the oldest and most influential television station in Serbia, represents a key institution in the history of the country's media landscape. With its long-standing tradition, RTS has maintained a loyal audience and continues to hold a dominant position in overall viewership, even as the digital age has reshaped media consumption habits. However, the changing dynamics of the broadcasting industry, marked by the rise of cable channels and on-demand streaming platforms, have also influenced the prominence of traditional television programming, particularly film content. Research indicates that RTS's film programming, once central to its identity, no longer holds the same level of significance in determining ratings as it did during the tenure of former film program editors Robert Nemeček (2004–2007) and Ivan Karl (2007–2013).

The editorial shifts during this period are intrinsically linked to the leadership of the late Aleksandar Tijanić, whose mandate as the general director (2004–2013) oversaw the transition of RTS from a public enterprise to a public media service. This transformation, which entailed significant technical and

organizational changes, coincided with a broader media environment shaped by digital advancements. The 2007–2011 period, often referred to as the third "golden era" of RTS, was marked by the digitalization process, the renovation of technical infrastructure, and the restoration of cultural landmarks such as the Avala Tower. These changes facilitated the expansion of RTS's reach and enhanced its capacity to deliver content that met international standards, as evidenced by Serbia's successful hosting of the Eurovision Song Contest in 2008. This achievement symbolized RTS's ability to maintain its competitive edge in a rapidly changing media environment, aligning with global trends while retaining its cultural and national identity.

At the heart of RTS's programming success during this era was its film content, which saw a significant increase in viewership. This was especially evident during Nemeček's tenure, when the station enjoyed higher production budgets and greater programming flexibility. Nemeček, drawing from his prior experiences at TV Pink and TV Politika, curated a film schedule that emphasized popular cinema, which resonated with a broad audience. While RTS was never a network focused exclusively on films, it became synonymous with high-quality movie programming that appealed to a diverse viewership.

In contrast, Ivan Karl's tenure as editor came at a time when RTS faced financial constraints, as the country experienced a decline in the collection of mandatory television subscriptions. Despite these challenges, Karl's editorial approach sought to revive and enhance RTS's film programming by reconnecting it to the rich tradition of TV Belgrade, particularly under the leadership of Nebojša Đukelić. This return to familiar formats such as *Letnji bioskop* (Summer Cinema), *Zimski bioskop* (Winter Cinema), *Oskarovci* (Oscar Winners), and *Festove premijere* (Festival Premieres), alongside the introduction of new cycles such as *Festival Festival*, reflected a strategic effort to maintain the station's prominence in a competitive media landscape. (Bjelica, 2007)

The years 2008–2012 marked the peak of RTS's film viewership, with iconic films like *Con Air* and the domestic comedy *Druga Žikina Dinastija* achieving unprecedented ratings, with viewerships reaching 18.9% and 26%, respectively. Bjelica (2007) emphasizes that public broadcasters play a key role in shaping the film industry and television, as they produce content that serves the interests of a wide audience, rather than just commercial objectives. In the context of Serbia, public broadcasters face the challenge of maintaining content quality in the digital environment.

These numbers, unparalleled in contemporary media, underscore the station's historical role as the leader in Serbian film broadcasting. However, by 2024, the landscape has shifted, with RTS facing a more fragmented audience base due to the diversification of content delivery platforms and viewing habits.

This study examines the evolution of RTS's film programming from its peak in the late 2000s to its current state in 2024, analyzing the challenges and strategies employed by RTS in adapting to the digital age. The research focuses on the editorial decisions of Nemeček and Karl, the impact of digitalization on film content, and the broader implications of these changes for RTS's role in the cultural and media landscape of Serbia. The analysis will also explore how RTS navigates the intersection of tradition and innovation in an era where the global shift towards on-demand content threatens the relevance of linear television broadcasting. In doing so, this paper aims to contribute to the academic discourse on the evolution of public service broadcasters in the digital era, offering insights into how such institutions balance cultural preservation with the demands of technological and audience-driven change.

Transition to Digital Television: Technical and Organizational Transformation

The digitization of RTS, as part of the broader transformation of Serbia's media landscape, began in the late 2000s. This process, which involved upgrading technical capacities, introducing digital channels, and renovating infrastructure such as the Avala Tower, allowed RTS to compete with global trends in television production. The digital era opened new opportunities for the production, distribution, and display of film content. However, this technical transformation was not enough for RTS to maintain the same dominant

position in film production that it had before the digital revolution. The digital transformation of television brings significant technical and editorial evolution, which changes how content is created and distributed. DigiTV describes this as one of the greatest challenges for media organizations in contemporary society. During the digitalization process, editors must adapt their practices to meet the needs of new technologies and audience expectations. (DigiTV, 2020).

