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Editorial

The Journal of Mediterranean, European and African Sciences (JMEAS is an international, peer-reviewed, and digital open-access scientific journal dedicated to the critical and interdisciplinary analysis of the legal, political, economic, social, and technological transformations currently shaping the European, Mediterranean, and African spheres.

The Journal stems from an awareness of the deepening structural interdependence between Europe, the Mediterranean, and Africa, and the subsequent need for a stable, qualified, and international scientific forum. Within this space, such dynamics can be examined through comparative, multilevel, and interdisciplinary lenses. JMEAS serves as a platform for academic dialogue designed to transcend Eurocentric, sectoral, or purely regional approaches, instead valuing pluralistic perspectives that remain sensitive to the historical, cultural, and institutional specificities of diverse contexts and their respective narratives.

A backbone of the Journal is the evolution of the concept of citizenship and the redefined dimension of fundamental rights. These are increasingly detached from the exclusive prerogative of the formal relationship between the individual and the State, and are instead rooted in the principle of human dignity as a transversal value across contemporary legal orders and economic systems. This evolution has led to a progressive expansion of recognized individual rights, accompanied by a rising awareness of the indispensable role played by international organizations, supranational institutions, States, and local governments in effectively guaranteeing and protecting these rights against the challenges of shifting global geopolitical balances.

In this framework, the Journal situates itself within a debate of particular prominence in the European context, which now extends far beyond its borders to encompass Euro-Mediterranean and Afro-European relations. Human rights have emerged as an essential analytical key for addressing general issues within the European Union legal order, as well as in international and comparative law. Traditional themes, such as norm-setting processes, enforcement mechanisms, and international responsibility, must today contend with market-underlying mechanisms, social and demographic dynamics, and emerging issues such as the relationship between the individual and new technologies, specifically Artificial Intelligence, global emergencies, and the sustainability of development and wealth-production models. The interactions and retroactions between these phenomena are now deeply intertwined with the modalities through which individual and collective interests are recognized, balanced, and shielded. Such interrelations are particularly evident at the intersection of critical domains: climate change and migration, healthcare and digitalization, business and human rights, equity and demographic growth, ethics and technology, communication and sociological evolution, and productivity and sustainable development.

JMEAS seeks to interpret these phenomena by creating a space for scientific reflection aimed at analyzing the impact that citizenship, fundamental rights, multilevel governance paradigms, and the characteristics of local and global markets have produced, and are capable of producing, across the legal, institutional, economic, and social strata of Europe, the Mediterranean, and Africa.

A further qualifying element of the Journal is its focus on the interaction between supranational, state, and sub-state dimensions. The institutional, regulatory, jurisprudential, social, and economic dynamics of these various levels, which constitute a hallmark of the contemporary human experience, reciprocally influence one another, generating structural tensions and at times conflicting approaches. This necessitates the construction of processes for dialogue and integration facilitated by science. The development of fundamental rights protection systems in Europe and Africa, as in other regional contexts, bears witness to the central role of these interactions and the propelling function performed by national and supranational jurisdictions in consolidating common standards of protection. This need is further evidenced by the increasing production of frameworks by Competent Authorities and administrations and fosters the harmonizing role of science across various fields of human knowledge.

Of equal importance is the markedly interdisciplinary, and indeed transdisciplinary, orientation of this editorial project. JMEAS was established by scholars from diverse fields of knowledge, founded on the conviction that the phenomena under investigation cannot be confined within the boundaries of a single discipline. The issues addressed require constant engagement between law, political science, economics, social studies, history, philosophy, the humanities, and technology, within a framework of open, respectful, and rigorous scientific dialogue.

Such engagement is rendered even more imperative by the disruptive impact of new technologies and AI on science, both in terms of developmental potential and speed, and regarding research methodology itself. Furthermore, it raises profound ethical questions, necessitating reflection on the need for human oversight of technology, an awareness of its limits, and the preservation of critical thinking and the freedom of interpretation, in a dimension of renewed impetus for philosophy and the humanities.

There remains, therefore, only a final wish, which is also an aspiration: to make this *new Journal*—through the commitment of all those who have joined the editorial project, those who already collaborate with it, and those who will choose to do so in the future—an authoritative, well-regarded and widely disseminated scholarly platform, both within the academic community and among a broader readership interested in the dynamics and prospects of the Mediterranean, Europe and Africa.

Prof. Luigia Melillo
Rector of MED.E.A. University

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The Role of Artificial Intelligence Technologies in Accelerating SustainableDevelopment in the Building Sector

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Abstract

The building sector plays a key role in the transition toward sustainability due to its significant impact on energy consumption, resource use, and greenhouse gas emissions. In this context, Artificial Intelligence (AI) has emerged as an important enabler for improving energy efficiency, environmental performance, and resilience in the built environment. The objective of this paper is to investigate how AI technologies can be systematically integrated across the building life cycle to support sustainable development in the construction sector.

The study is framed within major international and European policy frameworks, including the Sustainable Development Goals, the European Green Deal, and the New Urban Agenda. A review of recent scientific literature is conducted to analyze state-of-the-art AI applications in construction, focusing on BIM-based workflows, Digital Twin technologies, smart buildings, and AI-driven energy optimization systems. Based on the findings, the paper develops a conceptual framework and proposes guidelines for the effective adoption of AI in sustainable building design and operation, highlighting its potential to reduce environmental impacts and enhance long-term resilience.

Keywords: Sustainable development, green technology, renewable energy, nZEB buildings, AI-Driven Sustainable Design, Energy Management

1. INTRODUCTION

The built environment is widely recognized as one of the major contributors to urban pollution, due to the intensive use of materials, energy, and manufacturing technologies (Ramaglia et al, 2025). Across the entire building life cycle, from construction and operation to demolition, the European building stock is responsible, on average, for 36% of annual CO_2 emissions, 40% of total energy consumption, and approximately 50% of overall raw material extraction (Angrisano et al., 2024). However, the renovation of the existing built environment represents a significant opportunity to support the energy transition through energy efficiency interventions that integrate renewable energy technologies and the use of innovative materials, such as nanomaterials and biomaterials (Attia et al., 2021).

A further relevant aspect is that the existing building stock in Europe accounts for approximately 80– 90% of the buildings that are expected to still be in use by 2050, while the construction sector continues to account for about 40% of total energy consumption (Gravagnuolo et al., 2022).

Achieving sustainability in the building sector requires a holistic approach that considers the entire lifecycle of buildings, from design and construction to operation and end-of-life (Nocca and Angrisano, 2022). Digital transformation, and AI in particular, is reshaping traditional construction paradigms by enabling data-driven decision-making, predictive analysis, and adaptive control systems. AI contributesto reducing environmental impacts, optimizing resource use, and enhancing occupant well-being, aligning the construction industry with global sustainability objectives.

