WEBSITE DATA COLLECTION AND ANALYSIS FOR UNIVERSITIES’ INFORMATION AND ANALYTICAL SYSTEMS MONITORING GENDER EQUALITY

Abstract. This study proposes a novel approach to assessing and promoting gender equality within university settings through strategic data collection and analysis from online sources. Gender disparities persist in academia, evident in faculty hiring, student admissions, and administrative leadership roles. Comprehensive data is crucial for identifying these inequities and developing solutions to foster a more inclusive environment.

The research outlines a detailed data collection algorithm to systematically track gender equality metrics across universities. It highlights the advantages of leveraging advanced scraping and analysis techniques to gather nuanced insights from diverse online data sources like university websites. This data-driven approach enables deeper examination of gender gaps, informing more effective policymaking. The findings demonstrate how harnessing technology to automate and enhance data aggregation can yield a richer, more holistic understanding of gender equality compared to traditional methods.

University administrators and policymakers can apply these data collection practices to pinpoint disparities and guide targeted interventions promoting equity. This framework offers a valuable tool-set for monitoring and addressing gender imbalances in the academic sphere. It provides an innovative supplement to existing
initiatives by leveraging website data mining and AI analysis. Potential limitations include data source biases and ensuring ethical, privacy-conscious use of these technologies. Future research opportunities exist in further enhancing algorithmic fairness, expanding scope to capture intersectional inequities, and developing robust data governance standards.

Overcoming these challenges can unlock the full potential of data-driven solutions for cultivating truly equitable academic institutions. The proposed approach empowers decision-makers with comprehensive, data-backed insights to drive meaningful change towards gender parity in higher education. By harnessing the power of technology and data analysis, universities can proactively identify and address systemic biases, ultimately fostering an environment that celebrates diversity and provides equal opportunities for all individuals to thrive academically and professionally.

Keywords: website data collection, data analysis, gender equality, information and analytical systems, university.

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ЗБІР ТА АНАЛІЗ ДАНИХ ВЕБ-САЙТІВ ДЛЯ УНІВЕРСИТЕТСЬКИХ ІНФОРМАЦІЙНО-АНАЛІТИЧНИХ СИСТЕМ МОНІТОРИНГУ ГЕНДЕРНОЇ РІВНОСТІ

Анотація. У статті запропоновано новий підхід до оцінки та просування гендерної рівності в університетах шляхом стратегічного збору та аналізу даних з онлайн-джерел. В академічній царині зберігається гендерна нерівність у різних сферах, зокрема в працевлаштуванні викладачів, прийомі студентів і розподілі адміністративних керівних ролей. Комплексні дані мають вирішальне значення для виявлення цієї нерівності та розробки рішень, спрямованих на створення більш інклюзивного середовища.

У статті наведено детальний алгоритм збору даних для систематичного відстеження показників гендерної рівності в університетах. Підкреслено переваги використання цифрових методів отримання та аналізу даних для збору детальної інформації з різноманітних онлайн-джерел, зокрема вебсайтів
університетів. Такий підхід дозволяє детально дослідити гендерні розриви, що сприяє більш ефективному формуванню політики, яка спрямована на їх подолання. Результати дослідження демонструють, як використання технологій для автоматизації та покращення агрегації даних може сприяти більш ефективному вирішенню проблем гендерної рівності порівняно з традиційними методами.

Керівники університетів і політики можуть застосовувати ці методи збору даних для виявлення диспропорцій і застосування корекційних заходів, спрямованих на забезпечення рівності. У дослідженні запропоновано набір інструментів для моніторингу та усунення гендерного дисбалансу в академічній сфері на основі використання аналізу даних вебсайтів та штучного інтелекту, що є інноваційним доповненням до наявних ініціатив. Запропонований у статті підхід надає менеджерам всебічну інформацію, що грунтується на даних, для того, щоб стимулювати зміни в напрямку досягнення гендерного паритету в вищій освіті.

Потенційні обмеження цього дослідження охоплюють можливу упередженість джерел даних та виклики щодо забезпечення етичного використання цифрових технологій із дотриманням конфіденційності. Перспективи для майбутніх досліджень полягають у подальшому покращенні алгоритмів, розширенні сфери охоплення для виявлення перехресних нерівностей і розробці надійних стандартів управління даними в царині моніторингу гендерної рівності в університетах.

