Tirumal Classes Quality education

THE HINDU
INDIA'S NATIONAL NEWSPAPER SINCE 1878

Daily News Analysis

The Hindu Important News Articles & Editorial For UPSC CSE

Tuesday, 05 Aug, 2025

Edition: International

Table of Contents

U.S. President Donald Trump has signed an executive order to impose 25% tariffs on Indian imports, alleging:

- High Indian tariffs on U.S. goods.
- India's "profiteering" from Russian oil during the Ukraine conflict.
- India's continued military and energy purchases from Russia.

- India, through the Ministry of External Affairs (MEA), strongly refuted these claims, calling the targeting "unjustified and unreasonable".

India hits back as Trump steps up tariff war

Tariffs 'paid by India' will be substantially raised as it keeps profiting from Russian oil: U.S. President

MEA says U.S. 'actively encouraged' Russian imports since war in Ukraine, points at EU's trade with Russia

It adds that Russian oil imports are to ensure 'affordable energy costs' for Indian consumer

T.C.A. Sharad Raghavan
NEW DELHI

Less than a week after he announced a 25% tariff on imports from India "plus a penalty", U.S. President Donald Trump on Monday once again raised the issue of India buying oil from Russia and profiting from it. He stated that he would be "substantially" raising the tariff "paid by India to the USA".

It is important to note that such tariffs are paid by importers in the U.S., rather than the country on which the tariffs are levied.

The Indian government hit back at Mr. Trump's statements and also criticism from European countries on India's trade with Russia, saying that such "targeting of India" was "unjustified and unreasonable". In a statement, the government pointed out that not only did the U.S. encourage such trade previously, both the European Union and the U.S. continue to actively trade with Russia at levels significantly higher than India's."

Trump's remarks

"India is not only buying massive amounts of Russian Oil, they are then, for much of the Oil purchased, selling it on the Open Market for big profits," Mr. Trump posted on the social network Truth Social. "They don't care how many people in Ukraine are being killed by the Russian War Machine. Because of this, I will be substantially raising the Tariff paid by India to the USA. [sic]"

The Ministry of External Affairs responded to the statement, saying that the U.S. had previously "actively encouraged" the import of Russian oil.

"India has been targeted by the United States and the European Union for importing oil from Russia after the commencement of the Ukraine conflict," the official spokesperson of the Ministry of External Affairs said. "In fact, India began importing from Russia because traditional supplies were diverted to Europe after the outbreak of the conflict. The United States at that time actively encouraged such imports by India for strengthening global energy markets stability."

The MEA's statement added that India's oil imports from Russia are meant to ensure "predictable and affordable energy costs" for the Indian consumer.

"They are a necessity compelled by the global market situation," it said. "However, it is revealing that the very nations criticising India are themselves indulging in trade with Russia. Unlike our case, such trade is not even a vital national compulsion."

> They [India] don't care how many people in Ukraine are being killed by the Russian War Machine. Because of this, I will be substantially raising the Tariff paid by India to the USA
> DONALD TRUMP, U.S. President

> It is revealing that the very nations criticising India are themselves indulging in trade with Russia. Unlike our case, such trade is not even a vital national compulsion
> MEA STATEMENT

The MEA said that the European Union in 2024 had a bilateral trade of €67.5 billion in goods with Russia, in addition to a trade in services estimated at €17.2 billion in 2023.

The U.S. President had on July 31 signed an executive order that authorised a 25% tariff on imports from India.

A day earlier, he had posted on Truth Social that he would be imposing this tariff plus a penalty "because their [India's] tariffs are far too high, among the highest in the world, and they have the most strenuous and obnoxious non-monetary trade barriers of any country".

Apart from this, he also cited India's energy and military equipment purchases from Russia as an irritant.

Following this announcement, Union Minister of Commerce and Industry Piyush Goyal had informed both Houses of Parliament that the government was "studying the implications" of Mr. Trump's announcement, consulting all the relevant domestic stakeholders, and would "take all steps necessary to secure our national interest".

Trade with Russia

"This is significantly more than India's total trade with Russia that year or subsequently," the MEA added. "European imports of LNG [liquefied natural gas] in 2024, in fact, reached a record 16.5 mn tonnes, surpassing the last record of 15.21 mn tonnes in 2022."

Europe's trade with Russia includes not just energy, but also fertilizers, mining products, chemicals, iron and steel and machinery and transport equipment, the statement said.

"Where the United States is concerned, it continues to import from Russia uranium hexafluoride for its nuclear industry, palladium for its EV [electric vehicle] industry, fertilizers as well as chemicals," the MEA noted.

"In this background, the targeting of India is unjustified and unreasonable," it added. "Like any major economy, India will take all necessary measures to safeguard its national interests and economic security."

The 25% tariff places India at a relative disadvantage compared to some of its competitors such as Vietnam, Indonesia, Mexico, and the Philippines. Mr. Trump's new tariffs are expected to take effect from August 7.

INDIA AND THE TRUMP ERA
» PAGE 14
'REJECT THREATS'
» PAGE 4

Key Developments

Trump's Allegations:

- **Accused India of:**
  - Buying "massive amounts" of Russian oil.
  - Reselling Russian oil for profit.
  - Disregarding the Ukraine war's humanitarian cost.

- Maintaining high tariffs and non-tariff barriers on U.S. goods.

India's Response:

- **India's stand on Russian oil:**
  - India began imports only after Europe diverted its traditional supply routes due to the war.
  - The U.S. had initially encouraged India's Russian oil imports to stabilize global energy markets.
  - India imports Russian oil to ensure affordability for domestic consumers, not to profit.
- **On double standards:**
  - EU trade with Russia in goods (2024): €67.5 billion; services: €17.2 billion.
  - U.S. continues to import:
    - Uranium hexafluoride (for nuclear power),
    - Palladium (for EVs),
    - Fertilizers and chemicals.
- **Trade realities:**
  - The U.S. tariffs will hurt American importers, not Indian exporters directly.
  - India's total trade with Russia is far lower than EU or U.S. trade with Russia.
- **Commerce Minister PiyushGoyal:**
  - Announced that India is assessing the situation and will take necessary steps to safeguard its economic and strategic interests.

Implications for India

Strategic Autonomy and Sovereignty:

- India has consistently maintained an independent foreign policy, balancing its ties with the U.S., Russia, and other major powers.
- The criticism overlooks India's energy security needs and domestic compulsions.

Trade Disruption Risk:

- The 25% tariff could harm key export sectors like:
  - Engineering goods,
  - Pharmaceuticals,
  - Textiles, etc.
- It may also push U.S. buyers to shift to other markets (e.g., Vietnam, Mexico), affecting Indian competitiveness.

