ISLAMIC WORLD ACADEMY OF SCIENCES

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HUMAN SOLIDARITY AND THE DAWN OF A NEW ERA

HIS ROYAL HIGHNESS PRINCE EL HASSAN BIN TALAL
FOUNDING PATRON OF THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)

As we welcome the new year, we hope it will be a time of prosperity, marked by peace and tranquillity. This hope holds particular significance in a world increasingly characterised by harshness, polarisation and the spread of hatred amidst conflicts, wars, crises and natural disasters. These challenges have widened the gap between humanitarian needs and available resources, emphasising the urgent need to reconsider the optimal way to address these needs.

The Qur'an tells us that doing good is the path to a fulfilling life: ﴿Whoever does righteousness, whether male or female, while being a believer - We will surely cause him to live a good life﴾. This "good life" is the aspiration of every believer. Hope empowers individuals to face crises and persevere. Its importance extends beyond religious belief, serving as a vital necessity for resilience and strength.

Today, we witness a clear decline in the values of justice and compassion within our societies. The "right of might" has overshadowed the "might of right", where powerful nations oppress and occupy, defy the law, evade accountability and impose conditions on vulnerable nations burdened by debt and poverty.
In this context, a pressing question arises: How can we speak of human solidarity in a world where values have been distorted, human dignity is undermined, aggressors are celebrated, and the oppressed are punished?

There is an urgent need for a moral and cultural transformation, coupled with a thorough re-evaluation of the concepts of justice, rights, freedom and humanity. Charitable acts alone are insufficient to drive meaningful change. Emotional solidarity, while important, cannot alleviate the suffering of the marginalized. Instead, they must be empowered socially, educationally, medically and psychologically. This requires the establishment of effective institutions dedicated to fostering Islamic and human solidarity through mutual support and cooperation.

True human solidarity is built on the respect for human dignity, pluralism and diversity — values that stand in stark contrast to polarisation and hatred. Policies must prioritise human dignity and promote respect for others' identities. Achieving sustainable social and economic development within the Arab and Islamic societies requires

integration and solidarity, enabling the cultural and structural changes necessary to overcome crises.

We must reflect on critical global challenges and adopt humanitarian principles to create a new global system that upholds human dignity and strengthen solidarity among people. This approach is essential to address the challenges facing humanity and its future.

Change begins with embracing human dignity as core educational value, a policy framework and a basis for collective action. This Perspective fosters awareness and reinforces values that define our humanity — compassion, empathy, respect and cooperation. It calls us to engage in humanitarian efforts that advocate for shared human interests, environmental stewardship and accountability for our responsibilities toward the planet.

The advancement of human civilization requires building four fundamental relationships: between individuals and themselves, individuals and other, humanity and nature, and humanity and the Creator. These relationships are grounded in morality, faith, knowledge and actions. Efforts should focus on securing people in their homelands, facilitating the return of the displaced individuals, promoting community investment, and modernizing economies to ensure equitable wealth distribution.

For decades, I have called for the establishment of an institution to coordinate joint projects, provide disaster relief and support economic and social development. Such efforts would contribute to global initiatives aimed at eradicating poverty and deprivation, fostering "effective altruism" that leaves no one behind, and strengthening human brotherhood and social cohesion.

It is time to prioritise regional stability and adopt a vision rooted in integration and harmony between humanity and the environment. This necessitates reassessing priorities at every level - from individuals and communities to states and nations. We must champion responsible freedom as a tool for positive change, fostering awareness, spreading knowledge and promoting citizenship that celebrates diversity. Good governance must guide community development.

Addressing the suffering of vulnerable groups requires humanising statistics, implementing clear plans and adopting measures grounded in a clear vision. Binding international humanitarian laws are essential to achieving both internal and external peace, replacing exploitation and injustice with solidarity and justice. This shift could also reduce the massive resources allocated to military industries that profit from wars and conflicts.

Our Eastern societies remain vulnerable to external efforts to divide them along ethnic, sectarian, and religious lines. Such attempts exploit their rich diversity, turning it into a source of tension and conflict to facilitate control and subjugation. To counter these efforts, we must build bridges between the four pillars of the region—Arabs, Persians, Turks, and Kurds—while fostering platforms for integration, dialogue, and positive participation. Strengthening mutual understanding and promoting the values of tolerance are essential to resisting these divisive forces.

In conclusion, the peace we seek begins with self-reflection and the discovery of the inner goodness that God has instilled within us. This foundation enables us to challenge misconceptions that justify weakness, regression, and division, setting us on a path toward collective renewal and shared prosperity.

Source: *https://jordantimes.com/opinion/el-hassan-bin-talal/human-solidarity-and-dawn-new-era*
14 January 2025

ARTIFICIAL INTELLIGENCE IN MALAYSIA, TURKEY, AND PAKISTAN: A COMPARATIVE ANALYSIS

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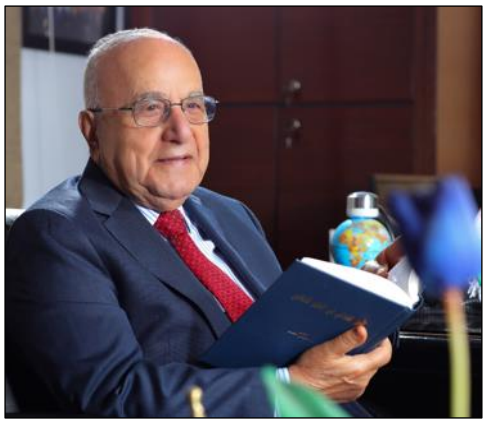

Abstract

Artificial Intelligence (AI) has emerged as a transformative technology across the globe, with varying degrees of adoption and development in different countries. This paper explores the state of AI in Malaysia, Turkey, and Pakistan, highlighting the advancements, challenges, and governmental initiatives in each country. By comparing the strategies and outcomes, this study aims to provide insights into how these nations can harness AI for economic growth and social development.

1. Introduction

The rapid evolution of AI technologies presents both opportunities and challenges for nations worldwide. Malaysia, Turkey, and Pakistan are at different stages of AI adoption, influenced by factors such as government policies, educational infrastructure, and industry collaboration. This paper examines the current landscape of AI in these three countries, focusing on their strategies, achievements, and obstacles.

2. Overview of Artificial Intelligence

AI refers to the simulation of human intelligence in machines programmed to think and learn. It encompasses various technologies, including machine learning, natural language processing, and robotics. The global AI market is expanding rapidly, with applications across industries such as healthcare, finance, transportation, and education.

3. Artificial Intelligence in Malaysia

3.1 Current Landscape

Malaysia has made significant strides in AI development, driven by government policies and private sector initiatives. The Malaysian government launched the National Artificial Intelligence Framework (NAIF) in 2021, aiming to position the country as a regional leader in AI by 2030.

3.2 Key Initiatives

- **Government Programs**: The Malaysian government has invested in AI research and development, establishing collaborations with universities and research institutions.
- **Industry Engagement**: Malaysian companies, particularly in sectors like finance and healthcare, are increasingly adopting AI technologies to enhance efficiency and customer experience.

3.3 Challenges

Despite its advancements, Malaysia faces challenges such as a shortage of skilled AI professionals, ethical concerns regarding AI deployment, and the need for a robust regulatory framework.

4. Artificial Intelligence in Turkey

4.1 Current Landscape

Turkey has recognized the potential of AI and has made it a priority in its national strategy. The Turkish government launched the National Artificial Intelligence Strategy in 2021, focusing on innovation, research, and development.

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4.2 Key Initiatives

- **Government Investment**: Turkey has allocated significant funding for AI research, establishing AI research centers and incubators.
- **Educational Programs**: Turkish universities are developing AI curricula and fostering partnerships with the tech industry to enhance research and application.

4.3 Challenges

Turkey faces a lack of infrastructure for AI research, and the need for better collaboration between academia and industry.

5. Artificial Intelligence in Pakistan

5.1 Current Landscape

Pakistan is in the early stages of AI development, with growing interest from both the government and private sectors. The country has recognized the importance of AI in achieving its economic goals.

5.2 Key Initiatives

- **Government Policies**: The government has launched initiatives to promote technology and innovation, including the establishment of the National Centre of Artificial Intelligence.
- **Emerging Startups**: The Pakistani startup ecosystem is rapidly growing, with several companies focusing on AI solutions in various sectors.

5.3 Challenges

Pakistan faces significant challenges, including limited funding for AI projects, a lack of skilled professionals, and inadequate infrastructure for research and development.

6. Comparative Analysis

6.1 Government Policies

- Malaysia and Turkey have more structured national AI strategies compared to Pakistan, which is still developing its framework.
- All three countries recognize the importance of AI for economic growth but differ in their implementation and investment levels.

6.2 Educational Infrastructure

- Malaysia and Turkey have stronger educational frameworks for AI compared to Pakistan, which is still developing its academic programs in this field.
- Collaboration between universities and industry is more pronounced in Malaysia and Turkey.

6.3 Industry Adoption

- Malaysia and Turkey have seen significant industry adoption of AI technologies, particularly in finance and healthcare.
- Pakistan's AI industry is emerging, with a focus on startups and innovation.

Conclusion

Artificial Intelligence presents immense potential for Malaysia, Turkey, and Pakistan to drive economic growth and social development. While Malaysia and Turkey are leading in terms of policy and implementation, Pakistan is beginning to recognize the importance of AI. All three countries must address challenges such as skill shortages, ethical considerations, and infrastructure development to fully realize the benefits of AI.

Recommendations

- **For Malaysia and Turkey**: Continue to enhance collaboration between government, academia, and industry to foster innovation and research.
- **For Pakistan**: Develop a comprehensive national AI strategy and invest in educational programs to build a skilled workforce.
- **For All Countries**: Establish ethical guidelines and regulatory frameworks to ensure responsible AI.

9. Future Outlook

The future of AI in Malaysia, Turkey, and Pakistan appears promising, given the increasing global emphasis on digital transformation. However, the pace of AI adoption will depend on several factors, including:

9.1 Investment in Research & Development

Continued investment in AI research and development is crucial for all three countries. Governments, private sectors, and academic institutions need to collaborate to create a robust

ecosystem that fosters innovation. Increased funding for AI-related projects and research initiatives can lead to groundbreaking applications and solutions tailored to local challenges.

9.2 International Collaboration

Collaborating with international AI research organizations and tech firms can provide access to advanced technologies and expertise. By participating in global AI forums and partnerships, Malaysia, Turkey, and Pakistan can enhance their capabilities and accelerate the adoption of AI.

9.3 Focus on Ethical AI

As AI technologies evolve, ethical considerations must be at the forefront. Developing ethical guidelines and regulatory frameworks can help address concerns related to data privacy, algorithmic bias, and job displacement. Establishing a clear ethical framework will foster public trust in AI technologies and ensure responsible usage.

9.4 Building a Skilled Workforce

The demand for AI professionals is growing, and all three countries must prioritize education and training programs. By enhancing AI curricula in universities and offering vocational training in AI technologies, these nations can build a skilled workforce equipped to meet industry needs. Initiatives such as internships, workshops, and partnerships with tech companies can provide practical experience for students.

10. Case Studies

10.1 Malaysia: AI in Healthcare

Malaysia has adopted AI technologies in healthcare to improve patient outcomes. The integration of AI in diagnostic tools, patient management systems, and telemedicine has shown promising results in enhancing healthcare services, especially in rural areas.

10.2 Turkey: AI in Agriculture

Turkey's agricultural sector has begun utilizing AI for precision farming. Technologies such as drone surveillance, predictive analytics, and automated irrigation systems are helping farmers optimize crop yields and reduce waste. The government's support for agricultural innovation has facilitated the adoption of these technologies.

10.3 Pakistan: AI Startups

Pakistan's startup ecosystem is witnessing a surge in AI-driven solutions. Companies are emerging in areas such as fintech, e-commerce, and healthcare, leveraging AI for data analysis, customer engagement, and service delivery. This trend highlights the potential for AI to drive economic growth and job creation in the country.

Conclusion

In conclusion, the comparative analysis of AI in Malaysia, Turkey, and Pakistan reveals diverse landscapes, each with unique strengths and challenges. While Malaysia and Turkey have established frameworks and strategies for AI development, Pakistan is making strides in its nascent AI ecosystem. By focusing on collaboration, investment, ethical considerations, and workforce development, these countries can harness the transformative power of AI to drive innovation, economic growth, and social progress.

Sources:

1. https://www.miti.gov.my/miti/resources/National_AI_Framework.pdf
2. https://www.btk.gov.tr/en/duyuru/2021/national-artificial-intelligence-strategy-draft
3. https://www.moitt.gov.pk/
4. https://www.weforum.org/reports/the-future-of-jobs-report-2022
5. https://www.mckinsey.com/featured-insights/artificial-intelligence
6. https://ieeexplore.ieee.org/document/9050001
7. https://www.mjms.usm.my/
8. https://www.journalofagriculturalscience.com/
9. https://www.pakistan.tech/

HALODULE UNINERVIS EXTRACT FACILITATES THE GREEN SYNTHESIS OF GOLD NANOPARTICLES WITH ANTICANCER ACTIVITY[**]

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Abstract

Gold nanoparticles (AuNPs) have been utilized in a plethora of applications due to their unique optical properties, high stability, and great biocompatibility. The use of plant extracts in the biosynthesis of AuNPs has emerged as an eco-friendly, inexpensive, and nontoxic approach. In the present study, the ethanolic extract of *Halodule uninervis* (HUE) was used for the first time in the green synthesis of AuNPs. The biogenic AuNPs were characterized using several spectroscopic and microscopic techniques and their anticancer potential was investigated. They displayed a surface plasmon resonance (SPR) band at 550 nm. Scanning electron microscopy (SEM) and Dynamic light scattering (DLS) analysis proved the synthesis of small and spherical AuNPs with a zeta potential of − 27.66 mV. X-ray diffraction (XRD) pattern established the crystalline nature of AuNPs. Thermogravimetric analysis (TGA) and Fourier transform infra-red spectroscopy (FTIR) data confirmed the role of HUE in the capping and stabilization of the manufactured AuNPs. The produced AuNPs exhibited anticancer activity against several human cancer cell lines, highlighting their potential efficacy as anticancer therapeutic agents. Further analysis revealed that this observed cytotoxicity is mediated via the induction of apoptosis. Overall, our data validate the effective use of *H. uninervis* extract in the biosynthesis of AuNPs with significant biological properties.

Citation: Wehbe, N., Mesmar, J.E., El Kurdi, R. et al. Halodule uninervis extract facilitates the green synthesis of gold nanoparticles with anticancer activity. *Sci Rep* **15**, 4286 (2025). https://doi.org/10.1038/s41598-024-81875-0

[**] *Link to the whole publication: https://www.nature.com/articles/s41598-024-81875-0*

EVALUATING THE IMPACT OF DIFFERENT BIOCHAR TYPES ON WHEAT GERMINATION**

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Abstract

This study assessed sustainable solutions for organic waste management, focusing on biochar derived from kitchen waste. The characteristics and phytotoxicity effects of biochar produced from four different types of kitchen waste were investigated in view of potential agricultural applications. Analysis of the chemical and physical properties of the different biochar samples by X-ray fluorescence and Fourier transform infrared spectroscopy revealed a nutrient-rich composition with carbon, calcium, and potassium contents that ranged from 35 to 48%, from 1.6 to 24%, and from 1.5 to 28.5%, respectively. In phytotoxicity tests, the highest germination rate (45%) was observed with Coffee residue biochar obtained at 300 °C (application rate of 1%) and the longest shoot length (25 cm) with orange peel biochar obtained at 300 °C (application rate of 1%). Germination rate and shoot length were not significantly different between biochar-exposed soils and control soils (without biochar), indicating no toxic effect due to biochar addition. Washing biochar improved germination rates significantly (control: 98%; potato peel biochar: 92%; banana peel biochar: 83%). The longest shoot length (8.3 cm) was obtained with the washed potato peel biochar (pyrolysis temperature = 400 °C) extract. These findings suggest that biochar can be safely used as a soil amendment without harming the environment or hindering plant growth. The Tukey honestly significant difference (HSD) test results further emphasized the influence of different factors, such as pyrolysis temperature and feedstock type, in biochar applications.