Editorial Strategy of Robert Nemeček: High Standards in Film Production

During the editorial leadership of Robert Nemeček (2004–2007), RTS's film program experienced its golden era, with film production and broadcasting becoming a central part of the editorial concept. Nemeček had significant resources and a wide range of time slots at his disposal, which allowed him to create a rich and diverse film program. Under his leadership, RTS's film program featured the most famous Hollywood titles, as well as European and domestic films, creating a program that appealed to a broad audience.

However, despite this success, Nemeček adapted the film program to his personal preferences for specific genres and themes, which did not always align with the social and cultural changes occurring in Serbia at the time. During his tenure, RTS became the center for screening film premieres and specialized programs but still did not focus its offerings on exclusive and specifically selected film programs, as some other specialized channels did.

Jovanović explores the challenges faced by the media industry in Serbia in the era of digitalization, emphasizing how the transition from analog to digital broadcasting requires a fundamental adaptation in infrastructure and programming strategies. This transformation process significantly impacts editorial work, particularly in balancing innovation with the preservation of traditional values." (Jovanović M., 2013)

Editorial Strategy of Ivan Karl: Maintaining Tradition and Adapting to New Circumstances

The period of Ivan Karl's editorial leadership (2007–2013) coincided with a time when financial difficulties began to affect RTS, and subscription revenue was declining. During this period, RTS's film program began to adjust to new economic conditions and the decreasing availability of production budgets. Ivan Karl worked to preserve the tradition and standards set by Nemeček, reintroducing some of the most popular formats, such as Summer Cinema, Winter Cinema, and Oscar Winners. Additionally, during his tenure, RTS hosted and broadcast popular series like "Prison Break" and "Desperate Housewives," and the film cycle "Half a Century of Bond" marked the fiftieth anniversary of the most famous film franchise of all time. (Službeni sajt RTS-a, 2007-2020)

Ivan Karl's editorial strategy focused on balancing the preservation of popular formats with adapting to new market conditions. Karl's task was to offer content that was widely accepted, while also balancing the declining financial stability and maintaining viewership, which was not easy to achieve in an era of reduced budgets and competition from cable channels.

Challenges in the Digital Age: Viewership and Editorial Decisions

During the 2000s and early 2010s, RTS (Radio Television of Serbia) maintained a prominent role in Serbia's television landscape, particularly through its film programming, which attracted significant viewership. However, as the digital era advanced, with the rise of new media platforms, streaming services, and specialized cable channels, RTS's influence began to wane. This shift brought with it an increasing fragmentation of the television market, as more niche genres, such as film, culture, and documentaries, found

dedicated spaces on various platforms. This development created greater competition for viewers, forcing traditional broadcasters like RTS to re-evaluate their programming strategies. A key question arose: how did editorial decisions regarding RTS's film programming influence its viewership during this digital transformation?

Thornham and Press explore the profound impact of digital television on audience consumption patterns. They highlight that the digital age has altered the media landscape in two significant ways: technologically and strategically. The technological advancements have revolutionized how content is delivered and consumed, while the strategic shift pertains to how content creators, particularly editors, must adjust to these new dynamics. Editors are no longer just responsible for curating content but must also manage the evolving relationship between viewers and the media they consume. Digital platforms have not only introduced new modes of viewing, such as on-demand and mobile viewing, but have also led to more interactive audience behavior, making it imperative for editors to engage audiences in new ways. According to Thornham and Press, editors in the digital age must rethink their editorial decisions, ensuring that content is both adaptable and engaging to a more fragmented and diverse audience. (Thornham, H., & Press, A., 2009)

Jenkins, in his book *Convergence Culture: Where Old and New Media Collide*, extends this argument by examining the concept of media convergence—where old and new forms of media intersect and create new patterns of content production and consumption. Jenkins contends that the blending of traditional television, the internet, and mobile platforms has given rise to a more participatory culture. (Jenkins, H., 2006).