Ключові слова: збір даних вебсайтів, аналіз даних, гендерна рівність, інформаційно-аналітичні системи, університет.

Statement of the problem. Gender equality in universities is a crucial issue impacting academic settings and societal norms. Despite progress towards gender parity, disparities persist in faculty representation, student enrollment, and administrative leadership. This inequity is often subtle, embedded in institutional structures and practices inadvertently favoring one gender. The challenge involves identifying and addressing these disparities through comprehensive data collection and analysis, enabling universities to foster a more inclusive and equitable environment.

Traditional methods of addressing gender equality issues in universities have relied heavily on manual data collection and self-reported surveys. While providing valuable insights, these approaches are often limited in scope, prone to biases, and lack granularity to uncover nuanced trends. This has led to a fragmented understanding of gender disparities, hindering targeted intervention development. There is growing recognition for systematic and sophisticated data collection and analysis methodologies. Leveraging technology to automate and enhance data gathering processes can provide a more accurate and comprehensive picture of
gender equality within universities. By systematically collecting data from diverse online sources, universities can gain deeper insights into gender distribution, pay gaps, representation across disciplines, and other critical metrics.

**Analysis of recent studies and publications.** The literature on ensuring gender equality in academia is extensive, reflecting varied approaches and critiques from multiple scholars. For instance, Stadler and Wroblewski highlight the contentious nature of reducing gender equality to quantifiable metrics within university policies. Their study of Austrian universities reveals that gender-segregated data, despite being widely used in reports, often lacks contextual depth and reflexivity. Critics like Hark and Hofbauer argue that such data overlooks the qualitative aspects of gender dynamics, leading to ineffective policy formulation. The authors advocate for a more nuanced approach that integrates theoretical frameworks with practical objectives, emphasizing the need for collaborative efforts among stakeholders to bridge the gap between theory and implementation [1, p. 154-155]. While the research provides a critical perspective on the limitations of quantification, it falls short in offering concrete case studies or actionable solutions for enhancing gender monitoring systems.

Wroblewski and Leitner propose the TARGET approach, which emphasizes reflexivity in developing and implementing Gender Equality Plans (GEPs). This approach requires meaningful indicators that align with GEP objectives and policies. The authors suggest that monitoring should be a dynamic tool, with continuous reflection on data gaps and indicator validity. They highlight the importance of empirical evidence from monitoring to support policy implementation and raise gender awareness [2, p. 48-49]. However, the article lacks specific methodologies for website data collection and analysis, which could limit its practical applicability in university settings.

Encarnacion, Seck, and Tabaco discuss the shift to remote data collection methods during COVID-19, emphasizing the need for gender-responsive approaches. They recommend mainstreaming gender in statistical operations and involving all gender data users in discussions. The authors stress the importance of monitoring data usage systematically to guide future gender-responsive efforts [3, p. 835-836]. While the paper provides valuable insights into remote data collection, it does not offer specific recommendations for website data collection and analysis within universities, missing an opportunity to directly address the unique challenges of academic environments.

Fardela, Marsa, Suhery, and Maulana explore the use of Agile Development methodology to develop a gender mainstreaming application for the Payakumbuh Public Works Department. This application, built using the Laravel Framework, aims to improve data processing and monitoring efficiency [4, p. 110]. Although the authors mention the technical aspects of the application, they do not provide details on how these methods can be applied to website data collection and analysis for
gender equality monitoring in universities. The integration and scalability of such applications in university settings remain unexplored.

Mujahidin et al. examine the design and implementation of a web-based sexual violence information system in universities. Their research highlights the role of Management Information Systems (MIS) in institutional decision-making and stakeholder engagement [5, p. 385-386]. However, the authors overlook the importance of incorporating gender-sensitive features into these systems and do not evaluate their impact on addressing gender disparities effectively.

Clavero and Galligan focus on developing analytical frameworks for studying institutional change concerning gender equality in higher education. They draw from feminist institutionalist studies to assess the implementation of gender equality plans, identifying barriers rooted in informal institutional rules [6, p. 11-12]. While the article provides a theoretical foundation, it lacks practical recommendations for researchers conducting such studies, limiting its applicability for future research endeavors.