WTO and Global Trade Norms:

- Arbitrary unilateral tariffs violate WTO norms.
- India could consider legal remedies at WTO or engage diplomatically to resolve the issue.

Geopolitical Undercurrents:

- The statements are likely linked to U.S. election politics and Trump's nationalist economic agenda.
- Raises questions about reliability of trade relations under shifting U.S. administrations.

Broader Issues

1. India's Energy Diplomacy:

- Balancing affordable energy with geopolitical alignments.
- Using oil imports strategically for domestic and diplomatic advantage.

2. India–U.S. Economic Relations:

- Opportunities and vulnerabilities in trade ties.
- Potential for diversification and reducing overdependence.

3. Multilateralism vs Unilateralism:

- Role of WTO, global trade rules, and how countries like India navigate unilateral sanctions/tariffs.

4. Strategic Autonomy:

- India's refusal to bow to Western pressure shows strength in foreign policy.
- Reinforces the principle of "nation-first" economic and diplomatic decision-making.

Way Forward for India

- Diplomatic engagement with both U.S. administration and stakeholders.
- Diversify exports and reduce over-reliance on any single market.
- Enhance domestic competitiveness through structural reforms and trade facilitation.
- Strengthen energy partnerships with other countries (Middle East, Africa) to avoid overdependence.

UPSCMainsPractice Question

Ques: "India's oil trade with Russia has become a flashpoint in India-U.S. relations." Examine this in light of recent tariff announcements and India's strategic autonomy. **(150 Words)**

Page 04:GS 2 : Social Justice

The inclusion of women in the Indian armed forces marks a significant shift towards gender equality in one of the most traditionally male-dominated sectors. Defence Minister Rajnath Singh's recent remarks reaffirm the government's commitment to enhancing women's representation in the military, showcasing both progress and potential in this evolving landscape.

Women's inclusion in armed forces a priority, says Rajnath

Officials highlight expanding opportunities for women across all three armed services; as per data, women make up 13.4% of IAF, 6.85% of Army, 6% of Navy, with numbers rising steadily since 2005

Saurabh Trivedi
NEW DELHI

The parliamentary consultative committee on Defence, headed by Defence Minister Rajnath Singh, was briefed on the representation of women in the armed forces.

Mr. Singh spoke on the government's commitment to provide maximum representation to women in the forces.

As per the data from the Ministry of Defence (MoD), women form 13.4% of the Indian Air force workforce – the highest among all three services – while they make up 6.85% of the Army's workforce and 6% of the Navy's.

In 2024, there were a total of 1,735 women in the Army, 1,614 in the Air Force, and 674 in the Navy.

According to data, 13.4% women constitute the Indian Air force workforce, the highest among all three services. EMMANUAL YOGINI

In 2005, the figures were 767, 574, and 154, respectively.

Twelve branches in the Army are open to women officers, including combat. In the Navy, all branches are open for women officers except submarines. All branches of the Air Force are open for women officers.

More to come

Asked about women's representation in the armed forces, a senior Defence Ministry official said that they were opening more and more branches for women for all categories. Women are eligible for various roles, including technical and non-technical positions, and can join through different entry schemes. Most of the defence training institutes and academies have been opened for women.

Colonel Sofiya Qureshi of the Indian Army, who led the Operation Sindoor briefing along with Wing Commander Vyomika Singh of the Air Force, have become an inspiration for women aiming to join the armed forces.

Another senior defence officer said that women in the armed forces are doing remarkably well and their number is only going to increase in the future as the forces adopt a more gender neutral approach.

Current Status and Trends:

According to data from the Ministry of Defence (MoD), the representation of women in the three services has been growing steadily:

- Indian Air Force (IAF): Women comprise 13.4% of the total workforce — the highest among the three services.
- Indian Army: Women form 6.85% of the workforce.
- Indian Navy: Women constitute 6%.

These figures reflect a steady rise since 2005, when the respective numbers stood at:

- **Army: 767**
- **Air Force: 574**
- **Navy: 154**

In 2024, the numbers have significantly increased to:

- **Army: 1,735**
- **Air Force: 1,614**
- **Navy: 674**

Structural Reforms and Opportunities:

- **Entry and Training:** Women can now join the armed forces through multiple entry schemes (technical, non-technical, short service, and permanent commission). Most defence training academies, such as NDA, OTA, and IMA, have opened their doors to women.
- Branch Inclusion:
  - **Army:** 12 branches are open to women officers, including combat roles.
  - **Navy:** All branches are open except submarines.
  - **Air Force:** All branches are open to women.
- Leadership and Role Models: Officers like Colonel Sofiya Qureshi and Wing Commander Vyomika Singh, who led high-profile operations, have emerged as role models and are inspiring more women to join the forces.

Challenges Ahead:

Despite progress, structural and cultural barriers persist:

- **Combat roles:** While some combat branches are now open, frontline roles for women are still limited in scope.
- **Infrastructure and logistics:** Adjustments are needed in training, accommodation, and deployment policies to ensure gender parity.
- **Gender bias and workplace dynamics:** Deep-rooted biases and resistance to change continue in some areas.

Conclusion:

The rising inclusion of women in the Indian armed forces reflects a broader commitment to gender justice and national integration. While policy reforms and positive role models have created momentum, the journey towards a fully gender-neutral force requires sustained political will, institutional reforms, and societal support. As India aspires to become a global power, empowering women in uniform is not just a matter of equality — it is a strategic imperative.

UPSC Prelims Practice Question

Ques: Consider the following statements regarding women's inclusion in the Indian Armed Forces:

1. All branches of the Indian Air Force are open to women officers.

2. Women are allowed to serve in submarine units in the Indian Navy.

3. Twelve branches in the Indian Army are open to women officers, including combat roles.

Which of the statements given above is/are correct?

A. 1 and 2 only

B. 1 and 3 only

C. 2 and 3 only

D. 1, 2 and 3

Ans : B)

In a landmark study, researchers from the University of Colorado Boulder (CUB) and the National Institute of Standards and Technology (NIST), with inputs from DRAND, have introduced the world's first quantum-powered and blockchain-verifiable random number generator. This innovation aims to overcome the long-standing challenge of producing truly random, certifiable, and tamper-proof encryption keys — a critical component in ensuring cybersecurity and data privacy in the digital age.

A random number generator using quantum physics and a blockchain

While a new study isn't the first to describe how quantum phenomena can be used to generate random numbers, the technique also incorporates blockchains. As a result, the technique is fully traceable and certifiable by independent parties, making it the first of its kind

Sayantan Datta

In September 2013, whistleblower Edward Snowden revealed that American and British intelligence agencies had successfully cracked much of the online encryption internet users used to keep their personal data private. Snowden's solution appeared ironic to many: to adopt end-to-end encryption *en masse*, rendering mass surveillance prohibitively expensive and cumbersome.

In end-to-end encryption, an algorithm converts readable data (plaintext) to an unreadable form (ciphertext) using a string of numbers and letters called a key. A user with the key can feed it into a decryption algorithm, which will use it to turn ciphertext to plaintext. The success of any encryption method thus hinges on the secrecy of the key.

To prevent an unauthorised person from guessing the key, it has to be sufficiently random, i.e., lacking predictable patterns.

How does one get a sufficiently random key? For cybersecurity company Cloudflare, the answer lay in a funky 1963 invention: the lava lamp.

A lava lamp comprises a glass container with blobs of wax suspended in water and placed over an incandescent bulb. The heat from the bulb melts the wax and causes droplets to rise up. As the droplets reach the top of the container, they cool down and fall back to the bottom, starting the cycle once again. The rising droplets in a lava lamp don't take the same shape twice. That is, the shapes are "consistently random."

At Cloudflare's headquarters in San Francisco in the US, the company has arranged a hundred lava lamps on one of its walls. A camera takes pictures of the wall periodically, and computers convert each pixel in the image into a numerical value. Thus, each picture generates a string of numbers (called the seed) that is then input to an algorithm to generate an encryption key.

There are two problems, however. One, even the "consistently random" movements of the lava lamp are determined in theory by the laws of thermodynamics, the branch of physics that deals with how heat moves in a system (e.g., the glass container with water and wax) and how that affects the properties of matter it contains. At least on paper, this makes the seed predictable.

Second, even if the seed is practically random, the algorithm used to generate the key is deterministic, i.e., not random. In other words, if a person gets hold of the seed, they can generate the exact same key using the algorithm. This is why such algorithms, which are commonplace in most encryption systems today, are called pseudorandom number generators.

True randomness has been elusive – but scientists have known for some time where they could best hope to find it: quantum mechanics, where randomness abounds.

Quantum randomness

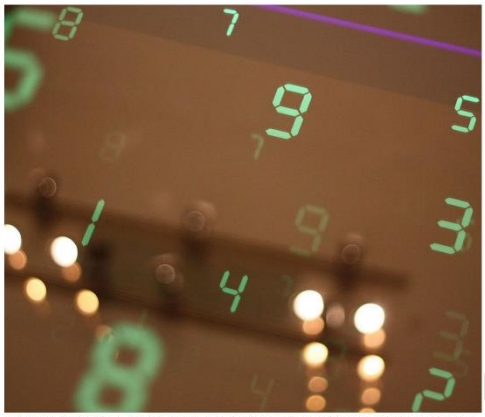
Quantum mechanics is the study of how matter and light behave in the atomic and subatomic realms. At those scales, the theories of physics are no longer able to make predictions with certainty. As Gautam A. Kavuri, a quantum communication researcher at the University of Colorado, Boulder (CUB) in the US, put it, the "outcome of a measurement [in the quantum realm] cannot be known before a measurement is made."

Consider the case of a photon, the particle of light. Each photon has an oscillating electromagnetic field. The direction in which the field oscillates is called the photon's polarisation. According to the laws of quantum mechanics, the polarisation of a photon can be both horizontal and vertical (or left and right) until it is measured – just like a coin tossed in the air is both 'heads' and 'tails' until it lands. It is only at the time of measurement that the polarisation becomes one of the two, and this choice is random.

In a paper published in *Nature* in June, Kavuri along with a team of researchers from the CUB and the National Institute of Standards and Technologies (NIST) in the same city have reported using this as a source to generate truly random numbers.

Once generated, the team broadcasts the numbers publicly via the CU Randomness Beacon (CURBy); this is a public service where receivers can pick up the numbers and use them in their applications.

While Kavuri *et al.* isn't the first team to press quantum phenomena in the service of generating random numbers, the technique incorporates a cryptographic tool called blockchains in their protocol. This makes the technique fully traceable and certifiable by independent parties – making it the first of its kind.



True randomness has been elusive — but scientists have known for some time where they could best hope to find it: quantum mechanics, where randomness abounds. NOAA-NGT/UNSPLASH

Calling the work "innovative," quantum information theory researcher and University of New Orleans associate professor Peter Bierhorst said "every step in the process, from harvesting the raw data (which is only somewhat random) to processing it down to a near-perfect (uniform) string of random bits, can be audited and verified."

Bierhorst has worked in the past with some of the authors of the 2025 *Nature* paper but wasn't associated with the new study.

Numbers from photons

The protocol in the test by Kavuri et al. begins at the NIST, where a process called spontaneous parametric down-conversion is used to generate a pair of quantum entangled photons.

The process uses a special material called a non-linear crystal to convert a photon with higher energy to a pair of photons of lower energy. These photons are entangled, meaning that even at great distances, their properties are correlated.

Once the entangled photons are generated, they are sent in two different directions to two laboratories at opposite ends of a hall at NIST. There, the polarisation of these photons is measured. This process is repeated 15 million times in about one minute, and the polarisation state in each case is truly random. This data is passed to the CUB, where the next step unfolds.

Almost 2 km away, at the CUB, a computer programme converts the data to a bit string, a series of zeroes and ones. At this stage, the string, while truly random, is also biased: the frequency with which zeroes and ones occur is not equal. This random-but-biased bit string is then processed through a mathematical function called a randomness extractor. This function uses an independent random seed, obtained from a different random number generator called DRAND and extracts from the biased bit string a uniformly unbiased random string of 512 bits.

> It is not possible to change the fingerprint at one step without changing the fingerprints of all the subsequent steps
>
> SANJIT CHATTERJEE, INFORMATION SECURITY RESEARCHER AND ASSOCIATE PROFESSOR AT THE INDIAN INSTITUTE OF SCIENCE, BENGALURU

DRAND is run by a confederation of many independent parties around the world, including Cloudflare, Ethereum Foundation, and the Swiss Federal Technology Institute of Lausanne in Switzerland.

Building trust

Impressive as the protocol is, its novelty lies elsewhere.

For random number generators that are used to encrypt and decrypt data, trust has always been an issue. Sanjit Chatterjee, an information security researcher and associate professor at the Indian Institute of Science, Bengaluru, explained: "Suppose I claim I have a random number generator. How do you verify or get a certificate stating that its output is truly random? Or that the protocol has not been tampered with?"

To surmount this issue, the team led by Kavuri integrated a blockchain in their protocol. In blockchain technologies, data from different steps of a process is stored in blocks that are linked to each other using the output of a mathematical algorithm called a hash.

The hash algorithm converts a long string of data to a string of fixed length called the fingerprint. The fingerprint is uniquely linked to the input data; any tampering with the input data leads to a substantially different fingerprint, which a verifying party can easily check and call out.

A shelf of lava lamps. DEAN HOCHMAN (CC BY)

According to Chatterjee, "It is not possible to change the fingerprint at one step without changing the fingerprints of all the subsequent steps."

Thus, by linking different blocks of data using different fingerprints, researchers are able to ensure that any tampering in one step of the process will be reflected in the fingerprints of all the subsequent processes.

Kavuri and colleagues developed a blockchain protocol they called 'twine' to "create a traceable ... cryptographic contract between three parties" responsible for a part of the random number generation process, they wrote in their paper.

The first party, NIST, provided the raw bit string. The second party, CUB, ran the randomness extractor. The third party, DRAND, provided the independent seed to the extractor.

Each step of the process was marked with a hash fingerprint, and the fingerprints could be used by one of the three parties or any user to verify the integrity of the process.

"As long as all the parties are not compromised, we can be sure that the analysis and extraction is carried out correctly," Kavuri said.

'Challenging proposition'

According to Chatterjee, the researchers have provided a "prototype" that shows generating traceable random numbers "is possible in practice".

"But if you think about the amount of random numbers generated in everyday operations, then this is nowhere near that stage," he added.

Kavuri *et al.* stated in their paper that they could generate 7,434 random numbers over a 40-day period.

Bierhorst, the University of New Orleans quantum information theorist, added that the protocol requires "an intricate apparatus employing state-of-the-art optical components to create and manipulate the entangled photons" – which would be the starting step for the protocol.

"Deploying this commercially is a challenging proposition," he said. He added that he expects it will take another few years before the protocol can be deployed widely.

Kavuri, meanwhile, said he was looking forward to bringing more parties under the ambit of their twine protocol. "This will further decentralise trust in the random number generation process," he said.

(Sayantan Datta is a faculty member at Krea University and an independent science journalist. The author thanks Apoorva Patel and Shayan Srinivasa Garani for inputs. dattasayantan95@gmail.com)

Background: Why Random Numbers Matter

- Encryption is foundational to modern digital communication, ensuring that sensitive information remains confidential. A key component in encryption is random number generation, which forms the basis of the cryptographic keys. If the random number is predictable, the system becomes vulnerable to attacks.
- Traditional methods — such as Cloudflare's lava lamp wall — use physical phenomena for randomness. However, these systems are either pseudorandom (deterministic algorithms) or theoretically predictable due to underlying physical laws like thermodynamics.

Quantum Mechanics: A New Source of True Randomness

Quantum mechanics inherently deals with indeterminism. For example, the polarisation of photons cannot be predicted before measurement. This principle is used by Kavuri et al. to generate randomness.

- Spontaneous Parametric Down-Conversion at NIST is used to produce entangled photons.
- Measurements of their polarisation yield truly random outcomes, repeated millions of times to generate raw bit strings.

However, the initial randomness can be biased, which is corrected using a randomness extractor with an independent seed provided by DRAND — a global random number distribution system.

Blockchain: Making the Process Transparent and Trustworthy

Random number generation has always faced the issue of verifiability. How can users trust that the numbers weren't tampered with?

The study solves this by using a custom blockchain protocol named "Twine", which:

- Logs every stage of the process using hash functions (cryptographic fingerprints).
- Ensures that any tampering in one stage will alter subsequent hashes, making interference easily detectable.
- Creates a cryptographic contract among the three independent parties: NIST (raw data), CUB (processing), and DRAND (seed input).

This traceability and decentralisation of trust is a first in the domain of random number generation.

Significance and Implications

1. **Cybersecurity:** Truly random, verifiable numbers enhance the strength and reliability of encryption systems.
2. **Transparency**: Independent third parties can audit and verify the process, boosting confidence in cryptographic tools.
3. **Innovation in Public Services:** Systems like the CU Randomness Beacon (CURBy) publicly distribute these random numbers for use in applications.
4. **Scientific Breakthrough:** This bridges quantum physics, cryptography, and blockchain technology — showcasing India's participation through expert commentary (e.g., Sanjit Chatterjee, IISc).

Challenges and Limitations

- **Scalability:** The current prototype generated only 7,434 random numbers over 40 days — far below commercial requirements.
- **Infrastructure Intensive:** Requires precision optical components and controlled lab settings.
- **Commercial Viability:** Experts like Peter Bierhorst agree that real-world deployment is still years away.

Conclusion

The fusion of quantum mechanics and blockchain technology in generating random numbers marks a paradigm shift in cybersecurity. While the current implementation is a proof of concept, it sets the foundation for future decentralised, auditable, and quantum-secure encryption systems. As data security becomes ever more critical in the digital era, such innovations could play a pivotal role in redefining how trust and privacy are maintained globally.

UPSCMainsPractice Question

Ques:Discuss how quantum mechanics and blockchain technology can be integrated to enhance cybersecurity. Illustrate with recent developments. (150 Words)

The COVID-19 pandemic not only tested India's health infrastructure but also exposed deep cracks in its mortality surveillance system. While the official death toll stands at approximately 5.33 lakh, emerging data from the Civil Registration System (CRS) and Medical Certification of Cause of Death (MCCD) suggests that the actual figure may be significantly higher — perhaps even aligning with the World Health Organization's (WHO) estimate of 47 lakh deaths. The discrepancy raises urgent questions about data accuracy, systemic preparedness, and the robustness of India's public health data architecture.

India's pandemic toll remains elusive

Shilka Abraham

Master of Public Health graduate, School of Health Systems Studies, Tata Institute of Social Sciences

Soumitra Ghosh

Associate Professor and Chairperson, Centre for Health Policy, Planning and Management, School of Health Systems Studies, Tata Institute of Social Sciences

The Civil Registration System (CRS) data has brought into sharp relief the magnitude of excess mortality that India witnessed during the COVID-19 pandemic years. Excess mortality refers to the difference between the total number of deaths during a pandemic or any other natural disaster compared to the number of deaths that would have been expected under normal conditions. According to the CRS, India recorded 76.4 lakh deaths in 2019. This figure rose to 81.11 lakh in 2020 and further surged to 1.02 crore in 2021 – an implicit acknowledgement of the fact that the true mortality impact of COVID-19 far exceeds the official toll of 5.33 lakh.

Data from the Medical Certification of Cause of Death (MCCD) for 2021, released alongside the CRS and Sample Registration System reports, adds further weight to this claim. COVID-19 was identified as the second leading cause of death, with 5.74 lakh certified fatalities attributed to the virus – already exceeding the official figure. However, this estimate was drawn from less than a quarter (23.4%) of registered deaths in 2021. Taken together, the rise in all-cause mortality and the limited scope of medical certification offer a compelling case that India's true pandemic death toll may be far closer to the World Health Organization's estimate of 47 lakh deaths – a model that the Government of India had earlier rejected, citing concerns over its methodological robustness.

A systemic deficiency

CRS data/all-cause mortality data is indispensable, especially given the widespread undercounting of COVID-related deaths. This metric captures not only confirmed cases but also fatalities arising from misdiagnoses, misclassification, and pandemic-induced systemic disruptions. Nonetheless, the utility of the all-cause mortality data in gauging the true impact of COVID-19 is limited in the Indian setting, as the recording of deaths is far from universal. The National Family Health Survey-5 states that nearly 29% of deaths between 2016 and 2020 went unregistered. The omission of civil registration from the list of essential services during the 2020 lockdown further obscured the mortality landscape. As a consequence, even comprehensive datasets such as CRS may fall short in reflecting the full impact of the pandemic.

Even comprehensive datasets such as CRS may fall short in reflecting the full impact of the pandemic

Beyond numerical discrepancies lies a deeper issue – the structural inadequacy of death certification and classification. During the pandemic years, we visited crematoriums and burial grounds in a locality in Kerala. We observed a marked rise in the number of daily cremations compared to previous years – an increase that was evident not only in facilities designated for handling COVID-19 deaths, but also in those without such designation. This raises pertinent questions regarding the misclassification of COVID-19 deaths and under-ascertainment of causes. A significant driver of this opacity is the absence of medical certification. In 2020, 45% of deaths occurred without any form of medical attention – 10% points higher than in pre-pandemic years. Within our study cohort, only 22.8% of the deceased had any formal medical documentation indicating the cause of death. Nationally, only 23.4% of deaths are medically certified as per the recent MCCD data. This systemic deficiency compromises mortality surveillance as well as public health planning.

Indirect deaths

A further dimension of the pandemic's mortality burden relates to indirect deaths – a category of deaths that, while not directly caused by SARS-CoV-2 infection, can be reasonably attributed to the wider repercussions of the pandemic. These fatalities, often absent from COVID-19 official statistics, occurred due to systemic disruptions: delays in seeking care due to fear of infection, scarcity of hospital beds and essential medicines, post-infection complications, economic distress, and logistical barriers to healthcare access during prolonged lockdowns.

During our field study, we found that a considerable share of deaths was indirectly linked to these cascading effects of the pandemic. Many people suffered physical and psychological deterioration post-infection, some experienced an exacerbation of chronic conditions, and others refrained from seeking timely medical attention. When extrapolated to the broader national context, particularly in regions where healthcare systems are fragile and supply chains were acutely disrupted, the implications would be sobering. To gauge the true mortality impact of the pandemic, it is insufficient therefore to rely solely on officially recorded COVID-19 deaths or all-cause mortality data.

Our study in Kerala found that 34% of deaths were indirectly attributable to the pandemic, and 9% may have been misclassified. If such patterns exist in a State with a relatively strong public health systems (although the death registration in the prescribed time was around 61% in 2021), the scale of undercounting could be even more pronounced in States such as Gujarat and Madhya Pradesh where discrepancies between excess deaths and official figures are significantly wider.

These findings make a compelling case for a systematic inquiry into the full extent of mortality during the pandemic. Policymakers should consider conducting a large-scale study, which could be also accomplished by including questions on decedents in the next Census. More importantly, they must serve as a wake-up call to urgently reform India's mortality surveillance architecture.

1. Understanding Excess Mortality: Beyond Official Counts

Excess mortality refers to the difference between actual and expected deaths during a crisis.

- CRS data reports:
  - 76.4 lakh deaths in 2019
  - 81.11 lakh in 2020
  - A dramatic 1.02 crore in 2021This surge far exceeds the official COVID-19 toll, indicating substantial undercounting — either due to misclassification, lack of testing, or systemic disruptions.

Moreover, while MCCD data recorded 5.74 lakh COVID-related deaths in 2021 (already more than the official tally), this was based on only 23.4% of registered deaths, highlighting serious coverage gaps.

2. Structural Deficiencies in Death Registration and Certification

India's mortality data suffers from two major issues:

- Under-registration of deaths: According to NFHS-5, about 29% of deaths went unregistered between 2016 and 2020.
- Low medical certification: Only 23.4% of deaths are medically certified, rendering the cause of death in most cases unknown or inaccurately recorded.

These systemic gaps are compounded by:

- Exclusion of civil registration from essential services during lockdowns.
- High incidence of deaths without medical attention (45% in 2020).
- Regional disparities: Even Kerala, with its strong public health system, had only 61% timely death registrations in 2021.

3. Indirect Deaths: The Hidden Burden of the Pandemic

The true pandemic toll must also account for indirect deaths — those caused not by the virus itself but by:

- Healthcare disruptions (bed shortages, medicine scarcity)
- Delayed treatment due to fear of infection
- Economic and psychological distress
- Post-COVID complications

The field study in Kerala found that:

- 34% of deaths were indirectly linked to the pandemic
- 9% may have been misclassified

These figures are alarming, especially considering Kerala's relatively strong data systems. The undercount could be much higher in States like Gujarat or Madhya Pradesh, where gaps between excess deaths and official data are more pronounced.

4. Implications for Public Health Policy

Accurate mortality data is essential for:

- Public health planning
- Disaster preparedness
- Equitable resource allocation
- Building public trust

The lack of reliable data hampers India's ability to respond to future health emergencies and undermines the credibility of official statistics.

Conclusion

India's pandemic experience has underscored the urgent need to reform its mortality surveillance architecture. With both quantitative undercounts and qualitative misclassifications, the current system is inadequate for capturing the full impact of health crises.

A large-scale retrospective mortality survey, integration of death-related questions in the next Census, and investment in universal civil registration and medical certification are imperative. If the gaps are not addressed, India risks repeating these failures in the face of future pandemics — with consequences that go far beyond numbers.

UPSC Mains Practice Question

Ques: Accurate mortality data is essential for effective public health governance. Discuss in the context of India's Civil Registration System and the challenges exposed during the COVID-19 pandemic.

Page 10:GS 3 : Internal security

The Indian Air Force (IAF), the fourth largest in the world, is facing a critical capability gap as it grapples with ageing aircraft fleets, delayed inductions, and an aggressive regional security environment dominated by China and Pakistan. With the impending retirement of the MiG-21 — India's first supersonic fighter — the IAF's squadron strength is set to fall further below the sanctioned limit, exposing the long-standing crisis in force modernization and indigenization.

IAF's unending fighter conundrum

Why have the MiG-21 fighter jets been called 'flying coffins'? Why has the induction of Mk-1A jets been delayed? How many jets does the Indian Air Force intend to induct in the next two decades? Are the engines for India's fifth generation fighter aircraft going to be indigenously developed?

EXPLAINER

Dinakar Peri

The story so far:

After over six decades in service, the MiG-21 fighter jets are set to be retired from the Indian Air Force (IAF) in September this year. The formal ceremony is scheduled to be held at Chandigarh where the jets were first inducted in 1963. With this the fighter strength of the IAF will dip from 31 to 29 squadrons, against the sanctioned strength of 42 squadrons. A fighter squadron typically has 16-18 jets. The IAF is awaiting deliveries of the Light Combat Aircraft (LCA)-MkIA, which is expected to begin in the next few months after repeated delays. All this at a time when the Chinese Air Force and Navy have fielded around 1,900 fighters including more than 1,300 fourth-generation aircraft, not including trainers, as per a 2024 U.S. Department of Defence report. China has also deployed two Fifth Generation Fighter Aircraft (FGFA), recently unveiled two more advanced jets, and is likely to supply 40 J-35s stealth jets to Pakistan.

What has been the legacy of MiG-21s?

Contracted from the erstwhile Soviet Union after the 1962 war with China, the MiG-21s heralded the onset of supersonic aviation in the IAF and was also its first non-western fighter. A total of 872 MiG-21 aircraft have been inducted in the IAF, a bulk of them licence-manufactured by the state-owned Hindustan Aeronautics Limited (HAL). The MiG-21s remained the mainstay of the IAF for several decades and a spate of accidents in the early 2000s earned them the name 'flying coffins'. Over the six decades, there were over 450 accidents involving the jet.

The jets played a key role in the 1965, 1971 wars, the 1999 Kargil conflict, and more recently in the aerial dual with Pakistan on February 27, 2019, a day after the Balakot air strike. During the attack, Group Captain (then Wg Cdr) Abhinandan Varthaman's MiG-21 was shot down and fell in Pakistan Occupied Kashmir after he shot down a Pakistani F-16, according to the IAF.

In fact, in the absence of an Advanced Jet Trainer (AJT), before the Hawks were inducted in 2008, the MiG-21s were used for stage III training of young pilots for a long time as it was the "most suitable" fighter even though it was considered "sub-optimal" as a trainer.

The MiG-21 is also among the most successful fighter jets globally with over 6,000 jets of 12 types flown by over three dozen countries. Currently, there are two MiG-21 Bison squadrons in service – the No. 23 'Panthers' and the No. 3 'Cobras'. Incidentally, the No. 3 Squadron has the distinction of being the first to get the upgraded MiG-21 Bisons still in service and will now be the first to get the LCA-MkIA. With the MiG-21s out, the MiG-29s are the last of the MiG series in service which together with the SU-30MKI remain the last of Russian-origin fighters.

What is the current status of the IAF?

Besides the MiG-21s, a majority of the current inventory, that is the early variants of the Jaguars, Mirage-2000s and Mig-29s, will start going out by the end of the decade. This leaves the SU-30MKI in service, the LCA variants planned to be inducted, and the Medium Role Fighter Aircraft (MRFA) while the indigenous FGFA, the Advanced Medium Combat Aircraft (AMCA) is under development.

The IAF currently operates two squadrons of the LCA-Mk1, which undertook maiden flight in January 2001 and was inducted in 2016. A more capable variant, the Mk-1A, which is to be inducted in large numbers, had been delayed initially due to development issues and later due to non-delivery of engines by General Electric (GE) Aerospace citing supply chain difficulties.

Long legacy: Technicians preparing a MiG-21 fighter for a test flight at the Base Repair Depot at Ozhar, Maharashtra on July 24, 1982. HINDU PHOTO ARCHIVES

How did it get delayed?

The Defence Ministry had signed a ₹48,000 crore contract with HAL for 83 MK1A jets, and deliveries were to start in March 2024 with at least 16 planes to be delivered to the IAF every year. However, not a single Tejas Mark-1A has been delivered so far. In August 2021, the HAL placed an order for 99 F-404 engines with GE Aerospace at a cost of ₹5,375 crore for the 83 MkIA jets. The first engine arrived in India only in April this year after a delay of one and half years and the second engine was delivered early this month. Additionally, a deal for 97 additional jets, estimated to ₹67,000 crore, is expected to be concluded in the next few months. HAL has assured to scale up production to 24 jets a year.

Amid these delays, an Empowered Committee for Capability Enhancement of the IAF headed by the Defence Secretary R. K. Singh identified key thrust areas and made recommendations for medium- and long-term measures in the report submitted to Defence Minister Rajnath Singh in March.

As per the IAF, the LCA Mk2, larger and more capable than the Mk1 variants, is meant to replace the Mirage 2000, MiG-29 and Jaguars. It is expected to take first flight in 2026. In February 2025, IAF Chief Air Chief Marshal A. P. Singh said that they need to add 35-40 jets every year to make up for the shortage in numbers. Both these programmes, LCA-MkIA and Mk2, are extremely critical to shore up fighter numbers of the IAF over the next 10-15 years. In an interview to *PTI* in June, HAL Chairman and Managing Director D. K. Sunil said that GE Aerospace is expected to supply 12 engines in the current fiscal and that the jets would be delivered to the IAF.

Moreover, India has procured 272 Su-30MKIs from Russia of which around 260 remain in service. Last December, the Ministry of Defence signed a ₹13,500 crore deal with HAL for 12 Sukhois to replace those lost in crashes. A major upgrade programme for the Sukhoi's has been lined up to be undertaken by HAL. The upgrade of 84 jets in the first batch has already been approved. Meanwhile, by early 2040s, some of the earlier batch of SU-30MKIs will go out.

What is the way forward?

The IAF has drawn up an ambitious plan to induct more than 600 jets over the next two decades, a large number of them being LCA variants. This includes 180 LCA-MkIA, over 120 LCA-Mk2, 114 MRFA and at least 120 AMCA. A Twin-Engine Deck Based Fighter for the Navy's aircraft carriers is also on the drawing board. However, all this hinges on timely production and deliveries.

Mr. Singh said in an interview recently that they are talking to partners for the likely import of a small number of fifth gen fighters as an interim measure while the AMCA development continues. The option is between the Russian SU-57 and American F-35. These are sensitive negotiations, Mr. Singh said adding, "When it reaches a tangible stage, whether it is an Acceptance of Necessity (AoN), a Request For Proposal or ultimately through a contract that is when the media will come to know."

Ultimately, it is the fifth gen AMCA that is the way forward while the LCA variants and MRFA fill numbers and add strength in the medium term. The Aeronautical Development Agency (ADA) that is developing the aircraft has floated an AoN inviting private sector participation for the production. Even HAL has to bid for it, unlike the nomination in the past. "I imagine it will take 3-6 months to reach the contract award stage", Mr. Singh said. "Thereafter the project itself of development and an AMCA prototype to actually take to the skies, it would be a 10-year program, I would imagine."

On the engine front, the F414 engine to power the LCA-Mk2 is to be licence manufactured by HAL for which commercial negotiations with GE are underway. The AMCA development is envisaged in two phases – MK1 development and couple of squadrons with the GE414 engine, and AMCA-Mk2 with a more powerful 110KN engine that is to be co-developed with a foreign partner for which talks are underway.

All this leaves the MRFA deal, for which the Request For Information was issued to global aircraft manufacturers in April 2019, but there has been no progress since. Given the huge cost involved, the long timelines and various other programmes already in the pipeline, it has to be seen how it can be taken forward.

Dinakar Peri is Fellow, Security Studies at Carnegie India.

India's fighter jet strength

IAF CURRENT SQUADRONS	
SU-30MKI	13
Jaguar	6
Mirage 2000	3
MiG-29UPG	3
Rafale	2
LCA	2
MiG-21	2
Total sqns	**31**

THE PLANNED LINE-UP	
LCA-MK1A	180 (83+97)
LCA-MK2	120<
MRFA	114
AMCA	120<

IAF LCA Tejas during the Aero India 2023 air show at Yelahanka air base in Bengaluru.

THE GIST

- Contracted from the erstwhile Soviet Union after the 1962 war with China, the MiG-21s heralded the onset of supersonic aviation in the IAF and was also its first non-western fighter.
- The IAF has drawn up an ambitious plan to induct more than 600 jets over the next two decades, a large number of them being LCA variants.
- The Defence Ministry had signed a ₹48,000 crore contract with HAL for 83 MK1A jets, and deliveries were to start in March 2024 with at least 16 planes to be delivered to the IAF every year. However, not a single Tejas Mark-1A has been delivered so far.

Legacy of the MiG-21 and the Gap It Leaves

- Inducted in 1963, the **MiG-21** was a symbol of India's transition to supersonic air power and served in key operations — 1965, 1971, Kargil, and Balakot.
- Over **450 accidents** and numerous pilot casualties earned it the nickname "**flying coffin**".
- Its retirement in 2024 reduces squadron strength to **29 from the required 42**, highlighting a dangerous shortfall.

Status of Fighter Jet Inductions

- **LCA Tejas Mk-1A:**
  - The ₹48,000 crore deal for 83 jets has faced **engine supply delays from GE Aerospace**.
  - First deliveries, expected in 2024, have not materialized yet.
  - HAL is expected to ramp up production to **24 jets/year**.
- **LCA Mk-2**:
  - Designed to replace Mirage-2000s, Jaguars, and MiG-29s.
  - First flight scheduled in **2026**.
  - Will be powered by the **GE-F414 engine**, to be license-produced in India.
- **Advanced Medium Combat Aircraft (AMCA)**:
  - India's 5th-generation stealth fighter program.
  - Development envisaged in **two phases**: Mk1 with GE-F414, and Mk2 with an **indigenously co-developed 110kN engine**.
  - Expected timeline: **10+ years**.

External Dependencies and Procurement Plans

- IAF plans to induct over **600 jets** in the next two decades:
  - 180 LCA Mk1A
  - 120+ LCA Mk2
  - 114 MRFA (Multi Role Fighter Aircraft)
  - 120 AMCA
- Negotiations are underway for limited procurement of **fifth-generation fighters** (Russian Su-57 or American F-35) as an interim measure.
- **MRFA project**, announced in 2019, remains stagnant due to budgetary and prioritization issues.

Challenges and Implications

- **Capability Gap**: While China has over 1,900 fighters, India's squadron strength is shrinking, risking a **two-front war disadvantage**.

- **Delays in Indigenous Production**: HAL's dependence on foreign engines and slow production timelines hinder operational preparedness.
- **Aging Fleet**: Jaguars, Mirage-2000s, and MiG-29s will be phased out by end of decade, intensifying the crisis.
- **Geopolitical Risks**: In an uncertain Indo-Pacific security environment, delays in modernisation directly threaten national security.

Conclusion

India's fighter aircraft roadmap reflects a **delicate balance between indigenisation, strategic autonomy, and operational urgency**. While the vision is ambitious, its realisation hinges on **timely execution, technological self-reliance, and streamlined procurement mechanisms**. The AMCA project represents the future, but immediate capability gaps must be addressed through accelerated LCA production and prudent foreign acquisitions. A holistic, mission-driven approach is essential to prevent India's air power from falling behind in an increasingly contested regional airspace.

UPSC MainsPractice Question

Ques: India's fighter aircraft program is caught between the challenges of indigenisation and urgent operational requirements. Critically examine the factors responsible for the delay in modernising the Indian Air Force and suggest a roadmap for the future. **(150 words)**

Page : 08 Editorial Analysis

The missing link in India's battery waste management

India, with its focus on decarbonisation, has witnessed rapid electrification, particularly in the realm of electric vehicle (EV) adoption. There are projections that India's EV lithium battery demand may skyrocket to nearly 139 gigawatt-hours (GWh) by 2035 from 4 GWh in 2023. India's expanding renewable energy sector is also catalysing demand for lithium batteries, with rapid adoption of battery energy storage systems (BESS) to meet India's Net Zero goal by 2070. While the growth in EV adoption is desirable, it may impose environmental costs without a robust recycling framework in place. Improper disposal of lithium batteries has severe repercussions, including leakage of hazardous materials into soil and water. Added to this is the growing volume of battery waste, with lithium batteries alone accounting for 7,00,000 of the 1.6 million metric tonnes of e-waste generated in 2022. Recognising these risks, the government notified the Battery Waste Management Rules (BWMR) in 2022 to ensure sustainable management and recycling.

The first problem is the floor price

A cornerstone of the rules is the Extended Producer Responsibility (EPR), which compels producers to fund battery collection and recycling, and aims to close the loop in the battery value chain. Producers rely on recyclers to meet their recycling targets since they do not possess the logistics and the infrastructure for the collection of battery waste. In practice, recyclers must receive a minimum price, known as the EPR floor price, in exchange for EPR certificates that attest that producers have met their recycling obligations. The EPR floor price ensures that recyclers are adequately compensated for their upfront investment in infrastructure, research and development, labour, technology and recycling methods.

Unfortunately, there are certain hurdles, the first being the EPR floor price being too low to sustain the robust recycling of battery waste generated by producers. Proper disposal of lithium battery waste is expensive, requiring advanced processing technologies, safe transportation, and skilled labour to prevent hazardous materials from leaching into ecosystems.

Arun Goyal

is a retired IAS officer. He is a former Secretary to the Government of India and a former Member of the Central Electricity Regulatory Commission

As the first step, it is essential that India ensures the adoption of fair Extended Producer Responsibility floor pricing

Lithium-ion batteries also have valuable and rare minerals such as cobalt, lithium and nickel, whose efficient recovery can significantly reduce India's import dependence. In case, the EPR floor price does not adequately cover proper recycling costs, it becomes economically unviable for legitimate recyclers to operate sustainably. As a result, informal and fraudulent recyclers tend to flourish, creating market distortions and perverse incentives for producers. They often issue false recycling certificates or dump hazardous waste – a failure previously witnessed in India's plastic waste management sector. If left unchecked, such practices may undermine India's circular economy ambitions. Without fair EPR floor pricing, India faces severe environmental degradation from improper battery recycling or dumping. The financial repercussions are equally alarming. Experts estimate that by 2030, inadequate battery recycling could cost India over $1 billion in foreign exchange losses.

A resistance to compliance

Large consumer electronics and manufacturers have further complicated the issue by resisting compliance. Large producers' policies are different for developed and developing countries, allowing corporations to circumvent environmental responsibilities in developing markets. This trend risks undermining the establishment of resilient and sustainable battery ecosystems across the global south.

Interestingly, adjusting the EPR floor price should not increase costs for consumers. While global metal prices have declined over the past two years, manufacturers have not passed on these savings to consumers, indicating that Original Equipment Manufacturers can absorb higher recycling costs without raising prices. A fair EPR floor price will ensure sustainable recycling without burdening end users, while fostering a circular economy that benefits industry and consumers.

To protect legitimate recyclers and encourage compliance, India must consider adopting a fair and globally comparable EPR floor price that reflects the real costs of recycling and industry building, and which can ease to market-driven prices when the ecosystem is mature and standardisation is in place. This requires immediate constructive dialogue among policymakers, industry and recyclers to establish a viable pricing structure after analysing global pricing structures and best practices. For instance, the United Kingdom requires producers to pay close to ₹600 per kilogram for EV battery recycling, whereas what is under consideration for India is less than a fourth of that. This is a significant difference even after adjusting for purchasing power between India and the U.K. The EPR floor price for recycling battery waste should cover the full spectrum of recycling expenses, from collection to material recovery, ensuring that recyclers can operate sustainably without resorting to shortcuts. A fair EPR regime will also incentivise battery producers to hold recyclers accountable through audits.

Integrate informal recyclers

Enforcement mechanisms need urgent strengthening in India. This includes implementing robust audit systems, digitising the issuance and the tracking of EPR certificates, and imposing stringent penalties for fraud and non-compliance. Additionally, integrating informal recyclers into the formal sector through training and regulatory support can help eliminate hazardous practices while expanding India's recycling capacity. This is not just an environmental challenge. It is an economic and strategic imperative. By recalibrating the EPR floor price, strengthening enforcement, and formalising the informal sector, we can transform battery waste from a looming crisis into a catalyst for green growth and a truly circular economy.

GS. Paper 03 Environment & Ecology

UPSC Mains Practice Question: The success of India's green transition depends not just on adoption but on sustainable disposal." Critically examine the challenges in battery waste management in India and suggest policy interventions. **(250 words)**

Context :

As India accelerates towards its Net Zero target by 2070, rapid electrification and the rise in Electric Vehicles (EVs) and Battery Energy Storage Systems (BESS) have led to a surge in lithium-ion battery usage. While this transition supports decarbonisation goals, the lack of a robust battery waste management framework threatens to create an environmental and economic crisis. The Battery Waste Management Rules (2022) and the Extended Producer Responsibility (EPR) mechanism aim to address this, but challenges persist.

Key Issues & Analysis:

1. Surge in Battery Waste Generation:

- Lithium battery demand may increase from **4 GWh (2023)** to **139 GWh by 2035**.
- In 2022, lithium batteries accounted for **7,00,000 MT** of India's **1.6 million MT** e-waste.
- Improper disposal risks **soil and water contamination** and long-term ecological damage.

2. Gaps in the EPR Mechanism:

- **EPR mandates** that producers finance battery collection and recycling.
- The **EPR floor price**, meant to compensate recyclers, is **too low** to cover actual recycling costs.
- Result: Viable recyclers struggle, while **informal players flourish**, issuing **fake certificates** or **dumping waste**, undermining environmental efforts.

3. Strategic Importance of Recycling:

- Lithium-ion batteries contain **critical minerals** like cobalt, lithium, and nickel.
- Effective recycling can reduce **import dependency** and save up to **$1 billion in foreign exchange** by 2030.
- Low EPR prices threaten both **economic security** and **India's circular economy goals**.

4. Industry Resistance and Global Comparisons:

- **Large manufacturers** often adopt lenient policies for developing countries, **evading compliance**.
- In the **U.K., EV battery recycling costs ~₹600/kg**, while India's proposed rate is **less than one-fourth**, even after PPP adjustments.
- Despite falling metal prices, OEMs haven't reduced consumer prices — indicating **ability to absorb higher recycling costs**.

5. Need for Structural Reforms:

- Enforce **robust audits**, **digitised EPR tracking**, and **strict penalties** for non-compliance.
- **Integrate informal sector** recyclers via **training**, **formal registration**, and **regulatory guidance**.
- Develop a **globally benchmarked EPR price** reflecting real recycling costs.

Conclusion:

India stands at a critical juncture where it must balance environmental responsibility with economic pragmatism. The success of its EV and green energy revolution hinges on closing the loop in battery life cycles through sustainable waste management. A recalibrated and fair EPR regime, stronger enforcement, and inclusive formalisation of informal recyclers can transform battery waste from a looming crisis into a cornerstone of India's circular and green economy. Timely policy intervention will ensure India's green growth is not only ambitious but also sustainable.