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The paper is framed within major international and European policy frameworks, including the Sustainable Development Goals, the European Green Deal, and the New Urban Agenda. A review of recent scientific literature is conducted to analyze state-of-the-art AI applications in construction, focusing on BIM-based workflows, Digital Twin technologies, smart buildings, and AI-driven energy optimization systems. Based on the findings, the paper develops a conceptual framework and proposes guidelines for the effective adoption of AI in sustainable building design and operation, highlighting its potential to reduce environmental impacts and enhance long-term resilience.

2. LITERATURE REVIEW

In the most recent studies published between 2024 and 2025, the scientific literature confirms the increasingly prominent role of Artificial Intelligence in the construction sector. Several review papers show that the application of AI algorithms can improve building energy efficiency, reduce operational costs, and enhance occupant comfort (Emedo et al., 2025; MDPI, 2025). Meta-analytical studies highlight energy savings ranging from 20% to 50% for AI-based energy management systems compared to traditional approaches (Bajwa et al., 2025), while recent conceptual frameworks illustrate the integration of AI with the Internet of Things (IoT) and regulatory tools such as the Smart Readiness Indicator to enhance the sustainability and adaptability of smart buildings (Buildings, 2025). Finally, the literature identifies both progress and persistent challenges in the widespread adoption of AI across the entire building life cycle (Ehtsham, 2025; Ekanayaka Gunasinghalge et al., 2025).

Systematic reviews published in 2025 indicate that the adoption of machine learning, deep learning, and reinforcement learning techniques in smart buildings enables significantly more efficient energy management compared to conventional control systems. These approaches allow for the prediction of energy loads, optimization of HVAC (**H**eating, **V**entilation and **A**ir **C**onditioning) system operation, and dynamic adaptation of building behavior to climatic conditions, occupancy patterns, and renewable energy availability, resulting in measurable reductions in energy consumption and CO_2 emissions (Wei et al., 2019; Li et al., 2021; Springer Review, 2025).

In parallel, several contributions from 2024 and 2025 emphasize the strategic role of integrating AI and the Internet of Things (IoT) in the development of nearly zero-energy and net-zero energy buildings. In this context, AI acts as a coordinating layer among sensor networks, monitoring platforms, and control systems, enabling a holistic approach to building life-cycle management. Recent conceptual frameworks demonstrate how this integration can overcome challenges related to data fragmentation and system interoperability, making predictive and adaptive building performance management possible(Sustainability, 2025; MDPI, 2025).

Another important research stream focuses on the application of AI to the energy retrofit of existing building stock, which represents the dominant share of buildings expected to remain in use over the coming decades. Recent studies propose the use of Explainable Artificial Intelligence (XAI) models to support retrofit decision-making even in the presence of incomplete or heterogeneous data. These approaches enhance the transparency of predictive models and promote the acceptance of AI-based solutions among designers, public decision-makers, and investors (arXiv, 2025).

The most recent literature also highlights the emergence of new application areas for AI, including the discovery and optimization of sustainable building materials and the use of large language models (LLMs) to support building energy modeling. These technologies accelerate simulation and environmental performance assessment processes, reducing time, costs, and decision-making uncertainty (Nature Scientific Reports, 2025; arXiv, 2024).

Overall, contributions converge in recognizing Artificial Intelligence as a key enabler for the transition of the construction sector toward more sustainable, resilient, and user-centered models. AI not only contributes to reducing environmental impacts and optimizing resource use, but also improves indoor environmental quality and occupant well-being, thereby supporting the achievement of global sustainability goals. However, the literature emphasizes the need to address remaining challenges, such as process standardization, data governance, and the development of interdisciplinary skills, in order to fully exploit the potential of AI at scale (IEA, 2023; Sustainability, 2025).

The integration of AI with established digital technologies such as Building Information Modeling (BIM), the Internet of Things (IoT), and Digital Twin systems enables the collection, processing, and interpretation of large volumes of heterogeneous data across the different phases of the building life cycle. These capabilities support evidence-based decision-making processes, improving the accuracy of design, operational, and energy performance predictions (Volk et al., 2014; Boje et al., 2020).

One of the main contributions of AI lies in predictive analytics applied to energy management, maintenance, and indoor comfort. Through machine learning algorithms, it is possible to anticipate energy demand, predict system failures or inefficiencies, and optimize the real-time operation of HVAC, lighting, and ventilation systems. These approaches enable significant reductions in energy consumption and greenhouse gas emissions, contributing to the achievement of climate neutrality targets (IEA, 2023; Wei et al., 2019).

At the same time, AI-based adaptive control systems allow buildings to dynamically respond to external environmental conditions, occupant behavior, and renewable energy availability. This aspect is particularly relevant in the context of smart buildings and smart grids, where demand-side flexibility represents a key factor for the large-scale integration of renewable energy sources (Li et al., 2021).

Beyond environmental and energy benefits, AI significantly contributes to occupant well-being by improving Indoor Environmental Quality (IEQ). Continuous analysis of parameters such as temperature, humidity, air quality, and lighting enables the creation of healthier and more comfortable indoor environments, with positive effects on health, productivity, and quality of life (Pisello et al., 2020).

Overall, AI-driven digital transformation aligns the construction sector with global sustainability objectives by supporting environmental impact reduction, efficient resource use, and the development of resilient and user-centered buildings. Nevertheless, the full adoption of these technologies requires further efforts in terms of standardization, interoperability, data governance, and interdisciplinary skillsdevelopment.

2.1 Theoretical Frameworks for Sustainable Construction

Artificial Intelligence–based applications in the construction sector represent a strategic enabler for achieving multiple Sustainable Development Goals (SDGs) by addressing key energy, environmental, and urban challenges of the built environment (Angrisano et al, 2025c). Through intelligent design tools, advanced energy management systems, and digital infrastructures, AI supports the transition toward more efficient, resilient, and sustainable building models. In particular, AI contributes to SDG 7 by optimizing energy production and consumption and facilitating renewable energy integration, while supporting SDG 9 through technological innovation enabled by BIM, Digital Twin technologies, and the Internet of Things. AI-driven solutions also foster SDG 11 by improving indoor comfort, reducing environmental impacts, and supporting urban regeneration, while contributing to SDG 12 and SDG 13 through life-cycle-based resource efficiency, emissions reduction, and climate adaptation strategies (united Nations, 2015). These objectives are reinforced by major policy frameworks such as the New Urban Agenda (NUA) and the European Green Deal. The NUA promotes an integrated and inclusive approach to urban development, emphasizing compact cities, adaptive reuse, environmental sustainability, resilience, and the role of digital innovation (United Nations, 2016). Similarly, the European Green Deal places the construction sector at the centre of climate neutrality strategies through building decarbonisation, circular economy principles, climate resilience, and digitalisation (European Commission, 2019) (Angrisano et al, 2025b). Together, these frameworks highlight AI as a key enabling technology for a sustainable, resilient, and socially inclusive built environment.

3. AI AND GREEN TECHNOLOGIES IN BUILDINGS

3.1 AI-Driven Sustainable Design

Artificial Intelligence is increasingly transforming architectural and engineering design processes through the adoption of generative design and simulation-based optimization techniques, enabling a shift from traditional intuition-driven workflows to data-driven and performance-oriented methodologies (Attia et al., 2020). This transformation is particularly relevant in the context of sustainable construction, where early design decisions strongly influence long-term energy performanceand environmental impacts.