Bianchi et al. introduce innovative methods for extracting knowledge from university websites using web mining techniques. These methods can update information frequently and provide flexible indicators for evaluating university activities [7, p. 52-53]. However, the study does not incorporate specific gender-related indicators, undermining its relevance to monitoring gender equality. The potential contributions of these methodologies to advancing gender equality remain unclear.

Courey and Seck emphasize the importance of measuring women's empowerment for global development. They highlight challenges in translating conceptual frameworks into measurable metrics, particularly within the context of Sustainable Development Goal (SDG) 5 [8, p. 100494]. While the article addresses difficulties in measurement, it lacks a detailed discussion on methodologies for website data collection and analysis, which could enhance the understanding of gender equality in universities.

Hanks examines the impact of website design on female recruitment into technology programs. The study finds no significant difference between computer science and applied departments in implementing female-oriented website features, suggesting that superficial changes are insufficient without addressing underlying inequalities [9, p. 8-11]. The author emphasizes visual aspects but neglects the role of textual content in shaping gender perceptions, missing an opportunity for a more comprehensive analysis.

Naicker and Mbengo investigate the role of Information and Communication Technologies (ICTs) in promoting gender parity in a South African higher education institution. Their findings reveal that ICTs facilitate education, independence, and career advancement for women [10, p. 32]. However, the study lacks empirical evidence and concrete examples to support its assertions, limiting its generalizability to other contexts.
Despite the valuable insights provided by above-mentioned studies, there is a clear need for more detailed and actionable recommendations regarding website data collection and analysis for monitoring gender equality in universities.

The purpose of the article is to explore the stages of website data collection and analysis for developing information and analytical systems that monitor gender equality in universities.

Outline of the main material. Tracking gender parity within academic institutions demands a methodical approach to accumulating and scrutinizing data from diverse online sources. Table 1 outlines a comprehensive algorithm with multiple phases, each contributing to the overarching objective of promoting gender equality through informed decision-making and analysis.

Table 1. Algorithm stages for university gender equality monitoring via website data collection and analysis

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Aim</th>
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<tbody>
<tr>
<td>1. Planning and scoping</td>
<td>Define objectives, scope, and resources for the data collection project.</td>
<td>Establish clear project framework</td>
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<td>2. Requirement analysis</td>
<td>Identify data requirements, including specific indicators and metrics related to gender equality.</td>
<td>Determine necessary data and sources</td>
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<td>3. Data source identification</td>
<td>Identify relevant websites and online resources where data can be collected.</td>
<td>Locate all potential data sources</td>
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<td>4. Data collection design</td>
<td>Design the methodology and tools (e.g., web scraping, APIs) for data collection.</td>
<td>Develop efficient data collection methods</td>
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<td>5. Implementation</td>
<td>Deploy data collection tools and start gathering data from identified sources.</td>
<td>Collect comprehensive data</td>
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<td>6. Data cleaning</td>
<td>Clean and preprocess the collected data to remove inconsistencies and errors.</td>
<td>Ensure data quality and accuracy</td>
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<td>7. Data integration</td>
<td>Integrate data from various sources into a unified database.</td>
<td>Create a consolidated data repository</td>
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<td>8. Data analysis</td>
<td>Analyze the data using statistical and computational methods to derive insights.</td>
<td>Identify trends and patterns</td>
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<td>9. Visualization</td>
<td>Create visual representations of the data (e.g., charts, graphs) for easier interpretation.</td>
<td>Facilitate understanding through visuals</td>
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<td>10. Reporting</td>
<td>Prepare detailed reports summarizing the findings and insights.</td>
<td>Communicate results to stakeholders</td>
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<td>11. Evaluation</td>
<td>Assess the effectiveness and accuracy of the data collection and analysis process.</td>
<td>Ensure reliability of the methodology</td>
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<td>12. Feedback and refinement</td>
<td>Collect feedback from stakeholders and refine the process for future cycles.</td>
<td>Improve future data collection efforts</td>
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<tr>
<td>13. Publication</td>
<td>Publish the findings and reports on appropriate platforms for accessibility.</td>
<td>Disseminate information widely</td>
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<td>14. Monitoring</td>
<td>Continuously monitor the data for new trends and update the analysis as necessary.</td>
<td>Maintain up-to-date insights</td>
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Source: elaborated by the authors
The initial phase, planning and scoping, entails establishing the foundational framework for the entire endeavor. This stage necessitates defining the specific objectives, scope, and resources requisite for the data collection and analysis process. The primary aim is to devise a lucid and concise project framework that delineates the intended accomplishments, the extent of data collection, and the resources (human, financial, and technical) required. This stage sets the direction and ensures alignment among team members regarding the project’s goals and objectives.

