1Lattice
(Erstwhile PGA Labs)

DRONE INDUSTRY REPORT

9th June 2023

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GLOSSARY OF ABBREVIATIONS USED

S.No.	Abbreviations used	Full form
1	2D	2-Dimensional
2	3D	3-Dimensional
3	5G	5th Generation
4	ADB	Army Design Bureau
5	ADSB	Automatic Dependent Surveillance–Broadcast
6	AI	Artificial Intelligence
7	AMA	American Medical Association
8	APAC	Asia-Pacific
9	APRERA	Andhra Pradesh Real Estate Regulatory Authority
10	B	Billion
11	BEI	Built Environment Inspection
12	BI	Business Intelligence
13	BSF	Border Security Force
14	BVLOS	Beyond Visible Line of Sight
15	C-UAS	Counter Unmanned Aircraft System
16	CAGR	Compound Annual Growth Rate
17	CAR	Civil Aviation Requirements
18	CBU	Completely Build Up
19	CEGR	Centre for Education Growth and Research
20	CIDC	Construction Industry Development Council
21	CKD	Completely Knocked Down
22	CMPDI	Central Mine Planning and Design
23	COTS	Commercial-Off-The-Shelf
24	CPI	Consumer Price Index
25	CRPF	Central Reserve Police Force
26	CY	Calendar Year
27	DARE	Department of Agricultural Research and Education
28	DFI	Drone Federation of India
29	DDP	Department of Defence Production
29	DGCA	Directorate General of Civil Aviation
30	DGFT	Directorate General of Foreign Trade
31	DiB	Drone in a Box
32	DoD	Department of Defense
33	DPR	Detailed Project report
34	DraaS	Drone-as-a-service
35	DRDO	Defence Research and Development Organisation
36	DTI	Defence Testing Infrastructure

37	DTIS	Defence Testing Infrastructure Scheme
38	E	Estimated
39	EBIT	Earnings Before Interest and Tax
40	EBITDA	Earnings Before Interest, Tax and Depreciation
41	EHT	Extra High Tension
42	EMD	Earnest Money Deposit
43	EO / IR	Electro-Optical and Infrared sensors
44	EV	Electric Vehicles
45	FAA	Federal Aviation Administration
46	FDI	Foreign Direct Investment
47	FMRA	FAA Modernization and Reform Act
48	FPV	First Person View
49	FY	Financial Year
50	GDP	Gross Domestic Product
51	GIS	Geographic Information System
52	GPS	Global Positioning System
53	GST	Goods and Service Tax
54	GVA	Gross Value Added
55	HALE	High-altitude long endurance
56	HAPS	High-Altitude Pseudo-Satellites
57	HD	High Definition
58	IESA	India Electronics and Semiconductor Association
59	INR	Indian Rupee
60	IMF	International Monetary Fund
61	IoT	Internet of Things
62	IP	Intellectual Property
63	ITBP	Indo-Tibetan Border Police
64	LAC	Line of Actual Control
65	LiDAR	Light Detection and Ranging
66	LoC	Line of Control
67	LOS	Line Of Sight
68	M	Million
69	m/s	metres per second
70	MALE	Medium-altitude long endurance
71	MAVLink	Micro Air Vehicle Link
72	ML	Machine Learning
73	MoCA	Ministry of Civil Aviation
74	MoU	Memorandum of Understanding
75	MSME	Micro Small and Medium Enterprise
76	NDAA	National Defense Authorization Act
77	NDRF	National Disaster Relief Force
78	NPNT	No Permission-No Take-off

79	O&M	Operations and Maintenance
80	OEM	Original Equipment Manufacturer
81	ONVIF	Open Network Video Interface Forum
82	OTC	Over-the-Counter
83	P	Projected
84	PLI	Production Linked Incentive
85	R&D	Research and Development
86	RBI	Reserve Bank of India
87	RC	Radio-controlled
88	RFID	Radio-Frequency IDentification
89	RFP	Request for proposal
90	RoCE	Return On Capital Employed
91	ROE	Return On Equity
92	RPAS	Remotely Piloted Aerial Systems
93	RPAV	Remotely Piloted Aerial Vehicle
94	SaaS	Software-as-a-service
95	SC	Scheduled Caste
96	SKD	Semi Knocked Down
97	SMAM	Sub-Mission on Agricultural Mechanization
98	SOI	Survey of India
99	SOP	Standard Operating Procedure
100	SIPRI	Stockholm International Peace Research Institute
101	ST	Scheduled Tribes
102	SVAMITVA	Survey of villages and mapping with improvised technology in village areas
103	T	Trillion
104	UAS	Unmanned Aerial System
105	UAV	Unmanned Aerial Vehicle
106	UIN	Unique Identity Number
107	US$	United States Dollar
108	UTM Policy	National Unmanned Aircraft System Traffic Management Policy
109	VTOL	Vertical Take-off and Landing
110	WEF	World Economic Forum
111	YoY	Year on Year

EXCHANGE RATE TABLE

Year (FY)	INR Equivalent of one US$	Euro equivalent of one US$	Year (CY)	INR Equivalent of one US$	Euro equivalent of one US$
2015-16	66.33	1.13	2016	67.95	1.05
2016-17	64.84	1.08	2017	63.93	1.20
2017-18	65.04	1.23	2018	68.36	1.14
2018-19	69.17	1.12	2019	69.89	1.12
2019-20	70.49	1.08	2020	74.18	1.21
2020-21	73.20	1.18	2021	74.50	1.20
2021-22	74.50	1.16	2022	79.19	0.98

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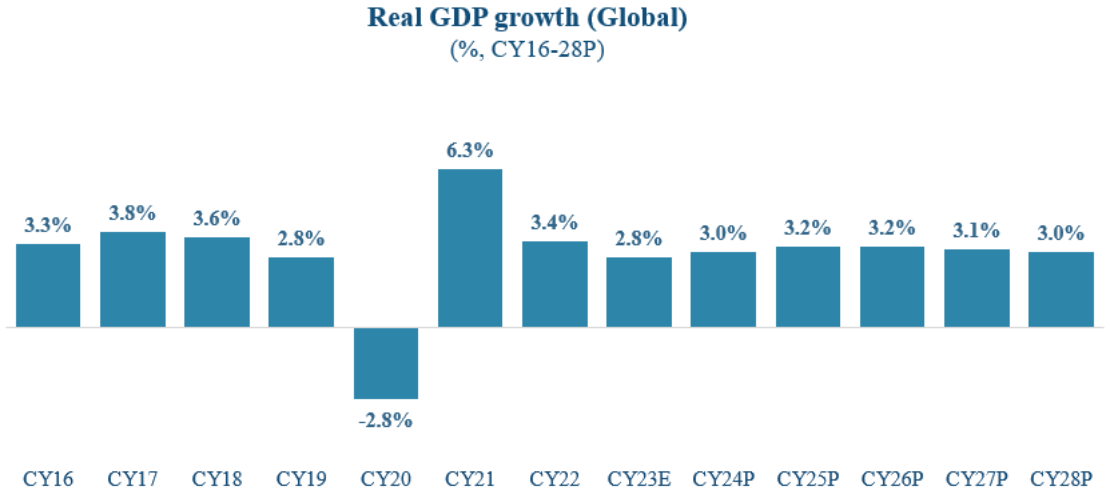
Macro-Economic and Geo-political overview

1.1 Global Macroeconomic and Geo-Political Overview

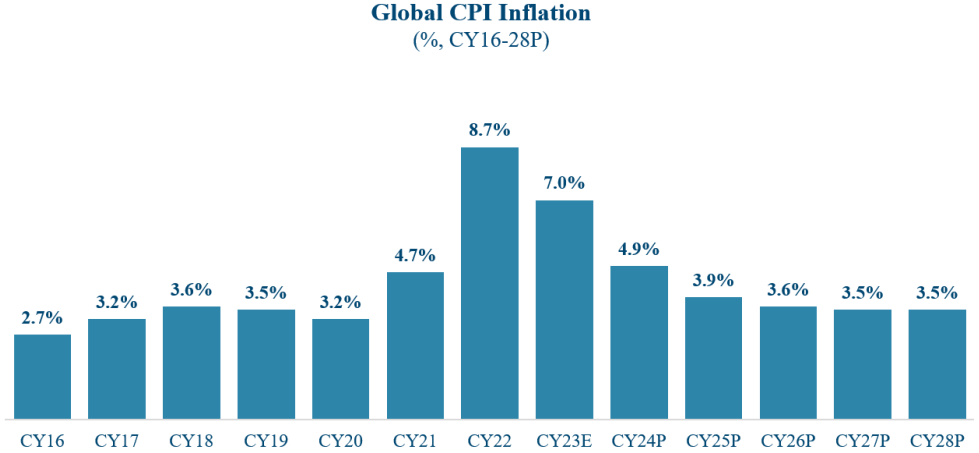
1.1.1 Global GDP growth of 6% by the end of CY21 offsets the contraction in global GDP caused by pandemic disruptions; Growth rate is likely to remain stable at ~3.1% through CY23-CY27



As per International Monetary Fund (IMF), global GDP growth is likely to stabilize at ~3.0% from CY24. Inflation is rising, given the impact of the Russian-Ukraine war, the cost-of-living crisis, and tightening of financial conditions. Strict lockdowns associated with China's zero COVID-19 policy have impacted the Chinese and global economies due to supply chain disruption. Post-CY23, global growth is expected to expand to between 3.0-3.2% in the medium term due to the generalized tightening of monetary policy driven by the greater-than-expected inflation targets.

1.1.2 Global inflation is expected to reach 7.0% in CY23 due to an increase in energy prices; and the Russia-Ukraine conflict

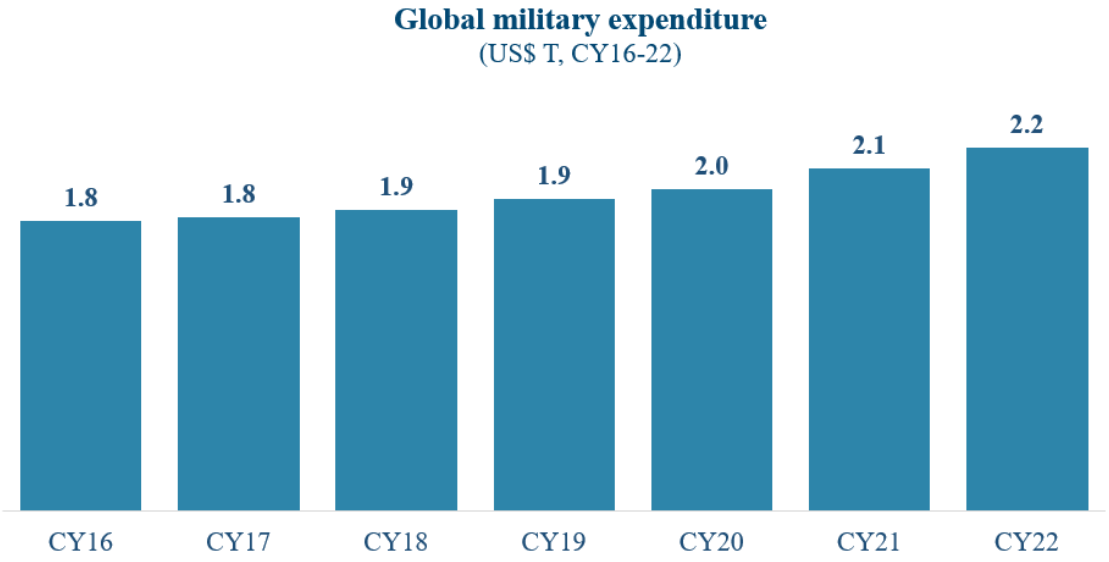
According to IMF, global consumer inflation is expected to fall to 7.0% by the end of CY23. The increase in CY22 was driven by soaring fuel and energy costs, the global supply chain disruptions caused by the Russia-Ukraine war, and China's Zero COVID-19 policy (Public health policy to suppress wide spread of COVID-19 and achieve zero new infections and resume normal economic and social activities).



With inflation at its highest in decades, multiple monetary and fiscal policies changes have been witnessed during CY22 and CY23 to reduce cost-of-living pressures. Structural reforms can help fight inflation by increasing productivity and relaxing supply restrictions.

1.1.3 Global military expenditure

The overall global military expenditure in CY22 was US$ 2.2T, with the U.S.A accounting the highest share of 39%. Since SIPRI (Stockholm International Peace Research Institute) started keeping track in 1949, the U.S.A has emerged as the nation with the highest military expenditure in CY22, accounting for 39% of global military spending.



India's military expenditure of US$ 81.4 B in CY22 was the fourth highest in the world. India's spending was up by 6% from CY21 and by 47% from CY13. Amid ongoing tensions and border disputes with China and Pakistan that occasionally spill over into armed clashes, India has prioritized the modernization of its armed forces and self-reliance in arms production. The use of drones is increasing for surveillance and security, combat and logistical support purposes for the Indian military.

1.1.4 Global geo-politics and drones

Over the past decade, drones have significantly altered the way critical, life-threatening operations are conducted. The first known drone used for defence purposes was deployed by Israel in in the Arab-Israeli war in 1973. Following Israel, by the 1990s, the U.S.A also started to employ drones in military operations.

1. Drone usage in Defence

Longer flight times, improved range, quality cameras and intelligent systems as drone offerings are changing the landscape of warfare by providing better surveillance, reduced cost, reduced human capital loss, increased convenience / flexibility. Drones change the economics of warfare as drones which cost few tens of thousands of dollars are able to precisely attack and incapacitate heavy artillery worth millions of dollars.

Drones have three main applications in defence:

1. Intelligence, surveillance, target acquisition, and reconnaissance (ISTAR)
2. Combat
3. Logistical support

Considering the various different missions, they have to perform, UAVs can be segregated on basis of range & operating altitude:

1. High-altitude long endurance (HALE): UAVs flying at an altitude more than 9 km (environment with thin air and low temperature)
2. Medium-altitude long endurance (MALE): Flies at an altitude window of 3–9 km
3. Tactical
4. Mini, micro, nano drones
5. High-Altitude Pseudo-Satellites (HAPS)

The ongoing Russia-Ukraine war, as well as the former Azerbaijan-Armenia conflict, have highlighted one feature of modern warfare: the utilization of drones for both surveillance and retaliatory action.

Major geopolitical events that witnessed drone usage:

1. **Russia-Ukrainian War (CY22):** Russia and Ukraine included advanced military drones in their arsenal and employed them for observation and attack. Majority of their drone fleet comprises of pre-made or custom-built machines modified at nationwide factories to drop grenades or anti-tank weapons.

2. **Striking opposition targets from distance by the U.S.A:** Since there is no risk to a human pilot and a drone can wait longer before firing, drones make targeted strikes easier for nations without losing human capital. Major General Qassim Suleimani, one of Iran's most influential figures, was assassinated by an aerial drone operated by the U.S remotely. In CY22, a U.S. drone strike killed al-Qaeda leader Ayman al-Zawahiri in Kabul, Afghanistan. Countries such as the U.K., Turkey, and Nigeria have followed the U.S.'s lead and are using drones to strike opposition targets.

3. **Attack on an oil refinery in Saudi Arabia by Yemen's Houthi group:** Drones attacked oil refinery in Riyadh, Saudi Arabia's capital city. The Yemen's Houthi group have targeted oil installations, including Saudi Aramco's pipelines and storage facilities as a part of their ongoing conflict with Saudi rulers.

4. **Azerbaijan-Armenia War:** Armenian forces, which mainly depended on traditional Russian weapons and tactics, were defeated by Azerbaijan due to use of sophisticated drone technology in CY20. To prevent further loss of life, territory, and military hardware, the Armenian troops had no choice but to sign the ceasefire.

5. **India-Pakistan drone intrusions:** In CY22, drone intrusions at the India-Pakistan border have almost doubled as terrorist organizations and drug traffickers based in Pakistan have stepped up their efforts to use drones to transport guns, explosives, and drugs.

Israel is a dominant player in UAV technology worldwide and has been using drones for over a decade for various military purposes. Until the early 2000s, Turkey relied on Israel for drones. Due to geo-political reasons, Turkey stopped purchasing Israeli drones and was prevented from procuring U.S.A. made Predator drones. As a result of this, the domestic drone industry grew in Turkey. A similar scenario can arise in India as well due to the regulations in favor of the drone industry. Indian Government banned drone imports from other countries (except for R&D and defence) combined with the Production Linked Incentive (PLI) scheme would help India become a global drone manufacturing hub.

2. Anti-China Sentiment

The USA raised concerns about spying by Chinese-owned apps TikTok Inc., WeChat, and Chinese telecom giant Huawei Technologies Co. Ltd., Shenzhen-based SZ DJI Technology Co. Ltd (leading drone manufacturer) were already under close watch as a potential national security threat. U.S.A customs authorities alleged that DJI drones likely gave China access to U.S. infrastructure and law enforcement data. In October 2022, the U.S. Department of Defense (DoD) blacklisted 13 Chinese companies, including SZ DJI Technology Co. Ltd, Shenzhen Huada Gene Technology Co. Ltd (BGI Genomics), and China State Construction Engineering Corp Ltd, citing that they have ties with the Chinese military. Further, in the US, the National Defense Authorization Act (NDAA) for Fiscal Year 2020 was passed on 20 December, 2019 and Section 848 remains in effect. The Act proposed a law that restricts purchase of drones by Department of Defense (DoD) with critical components from covered foreign country (People's Republic of China).

Chinese-based manufacturing companies help reduce the cost of drones to a reasonable level. As a result, countries with limited resources have been procuring Chinese drones for their military, leading to a rise in the number of nations using Chinese UAVs. The rapid increase in the production scale of Chinese drones led to a rise in unreliability and performance issues. Saudi Arabia and Jordan have called out China for their shortcomings (e.g., lack of repair and maintenance documentation, lack of a spare part inventory or procurement mechanism).

The data confidentiality issues and low reliability of Chinese drones, coupled with the global anti-China sentiments are paving an opportunity for the Indian drone industry to provide an alternative option in the market. Indian UAVs can compete in this market given the favorable ecosystem created by the government's industry-

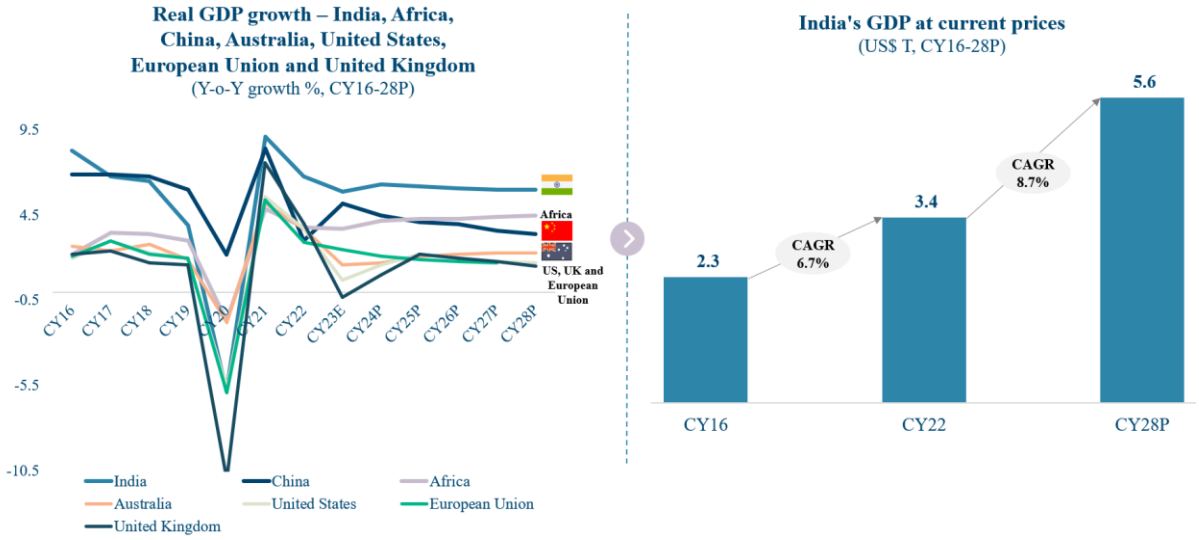
friendly policies, significant investments, and increasing demand for drones globally. Through meticulous public and private investments, the Indian drone sector is looking to position itself as a global competitor in exports for both civil and military drones.

3. COVID-19 Impact

Drone companies responded to COVID-19 challenges by looking for ways to demonstrate how small flying robots may help within applications such as vaccine/medicine delivery, enforcing social distancing, etc. Although many businesses were already testing contactless drone delivery, the pandemic immediately raised awareness of this necessity. Delivery-based drone manufacturers jumped into action as companies had some experience delivering medical goods before the pandemic. Drone deliveries were once thought of as just a marketing ploy. Suddenly, they were seen as a necessity for safety. Drones could offer a safe substitute for conventional delivery techniques by eliminating direct human touch. Before the pandemic struck, drone delivery firms, had been testing drone delivery systems for portable medical supplies in Rwanda and Ghana. The use of drones to distribute vaccinations in Ghana is arguably the best example of how drones made a clear and immediate impact on the fight against the virus. Beyond deliveries drones were also used for monitoring and ensuring social distancing among people and for making public announcements in remote areas and other such applications.

1.2 India Macroeconomic and Geo-Political Overview

1.2.1 India's real GDP (at current prices) is expected to grow at a rate of 8.7% from CY22 to CY28, making it one of the fastest-growing large economies globally

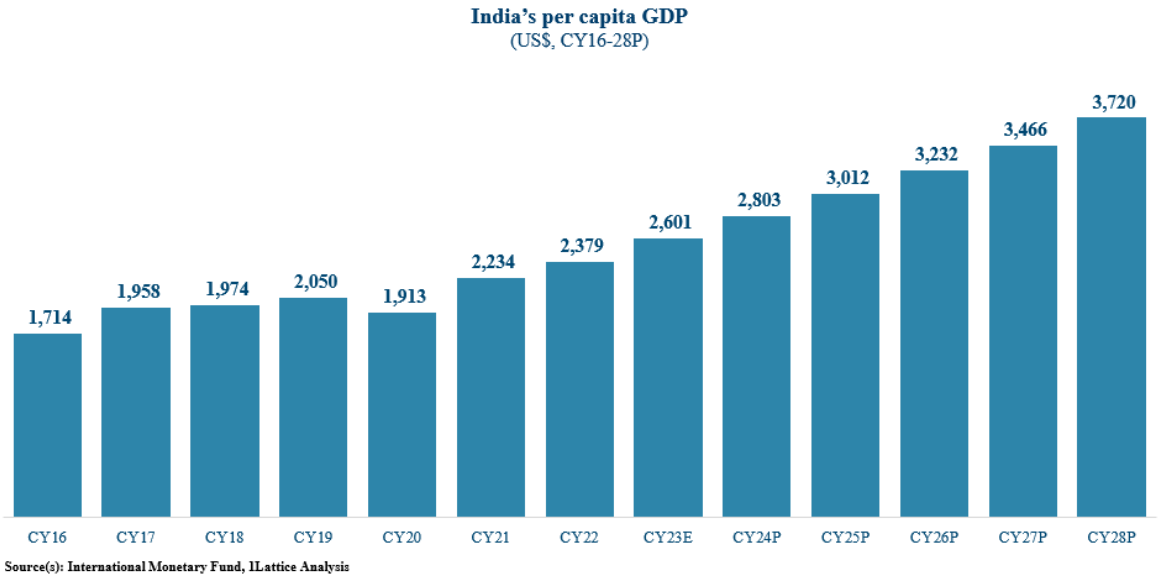


As per IMF, India became the world's fifth largest economy at market exchange rates after overtaking the U.K. in CY22 and is expected to be the third largest by CY30. Over the next 10-15 years, India is anticipated to be among the top economies on the back of rising demand, robust growth in various sectors, and increased private consumption. As per World Economic Forum (WEF), Indian private consumption is expected to be driven by an increasing proportion of the male and female working-age population and a rise in household income.

India's GDP (at current prices) grew from US$ 2.1T to US$ 3.2T between CY15 and CY21 on the back of robust reforms like GST, corporate tax revision, and revised FDI limits. Due to the impact of the first wave of COVID-19, the Indian economy witnessed a negative real GDP growth rate of 5.8% in March 2020, but recovered quickly to deliver real GDP growth of 9.1% in CY21. As per IMF projections, India's GDP (at current prices) is expected to grow at a rate of 8.7% from CY22 to CY28, making it one of the fastest-growing large economies globally.

1.2.2 India's GDP per capita is predicted to reach US$ 3,720 by CY28

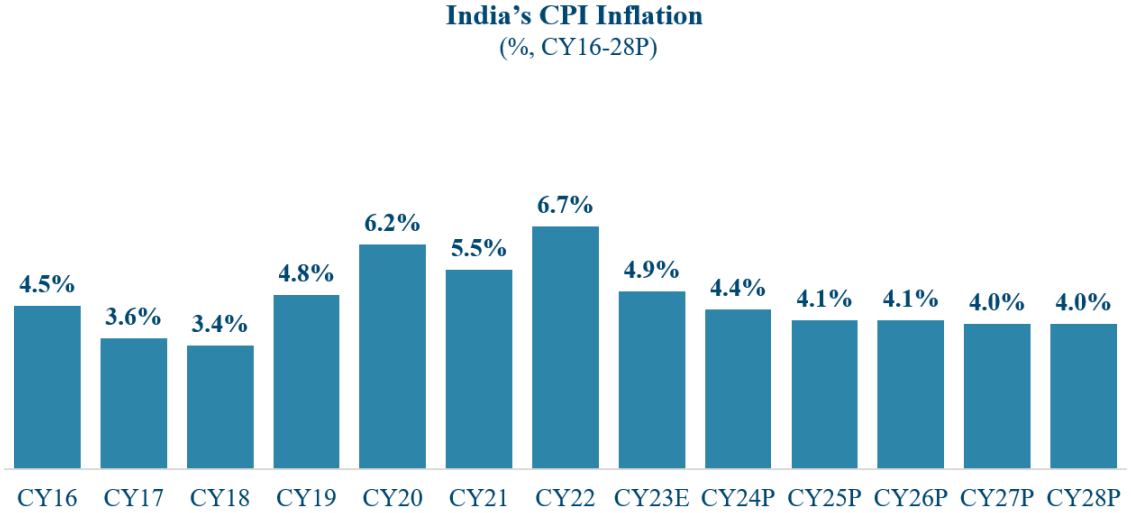
According to the IMF, India's GDP per capita is anticipated to be at US$ 2,601 by the end of CY23 and US$ 3,720 by the end of CY28.



India aims to become a developed nation by 2047. This mission is expected to be attained by sustained high GDP growth and rising per capita income. Many countries (South Korea, Singapore, and China) transitioned from developing to developed status in 3-5 decades, driven by growth in per capita income. The individual Indian states hold the key to achieving the status of a developed country in the coming three decades and are looking to diversify their economies and take giant strides in human development indicators. State governments are striving to modify rules and regulations to make the legal framework more compatible with economic and technological advancements and are looking to attract private investments in various sectors like manufacturing, tourism, financial services, etc.

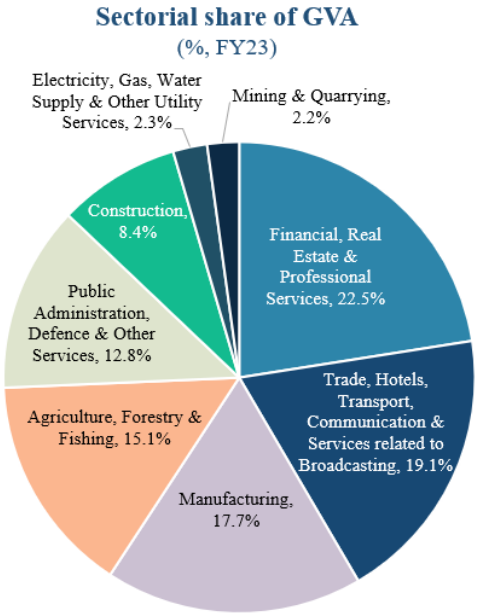
1.2.3 India's CPI inflation rate is estimated to be 4.9% in CY23 and the RBI aims to bring it to around 4% by the end of CY27

According to the IMF database, India's CPI inflation rate is 6.7% in CY22 and estimated to be decline to 4.9% by CY23 as the impact of the Russia-Ukraine war on global commodity prices diminishes. By CY26, the RBI aims to bring the CPI inflation rate below 6% to a target of 4%, with a soft landing (bringing inflation back to a target without a recession).



CPI inflation rates have increased due to volatile components like vegetable prices, fuel costs, and commodities such as gold and edible oils. Still, comparatively weak global growth could translate to lower commodity prices leading to lower CPI inflation rates for India.

1.2.4 As of FY23, financial, real estate, and professional services holds 23% of the GVA followed by trade, hospitality and broadcasting services at 19% and manufacturing at 18%



The agricultural sector was least impacted by the pandemic-related disruptions. Agriculture attributes to 15% of the GVA share. The industry sector was impacted the most but is recovering back to previous levels. The industry sector is expected to grow in FY23 given the manufacturing and construction boost. Basic services such as electricity and water supply were maintained even at the height of the national lockdown. Financial, real estate and professional services hold the highest share of 23% in the overall GVA.

1.2.5 Indian Geo-politics and drones; Due to its varied use cases in both defence and civil, drone technology can be fully utilized by India with its homegrown technological potential post-ban on imports

Drones may greatly assist governments in assessing the current state of infrastructure such as power systems, communication networks, ports, airports, railways, bridges, and so on. Drones are utilized to automate time-consuming and dangerous activities. Drones can be used by construction companies to monitor the structure of such projects to develop city plans. Drones can provide useful analytical data for crowd and traffic management along with other actionable insights. Above all, it can help engineers reduce the dangers associated with physical labor. India is adopting innovative approaches to include UAV technology in various sectors as to meet increasing demands and international standards.

The relaxed drone usage guidelines and ban on drone imports due to security reasons has resulted in a quick climb of the Indian drone industry in the last couple of years and aims to position itself as Global drone hub by CY30. An increase in the adoption of drones in India across varied industries for different use cases has been seen over the past few years. Advanced technology and investment in Indian drone companies will lead to the massive potential for homegrown drone companies in India. The drone segment is also expected to open employment opportunities in manufacturing, software, and services due to various use cases across industries.

1. Increase in adoption of drones in India:
India is experimenting, exploring, and using drones for various use cases in both defence and civil sectors. On the civil front, agriculture, media and entertainment, energy and utilities, disaster management, geospatial mapping, forest and wildlife, and law enforcement are among the most prominent.

1. Defence:
After the CY20 border skirmishes between Indian and Chinese forces, India has been looking to purchase UAVs for surveillance and reconnaissance along the line of actual control (LAC). In CY20, the Indian Navy acquired two MQ-9B SeaGuardian drones from General Atomics Aeronautical Systems, Inc. (U.S.) for one year to surveil the Indian Ocean.

By May 2022, 53 drone incursions were noticed along the India-Pakistan border. Security forces shot down these UAVs nine times. According to Border Security Force (BSF) sources, increased drone activity has been detected at several Pakistani border outposts. To defend against such UAVs, India will look forward to expanding its fleet of drones and integrating counter-drone technology into its defence program.

The clash in the Galwan Valley in CY20, and the subsequent border standoff with China along the Line of Actual Control, compelled India to strengthen border controls and security. These included faster acquisition and deployment of drones along the LAC. Both sides have been using an array of drones to keep an eye on each other during the conflict. The drones used had the capability to operate in adverse weather conditions and perform operations at height of over 10,000 meters and provide real-time video footage in all weather conditions.

Currently both globally and also in India, defence continues to be the largest segment. The Indian army has as part of its Make II program has significant requirements for the purchase of drones and also has published requirements for the purchase of integrated surveillance and loitering munition systems.

As of October 2022, Indian government issued request for proposal (RFP) for 80 mini Remotely Piloted Aerial Systems (RPAS) which can be used for military purposes such as tactical surveillance to locate adversary troops, equipment, and weapon systems in a particular sector. Shortly after this, government issued RFP for 750 RPAVs to be deployed with the Indian Army's Special Forces as they are mandated to execute special missions behind enemy lines. Additionally, the Army is looking for 1,000 surveillance drones to fly over the Himalayas and broadcast live video to the war rooms for planning attack at the time of war. Keeping the commitments for indigenous solution, these RPAVs and UAVs will all be procured from Indian businesses. In July 2022, The Defence Ministry approved a budget of ~US$ 88M to buy drones. The proposed budget would be used to procure autonomous surveillance and armed drone swarms. The armed forces already have and in future will partner with multiple indigenous drone manufacturers for this plan.

2. Civil

i. Energy and utilities

Drone surveys are helping solar energy, the fastest-growing sector of the energy industry. Drones can ensure that electrical panels are accurately analyzed and in good functioning order. These drones can be used to detect flaws like cracking, deamination, discoloration, and issues such as dust collection. Manual inspections are generally time-consuming and inaccurate compared with drones. Drones are also very useful for vegetation management where any vegetation that comes in contact with the powerline has to be trimmed and managed. Drones can significantly reduce the manual effort required in this for monitoring and inspection of power lines.

ii. Agriculture

Weather, soil conditions, and temperature are all critical aspects of farming. Agriculture drones enable farmers to gather the information that can aid in crop health management, crop treatment, crop scouting, irrigation, field soil analysis, and crop damage assessments. Depending on national regulations, special permits are given to deploy drones for agricultural research purposes, which is likely to drive a wave of technology in the agriculture sector. Kisan drones are used in India for agriculture assessments, land records, insecticide, and nutrient applications. Under the guidelines of the Sub-Mission on Agricultural Mechanization (SMAM), provisions are made to encourage the use of drone technology in agriculture. For example, financial assistance of 100% of the cost of an agricultural drone up to a maximum of Rs. 10 lakhs per drone is provided for purchase by institutes under the Government of India engaged in agricultural activities. For promoting use of Kisan Drones, the government would be providing 50% or maximum INR 5 lakh subsidy to SC-ST, small and marginal, women and farmers of northeastern states to buy drones. Financial assistance will be given upto 40 percent or maximum INR 4 lakh for other farmers.

iii. Media and entertainment

The use of drones in the entertainment industry has evolved over years and is seen as a product capable of mass influence. Film directors are using drones to capture aerial shots for specific scenarios that previously required helicopters, ultimately reducing operating costs. Aerial photography, which captures images from high elevations, has also grown in popularity. The Indian government held the 'Drone Olympics' during Asia's major air show, Aero India-2019, to allow drone pilots to demonstrate their ability to fly these machines.

iv. GIS – Mapping and Surveying

SVAMITVA, a Central Sector Scheme of Ministry of Panchayati Raj was launched nation-wide by the Hon'ble Prime Minister on National Panchayati Raj Day, 24th April 2021 after successful completion of pilot phase of scheme (2020-2021) in 9 states. Scheme is a reformative step towards establishment of clear

ownership of property in rural inhabited (Abadi) areas, by mapping of land parcels using drone technology and providing 'Record of Rights' to village household owners with issuance of legal ownership cards.

The large opportunity in mapping (SVAMITVA program) is being rolled out as services projects by different state land revenue departments and Survey of India. Over six lakh villages are being mapped using geospatial technology and drones, and 3D pan-Indian mapping of 100 Indian cities are also being developed. Mapping of villages in the country is launched under the government's SVAMITVA (Survey of Villages and Mapping with Improvised Technology in Village Areas) scheme. Full-scale re-surveys for mapping the entire land of states has also started.

The data procured from the easy access to the geospatial technology has helped in maximizing the use and reuse of data since the launch of SVAMITVA. Future economic growth in India will be highlighted by the use of geospatial systems, drone regulation, and advances in space industry. Government is anticipating more innovative solutions and new business models in the coming times building value upon existing resources.

v. Mining

As per the amended Mineral Conservation and Development Rules, lessees having annual excavation plan of one million tonne or more or leased area of 50 hectare or more are required to submit drone survey images of leased area and up to 100 meter outside the lease boundary every year. This is mandated to improve mine planning practices, security and safety in the mines along with better supervision of mining operations.

Drones can help to achieve many benefits for effective mine planning - conducting initial survey, carrying out exploration activity, physical terrain mapping for segregation of land use, contour mapping, 3D modelling and terrain modelling. Indian states have started to incorporate drone practices and are leveraging drones as part of mining automation. For instance, Andhra Pradesh government deployed drones for the monitoring of stockpile storage, 3D mapping, and volumetric analysis of limestone. Rajasthan government has deployed drones to prevent illegal mining in the state

vi. Public Safety

There is a significant opportunity for adoption of drones in public safety. A number of state police departments have adopted drones as first responders for (Dial 100/112) and also for other use cases such as crowd monitoring, traffic management, beat patrolling, etc. India is already using the drone technology and trying to utilize its potential for safety. Recently, in Kolkata, police used a drone to patrol polling places where elections were being held. In CY16, Delhi Police piloted a squadron of drones to monitor temples and expressways on Republic Day.

vii. Logistics / Delivery

The pandemic provided an opportunity for a number of drone companies to do delivery trials with medicine and vaccine delivery. The second half of this decade is expected to see a significant adoption of logistics drones both globally and in India. An increase in demand for faster and more efficient delivery at low cost is being witnessed especially in the e-commerce sector with customers willing to pay extra to get package is delivered on the same day. This is likely to increase the usage and acceptance of drones in logistics and transportation market in India.

2. Ban on imports from China due to security purposes:

India and China are engaged in a sustained standoff along their disputed Himalayan border. Additionally, India is one of many nations trying to find alternatives to China for goods and components. The pandemic and international trade tensions intensify the need to diversify supply chains and reduce risk. An expanding market for China's SZ DJI Technology Co., a leading drone manufacturer, was essentially closed off due to India's recent restriction on drone imports. This encouraged the development of local businesses to boost production.

In February 2022, the Directorate General of Foreign Trade (DGFT) under the Ministry of Commerce and Industry issued an order to ban the import of drones. However, Drones used only for research and development, defence, and security will be exempt from the ban. Import of drones will be allowed by government entities, central or state government approved educational institutions, and drone manufacturers and government recognized R&D entities provided an import authorization is obtained from the DGFT. In summary current geo-political environment, with economies decoupling with China, especially for anything related with data capture and analysis, coupled with Indian technological capabilities in the rugged environment of India, is a major contributing factor for Indian companies to expand globally in both defence and civil drone opportunities.

3. Relaxed guidelines on drones' usage and investments:
The government is trying to facilitate the production and operation of drones with the recent liberalization of drone guidelines to make the market more accessible to drone start-ups and international investors. There are no restrictions for foreign owned/controlled Indian companies for operating drones in India. Consequently, the recent regulations aim to attract global investment in the sector. Over the next three years, the government has targeted an investment of ~US$ 600M in the drone manufacturing industry, creating over 10,000 job opportunities.

After the introduction of The Drone Rules 2021, drones are permitted to operate within green zones, and no remote pilot license is required for non-commercial use of micro drones. Recently a notification amending 'The Drone Rules 2021' stated that the Indian government introduced relaxed regulations on usage and registration of drones, pilot licenses and allowed drones to carry heavier payloads, to enable utilization of drones in multiple use cases.

While India has significantly lagged in drone adoption compared to other nations, recently there has been a strong push nationwide towards increased adoption of drones for various purposes. With the production linked incentive (PLI) scheme launched in September 2021, India will offer incentives for drone makers, to encourage and boost manufacturers to develop their products in India and export them to the world.

4. India positioning to become global drone hub
Since CY21, the Indian government has stepped up efforts to establish a sustainable drone manufacturing ecosystem in India. Over the span of last couple of years, there has been liberalization of drone regulations. Favorable policies, incentives and indigenous demand creations will be the vital drivers to make India a global drone hub. Government's goal is to establish India as a global powerhouse for drone research and development, testing, production, operation, and export. Application of drones is to be seen across industries such as defence and civil (industries such as health, agriculture, GIS, construction, real estate, etc.

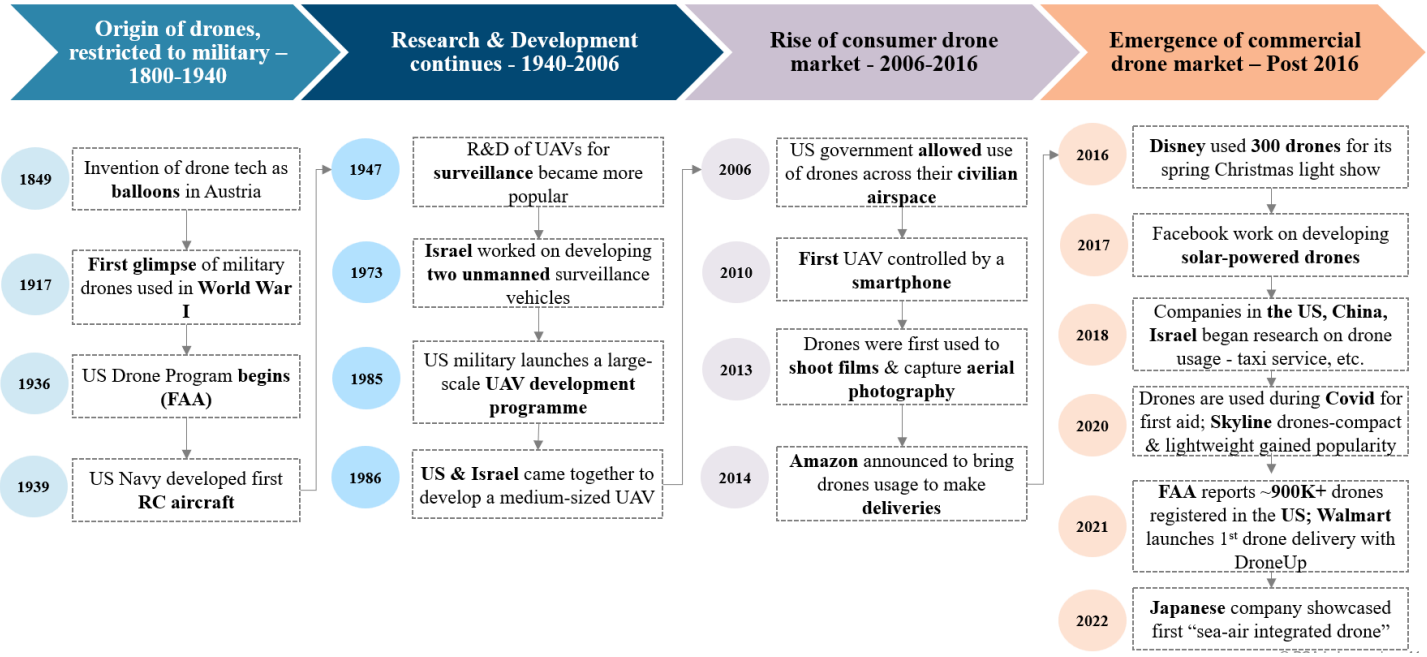
02

Global UAV / Drone Industry

2.1 Evolution of the Drone Industry

The first usage of drones dates back to the 1850s. Drones have been used by armies all around the world for training, defence, surveillance operations and strikes on targets since the 1800s. Commercial drone permits weren't issued for almost 150 years after the first military usage of drones, despite the advancement of drone technologies. Today, drones are used in a wide variety of defence and civil applications that are growing across industries. Drone technology is a sunrise sector, poised for exponential growth worldwide. Its recent exponential expansion has been fueled by the rise of multiple use cases across varied industries.

Evolution of the Drone Industry



Drones have been used for various tasks in a wide range of sectors and applications for the past several years. Drones are proven to be quite helpful in places where humans cannot access or are unable to undertake tasks in a fast and effective manner, from battling in combat missions to express shipping and delivery.

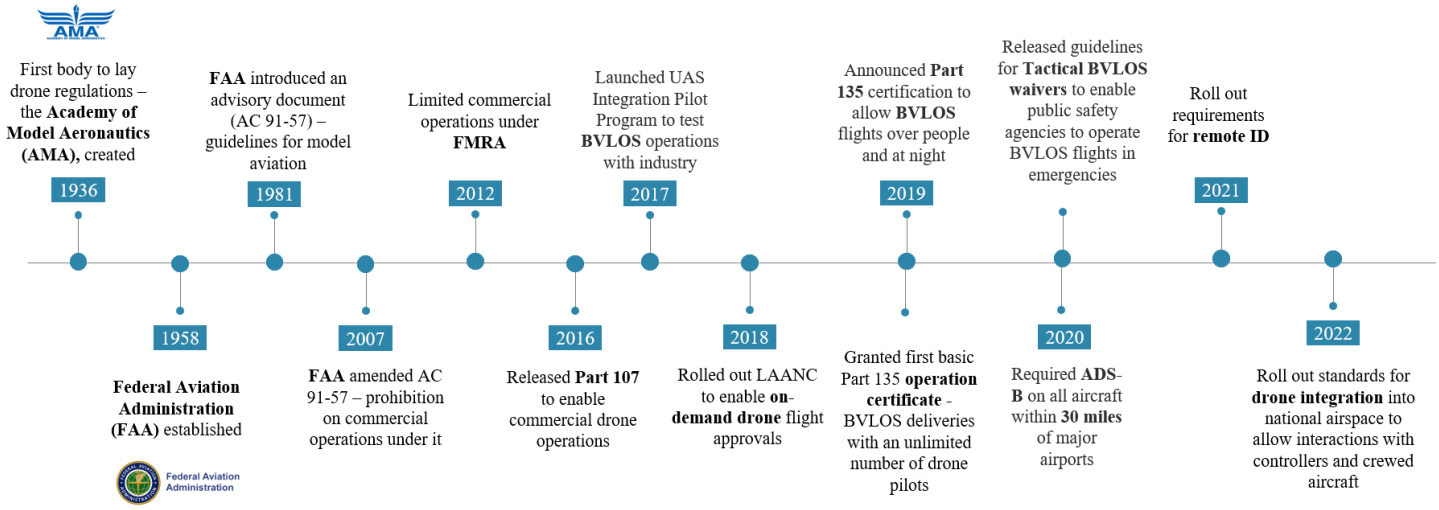
UAVs are a subset of unmanned aerial systems (UASs). A UAS includes not only the unmanned aerial vehicles or drones, but also the Ground Control Station on the ground controlling the flight and the system in place that connects both of them. A UAV is a component of the UAS, since it refers to only the vehicle/aircraft itself. UAS also comprises of elements such as camera, GPS, system software and tools required for maintenance. While components such as cameras and GPS have developed in their own respective timelines, drone system software and ground control systems have evolved along with drones.

As drone usage grows globally, the global regulatory landscape has also evolved in sync with the industry needs to guarantee innovation and widespread acceptance of drones.

2.1.1 Drone regulations

The global use of drones, as well as their technology, range and use cases are growing at an exponential rate and this calls for the continued evolution of the regulatory framework, accompanying security measures and related economic arrangements. The use of drones is regulated by extensive laws that have been developed by nations around the world after careful deliberation of the relevant concerns. The United States has been working on creating a regulatory framework for drones for almost a century and is a global leader in drones. The Federal Aviation Administration's (F.A.A.) move to streamline approvals for drone flight, makes the future of drones promising as more sectors adopt drones and find new use cases that offer better value.

History of drone laws in the United States

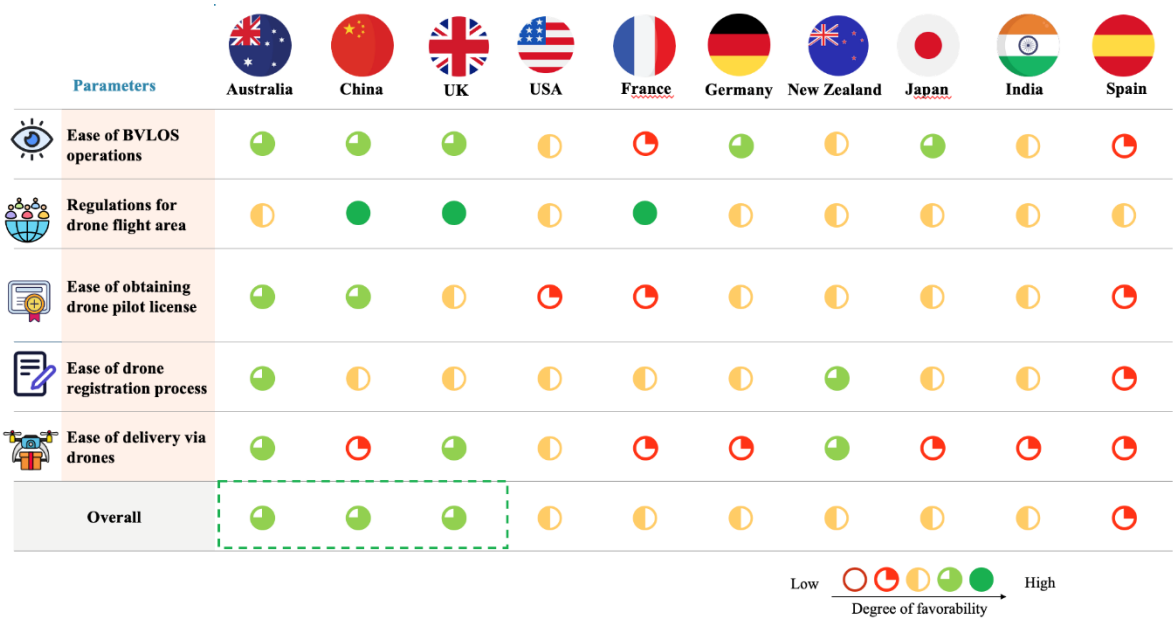


Drone regulations vary from country to country, with no universally applicable international drone legislation yet. However, regulatory frameworks are being developed by national and international aviation authorities to ensure that drones be used in safe and beneficial ways for business.

2.1.2 Global drone regulations currently have varying levels of maturity across countries and will continue to evolve with the growth of the drone industry

The increasing usage of drones has prompted a variety of responses from legislators around the world. Nations like Australia, U.K. and China have made it possible for businesses to use drones with minimal regulations, while some nations such as Cuba, Iraq, Iran, and Kuwait have officially outlawed the use of unmanned aircraft, others have established legislation allowing for more experimental use of the technology. Drones are increasingly being used in defence and civil segements. In civil, there are a a variety of industries, including infrastructure, retail, agriculture, logistics, and many more. As a result, these markets have seen significant capital invested in their drone ecosystems and are driving innovation within the market.

The regulatory environment as it stands today in 10 nations across five continents is shown in the table below. Many nations have moved towards the liberalized approach of regulatory framework to ensure a legal climate that is business friendly.



Globally, most governments have restrictions on Beyond Visual Line of Sight (BVLOS) operations,which refers to flying a drone beyond the remote pilot or operators visible range. This limits the number of applications that drones can be used for. Increasingly most countries are moving towards removing restrictions and have started allowing BVLOS operations.. As a result, the applications that drones can serve will increase and the operational cost of operation will go down as this enables autonomous operations and the ability of one drone pilot to operate multiple drones. Allowing BVLOS operation will significantly increase the demand for drones.

The major countries in drone operations are Australia, China and U.K. These countries possess advanced regulatory frameworks which have evolved over time. Although U.S. leads the drone industry innovation but still have stringent regulations which have been getting more liberal over time. BVLOS operations are prohibited in certain countries like USA, France, New Zealand unless a waiver is requested. In the US, the Federal Aviation Administrator (FAA) has recently come out with the draft guidelines for BVLOS operation. The degree of ease of getting a waiver approved is drastically low in such countries. While countries like Australia, UK, New Zealand have already started with drone delivery operations, other nations are still in their trial and testing phase of drone delivery operations.

While ease of drone operation varies significantly worldwide, the general national drone usage guidelines typically include the following components – pilot's license, LOS operations, flight over people, registration rules etc. This process of registration includes UIN (Unique Identification Number), pilot certificate and license for drones that are required to undertake flight operations within green areas. Pilot licensing mandates which include pilot's age, training requirements, etc. are more favorable in countries such as Australia, China followed by nations like UK, New Zealand, India. This is due to the simplification of regulations and approval-seeking process by the government in such nations.

The major countries in drone operations are Australia, China and U.K. These countries possess advanced regulatory frameworks which have evolved over time. Although U.S. leads the drone industry innovation but still have stringent regulations which have been getting more liberal over time. BVLOS operations are prohibited in certain countries like USA, France, New Zealand unless a waiver is requested. The degree of ease of getting a waiver approved is drastically low in such countries. While countries like Australia, UK, New Zealand have already started with drone delivery operations, other nations are still in their trial and testing phase of drone delivery operations.

The regulatory bodies in India have taken a step towards a more liberalized approach after considering the potential of drones in boosting the economy. With the new 'The Drone Rules 2021', the government has taken several measures such as reducing extensive paperwork involved, increasing the number of "free to fly" green zones, and simplifying granting of permission for every drone flight, among others. The Indian legislatures believe that drones have significant advantages to different sectors of the economy and are creators of employment and economic growth. As a result this transformed outlook and upcoming regulations will help boost the manufacturing potential in India to make India the drone hub of the world by CY30.

2.2 Key trends in the global drone industry

1. **Relaxation in drone regulations:** Several aviation authorities have relaxed their guidelines to allow commercial and recreational use of drones. Previously, without a waiver, unmanned aircraft were generally not permitted to fly over people or out of the operator's line of sight. But as laws soften and drone usage increases for business purposes, widespread use of drones is sure to follow.
2. **Growth in Enterprise usage:** Technological advances from defence-funded R&D are anticipated to produce more enterprise-ready drone technology, accelerating adoption in the enterprise sector. Enterprise usage will continue to be driven by applications in GIS, agriculture, utilities, construction, oil and gas etc. due to low cost of service, improved operational efficiency, accuracy of data and safety. A few industries like mining, construction and agriculture have used drones for the past few years due to a healthy return-on-investment evaluation in such use cases.
3. **Drone-as-a-service:** The "As a Service" concept has gained much traction in the tech sector. Similarly, corporations are using drones-as-a-service models, which is gaining significant traction due to higher operational efficiency and reduced cost. Drones can help various industries by incorporating specialized software into the embedded system, such as construction, mining, agriculture, utilities etc.

4. **Positive attitude towards BVLOS:** Drones can travel great distances while operating in BVLOS, which increases data collection and boosts operational effectiveness. This is important for many industries, including security, data gathering and logistics. Nations such as the UK, Canada, Singapore, and Kenya have allowed BVLOS operations for different purposes and use cases. Considering the improving regulatory attitudes, it seems that BVLOS would be enabled on a larger scale.
5. **A shift in the demand away from Chinese drones:** Countries have been disassociating from Made in China drones due to rise in anti-China sentiment and data-related security concerns
6. **Drone swarms is an emerging trend:** In China, drones collectively navigated a dense forest with their trajectories controlled by central computers monitoring their positions and issuing commands. AI-enabled swarm drones can also boost operations readiness at the borders of neighboring countries.
7. **Drone in a Box (DiB):** It allows drones to navigate and return to self-contained landing "boxes." The three necessary components required to successfully implement DiB include a drone with automatic charging, a box for drone launch and land and a control software used to control flight routes.