AI-based generative design systems explore large solution spaces defined by climatic, geographic, regulatory, and functional constraints, including local climate data, solar radiation, site characteristics, building orientation, and occupancy profiles. By processing these variables simultaneously, AI algorithms generate multiple design alternatives that would be impractical to explore manually (Pisello& Cotana, 2014). Simulation-based optimization further enhances this process by integrating environmental and energy performance analyses directly into the design loop, allowing each design option to be evaluated in terms of energy demand, thermal comfort, daylight availability, material use, and carbon emissions (Angrisano et al, 2024).

These tools enable architects and engineers to compare numerous design scenarios at early project stages, when decisions have the greatest impact on long-term building performance. From a sustainability perspective, generative design supports the reduction of operational energy demand through climate-responsive forms, optimized envelopes, and passive strategies, while also contributing to lower embodied carbon by optimizing structural systems and material use

(Attia et al., 2020). Overall, AI-driven design methodologies provide a robust framework for developing high-performance buildings aligned with energy efficiency, resource efficiency, and climate resilience goals.

3.2 Intelligent Microclimate Management

Intelligent microclimate management represents a key application of Artificial Intelligence in the building sector, enabling continuous monitoring, prediction, and control of indoor and outdoor environmental conditions. Through the integration of sensor networks, Internet of Things (IoT) technologies, and AI-based algorithms, buildings can dynamically respond to changing climatic conditions and occupancy patterns, improving both energy efficiency and occupant comfort (Wei et al.,2019).

High-resolution data on temperature, humidity, solar radiation, wind speed, and air quality are processed by machine learning and predictive control models to enable adaptive and anticipatory system responses (Pisello et al., 2020). When integrated with nature-based solutions such as green roofs, vegetated façades, and water-sensitive design elements, AI-driven microclimate management enhances passive cooling, reduces cooling energy demand, and mitigates urban heat island effects (Santamouris, 2014; Speak et al., 2020).

Several studies demonstrate that AI-supported green infrastructure can significantly reduce surface and air temperatures in dense urban areas, improving outdoor thermal comfort and reducing heat stress during extreme weather events (Santamouris et al., 2018; Bowler et al., 2010). By coordinating natural ventilation, shading, and mechanical systems based on real-time microclimatic conditions, AI-based control strategies achieve improved thermal comfort with reduced energy input, supporting climate- adaptive and resilient built environments (Pisello & Cotana, 2014; IEA, 2023).

4. AI AND RENEWABLE ENERGY SYSTEMS

4.1 Forecasting and Energy Management

Artificial Intelligence plays a central role in integrating renewable energy systems within buildings through advanced forecasting and energy management capabilities. AI-based models use historical operational data, real-time measurements, and weather forecasts to predict energy generation from solar and wind sources with high accuracy, outperforming traditional statistical approaches (Voyant et al., 2017; Ahmed et al., 2020).

Reliable forecasting enables optimized energy storage, increased self-consumption, and reduced dependence on external energy supply. AI-driven energy management systems determine optimal charging and discharging strategies for batteries and thermal storage, aligning energy demand with renewable availability and minimizing reliance on fossil fuel–based electricity (Lund et al., 2015; Li et al., 2021). These capabilities support intelligent interaction with the power grid through demand- response and flexibility mechanisms, contributing to grid stability in systems with high shares of variable renewable energy (Siano, 2014; IEA, 2023).

From a sustainability perspective, AI-based forecasting combined with optimized energy management reduces greenhouse gas emissions and operational costs at both building and district scales (Vázquez- Canteli & Nagy, 2019; Ekanayaka Gunasinghalge et al., 2025).

4.2 Smart Buildings and Smart Grids

AI-enabled smart buildings act as active nodes within smart grids, dynamically adjusting energy consumption in response to real-time grid conditions, renewable availability, and pricing signals. Through AI-based demand-response strategies, buildings optimize HVAC, lighting, and storage systemsto reduce peak demand and smooth load profiles without compromising occupant comfort (Wei et al., 2019; Li et al., 2021).

This flexibility enhances grid stability and supports higher penetration of renewable energy sources, reducing curtailment and improving system resilience (IEA, 2023; Gellings & Samotyj, 2020). AI- driven coordination between on-site renewable generation, energy storage, and grid interaction further enables buildings to operate as prosumers within decentralized energy systems, aligning economic performance with environmental objectives (Vázquez-Canteli & Nagy, 2019).

5. AI-ENABLED BUILDING OPERATION AND NET-ZERO STRATEGIES

5.1 Smart Buildings and Building Management Systems (BMS)

AI-powered Building Management Systems represent a major advancement in building operation, enabling predictive and adaptive control of HVAC, lighting, and energy systems. By processing data from sensors and smart devices, AI-driven BMS anticipate building behavior, optimize system operation, and balance energy efficiency with occupant comfort (Wei et al., 2019; Pisello et al., 2020). Studies show that AI-enabled BMS can achieve energy savings ranging from 10% to over 30% compared to conventional control systems, while also enhancing operational reliability through predictive maintenance (IEA, 2023; Ekanayaka Gunasinghalge et al., 2025). These systems reduce downtime, extend equipment lifespan, and facilitate integration with smart grids and renewable energysources (Volk et al., 2014; Boje et al., 2020).

5.2 Digital Twins in Sustainable Construction

AI-enhanced Digital Twins provide dynamic virtual representations of buildings by integrating real-time data from sensors, BMS, and IoT devices. These systems support continuous performance monitoring, predictive maintenance, and scenario analysis, enabling proactive building management (Boje et al., 2020; Tao et al., 2019).

By linking operational data with life-cycle assessment information, digital twins support resource-efficient operation, retrofit planning, and long-term sustainability strategies (Lu et al., 2020; Ehtsham, 2025). At district and urban scales, interconnected digital twins enhance resilience by enabling coordinated responses to climate-related and operational challenges (Batty, 2018; IEA, 2023).

5.3 Net-Zero Energy Buildings

Net-zero energy buildings rely on the integration of high-performance envelopes, renewable energy systems, and AI-driven control strategies. While envelope efficiency reduces baseline energy demand, AI optimizes the balance between energy production and consumption under dynamic climatic and occupancy conditions (Attia et al., 2020) (Angrisano et al, 2025).

Through predictive control, demand-response strategies, and intelligent energy flexibility management, AI enables buildings to maximize renewable self-consumption, reduce peak demand, and interact effectively with smart grids (Vázquez-Canteli & Nagy, 2019; Li et al., 2021). Recent studies demonstrate that AI-driven optimization significantly improves net-zero performance compared to rule- based control strategies, while maintaining high levels of occupant comfort (Pisello et al., 2020; Ekanayaka Gunasinghalge et al., 2025). As a result, AI-driven net-zero buildings represent a key pathway toward climate-neutral and resilient built environments.

6. ANALYSIS OF RESULTS

6.1 Catalogue of AI Technologies in the Construction Sector Linked to the SDGs, the European Green Deal, and the New Urban Agenda

AI adoption in sustainable construction offers significant benefits, including emission reductions, cost optimization, and improved environmental quality. The convergence of AI, Internet of Things (IoT), and renewable energy technologies will lead to increasingly autonomous, adaptive, and resilient buildings.

However, challenges remain, such as data availability, interoperability, cybersecurity, and the need for interdisciplinary skills. Addressing these barriers is essential for widespread implementation. As part of the results analysis, the study develops a comprehensive mapping of the most widely adopted AI-based technologies in the construction sector, systematically linking each solution to the objectives of the 2030 Agenda, the New Urban Agenda, and the European Green Deal (Table 1).

Table 1. *Catalogue of AI Technologies in the Construction Sector Linked to the SDGs, the European Green Deal, and the New Urban Agenda.*

Domain	AI Technologies	Main Applications	UN SDG	European Green Deal	New Urban Agenda (NUA)	References
Design and Planning	Generative Design, Evolutionary Algorithms, Machine Learning	Energy and morphological optimization, multi-criteria simulations	SDG 9 SDG 11 SDG 12	Efficient use of resources; Circular economy	Integrated urban planning; efficient land use	Azhar et al., 2011; Wong & Zhou, 2015
Advanced BIM and Digital Twin	Machine Learning, Semantic AI, Data Fusion	Dynamic life-cycle management, predictive simulations	SDG 9, SDG 11, SDG 13	Digitalisation as an enabler; Climate neutrality	Data-driven urban governance; resilience	Volk et al., 2014; Boje et al., 2020
Construction Site Management	Computer Vision, Deep Learning, Robotics	Work monitoring, safety management, logistics optimization	SDG 8 SDG 9, SDG 12	Sustainable industry; waste reduction	Safe and sustainable construction sites	Emedo et al., 2025; Bajwa et al., 2025
Energy Management and Smart Buildings	Reinforcement Learning, Predictive Analytics, Edge AI	Adaptive HVAC control, demand-response strategies	SDG 7 (Energy), SDG 11, SDG 13	Renovation Wave; Energy efficiency	Efficient and resilient buildings	Wei et al., 2019; Li et al., 2021; IEA, 2023
Predictive Maintenance	Machine Learning, Anomaly Detection, Time-Series Analysis	Failure prediction, maintenance optimization	SDG 9, SDG 11, SDG 12	Resource efficiency; durability	Sustainable management of the building stock	Pisello et al., 2020; Springer Review, 2025
Sustainable Materials and Circular Construction	AI for materials discovery, predictive models	Low-carbon material selection, durability optimization	SDG 9, SDG 12, SDG 13	Circular Economy Action Plan	Reduction of resource consumption ; urban regeneration	Zhang et al., 2025; ISO 14040–44
Environmenta l Assessment	Big Data Analytics,	Automated LCA, ESG	SDG 12, SDG 13,	Sustainable finance; EU	Transparent and	ISO 14040–44; Ehtsham,

(LCA, ESG)	Explainable AI	reporting	SDG 17	taxonomy	inclusive decision-making	2025
Human–Building Interaction and Well-being	User behavior modeling, NLP, Adaptive control	Personalized comfort, IEQ, health	SDG 3 SDG 11	Healthy buildings; social inclusion	People-centered design and quality of life	Pisello et al., 2020; Sustainability, 202
Domain	AI Technologies	Main Applications	UN SDGs	European Green Deal	New Urban Agenda (NUA)	References
Design and Planning	Generative Design, Evolutionary Algorithms, Machine Learning	Energy and morphological optimization, multi-criteria simulations	SDG 9 SDG 12	Efficient use of resources; Circular economy	Integrated urban planning; efficient land use	Azhar et al., 2011; Wong & Zhou, 2015

6.2 Guidelines for the Application of Artificial Intelligence in Sustainable Building Design

The integration of Artificial Intelligence into building design processes represents a concrete opportunity to reduce environmental impacts throughout the entire building life cycle. However, in order to fully exploit the potential of AI, it is essential to adopt design guidelines that steer its application in a conscious, systemic, and sustainability-oriented manner.

First, AI should be integrated from the earliest design stages, when decisions related to building form, orientation, envelope configuration, and passive strategies have the greatest influence on energy and environmental performance. The use of generative design tools and advanced simulation techniques allows designers to explore a wide range of design solutions, simultaneously evaluating energy performance, indoor comfort, material use, and carbon emissions. In this way, the design process becomes iterative and evidence-based rather than driven by intuition alone.

A second guideline concerns the adoption of a life-cycle-oriented approach. AI models should be used not only to optimize operational performance, but also to reduce the environmental impacts associated with materials and construction processes. Integrating AI with Life Cycle Assessment (LCA) tools supports the selection of low-carbon materials, the optimization of material quantities, and the evaluation of alternative scenarios related to durability, maintenance, and end-of-life, thereby contributing to the implementation of circular economy principles.

Another key aspect is the integration of AI with Building Information Modeling (BIM) and Digital Twin technologies, which ensures information continuity across design, construction, and operational phases. The use of interoperable digital models allows design assumptions to be updated based on real operational data, progressively improving simulation accuracy and supporting adaptive optimization strategies. This approach is particularly effective in reducing the performance gap between designed and actual building performance.

From an energy perspective, design guidelines should promote the use of AI to maximize renewable energy integration and demand-side flexibility. Predictive models can support optimal system sizing, energy storage management, and interaction with smart grids, reducing reliance on fossil fuels and operational emissions. In this context, AI plays a central role in coordinating building envelopes, technical systems, and occupant behavior.

Specific attention should also be given to indoor environmental quality and occupant well-being, recognizing that environmental and social sustainability are closely interconnected. AI can support the design of healthier and more comfortable indoor environments through predictive analysis of microclimatic conditions and occupancy patterns, avoiding solutions that reduce energy consumption at the expense of user comfort.

Finally, the application of AI in sustainable building design requires adherence to principles of transparency, interoperability, and data governance. The adoption of Explainable AI models, open standards, and interdisciplinary skills is essential to ensure the reliability of results, promote acceptanceamong designers and public decision-makers, and enable large-scale implementation. Overall, these guidelines outline an operational framework in which Artificial Intelligence is not conceived as an isolated tool, but as an enabling technology integrated within a design process oriented toward environmental impact reduction, climate resilience, and the quality of the built environment, in line with the objectives of the 2030 Agenda, the New Urban Agenda, and the European Green Deal (Table 2).

Table 2. *Guidelines for the Application of Artificial Intelligence in Sustainable Building Design.*

Design Domain	AI-Based Strategies	Design Objectives	Environmental Benefits	Related Sustainability Frameworks
Early-StageDesign and Planning	Generative design, evolutionary algorithms, parametric optimization	Exploration of climate-responsive forms and layouts	Reduced operational energydemand; optimizedland use	SDGs 9, 11, 12; European Green Deal; New UrbanAgenda
Building Envelope Optimization	Machine learning models, simulation-based optimization	Optimization of envelope performance (insulation, glazing, shading)	Lower heating and cooling loads; reduced carbon emissions	SDGs 7, 12, 13; European GreenDeal
Passive Design Strategies	AI-assisted environmental simulations	Enhancement of natural ventilation, daylighting, and solar control	Reduced reliance on mechanical systems; improved indoor comfort	SDGs 7, 11; New Urban Agenda
Energy Systems Integration	Predictive analytics, reinforcement learning	Optimization of renewable energy integration and storage	Increased self-consumption; reduced fossil fuel use	SDGs 7, 13; European GreenDeal
Indoor Environmental Quality (IEQ)	User behavior modeling, adaptive control systems	Personalized thermal, visual, andair quality comfort	Improved occupant well-being; energy-efficient comfort management	SDGs 3, 11; New Urban Agenda
Life-Cycle Environmental Assessment	Big data analytics, Explainable AI (XAI)	Automated and dynamic life-cycle impact evaluation	Reduced embodied carbon; informed material selection	SDGs 12, 13; European GreenDeal
Climate Resilience and Adaptation	Predictive climate modeling, AI-based scenario analysis	Design adaptationto future climate conditions	Enhanced resilience; reducedclimate-related risks	SDGs 11, 13; European Green Deal; New Urban Agenda
Design Decision Support	AI-driven multi-criteria decision-making tools	Evaluation of trade-offs betweenenergy, cost, and Environmental impact	Evidence-baseddesign choices;reduced environmental footprint	SDGs 9, 12; European GreenDeal
Design Domain	AI-Based Strategies	Design Objectives	Environmental Benefits	Related Sustainability Frameworks
Early-Stage Design and Planning	Generative design, evolutionary algorithms, parametric optimization	Exploration of climate-responsive forms and layouts	Reduced operational energy demand; optimized land use	SDGs 9, 11, 12; European Green Deal; New Urban Agenda

7. CONCLUSIONS

Artificial Intelligence technologies act as powerful accelerators of sustainable development in the building sector by enabling a paradigm shift toward data-driven, adaptive, and performance-oriented approaches across the entire building life cycle. Through the integration of AI with green technologies, nature-based solutions, and renewable energy systems, the construction industry can significantly reduce energy consumption, greenhouse gas emissions, and resource use, while enhancing operational efficiency, occupant well-being, and long-term resilience.

AI-driven tools such as generative design, intelligent microclimate management, smart Building Management Systems, Digital Twins, and predictive energy optimization support informed decision- making from early design stages to building operation and retrofit. These technologies facilitate the alignment of building performance with international and European sustainability frameworks, including the Sustainable Development Goals, the New Urban Agenda, and the European Green Deal, translating policy objectives into measurable and operational strategies.

Despite the significant benefits, the effective adoption of AI in the construction sector requires addressing key challenges related to data availability, interoperability, cybersecurity, and skills development. Overcoming these barriers is essential to fully unlock the potential of AI as an enabling technology for a low-carbon, resilient, and inclusive built environment. Overall, Artificial Intelligence emerges not only as a technological innovation, but as a strategic lever for steering the construction sector toward a sustainable and climate-resilient future.

Author Contributions

Conceptualization M.A., F.F, methodology F.F. and G.C.; formal analysis, M.A., F.F, investigation M.A., F.F., data curation, M.A., F.F.; writing—original draft preparation, M.A., writing, review and editing, M.A.F.F, supervision, F.F. Funding acquisition by Francesco Fabbrocino. All authors have read and agreed to the published version of the manuscript.

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Toward a Science of Cities

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Abstract

Cities are increasingly at the center of global challenges related to climate change, social inequality, economic transformation, and technological innovation. The growing complexity of urban systems calls for new theoretical and methodological frameworks capable of integrating knowledge across traditionally separated disciplines. This article argues for the development of a coherent Science of Cities, understood as an interdisciplinary field that brings together urban planning, engineering, environmental sciences, social sciences, and education studies.

Starting from a critical analysis of the current state of urban research, the paper highlights the fragmentation of existing approaches and the limitations of sectorial perspectives in addressing contemporary urban problems. It then explores emerging issues related to sustainability, resilience, governance, and knowledge production in urban contexts, emphasizing the need for systemic and holistic models.

Rather than presenting empirical results, the article offers a conceptual reflection aimed at fostering dialogue among disciplines and encouraging the construction of shared analytical frameworks. The proposed perspective seeks to contribute to the advancement of urban studies by promoting integrative thinking and by outlining the foundations for a more unified scientific understanding of cities in the Mediterranean, European, and African contexts.

Keywords: Science of Cities, urban studies, interdisciplinary research, sustainable cities, urban complexity, climate change, governance

DISCLOSURE: ALL AUTHORS REPORT NO CONFLICTS OF INTEREST RELEVANT TO THIS ARTICLE.

1. INTRODUCTION

Anyone currently working on topics related to cities, territories, environments, and landscapes cannot help but be confronted with some ongoing processes of change that will increasingly affect living conditions in cities.

To better understand the considerations we will make, let's recall some of the most relevant ones:

1. The city is the place where most of humanity currently lives, and by 2050, the urban population will reach 70% of the total (9.8 billion), meaning there will be over 6.0 billion city dwellers.
2. This place takes on a wide variety of forms: from the small medieval villages that dot the heart of Europe, to the medium-large cities found throughout the world, to the vast megalopolises of Asia, Africa, and South America.
3. There is also a clear perception that certain global macro-phenomena are emerging—climate crisis, demographic disparity, urban inflation, economic inequality, artificial intelligence—destined to profoundly alter the structure and form of 21st-century cities.
4. For its part, urban planning now seems to have forgotten its original mission, the one for which it was born in the second half of the 19th century: to plan and design urban spaces in a way that responds to the needs, expectations, desires, and fears of their inhabitants.
5. These global phenomena and the glaring shortcomings of urban planning in urban governance are compounded by a failure to understand that the complexity of cities requires the contribution of multiple fields of knowledge alongside those traditionally associated with the city. That is, it is necessary to involve other fields of knowledge, diverse and interconnected: history, geography, sociology, economics, literature, archaeology, law, computer science, biology, medicine, and others.

These considerations are the starting point for broadening the scope of studies on the theme of the city and, at the same time, moving it beyond the confines of a specialist context to make it the subject of broader reflection.

2. THE CURRENT STATE OF THE ART

If this is the goal, the starting point can only be to take stock of the state of the art of the various disciplines with regard to 21st-century cities.

To put it in question: what are the current theories and methods with which the disciplines we believe should converge to form the most suitable scientific body for interpreting cities' structure and form?

This is the question we posed to scholars from various backgrounds, whose writings have yielded insights of extraordinary importance for pursuing the objectives of ensuring:

- that the fusion of multiple fields of knowledge leads to the construction of a Science of Cities as a place of research and training in theories and methods of knowledge, planning, design, construction, and management of cities that are capable of addressing the massive phenomena currently affecting the planet, their local impacts, and the specific situations that the local environment presents.
- that urban planning be regenerated, in the true sense of acquiring *peculiar and distinctive characteristics* that will once again make it responsive to the purpose for which it was created—to provide the tools to govern cities in the primary public interest—which seems long forgotten.