Keywords Biochar, Organic waste valorization, Germination test, Soil amendment, Characterizations

Citation: Kataya, G., Charif, Z.E., Badran, A. et al. Evaluating the impact of different biochar types on wheat germination. *Sci Rep* **14**, 28663 (2024). https://doi.org/10.1038/s41598-024-76765-4

**Link to the whole publication: https://www.nature.com/articles/s41598-024-76765-4*

MEDICINAL AND AROMATIC PLANT RICHNESS OF TÜRKIYE - WHAT TO DO FOR RATIONAL PHYTOTHERAPY?

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The use of plants for therapeutic purposes has been known to mankind since ancient times. Compared to the flora of the European continent, which has a total of around 8000 plant species, our country is much richer with a flora of over 12000 plant species. There are 11,707 plant taxa belonging to 167 families in the flora of Türkiye, of which 3,649 are endemic. The rate of endemism, which refers to plant species that grow only in Türkiye, is approximately 30%. Anatolia is also the gene center of many plants. Of these, 500 plants are used for medicinal and aromatic purposes. Approximately 100 of these plants are collected from nature for export purposes. This herbal richness has been passed down from generation to generation for centuries in our country and has formed the concept of "Anatolian folk medicine".

Medicinal and aromatic plants have been widely used in traditional food forms, as food supplements or herbal medicines from the past to the present. Medicinal and aromatic plants have become popular in Türkiye, where the return to nature has become a slogan. In line with this trend, recently referred to as the "back to nature" or "green trend", interest and demand for herbal or other naturally derived products has increased in both developed, developing, and underdeveloped societies of the world. Medicinal, aromatic, and dye plants are divided into two categories: those collected from nature and those cultivated. Medicinal and aromatic plants collected from nature are the parts of plants that grow spontaneously in habitats such as forests, pastures, unused agricultural lands such as fruits, stems, leaves, flowers and sometimes weeds growing in agricultural lands. A significant portion of medicinal and aromatic plants traded worldwide are collected from nature. On the other hand, it is recommended that cultivated medicinal and aromatic plants should be produced in a controlled manner according to "good agricultural practices" (GAP). In fact, quality and control in herbal medicine starts in the field. Various factors such as the place where the plant grows, seasonal conditions, time of collection of plant parts (season, time of day, etc.), environmental factors (climate, humidity, etc.), differences in agricultural methods applied, post-harvest processing, and storage conditions (temperature, humidity) can change the amount of active substance in the plant species and its pharmacological effect.

Herbal medicinal products are currently a rising trend both in the world and in Türkiye. The fact that herbal medicinal products are recognized as safe and healthy products with fewer side effects than chemical drugs is an important point in the formation of this perception. For example, the market for herbal medicinal products and pharmaceuticals has grown significantly in the past 10-15 years, despite the global economic recession and pandemic conditions. Currently, the global herbal product market is worth over $100 billion, and in Türkiye, this market is estimated to be around $5 billion. In Türkiye, called as a plant paradise, we still meet our extract and raw material needs through imports. The medicinal and aromatic plants we export are sold at very cheap prices and are returned to us as processed or finished products at great cost. We definitely need to reverse this.

According to the Medicinal and Aromatic Plants Sector Policy Document (2020-2024) published by the Ministry of Agriculture and Forestry, Türkiye increased its exports of medicinal and aromatic plants by 3.5 times from approximately USD 106 million in 2001 to approximately USD 371 million in 2019. Among the main group of the plants, thyme has an export value of USD 53.9 million, while bay leaf has an export value of USD 38.2 million. The most important medicinal and aromatic plants exported from Türkiye Türkiye are thyme, bay leaf, cumin and aniseed, as well as fennel, saffron, juniper bark, mahaleb, fenugreek, cumin, rosemary, black cumin, licorice, ginger, mint, sumac, sage and lime blossom... However, with the right policies and coordination, it is possible for our country to get a much larger share of this trade.

There are 74 plants in the medicinal aromatic plant reference list announced by the Agriculture and Rural Development Support Institution (ARDSI) in Türkiye, which are supported. Some of these are; sage, aloe vera, aronia, rosemary, black cumin, bay laurel, dill, mallow, echinacea, basil, goji berry, jujube, linden, buckwheat, thyme, lavender, sweet gourd, and blueberry. ARDSI provides a minimum of 5,000 Euros and a maximum of 500,000 Euros for medicinal aromatic plant cultivation. The part of the projects exceeding this upper limit is not supported. Investments with a total eligible expenditure amount below the lower limit are rejected. It is necessary to carry out breeding studies in plants completed as a result of agronomic studies of certified medicinal and aromatic plants seed and to complete registration and certification in species and varieties whose breeding is completed.

What we mean by the term “herbal medicine” in the definition of phytotherapy is “phytopharmaceuticals/phytotherapeutics”, which are products that contain various parts of the plant or standardized plant extracts in raw or processed form, whose mode of action has been explained, whose acceptable safety limits, side effects, contraindications, stability and toxicity have been determined, which have reproducible physiological effects and which comply with the definition of modern pharmaceuticals. They are produced in accordance with GMP rules and prepared in pharmaceutical form. This definition is technically not much different from conventional (synthetic) drugs. The only difference is that phytotherapeutics contain a standardized pharmaceutical-quality extract of one or more compounds instead of a single active ingredient. In other words, there is no difference in production between a paracetamol preparation you buy from a pharmacy and an herbal medicine from preparation to delivery to the patient. Both must offer the same quality of medicine to the patient and demonstrate efficacy.

In fact, although the flora of Türkiye is of great economic importance due to its wide potential and cultural richness in terms of plant diversity and being the gene center of many medicinal and aromatic plants, unfortunately, this potential still cannot be used effectively. Today, high share of the herbal medicine/product market in Türkiye consists of imported products. In fact, the pharmaceutical industry in Türkiye has sufficient resources, know-how and technology to produce, develop, and introduce new products to the market. However, if the local pharmaceutical industry takes ownership of this field, herbal medicinal preparations, which are quite expensive, will be obtained more reasonably as a result of local production, high quality, and drug form preparations will be obtained and their market share will increase. The medicinal and aromatic plant potential of our country should be evaluated very well, as they are very important materials not only for phytotherapeutic or herbal medicine, but also for cosmetics and nutraceutical/supplementary food markets.

CO_2 FROM CLIMATE LIABILITY TO RAW MATERIAL SUPPLY: CO_2 GREEN CONVERSION TO MULTI-FUNCTIONAL CARBONATES

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Abstract:
This article describes a proven new nanotechnology that aims to transform CO_2 into multifunctional nano-scaled carbonates in an environmentally friendly, economical, and energy-efficient manner. This latter family of 1-D shape anisotropy calcium carbonates demonstrated a high porosity for potential drug carriers and supplementary compounds in the pharmaceutical and cement industries, as well as an effective response as a nanofetilizer for the agriculture sector and a highly reflecting paint compound for potential radiative cooling. Natural extracts can be used as efficient chelating agents to replicate this green bio-waste bio-engineering-based technique.

1. Introduction

From 1900 onwards, the world's CO_2 emissions from fossil fuels increased significantly, with emissions coming from both industrial operations and the burning of fossil fuels. The booming industrial revolution, which served as a powerful accelerator for today's technological advancements, was mostly to blame for these emissions. In addition to the use of fossil fuels, other CO_2-intensive industries that contribute to CO_2 emissions include the production of cement [1-2]), waste-to-energy [3-4], ethanol facilities [5], and chemical production plants including agri-fertilizers sectors [6]. The total annual carbon dioxide (CO_2) emissions recorded increased every year from 1990 (20.5 Gt CO_2) to 2019 (33.4 Gt CO_2), a 63% increase over 29 years, with the exception of 2009 (due to the economic recession) [7] and 2020 (due to the COVID-19 pandemic) [8-10].

As summarized in Figure 1, several nations from the Islamic organization are among the top emitters per capita. Qatar, Kuwait, UAE contribute at the highest level; of about 19.5 Metric tonnes per person per year (MTpy). Saudia Arabia (14.5), Kazakhstan (11.7), Iran (7.0), Turkey (4.4), Iraq (3.5) with China & the USA at the levels of 7.1 and 14.4MTpy respectively.

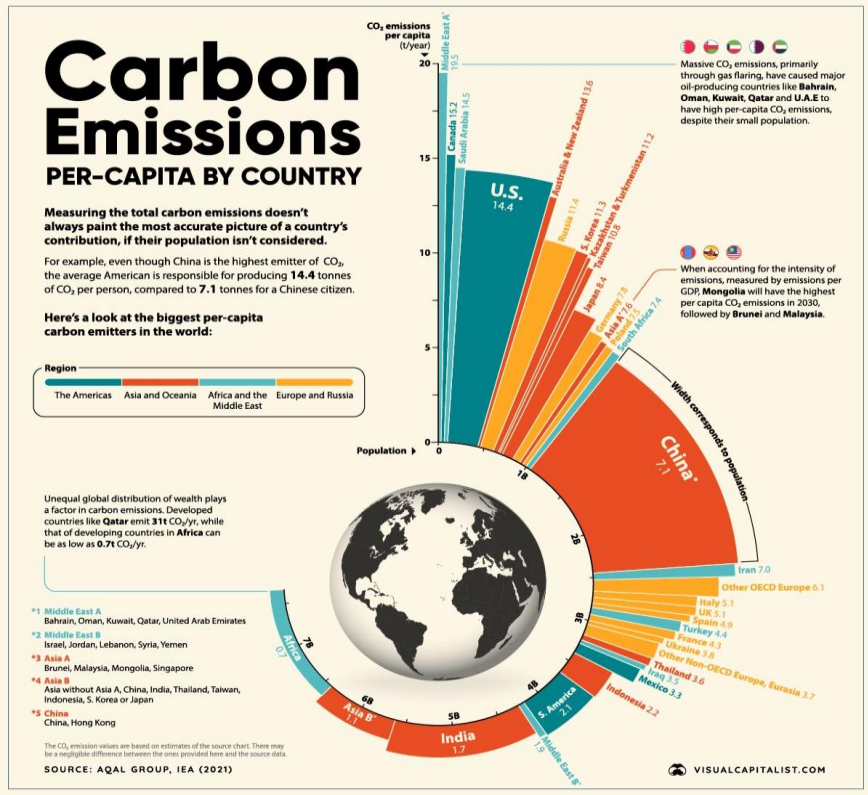

Figure 1: CO_2 emission per capita [Aqal Group, IEA(2021 & World Bank(2018).

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Above & beyond these alarming figures, and besides the existing CO_2 technologies which are costly & energy intensive in general, it is necessary to develop innovative green & non energy intensive CO_2 minimization processes. De-carbonization techniques and associated technologies (CO_2 sequestration, CO_2 cycling, CO_2 conversion, etc.) are being thoroughly researched in light of the urgent urgency of climate change [11] in order to reduce the global footprint of CO_2 [12–14]. It is possible to efficiently produce cabonates (XCO_3) in general and calcium carbonate ($CaCO_3$) specifically by using atmospheric CO_2 and turning it into a useful end product, such as a major component in the cement industry [15], white paint pigment for radiative cooling [16], green fertiliser in the agriculture field [17], or as a drug carrier in the pharmaceutical sector [18-19].

It is to be pointed that nearly 4% of the Earth's crust is made up of $CaCO_3$. This has been the subject of much research because of its significance in bio-mineralization in natural systems. This includes but not limited to the production of alkalinity and the biogeochemical cycling of elements [7]. Such a bio-mineralization is the major driving natural process in the formation of sea shell systems comprising pearls & coral [20–23]. Likewise, egg-shells of thee fauna family form a calcite carbonate by opposite to the highly ordered carbonate of Pearls. The main difference between such carbonates are their crystallographic structures. These latter encompasses Calcite, Aragonite, Vaterite crystallographic structures and their polymorphs [18-20].

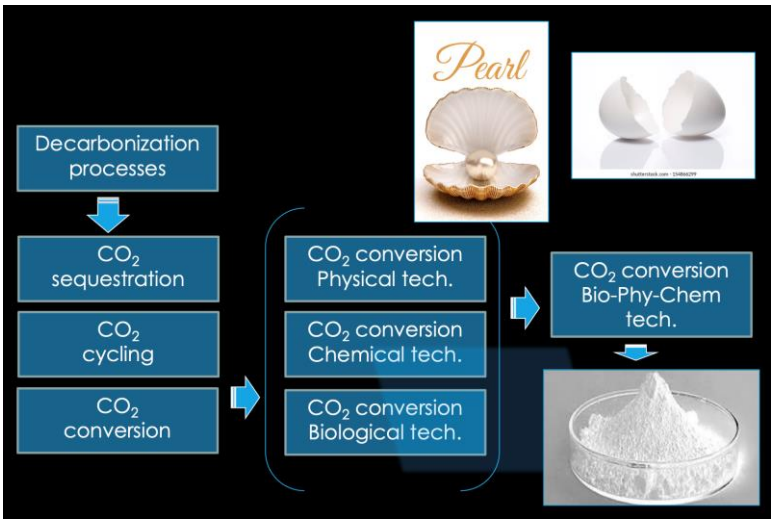


Figure 2: Major decarbonisation processes.

Within the landscape of decarbonisation, one can distinguish 3 major processes; (i) CO_2 sequestration, (ii) CO_2 cycling & (iii) CO_2 conversion (Figure 2). Within this latter process, and as reported in Figure 2, there are 3 modes; (i) Physical, (ii) Chem–engineering based and (iii) bio-based approaches. Recently, a novel green & cost effective bio-based technology was validated [24]. This latter is an outright green novel bio-engineering approach for the biosynthesis of single phase crystalline nano-scaled CaCO3 using H_2O as the unique solvent and natural extract of Hyphaene thebaica fruit as an effective chelating agent.

In this room temperature green process of converting CO_2 to Carbonate, $CaCl_2$ and CO_2 are used as the sole source of Ca and CO_3 respectively in view of bio-engineering nano-scaled $CaCO_3$ with a significant shape anisotropy and an elevated porosity.