Audiences no longer passively consume content; they are active participants who engage with content across multiple platforms. This convergence requires editors to rethink not only the content they produce but also how they interact with their audiences. In the context of RTS, this would mean adapting to the demands of a more tech-savvy and platform-diverse audience. Jenkins argues that this shift calls for editors to create content that is flexible and transmedia-friendly, allowing for a seamless viewing experience across different devices and formats. Furthermore, editors must be prepared for an audience that has access to a much broader range of content options, making it essential to build loyalty and maintain relevance in an increasingly competitive landscape.

The challenges posed by the digital age are thus multifaceted. Editors working in traditional broadcasting institutions like RTS must navigate technological advancements, shifting audience expectations, and the pressures of competing with digital-native platforms. The impact of digitalization is not just about improving broadcast quality or technical infrastructure; it's about adopting a new mindset that embraces interactivity, responsiveness, and adaptability. The editorial decisions made in response to these challenges will play a crucial role in determining the future success of RTS's film programming and its ability to connect with a modern, dynamic audience.

Competition

The business of television consists of conceiving programs and providing an opportunity for viewers to watch these programs. As the supply chain illustrates, it covers a range of separate businesses that come into focus in the era of convergence among contemporary technologies. The uncertainty of organizations within the television industry regarding their positioning in the market has led to various strategies and a series of shifting alliances. For example: TV B92 is the only channel that airs movies during prime time, while TV PINK has developed its own special movie channels based on the themes of the films (Pink Action Movies, Pink Romantic Movies, Pink Science Fiction, etc.), and TV PRVA has moved its movie programming to TV PLUS.

"Van Zoonen, in 'Digital Television: A Critical Introduction,' discusses how digital television is reshaping the media landscape, particularly with regard to changes in content production and distribution. She emphasizes that the digital era allows for greater accessibility and flexibility of content, but also introduces new editorial challenges in terms of program selection and curation." (Zoonen, L. Van, 2018)

There are many cable movie channels, ranging from pay channels like HBO to free cable channels such as FOX MOVIES, CINEMANIA, TV 1000, and CINESTAR.

On a daily basis in Serbia, if all available channels are counted, viewers can watch about 100 movies on television. The new era brings new conditions regarding network passage, as technological advancements have led to a direct connection between TV stations and consumers, viewers, and subscription-based access management systems, allowing only those who have paid for a subscription to view the corresponding signal.

The conventional movie program is gradually dying out. Despite the modern age and digital signal, which further facilitates programming, unfortunately, we are left with an unattractive selection of films.

Improvement of societal norms and the value system, in order to maintain good communication within Serbia's public service, would be an ethically and socially responsible task. This would help minimize the negative impacts of all demands on the public service, not just for the curation of film programs but also for the management as a whole.

Channels that target a broad audience, such as Prva, Pink, and B-92, might survive for some time. However, their ability to attract a large number of viewers and offer premiere drama series in prime time, as well as occasionally broadcast high-budget Hollywood classics, might begin to decrease over time, given the rise of specialized services that subscribers of cable operators are willing to pay for.

As a result, RTS, nevertheless, survives and remains the longest-standing national television with a solid brand. However, since there is evidence of inertia among younger viewers, who are less influenced by tradition, it seems that the younger generation will likely opt for a series of separate cable channels to meet their needs.

RTS has a certain advantage over its competitors due to sports events, as sports are considered to be the precursor to all other genres and set viewing records. Additionally, RTS has a significant advantage when it comes to broadcasting international events at the national level, such as the already mentioned Eurovision. The long-term result of this could be higher quality programming as channels begin to compete for viewers, although there is a high risk of a drastic decline in program quality, as a small number of viewers are unable to sustain high-budget productions.

The Internet as the Most Dangerous Competitor

The biggest challenge for media over the past decade, growing stronger day by day, is the influence of modern information technologies. Many television workers fear that the television we know today could disappear in the next twenty years. When it comes to movie programming on television, the internet is becoming a serious competitor. This is because piracy is increasing, and the latest pirated films can be easily found on platforms like Torrent, YouTube, Leptirica, etc.

In the past, pirated movie copies were of unacceptable and poor quality, but today, thanks to advanced technologies, the latest films can be viewed in exceptional quality online. In such cases, when TV stations announce a tender for purchasing films from independent productions, they tend to choose hit movies that are not available on internet portals, and a special clause in the contract stipulates the rights and obligations of both parties. TV stations can purchase broadcasting rights for a film, sometimes even for up to three years.