Requirement analysis is the stage wherein the project team identifies the specific data prerequisites needed to effectively monitor gender equality. This involves determining the key indicators and metrics pertinent to gender equality, such as gender distribution among students and staff, gender pay gap, representation across academic disciplines, and more. The main objective here is to ascertain the necessary data and the sources from which it should be collected. This stage ensures that the project focuses on collecting relevant and meaningful data that will provide insights into gender equality within the university.

In the data source identification stage, the team identifies all relevant websites and online resources where the required data can be collected. This includes university websites, government education portals, academic publications, and other online repositories that contain information pertinent to gender equality. The goal is to locate all potential data sources that can provide the necessary information for analysis. Identifying diverse and credible sources is crucial for obtaining a comprehensive and accurate dataset.

The data collection design stage involves designing the methodology and tools for data collection. This includes deciding on the techniques (such as web scraping, APIs, or manual data entry) and developing the necessary tools and scripts to automate and facilitate the data collection process. The main goal of this stage is to create efficient and reliable data collection methods that ensure the comprehensive gathering of data from various sources.

Implementation is the stage where the designed data collection tools are deployed, and the actual data collection begins. This involves running the web scraping scripts, querying APIs, and manually collecting data as necessary. The primary goal of this stage is to gather comprehensive and accurate data from the identified sources. Proper implementation ensures that the data collection process is systematic and efficient, minimizing errors and omissions.

Once the data is collected, it undergoes the data cleaning stage. This stage involves preprocessing the data to remove any inconsistencies, duplicates, and errors. Data cleaning ensures that the dataset is of high quality and is accurate and reliable for analysis. The main goal here is to enhance the integrity and usability of the collected data by addressing any issues that could compromise the analysis results.
In the data integration stage, the cleaned data from various sources is combined into a unified database. This involves merging datasets, aligning formats, and ensuring consistency across the integrated dataset. The goal is to create a consolidated data repository that provides a holistic view of gender equality within the university. Proper data integration ensures that the analysis considers all relevant information from diverse sources, leading to more comprehensive insights.

Data analysis is the stage where the integrated dataset is analyzed using statistical and computational methods. This involves applying various analytical techniques to derive insights, identify trends, and uncover patterns related to gender equality. The primary goal of this stage is to transform raw data into meaningful information that can inform decision-making and policy development. Effective data analysis provides a deep understanding of the current state of gender equality within the university.

The visualization stage involves creating visual representations of the analyzed data. This includes developing charts, graphs, and dashboards that present the data in an easily interpretable format. The main goal is to facilitate understanding and communication of the analysis results through visual means. Effective visualization helps stakeholders quickly grasp key insights and trends, making the data more accessible and actionable.

In the reporting stage, detailed reports summarizing the findings and insights from the data analysis are prepared. These reports provide a comprehensive overview of the gender equality status within the university, highlighting key areas of concern and progress. The goal of this stage is to communicate the results to stakeholders, including university administration, policymakers, and the broader academic community. Clear and concise reporting ensures that the findings are effectively disseminated and understood.

The evaluation stage involves assessing the effectiveness and accuracy of the data collection and analysis process. This includes reviewing the methodology, tools, and outcomes to identify any areas for improvement. The primary goal is to ensure the reliability and validity of the entire process, making any necessary adjustments to enhance future data collection efforts.

Feedback and refinement is the stage where feedback from stakeholders is collected and used to refine the process for future cycles. This involves incorporating suggestions and addressing any issues raised during the evaluation stage. The goal is to continuously improve the data collection and analysis methodology, ensuring that it remains relevant and effective in monitoring gender equality.