In terms of novelty and originality, and relatively to the reported scientific and patented literature in relation to the fabrication of $CaCO_3$ by green nano-chemistry, the reported cost effective room temperature green process can be singled out as per the following specificities:

(i) Only water as universal solvent is used,
(ii) (ii)No additional base or acid chemicals for pH control,
(iii) No additional catalyst,
(iv) No critical or supercritical CO_2 usage conditions,
(v) Only natural extract of Hyphaene thebaica as an effective chelating agent via its phytochemicals and/or enzymatic compounds,
(vi) Room temperature processing,
(vii) Atmospheric pressure processing,
(viii) No extra thermal annealing required,
(ix) Nano-scaled size particles,
(x) Nanoparticles with a significant shape anisotropy (1-D like nanoparticles)

2. Results & discussions

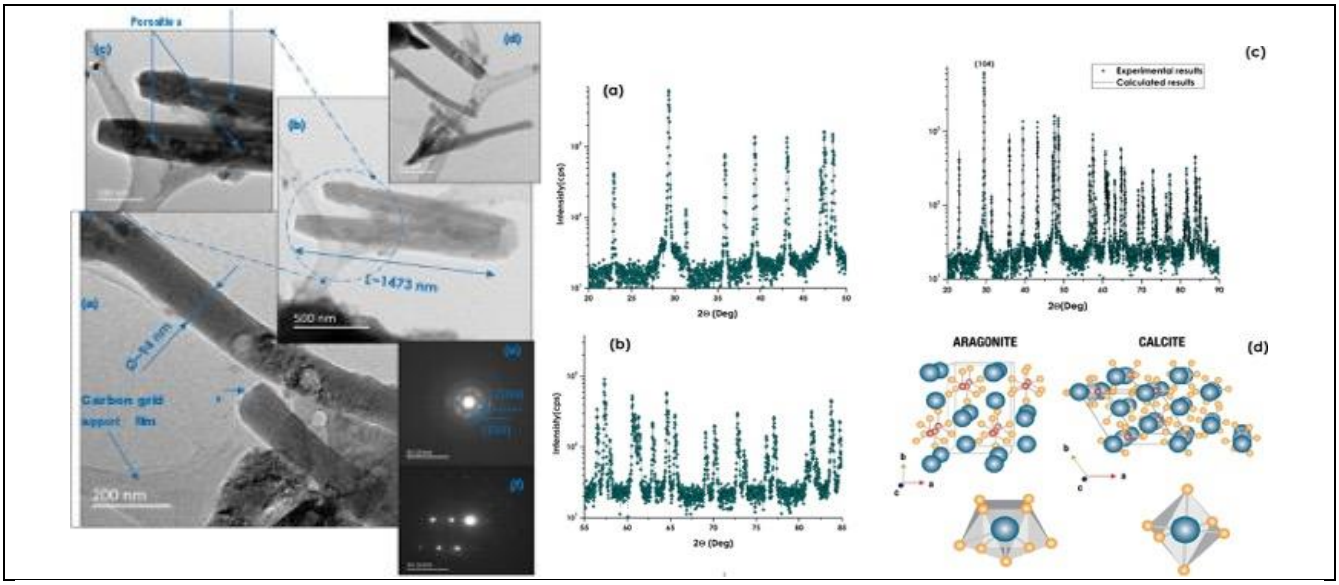


Figure 3: Typical high resolution transmission electron microscopy (HRTEM) and selected area electron diffraction (SAED) & X-rays diffraction pattern of the bio-engineered $CaCO_3$.

Figure 3 reports the high resolution transmission electron microscopy (HRTEM) and Selected Area Electron Diffraction (SAED) of the bio-engineered $CaCO_3$. The particles exhibit nano-scale size and a crystal-clear shape anisotropy in a form of 1-D tubular nanorods with sharp truncated end facets in general. Their basal diameter as well as their longitudinal dimension are relatively polydisperse. A typical Basal and longitudinal dimensions of such nanorods are $ø_{Basal}$ ~ 94 nm and D_{Long} ~ 1473 nm. But they can be longer (> 1µm). In some cases, they form bundles.

As established, in standard P–T conditions, $CaCO_3$ crystallises in three major basic phase: calcite (rhombohedral), Aragonite (orthorhombic), and Vaterite (orthorhombic). Calcite is thermodynamically the most stable in most environments. Figure 3 displays the Θ–2Θ X-rays diffraction spectra within the angular range of 20°–50° and 55°–85° respectively of the currently bio-engineered $CaCO_3$. As per Figure 3, 16 Bragg peaks were observed. The most intense is the one centred at 29.45° which is the most strong characteristic (104) reflection of the Calcite. Following a MAUD treatment. The simulation of the full spectrum, the derived lattice parameters are ⟨a⟩ = ⟨b⟩ = 4.883 Å and ⟨c⟩ = 16.310 Å. Within the experimental bar errors, these parameters are in agreement with pure Calcite trigonal crystallographic structure with a space group R-3c. One should mention that the lattice parameters of the 3 major phases in their bulk configuration are as follows:

Bulk Calcite trigonal: ⟨a⟩ = ⟨b⟩ = 4.9892 Å and ⟨c⟩ = 17.06089 Å, Space group R-3c.
Bulk Aragonite orthorhombic: ⟨a⟩ = ⟨b⟩ = 4.9803 Å and ⟨c⟩ = 17.0187 Å.
Bulk Vaterite orthorhombic: ⟨a⟩ = ⟨b⟩ = 4.1226 Å and ⟨c⟩ = 8.4653 À, Space group P63/mmc.
Hence, the currently bio-engineered $CaCO_3$ is of single phase calcite structure

3. R&D translations: potential technological applications Properties:

3.1 Light scattering and white pigment paint applications

Figure 4a displays the standard diffuse reflectance spectrum under normal incidence of the bio-engineered CaCO3 nanoparticles (in their pelletised powder form) within the spectral range of 200–1000 nm. Figure 4.b. displays the corresponding zoom on the UV-Bleu spectral region of 200–345 nm. From Fig. 4a, one can safely state that there are 2 major regions, separated approximately at 300.1 nm, above which the average diffuse reflectivity is about ~ 83.7%. Such

an elevated reflectivity within the visible (VIS) and Near infrared (NIR) solar spectral regions is a characteristic of highly reflecting solar materials equivalent to that of standard white pigments including $BaSO_4$, ZnO and TiO_2. Henceforth, one could safely conclude that the bio-engineered $CaCO_3$ nanoparticles could be a potential compound for white pigment coatings' applications. If one considers the zoom of Fig. 4.b., one could single out the minimum in the diffuse reflectance centred approximately at about ~ 221.5 nm with a reflectivity as low as 37.5% and the region delimited between 244.0 nm and 301.1 nm. If one consider the cut-off wavelengths $\lambda_{cut\text{-}off}$ as defined as the limit between the low and high reflectivity regions, then the value of $\lambda_{cut\text{-}off}$ could be approximated as defined by the intersection of the slope with the wavelength x-axis as indicated in Fig. 4.a. (dashed line intersecting the x-axis). Such an intersection is ~ 213.5 nm. If so, one could associate an optical bandgap of $E_g = hc/(\lambda_{cut\text{-}off} = 6.42$ eV ($\lambda_{cut\text{-}off}$ ~ 213.5 nm) (h, Plank's constant and c, Celerity of light). This latter value of $E_g = 6.42$ eV is not far from the experimental bulk Calcite value of 6.0 ± 0.35 eV and hence potential applications as paint white pigment [26-28].

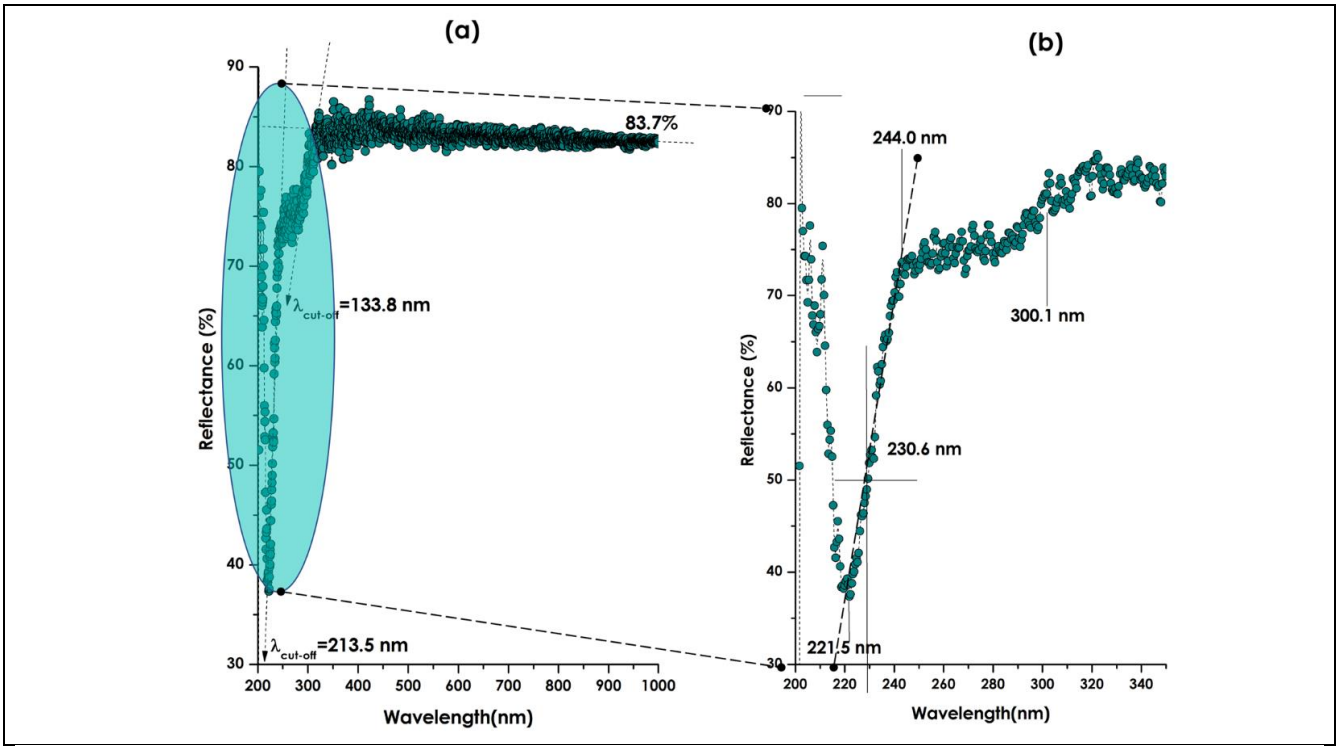


Figure4: (a)Standard diffuse reflectance spectrum under normal incidence of the bio-engineered $CaCO_3$ 1-D nanoparticles within the spectral range of 200–1000 nm, (b) the corresponding zoom on the UV-Bleu spectral region of 200–345 nm.

3.2 Nano-nutrient / fertilizer response and agri-applications:

As in the case of Zinc, Calcium is a crucial plant nutrient playing a vital role in maintaining plant cellular metabolism. As a biocatalyst becoming functional through Calcium ionic species, These Calcium ionic species are concerned with hydrocarbons metabolism, maintenance of cellular membranes, leaf morphology, physiology of membrane, protein production, [29]. Likewise, it is established that Ca^{2+} activates various types of enzymes, hence is a pivotal co-factor within the plant system. More precisely, It participates in membrane transport metabolisms, nitrate take-up and in biomass proportion [29] and photosynthetic rate [30–32]. In addition, it has been demonstrated that Ca^{2+} enhances the saltiness and improves the plant development [33–35]. Calcium is found in upwards of 80 compounds some of the time called calcium salts, primarily, calcium carbonate. $CaCO_3$ is an essential part of the nursery lime, otherwise called agrarian lime. In addition, holding limit of acidic soils. $CaCO_3$ sources, for example, limestone and chalk, alongside other synthetic compounds are utilized in the readiness of agrarian lime.

In view of investigating the effectiveness of the currently bio-engineered $CaCO_3$ nanoparticles, they were tested as a bio/nano-fertilizer in the case of Lycopersicum esculentum (Tomato). In this regard, a similar study with the same parameters and growth conditions was performed as the one conducted previously with ZnO nanoparticles [25,37]. For the current study, 3 solutions of the nano-scaled $CaCO_3$ colloidal solutions were prepared at various concentrations (0.01, 0.03 and 0.05 g/l) with a reference plant as the control, 3 other Lycopersicum esculentum plants were considered. These latter were fed regularly with the colloidal solutions while the control one was fed with pure water only.

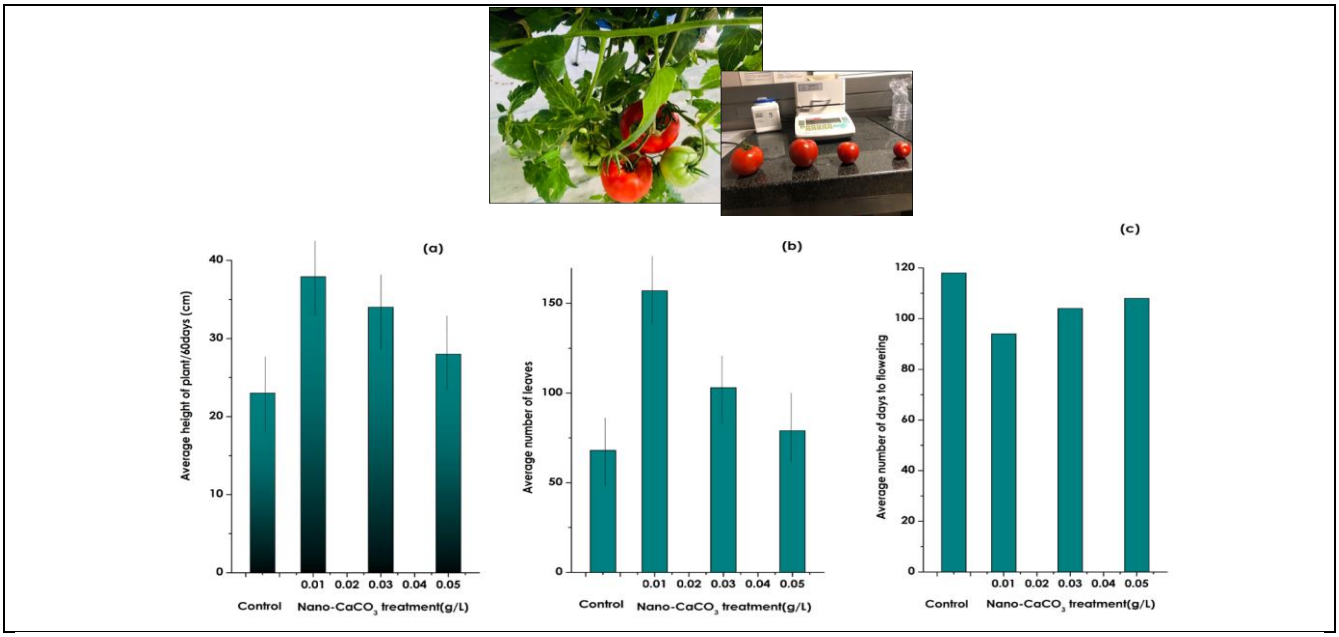


Figure 5: Evolution of: (a)the average of plant's height, (b) the average number of leaves and (c) the average days to flowering relatively to the control sample versus the concentration of bio-engineered $CaCO_3$ nanoparticles.

Accordingly, the average plant's height, the average number of leaves as well as the average number of days to flowering were collected. Figure 5a displays the evolution of the average of plant's height versus the $CaCO_3$ nutrient concentration. As one can, crystal clearly observe that the plant's height is higher than that of the control one for each of the $CaCO_3$ nutrient's concentration especially for the lowest value of 0.01 g/l. A similar behaviour is observed for the average number of leaves vs nutrient concentration (Fig. 5.b.). Figure 5.c. seems to be of a special interest. It indicates that the average days to flowering is lower with the $CaCO_3$ nutrient concentration relatively to the control sample. Especially for the 0.01 g/l, the flowering is 24 days before the control. As a pre-conclusion, the plant's growth parameters are far competitive relatively to the control especially for the lowest concentration of 0.01 g/l which seems the optimal value within this conditions of experimentation.

3.3 Porosity & nanoscale specificities of the bio-engineered and Cement industry potential applications

Within the building sector, especially via cement within which $CaCO_3$ is a pivotal chemical component, it is established that $CaCO_3$ contributes increasing the concrete's strength and its workability [36–39]. It also improves the concrete's particle packing while providing concrete with a spacer efect, and promotes self-compacting properties of concrete [40–42]. In addition, $CaCO_3$ reduces porosity and air void in concrete and adds to smoother surfaces87. From cost effectiveness viewpoint, $CaCO_3$ can be used as a fller in Portland cement, reducing the product's high cost. It was evidenced that replacement of cement by just 2% $CaCO_3$ helps reduce the CO_2 emission from cement plants by 69%, meeting the economic and environmental aspects of fly ash as well as contributing equal positive effects to concrete [43–45]. As per Fig.

6, the bio-engineered $CaCO_3$ is nano-scaled in size, and hence has a finer particles size as compared to the Ordinary Portland Cement (OPC) particles (which is in the range of 10µm in average) [45]. This fine aspect would likely improve the particle packing of concrete and give a superior spacer efect. Also, the concrete with $CaCO_3$ replacement possess a higher slump, which increases the workability. In addition, in a statistical spatial distribution, the 1-D morphology of the $CaCO_3$ nanoparticles would favour if not enhance the local mechanical strength of the $CaCO_3$/Cement composite as a local reinforcer. Last but not least, the porosity of the $CaCO_3$ nanorods (Figure 6) could, a priori, favour an enhanced binding in view of the high surface to volume of the individual porous $CaCO_3$ nanorods. Compared to literature, the general TGA and DSC variations/trends of the bio-engineered $CaCO_3$ are, equivalent to that of bulk $CaCO_3$ but with a significant shift to lower temperatures. More accurately, the decomposition and phase transition temperature are~648.8 °C instead of~750 °C for Bulk. This is likely due to the high surface to volume ratio of the current nanoscaled $CaCO_3$ comparatively to their bulk equivalent. A priori, this would improve its workability within the cement composite.

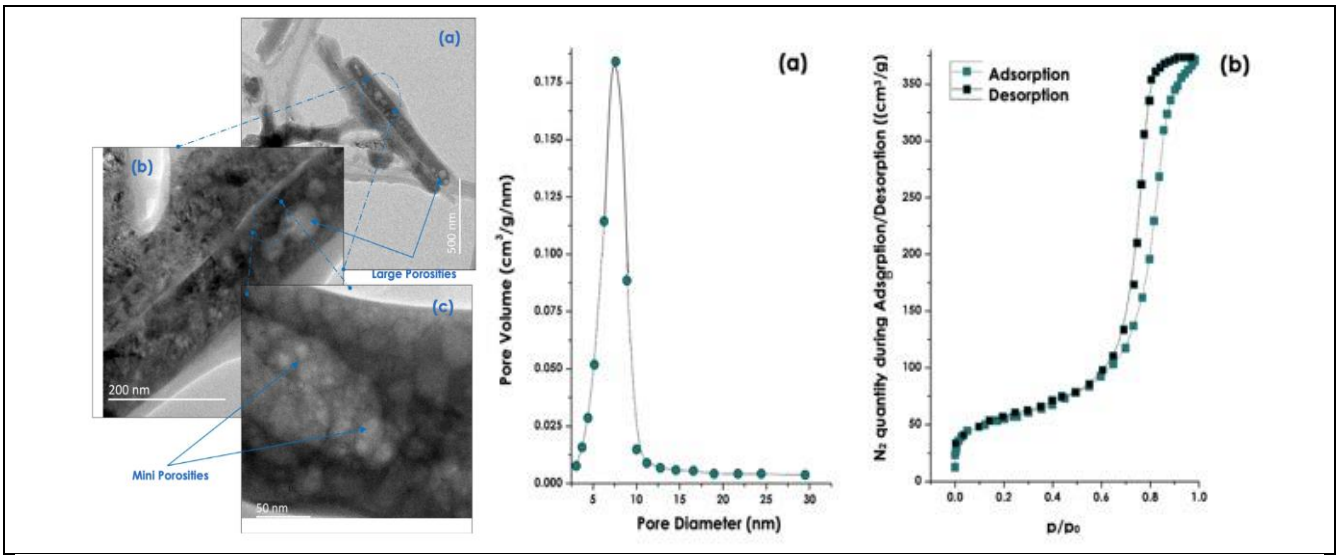


Figure 6: Multi-scale porosity in the bio-engineered $CaCO_3$ 1-D nanoparticles.

In view of sustaining the above mentioned cement applications, a mixture of the $CaCO_3$ nano-rods with standard Ordinary Portland Cement (OPC) particles will be performed. Their mechanical and thermogravimetric properties will be investigated accordingly including early degradation in harsh environments. One should highlight that Aragonite needle-like particles were synthesized by bubbling CO_2-containing gas into $Ca(OH)_2$ aqueous slurry in the presence of a signifcant amount of $MgCl_2$. It was elucidated that calcite needle-like particles can be fabricated by calcining aragonite needle-like particles at 500 °C. Tis fabrication method of thermodynamically stable calcite needle-like particles may broaden the applications of calcium carbonate as a cement filling material.

4. Conclusion:

This study validated the possibility of green bio-engineering of 1-D single phase calcite $CaCO_3$ porous nano-rods. The bio-synthesis is performed at room temperature with H_2O as universal solvent with $CaCl_2$ and CO_2 as the unique source of Ca and CO_3. The bio-engineered nano-scaled $CaCO_3$ exhibited an effective multi-functionality including a significant efficiency as white pigment, an effective response as a nano-fertilizer and as a potential source for green cement and cement industry.

The same approach is likely to be valid for the synthesis of various Carbonates including but not limited to, $FeCO_3$, $CuCO_3$, $MgCO_3$, $NiCO_3$, $SrCO_3$,… Yet the natural extract of Hyphaene thebaica L. Mart fruit was used as an effective chelating agent at room temperature, it is safe to confrm that natural extract of other plants with equivalent phyto/enzymes composition would also be effective for the biosynthesis of Carbonates.

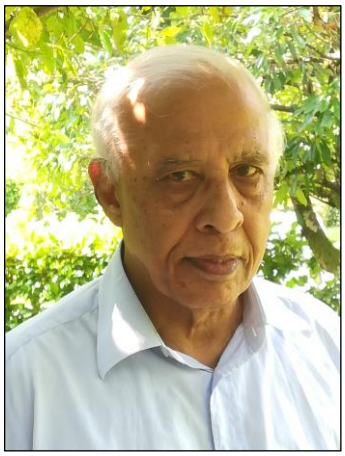
References:

1. Markewitz, P., Zhao, L., Ryssel, M., Moumin, G., Wang, Y., Sattler, C., Robinius, M., & Stolten, D. (2019). Carbon capture for CO2 emission reduction in the cement industry in Germany. Energies, 12 (12), 2432. Available from https://doi.org/10.3390/en12122432.
2. Zuberi, M. J. S., & Patel, M. K. (2017). Bottom-up analysis of energy efficiency improvement and CO_2 emission reduction potentials in the Swiss cement industry. Journal of Cleaner Production, 142, 4294-4309. Available from https://doi.org/10.1016/j.jclepro.2016.11.178.
3. Chen, Y. C. (2018). Evaluating greenhouse gas emissions and energy recovery from municipal and industrial solid waste using waste-to-energy technology. Journal of Cleaner Production, 192, 262-269. Available from https://doi.org/10.1016/j.jclepro.2018.04.260.
4. Lee, U., Han, J., & Wang, M. (2017). Evaluation of landfill gas emissions from municipal solid waste landfills for the life-cycle analysis of waste-to-energy pathways. Journal of Cleaner Production, 166, 335-342. Available from https://doi.org/10.1016/j.jclepro.2017.08.016.
5. Lozano-Moreno, J. A., & Maréchal, F. (2019). Biomass logistics and environmental impact modeling for sugar-ethanol production. Journal of Cleaner Production, 210, 317-324. Available from https://doi.org/10.1016/j.jclepro.2018.10.310.
6. Ramsagar, V., Sarath, B. A., Anjan, K. T., Mario, R. E., & Gani, R. (2019). Energy and CO2 management for chemical and related industries: Issues, opportunities and challenges. BMC Chemical Engineering, 1(1), 17. Available from https://doi.org/10.1186/s42480-019-0008-6.
7. Olivier, J., & Peters, J. (2010). No growth in total global CO2 emissions in 2009. Netherlands Environmental Assessment Agency (PBL).
8. IEA. (1990). Global energy-related CO2 emissions, IEA.
9. Laskar, A. H., Lin, L. C., Jiang, X., & Liang, M. C. (2018). Distribution of CO2 in Western Pacific, studied using isotope data made in Taiwan, OCO-2 satellite retrievals, and carbontracker products. Earth and Space Science, 5(11), 827-842.
10. Global CCS Institute. (2020). The Global Status of CCS: 2020, Global Carbon Capture and Storage. Australia: Institute Ltd.
11. Toavs, T. R. et al. A 30-year dataset of CO2 in flowing freshwaters in the United States. Sci. Data 10(20), 2023. https://doi.org/10.1038/s41597-022-01915-0 (2023).
12. Franta, B. Early oil industry knowledge of CO2 and global warming. Nat. Clim. Chang. 8, 1024–1025 (2018).
13. Beck, L. Carbon capture and storage in the USA: The role of US innovation leadership in climate-technology commercialization, Clean Energy 4(1), 2–11. https://doi.org/10.1093/ce/zkz031(2020) (2020).
14. Salzmann, M. Global warming without global mean precipitation increase?. Sci. Adv. 2, 6. https://doi.org/10.1126/sciadv.15015, 72 (2016).
15. McDonald, L., Glasser, F. P. & Imbabi, M. S. A new, carbon-negative precipitated calcium carbonate admixture (PCC-A) for low carbon portland cements. Materials (Basel). 12(4), 554 (2019).
16. Kalafati K., & Christidis G. E., Replacement of TiO2 pigment by CaCO3, Bulletin of the Geological Society of Greece Vol. 40. In 2007 Proceedings of the 11th International Congress of the Geological Society of Greece, (2007).
17. Stocks-Fischer, S., Galinat, J. K. & Bang, S. S. Microbiological precipitation of CaCO3. Soil Biol. Biochem. 31, 1563–1571 (1999).
18. Chu, D. H. et al. CO2 mineralization into different polymorphs of CaCO3 using an aqueous-CO2 system. RSC Adv. 3, 21722-21729 (2013).
19. Cai, A. et al. Direct synthesis of hollow vaterite nanospheres from amorphous calcium carbonate nanoparticles via phase transformation. J. Phys. Chem. C 112, 11324-11330 (2008).
20. Kim, Y. Y. et al. A critical analysis of calcium carbonate mesocrystals. Nature Communications. 5, 1 (2014).
21. Mitchell, A. C. & Te Ferris, F. G. Influence of Bacillus pasteurii on the nucleation and growth of calcium carbonate. Geomicrobiol. J. 23, 213–226 (2006).
22. Warren, L. A., Mauri, P. A., Parmar, N. & Ferris, F. G. Microbially mediated calcium carbonate precipitation: Implications for interpreting calcite precipitation and for solid-phase capture of inorganic contaminants. Geomicrobiol. J. 18, 93-115 (2001).
23. Pavez, J.; Silva, J.; Melo, F. Homogeneous calcium carbonate coating obtained by electrodeposition: In Situ atomic force

microscope observations. Electrochim. Acta 2005, 50, 3488-3494.
24. Mohamed, H., Hkiri, K., Botha, N., Maaza, M. et al. Room temperature bio-engineered multifunctional carbonates for CO2 sequestration and valorization. Nature Scientific Reports 13, 16783 (2023). https://doi.org/10.1038/s41598-023-42905-5
25. Gaf, M., Nagli, L., Panczer, G., Waychunas, G. & Porat, N. Te nature of unusual luminescence in natural calcite CaCO3. Am. Miner. 93, 158–167 (2008).
26. Pfaf, G. White pigments. J. Phys. Sci. Rev. 6(12), 11–83. https://doi.org/10.1515/psr-2020-0202 (2020).
27. Baer, D. R. & Blanchard, D. L. Appl. Surf. Sci. 72, 295 (1993).
28. Hossain, F. M., Murch, G. E., Belova, I. V. & Turner, B. D. Electronic, optical and bonding properties of CaCO3 calcite. Solid State Commun. 149, 1201–1203 (2009).
29. Jabeen, N. et al. Optimised synthesis of ZnO-nano-fertiliser through green chemistry: Boosted growth dynamics of economically important L. esculentum. IET Nanobiotechnol. 12(4), 405–411 (2018).
30. Savithramma, N. Influence of calcium supply on biomass production of endemic and endangered tree species of Tirumala hills of South Eastern Ghats. J. Indian Bot. Soc 81, 323–326 (2002).
31. Savithramma, N. Influence of calcium supply on photosynthetic rate in relation to calmodulin in endemic and endangered tree saplings of Seshachalam hills of South Eastern Ghats of India. J. Plant Biol 31, 159–164 (2004).
32. Savithramma, N., Fareeda, G., Madhavi, V. & Murthy, S. S. D. Effect of calcium on photochemical activities of green leafy vegetables. J. Plant Biol. 34(2), 95–98 (2007).
33. Savithramma, N. & Swamy, P. M. Uptake and distribution of calcium in groundnut (Arachis hypogeae L.) cultivars during pod development. Indian J. Plant Physiol. 38, 28-33 (1995).
34. Savithramma, N., Yugandhar, P., Prasad, K. S., Ankanna, S. & Chetty, K. M. Ethnomedicinal studies on plants used by Yanadi tribe of Chandragiri reserve forest area, Chittoor District, Andhra Pradesh India. J. Intercult. Ethnopharmacol. 5(1), 49 (2016).
35. Gandhi, N., Shruthi, Y., Sirisha, G., & Anusha, C.R. Facile and eco-friendly method for synthesis of calcium oxide (CaO) nanoparticles and its potential application in agriculture. Haya Saudi J. Life Sci. ISSN 2415-623X |ISSN 2415-6221. https://doi.org/10.36348/sjls.2021.v06i05.003 (2021).
36. Taylor, H. F. W. Cement Chemistry (Tomas Telford, 1997).
37. Daval, D. et al. Carbonation of Ca-bearing silicates, the case of wollastonite: Experimental investigations and kinetic modeling. Chem. Geol. 265(1-2), 63 (2009).
38. Taylor, H. F. W. Cement Chemistry (Tomas Telford, 1997), 87. Daval, D. et al. Carbonation of Ca-bearing silicates, the case of wollastonite: Experimental investigations and kinetic modelling, Chem. Geol. 265(1-2), 63 (2009).
39. De Muynck, W., De Belie, N. & Verstraete, W. Microbial carbonate precipitation in construction materials: A review. Ecol. Eng. 36(2), 118 (2010).
40. Al-Tawadi, S. High strength in-situ biocementation of soil by calcite precipitating locally isolated ureolytic bacteria (Murdoch University, 2008).
41. Al-Tawadi, S. M. Ureolytic bacteria and calcium carbonate formation as a mechanism of strength enhancement of sand. J. Adv. Sci. Eng. Res. 1(1), 98 (2011).
42. Ariyanti, D. & Handayani, N. A. Feasibility of using microalgae for biocement production through biocementation. J. Bioprocess. Biotech. 02(01), 1-4 (2012).
43. Hendriks, C. A., Worrell, E., De Jager, D., Blok, K. & Riemer, P. Emission reduction of greenhouse gases from the cement industry. Int. Energy Agency IEA 939, 1 (2002).
44. Worrell, E., Price, L., Martin, N., Hendriks, C. & Meida, L. O. Carbon dioxide emissions from the global cement industry. Annu. Rev. Energy Environ. 26(1), 303 (2001).
45. Lee, T. & Lee, J. Evaluation of chloride resistance of early-strength concrete using blended binder and polycarboxylate-based chemical admixture. Appl. Sci. 10, 2972. https://doi.org/10.3390/app10082972 (2020).

FLUID LAMINAR AND TURBULENT FLOWS

Mohammed Asghar[^] *FIAS*



Abstract: This text treats the laminar and turbulent flows of fluids, the rule governing them, the dynamics within a turbulence and presents a list of examples of the phenomena.

1. Introduction.

In fluid dynamics, turbulence or turbulent flow is fluid motion characterized by chaotic changes in pressure and flow velocity. It contrasts with a laminar flow, which occurs when a fluid flows in parallel layers, with no disruption between those layers (2).

In the case of air, the friction between it and irregular terrain and man-made obstacles causes eddies and therefore turbulence in the lower levels. The intensity the eddy motion depends on the surface wind, the nature of the surface and the stability of the air.

2. Reynolds number (1).

In fluid dynamics, the Reynolds number Re is used to characterize quantitatively the nature of fluid flow:

$$\mathbf{R_e = \varrho\, v\, L\, /\, \mu,} \qquad \mathbf{(1)}$$

where ϱ is the density of the fluid (kg /m^3),
v, the characteristic velocity of the fluid relative to the object (m/s),
L, a characteristic linear dimension (m), introduced to reduce the relation (1) to a dimensionless number.
μ, the dynamic viscosity of the fluid (kg/m.s).
The relation (1) expresses the ratio of the fluid's inertial kinetic energy to its dynamic viscosity force. As long as viscosity dominates, the R_e remains low and the fluid flow is laminar and orderly in its internal structure, but when the kinetic energy of the fluid becomes dominant, the value of R_e is high, and the fluid flow becomes turbulent and disorderly.

The characteristic linear dimension for a pipe flow, it is the diameter D of the pipe, for a channel flow of width w and depth h, it is the hydraulic radius $R_{hyd} = w\, h\, /\, P$, where P is the wetted perimeter. For an open channel P = (2h + w) and for a closed one P = 2 (h + w).

The significance of this number is that flows at Reynolds numbers larger than 5000 are mostly turbulent, while at low numbers, they generally remain laminar.

3. Examples of turbulent flow.

* Smoke of a cigarette. For a first few centimeters the smoke flow is laminar, and then it becomes more and more turbulent with the increase in the Reynolds number due to an increase in its flow velocity and the characteristic length.
* Clear-air turbulence experienced during airplane flight.
* The external flow of all kinds of vehicles such as cars, airplanes, ships, and submarines is turbulent.
* In medical field of cardiology, a stethoscope is used detect the heart sounds and noise that are due to turbulent blood flow.

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* For a public fountain, the water jet is mostly laminar at low flow velocity, but as the flow velocity goes up, it becomes more and more turbulent.
* Waterfall, where the water starts to fall laminarly, but with a further fall, its velocity increases and the fluid becomes more and more turbulent and disordered.
* Bridge supports in water. With a low water velocity, the flow is laminar, and water follows the physical profile of the bridge supports, but when the Reynolds number goes up due to the increase in water flow velocity, the turbulence sets in, and disordered water flow mostly detaches from the physical profile of the bridge supports.
* In nuclear fission reaction, the nucleus deforms laminarly under the control of its potential energy and at the end the neck joining the two nascent fragments ruptures violently and turbulently.
* The smoke plume from the candle flame (Figure 1) goes from being laminar as a compact vertical column at the beginning to a spreading-out turbulent flow later.

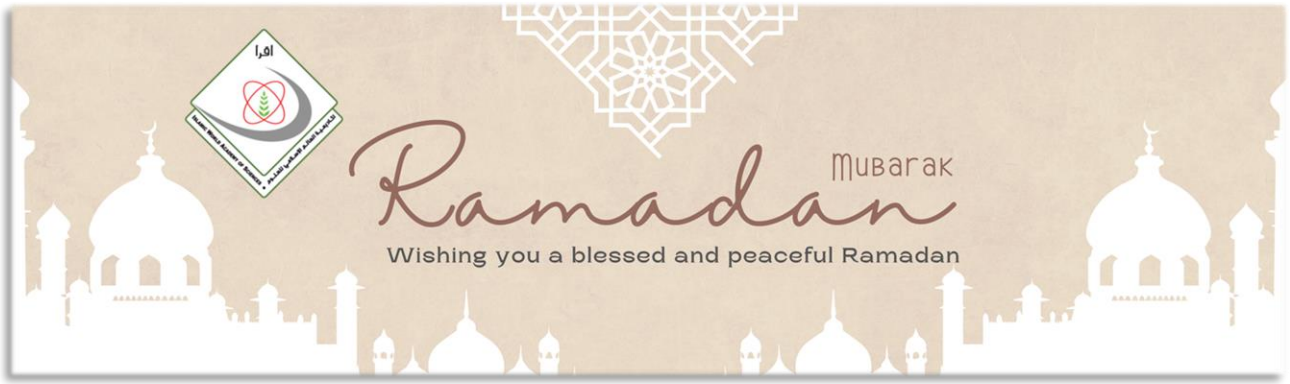
Figure 1. Candle plume and its laminar and turbulent flow stages (2).

4. Heat and momentum transfer within a turbulence.

When the flow is turbulent, particles exhibit additional transverse motion which enhances the rate of energy and momentum exchange between them, thus, increasing the heat transfer and the friction coefficient. Moreover, this transverse motion leads to the creation of angular momentum and the formation of unsteady and interacting vortices of many sizes in the turbulent region leading to a dissipation of energy into heat.

References

1. *Reynolds Osborne (1883), "An experimental, investigation of the circumstances which determine whether the motion of water shall be direct or sinuous and of the law of resistance in parallel channels", Philosophical Transactions of the Royal Society 174, 935 – 98*
2. *Courtesy Wikipedia.*



THE NEH (NAWAZ, ENSCORE, HAM) ALGORITHM: A MILESTONE IN SCHEDULING RESEARCH

Muhammad Nawaz[**]

The algorithm, now widely known as the NEH (Nawaz, Enscore, Ham) algorithm in the scheduling discipline, was devised by **Muhammad Nawaz - a Pakistani** researcher and alumnus of UET Lahore—as part of his Master's research at Penn State University in 1980. Professors Emory E. Enscore and Inyong Ham served as his first and second supervisors, respectively. Nawaz's research was published as a paper titled "*A heuristic algorithm for the m-machine, n-job flow-shop sequencing problem*" by M. **Nawaz,** E.E. **Enscore**, and I. **Ham** in *Omega: The International Journal of Management Science* in 1983.

Since its publication, the article by Nawaz et al has become one of the most-cited papers in the scheduling discipline, with the NEH algorithm widely recognized as a benchmark for researchers. Numerous studies have demonstrated that the NEH algorithm is among the most effective approaches for minimizing makespan in general NP-hard flow-shop scheduling problems, balancing complexity and result quality. The algorithm consistently produces high-quality results—within 5% of the optimal solution—while maintaining computational efficiency. It is frequently used as a seed solution generator for metaheuristics.

Introduction to Scheduling and Sequencing

Before delving into the NEH algorithm and its prominence in scheduling literature, it is essential to understand the background of scheduling and sequencing problems. Early research in scheduling originated in production and industrial environments, using terms like "jobs," "machines," and "shops," which are still in use today. However, these terms can be adapted depending on the context. In our discussion below, for consistency, we will use "jobs" and "machines" here.

Key Terms in Scheduling Literature:

- **Job(s) or Task(s):** Represent products, customers, data files, patients, loan applications, aircraft landings, etc.
- **Machine(s) or Processor(s):** Represent machines (e.g. manufacturing), workers, CPUs, doctors, printers, clerks, managers, runways, or air traffic controllers.
- **Sequence:** The order in which jobs/tasks are (to be) processed.
- **Schedule:** The start and finish times of job(s) or task(s).
- **Makespan:** The total time from the start of the first job on the first machine to the finish of the last job on the last machine.

Number of Jobs and Sequences

Scheduling involves decision-making, specifically deciding which job to process and when. For a single job, no sequencing decision is required. However, when multiple jobs with different process times are involved, sequencing decisions are essential.

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The number of feasible sequences increases with number of jobs. Consider the examples:

- For 2 jobs (A and B), there are 2 feasible sequences: A-B or B-A.
- For 3 jobs (A, B, and C), there are 6 feasible sequences (3!).
- For 10 jobs, there are 3,628,800 sequences (10!).
- For 50-job problem, feasible sequences are 50! ie 3.04×10^{64}.

While evaluating all feasible sequences for a small number of jobs is manageable, exploring every sequence for a large number of jobs (e.g., 50 jobs) becomes economically impractical.

Single vs. Multi-Machine Problems

Scheduling problems are categorized by the number of machines:

- **Single-Machine Problem:** All jobs are processed on one machine. The total completion time remains constant regardless of the sequence, but measures like mean flow time may vary. Different priority rules, such as FCFS (First Come First Serve) and SPT (Shortest Processing Time), or others, are applied depending on the objective criteria.
- **Multi-Machine Problem:** Jobs are processed on multiple machines. For example, in a textile manufacturing process involving cutting, sewing, finishing, and packing for different jobs (e.g., shirts and trousers) with different process times, sequencing decisions affect makespan.

In **1954**, S.M. Johnson introduced a procedure, now known as **Johnson's Rule**, which solves the 2-machine (and a special 3-machine) permutation flow-shop scheduling problem (PFSP) for minimizing total completion time; this was a breakthrough. Johnson's Rule provides an optimal sequence for minimising makespan for any number of jobs. However, it does not provide a solution for more than 2 machine problems.

Emergence of the NEH (Nawaz, Enscore, Ham) Algorithm

For scheduling problems involving large numbers of jobs and machines (e.g., 50 jobs and 3 or more machines), the PFSP is classified as *NP-hard*, necessitating heuristic approaches. Building on Johnson's work, many researchers proposed heuristics to find a good sequence for minimising makespan in PFSPs with large numbers of jobs (n) and 3 or more machines (m). Among these, the **CDS** (Campbell, Dudek, Smith) algorithm (**1970**) stands out. The CDS algorithm applies Johnson's Rule repeatedly, selecting the best out of (m – 1) sequences.

In **1980**, Muhammad Nawaz, a graduate student at Penn State University, took a fundamentally different approach. Unlike Johnson's Rule, Nawaz's algorithm considers only the number of jobs rather than the number of machines. Instead of evaluating all feasible sequences ($n!$), the NEH algorithm evaluates only $\{n(n-1)/2 - 1\}$ sequences, producing excellent results for any number of jobs and any number of machines.

(Please note: $n! = 1x2x3x\text{------}xn$, and $n(n-1)/2 = 1+2+3+\text{---------}+n$)

The algorithm was published in the aforementioned paper in **1983**, leading to its naming as the **NEH (Nawaz, Enscore, Ham) algorithm**. Although the NEH algorithm does not guarantee optimality, it achieves solutions with less than 5% average deviation from the optimal result, efficiently. Initially designed for flow-shop environments aiming to minimize total job completion time, the algorithm has since been applied in diverse scenarios and objectives.

How the NEH Algorithm Works

The NEH algorithm is a **constructive heuristic**, building the final sequence step by step while evaluating only a small subset of feasible sequences at each step. In the whole process, the total number of sequences evaluated is $\{n(n-1)/2-1\}$. For example, for a 10-job problem, it evaluates only 54 sequences out of 3,628,800 and suggests only one. Below is an example:

Example: For 4 Jobs (A, B, C, D), Objective: Makespan minimisation

1. **Order Jobs:** Arrange all jobs with decreasing total processing times. Assume the resulting order is B, C, A, D.
2. **Construct the Sequence Step by Step:**
   - Take the first two jobs (e.g., B and C) and evaluate two feasible sequences (e.g. B-C and C-B). Retain the best one for the next step (e.g. C-B).
   - Insert the 3rd job into all (3) possible positions of the retained sequence for the previous step. (e.g. A-C-B, C-A-B, C-B-A). Evaluate 3 sequences. Retain the best result (e.g. C-A-B) for the next step.
   - Repeat the above step for the 4th job (D). Insert the 4th job into all (4) possible positions of the retained sequence for the previous step. (e.g. D-C-A-B, C-D-A-B, C-A-D, C-A-B-D). Evaluate 4 sequences. Retain the best result (e.g. C-A-D-B).

For the 4-job problem, instead of evaluating all 24 sequences (4!), the NEH algorithm evaluates only 9.

Scores of studies have concluded that, given its complexity (computing time) and quality of results, the NEH algorithm is the best for the PFSP makespan minimisation.

Why Is the NEH Algorithm so Popular?

The NEH algorithm's popularity stems from its simplicity, efficiency, and outstanding results:

- Produces high-quality results (less than 5% deviation from optimal).
- Provides quick solutions.
- Relies on a simple, intuitive approach.
- Is easy to implement in code.

Its **applications** span disciplines/scenarios, including:

- Manufacturing
- Supply chain management
- Particle therapy scheduling
- Reducing energy consumption in CPUs
- UAV (drone) operations for search-and-rescue and agriculture
- Autonomous vehicle data processing

Impact and Legacy of the NEH Algorithm

The groundbreaking paper by Nawaz et al. has received over 3,380 citations on Google Scholar and 2,270 citations on Scopus to date. Its influence endures, garnering hundreds of citations annually. Even 42 years after its introduction, the NEH algorithm remains a cornerstone for minimizing makespan in scheduling problems and is still considered part of state-of-the-art heuristics. Following Johnson's Rule, the NEH algorithm (and by extension, Nawaz) is the second most **recognized academic contribution in the field of scheduling**. Its inclusion in academic literature across diverse languages underscores its status as a globally recognized and landmark contribution to scheduling research.

The NEH algorithm has established itself a component of academic curricula and is covered in management science **textbooks** worldwide. It is widely taught at both undergraduate and postgraduate levels. In addition to its practical applications, the algorithm has evolved into a **subject of ongoing research**, with numerous studies examining its methodology and many researchers proposing various enhancements to refine its performance.

Conclusion

The NEH algorithm exemplifies the power of innovative thinking in solving complex, real-world challenges. Muhammad Nawaz's seminal work has made a lasting impact on scheduling research, solidifying its place as a cornerstone of the field. The algorithm's enduring relevance and broad adoption underscore its efficiency, simplicity, and versatility. As a testament to its creator, the NEH algorithm showcases the profound global influence a single academic contribution can achieve. Muhammad Nawaz's remarkable innovation leaves a legacy that continues to inspire researchers and drive advancements across various disciplines.

RAB'-E RASHIDI: A PIONEERING MODEL OF KNOWLEDGE AND INNOVATION IN THE ISLAMIC WORLD

Prepared by the Academy of Sciences of IR Iran

Introduction

The Islamic Golden Age was a period of remarkable advancements across various disciplines, including science, medicine, philosophy, and architecture. Among the most significant academic and cultural institutions of this era was *Rab'-e Rashidi*, an extraordinary educational and scientific complex established in the late 13th and early 14th centuries in Tabriz, Iran. Founded by the eminent vizier and statesman *Rashid al-Din Hamadani* (1247–1318), Rab'-e Rashidi exemplified the spirit of intellectual inquiry and cross-cultural exchange that characterized the Ilkhanid period (Figure 1).

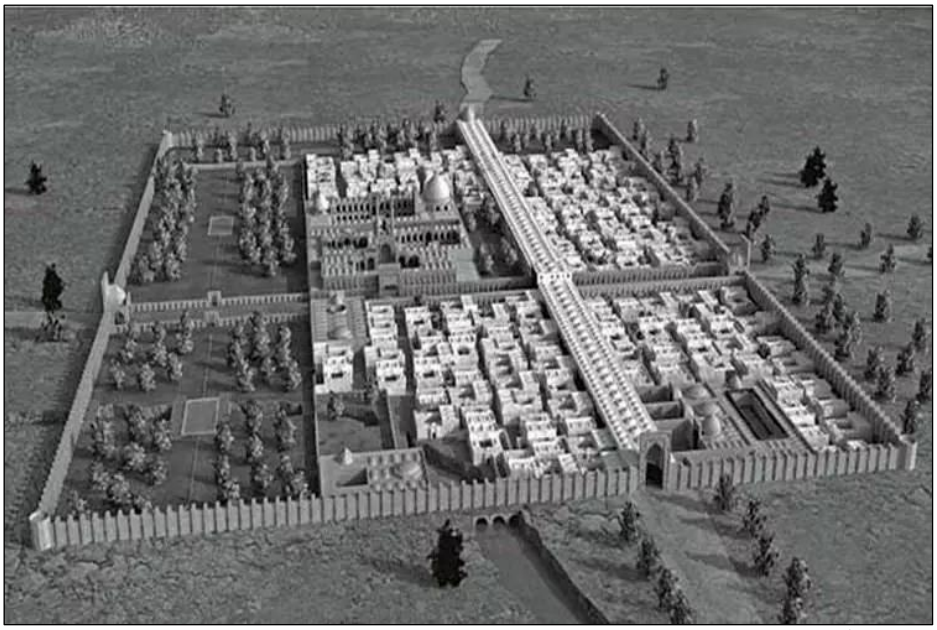


Figure 1: Schematic structure of Rab'-e Rashidi building in the late 13th century.

Historical Context and Foundation

Rab'-e Rashidi emerged during a transformative period in the Islamic world. Under the Mongol Ilkhanate, which ruled over Persia and surrounding regions, the sociopolitical and intellectual landscape experienced significant shifts. Rashid al-Din, a visionary scholar and administrator, sought to establish an institution that would promote the production, preservation, and dissemination of knowledge on an unprecedented scale. His vision materialized in Rab'-e Rashidi, a comprehensive complex that functioned as an educational hub, a research center, a hospital, and a library, attracting scholars from diverse backgrounds and disciplines.

Architectural and Institutional Structure

Situated in Tabriz, a major cultural and political center of the Ilkhanid dynasty, Rab'-e Rashidi was meticulously designed to accommodate various academic and administrative functions. The complex comprised:

- Madrasas: Centers of higher learning where scholars engaged in advanced studies of theology, philosophy, medicine, astronomy, and the natural sciences.
- Libraries: A vast repository of manuscripts and books, including translations from Arabic, Persian, Greek, and Sanskrit, fostering intellectual synergy.

- Hospitals (*Dar al-Shifa*): Medical facilities that provided healthcare and served as training centers for aspiring physicians.
- Workshops and Scriptoriums: Dedicated spaces where scholars and scribes produced, copied, and illustrated manuscripts, ensuring the transmission of knowledge across generations.
- Residential Quarters: Living spaces for students, teachers, and visiting scholars, creating a vibrant academic community.

Academic and Cultural Contributions

Rab'-e Rashidi was more than an educational institution; it was a hub of scientific thought and cultural synthesis. Rashid al-Din actively promoted a pluralistic approach to knowledge, encouraging engagement with diverse intellectual traditions. The institution played a crucial role in the translation and preservation of scientific and philosophical texts, ensuring the transmission of classical knowledge to future generations.

One of Rab'-e Rashidi's most notable contributions was Rashid al-Din's own monumental historical work, the *Jami' al-Tawarikh* (*Compendium of Chronicles*). This comprehensive account of world history provided invaluable insights into the civilizations of Persia, China, India, and the Islamic world. The work exemplified the scholarly rigor and cosmopolitan ethos that defined Rab'-e Rashidi.

Legacy

Today, Rab'-e Rashidi is recognized as an essential milestone in the history of science and education. The remnants of the complex in Tabriz stand as a testament to the enduring legacy of Rashid al-Din's intellectual vision. Efforts to study and preserve its contributions continue to shed light on the dynamic scholarly traditions of the medieval Islamic world. However, the institution's influence persisted, as its model of integrated learning and research inspired subsequent educational centers across the Islamic world (Figure 2).

Conclusion

Rab'-e Rashidi exemplified the harmonious fusion of knowledge, innovation, and cultural exchange that defined the Islamic Golden Age. It set a precedent for future institutions of learning and remains an inspiring example of how visionary leadership can shape the intellectual landscape of a civilization. As scholars and historians continue to explore its impact, Rab'-e Rashidi stands as a testament to the rich heritage of scientific and academic excellence within the Islamic world.

Figure 2: Ruins of Rab'-e Rashidi in the northeastern part of Tabriz, Iran.

THE INTERNATIONAL SCIENCE COUNCIL (ISC)
MUSCAT DIALOGUE CLOSES WITH A COLLECTIVE CALL FOR ACTION TO LEVERAGE SCIENCE FOR THE GLOBAL GOOD♦

The International Science Council (ISC) concluded its fourth Global Knowledge Dialogue (GKD) in Muscat, Oman, marking the end of an ambitious series of dialogues aimed at periodically considering key issues at the science-society and science-policy interfaces.

Hosted under the patronage of His Highness Sayyid Asaad bin Tariq Al Said, the Muscat GKD gathered over 415 representatives from ISC Members across 132 countries for two days of discussions on science priorities in advancing sustainability and global development. The event concluded with the adoption of the Muscat Declaration, a call to action for equitable access to knowledge, transformative science systems, and strengthened international collaboration to address pressing global challenges.

THE MUSCAT DECLARATION ON GLOBAL SCIENCE♠
ON THE OCCASION OF THE MUSCAT GLOBAL KNOWLEDGE DIALOGUE 26- 28 JANUARY 2025, MUSCAT, OMAN

Preamble

The Global Knowledge Dialogue is an initiative of the International Science Council (ISC) to periodically consider key issues at the science-society and science-policy interfaces. This edition was convened jointly by the ISC and the Ministry of Higher Education, Research and Innovation of the Sultanate of Oman.

The International Science Council's global membership brings together 250 international scientific unions and associations, national and regional scientific organizations, including academies, government agencies and ministries, research and science councils, international scientific federations and societies, young scientific organizations.

Recalling that the vision of the ISC is of science as a global public good, meaning that scientific knowledge and its practice should be universally considered as shared resources from which everyone should be able to benefit,

Recognizing the diversity of ambitions, challenges, opportunities and approaches in science globally, the growing disparities in research capacity and quality of education between countries and regions, and the need to address these gaps to foster global progress,

Recalling that to realize its vision, the mission of the ISC is to provide a robust, effective, and trustworthy global voice for science,

Considering that the global context in which science is done has changed significantly in the

♦ *Source: https://shorturl.at/lpULX*

♠ *Source: https://council.science/news/muscat-declaration/*

last decade, and that emerging technologies are further changing the paradigms of scientific research,

Noting that in this context, science has a key role to play in promoting social justice, peace, security, and sustainability,

Considering the role of the ISC in strengthening the voice of scientists and their diversity, advancing their freedom and safety, and promoting the right to participate in and benefit from science.

Actionable statements

Participants in the Muscat Global Knowledge Dialogue, therefore,

Defend and ***promote*** the free and responsible practice of science by:

-*Advancing* the right to participate in and benefit from science and, more broadly, upholding the role of science as a global public good

-Maintaining cross-border scientific collaboration in times of tensions and crisis

-Supporting the protection of science ecosystems and scientists in emergency and conflict settings, with particular attention to displaced scientists

-*Supporting* ,the free, safe, ethical, inclusive, accountable and equitable conduct of science,

Stimulate and ***support*** international, inter- and transdisciplinary collaborations in scientific research and scholarship on issues of global concern, including by:

-*Actively supporting* the UN International Decade of Sciences for Sustainable Development as a tool to advance the sustainability agenda

-*Mobilizing for* the International Polar Year 2032-33 and the UN Decade for Cryospheric Sciences

-*Taking* a holistic approach that integrates all formal and applied sciences (natural, medical, social, humanities, engineering sciences) as necessary in addressing these complex challenges

-*Encouraging* the pursuit of research on inequality and social cohesion, including gaps where science can play an effective role

-*Calling upon* funding organizations, philanthropic entities, and leading scientific institutions worldwide to take proactive steps in supporting under-resourced regions by investing in capacity-building initiatives

-*Working collectively* to develop practical solutions to prevent or reduce pollution and achieve the vision of zero-emissions,

Contribute to the fair evolution of science systems, in the context of emerging technologies and global inequalities, including by:

-*Engaging* with science and research funders, policy-makers and other relevant stakeholders to provide expert guidance on the transformation and reform of science systems (in, for example, open science, research assessment, and science publishing) and the enhancement of their transparency, efficiency, inclusion and integrity,

-*Promoting* a transformation in the higher education institutional environment by equipping future scientists globally with the necessary transdisciplinary knowledge, tools, and skills to tackle urgent and complex societal and environmental issues,

-*Critically evaluating* the potential impacts of artificial intelligence and other emerging technologies on multiple facets of science and education systems,

-*Ensuring* that scientific data is generated, stored, managed and accessed in a way that facilitates the address of cross-domain grand challenges,

-*Supporting* academies and associations of young scientists,

Continue advocating for the value of science and promoting evidence-based understanding and decision-making at all levels,

Promote capacity-building initiatives, appropriate training, and adoption of principles and models to strengthen science's role in the multilateral system,

Promote and ***assist*** the use of science diplomacy to advance the common good and address global challenges,

Advocate for the growth and maintenance of investment in international science programmes and free and open knowledge sharing,

Encourage the contribution of scientific research and innovation to the goals of global peace, human well-being, planetary stewardship, and global sustainability,

Reiterate the importance of improving the representation of women scientists and underrepresented groups in the governance of scientific organizations and in science endeavours in general,

Conclude that science is a universal endeavour that can act as a positive force to bridge divides, foster trust, and catalyse collective action on shared global challenges at multiple levels.

REPORT ON MUSCAT GLOBAL KNOWLEDGE DIALOGUE AND THIRD GENERAL ASSEMBLY OF THE INTERNATIONAL SCIENCE COUNCIL (ISC)

Ilkay Erdogan Orhan FIAS
Dean, Faculty of Pharmacy, Lokman Hekim University, Ankara, Türkiye
Principal Member and Council Member of Turkish Academy of Science (TÜBA)

The Global Knowledge Dialogue is an initiative of the International Science Council (ISC) that periodically addresses key issues at the science-society and science-policy interfaces. The global membership of the International Science Council brings together 250 international scientific unions and associations, national and regional scientific organizations, including academies, government agencies and ministries, research and science councils, international scientific federations and societies, youth scientific organizations.

The Muscat Global Knowledge Dialogue, held in Muscat, Oman, from 26-31 January 2025, brought together more than 400 representatives from ISC Members in 132 countries to advance the role of science in addressing global challenges. The event was jointly organized by the ISC and the Ministry of Higher Education, Research and Innovation of the Sultanate of Oman. The event culminated in the Muscat Declaration on Global Science, calling for equal access to knowledge, stronger international cooperation and transformative science systems to ensure that science benefits everyone as a global public good.

It explored international, interdisciplinary and transdisciplinary collaborations in scientific research on global issues. It encouraged research on issues of inequality and social cohesion where science can play an active role. It was noted in several sessions that science is a universal endeavor that can act as a positive force to bridge divides, promote trust and catalyze collective action on common global challenges at various levels.

The three draft resolutions under consideration by the Resolutions Committee are as follows:
1. Proposed resolution on the ethics of war
2. Proposed decision on the free movement of scientists
3. Proposed decision on early and mid-career researchers

On January 29, the program of the meeting consisted of the ISC Members' Forums, and I participated in the 3rd category of the ISC Members' Forum in meeting room 8, representing both TUBA and the Islamic World Academy of Sciences (IAS).

On the same day, the ISC General Assembly was held in the auditorium between 14.00-15.15, where the amendments to the ISC Statutes and Rules of Procedure and financial matters were presented, followed by electronic voting. Voting on legal matters and voting on financial matters were also held.

Some of the points of the Muscat Declaration on Global Science are presented below:
- Contribute to the equitable evolution of science systems in the context of emerging technologies and global inequalities
- Engaging with science and research funders, policy makers and other relevant stakeholders to provide expert guidance on the transformation and reform of science systems (e.g. open science, research assessment and science publishing) and on improving their transparency, efficiency, inclusiveness and integrity,
- To foster a transformation in the institutional environment of higher education by equipping future scientists with the transdisciplinary knowledge, tools and skills necessary to tackle globally urgent and complex societal and environmental challenges,
- Critically evaluate the potential impact of artificial intelligence and other emerging technologies on various aspects of science and education systems,
- To ensure that scientific data is generated, stored, managed and accessed in a way that facilitates addressing major cross-domain challenges,
- Supporting academies and associations of young scientists,
- Continue to champion the value of science and promote evidence-based understanding and decision-making at all levels,

- Promote capacity building initiatives, appropriate training and the adoption of principles and models to strengthen the role of science in the multilateral system,
- Promote and assist in the use of science diplomacy to advance the public interest and address global challenges,
- Advocate for the growth and sustainability of investments in international science programs and free and open knowledge sharing,
- Promote the contribution of scientific research and innovation to the goals of global peace, human well-being, planetary governance and global sustainability,

The Declaration reiterates the importance of improving the representation of women scientists & underrepresented groups in the governance of scientific organizations and in science in general; and Concluding that science is a universal endeavor that can act as a positive force to bridge divides, promote trust and catalyze collective action on common global challenges at various levels.
It was concluded with recommendations.

Finally, I proudly represented the IAS at the overall meeting, the ISC General Assembly and in groups in the workshops organized during the event. It was recommended that the IAS should be more visible and represented at ISC meetings and various other meetings of scientific academies. Since many academies in the world have young academies, it was also stated that it would be useful for IAS to establish a young academy.

MOROCCAN SCIENTISTS PLAY KEY ROLE IN HISTORIC NEUTRINO DISCOVERY

Rabat - Moroccan scientists have played a key role in a historic discovery in the Mediterranean, where the international telescope KM3NeT detected a neutrino (particle) with a record energy level of approximately 220 PeV (220 million billion electron volts).

This exceptional discovery, with a level of energy never before recorded in high-energy astrophysics, published in the prestigious journal Nature, was possible thanks to this international telescope, a massive detector that is the result of an international collaboration in which Morocco is an active member, Professor Yahya Tayalati, the national coordinator of the KM3NeT project in Morocco, told MAP.

In this context, Tayalati, a professor at Mohammed V University in Rabat and affiliate professor at Mohammed VI Polytechnic University in Benguerir (UM6P), explained that the KM3NeT telescope is a "large multidisciplinary research infrastructure consisting of a network of underwater detectors installed in the deep Mediterranean abyss at a depth of 3,000 meters".

The primary objective of KM3NeT is the detection and study of neutrinos by capturing the light emitted when these particles pass through and interact with seawater.

KM3NeT is the outcome of an international collaboration involving renowned institutions and researchers from 21 countries, including Morocco, he noted.

The Moroccan consortium is represented by Mohammed V University in Rabat, Mohammed I University in Oujda, Cadi Ayyad University in Marrakech, and Mohammed VI Polytechnic University in Benguerir as official members, along with the National Center for Energy, Sciences, and Nuclear Techniques as an observer member.

The signal, named KM3-230213A, with an energy level of 220 PeV (220 million billion electron volts), was detected on February 13, 2023, by the KM3NeT detector, located in the depths of the Mediterranean.

This discovery, which represents energy levels ten thousand times higher than those produced by the world's largest particle collider, opens new perspectives on extreme astrophysical phenomena such as supermassive black holes, supernovae, and gamma-ray bursts-sources of ultra-energetic cosmic neutrinos capable of traveling across the universe. *https://www.mapnews.ma/en/actualites/social/moroccan-scientists-play-key-role-historic-neutrino-discovery*

PROF. DR. IQBAL CHOUDHARY FIAS APPOINTED AS FIRST CHAIRHOLDER OF MA RAOOF LAB AT LAHORE UNIVERSITY

The Board of Governors of the University of Lahore (UOL) has appointed renowned Pakistani scientist Prof Dr Muhammad Iqbal Choudhary as the first Chairholder of the M.A. Raoof Laboratory. He is a globally renowned scientist and a Mustafa (pbuh) Prize Laureate. This appointment recognizes his exceptional contributions to the field of Bio-organic and Natural Products Chemistry.

The M.A. Raoof Laboratory was inaugurated during a high-profile ceremony. Prof. Zhao Yuefen, a renowned Chinese scientist and academician, officially unveiled the facility. The event was attended by the Rector of UOL and other dignitaries. The inauguration reflects the university's commitment to cutting-edge scientific research.

Prof. Dr. Muhammad Iqbal Choudhary is a Distinguished National Professor at the International Center for Chemical and Biological Sciences (ICCBS). He is also the Coordinator General of COMSTECH, which is the OIC's Ministerial-level Committee on Scientific and Technological Cooperation. Additionally, he serves as the Vice President (Central & South Asia) of The World Academy of Sciences (TWAS). He is also a WHO expert for Traditional Medicine Research Priority Setting.

Prof. Choudhary has made groundbreaking contributions to natural product chemistry. He has played a significant role in scientific capacity-building across the Afro-Asian region. His efforts have helped establish research centers in Pakistan, Africa, and Central & South Asia. He has also trained hundreds of researchers, with a special focus on empowering women in science.

Prof. Choudhary has received numerous national and international awards. He is a recipient of Hilal-e-Imtiaz, Sitara-e-Imtiaz, and Tamgha-e-Imtiaz from the President of Pakistan. He has also won the Mustafa (pbuh) Prize, known as the "Nobel Prize of the Muslim World." Other notable awards include the Sheikh Zayed International Award for Traditional Medicine and the Chinese Government Friendship Award.

Prof. Choudhary has an outstanding academic record. He has over 1,370 publications with an impact factor exceeding 3,800. His work has received 46,041 citations, and he has an h-index of 88. He has authored 94 books and 40 book chapters. He also holds 94 patents, including 64 US patents. More than 100 Ph.D. students have completed their research under his supervision.

The establishment of the M.A. Raoof Laboratory at UOL is a landmark initiative. It celebrates the achievements of Prof. Choudhary and highlights UOL's dedication to scientific research and innovation. This initiative strengthens UOL's position as a leading institution for pioneering discoveries with global impact.

Source: https://24newshd.tv/07-Feb-2025/prof-dr-iqbal-choudhary-appointed-as-first-chairholder-of-ma-raoof-lab-at-lahore-university#:~:text=The%20Board%20of%20Governors%20of,Mustafa%20(pbuh)%20Prize%20Laureate.

NOMINATIONS FOR 2025 TÜBA ACADEMY PRIZES

The nomination process for the International TÜBA Academy Prizes for 2024, established by TÜBA as part of its mission to encourage and recognize scientists, has started. Nominations will continue **until April 4, 2025.**

Every year, the International TÜBA Academy Prizes, which are given as an award in each category to those nominated in three categories: Science and Engineering Sciences, Health and Life Sciences, and Social Sciences and Humanities, are awarded to scientists with original, pioneering and groundbreaking studies in the relevant field. Turkish citizens and foreign nationals can be nominated for the TÜBA Academy Prizes from the international arena with the decision of the Academy Council, provided that they have conducted studies related to Türkiye, have collaborated with scientists and scientific organizations in Türkiye, and have conducted joint scientific studies with scientists from Türkiye and Turkish citizens. The Prizes in all three categories are open to all scientists in Türkiye and around the world.

Nominations for the International TÜBA Academy Prizes can be made by TÜBA members, University Rectorates in Türkiye, Science Academies and inter-Academy umbrella organizations with which TÜBA is associated, and scientific organizations such as YÖK, TÜBİTAK and TÜSEB. Current TÜBA members, employees and scientists involved in the evaluation processes cannot be nominated. In addition, nominees for the Academy Prizes must not have received any other national and/or international science award from public institutions and organizations in Türkiye within the last three years.

Award winners are determined by the Academy Council based on the opinions of local and foreign referees and the evaluations of the field committees. As defined in the Academy Prizes Procedures and Principles, the Academy Prizes, which consist of the Academy Award Medal and Beret and the monetary award determined by the Academy Council every year, will be presented to their owners at a ceremony held at the Presidential Complex under the auspices of the Presidency of the Republic of Türkiye.

For more informarion:
https://www.tuba.gov.tr/en/tuba-awards/tuba-academy-prizes/nominations-for-2025-tuba-academy-prizes

Email:
academy.prizes@tuba.gov.tr

THE LATE
PROF. HUSSEIN SAMIR SALAMA
(EGYPT)

(1936 – 2025)

It is with a sense of sadness and sorrow that the Secretariat of the Islamic World Academy of Sciences (IAS), announces the passing away of the eminent scientist **Prof. Hussein Samir Salama (Egypt).**

Prof. Salama was a Founding Fellow of the Islamic Academy of Sciences (1986). He was born on January 26, 1936 in Gharbia, Egypt. He earned his degrees at Ain Shams University, Faculty of Science (BSc in 1955, MSc in Entomology in 1959) and Cairo University, Faculty of Science (PhD and DSc Entomology in 1962 and 1987, respectively).

A post-doctoral fellow (1963-1965) at the Department of Entomology, University of Alberta, Edmonton, Canada (1963-1965); Prof. Salama was also a fellow of Alexander Von Humboldt Organisation where he joined the Institute of Applied Zoology, University of Munich (1974-1976).

He started his career as a Research Assistant, Entomology Research Unit, National Research Center (NRC) in Cairo in 1956. He then became Researcher (1962-1967); Associate Research Professor (1967-1973); and Research Professor of Entomology at NRC in 1973, before he was appointed as Vice-President of NRC. He went on to become President for the NRC between 1988-1992 and then Emeritus Research Professor since 1996.

Prof. Salama was awarded the State Prize for Biological Sciences (1973); the Golden Medal of NRC (1981); the Golden Medal of the Entomological Society of Egypt (1982); the State Prize for Sciences Prize for Agricultural Sciences (1983); the African Academy of Sciences Prize for Agriculture (1991); Recognition State Prize for Basic Sciences (1994) and Scientific Recognition Prize of NRC. He was awarded the merit of science and Arts-First Rank, 3 times.

Prof. Salama was member of several learned bodies including: the governing board of the National Research Centre, Egypt; Vice-President of the Research Council for Basic Sciences, Egyptian Academy of Scientific Research and Technology; the National Committee for Biological Sciences; President of the Egyptian Institute for Scientific Culture (1991); the International Union of Biological Sciences (IUBS); the Association for advancement of Agricultural Sciences of Africa (AAASA); the Council for International Congresses of Entomology; the African Association of Insect Scientists (1984); Vice President of the Entomological Society of Egypt; an elected member of the board of the Egyptian Academy of Sciences, Member of TWAS, African Academy of Sciences.

إنّا لله وإنّا إليه راجعون

Innalillahi wa Inna ilaihi Rojiun

Indeed we belong to Allah and indeed to him we will return

PICKS OF THE CHIEF EDITOR

2025 PREDICTIONS: WHICH TRENDS ARE SET TO SHAPE THE BIOTECH INDUSTRY THIS YEAR?*

The evolution of AI: A consistent trend reshaping the biotech industry

It is difficult these days to talk about biotech without mentioning the revolutionary role that AI is playing – and will continue to play – in the industry. When making these same predictions last year, we said that AI was likely to be a key biotech trend in 2024. This was most certainly the case, and as the year continued, we discussed all things AI, from whether the biotech AI sector is in the midst of a market bubble to how the technology is transforming cancer care.

Advancements in AI are expected to continue in 2025, with the technology likely to become more mainstream, allowing for an even better understanding of potential drug candidates earlier in the discovery and development process.

Kelly Abernathy, vice president (VP) of Clinical Development at Arrivo BioVentures, told Labiotech: "Biomarkers and evidence of target engagement are essential in studying disorders where, in the past, we relied only on subjective rating scales. From drug discovery and design where AI is speeding the creation of novel structures, to the ability to compare the profile of a drug candidate across a variety of parameters, to databases of both human subjects with disease and normal volunteers, the amount of information available to drug developers earlier in the process will allow for more efficient and potentially faster development."

Agreeing with this sentiment, David Del Bourgo, chief executive officer (CEO) and co-founder of WhiteLab Genomics, commented that AI is already starting to help analyze massive datasets to predict molecular interactions, enabling quicker and more targeted therapeutic development, in turn reducing time and cost for research and development (R&D). He noted that companies such as Insilico Medicine and DeepMind's AlphaFold have already demonstrated the potential of AI in protein structure prediction and drug design, setting a precedent for wider adoption in 2025.

Meanwhile, Cara Brant, CEO of Clinical Trial Media, expects that we will see a hybrid technology-human approach take hold across healthcare in everything from drug discovery to hospital operations. "The key for healthcare organizations will be building on what they've already learned and toeing the line between using AI to optimize and scale data-driven processes while reserving deeply personal and intimate tasks for humans. The latter is one of the largest limitations of AI, but one of the unequivocal strengths of human healthcare providers."

2025: The expansion of the gene therapy field

With the potential to cure numerous genetic disorders by introducing, modifying, or repairing genetic material within a patient's cells, gene therapy has been a hot topic in the biotech industry for a good few years now and is continuing to evolve.

"Regardless of potential changes within the drug regulatory organizations globally, we believe innovations in gene therapies will continue to grow," said Cem Zorlular, CEO of Er-Kim Pharmaceuticals. "In years past, logistical commercial challenges have been holding back therapies, however, with

* *Source: https://www.labiotech.eu/in-depth/biotech-trends-2025/*

improved data (based on successes and failures) as well as more advanced technology, the industry has a better understanding of what works and what needs to be improved. We believe we will see more approved novel therapies as a result of this."

CRISPR in particular could have a big role to play this year. As the end of 2023 saw the approval of the first-ever CRISPR-based gene therapy, Casgevy, for the genetic conditions sickle cell disease and beta-thalassemia, Svetlana Lucas, chief business officer (CBO) of Scribe Therapeutics, believes that 2025 could signal a turning point in the sentiment toward the commercial potential of curative CRISPR-based genetic medicines.

With Casgevy finally gaining traction in the market with wider access and adoption, plus other CRISPR-based therapies entering early and late-stage clinical trials in larger indications such as cardiovascular disease, Lucas said that this type of genetic medicine will be poised to drive a paradigm shift in how we approach and treat not just rare disease, but chronic diseases as well.

"Advancements in CRISPR engineering will enable increasingly precise genetic and epigenetic modifications to address the underlying causes of cardiometabolic diseases, targeting genes like PCSK9, APOC3, and LPA. Key innovations, including improved delivery methods and tissue-specific editing, will enhance the specificity, efficiency, and safety of these therapies, minimizing off-target effects and making in vivo genetic medicines a reality. Global partnerships will accelerate this effort to move breakthrough science from bench to bedside and tangibly change our standard of care for the better."

According to a report released in December 2024, the global CRISPR and Cas gene market is expected to grow from $3.3 billion in 2023 to $8.8 billion in 2028 at a rate of 21.90%, before continuing to grow at a compound annual growth rate (CAGR) of 22.76% from 2028, reaching $24.6 billion in 2033. This suggests that CRISPR-based gene therapy will remain an extremely significant field in the biotech industry for the foreseeable future.

Del Bourgo told Labiotech that the overall gene therapy field will likely also see growth when it comes to viral and non-viral delivery methods. As gene therapy expands, the demand for safer, more effective delivery systems is driving innovations in these areas, and advances in synthetic biology and delivery technologies are leading to more refined, customizable solutions, ultimately providing more precise and versatile options for genetic correction.

"Viral vectors, such as AAV and lentiviruses, will be optimized for safety and efficiency, while non-viral approaches, including lipid nanoparticles and electroporation, will continue to reduce immune risks and improve target specificity," explained Del Bourgo. "This will extend gene therapy's reach from rare disorders to more prevalent conditions, such as muscular dystrophies, hemophilia ,and genetic eye diseases."

GLP-1 drugs: Still an attractive proposition to biotechs, but challenges will mount

Since their approval, GLP-1 drugs have been a hot topic in the biotech industry. Despite the competition, startups and big pharma are still looking to create a better version of this drug class than blockbusters Wegovy and Zepbound.

Last year, the demand for GLP-1 drugs led to widespread stock shortages, which is expected to continue to be an issue in 2025. Michael Grosberg, VP of product management at Model N, told Labiotech that there will be ongoing tensions between branded manufacturers and compounding pharmacies, which have been in the news lately due to reports of some of them marketing and selling in-demand weight loss drugs due to the branded drugs not being commercially available.

"...When a drug like tirzepatide is no longer on the shortage list, those taking compounded versions legally can no longer access that version and must try to get prescriptions for the branded drug," said Grosberg. "This could reignite the shortage. Additionally, we should be prepared for more issues like contamination related to substandard compounded versions, potentially leading to a consumer backlash against compounding pharmacies."

An article in Fierce Pharma, however, forecasts that there won't be as many shortage issues in 2025, as both Novo Nordisk and Eli Lilly have poured billions of dollars into capacity expansions and have recently managed to largely erase their GLP-1 drugs from the U.S. Food and Drug Administration (FDA)'s online shortage roster. But, in line with what Grosberg said, Fierce Pharma's article points out that analysts at consulting and technology firm ZS believe that there could indeed be a showdown with the compounding pharmacies that helped provide patients with a consistent supply of GLP-1 drugs when Novo and Lilly were facing shortages.

Furthermore, despite their undeniable success, some experts are wondering whether the GLP-1 drug market has reached its peak. Mizuho healthcare expert Jared Holz wrote in a note to Yahoo! Finance that it's doubtful that "patients are seeking to lose more weight than what drugs like Zepbound and Wegovy are providing."