Therefore, the biggest threat to TV stations is the global network — the internet. Some companies and platforms provide legal streaming services, allowing viewers to watch multimedia content, films, and series

online. Year after year, advertising revenue for TV stations continues to decline. It is estimated that advertisers will soon invest their money primarily in digital and internet platforms.

The internet is consuming the media. Daily and periodical print media have already been overtaken by radio in some ways, and the next target will be television, with films being the sweetest prey. There are already announcements that Hollywood will soon allow viewers to pay a fee to watch films online, simultaneously with their release in theaters.

Forming the Film Program on RTS

When it comes to the movie program on RTS, the film program editor is solely responsible for the content, meaning the selection of films. The key to any television program is the ideas and the team that implements them through their creative efforts. The essence of the editorial role is knowing precisely what should never be included in the program, to protect viewers from bad and vulgar content, because only by doing so do viewers gain trust in the editor, who ultimately benefits the television station the most.

It is a misconception that having the most blockbuster movies in the program is the most important. It is much more important that there are no "waste films" in the program. Movie "waste" repels most viewers from the TV screen, which is unfortunately the most common scenario today. It is a fact that there are films, especially American ones, made for an audience that is not American. Themes like violence, blood, pedophilia, drug addiction, and violent disruptions of the value system are becoming the basic content of films coming from the West.

However, the primary role and duty of the film program editor is to choose films to be shown on television, while respecting the moral codes and traditions of our region. The editor must consider the film's content and their own personal experience before it is broadcast to the public because, unfortunately, a lot of inappropriate content is aired "out of ignorance," especially for the generations who are still shaping their life values.

Televisions have created an alibi for broadcasting trash, hiding behind the phrase "viewers like to see this" and supporting it with ratings, instead of acknowledging how many people were actually not in front of the screen during the airing of such trash because it offends them. A particular problem is the personal preferences of the editor, which can further undermine the programming process by replacing the thesis that viewers want to watch what, in reality, the editor and their inner circle of colleagues and friends want. This happens too often, and such projects typically have poor ratings, but that is no obstacle for certain editors to continue with them since viewers do not have an objective influence on the programming policy.

Film programming on television, especially in the editorial sense, has been cast adrift and left to chance. For example, one program aired a children's film at midnight — "Free Willy" — which is about a whale, but not a killer whale, just a kind-hearted one. The proper time for such a film would be 10 AM. Similarly, I have seen a film like "Cell" about a necrophiliac murderer, airing at 8 AM on a Saturday. On another channel, a film called "Clip," which is a domestic production with festival success but classified as 18+, aired at 10 PM. It should not have been shown before midnight. There are many such inconsistencies on all channels, which indicates that the potential of films is not being treated properly.

Despite everything, the film program on RTS has had over five thousand film slots, ranging from big Hollywood hits, Oscar winners, new Serbian films, to retrospectives of selected filmmakers and showcases of world cinematographies such as German, French, and Chinese.

RTS also aired the best works of filmmaking giants like Ingmar Bergman, the Czech school, Quentin Tarantino, Jim Jarmusch, Ang Lee, Woody Allen, David Cronenberg, Bernardo Bertolucci, Michael Moore, Luc Besson, Krzysztof Kieslowski, Pedro Almodóvar, and Alfred Hitchcock.

On an annual basis, through thirty series, RTS broadcast quality BBC drama in 2014, new Russian and Italian productions, and popular American franchises. For younger viewers, RTS also dubbed 250 hours of animation from the Disney studios into Serbian and continues its tradition of Winter and Summer cinemas.

RTS is the only public service in the region that has specially dubbed films for the blind and visually impaired, which is highly commendable. RTS regularly covers domestic film festivals (FEST, Kustendorf, Kratki Metar, Sinema City, Vrnjačka Banja, Film Encounters Niš) and international ones (Berlin, Cannes, Venice), and broadcasts the Academy Awards ceremony live. "McQuail, in his work 'Mass Communication Theory,' analyzes the key processes shaping the relationship between media and society, with a particular focus on the impact of digital media on traditional forms of communication. According to him, digitalization allows for greater interactivity and personalization of content, posing new challenges for editors who must balance commercial and public interests." (McQuail, D., 2010)

There is even a section on RTS's website called "Ask the Editor," designed for better communication with their loyal viewers. Despite the digital age and modern technology, RTS's film program continues to have a better rating in comparison to other broadcasters.

Conclusion

The digital transformation of RTS has posed both technical and organizational challenges, reflecting broader trends in the global media landscape. The shift to digital television in the late 2000s was not merely about upgrading technical infrastructure but also about adapting editorial strategies to the evolving media environment. While the technical improvements, such as the renovation of infrastructure like the Avala Tower and the introduction of digital channels, allowed RTS to remain competitive, they were not enough to preserve the station's dominant position in film production as it had enjoyed before the digital revolution. "Vuković (2015) examines how the digital transformation of television in Serbia brings new challenges, including the adaptation of production teams and editors to new technologies and content formats. He specifically highlights the need for further education for editors to effectively use digital tools and format content that meets the new standards of the audience." (Vuković J., 2015)

Under Robert Nemeček's leadership (2004-2007), RTS's film programming reached its peak, becoming a central element of the station's editorial strategy. Nemeček's substantial financial resources and a wide range of available time slots enabled him to curate a rich and diverse film schedule that included both Hollywood blockbusters and European and domestic films. However, despite this success, Nemeček's editorial choices were sometimes out of step with the rapidly changing societal and cultural dynamics in Serbia. While RTS continued to showcase major film premieres and specialized programs, it struggled to compete with the emerging specialized film channels of the digital era.

In the following period, under Ivan Karl's leadership (2007-2013), RTS faced mounting financial difficulties as subscription revenues declined. Karl's strategy focused on preserving Nemeček's legacy by reintroducing beloved formats such as Summer Cinema, Winter Cinema, and the "Oscar Series." However, the digital age brought increasing competition from cable channels and specialized broadcasters, resulting in a fragmented television market. Karl's challenge was to balance popular content with the new economic and technological realities.

The onset of digitalization further complicated RTS's position within the media landscape. With the rise of new media platforms and the proliferation of niche channels, RTS's dominance in viewer ratings began to wane. The increasing number of specialized TV stations focusing on specific genres, such as film

and culture, further fragmented the market, making it harder for RTS to maintain its previous levels of audience engagement. The editorial decisions made by Nemeček and Karl, while successful in some areas, were not fully adapted to the technological advancements and shifting audience preferences that characterize the digital era.

The challenges faced by RTS reflect a broader global trend: the need for public broadcasters to adapt to a highly competitive, digitalized media environment. RTS, like other public broadcasters, had to balance its role as a cultural institution with the need to remain commercially viable amid budget cuts and growing competition from private and international broadcasters. While RTS managed to retain its relevance by adjusting certain programming formats, the larger challenge of maintaining high viewership and relevance in the face of digital transformation remains ongoing.

In conclusion, the digital era has presented both opportunities and challenges for RTS and other public broadcasters worldwide. The key to future success lies in balancing traditional public service goals with the demands of an increasingly fragmented digital media landscape. RTS must continue to innovate in both technical and editorial strategies, providing unique content that resonates with audiences while exploring new ways to engage viewers in a digital-first world. The future of RTS will depend not only on its ability to adapt to technological changes but also on its capacity to navigate the complex social, cultural, and economic challenges of the modern media environment.

Conflict of interests

The authors declare no conflict of interest.

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SYNTHESIS OF ART AND MEDIA

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Abstract: This theoretical work deals with hybrid artistic practice and its determination by media and technology. As an inevitable example of thinking about art through the context of media, Vladan Radovanović is highlighted, who is the only theorist who systematically proposed a classification of art in relation to media. Through his theory of polymedia art, as an interdisciplinary form that synthesizes within itself various disciplines with the aim of achieving "total art," and the visionary thoughts of Marshall McLuhan on media, we will try to find an answer to the question of the possibilities and significance of media for the development of art. I will interpret hybrid artworks that have emerged from the integration of different media using the method of textual analysis and interpretation, which allows for their semantic, narrative, and sensory extension in the site, in which we will explain the significance of media possibilities in relation to art.

Keywords: media, technology, art, polymedia art, opera, film, digital, screen, spatial montage, perception, senses, progress

Introduction

In artistic practice, the way of externalizing content through an appropriate form, or through the medium that serves as a link between the work and the audience, is often questioned. Many authors are trying to improve their work and elevate art to a higher level by using new media and the possibilities it offers in expanding information and performing ideas. Art, media, and technology represent an inseparable trinity. What distinguishes traditional art from contemporary art is primarily the use of new techniques, digital technologies, and media as the main means of conveying information, expressing thoughts, and emotions. During the evolutionary progress of media and technology in the last century, there was also a sudden development of art, creating new artistic disciplines (film, photography, video art, etc.).

This has provided opportunities for the development of the artistic avant-garde. In today's age, when the progress of media and technology has reached its peak, the question arises whether this pace is accompanied by progress in art, or if perhaps a disbalance has occurred, as there are almost no new artistic disciplines. Thanks to media progress, today we have an integrated synthesis of art that encompasses film, photography, performance, TV, video, and sound-music. What attracts attention are certainly post-opera spectacles and expanded cinema - as some of the more complex forms of polymedia art. In the following text, we will address the classification of polymedia art and the significance of media as an expressive component, which allows the content of an artistic work to reach the senses of the recipient, as well as their influence on the perception of the work. We also address the relationship between media with unlimited possibilities towards the development of new hybrid forms in art.

Media in art

The media is a broader concept than the media of mass communication and can be understood in several different ways depending on the scientific, artistic, or social context. The word "media" comes from the Latin word "medius," which means "middle" or "between," and denotes an auxiliary means or channel through which something comes. In the theory of mass communication, this concept is defined as a material medium that, by transmitting a message, connects individuals and groups. In the context of mass

communication, the medium is not just the carrier of the message, but it is also part of the message itself, which fits into the well-known thesis of media theorist Marshall McLuhan that "the medium is the message" (Markovic D. 2010, pp 30). McLuhan primarily has in mind the environment of social communication, both classical and modern: speech, writing, press, radio, television. It implies technological means that replace and supplement the work of human organs and capabilities, tools, devices, weapons (Radovanovic D. 2010, pp2). McLuhan's understanding of media are significant for reflections on the future of art. Since our subject of interest is the media potential for the development of art, it is useful to note that contemporary art, in most cases, builds its unclear classification and division based on the media, the following terms are used in everyday usage: intermediate, multimedia, new media, expanded media, mixed media, transmedia, etc. Despite the poetic and aesthetic differences that dominate in these fields, they share a media and technological aspiration towards the development of art.

For pragmatic reasons, we accept the media classification of Vladan Radovanović as the most relevant and logical. Vladan Radovanović makes a general division of art based on sensory-media criteria. According to media criteria, all arts are divided into monomedia and polymedia.

The monomedia arts are: painting, sculpture, music, literature, poetry, photography, etc. The polymedia arts are: film, video art, theater, opera, ballet, performance, etc.

According to Radovanović, polymedia art involves the synthesis (into artwork) of several different media that differ from each other by:

- sensations on the senses (visual, auditory, kinetic, etc.)
- by the type of signs (distinction between speech and musical media within sound)
- by type of technology (materials, devices, signal carriers)
- and procedures (pigment, acoustic element, film, etc.)

According to Radovanović, all media in art should participate equally, but they should alternate in dominance.

Perception and integration of media

The sensory nature of media in art is best explained to us by the theorist and composer Michel Chion with the concept of audiovision- which in film, television, and other similar media represents a special kind of perception that arises in the audio-visual combination, when one perception influences another and changes it in the process. Or, as Michel Chion says: "We do not see the same thing when we listen at the same time and we do not hear the same thing when we look at the same time" (Šion M. 2007, pp 5).

Contemporary artistic practice aims for interdisciplinarity and multimedia creation—a synthesis of art, for example, increasingly combining poetry with visual elements (video, photography, performance), the so-called visual poetry (it ceases to be a monomedia art and begins to be a polymedia art that acts on multiple senses simultaneously).

The futuristic significance and need for polymedia art - as a synthesis of artistic disciplines within single artwork, emphasized by German composer and theater director Richard Wagner. He called such complex artistic forms the term "Gesamtkunstwerk" ("total work of art," "comprehensive art"). For him, opera was the best example of "gesamtkunstwerk", as it encapsulates: theater, music, dramaturgy, literature, painting, ballet, directing, etc.

Polymedia spectacl

As we pointed out, with the development of media and digital technologies, art is evolving, but in

modern times, this is happening in a different way (not as many new artistic disciplines are emerging as in the time of avant-garde) but innovative hybrid polymedia artworks are created. The development of media has significantly influenced opera (as a "Gesamtkunstwerk" - "total art"), best evidenced by the video opera "The Cave" and "Tree Tales" by composer Steve Reich and video artist Beril Korot. While in traditional opera the work is created in the order of libretto¹ - music - direction, in post-opera it "emerges as a performance and opposition of operatic signifiers simultaneously" (Novak J. 20026. Pp 23).

In the post-opera spectacle (video opera), the way of directing and composing is different. While creating the work, Korot and Reich are in different, electronically connected studios, and they send carefully measured fragments of musical and video documentary material to each other that "network" into the artwork.

The Tree Tales and The Cave is a post-opera, an opera after opera, or an opera after the completed history of opera. This work uses the media of film, photography, magazines, TV interviews, video, theater, and concerts simultaneously. This art work begins by highlighting the documentary potential of musical theater. The video "text" work is broadcast on multiple screens whose operation is coordinated and composed by the decisions of video artist Beryl. In the rhythm of the spoken words on the screen, titles and texts from the New York Times are "typed out." (Opera The Tree Tales). One of the most commonly used compositional techniques of these authors is the placement of verbal text on screens at the moment when the voices in the opera speak it.

The humanistic dimension of the work is reflected in the expanded use of certain screens that are used to clarify operatic events with verbal text, making video opera more accessible to the audience with hearing impairment (Opera The Cave). Such a function of artistic media that we use as "aids," as "extensions of human senses," refers us to Marshall McLuhan and his thesis is that the media have become extensions of man, , and they expand the spectrum of abilities (Makluan M. 1971, pp57).



Figure 1. Video opera's The Cave and The Tree Tales

However, what is the sharpest offense in the context of these two parts is the fact that the medium of opera has been significantly altered by the introduction of video and film in the world of opera, videos that have replaced the theater stage. The violation of the operatic order can also be found in the simultaneous live performance of the music ensemble with digitally reproduced with voices and sound effects. The screen has become a stage on which an opera is performed. Reich emphasizes that it is the "main theatrical action on screen" ² The screen is divided (split screen) - it itself becomes a collage of different screens, where the

¹ A libretto is a textual template based on which a musical stage work is written.

² "The main theatrical action is on the screen" Steve reich, u David Allenbi, A tether of ideas, Steve Reich and Beryl

multiplication of information occurs. Split screen is a technique with great possibilities that has the power of dynamically displaying temporal and spatial simultaneity, the possibility of direct comparison of two presented objects/events or more.

The video opera's works of Stiv Reich and Beriyl Korot stand out as complex polymedia forms—between film with music, video art with music, television shows, and opera, and printed media (press). By integrating different media in the post-opera section that aims to expand the boundaries of opera art, there is an expansion of human consciousness. The audience participates more actively perceptively, connecting various cultural texts with the context of the work and the nature of the media.

Media extension of film

The extent to which the development of art is conditioned by the development of media and technologies is evidenced by film art. The improvement of registration media (cameras - which operate on the principle of the human eye, as a "technological extension of human senses"), the projector and later the sound equipment, the film standardizes the speed of image/frame projection- It gains a stable time dimension of duration, the ability to listen to human speech, the ability to see colors, and the expansion of the image in space using multiple screens.

At the beginning of the 20th century, even though cinema was just a newly born art form, some authors already understood the power of new media and began to experiment with cinematic aesthetic form. Avant-garde French artist Abel Gance is the first person in the history of art to film the media-extension feature film "Napoleon" (1927) simultaneously with three cameras, from three different perceptual angles and projected it simultaneously on three screens. "With multiple screens, the audience was given an evolutionary task - to follow the events simultaneously on multiple screens , and thus there is a spread of information and a deeper experience of the work of art. It was a unique media spectacle far ahead of its time. At that time, such a media spectacle required the application of complex techniques on film, such as spatial montage (split screen and coordination of multiple screens), multiple exposures, monochromatic texture of the image, as well as simultaneity of display on polymorphic screens" (Agel H. 1962, pp 18). It required much more work, money, and time than would be necessary today.



Figure 2. Napoleon movie

The technical innovation of this part consisted of simultaneous recording using three cameras that they capture the same character, object, or event from three different angles. The triple screen provided the possibility of composing and editing different movements and dramatic situations. within the frames that are shaped into a unique visual whole, as well as the possibility of achieving an attractive visual counterpoint. The main action is usually displayed on the central screen, while the other two were for simultaneous

Korot on Tree tales, CD/DVD booklet, nonesuch 7559-79835-2, 2003.

information supplementation, visualizing the same scene from different perspectives. This filming and editing technique (discovered in 1926), which aims to media-expand film in space, Abel Gance called the technique of polyvision³.