In the publication stage, the findings and reports are published on appropriate platforms for accessibility. This includes academic journals, university websites, and other relevant online platforms. The main goal is to disseminate the information widely, making it accessible to a broader audience and contributing to the ongoing discourse on gender equality in academia.
The final stage, monitoring, involves continuously monitoring the data for new trends and updating the analysis as necessary. This ensures that the insights remain up-to-date and relevant, allowing the university to respond proactively to changes in gender equality dynamics. The primary goal is to maintain an ongoing and current understanding of gender equality within the university, supporting continuous improvement and informed decision-making.

Table 2 sheds light on the opportunities and threats associated with using AI for monitoring gender equality in universities, as well as measures to mitigate the identified threats.

**Table 2.**

<table>
<thead>
<tr>
<th><strong>Opportunity</strong></th>
<th><strong>Description</strong></th>
<th><strong>Threat</strong></th>
<th><strong>Description</strong></th>
<th><strong>Measures to tackle</strong></th>
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<tr>
<td>Enhanced data accuracy</td>
<td>AI can automate data collection, reducing human error and improving accuracy.</td>
<td>Data privacy</td>
<td>AI systems may inadvertently collect sensitive personal data.</td>
<td>Implement strict data privacy policies and ensure compliance with GDPR and other regulations.</td>
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<td>Real-time monitoring</td>
<td>AI enables real-time tracking of gender equality metrics, allowing for timely interventions.</td>
<td>Bias in AI</td>
<td>AI algorithms can perpetuate existing biases if not properly designed.</td>
<td>Regularly audit and update AI algorithms to ensure fairness and inclusivity.</td>
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<tr>
<td>Comprehensive data analysis</td>
<td>AI can analyze large datasets to uncover trends and patterns that might be missed by humans.</td>
<td>Over-reliance on</td>
<td>Dependence on AI might reduce critical thinking and human oversight.</td>
<td>Maintain a balance between AI insights and human judgment in decision-making processes.</td>
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<td>Predictive analytics</td>
<td>AI can predict future trends in gender equality, helping universities to plan proactive measures.</td>
<td>Lack of</td>
<td>AI decision-making processes can be opaque and difficult to understand.</td>
<td>Ensure AI systems are transparent and their decision-making processes are explainable.</td>
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<td>Efficient resource allocation</td>
<td>AI can identify areas needing resources for gender equality initiatives more effectively.</td>
<td>Ethical concerns</td>
<td>AI might make decisions that are ethically questionable.</td>
<td>Establish ethical guidelines for AI use and ensure all decisions are reviewed ethically.</td>
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<td><strong>Customizable dashboards</strong></td>
<td>AI can create personalized dashboards for different stakeholders, improving accessibility.</td>
<td>Data security</td>
<td>AI systems can be vulnerable to cyber-attacks, risking data breaches.</td>
<td>Implement robust cybersecurity measures and regular security audits.</td>
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<tr>
<td><strong>Enhanced reporting capabilities</strong></td>
<td>AI can automate and enhance the quality of reports on gender equality.</td>
<td>Job displacement</td>
<td>Increased automation might lead to job losses in data analysis roles.</td>
<td>Upskill employees and integrate AI as a tool to assist rather than replace human workers.</td>
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<tr>
<td><strong>Identifying hidden disparities</strong></td>
<td>AI can reveal subtle or hidden disparities in gender equality data.</td>
<td>Misinterpretation of data</td>
<td>AI analysis might be misinterpreted without proper context.</td>
<td>Provide training on interpreting AI-generated insights correctly.</td>
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<tr>
<td><strong>Improved stakeholder engagement</strong></td>
<td>AI-driven insights can be used to engage stakeholders more effectively in gender equality issues.</td>
<td>AI system failure</td>
<td>Dependence on AI systems can lead to disruptions if they fail.</td>
<td>Develop contingency plans and regular system maintenance schedules.</td>
</tr>
<tr>
<td><strong>Automated compliance checks</strong></td>
<td>AI can automatically check for compliance with gender equality regulations and standards.</td>
<td>Lack of human touch</td>
<td>AI might lack the empathy and understanding that human oversight provides.</td>
<td>Ensure human involvement in key decision-making processes and maintain open communication.</td>
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Source: compiled by the authors

AI has the potential to significantly improve the accuracy of data collection processes. Automated systems reduce the likelihood of human error, ensuring that the data collected is more reliable and precise. This accuracy is crucial for effective monitoring and decision-making. AI enables real-time tracking of gender equality metrics. This capability allows universities to identify and address issues promptly, ensuring timely interventions and continuous improvement. AI can process and analyze large datasets efficiently, uncovering trends and patterns that may be overlooked by human analysts. This comprehensive analysis can provide deeper insights into gender equality issues, facilitating more informed decision-making. AI’s predictive capabilities can forecast future trends in gender equality, helping
universities to plan proactive measures. By anticipating potential issues, institutions can implement strategies to address them before they escalate.