While Lilly's Zepbound provides up to 24% weight loss, Novo's Wegovy provides up to 16%. Even Novo's most recent clinical trial data for its new GLP-1 drug CagriSema showed just 23% weight loss, putting it just under Lilly's ceiling for Zepbound. The company had indicated it expected higher results, and its shares subsequently plunged.

According to Yahoo! Finance's analysis, the question facing investors is whether or not Lilly and Novo can keep their lead in the market or if incoming competition from other players is going to dilute the market.

For now, though, investors do not seem to be put off. Just last week, London-based Verdiva Bio launched with a weekly-dosed oral GLP-1 drug, having raised an incredible $410 million in series A funding.

Precision medicine: A key trend for biotech in 2025

Precision medicine, or personalized medicine, is rapidly transforming healthcare by tailoring treatment plans to the unique genetic makeup, environment, and lifestyle of each patient, differing from a "one-size-fits-all" approach, which often only works for certain people and certain conditions, but not others. Ultimately, this precise approach allows healthcare providers to predict which prevention strategies and treatments will work with which groups of people.

Advancements in genome sequencing technologies are helping to progress precision medicine by making it faster and more affordable to decode an individual's DNA, allowing companies to identify genetic mutations associated with specific diseases. This is particularly evident in oncology, where more and more companies are developing targeted therapies that are designed to inhibit cancer growth based on a tumor's unique genetic profile, for example.

According to Nathan Buchbinder, chief strategy officer and co-founder of Proscia, precision medicine business units will gain more prominence at both biotech and pharma companies in 2025, as more organizations form them and shift work under them. These types of units include various platform, technology, and functional teams, and will increasingly influence portfolio strategy and execution.

"As we've seen from some of the precision medicine business units that are already up and running, it will integrate and oversee activities across early discovery, preclinical and clinical development, and commercial to spearhead a more integrated approach that accelerates the introduction of targeted therapies to the most appropriate markets

and patients. This reorganization will have as big of an impact – if not bigger – as the rise of translational medicine as an R&D group in the early-to-mid 2000s," commented Buchbinder.

Meanwhile, Andrea Choe, CEO of Holoclara, believes that one particular area of precision medicine that will step into the spotlight in the biotech industry in 2025 is metabolomics, an emerging field that is broadly defined as the comprehensive measurement of all metabolites and low-molecular-weight molecules in a biological specimen. Building on genomics and proteomics, companies now have advanced tools and data platforms to uncover critical molecules, which Choe describes as "needles in infinite molecular haystacks."

"This expansion will redefine therapeutics. Rather than refining old targets, we'll discover entirely new molecules that complement precision medicine. Just as CRISPR and GLP-1 drugs revolutionized genetic and metabolic therapies, metabolomics will further unlock novel strategies that match the complexity of human biology. The result will be more diverse, robust, personalized treatments that transform healthcare, guiding us into an era of truly customized medicine."

So, as it gradually becomes more mainstream, it seems that precision medicine will progress even further in 2025, potentially transforming disease management across a wide range of applications.

Immunology and inflammation (I&I) expected to see continued growth in 2025

Last year saw the immunology and inflammation (I&I) sector attract a major wave of investment, as inflammatory diseases became one of the hottest areas of drug development, spurred on by an interest in novel therapies that have the potential to be more precise and powerful than existing treatments. There were several high-profile buyouts of I&I drug developers by big pharma, and multiple companies raised impressive financing rounds to advance the development of their immune-related drugs.

Natalie Dolphin, managing director of Investor Relations at HLTH Communications, said that the I&I sector is expected to continue its robust growth in 2025, driven by advancements in understanding immune system mechanisms and the development of targeted therapies. "Innovations in biologics and personalized medicine are enhancing treatment efficacy for autoimmune and inflammatory diseases, leading to increased investment and research in this area."

In the next few years, multiple new therapies for immune-related conditions are likely to receive approval. Ebru Karpuzoglu, an immunologist trained in molecular medicine and skincare specialist, and chief scientific director and founder of AveSeena, told Labiotech in a previous article: "The recent surge of investment in the immunology and inflammation sector is poised to catalyze a significant breakthrough in therapeutic development. This influx of capital, coupled with rapid advancements in scientific understanding and technology, has created a fertile ground for innovation in the field. The convergence of these factors suggests that we are on the cusp of a new era in I&I treatments, with the potential to address a wide range of conditions more effectively than ever before."

Valued at $97.58 billion in 2023, the global immunology market is now projected to grow from $103.18 billion in 2024 to $257.39 billion by 2032, exhibiting a CAGR of 12.1% during the forecast period. The U.S. immunology market in particular is expected to grow significantly, reaching an estimated value of $131.25 billion by 2032, driven by the surge in cases of autoimmune disorders.

M&A and investment could surge in 2025

After a downturn following the COVID-19 financial bubble between 2020 and 2022, biotech investment finally saw an upswing in 2024.

In October last year, biotech IPO activity in the U.S. spiked for the second time in 2024, following an initial boost in Q1, largely driven by the Federal Reserve's decision to cut interest rates. Meanwhile, looking at private funding, more than 50 companies announced $100 million-plus in private equity financing rounds in 2024, according to an article by Bryan Spielman in BioSpace. The article also noted that UBS Investment Bank stated that biotech follow-on issuance activity was up 64% in 2024 compared with 2023 and overall volume surpassed five of the last six years' totals.

According to Spielman, while last year did not bring the sector back to pre-pandemic levels of investment, he predicts that it may reach that milestone in 2025, as activity continues to increase. Another important factor, he noted, is that the incoming Trump administration will likely be more open to M&As than the Biden administration has been.

Dolphin agreed that the biotech industry is likely to witness a surge in M&A activities in 2025, as companies seek to diversify their portfolios, access new technologies, and expand their market reach. "Smaller biotech firms with innovative solutions may become attractive acquisition targets for larger pharmaceutical companies aiming to bolster their pipelines and maintain competitive advantage."

Artem Trotsyuk, operating partner at LongeVC, said that there is in fact now a trend of bigger companies buying smaller biotechs to get new medicines and technologies, especially when their old drug patents run out. "Even medium-sized companies are now buying other companies, showing this trend is growing."

In terms of the areas that investors might be taking bets on in 2025, Katrina Rice, chief delivery officer of Biometrics Services at eClinical Solutions, believes that we will see more investments in rare and specialty medicine. "The aftermath of the IRA's drug pricing negotiations and the Rare Disease Voucher Program will drive a shakeup in investment strategies. Investors will adopt a more fearless approach, taking calculated risks on specialty and rare disease R&D where breakthroughs can yield unmatched returns. This shift will fuel innovation in areas once considered too niche or high-risk."

We will have to wait and see what happens, but there does seem to be a certain buzz in the biotech industry of late with regard to investment prospects, and it seems to be a perfect time for new startups to come into the game.

The path to better clinical trials in 2025

Given her position at eClinical Solutions, Rice helped us understand which clinical trial trends would likely take place in 2025. She noted three distinct trends:

The FDA's Diversity Action Plans will break down barriers to inclusive trials: With the FDA's Diversity Action Plans raising the stakes, sponsors will finally abandon outdated recruitment models. "By forging bold alliances with urban leagues, faith-based organizations, and HBCUs, they'll tackle entrenched issues of accessibility and trust, delivering trials that are not only faster but also far more representative – and transformative for patient outcomes," explained Rice.

Predictive analytics will emerge as biotech's superpower: Here, Rice said that AI will "leap from buzzword to backbone," and we can expect predictive analytics to pinpoint high-impact patient groups, streamline complex trial designs ,and catch safety risks before they escalate. "AI will cut inefficiencies, align trials with real-world needs, and ultimately make precision medicine more than just a lofty goal."

RBQM will set the new standard for trial operations: Risk-based quality management is evolving into a critical strategic tool. In 2025, clinical teams will integrate AI-driven RBQM solutions to unearth hidden risks, safeguard patient safety, and elevate data quality. "This isn't just operational efficiency – it's a new standard of excellence for trial execution," said Rice.

Michel van Harten, CEO of myTomorrows, concurred with Rice's opinion that clinical trials will focus more on inclusion in 2025, saying that emerging strategies for this will include decentralized trial designs that minimize geographic and socioeconomic barriers, along with enhanced community engagement through local trial sites and partnerships with trusted patient advocacy groups. Biotech companies are also implementing multilingual resources, such as patient navigator services, and providing cross-border travel support to improve participation from underrepresented groups.

"Investments in diverse investigator teams and inclusive study designs aim to build trust and produce more representative trial outcomes. These efforts highlight a broader industry shift towards delivering equitable healthcare solutions and fostering greater inclusivity in medical research," said van Harten.

Meanwhile, Brant agreed that AI will be significant for clinical trials in 2025, noting patient recruitment as a key area for the technology to improve outcomes. "For instance, AI has proven its ability to effectively pre-screen participants by comparing prospective participant data against trial requirements. It's also able to scale outreach to identify untapped audiences and make sure different demographics see the messages that are right for them. This not only ensures that clinical trials are fully populated – and faster – but also that trials can significantly increase the diversity of patients."

2025: An interesting year for the biotech industry, with political shifts potentially playing a key role

Whether we are talking about the evolution of AI, a rise in M&As and investment, or the potential of precision medicine and CRISPR, the trends in this article are set to play a key part in shaping innovation in the biotech industry in 2025.

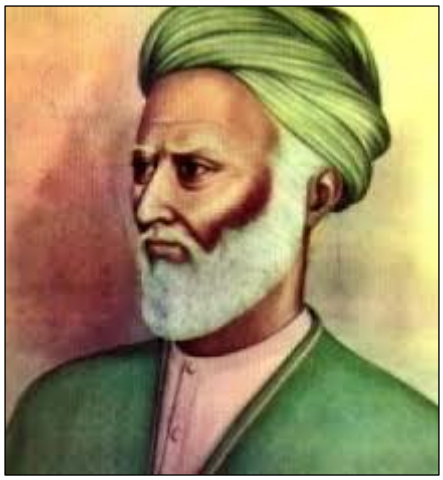
It is also worth keeping an eye on the political landscape and its potential impact on the biotech industry, particularly in the U.S., as the country gets ready to welcome Donald Trump in for his second tenure as President, with some highly contentious healthcare picks.

Additionally, as touched upon previously, the new administration's stance on healthcare regulations and drug pricing may influence M&A activities, as companies reassess strategies in response to potential policy changes. The industry's ability to adapt to these developments will be crucial in navigating the evolving landscape.

Looking at the overall outlook for the global biotech market in 2025, however, there is a cautious optimism in the air: it is projected to expand from $483.0 billion in 2024 to $546.0 billion by 2025, reflecting a robust compound annual growth rate (CAGR) of approximately 13%.

So, whatever happens politically, one thing is for certain: 2025 is set up to be a very interesting, and potentially crucial, year for the biotech industry, which is bound to once again provide patients with more life-changing – and life-saving – treatment options.

ABU AL-HASSAN AL MAWARDI* (972 - 1058 AD)



Abu Al-Hassan Ali Ibn Muhammad Ibn Habib Al-Mawardi was born at Basra in 972 AD. He was educated at first in Basra where, after completion of his basic education, he learned Fiqh (Islamic jurisprudence) from the jurist Abu al-Wahid al-Simari. He then went to Baghdad for advanced studies under Sheikh Abdul-Hamid and Abdallah al-Baqi.

His proficiency in jurisprudence, ethics, political science and literature proved useful in securing a respectable career for him. After his initial appointment as Qadi (Judge), he was gradually promoted to higher offices, until he became the Chief Justice of Baghdad. The Abbasid Caliph al-Qaim bi-Amr Illah appointed him as his roving ambassador and sent him to a number of countries as the head of special missions. In this capacity, he played a key role in establishing harmonious relations between the declining Abbasid Caliphate and the rising power of Buwaihids and Seljukes. He was favoured with rich gifts and tributes by most Sultans of the time. He was still in Baghdad when it was taken over by Buwaihids. He died in 1058 AD.

Al-Mawardi was a great jurist, mohaddith, sociologist and an expert in political science. He was jurist in the school of Fiqh and his book Al-Hawi on the principles of jurisprudence is held in high repute.

His contribution in political science and sociology comprises a number of monumental books, the most famous of which are Kitab al-Ahkam al-Sultania, Qanun al-Wazarah, and Kitab Nasihat al-Mulk. The books discuss the principles of political science, with special reference to the functions and duties of the caliphs, the chief minister, other ministers, relationships between various elements of public and government and measures to strengthen the government and ensure victory in war. Two of these books, al-Ahkam al-Sultania and Qanun al-Wazarah have been published and also translated into various languages. He is considered as being the author/supporter of the 'Doctrine of Necessity' in political science. He was thus in favour of a strong caliphate and discouraged unlimited powers delegated to the governors, which tended to create chaos. On the other hand, he has laid down clear principles for election of the caliph and qualities of the voters, chief among which are attainment of a degree of intellectual level and purity of character.

In ethics, he wrote Kitab A'adab al-Dunya wa al-Din, which became a widely popular book on the subject and is still read in some Islamic countries.

Al-Mawardi has been considered as one of the most famous thinkers in political science in the middle ages. His original work influenced the development of this science, together with the science of sociology, which was further developed later on by Ibn Khaldun.

* *Source: Personalities Noble, 2nd Edition, 2000, Edited by Hakim Mohammed Said, published by IAS with permission of Hamdard Foundation Pakistan.*

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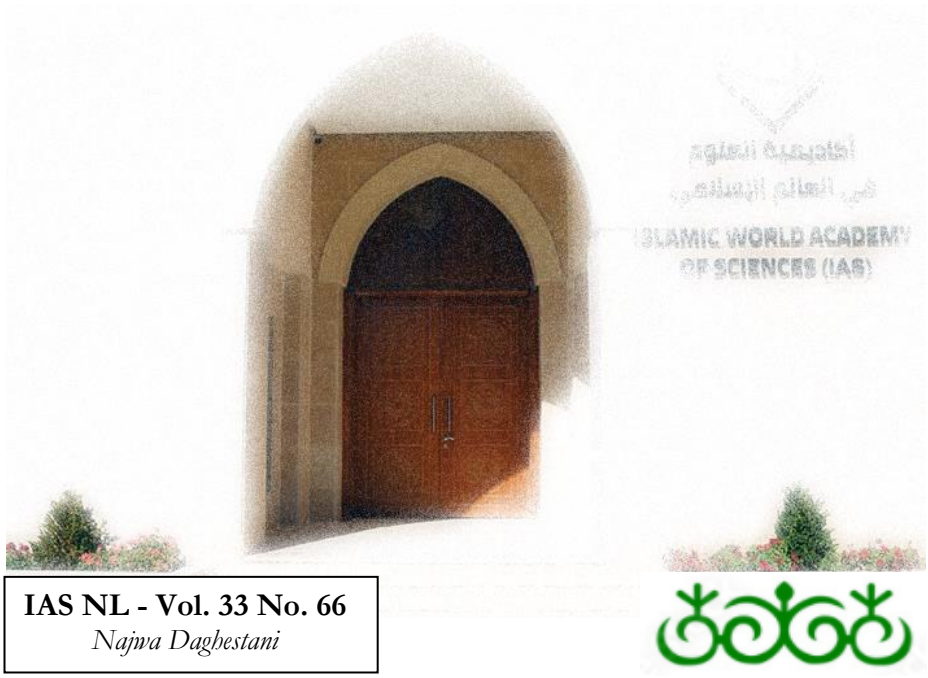

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