At the moment he is finishing the film (1927), Gance writes: "The boundaries of space and time will be erased by the possibilities of a polymorphic screen that adds, creates and multiplies the image as desired by the creator or as artistic reasons require. The omnipresence of the action. The omnipresence of time and age. The past, present, and future merge into their own destruction" (Angel H. 1962, pp18). The main technique from Gance's polyvision that successfully connects various spaces and times within the frame and directly enables the depiction of the simultaneity of events is spatial montage- montage within the frame. It involves the use of a divided (polymorphic) screen and the process of applying multiple exposures (superimposing transparent multiple images), At moments, with the desire to fill the screen with as much information as possible.

This media expansion of images in space using multiple screens provides the viewer with the opportunity to expand their own perception, as the medium is considered a "technological extension of human senses." (Makluan M. 1971, pp 57). This statement largely agrees with the theory of Gene Youngblood, which states that film functions as human consciousness, or that "film is an extension of human consciousness" (Youngblood G. 1970, pp 159).

Media theorist and digital arts expert Lev Manovich (Лев Манович), in his book "Metamedia," discussing montage and new technologies, states that there are two basic types of film montage in the 20th century "time montage" and "spatial montage, which is referred to as montage within the frame. Time montage enables the process of alternating images of different realities: one after the other, in a temporal sequence. This editing technique is widely used, defines conventional, "standard" film, and is most commonly used in practice. According to Manovich, temporal editing is not an efficient enough method, as "the representation of each additional piece of information requires a certain amount of observation time, which slows down communication" (Manovič L. 2001, pp 65-67). The second type of montage, which Manovich considers more efficient, is spatial or montage within the frame, and it implies the coexistence of different realities within the same frame, the use of split screens (which appeared as far back as 1908), the technique of multiple exposure, as well as the use of multiple screens. In the past, the realization of montage within the frame (spatial montage within a split screen) was an expensive and complex process, which is why this technique was only used fragmentarily in films, rarely and exclusively for dramatic purposes, while today, with the use of digital technologies, the process of creating such a collage film composition is much more accessible to artists.

We also encounter spatial montage (split screen) in other media forms (television-sports shows, live broadcasts, video games). Heidegger reminded that "technology does not exist only where technical instruments are used, but rather it exists more universally and problematically where all observation, thinking, and action are technically structured" (Velš V. 2000, pp 234).

The use of spatial montage technique with the aim of expanding information is widespread and significant, because we live in an "accelerated" era, so this type of editing speeds up communication by providing a simultaneous display of many informations. The split screen allows for visual analysis of the work, establishing a visual collage, and cinematic embodiment of cubist principles. By using spatial arrangement with a split screen, where information is displayed simultaneously, we achieve time efficiency (economy of time). By merging diverse shots within a split screen, they seek to activate thought processes in the viewer who connects, analyzes, and draws conclusions. This use of artistic media refers us again to McLuhan, who says of the media that they do not only transmit a message, but that the medium itself is the message. The

³ Polyvision is a term that the French film critic Émile-Jean Vuillermoz gave to a special film format in widescreen, designed exclusively for the filming and projection of the movie *Napoléon*.

media unequivocally tells us that the future and development of artistic communication: The public's work depends exclusively on an innovative approach to the media - so that the idea and content of the work are as complete as possible: artwork- public realtions depends exclusively on an innovative approach to the media - so that the idea and content of the work are as complete as possible and an experience enhanced through actions on different senses.



Figure 3. Polymorphic screen (split screen) and the technique of spatial editing. Film-Vremevidac (2021)

Conclusion

By using different media, techniques, and technologies, the artist can create an artistic whole that transcends the boundaries of tradition arts. The future of art depends on the development of media and their critical application. Media in art, besides conveying information (messages), I can also be a message about their inevitability in creating complex artistic projects that require the multiplication of information. Additionally, the media in art have a humanistic task as an extension of human senses, as they enable individuals with impaired senses-, as through various media, they have the opportunity to perceive and experience art. The camera, as a media extension of the human eye, has the opportunity to move and explore spatial-temporal relationships in a way that is impossible for humans. The media provide the opportunity to expand artistic works: informationally, semantically, narratively, spatially, and temporally. Media can expand human consciousness and offer a completely different experience of artworks - at a higher level of understanding. Digital transformation of media has drastically changed the way artworks are created and performed, providing new opportunities for innovation and experiments.

Conflict of interests

The authors declare no conflict of interest.

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