An initial assessment of the progress of this research path revealed a widespread awareness that we are in a phase of urban life that presents considerable difficulties in interpreting. Nevertheless, it is in this direction that numerous scientific fields are moving, addressing both the significant global phenomena currently underway and the specific situations present in different local contexts.

3. EMERGING ISSUES

Within this general framework of reference, the first emerging aspect is the *Climate change* and its impact on cities, a topic that has received specific attention from environmental economics — that is, the branch of economics that focuses its studies on the pervasive issue of environmental changes —suggesting that cities, in addition to mitigating the causes, primarily by limiting CO2 levels, must also implement measures to adapt to the effects. This theme is in line with the 2019 European Green Deal, which directly addresses urban planning.

Next up is *Environmental engineering*, which focuses on the same topic, highlights one of the most serious problems affecting the landscapes of many countries: hydrogeological instability. This problem, in addition to ongoing climate crisis, stems from a historical disregard for the effects of land management based on widespread urbanization, intensive agriculture, deforestation, and the abandonment of mountain slopes. This observation leads to the emergence of so-called *sponge cities*, cities that absorb excess rainfall, because this is how true conditions of resilience are created.

A particularly serious aspect of this issue concerns cities that, due to climate change, are subject to periodic catastrophic events—floods, hurricanes, rising sea levels—which raise the question: should the city be rebuilt on its original site or relocated?

This is a question that already directly affects cities like New Orleans, Jakarta, and St. Louis, but which, albeit with different connotations, will eventually affect many other cities in many parts of the world.

Another emerging aspect concerns one of the crucial issues that are on humanity's table in this century, linked to the *Demography of the planet* and the *Economic disparities* between countries, regions and continents. The consequence of this condition can only be an epochal migration of people because, as has been said, *either the poor countries will become richer, or the poor will move to the rich countries* (Livi Bacci, 2015).

Therefore, we have to consider that already in the year 2000 the population of Africa (1.5 billion) was twice the size of Europe (745 million) and that by 2050 it was tripling (2.5 billion versus 703 million). This indicates in the unequivocal way that the European city is the main point of arrival of mass emigration, it is significant that it will increase the social disruption. As Bernardo Secchi wrote, *social inequalities are one of the most relevant aspects of what I call the* "*new urban question*" *and this is a significant cause of the crisis that the planet's major economies are experiencing today* (Secchi, 2013).

Urban Geography also has a careful vision of these phenomena, in particular of the processes of territorial organization and the emerging dynamics within the city: *on inequalities, on gentrification and the right to the city, on individual agency and on the practices of reappropriation of public space* (Secchi, 2013).

A further significant contribution comes from *Urban Archaeology*, which not only addresses the past of cities but also delves into the continuity of their life and proposes *a new idea of the relationship between archaeology and the city: an archaeology linked to urban planning, the construction of major works, and preventive protection* (Volpe, 2025).

Finally, it does so with a vision of *Urban aesthetics* that distances itself from a way of understanding it that distances it from culture and education in favor of *a strong but facile taste for amazement, for the wonder of the unusual, of the grandiose, of something beyond our reach*. (Todaro, 2025)

Urban aberrations such as *Dubai City*, the under-construction *The Line* in the Arabian desert, and the built-and-abandoned *Forest City* in Malaysia demonstrate how difficult the road ahead is to ensure that aesthetics continues to play its fundamental role in 21st-century cities.

4. CONCLUSION

In light of what has been said so far, what can we say about the idea of building a Science of Cities as a place of research and higher education characterized by the presence and fusion of multiple and diverse fields of knowledge?

We can say that we must continue this journey with awareness and caution.

Awareness of the fact that we have achieved consensus across many disciplines, which, on the one hand, has confirmed the correctness of the idea from which we began and the project we have implemented; on the other, it has created an initial group of scholars with whom to work on further refinements of the proposal.

Caution, given that the concrete implementation of the project requires an agreement with a university institution that formally places it within its structure, granting it legal legitimacy.

At what level? The final stage must be a *School of Higher Education*, but the possibility of moving through an experimental phase with the launch of a second-level Master's program could be considered.

The current phase of the activity of the School *La Fenice Urbana* and the Magazine of the same name is dedicated to perfecting these further steps.

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AI Diffusion in Universities: Challenges for Academic Integrity, Cognitive Labor, and Knowledge Production

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Abstract

The diffusion of artificial intelligence (AI) in higher education represents one of the most significant transformations in the history of universities. Since the second half of the twentieth century, higher education systems have expanded rapidly, particularly in developing countries, driven by globalization, demographic growth, and economic demands. In parallel, recent advances in artificial intelligence—especially generative models—are profoundly reshaping academic practices, redistributing cognitive labor, and challenging traditional notions of authorship, originality, and intellectual effort.

This paper offers a critical analysis of the impact of AI diffusion in universities, focusing on methodological, epistemological, and ethical implications. It examines how AI increasingly relieves humans of intellectual competencies, compresses the time required for academic production, and undermines conventional assessment and anti-plagiarism systems.

Particular attention is paid to the erosion of critical thinking, the illusion of originality in student work, the limitations of technological fraud detection, and the growing disconnection between historical knowledge and AI-generated outputs.

The paper argues that universities must undertake urgent and structural reforms, redefining assessment practices, pedagogical objectives, and the meaning of intellectual responsibility in the age of artificial intelligence.

Keywords: Artificial intelligence, higher education, academic integrity, cognitive labor, plagiarism, critical thinking

1. INTRODUCTION

The second half of the twentieth century and the beginning of the twenty-first century witnessed a dynamic and unprecedented expansion of education systems worldwide. Universities transitioned from elite institutions serving limited social groups to mass systems enrolling millions of students (Selwyn, 2019). This process was particularly pronounced in developing countries, where higher education became a central pillar of national development strategies and social mobility.

While this expansion democratized access to knowledge, it also placed universities under increasing pressure to standardize teaching, accelerate learning processes, and manage large student populations (Selwyn, 2019). These structural pressures form the background against which the rapid diffusion of artificial intelligence must be understood.

Artificial intelligence is no longer a speculative or marginal technology. It has become deeply embedded in everyday life and academic practice. From automated translation and data analysis to text generation and conceptual assistance, AI systems now perform tasks that were traditionally associated with human intellectual effort (Bender et al. 2021; Zawacki-Richter et al., 2019). This development raises fundamental questions about the future direction of higher education, particularly regarding learning, evaluation, and the nature of academic work itself.

2. EXPANSION OF HIGHER EDUCATION AND STRUCTURAL FRAGILITY

The massification of higher education produced significant benefits, including wider access, increased diversity, and stronger links between universities and labor markets. However, it also exposed systemic fragilities. Assessment practices often rely on standardized written assignments, large-scale examinations, and output-oriented evaluation methods (Selwyn, 2019). These mechanisms presuppose individual authorship, stable criteria of originality, and measurable intellectual effort (Bender et al., 2021; Spinger, 2024).

Such assumptions are increasingly problematic in an academic environment shaped by AI. The traditional university model was built on a temporal logic of slow intellectual maturation: reading, reflection, drafting, revision, and critique. This model is now confronted with technologies capable of generating large volumes of coherent academic-style text almost instantaneously.

3. ARTIFICIAL INTELLIGENCE AND THE REDISTRIBUTION OF COGNITIVE LABOR

One of the most significant consequences of AI diffusion is the redistribution of cognitive labor. AI systems increasingly relieve humans of intellectual competencies that were once central to academic training (Bender et al., 2021). Tasks such as summarizing literature, generating arguments, structuring essays, and even proposing theoretical interpretations can now be delegated to machines (Zawacki-Richter et al., 2019).

Historically, the preparation of a high-quality academic paper required months of sustained intellectual effort. Today, a program equipped with extensive databases and advanced language models can generate billions of textual variations in seconds. This radical compression of time fundamentally alters the meaning of academic production and challenges the implicit link between effort, time, and intellectual value.

As a result, academic work increasingly takes the form of cooperation between humans and machines. Students do not merely copy AI outputs; they often curate, modify, and integrate them into final submissions (Perkins et al., 2024). This hybrid authorship complicates the distinction between human and non-human intellectual activity and undermines traditional notions of originality.

4. AUTHENTICITY, ORIGINALITY, AND THE ILLUSION OF STUDENT AUTHORSHIP

Universities continue to require students to write papers independently, assuming that written output reflects individual understanding and learning. However, in the age of AI, this assumption is increasingly untenable.

It should be noted that many student works are no longer original in a traditional sense. Rather, they often consist of a clever combination of compilation, paraphrasing, and recombination of existing ideas mediated by AI systems (Springer, 2024). While such texts may be formally correct and stylistically sophisticated, they frequently lack genuine intellectual authorship.

This situation creates a paradox: student work may appear original while being epistemically derivative. The problem is not simply plagiarism, but the erosion of the connection between writing and thinking (Springer, 2024).

5. THE LIMITS OF ANTI-PLAGIARISM TECHNOLOGIES

A widespread institutional response to AI-related concerns has been the reliance on anti-plagiarism and AI-detection software (Perkins et al. 2024; Springer, 2024). However, it is a mistake to assume that professor-controlled technological surveillance can reliably identify fraud.

Traditional plagiarism detection tools are designed to identify textual overlap with existing sources (Perkins, 2024). Machine-generated texts, by contrast, are often statistically unique, even when they recombine existing knowledge. As a result, AI-generated works frequently bypass detection systems, rendering them ineffective (Perkins et al., 2024).

This technological limitation exposes a deeper conceptual flaw: academic integrity cannot be reduced to similarity detection. When machine-generated texts are unique, the problem is no longer technical but epistemological and pedagogical (Floridi 2019).

6. CRITICAL THINKING AND COGNITIVE DEPENDENCY

Another major concern is the potential loss of critical thinking in the age of AI. When students rely heavily on AI for idea generation and argument construction, they may disengage from processes of analysis, interpretation, and judgment.

The risk is not that students use AI, but that they delegate responsibility for thinking itself. Cognitive dependency emerges when learners accept AI outputs uncritically, without questioning assumptions, sources, or conceptual coherence (Floridi, 2019).

Universities must therefore redefine critical thinking to include the ability to interrogate AI-generated content, understand its limitations, and situate it within broader intellectual frameworks.

7. AI AS ACADEMIC SUPPORT: OPPORTUNITIES AND AMBIVALENCE

Despite these challenges, AI also offers significant opportunities for higher education. For lecturers and researchers, AI can automate repetitive tasks, support data analysis, and facilitate personalized learning environments (Zawacki-Richter et al., 2019). When used responsibly, AI can reduce cognitive overload and allow academic staff to focus on mentoring, dialogue, and conceptual development.

However, this supportive role must be carefully regulated. Without clear institutional guidelines, AI risks becoming a substitute for intellectual engagement rather than a tool that enhances it.

8. DISCONNECTION FROM HISTORICAL KNOWLEDGE AND INTELLECTUAL TRADITION

A further challenge concerns the relationship between AI-generated knowledge and historical intellectual achievements. AI systems operate by identifying patterns in existing data, not by understanding historical context, theoretical genealogy, or disciplinary debates (Floridi, 2019).

As a result, AI-generated academic texts may be formally correct yet disconnected from intellectual traditions. This threatens the university's role as a guardian of historical continuity, critical memory, and theoretical depth.

Universities must ensure that AI-assisted learning remains anchored in historical awareness and disciplinary identity, preserving the link between past knowledge and future innovation.

9. IMPLICATIONS FOR ASSESSMENT AND INSTITUTIONAL REFORM

The diffusion of AI compels universities to rethink assessment methodologies (Selwyn, 2019). Output-based evaluation is no longer sufficient. Alternative approaches may include:

- process-oriented assessment;
- oral examinations and defenses;
- reflective writing on AI use;
- project-based and collaborative learning;
- emphasis on interpretation rather than production.

Institutional policies should explicitly address AI use, not as a purely technical issue, but as a matter of academic responsibility and epistemic integrity.

10. CONCLUSION

The diffusion of artificial intelligence in universities represents a structural transformation rather than a temporary disruption. By redistributing cognitive labor, compressing intellectual time, and challenging traditional assessment mechanisms, AI forces universities to confront foundational questions about knowledge, learning, and human intellectual responsibility.

Attempts to control AI through surveillance technologies alone are insufficient. What is required is a deeper rethinking of pedagogical goals, assessment practices, and the meaning of originality in academic work. Only through critical and reflective integration of AI can universities preserve their role as institutions of critical thought, historical continuity, and genuine intellectual formation in the age of artificial intelligence.

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Homocysteine: From an Emerging Biomarker to a Functional Indicator of Endothelial Dysfunction

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Abstract

Homocysteine has emerged over recent decades as a significant biomarker associated with cardiovascular and cardiometabolic risk. Elevated plasma homocysteine levels have been linked to endothelial dysfunction, oxidative stress, inflammation, and prothrombotic states, all of which play a central role in the development and progression of atherosclerotic disease. This article provides an updated overview of the biological mechanisms through which homocysteine contributes to vascular damage, with particular attention to its impact on endothelial homeostasis.

The paper reviews current evidence on homocysteine metabolism, genetic and nutritional determinants of hyperhomocysteinemia, and its clinical relevance as a functional indicator rather than a mere biochemical marker. Special emphasis is placed on the interaction between homocysteine and B-group vitamins, oxidative pathways, and nitric oxide bioavailability, highlighting the multifactorial nature of endothelial impairment.

In addition, the role of targeted nutritional strategies and cardiovascular nutraceuticals in the management of elevated homocysteine levels is discussed, with reference to their potential contribution to primary and secondary prevention of cardiovascular disease. Rather than presenting new experimental data, this article aims to integrate existing clinical and pathophysiological knowledge to support a more comprehensive interpretation of homocysteine in cardiovascular risk assessment.

Overall, homocysteine is proposed as a clinically relevant functional indicator of endothelial dysfunction, offering useful insights for personalized prevention strategies in cardiometabolic medicine.

Keywords: Homocysteine, endothelial dysfunction, cardiovascular risk, oxidative stress, cardiometabolic prevention, nutraceuticals

1. INTRODUCTION

Homocysteine has long been a subject of interest in cardiovascular research, initially regarded as a simple biomarker associated with atherothrombotic risk (Refsum et al., 1998). More recent evidence has broadened its clinical significance, demonstrating that hyperhomocysteinemia represents a factor actively involved in processes of endothelial dysfunction, oxidative stress, and disruption of thrombotic balance (Lentz, 2005).

Within the context of modern cardiovascular prevention, homocysteine emerges as a transversal indicator capable of integrating metabolic, nutritional, and genetic information, particularly in patients with residual cardiovascular risk not explained by traditional risk factors (Nygård et al., 1997).

2. BIOCHEMISTRY OF HOMOCYSTEINE AND METHYLATION METABOLISM

Homocysteine is a sulfur-containing amino acid produced endogenously during methionine metabolism (Refsum et al., 1998). It occupies a central position between two fundamental pathways: remethylation to methionine and transsulfuration to cysteine. Proper functioning of these pathways depends on the availability of folates, vitamin B12, and vitamin B6, as well as on the efficiency of the enzymes involved (Refsum et al., 1998).

Even mild alterations in this balance can lead to an accumulation of plasma homocysteine, reflecting an impairment of cellular methylation capacity and antioxidant defenses, particularly glutathione synthesis (Lentz, 2005).

3. MECHANISMS OF VASCULAR DAMAGE

Hyperhomocysteinemia exerts a direct effect on the vascular wall through multiple pathogenetic mechanisms, including:

- reduction of nitric oxide bioavailability, resulting in loss of endothelium-dependent vasodilation;
- increased production of reactive oxygen species, leading to lipid and protein oxidation;
- induction of a pro-inflammatory state through up-regulation of endothelial adhesion molecules;
- activation of the coagulation cascade and inhibition of fibrinolytic mechanisms.

These processes contribute to the progression of atherosclerosis and promote the formation of unstable plaques, increasing the likelihood of acute ischemic events (Lentz, 2005).

4. HOMOCYSTEINE AND CARDIOVASCULAR DISEASE

Numerous epidemiological studies have shown that an increase of 5 µmol/L in homocysteine levels is associated with a 20–30% increase in the relative risk of cardiovascular events (Homocysteine Studies Collaboration, 2002). This association is particularly evident in early ischemic heart disease, cerebrovascular disease, and peripheral arterial disease (Wald et al., 2002).

The effect of homocysteine is not isolated but synergistic with other risk factors such as dyslipidemia, hypertension, diabetes, and smoking, contributing significantly to the so-called residual cardiovascular risk (Clarke et al., 2010).

5. CLINICAL EVIDENCE AND LIMITATIONS OF INTERVENTION TRIALS

Large randomized trials investigating vitamin supplementation (NORVIT, HOPE-2, VISP) have demonstrated effective reductions in plasma homocysteine levels; however, they failed to show a clear reduction in major cardiovascular endpoints in the general population (Bønaa et al., 2006; Lonn et al., 2006).

These findings do not negate the clinical relevance of homocysteine but suggest that it functions more as a marker of metabolic dysfunction than as an isolated therapeutic target. Timing of intervention, the form of folates used, and appropriate patient selection appear to be crucial determinants of clinical efficacy.

6. APPLICATIONS IN CARDIOVASCULAR CLINICAL PRACTICE

Measurement of homocysteine is particularly useful in patients with early cardiovascular events, progression of atherosclerosis despite optimal lipid profiles, or unexplained thrombotic events (Refsum et al., 1998). In these contexts, homocysteine helps identify subclinical metabolic alterations and guide personalized nutritional and nutraceutical interventions.

Interpretation should always be integrated with assessment of folates, vitamin B12, vitamin B6, and, in selected cases, genetic profiling—particularly MTHFR polymorphisms (Nygård et al., 1997).

7. AI AS ACADEMIC SUPPORT: OPPORTUNITIES AND AMBIVALENCE

Despite these challenges, AI also offers significant opportunities for higher education. For lecturers and researchers, AI can automate repetitive tasks, support data analysis, and facilitate personalized learning environments (Zawacki-Richter et al., 2019). When used responsibly, AI can reduce cognitive overload and allow academic staff to focus on mentoring, dialogue, and conceptual development.

However, this supportive role must be carefully regulated. Without clear institutional guidelines, AI risks becoming a substitute for intellectual engagement rather than a tool that enhances it.

8. CONCLUSIONS

Homocysteine currently represents a functional biomarker of endothelial dysfunction and vascular vulnerability. More than a simple risk factor, it reflects a systemic imbalance between methylation metabolism, oxidative stress, and inflammation (Lentz, 2005).

Integrating homocysteine measurement into advanced cardiovascular assessment pathways allows for more refined risk stratification and supports a preventive and personalized medicine approach focused on pathophysiology rather than on the control of traditional parameters alone.

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Closing Statement

This inaugural issue of JMEAS – Journal of Mediterranean, European and African Sciences represents both the beginning of a new scientific publication and a milestone of profound institutional significance.

Published on a four-monthly basis, JMEAS is conceived as an international, peer-reviewed journal dedicated to the dissemination of high-quality research in engineering, applied sciences, and related multidisciplinary fields. The launch of Issue No. 1 coincides with the official recognition of Medea University as a university institution on December 9, 2025, marking a foundational moment in the academic mission and international development of the University.

The establishment of JMEAS reflects a strategic vision aimed at strengthening scientific dialogue and cooperation across the Mediterranean, European, and African regions. In a rapidly evolving global research environment, the journal seeks to promote rigorous, ethical, and innovative scholarship that transcends disciplinary and geographical boundaries, addressing complex scientific and societal challenges.

All contributions published in this issue have undergone a double-blind peer review process, in accordance with internationally recognized standards of academic quality, transparency, and integrity. The journal is committed to maintaining editorial independence, methodological rigor, and ethical publishing practices, in line with the requirements of major indexing and abstracting services.

Issue No. 1 brings together original research and applied studies that exemplify the multidisciplinary scope of JMEAS and its commitment to fostering collaboration among scholars from diverse academic traditions. By offering an inclusive platform for both established researchers and early-career scholars, the journal aims to support the advancement of knowledge and the dissemination of research with tangible scientific impact.

This first issue is intended not only as the starting point of a regular publication but also as a statement of purpose. JMEAS aspires to become a stable and recognized reference journal, contributing to the sustainable development of science, technology, and society across regions.

On behalf of Medea University, I am pleased to present this inaugural issue and to invite the international scientific community to engage with, contribute to, and grow alongside JMEAS – Journal of Mediterranean, European and African Sciences.

David Vannozzi

President and CEO

Med.E.A. - Pegaso International LTD