AI can help identify areas that require more resources for gender equality initiatives, optimizing the allocation of funds and efforts. This ensures that resources are used effectively to address the most pressing issues. AI can create personalized dashboards for different stakeholders, enhancing accessibility and usability. These dashboards can provide tailored insights and reports, catering to the specific needs of various users. AI can automate the generation of reports on gender equality, improving the quality and consistency of these reports. Automated reporting can save time and reduce the workload for staff. AI can reveal subtle or hidden disparities in gender equality data that might not be apparent through manual analysis. This capability can help universities address nuanced issues and promote a more equitable environment.

AI-driven insights can be used to engage stakeholders more effectively in gender equality issues. By providing clear and actionable information, AI can facilitate better communication and collaboration among stakeholders. AI can automatically check for compliance with gender equality regulations and standards, ensuring that universities adhere to legal and policy requirements. This automation can help institutions stay up-to-date with changing regulations.

The use of AI in data collection may inadvertently lead to the collection of sensitive personal information, raising privacy concerns. To mitigate this threat, it is essential to implement strict data privacy policies and ensure compliance with regulations such as the General Data Protection Regulation (GDPR). AI algorithms can perpetuate existing biases if not properly designed and monitored. Regular audits and updates of AI algorithms are necessary to ensure fairness and inclusivity, preventing biased outcomes.

Dependence on AI might reduce critical thinking and human oversight. To counter this threat, a balance between AI insights and human judgment should be maintained, ensuring that AI serves as a tool rather than a replacement for human decision-making. AI decision-making processes can be opaque and difficult to understand. Ensuring transparency and explainability of AI systems is crucial for building trust and accountability. AI might make decisions that are ethically questionable. Establishing ethical guidelines for AI use and ensuring that all decisions are reviewed ethically can help address this concern. AI systems can be vulnerable to cyber-attacks, risking data breaches. Implementing robust cybersecurity measures and conducting regular security audits are essential to protect sensitive data.

Increased automation might lead to job losses in data analysis roles. Upskilling employees and integrating AI as a tool to assist rather than replace human workers can mitigate this threat, ensuring that AI complements human efforts. AI analysis might be misinterpreted without proper context. Providing training on
interpreting AI-generated insights correctly can help users understand and apply these insights appropriately. Dependence on AI systems can lead to disruptions if they fail. Developing contingency plans and regular system maintenance schedules are necessary to ensure continuity and reliability. AI might lack the empathy and understanding that human oversight provides. Ensuring human involvement in key decision-making processes and maintaining open communication can help retain the human touch in AI-driven systems.

Conclusions. The systematic collection and analysis of website data provide a robust framework for monitoring gender equality within universities. The outlined algorithm, encompassing stages from planning and scoping to continuous monitoring, ensures a comprehensive approach to data management. By meticulously defining objectives, identifying relevant data sources, and employing advanced data collection and analysis techniques, institutions can gain valuable insights into gender parity. This method facilitates informed decision-making, enabling universities to address gender disparities proactively.

The adoption of AI enhances this framework by improving data accuracy, enabling real-time monitoring, and uncovering hidden trends. However, it is crucial to address potential threats such as data privacy concerns, algorithmic biases, and ethical issues. Implementing strict data privacy policies, regularly auditing AI systems, and maintaining human oversight are essential measures to mitigate these risks.

Future research should focus on refining AI algorithms to enhance fairness and inclusivity further. Developing more transparent and explainable AI systems will build trust and improve stakeholder engagement. Additionally, exploring the integration of AI with other emerging technologies, such as blockchain, could enhance data security and integrity.

References:


Література: