Topics

- ISRO and space economy
- spade-toothed whales
- Heat waves impact on women
- What is an EEG?
- Mains

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By saurabh Pandey

THE HINDU

Target Mains -2024/25 -

Q ‘Space economy has to be demand driven rather than supply driven’ . Explain this statement in the context of ISRO approach towards commercialisation of space

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ISRO has a problem: many rockets, but too few satellites to launch

The Indian space programme used to follow a supply-driven model: ISRO would launch satellites and then look for customers for services provided by the satellites. This changed to a demand-driven model in 2019-2020, in which a satellite is built and launched only if there is already demand for it

Pradeep Mohandas

In June, S. Somanath, Chairman of the Indian Space Research Organisation (ISRO) and Secretary of the Department of Space, said ISRO's launch vehicle capability was three-times the demand. Many experts in the spaceflight sector and beyond interpreted this to mean the space launch market was grim. Mr. Somanath also suggested strong demand was needed for launch vehicles from the domestic Indian market.

India currently has four launch vehicles: the Small Satellite Launch Vehicle (SSLV), the Polar Satellite Launch Vehicle (PSLV), the Geosynchronous Satellite Launch Vehicle (GSLV), and the Launch Vehicle Mark-III (LVM-3). These rockets can launch satellites weighing up to four tonnes to the geosynchronous orbit. India also relies on foreign launch vehicles, like Europe's Ariane V and SpaceX's Falcon 9, when a satellite weighs more than four tonnes.

At present, the country operates a fleet of satellites with applications in communications, remote sensing, positioning, navigation and timing (PNT), meteorology, disaster management, space-based internet, scientific missions, and experimental missions. It also needs launch vehicles for space missions like Chandrayaan 3 and Aditya L1.

All this makes it look like there are more applications and satellites than there are launch vehicles – which is the opposite of what Mr. Somanath mentioned. Where then is the issue?

An LVM-3 launch vehicle lifts off from ISRO's Sriharikota spaceport carrying the Chandrayaan-3 mission to orbit. ISRO

Demand-driven model

The Indian space programme used to follow a supply-driven model: ISRO would build and launch satellites and then look for customers who needed the services provided by the satellites. When the Indian government reformed the space sector in 2019-2020, it changed this to a demand-driven model. Here, a satellite needs to be built and launched only if there is already demand for it. This may have led to the situation Mr. Somanath mentioned.

There is now a chicken and egg problem. The customer of the services provided by the satellite needs to be educated about the need for the service. The customer will then create a demand for a service that will need a satellite to be launched. This will provide the demand Mr. Somanath is asking for.

Consider the example of the internet. There needs to be a demand for space-based internet in a country already filled with affordable fibre and mobile-based internet services, so a company will launch a constellation of satellites into orbit to provide that service.

The question arises: Who will educate the customer, ISRO or the industry?

Without such educated customers, demand at the scale ISRO expects will not be created. The customers here are not only consumers of space-based internet. These are other companies, government institutions, defence enterprises, and ordinary people including farmers, bankers, etc. So the 'amount' of education required is very great.

The other area from which demand is likely to arise is human spaceflight. This includes human-rated launch vehicles that carry humans and supplies into orbit station or the moon. There could in future be demand for space tourism as well.

Launch capability limitations

India's launch vehicles are also not powerful enough to undertake certain missions, like Chandrayaan 4. China used its Long March 5 launch vehicle to launch its Change'e 4 and Chang'e 5 missions in a single launch. India's LVM-3 has less than one-third of Long March 5's capability (28% to be more precise) and will need two LVM-3 launches to launch all the components of Chandrayaan 4.

ISRO will be upgrading the LVM-3 with a semi-cryogenic engine to boost its payload capacity to six tonnes to the geostationary transfer orbit (GTO). The organisation will also need a new launch vehicle – already dubbed the Next Generation Launch Vehicle (NGLV), a.k.a. Project Soorya – to carry 10 tonnes to GTO. But it has only submitted a funding proposal thus far for this project. Other variants of this launch vehicle are expected to raise this vehicle's lift capacity.

India will also need one more successful flight of the SSLV to be confident about its ability to launch smaller satellites. Smaller satellites are usually experimental and university-built. More success in this domain will encourage space companies to build larger satellites, eventually leading to a demand for launch vehicles.

Launch vehicle economics

All these launch vehicles will need satellites to launch. The heavier vehicles can fulfil some national goals like lunar

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ISRO can use the smaller satellites for technology and capability demonstration. However, the latter will constitute only a small number of launches.

Satellites have a defined mission life. As they get old, they will need to be replaced with newer satellites. This will also create a demand for launch vehicles. However, mission operators like their satellites to live longer and have been improving their lifetimes with software and hardware upgrades. This complicates estimates of the number and frequency of launch vehicles that will be needed.

Launch vehicles are improving as well. In a single launch, the PSLV can deliver multiple satellites in multiple orbits. Rocket stages are becoming reusable, which reduces the cost of building the rocket and increases profitability. ISRO has been building its Reusable Launch Vehicle and vertical landing technologies to make reusable landing stages. It is also making an effort to replace toxic fuels for rocket engines with green alternatives.

Private sector vs government

Mr. Somanath himself provided a solution for the problem he highlighted. He suggested we need an ecosystem that creates demand for various services, more sources of data (like satellites), culminating in a demand for launch vehicles. The richer the ecosystem, the greater the demand.

The Indian government wants the private sector to create demand among customers and to build and launch satellites. It wants them to look for services to offer customers in India and abroad. It also wants revenue by providing launch services of its own. Finally, the government wants to upskill workers and give them jobs.

However, private companies don't want the government to be in the launch business. Instead, they want the government to be their customer and to provide rule of law and reliable regulations.

This is because private players desire a reliable source of revenue, which the Indian government can be over a long period of time. There is thus talk of the government being an 'anchor customer' helping companies in their early days.

The roadmap here is for the government to exit the launch vehicle business at some point, leaving the companies with sufficient demand for launch vehicles. This is similar to the situation in the U.S., where arms of the U.S. government award contracts to SpaceX, Blue Origin, etc. to execute launches with their payloads.

Thus, the Indian government will absorb the cost of the transition from supply-driven to demand-driven building of satellites and launch vehicles. But it isn't yet educating its own Ministries and creating some of the anchor demand for satellites and launch vehicles.

(Pradeep Mohandas is a technical writer

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ISRO and space economy

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- The customer of the services provided by the satellite needs to be educated about the need for the service.
- The customer will then create a demand for a service that will need a satellite to be launched.
- The other area from which demand is likely to arise is human spaceflight.
- This includes human-rated launch vehicles that carry humans and supplies into orbit and to destinations like an orbiting space station or the moon.
- There could in future be demand for space tourism as well.

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- **Launch capability limitations India's launch vehicles are also not powerful enough to undertake certain missions, like Chandrayaan 4.**
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Launch vehicle economics

- All these launch vehicles will need satellites to launch.
- The heavier vehicles can fulfill some national goals like lunar exploration and a space station while ISRO can use the smaller satellites for technology and capability demonstration.
- However, the latter will constitute only a small number of launches. Satellites have a de□ned mission life.
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A rare spade-toothed whale after it was found washed ashore in the second week of July on a beach near Otago, New Zealand. AP

World's rarest whale may have washed up on beach in New Zealand

Associated Press

The spade-toothed whales are the world's rarest, with no live sightings ever recorded. No one knows how many there are, what they eat, or even where they live in the vast expanse of the southern Pacific Ocean. However, scientists in New Zealand may have finally caught a break.

The country's conservation agency said Monday a creature that washed up on a South Island beach this month is believed to be a spade-toothed whale. The five-meter-long creature, a type of beaked whale, was identified after it washed ashore on Otago Beach by its colour patterns and the shape of its skull, beak, and teeth.

"We know very little, practically nothing about the creatures," Hannah Hendriks, Marine Technical Advisor for the Department of Conservation said. "This is going to lead to some amazing science and world-first information."

If the cetacean is confirmed to be the elusive spade-toothed whale, it would be the first specimen found in a state that would permit scientists to dissect it, allowing them to map the relationship of the whale to the few others of the species found, learn what it eats, and perhaps lead to clues about where they live.

Only six other spade-toothed whales have ever been pinpointed, and those found intact on New Zealand's North Island beaches had been buried before DNA testing could verify their identification, Hendriks said, thwarting any chance to study them.

This time, the beached whale was

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quickly transported to cold storage, and researchers will work with local Maori iwi (tribes) to plan how it will be examined, the conservation agency said.

New Zealand's Indigenous people consider whales a taonga – a sacred treasure – of cultural significance. In April, Pacific Indigenous leaders signed a treaty recognising whales as "legal persons," although such a declaration is not reflected in the laws of participating nations.

Nothing is currently known about the whales' habitat. The creatures deep-dive for food and likely surface so rarely that it has been impossible to narrow their location further than the southern Pacific Ocean, home to some of the world's deepest ocean trenches, Hendriks said.

"It's very hard to do research on marine mammals if you don't see them at sea," she said. "It's a bit of a needle in a haystack. You don't know where to look." The conservation agency said the genetic testing to confirm the whale's identification could take months.

It took "many years and a mammoth amount of effort by researchers and local people" to identify the "incredibly cryptic" mammals, Kirsten Young, a senior lecturer at the University of Exeter who has studied spade-toothed whales, said in emailed remarks.

The fresh discovery "makes me

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spade-toothed whales

- **The spade-toothed whales are the world's rarest, with no live sightings ever recorded.**
- **The spade-toothed whale (*Mesoplodon traversii*) is a very little-known species, the rarest species of beaked whale.**
- **No one knows how many there are, what they eat, or even where they live in the vast expanse of the southern Pacific Ocean.**
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- The spade-toothed whale is covered by the Memorandum of Understanding for the Conservation of Cetaceans and Their Habitats in the Pacific Islands Region (Pacific Cetaceans MOU).
- The species' IUCN Red List conservation status is "Data Deficient (DD)" due to lack of information and uncertain data

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The toll that extreme heat takes on women

Pradeep Kumar Choudhury

Assistant Professor at Zakir Husain Centre for Educational Studies, School of Social Sciences, Jawaharlal Nehru University, New Delhi

Steny Rapheal

PhD student at Zakir Husain Centre for Educational Studies, School of Social Sciences, Jawaharlal Nehru University, New Delhi

Extreme heat is our planet's norm for now and perhaps for years to come. The warmest year on record was 2023. Temperatures in several parts of India during May-June 2024 were reported to be record-breaking. Women are disproportionately harmed by extreme heat, largely because of unequal power dynamics, gender norms, and unequal access to resources, as reflected in the Global Gender Gap Index that places India at 18th rank from the bottom. Perhaps we should be alarmed by the numbers – India is home to more than one-in-six women in the world – and extreme heat is now their reality.

Hidden toll

A recent report by the ADB (Rising Above the Heat) highlights the unequal impact of extreme heat on women in Asia and the Pacific. For instance, women living in informal settlements in cities (also at the margins and in slums) face multiple challenges due to rising temperatures. Their homes could turn into heat chambers since the material used in informal, urban neighbourhoods, such as tin, asbestos, and plastic, trap heat. Women also toil in poorly ventilated kitchens, experiencing scorching temperatures while cooking. Rising temperatures are compounded by extreme time poverty and care burden for them.

Due to lower productivity stemming from heat stress, women work considerably longer hours to complete their share of unpaid work at home. According to Arsht-Rock's 'Scorching Divide' report, the productivity loss due to heatwaves translates to 90 more minutes of care work per day in India. This adds to the pre-existing gender differences in time-use pattern; in doing unpaid work like cooking, cleaning, and fetching water and fuel, women spend two and a half times minutes more per day than men (National Statistical Office 2019 data). Intriguingly, more than two-third of women's productivity loss from heat strain occurs in the domain of unpaid labour in India. The loss also reflects opportunity costs associated with heat stress – that women could have earned extra income, acquired skills, or rested enough.

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Worryingly pervasive

Urban female informal labourers face harsh weather, whether working in marketplaces, streets, construction sites, landfills, or even their employers' homes. Due to their occupational settings, these casual-wage workers – street vendors, paid domestic helpers, construction workers, and sanitation workers – are vulnerable to climatic extremes, reports the International Labour Organization ('Work in a Changing Climate'). The situation worsens with energy poverty – living without cooling facilities such as ventilated spaces, fans, air conditioners, or coolers. Greenery and other natural forms of cooling are also becoming increasingly unavailable for public consumption in dense urban areas. Furthermore, water scarcity and power fluctuations raise the challenge of being hydrated and staying comfortable.

The situation in rural India is equally severe. Consider the daily routine of a woman in a heatwave-affected rural area: she begins her morning cooking using biomass over a hot stove, bearing the brunt of ensuing disease burden. Since 56.8% of rural Indian families cook on biomass (NFHS-5), acknowledging the extent of this public health hazard is essential. Women's days also involve longer working hours under heat stress. If she does home-based work inside the living area with asbestos or tin roofing, temperatures could become unbearable, making labour increasingly unsafe. Also, if she faces restrictive gender norms on mobility and clothing, she could be forced to stay indoors and follow dressing styles that are not heat friendly. Conversely, if she works outdoors in the field, MGNREGA, for example, it is under the scorching sun. Additionally, prolonged exposure to heatwaves adversely affects crop yields; for poor rural women, heat may decide whether they live in hunger and poverty or not.

Unequal health strain

The incidence of heat-related diseases is also on the rise with increasing temperature. Heat stress puts the body under a great deal of strain, making it harder for it to regulate its temperature, leading to several illnesses, including heat cramps, severe heat stroke, and hyperthermia. Women are at greater risk because of their physiological makeup – their body fat percentage and water content levels affect heat tolerance and hydration, while hormonal changes associated with menstrual cycles and pregnancy affect body temperature regulation. Women have a dual burden from heat-related health issues since they are more susceptible to its effects and also shoulder majority of the care-giving responsibility that follows. Additionally, heat stress has a pronounced impact on maternal and child health. The data on heat strain's effects translating to a rise in preterm delivery, miscarriage, and stillbirths is especially worrying in India, given its higher maternal mortality rates.

The burden on women becomes evident as India grapples with soaring temperatures. Millions continue to face worse heat-related losses, with no respite in sight. Strengthening their resilience to heat strain is the need of the hour – climate-friendly urban planning, development of and access to sustainable cooling technologies, fair division of care work, and public provisioning of essential services should be our immediate concerns. And we cannot talk about adaptation and resilience without addressing the social power gradient that determines women's capacity to face the crisis we are experiencing.

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Heat waves impact on women

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Inside the brain: Researchers inject gel under the electroencephalography (EEG) cap at the Technische Universitaet Muenchen (TUM) in Garching near Munich in 2014. REUTERS

100 years of EEG: how does it work and what is its significance?

This year marks the centenary of the first human EEG, produced by German physiologist Hans Berger. EEG measures electrical activity in the brain generated by neurons. In research, scientists use EEG for neuroscience, cognitive psychology, neurolinguistics etc

Vasudevan Mukunth

The EEG is a marvel of physics and neurobiology that opens a simple window into the human brain. This window is often small and yet it reveals so much. But not least is the wonder that it reveals anything at all without having to break open the skull first. This year is the centenary of the first human EEG, produced by German physiologist Hans Berger.

How was the EEG invented?
Berger's feat was preceded by incremental but significant advances across Europe from the late 19th century. In 1875, British physician Richard Caton reported evidence of electrical activity in the brains of monkeys and rabbits. Fifteen years on, his Polish peer Adolf Beck found evidence of fluctuating activity in the brains of dogs and rabbits when he stimulated their senses. In 1912, Vladimir Pravdich-Neminsky produced the first mammalian EEG, of a dog's brain. Berger succeeded him in 1924 with the human counterpart. He is also credited with inventing the EEG, naming it, and introducing its utility in clinical settings.

What is an EEG?
EEG stands for electroencephalography. 'Electro' pertains to electricity; 'encephalo' refers to the brain; and 'graphy' is a suffix meaning to show or to represent. Neurons in the brain perform various functions by moving electrically charged particles such as ions. The movement of these particles gives rise to electrical activity that a health worker can use an EEG test to visualise. Researchers have also been able to relate data obtained from an EEG with different levels and modes of brain activity, and used it to distinguish reliably between normal and abnormal states.

EEG is not an uncommon diagnostic test in clinical settings. Among other applications, it is the reference standard – that is, the best test available – to diagnose epilepsy. An EEG test can also reveal the effects of anaesthesia, sleeping patterns, neurological activity during a coma, and availability of oxygen. EEG can also confirm brain death, one of the two legally recognised forms of death in India.

In research, scientists use EEG for neuroscience, cognitive psychology, neurolinguistics, neuromarketing studies and to develop brain-computer interfaces.

What is volume conduction?
EEG measures electrical activity in the brain generated by neurons. During an EEG test, a health worker will place electrodes on your scalp. There are many layers of skin, fluid, and bone between the electrodes and the neurons. When a neuron produces electrical activity, charged particles will move through all these media before reaching the electrodes, and will be reflected, refracted, scattered, etc. en route.

Volume conduction refers to the movement of electrical activity through this three-dimensional volume. It also stands for the fact that the electrical activity is produced in one place whereas the detectors that detect it are located at some distance. The raw data collected by the electrodes will first need to be corrected for the effects of volume conduction, and then for noise in the data arising from faulty electrodes and incidental physiological activity (such as blinking or muscle activity). A clinician finally interprets the processed data.

How does an EEG test work?
The neurons that make up the human brain are constantly exchanging atoms, molecules, proteins, etc. with their surroundings. Sometimes neurons will push ions out into the space between neurons. Since ions of the same charge repel each other, this 'motion' can push away other ions, which push away even other ions, and so on.

When a large number of neurons start this cascade at the same time, a (relatively) big wave of electrical activity flows through the brain. The electrodes on the scalp are made of metal and track the changes in voltage as the waves move past them, creating an electroencephalogram.

Where are the electrodes placed?
You can place them anywhere, but if you're comparing notes with a scientist or want to follow clinical standards, you should follow the International 10-20 System.

In this system, the distance between two adjacent electrodes is either 10% or 20% of the total distance between two points on the head along which electrodes are being placed.

Four common points of reference are the nasion (the depression between the eyes, just above the bridge of the nose) and the inion (the crest at the back of the skull) going front to back, and from tragus to tragus going side to side. (The tragus is the small flap-like projection on the outer ear; you push it in to shut your ears when there's a loud noise.)

What does and doesn't EEG show?
The changes in voltage recorded at the electrodes are transmitted to a computer, which plots the readings on a graph with voltage on one axis and time passed on another. Health workers are typically interested in two types of data in the graph: the voltage (measured in millionths of a volt) and the frequency of the variations (measured in hertz). They will also factor in, among other things, the location of the neurons responsible for the electrical activity recorded by the test (for example, in the neocortex or the allocortex, the two types of cortices of the cerebral cortex).

EEG is better than other diagnostic devices at tracking relatively rapid electrical activity in the brain, in the order of milliseconds. On the downside, it is biased towards electrical signals generated closer to the surface of the cortex, and significantly so towards currents generated by neurons' dendrites and against those generated by the axons. The process to pinpoint where some electrical activity originated within the brain, to result in some electrical data, is also less than straightforward.

To overcome these and other challenges, researchers have used EEG together with other tests, like magnetic resonance imaging (MRI), and have developed sophisticated data acquisition, processing, and reconstruction methods.

Are EEGs affordable?
Aside from its metrological and diagnostic abilities, an EEG setup is also relatively simple and cost-effective.

The equipment involved doesn't take up much space, doesn't emit high-energy radiation or sounds, doesn't confine patients to small spaces (like MRI), is non-invasive, and is portable (the invasive version of EEG is called electrocorticography, or ECoG).

Similarly, aside from its diagnostic downsides, setting up an EEG test requires time – including applying a gel on the person's head and placing the electrodes in precise locations according to the 10-20 System – and its readings can be affected if the person has so much as thicker hair.

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SC to look into use of Money Bills to pass laws

Chief Justice Chandrachud says appeals challenging the use of Money Bills by the Centre to pass contentious amendments in Parliament will be listed when he forms Constitution Benches; a Money Bill is restricted only to specified financial matters; Justice Chandrachud had delivered a dissenting opinion in 2021, overruled by the majority

The Hindu Bureau
NEW DELHI

Chief Justice of India D.Y. Chandrachud on Monday agreed to list petitions challenging the Money Bill route taken by the Centre to pass contentious amendments in the Parliament.

"I will list when I form Constitution Benches," the Chief Justice addressed senior advocate Kapil Sibal, who made an oral mentioning on behalf of the petitioners, including Rajya Sabha MP Jairam Ramesh.

The Money Bill question was referred to a seven-judge Bench in November 2019 by a five-judge Bench headed by Chief Justice Ranjan Gogoi in the case of Rojer Mathew vs. South Indian Bank Ltd. The cardinal issue is whether such amendments could be passed as a Money Bill, circumventing the Rajya Sabha, in violation of Article 110 of the Constitution.

The provisions

A Money Bill is deemed to contain only provisions dealing with all or any of the matters under clauses (a) to (g) of Article 110(1), largely including the appropriation of money from the Consolidated Fund of India and taxation.

In other words, a Money Bill is restricted only to the specified financial matters.

The reference includes legal questions concerning amendments made from 2015 onwards in the Prevention of Money Laundering Act (PMLA) through Money Bills, giving the Enforcement Directorate almost blanket powers of arrest, raids, etc. Though the court had upheld the legality of the PMLA amendments, it left the question whether the amendments could have been passed as Money Bills to the seven-judge Bench.

Similarly, the case also raises questions about the passage of the Finance Act of 2017 as a Money Bill to alter the appointments to 19 key judicial tribunals.

Mr. Ramesh, a petitioner in this case, had argued that the 2017 Act was deliberately categorised as a Money Bill to "extend executive control over these institutions (tribunals) by altering the composition of the selection committees and vastly downgrading the qualifications and experience required to staff these bodies".

The question of passage of laws after dressing them up as Money Bills had come up in the Aadhaar case too. However, the top court had, in a majority verdict in 2021, refused to review its 2018 judgment (K. Puttaswamy case) upholding the validity of the Aadhaar Act and its certification as a Money Bill.

Justice Chandrachud (as he was then) had delivered a dissenting opinion on the Review Bench in 2021. The two questions before the Review Bench had been whether the Lok Sabha Speaker's decision to declare the proposed Aadhaar law as a Money Bill was "final". The second, whether the Aadhaar (Targeted Delivery of Financial and Other Subsidies, Benefits and Services) Act, 2016 was correctly certified as a 'Money Bill' under Article 110(1) of the Constitution.

Justice Chandrachud, in his dissent, had said the Review Bench ought to wait till the seven-judge Bench decided the larger questions on the Money Bill in the Rojer Mathew reference. But the majority had disagreed with him.

The contentious route

Some of the legislations passed as Money Bills in the Parliament include:

- Amendments to the Prevention of Money Laundering Act
- The Finance Act of 2017
- Aadhaar Act, 2016

A Money Bill is a financial legislation that contains provisions exclusively related to revenue, taxation, government expenditures, and borrowing

Cong. welcomes court's decision

NEW DELHI

The Congress on Monday welcomed the Supreme Court agreeing to consider a submission for setting up a Constitution Bench to hear pleas challenging the validity of passage of laws as Money Bills. » PAGE 5

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Q ‘Space economy has to be demand driven rather than supply driven’ . Explain this statement in the context of ISRO approach towards commercialisation of space

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