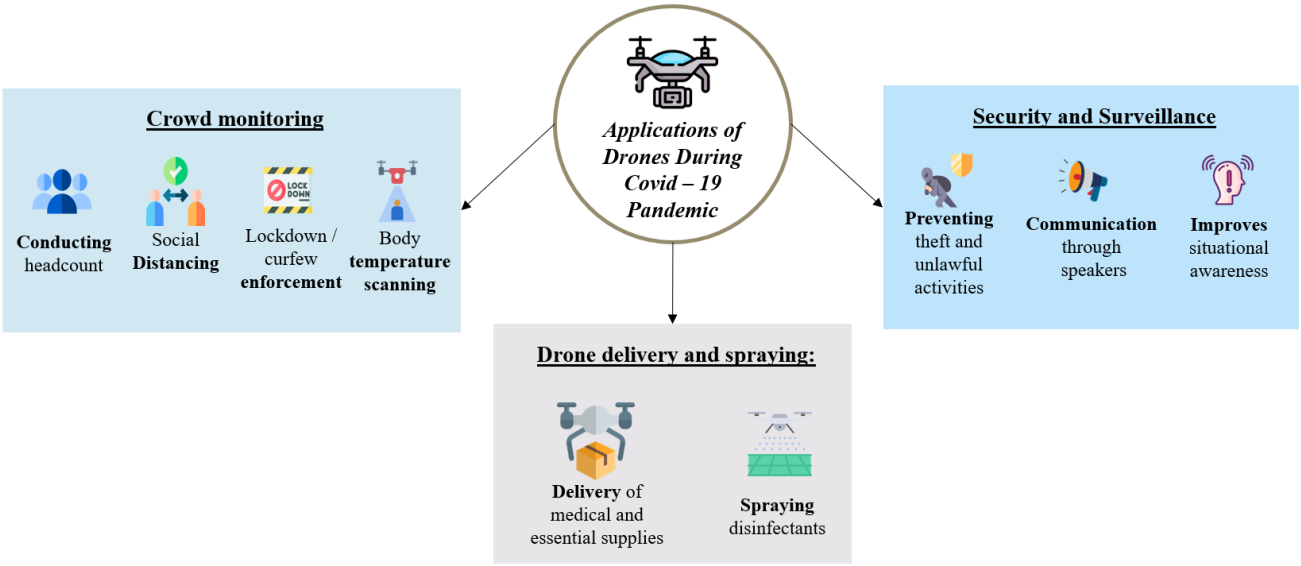
2.3 COVID-19 has accelerated the growth and reshaped the global drone industry

Drone technology has existed for a while, but it has started to evolve rapidly towards its considerable potential during the pandemic. The crisis has resulted in an acceleration in the adoption of drone technologies. The pandemic pushed the world further into the future as businesses are forced to adapt to cutting-edge technology to provide services to customers.

Positive impact on the global drone industry:

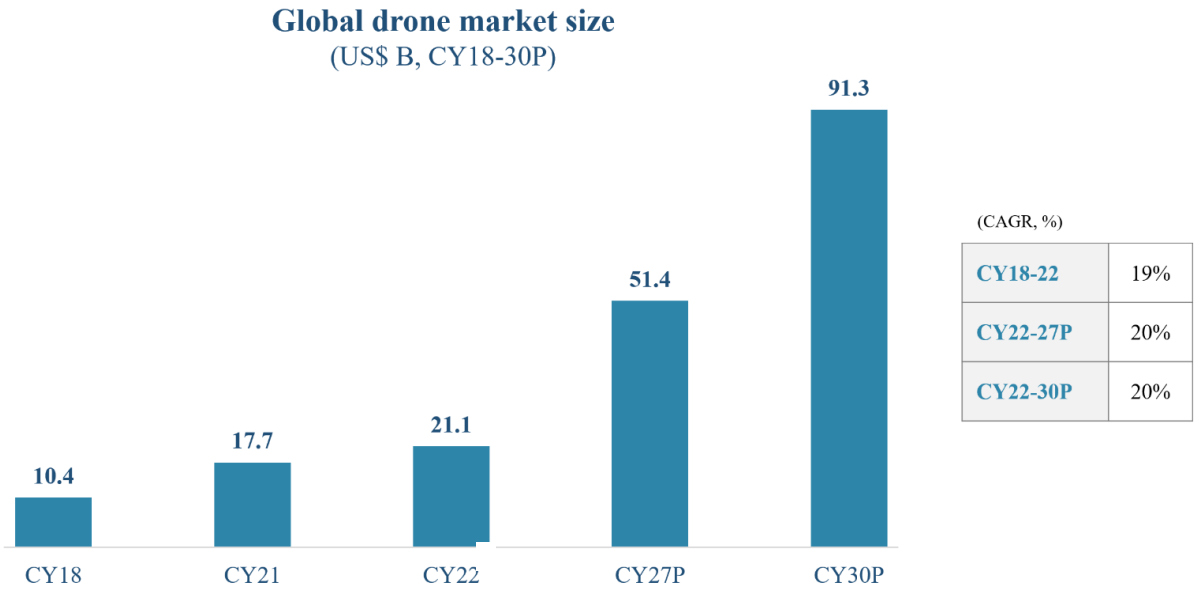
1. **Emerging role of drone use cases:** Drones were used for contact-free delivery, surveillance, enforcement, and hygiene applications, to combat the pandemic.
2. **Exemptions for the usage of drones:** Administrative exemptions from existing, limiting airspace regulations and fast-track partial deregulation were undertaken to deploy drones against COVID-19.
3. **Shifting attitudes towards drone usage for emergencies:** Positive experiences with drones during the epidemic have altered perceptions of drones and boosted support for non-emergency uses. Hence, developing the capability for future emergency responses.

The drone industry was growing at a normal pace before the pandemic. However, due to the growing drone usage across different sectors, relaxation and simplification of drone regulations and growing drone benefits ranging from cost competitiveness to reduction in labour risk, have contributed more to the growth of the drone industry at a faster pace.



2.4 The global drone industry is expected to increase in a fast pace at a CAGR of ~20% from CY22-30, reaching US$ ~91.3B by CY30

The global drone industry is estimated to be US$ 21.1B in CY22. The industry has witnessed a significant growth at a CAGR of 19% over CY18-22 and is expected to grow even faster at a CAGR of 20% to be ~US$ 51.4B in CY27 and further leap to ~US$ 91.3B by CY30.



With global drone market poised to become US$ 51.4B market in CY27, drones are expected to be the disrupters of the future. They are revolutionizing a number of spaces - notably military, and on the civil front emergency services, aerospace, and potentially even the taxi industry.

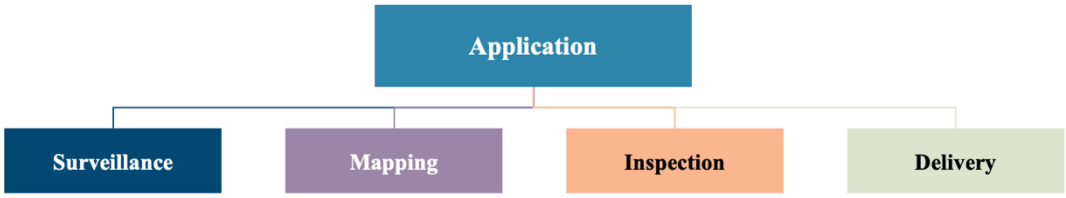
Key reasons for increase in drone adoption:

1. **Low operation cost of drones:** Drones can significantly reduce fuel and labor costs compared to conventional methods. conventional methods. Drones can be proved useful if high volume of deliveries are to be fulfilled across a larger geography compared to traditional methods, helping save resources and reduce costs for enterprises.
2. **Environment-friendly:** Due to use of battery-based technology make drones operate on renewable energy making them environment friendly.
3. **Time efficiency:** Drones facilitate faster, reliable delivery services by providing a predictable delivery time. In France during a cost assessment analysis of drones, drone delivery of biomedical samples took about 15 minutes on average, compared to 42 minutes estimated for road delivery.
4. **Advancement in technology:** Due to technological advancement, drones can conduct large-scale operations. Mapping and surveillance applications are widely used in mining, construction, traffic management, earth sciences etc.
5. **Authentic data collection:** Any innovation that might improve and facilitate data collection is highly desired. Thus, drones gained value for authentic data collection thus providing higher return on their investment.
6. **Favorable regulations:** Despite initial opposition to defining clear drone regulations, the last decade has seen a shift in policy and regulatory approach. The laws governing drone operations are currently being liberalized to unleash the full potential of drones.

Drone segments by application:

Drone applications can be majorly clarified into 4 broad categories, Surveillance, Mapping, Inspection and Delivery

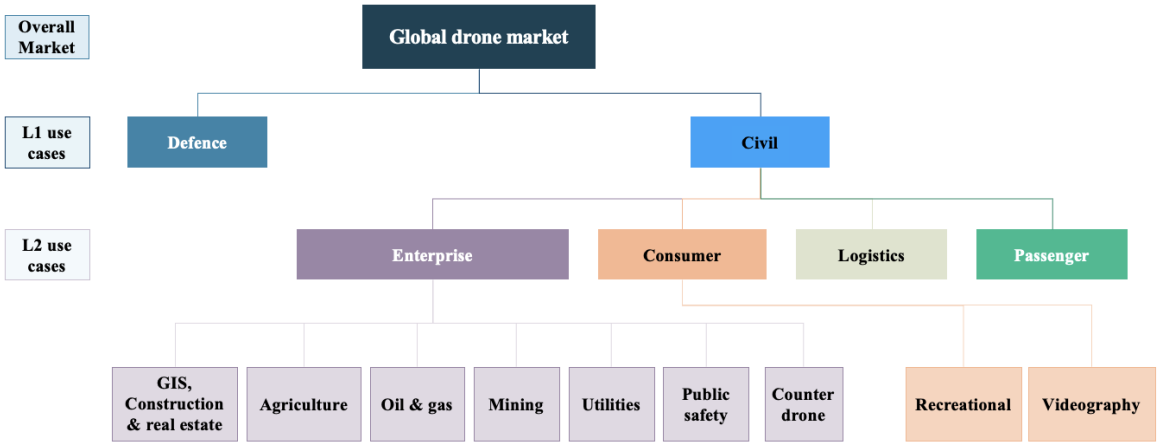
Drone market segmentation by application



1. **Surveillance**: Drones provide high-performance aerial vision providing a real-time video feed, in daytime as well as night via advanced payloads. Drones provide an easy way to get a bird's eye view of large areas. These days drone are also equipped with advanced analytics capabilities such as, target detection, target tracking and moving target indicator.
2. **Mapping:** Drone technology showcases a huge potential for surveyors and GIS services where aerial photographs taken from drones using different types of sensors can provide accurate mapping information. It greatly cuts the cost and work hours of data capture. Further, drones can survey otherwise unreachable areas and deliver high-resolution aerial maps that would be otherwise impossible to produce in a safe or cost-effective way. Drones can help to achieve many benefits for effective mine planning - conducting initial survey, carrying out exploration activity, physical terrain mapping for segregation of land use, contour mapping, 3D modelling, terrain modelling and stockpile management. In agriculture, multispectral mapping can be used for crop health monitoring and yield estimation. There are a number of new sensors such as LiDAR, which enable the ability to create 3D maps and point clouds.
3. **Inspection:** Inspection drones are redefining manual inspection procedures by enabling inspectors to collect inspection data rapidly while eliminating risky, labor-intensive human stages. There are a number of inspection use cases such as property inspection, railway inspection, bridge, pipeline inspection.
4. **Delivery:** Drone delivery services can be used to distribute prescription drugs, packages, groceries, food, and other home healthcare supplies. Another specific application of delivery is spraying drones which can make a big difference in agriculture with more precise delivery of fertilizer and pesticides

The versatility of drones due to their numerous benefits is crucial in unlocking their potential across various industries such as defence, consumer, logistics, among others. Ultimately, the growth and adoption of drones in a particular industry is driven by the direct correlation between the benefits of drones and evolving nature of the use cases. The L1 use cases encompasses both military and civil (non-military) applications, while L2 technology encompasses the deployment of drones across various non-military settings with the aim of reducing the need for human labor, time and productivity.

Global drone market segmentation by use case

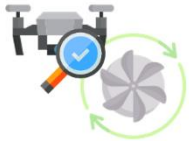


2.5 Evolution of use cases of drones

Amazon's announcement that it would employ drones to deliver packages in CY13 marked a turning point for the drone industry. Since then, drones and drone-based services have skyrocketed in the retail and business sectors. Drones are being explored extensively across various industries, including construction, real estate, e-commerce, agriculture, utilities and energy, financial services, and media and entertainment.

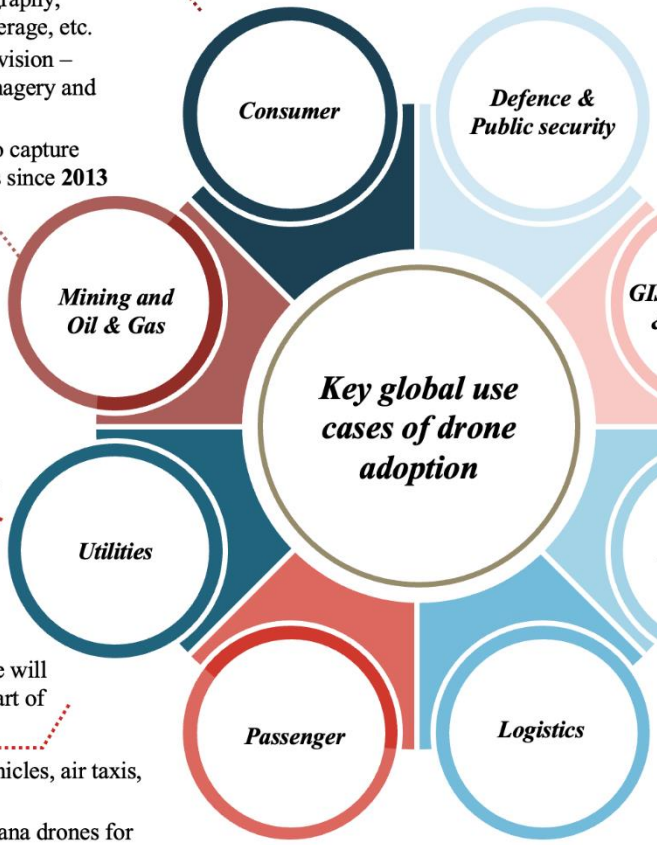
- **Use cases:** Cinematography, videography, photography, advertising, news coverage, etc.
- In CY16, **CNN** launched a drone division – dedicated to fully integrate aerial imagery and reporting
- Hollywood has been using drones to capture **aerial footage** for blockbuster films since **2013**

- **Use cases:** Surveying and mapping, stockpile management, and road haulage optimization
- Mining giant **BHP** employs drones to inspect cranes, towers and flare stacks, etc.
- **Use cases:** Inspect refineries, pipelines, onshore and offshore platforms
- **Royal Dutch Shell** the earliest adopters of drones in oil & gas, uses **surveillance** drones daily across their global portfolio



- **Use cases:** Tower inspection, power transmission, wind turbine inspection etc.
- To provide statewide coverage across the significantly shorter 5G range, **AT&T** alone will need 300K+ new cell towers in the **US** as part of the ongoing rollout of 5G networks

- **Use cases:** Autonomous flying vehicles, air taxis, eVTOL vehicles, etc.
- In the US, **Airbus** is building Vahana drones for passenger transportation – undergoing tests and trials
- **Dubai** soon plan to offer a flying taxi service with its supersized quadcopter called **eHang**



- **Use cases:** Engage with enemies, data gathering, troop safety, **surveillance** – disaster management, forest fires, etc.
- Military expenditures are on the rise around the globe
- **Top nations** spending on military drones include the US, China, India, etc.
- Drones are used in Ukraine – Russia war; Used by US, Saudi and terrorist organizations to strike opponents

- **Use cases:** Remote monitoring, preparing progress reports, topographic mapping, land surveys etc.
- Recently allowed all bridge inspections to be completed by drones in a Canadian city
- Major construction companies in the US such as Kier, Balfour Beatty have started using drones as an **inspection tool**
- **Use cases:** Aerial photography, showcase, and market properties in real estate
- Majority of realtors in the US have **employed drones** or have plans to do so in the future

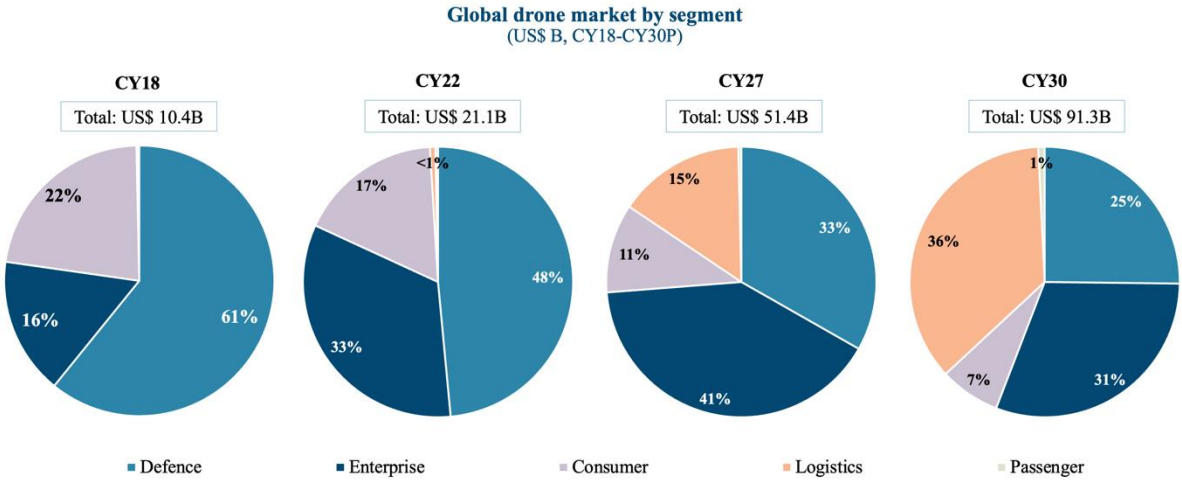
- **Use cases:** Predict and analyze crop growth, provide aerial views, pest detection, etc.
- In India, **Kisan Drones** are already being utilized for crop assessments, land records and insecticide spraying

- **Use cases:** Food delivery, medication / prescription delivery, lab sample delivery, organ transportation, etc.
- **McDonald's** & **Uber Elevate** have partnered and have promised food drone deliveries by **CY23**
- In CY19, a 2.8 miles long drone trip transported a kidney in Baltimore within 10 mins

2.6 The Global drone industry is rapidly expanding into various business segments

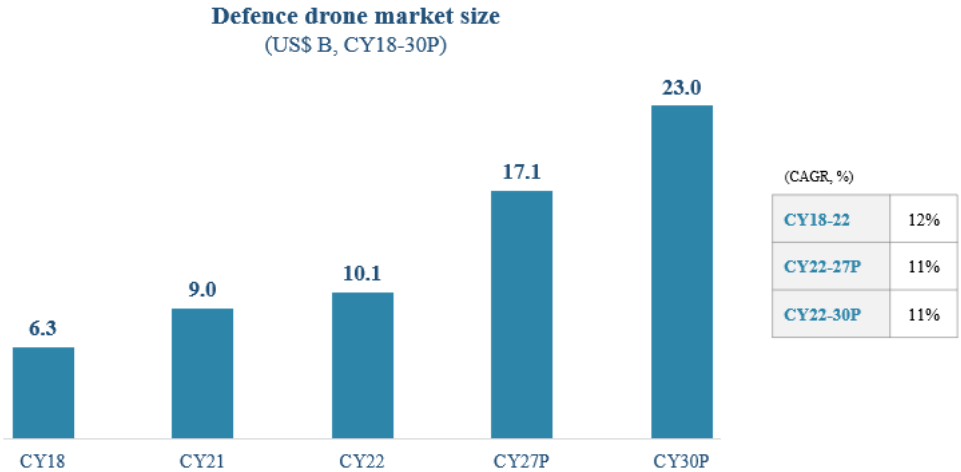
Similar to microwaves, computers, GPS and the Internet, drones were initially created for military purposes but have now also evolved for enterprise and civil usage. While traditional uses for drones, such as security, surveillance, and monitoring, continue to expand, especially in areas where labor costs and human risks are high, almost every industry has room for this technology, from real estate, construction, and mining to public safety, insurance, journalism, agriculture, transportation, energy, and telecommunication costs.

Within the global drone market, defence has had the largest share in CY18 and is expected to have the largest share (48%) in CY22 as well. As defence technology is adapted for commercial use and relaxed regulations, usage of drones in enterprise sector is expected to grow and contribute ~41% of the total market in CY27. The regulations are stringent for drone use in the logistics sector currently, although the situation is expected to change with relaxed norms for drone deliveries and other logistical use cases. The logistics drone market is expected to have the largest share of the overall drone market in CY30, followed by enterprise and defence.



2.6.1 Defence:

Modern defence has been reshaped to engage enemies without endangering soldiers' lives. The global defence drone market size was estimated to be around 60% of the entire drone market at US$ 6.3B in CY18. The growth of artificial intelligence and robotics-based applications in drones have led to their increased adoption in the defence sector.



Over the next decade, A.I. based drones will augment existing platforms with new capabilities and empower humans to use robotic systems to improve safety and decision-making. The market is projected to grow from US$ 10.1B in CY22 to US$ 17.1B by CY27 and US$ 23B by CY30, exhibiting a stable CAGR of around 11% during

CY22-27 and CY27-30. With global defence spending growing at a CAGR of 4.4% from US$ 1.86T in CY18 to US$ 2.11T in CY21 and the race to gain air superiority, the defence sector is expected drive innovation in the overall drone market and remain a significant contributor till CY27.

Since the 1950s, the U.S. Department of Defense has employed drones in most military operations for the observation, surveillance, and intelligence of enemy forces. A number of countries are already using military drones. Drones in defence can be classified into three broad categories based on their usage:

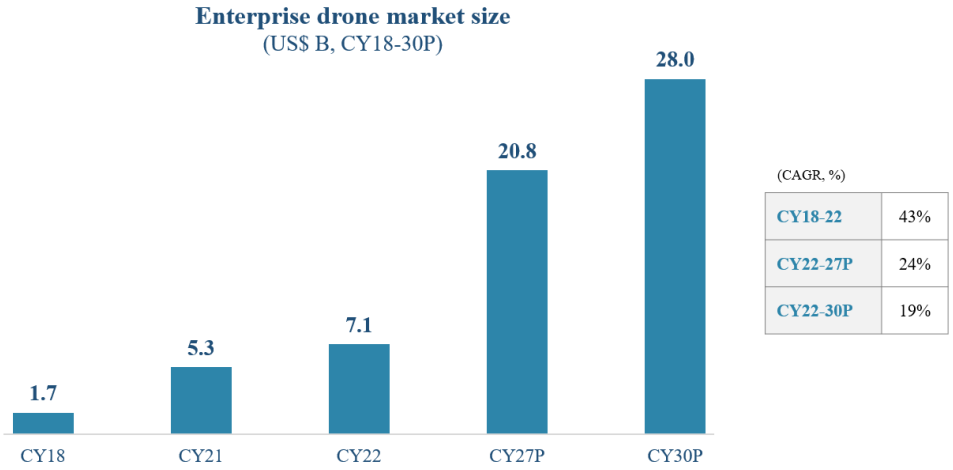
1. **Intelligence, surveillance, target acquisition and reconnaissance (ISTAR):** Drones are considered the best when it comes to data gathering and surveillance across borders. These drones can be deployed kilometers away and provide real-time updates. Drones with artificial intelligence also communicate continuously and provide information on any threat / movement around borders.
2. **Combat:** Drones used for combat are armed with guns, cannons, munitions and other types of arsenals. They engage in air-to-air and air-to-ground combat against enemies or provide close air support to ground troops.
3. **Logistical support:** Drones can be used to offer logistical support to soldiers who are on the battlefield or in difficult-to-reach places. Drones can develop supply networks that get supplies to troops quickly without possibly losing an individual. Drones step in and replace traditional logistics techniques when combat zones and stations are difficult to reach.

By use case, drones in defence can be classified as large, micro and counter drones. Spend on the large defence drones, which are high altitude pseudo satellite (HAPS), high altitude long endurance (HALE) and medium altitude long endurance (MALE) drones, account for and will continue to account for the highest share of global defence market, but micro drones, which are compact rotary drones, are on the rise. Currently majority of the spending on counter-drones by the defence sector was only towards R&D contracts and not actual procurement and usage, as current counter-drone systems either offer unproven capabilities or perform differently than advertised outside of a controlled environment.

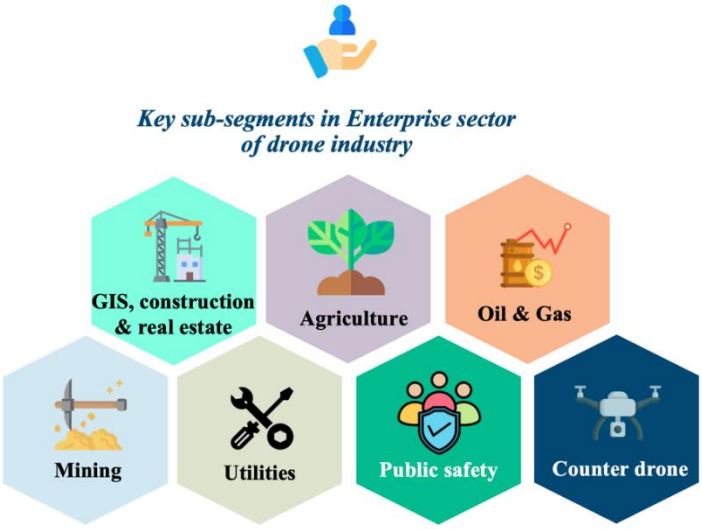
The global defence drone market expansion is anticipated to be aided by the rise in defence spending as more nations purchase modern, technologically advanced military drones/UAVs for enhanced combat capability from drone suppliers who benefit from high entry barriers like capital requirements and technological prowess in the defence industry. Rising cross-border conflicts in several countries will also drive drone usage in defence space for surveillance.

2.6.2 Civil:

Civil comprises of enterprise, consumer, logistics and passenger segments. Enterprise drone market has been the fastest-growing drone market segment, having grown at a CAGR of 43% from CY18 to CY22. It is the second largest market after the defence sector, pegged at US$ 7.1B in CY22.

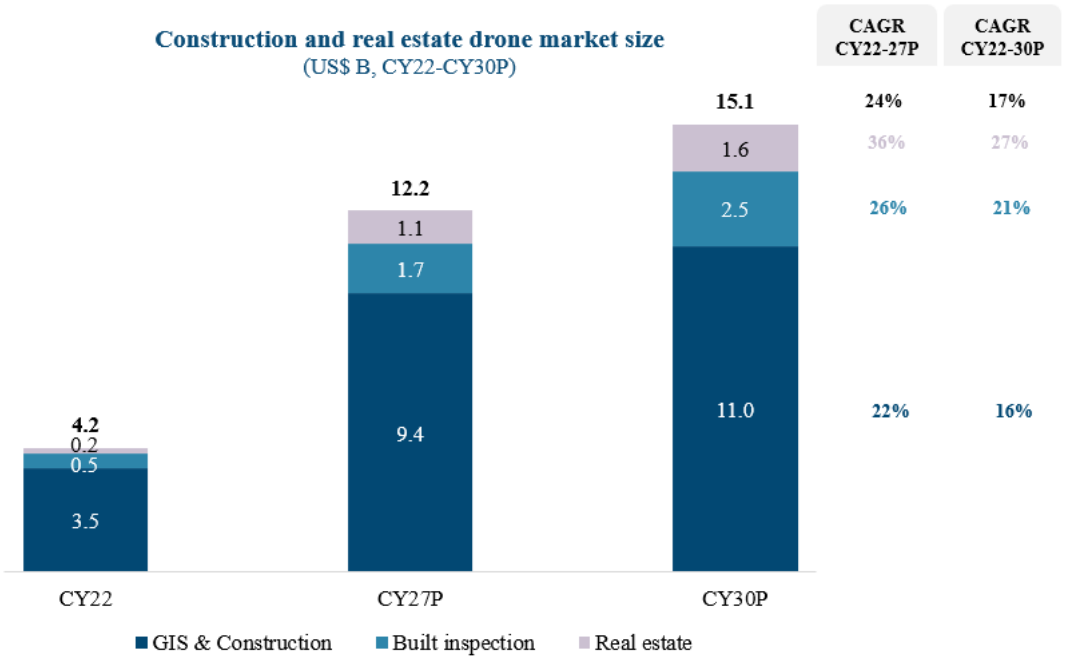


Currently, the enterprise drone market is in its nascent stages with regulatory complications such as the Line-of-Sight requirement, among others. Drones are expected to be employed on a massive scale in various industries, with construction and real estate and agriculture being the most significant segments of the enterprise drone market due to them being early adopters of the technology. Research and development into advanced drone technology and industry-specific software are expected to drive adoption and improved operational efficiencies. With increasing drone autonomy and an uptick in drone licenses and registrations, the cost of drone adoption will lower, further encouraging more use cases across various industries.



2.6.2.1 GIS, Construction and Real estate:

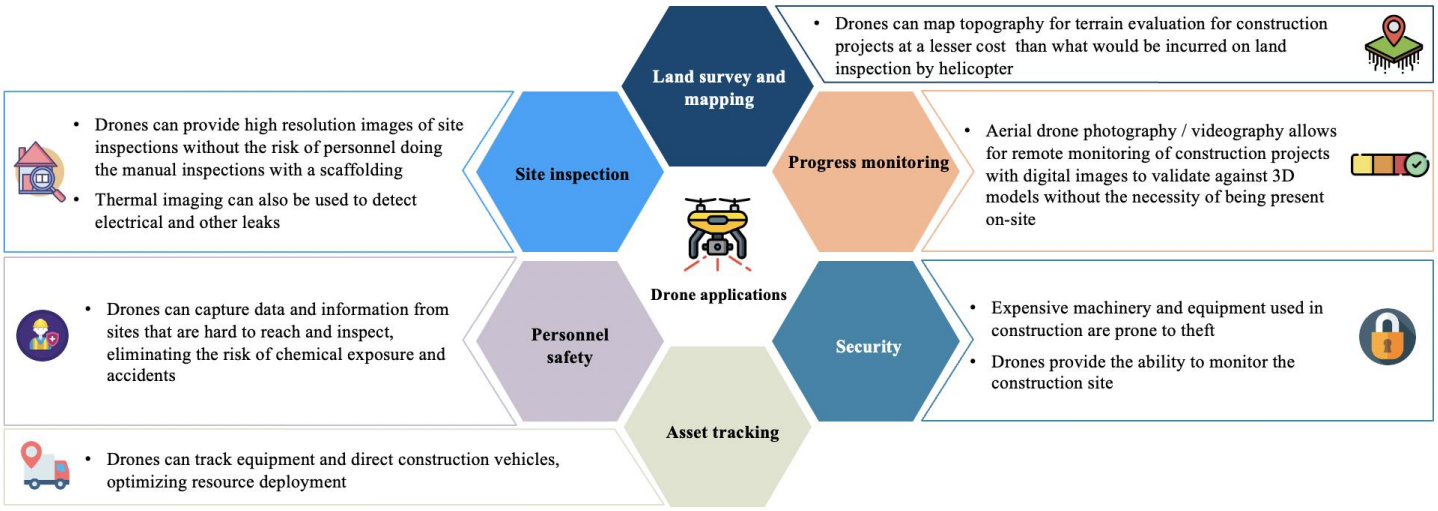
The GIS, construction and real estate drone market comprises of GIS, construction, built inspection and real estate markets combined. The market is expected to go from US$ 4.2B in CY22 to US$ 12.2B in CY27, growing at a CAGR of 24%, with real estate being the fastest growing segment amongst the three and construction to make up ~77% of the construction and real estate market in CY27.



2.6.2.1.1 GIS & Construction:

The GIS & construction drone market is the largest global enterprise drone market segment, standing at US$ 3.5B in CY22. The market is expected to be US$ 9.4B in CY27, growing at a CAGR of 22% between CY22-27, considering the relaxation of drone regulations for enterprise use. Drones are being used to improve the efficiency

of construction operations by aiding land surveys, progress monitoring, and safety check functions. A.I.-backed drone technology is now being deployed to plan construction sites, quantify resources and manage assets on-site.



The impact of COVID-19 on the construction industry has aided the adoption of drones by the industry. The pandemic resulted in the reduction of on-site workers and adoption of drone technology to monitor sites and ensure worker safety. Construction companies majorly work on asset-light models and lease equipment on a project-to-project basis and these companies will use drones-as-a-service. For that reason, the construction industry is expected to move quickly towards automation of drone-based data collection and analysis.

2.6.2.1.2 Built Inspection:

Built inspection or Built Environment Inspection (BEI) refers to the examination of completed structures such as bridges, railroads, and buildings with the help of drone technology. The global drone-built environment inspection market is currently at a size of US$ 0.5B in CY22 and is projected to reach US$ 1.7B in CY27, growing at a CAGR of 28%. Increase in BVLOS acceptance, improved autonomy, and powerful data analytics will allow BEI to grow as one of the largest markets for enterprise drones through CY30. In a test survey conducted by Arcadis, a global engineering consultancy, saw that surveillance led by drone took less than half the time taken by traditional methods.

The primary benefits of deploying drones for built inspection include:

1. **Increased safety for inspectors:** Inspector no longer has to be put into potentially hazardous circumstances
2. **Savings on cost of temporary structures:** Companies can save on inspection costs by not having to construct scaffolding or other transient infrastructure for a manual inspection.
3. **Reduction in insurance cost:** Companies can dramatically lower their insurance-related costs by drastically reducing the time employees are exposed to risky situations.
4. **Helps create a digital footprint of the company's assets:** Visual data collected by drones help companies retrieve a digital record of an asset's life history at any moment.
5. **Advantageous for nuclear power plants:** Currently, nuclear power reactors or pressure vessels are turned off before every inspection. This downtime results in a revenue loss which can be resolved by drones to a great extent.

BEI can be divided into three sub-categories: railway inspection, bridge inspection, and property inspection.

1. Railway inspection:

The major use cases for drones are to examine bridges, remote railway networks, and radio towers on railroads. Growth of drone-based inspection will majorly be driven by relaxation on BVLOS flight limits in low human density areas. The on-time approval of BVLOS operations will act as a catalyst. Soon, drones that launch from and land in self-contained "boxes" will be strategically placed to carry out autonomous inspections. Asset-light railroad owners who do not want to maintain a distributed crew of drone monitors will probably scale back their internal drone operations in favor of an outsourced model as autonomous drone railway inspections become more

prevalent. For instance, BNSF Railway Co., a US based rail infrastructure company, is employing drones to optimize inspection procedures for its rail network.

2. Bridge inspection:

Ageing bridge infrastructure, slow and traditional bridge inspection methods and an increase in the frequency of bridge inspection will majorly drive the bridge inspection by drones cost-effectively. Drones are increasingly performing autonomous bridge inspection missions on-site and are becoming standard equipment on utility vehicles. The time and cost for bridge inspection by drones is drastically less than traditional assessment methods. For instance, drones are used by state transportation departments in the U.S. for surveying and emergency response. Using drones-based bridge inspections they were able to save up to 70% of traditional assessment method cost. In the US, Schemmer Associates Inc., engineering and construction-based consulting firm, deploys drones to assist in bridge inspections, ensuring inspector's safety and reach in accessible locations.

3. Property inspection:

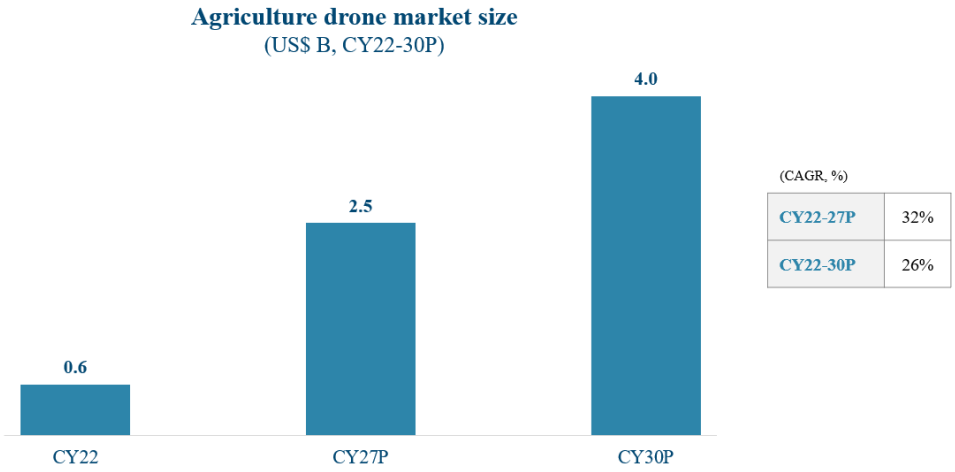
Drones are useful tools for monitoring properties and identifying potential problems. Detecting property changes, inspection of landscape damages, roof damages, etc. are some of its primary use cases. Also, they are revolutionizing how insurance companies and building inspectors inspect structures. Since CY15, insurance companies have been using drones to expedite risky and time-consuming inspections at claim locations while keeping staff safely on the ground. Drones are already becoming commonplace among those who handle insurance claims. The increased adoption rate for property inspection will be accelerated by insurance companies seeking to take benefit of the efficiency gains due to drones. To conduct regular annual inspections on tall buildings, building inspectors either build costly scaffolding or rappel down the sides of the buildings. Except for repair work, drones will make scaffolding and rappelling obsolete. A Canadian company, Industrial SkyWorks Inc., have used drones to examine walls and roofs of structures at night.

2.6.2.1.3 Real estate

Drones have been used in the real estate market for a long time. The market is expected to grow at a CAGR of 41%, from US$ 0.2B in CY22 to US$1.1B in CY27. With many use cases such as real estate marketing, aerial video tours, and resort living to 360 panoramas, real estate will continue to be a competitive market for drones. Agents who use drones for real estate could potentially see an increase in their listings and a higher chance of deal closing. The use of drones has been steadily increasing since the COVID-19-induced lockdowns, where a rise in 3D panoramic virtual tours was on the rise. With increasing adoption due to comparatively relaxed regulatory norms and growing demand for virtual panoramic views of properties, this segment is expected to grow in the next five years. A recent project of surveying a village in India where nearly 80 drones deployed for data collection, saw that the cost was reduced roughly by 4 times when compared with traditional methods.

2.6.2.2 Agriculture

Drone technology is increasingly being used by agricultural businesses worldwide to modernize farming. Agriculture drones would carry sensors that can provide real-time information on crop status or animal movement, allowing for efficient and precise decision-making on operations and management. These drones may be upgraded with various sensor payload configurations and digital imaging capabilities for field surveys, crop monitoring, spraying, spreading applications, and livestock and fisheries surveillance. The global agriculture drone market is estimated to be US$ 0.6B in CY22 and projected to reach US$ 2.5B by CY27, growing at a CAGR of 32%.



Yamaha Motor India Pvt. Ltd., a Japanese multinational manufacturer of motorized products, began selling multi-rotor drones in CY18 as demand surged in Japan. Operators rent 2,500 or more manual radio-controlled or fully autonomous Yamaha drones to spray roughly 42% of Japan's paddy fields. In South Korea, nearly 100 manual radio-controlled or fully autonomous drones are in operation. Yamaha has begun rolling out its technology in Australia and New Zealand, as well as in the U.S.A., where the F.A.A. has granted Yamaha permission to conduct commercial trial services and research. Similar to Yamaha, a number of companies like SZ DJI Technology Co., Ltd, Parrot Drones SAS, and PrecisionHawk Inc. have been providing drone based agricultural solutions to governments, enterprises and the public, across the world.

Precision agriculture improves farm efficiency by utilizing technologies capable of rapid data insight analysis and is being used by large commercial farms currently in the U.S. Among the plethora of applications for drones in agriculture, precision agriculture applications will be focused on as 'drone-based agriculture', which is anticipated to be a premium service until CY25 due to the prohibitive costs of high-tech drone services.

1. Soil and crop monitoring

High-resolution aerial photos can create 3D maps for crop and soil analysis, which can be used to design seed planting patterns, regulate irrigation and nitrogen levels, and monitor crop development throughout the season. Soil and crop monitoring can be performed by using satellites, general aviation aircraft, and drones.

Satellites can collect vast amounts of data. However, high-resolution satellite photography is costly, has limited revisit times, and is vulnerable to weather conditions. General aviation planes are less expensive than satellites. They can cover more ground than drones making them ideal for surveying large areas, but produce lower-resolution imagery than drones. Drones can monitor crops and soil on large pieces of land while being cost and time effective.

Parameters	Satellite	General aviation aircraft	Drone
Operational expense	Very high	Medium	Low
High resolution imagery	Available, but expensive	Low availability	High
Revisit times	Highly limited	Unlimited	Unlimited
Vulnerability to weather conditions	High	Medium	Low
Most suitable area size	Extremely large areas	Very large areas	Medium and large areas

2. Irrigation and crop spraying

Drones for crop spraying are still relatively new in adoption, but they are gaining traction. Due to the limited availability of drones for crop spraying and local drone regulations, this use case has witnessed slow adoption. However, crop-spraying drones will become more widely used, with many countries such as China, the United States, India, and the European Union relaxing drone laws related to agriculture.

Many components of farming are still labor-intensive, and manually spraying chemicals is difficult, dangerous, and time-consuming. Using drone technology to spray crops avoids any detrimental effects pesticides may have on humans. Drones are a faster and more effective use of resources in farming. Another advantage of employing drones for crop spraying is that they can reach locations challenging to access by land.

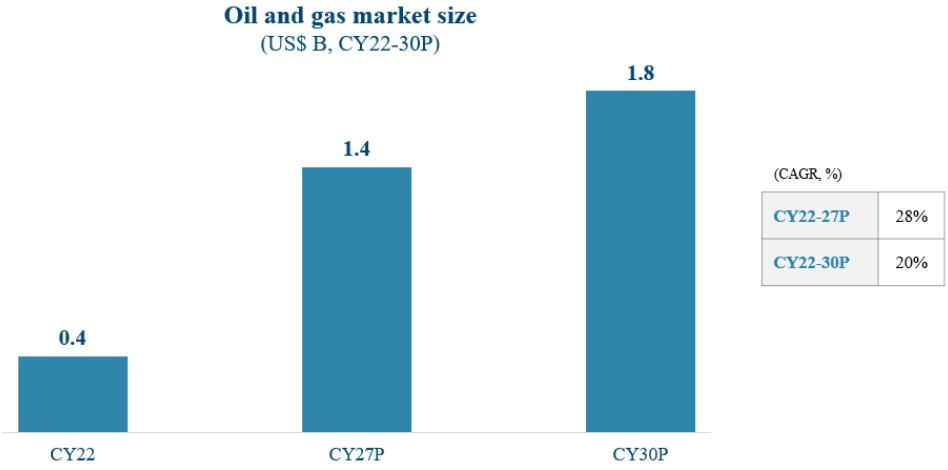
3. Health assessment

Drones configured with sensors capable of scanning crops with visible and near-infrared light can be used to check crop health over time to understand when to follow corrective actions. Farmers can use data from modern sensors presented as 2D or 3D models to understand better and find new ways to boost crop yields while decreasing crop damage. This data can then also be used to develop crop damage valuations for crop insurance as traditional inspection methods can be slow and inaccurate.

Globally, drone-based precision agriculture is likely to continue to be provided as a managed service offered to farmers as part of package deals with seed and crop protection companies.
The farming subsidies for drone services will increase as governments move towards adopting technology in agriculture to maintain adequate food supply for their growing populations. In December 2021, the Government of India released the Standard Operating Procedure (SOP) for the use of drones in crop protection and spraying. Several countries are releasing guidelines on the usage of drones in agriculture as a thumbs up to technology's potential benefits.

2.6.2.3 Oil and Gas:

Drones are used in the oil and gas sector to check platforms on land and at sea, pipelines, and refineries. Drones enhance worker safety in the oil and gas sector while lowering inspection and maintenance expenses. The global oil and gas-based drone market is currently valued at US$ 0.4B in CY22, which is projected to reach US$ 1.4B by CY27, growing at a CAGR of 28%. In the future, development of autonomous drones will help reduce critical infrastructure downtime and allow faster inspections of hazardous areas.



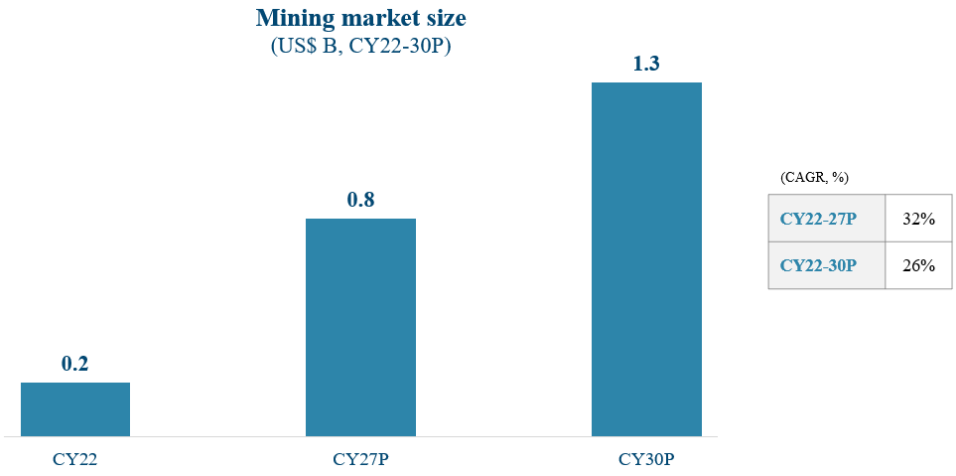
The usage of drones in the oil and gas sector is divided into three segments: upstream, midstream, and downstream. The upstream segment includes the discovery and production of oil and gas, such as drilling and bringing resources to the surface. The midstream segment refers to all activities necessary for transporting and storing crude oil and gas before refinement. Downstream encompasses all the processes required to transform crude oil into finished goods and transportation. Top global oil and gas firms using drones to enhance their operations and obtain real-time insights include Bharat Petroleum Corporation Limited, Chevron Corporation, ConocoPhillips Company, Equinor ASA, Exxon Mobil Corporation, among others.

Upstream	Midstream	Downstream
		
• **Monitors** onshore and offshore assets on safety and regulatory aspects • **Inspection** activities include vegetation encroachment detection, spill detection, gas emissions tracking, etc. • Crucial role during **emergency scenarios** as upstream drone aid in video analytics and real-time imagery	• Above-ground **aerial inspection** facilitates monitoring of underground pipelines; checks for anomalies, disturbances • Drones help in **data collection** - allow operator to predict the health of assets & forecast potential malfunctions	• **Inspection** of inside of chimneys – to detect **cracks** & anomalies • Drone monitor and **inspect** external pipelines • Inspection of storage tanks for **corrosion** and leaks

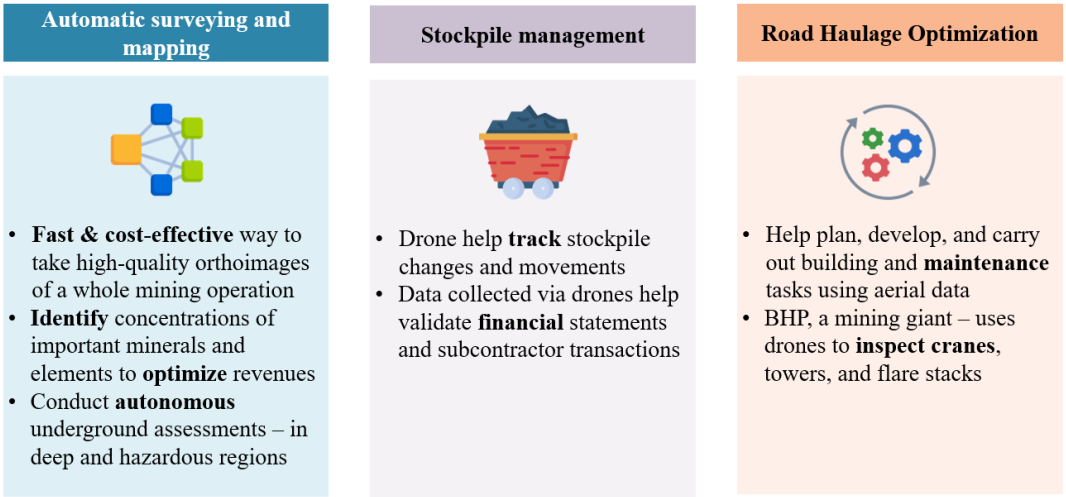
2.6.2.4 Mining:

There are three primary use cases of Drones at mines: Surveying and mapping, stockpile management, and road haulage optimization. The global mining-based drone market is currently valued at US$ 0.2B in CY22, projected to reach US$ 0.8B by CY27, growing at a CAGR of 32% over CY22-27.

Drones are capable of a wide range of mining applications, including exploration, mapping, surveying and data collection, as well as maintaining safety and strengthening security. Recently popularity of drones has increased in the mining industry, with several mining sites investing in drone technology. Mining professionals have seen that drones provide tremendous value to their operations. Drones in mining deliver accurate and complete information on quarry and mine conditions quickly, increasing the efficiency of large mine sites and quarries. They will improve coordination between teams on-site and globally and also provide a dynamic picture of all operations.

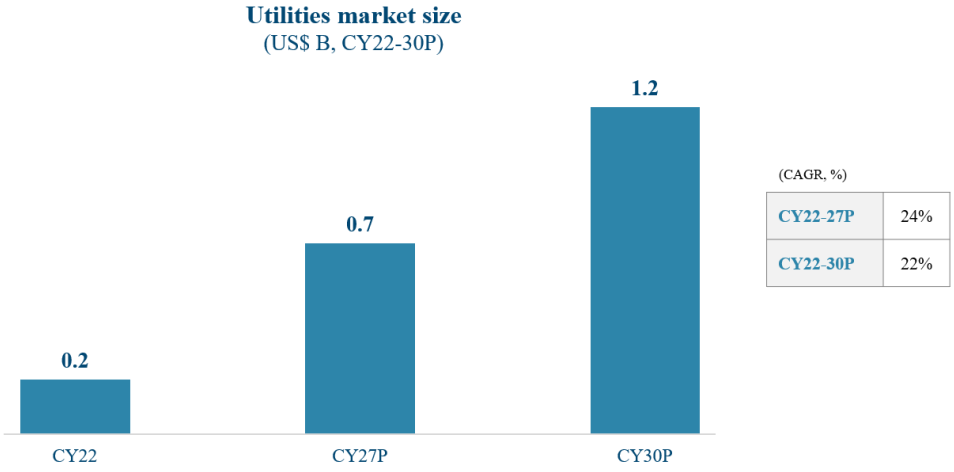


Benefits of drones in mining include higher accuracy compared to traditional surveying and inspection techniques, more rapid data collection which is faster than conventional land-based practices carried out by personnel, higher-resolution data, increased worker efficiency, cost-effectiveness and enhanced worker security. Massive mines are using drone surveillance to locate potential deployment sites for resources and reserves and increase exploration expenditures' effectiveness. These factors, including fewer regulations to comply with compared to other sectors, as there is barely any drone usage in a high human-density environment, will drive the growth of drones in the mining sector. For instance, Coal India Limited has decided to utilize drones for variety of monitoring tasks such as mine repair, reviewing topsoil loss, etc.



2.6.2.5 Utilities:

The utilities sector encompasses tower inspection, power transmission and wind turbines, among others. The drone utilities market is expected to grow at a CAGR of 28% from US$ 0.2B in CY22 to US$ 0.7B in CY27. The difficulty of inspecting various installations, such as power lines and wind turbines necessitates the need for drones. Drones are primarily being used to carry out inspection and maintenance jobs due to cost savings, safety and accuracy provided by drones.



1. Tower inspection:

About 5,60,000 inspectors work on about 5 million communication towers globally. With new 5G towers coming up, routine inspection of towers would require additional help. Autonomous drones equipped with high-resolution thermal cameras allow remote inspections to be undertaken. Tower inspection by drones requires them to be close to the towers to meet the Beyond Visual Line of Sight requirements for most nations such as the U.S.A., Australia, U.K and India. Telecom operators have started using drones in maintenance monitoring, maintaining a record of equipment mounted on cell towers and maintaining a central repository. The potential market for drone-powered solutions is immense, with the possibility of telecom operators providing such services themselves. For instance, Verizon Communications, Inc. acquired Skyward IO, Inc., a drone company which allows users to connect drones wirelessly and share data plans on its network. Vodafone Group Plc. too is in talks with regulatory authorities of many countries to contribute to drone traffic control centers.

2. Power transmission:

Drones have numerous close-range use cases around power lines, such as checking vegetation growth and detecting damage to avert a power outage or fire damage etc., drones fitted with thermal sensors can pinpoint discharge and overheating lines and facilitate timely maintenance. Requirements of electromagnetic shielding, pilot training and BVLOS restrictions hinders high adoption in this segment.

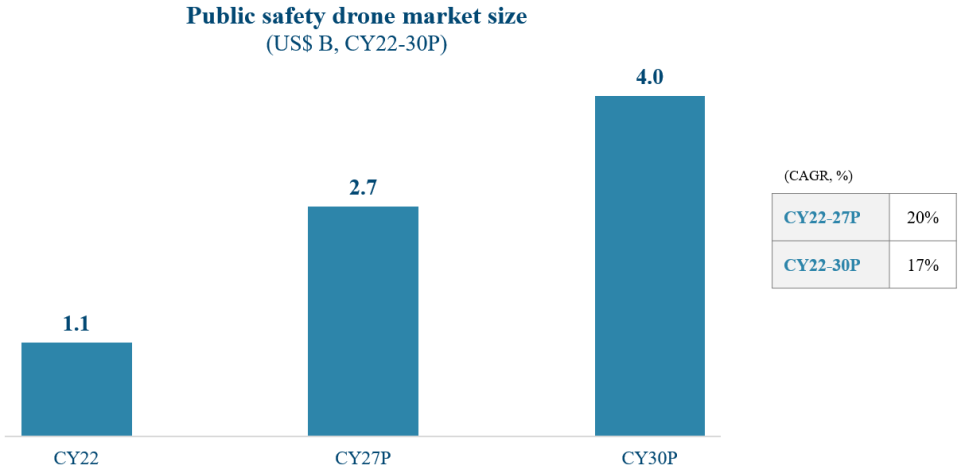
3. Wind turbines:

Drone usage in the wind turbines market is positioned against ground-based solutions. The energy industry spends around US$ 8B annually on wind farm maintenance. Wind turbines require preventive maintenance checks, including manual inspections for signs of wear and tear. Drones can perform 360-degree inspections, maintain a central repository of data, transport maintenance equipment and chart an automatic flight path to check for erosion and cracks by performing on-demand remote monitoring. A limiting factor is that wind speeds can range from 4m/s to 5.8m/s, which may be more than the windspeed limits of drones, acting as a barrier to their usage.

2.6.2.6 Public safety

As the usage of drones for public safety grows, so does their utility in emergency and law enforcement scenarios. The public safety-based drone market is currently valued at US$ 1.1B in CY22 and is projected to reach US$ 2.7B by CY27, growing at a CAGR of 20%.

Drones have changed public safety operations by providing responders with a wide range of airborne reconnaissance and mapping capabilities. Although, constraints on flying beyond visual line of sight (BVLOS), limited battery life, and community concerns about privacy are all barriers to increasing the usage of public safety drones. As most limitations are critical to the growth of drone usage in public safety, drone adoption is only expected to accelerate once regulatory concerns are met.



The market for drones in public safety is majorly made up of two use cases:

1. Law enforcement

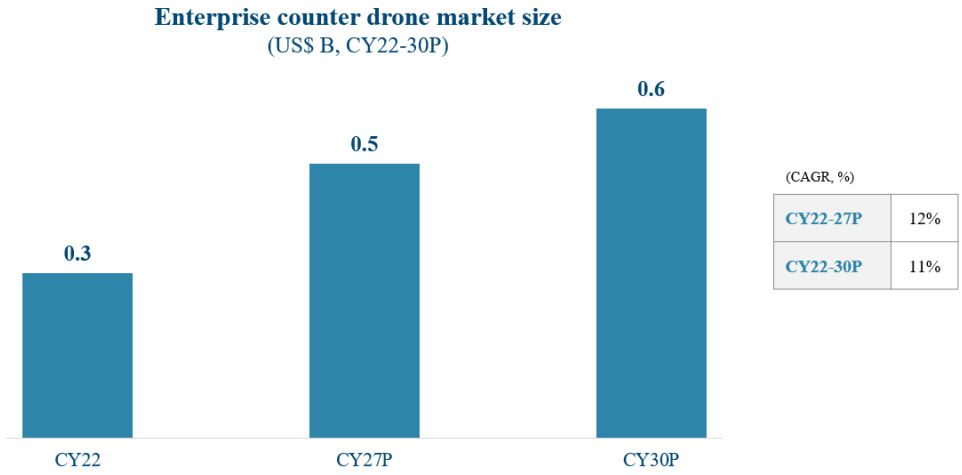
Due to the entry of new technologies, policing looks significantly different now than it did a decade ago. New technologies like facial recognition software and a wide range of computer applications made possible by high-speed broadband wireless systems have substantially expanded the capabilities of law enforcement. Police and government officials worldwide have used drones to perform remote policing and enforce social distancing during COVID-19 lockdowns. Pilot programs are expanding drone adoption, as agencies turn to technology to address operational inefficiencies. However, drone adoption in law enforcement is highly regulated as law enforcement agencies are not allowed to use foreign-made drones, in key countries like the U.S.A., China and Japan for the protection of public and agency privacy. As a result, the drone market in law enforcement is estimated to grow conservatively as authorities are reliant on country's manufacturing capabilities.

2. Firefighting

Fire departments worldwide, especially in the United States, are increasingly harnessing the benefits of drone technology during firefighting operations. Drone usage while firefighting goes beyond putting fires out in areas that are tough to reach. They are used for situational awareness, thermal assessment, and search and rescue operations, amongst other use cases. Increasingly drones are finding a place in the prevention of forest fires.

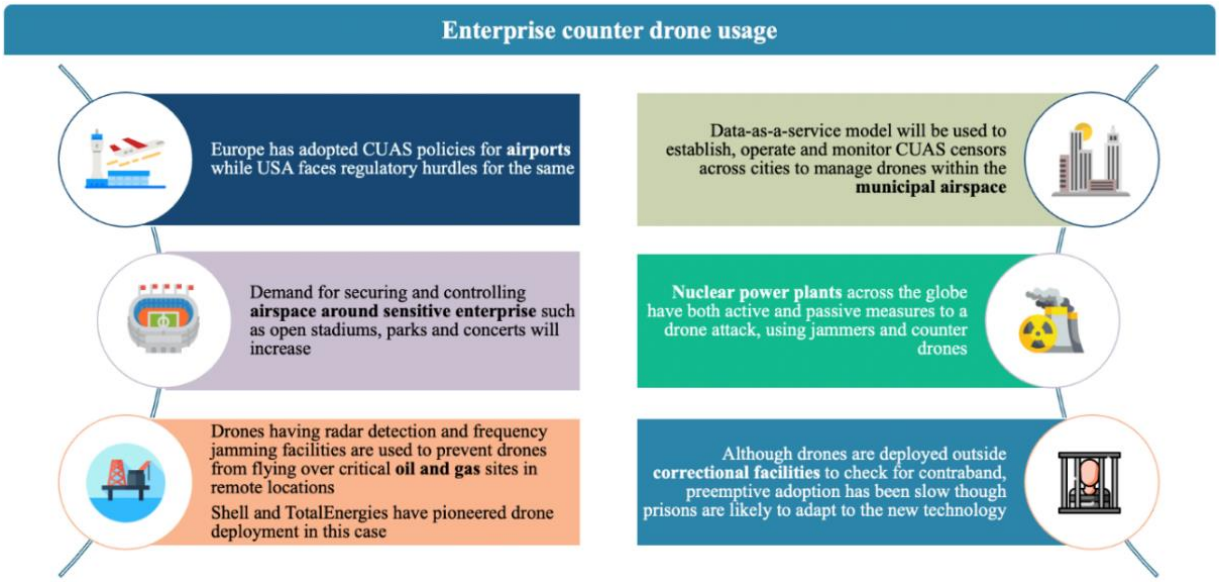
2.6.2.7 Enterprise counter drone:

Counter drone technology, which is often referred to as counter-UAS, C-UAS or counter-UAV is the system that is used to detect and disable an unmanned aerial vehicle. Enterprise counter drones primarily consist of drones used at airports, nuclear power plants, prisons, oil and gas, enterprise airspaces, municipal airspaces and other commercial spaces for drone attack detection and mitigation. The counter-drone market is expected to grow at a CAGR of 12% from US$ 0.3B in CY22 to US$ 0.5B in CY27.



Places of critical nature and mass gatherings are susceptible to drone and other attacks, making counter-drones essential. Anti-drones can undertake the following activities:

1. Detection and tracking of invasive drones and other technology over restricted airspaces
2. Signal a warning to the drone pilot, informing the pilot about the infraction
3. Disrupt the flight path of the invading drone
4. Confiscate invading drone
5. As a last resort, destroy the invading drone

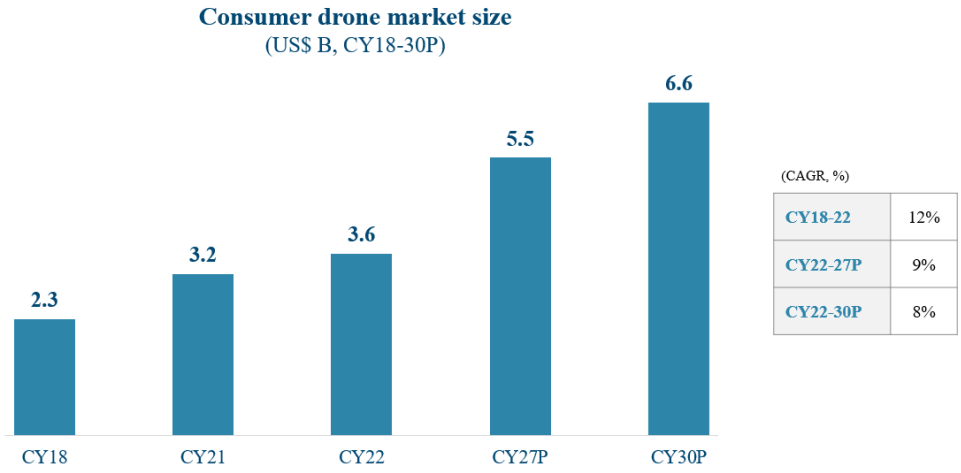


Commercial C-UAS solutions can be used instead of military-grade jammers and electromagnetic counters, which are prohibited under general circumstances. Usage of other solutions, such as missiles and other projectiles, risk incurring severe collateral damage. Governments have not yet set specific C-UAS policies, and many regulations will be overlapping with Aviation Security Act etc. would lead to slower adoption.

2.6.2.8 Consumer:

Consumer drones have been operating as the face of the drone market for the last decade; however, it currently had a smaller market compared to defence and enterprise. The current market size of the consumer market is US$

3.6B and is expected to grow at a CAGR of 9% to stand at US$5.5B in CY27. While commercial drones are in the early adopters' phase, drone usage by consumers is expected to reached maturity by CY27.



Consumer drones are broadly categorized into the following:

1. Recreational
2. Videography
    a) Journalism
    b) Cinematography

Recreational use:

Drone usage for recreational purposes relates to the use of drones by hobbyists for videography or simply for the fun of flying a drone. The drone market for recreational use is expected to grow due to growth in the "experience economy" as social media takes center stage. While in the early days, hobbyists drove the industry. This trend will reverse as enterprise solutions mature and the growth rate of the consumer market is expected to slow down. The European and American markets are expected to stagnate in the coming years.

Videography:

Videography consists of two broad categories, namely journalism and videography.

1. Journalism

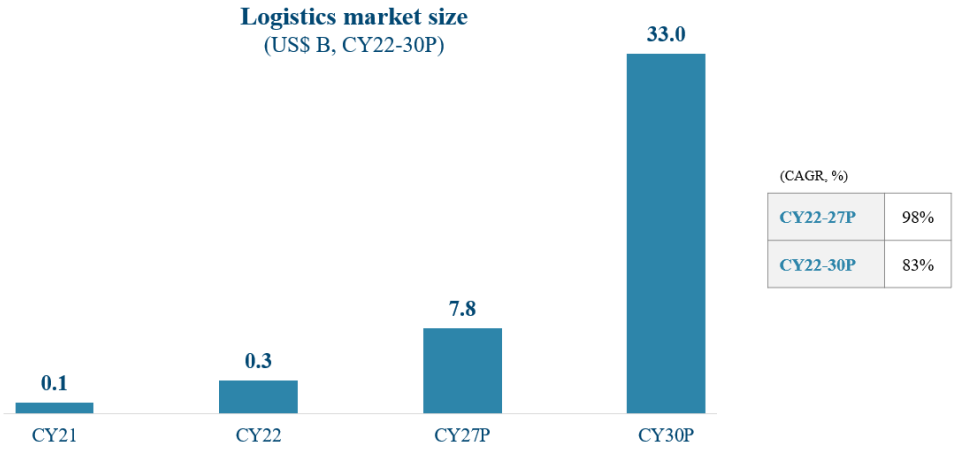
Drones have been used to cover news, such as natural disasters and other events up close, without putting a cameraperson in danger. Drones with high-tech cameras and thermal sensors can cover larger areas and reduce overall reporting costs as they are less expensive at the same time offer more maneuverability than the next best alternative, which is a chopper. Drone usage is expected to grow steadily due to the ease of regulations for drones' usage in low-density public areas and during night time.

2. Cinematography

Drones have been used for filmography, cinematography and broadcasting for the last few years. In USA, they have been used regularly for filming aerial shots in movies, television shows and commercials since CY14 when drones in filmmaking became legal in the country. Sports documentaries make use of F.P.V. drones to create camera movement. Most drone usage in cinematography is outsourced to drone service providers. Drones fare better than cranes and replace their role by having advanced payload capacity, high altitude capability and high-resolution cameras. They also prove to be less costly than helicopters for long-range shots.

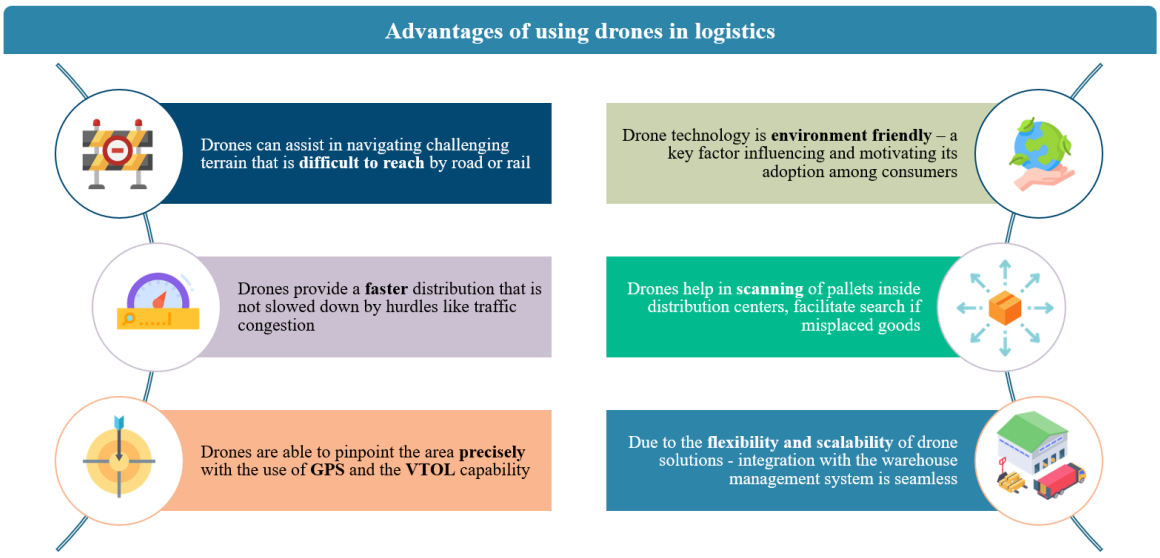
2.6.2.9 Logistics:

The drone logistics market is currently valued at US$ 0.3B in CY22 and is projected to reach US$ 33B by CY30. This market growth can be attributed to surging demand for efficient logistics and last-mile delivery and technological advancements such as Vertical Take-Off and landing (VTOL), geospatial mapping, IoT, and machine learning resulting in higher accuracy of package delivery. Furthermore, revamped government regulatory framework will drive growth opportunities for drones in the logistics sector.



With the growing effects of the pandemic and increase in environmental consciousness among companies and consumers, the logistics industry has become more dynamic, and adaptive. The logistics movement and supply chain complexity can be efficiently solved by bringing an autonomous vehicle element. This will fulfil the four critical areas considered by logistics companies: optimizing efficiency, recognizing value, being flexible, and resilient and having zero negatives.

The pandemic has also fueled the desire for delivery drones, which address structural challenges such as delivery timing (same day) and delivering to isolated locations. In a period when there were few people available to transport items but tremendous demand, the ability of drones to make contactless deliveries in the lowest amount of time established its value. Furthermore, modern drones can transport bulkier packages over more considerable distances in a shorter time. During a study in CY22, in last-mile delivery, energy consumption per package by a medium-duty diesel truck was reduced to more than half when delivered through a very small quadcopter drone. Companies in various sectors, including logistics, healthcare, food, and e-commerce, are being prompted to pilot drone delivery technologies. International corporations, including The Boeing Company, Zipline Inc., United Parcel Service, Inc., Amazon.com, Inc., Wing Aviation Private Limited, and others, provide stores and online shoppers with immediate delivery services using drones.



Global examples of drone adoption in logistics:

The first drone-based delivery was performed by Domino's Pizza, Inc., in November 2016 to deliver a pizza to a customer's doorstep. Since then, several large and small businesses have been testing autonomous delivery using drones. In CY19, Amazon.com Inc. announced 'PrimeAir', a drone delivery service to deliver packages within 30 minutes of ordering. The Wing, owned by Alphabet Inc., develops drone-based freight technology, and works with organizations like Walgreens and FedEx to deliver two and three-pound drone packages.

United Parcel Service, Inc. Flight Forward was the first drone delivery service to be launched by a commercial logistics company. To advance their effort to provide medications, they have teamed with CVS Health Corporation. Walmart Inc. in association with DroneUp LLC will potentially serve four million households across six states in the US by expanding DroneUp delivery network across 34 sites. Drone Delivery Canada Corp., Airbus SE, Matternet Inc, DHL International GmbH., Shenzhen SF City Logistics Co., Ltd, and Rakuten Group Inc. are some other major drone delivery companies.

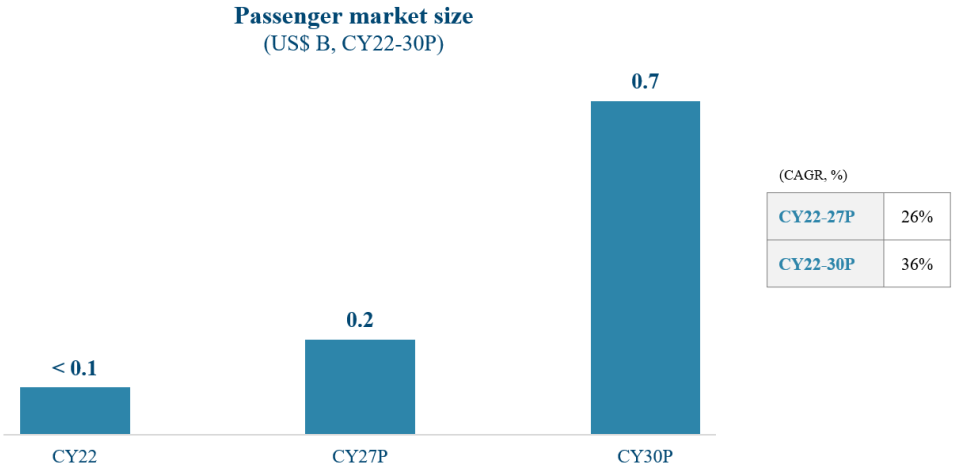
The US is the leading player in the drone delivery industry due to the enormous number of e-commerce giants and technological start-ups with headquarters in various states around the nation. Additionally, Canada is accelerating the delivery process by implementing drone delivery technologies. In Asia, China and Japan are dominating this industry. Drones are being used more frequently in Europe by Switzerland, Iceland, and Finland to deliver prescription drugs and other retail items to remote locations. Drones are used in African nations like Ghana and Rwanda to transport test samples and medical supplies.

2.6.2.10 Passenger:

Passenger drones (also called air taxis, eVTOLs, flying cars, etc.) will be used to transport passengers over short and medium distances flown manually, remotely, or automatically. Passenger drones do not require a runway for landing due to vertical take-off and landing (VTOL).

Commuters will benefit from drone-led faster intra-city and inter-city transportation. These drones are battery-powered, making them capable of running on renewable energy sources. Passenger drones can also be employed for special operations, including search and rescue, emergency supply delivery, air ambulance transport, and fire rescue.

The global passenger drone market size is currently in a very nascent stage valued at less than US$ 0.1B and is anticipated to grow to US$ 0.2B in CY27 at a CAGR of 26% during CY22-27. A decline in equipment costs, technological advancements, a growing urban population, and increasing need to travel faster, cheaper and cleaner will accelerate the growth of the passenger drone market.

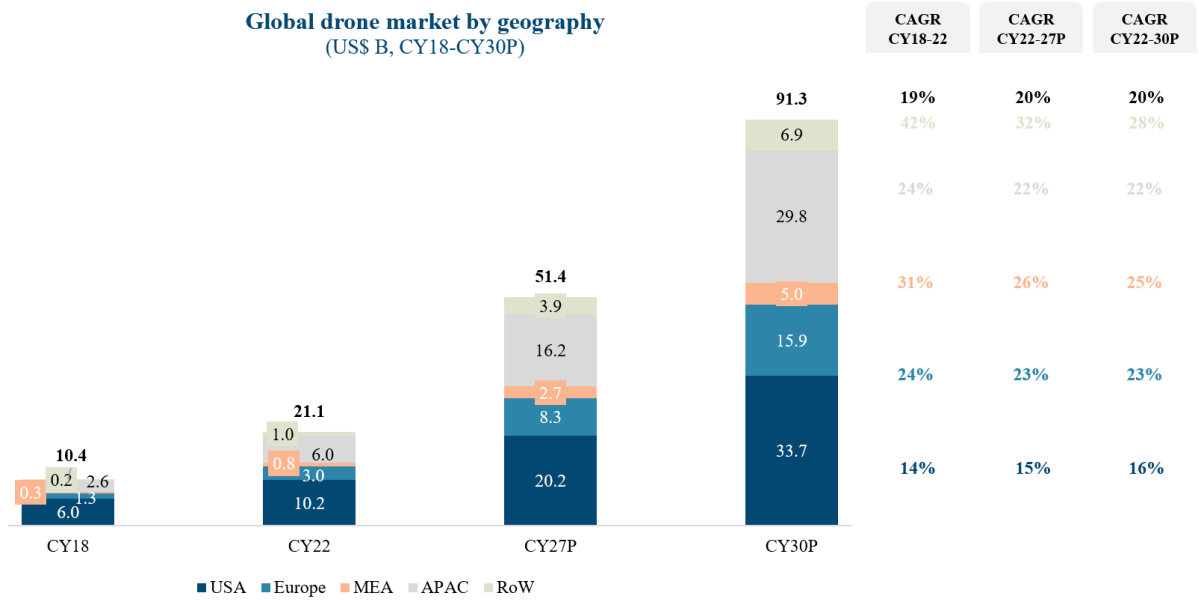


2.7 Drone industry by geography

The growth in the overall drone market across regions is anticipated to be driven by relaxations in regulations and testing of drone applications. Several governments are working out ways to form regulations for the adoption of drones in commercial applications. In CY22, USA is expected to be the biggest market for drones standing at US$ 10.2B with ~49% market share and predicted to grow to US$ 20.2B in CY27.

The agriculture drone market is expected to witness a steady growth in the APAC region with China at the forefront of the market. With the Government of China providing various subsidy schemes and favorable domestic policies for drone usage in industries, energy, agriculture and consumer markets are expected to drive growth in the coming years. The Indian government is also encouraging the adoption of drone technology in agriculture and has released standard operating procedures (SOPs) for drone-assisted pesticide and nutrient application. There is

a growing number of Unmanned Aircraft Operator Permits in India currently. With the new 'The Drone Rules 2021', PLI scheme, UTM policy and liberalized drone policy, India is also positioned to become a global manufacturing hub for drone technology.



While the adoption of drones is growing at a rapid pace, each country has been developing their own ways to tackle certain headwinds that the drone industry faces. The way each country decides to combat these concerns would decide the level of sustainable growth the drone industry would witnesses within that country.

2.8 Key challenges in the drone industry

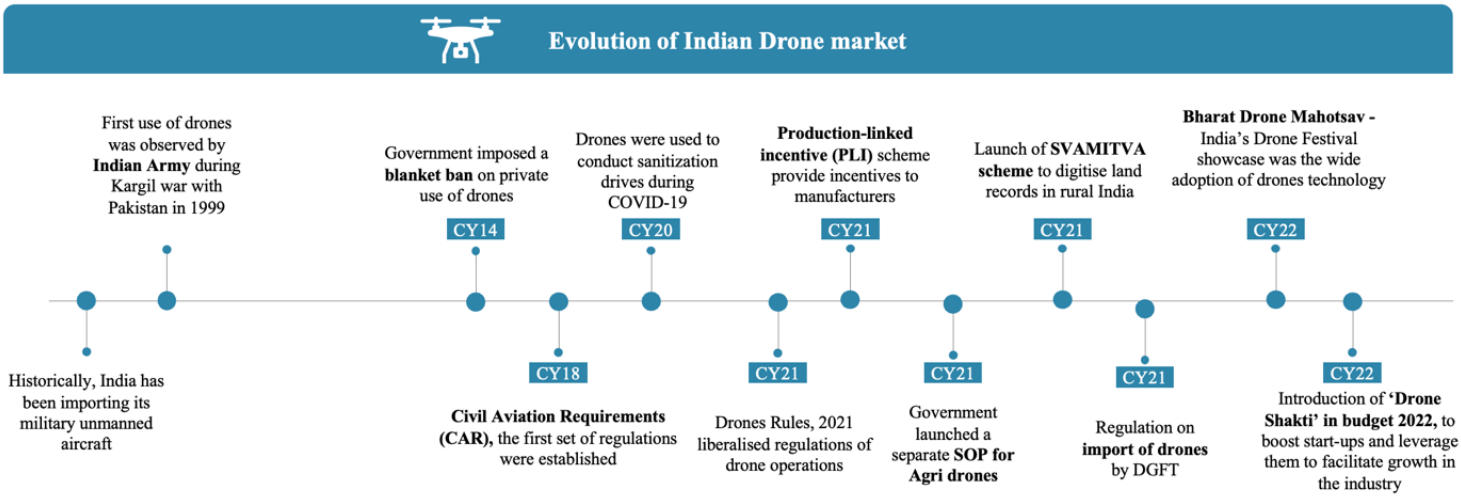
Drone safety is still a concern, as are the effects on ecology, security, and privacy. Additional problems include consequences on jobs and fair use. Future emergency responses may be enhanced by creating a regulatory framework for drones that considers issues beyond safety.

03

Indian UAV / Drone Industry

3.1 Evolution of the drone industry in India and how it could evolve given how it has in other markets

Back in the 1990s, the Indian Army acquired UAVs from Israel. First application was use as military drones during the 1999 Kargil war against Pakistan for photo surveillance along the Line of Control (LOC).



In CY14, the Directorate General of Civil Aviation (DGCA) under the MoCA (Ministry of Civil Aviation) banned the use of commercial drones in India until it formulated proper rules and regulations to govern their usage. In CY18, the DGCA released the CAR (Civil Aviation Requirements), which established a paperless procedure for filing permits for drone activities and registering licenses for drones, owners, and pilots. Apart from defence, drones came into commercial action after CY18.

In CY20, drones played a crucial role in maintaining social distance and performing sanitization operations during the peak of COVID-19. Indigenously developed drones were used to deliver COVID-19 vaccines to access compromised areas and strengthen the vaccine delivery system. With the new 'The Drone Rules 2021', individuals and organizations in India are set to find it easier to own and operate drones, setting the stage for the broader use of drones in the country. As a part of reforms to make India a global drone hub by CY30, the government also launched Production-Linked Incentive (PLI) scheme for drones and drone components companies in September 2021 to enable drone manufacturing in India.

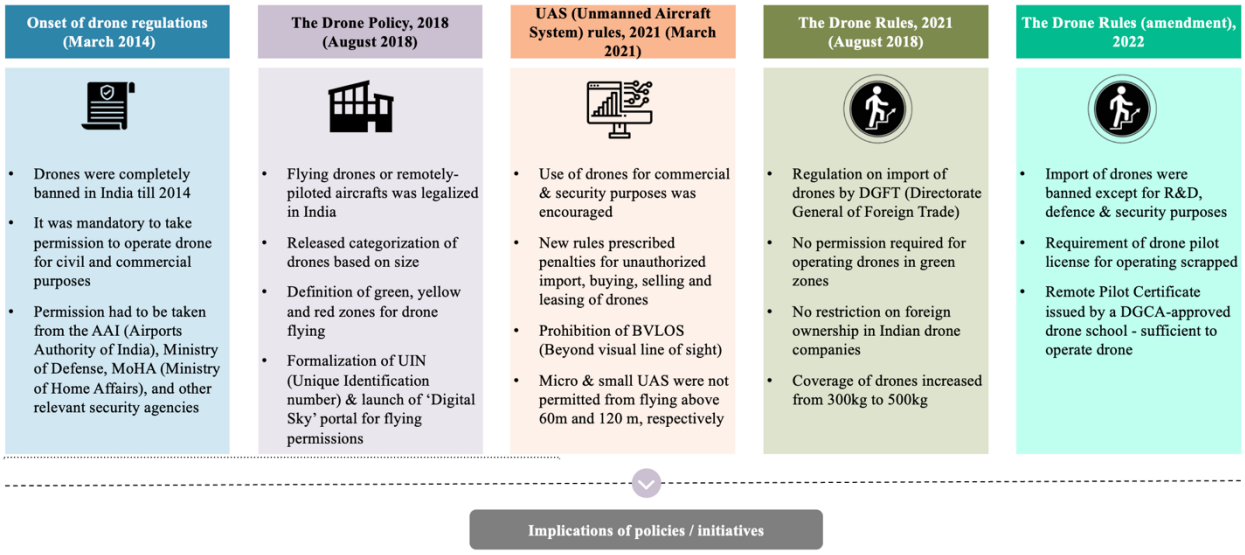
In the FY22 budget, the Finance Minister of India introduced the 'Drone Shakti'. Startups are encouraged to provide Drone-as-a-Service. In F23 budget, the Finance Minister of India mentioned MoCA will take up with 15 identified Union Ministries to use Drone-as-a-service for which MoCA will hand-hold these Ministries by way of faster clearances and by brining industry, academia and startups together. Customers may hire drones and utilize them for various purposes, including shooting pictures and films. India's biggest drone festival, Bharat Drone Mahotsav, was inaugurated in May 2022. With "Atmanirbhar Bharat" initiative, the Government of India has been pushing Indian drone companies for innovation in the sector through its policies. The purpose was to showcase the broad adoption of drones and the substantial employment opportunities the industry can create.

India finds itself to be at a critical juncture in the evolutionary timeline of drone technology and aims to position itself as a global drone hub by CY30. The rise of the drone manufacturing industry in India will result in significant trickle-down effects across the sub-component value chain, right across motors/ propulsion systems, payloads, communication modules, batteries/ power systems, propellers, assembly, navigation systems, airframes and software solutions.

In order to boost indigenous drone production, India has introduced laws and policies that address both the supply side (through PLI and import bans) and demand sides (through drone policy). By implementing drone indigenization initiatives in use cases such as defence, commercial, homeland security, and counter UAV sectors, India has the remarkable opportunity to target approximately 1.8 lakh crore of total domestic manufacturing potential.

3.2 The policy environment in the Indian drone space is becoming more liberal and relaxed with regulations such as 'The Drone Rules 2021'

Drone ownership and operation are far more simplified under 'The Drone Rules 2021', than under earlier regulations. 'The Drone Rules 2021' have list of compliances that drone operators must be aware of to ensure full compliance and few restrictions in place with specific emphasis on approvals.
Permission was mandatory for commercial use of drones, this limitation was eased with 'The Drone Rules 2021', which were curtailed in the regulations released in August 2018.



As of February 2022, India banned the import of drones and drone components except for security and defence, to encourage the domestic drone manufacturing industry and make India a global drone hub by CY30. On 9th February 2022, The Directorate General of Foreign Trade (DGFT) under the Ministry of Commerce and Industry, modified the Indian Trade Classification (Harmonised System) 2022 Schedule-1 (Import Policy) and banned the import of drones in completely-built-up (CBU), semi-knocked-down (SKD) or completely-knocked-down (CKD) form, with the exceptions of:

- Import of drones by government entities, educational institutions recognized by central or state government, government recognized R&D entities and drone manufacturers for R&D purpose are allowed in CBU, SKD or CKD form, subject to import authorization issued by DGFT in consultation with concerned line ministries, and
- Import of drones for defence and security purposes are allowed in CBU, SKD or CKD form, subject to import authorization issued by DGFT in consultation with concerned line industries. However, the import of drone components is not banned and does not require any approval.

The announcement of the Drone Rules 2021 and the Drone (Amendment) Rules CY22 simplifies the operation of drones more than ever before. New legislation and standards assist the Indian government's ambitious objective of becoming a global drone hub by CY30.

The Drone Rules 2021:

The Drone Rules 2021 were released in August 2021 to regulate the use and operation of drones in India. Some prior strict requirements have been relaxed under this policy.
For instance:

1. The number of permits and approvals required by a drone operator has been reduced from 25 to 5.
2. The Rules have established an online platform hosted by the Directorate General of Civil Aviation for managing various drone-related activities in India called 'Digital Sky'. The platform seeks to provide a single-window online system where most of the permissions of drones can be generated by individuals without any human intervention.

Ministry of Civil Aviation (MoCA) has deployed an interactive airspace map on the Digital Sky platform for the convenience of drone operators and all other stakeholders. The map is color-coded into green, yellow, and red zones, which opened nearly 90% of Indian airspace as a green zone. This will help drone operators plan their flights in a better way and prevent flying in restricted zones. These regulation aims to boost innovation and business in India.

Production-Linked Incentive (PLI) scheme:

The PLI scheme, launched in September 2021, aims to incentivize Indian drone and drone components' manufacturing companies, to make them self-sustaining and globally competitive. With liberalized rules and the incentive scheme, the government expects the drones and drone components manufacturing industry to attract investments from foreign investors. Micro Small and Medium Enterprise (MSME) will be key beneficiaries, and the eligibility norm has been set for the same.

Under the scheme, a total incentive of US$ 15M is spread over three financial years. PLI will encourage entrepreneurs to strive towards building drones, components and software for the global market. This initiative is anticipated to help reduce imports and increase market exports and achieve the Government's aim to make India 'The global drone hub of the world'. A provisional list of 23 PLI beneficiaries was released in July 2022. The beneficiaries include 12 drone manufacturers and 11 drone component manufacturers. The list of shortlisted drone manufacturers is as follows:

1. Aarav Unmanned Systems, Bengaluru, Karnataka
2. Asteria Aerospace, Bengaluru, Karnataka
3. Dhaksha Unmanned Systems, Chennai, Tamil Nadu
4. EndureAir Systems, Noida, Uttar Pradesh
5. Garuda Aerospace, Chennai, Tamil Nadu
6. IdeaForge Technology, Mumbai, Maharashtra
7. IoTechWorld Avigation, Gurugram, Haryana
8. Omnipresent Robot Technologies, Gurugram, Haryana
9. Raphe Mphibr, Noida, Uttar Pradesh
10. Roter Precision Instruments, Roorkee, Uttarakhand
11. Sagar Defence Engineering, Pune, Maharashtra
12. Throttle Aerospace Systems, Bengaluru, Karnataka

In April 2023, 6 drone manufacturers received the PLI disbursements. The list of drone manufacturers who received the PLI disbursement is as follows:

1. IdeaForge Technology, Mumbai, Maharashtra
2. Raphe Mphibr, Noida, Uttar Pradesh
3. AEREO (Aarav Unmanned Systems), Bengaluru, Karnataka
4. Throttle Aerospace Systems, Bengaluru, Karnataka
5. Sagar Defence Engineering, Pune, Maharashtra
6. Roter Precision Instruments, Roorkee, Uttarakhand

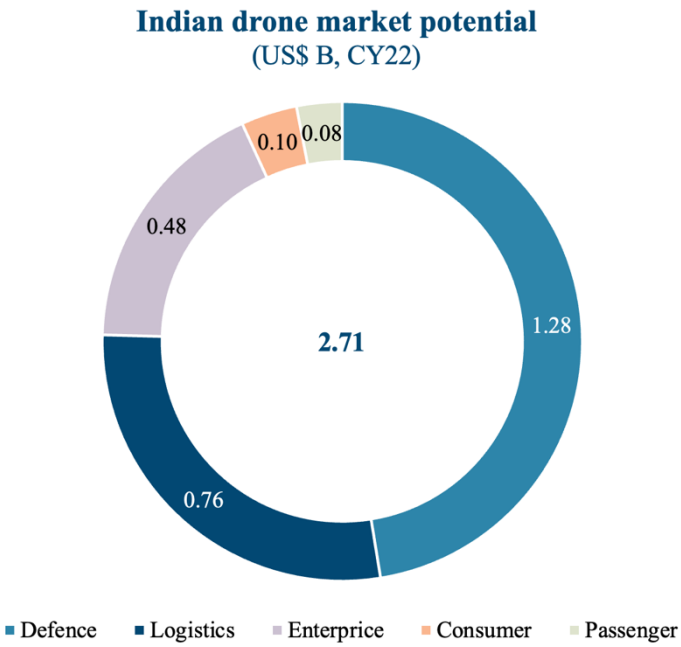
Drone makers and service providers are ramping up their product offerings and hiring to meet a spurt in demand that is expected to accelerate with the government's PLI scheme, which is expected to bring down drone prices further. The annual sales turnover of the drone manufacturing industry may grow from US$ 8M in FY21 fold to over ~US$ 110M in FY24.

The Drone (Amendment) Rules 2022, eliminate the need for a drone pilot license for drone operations up to 2 kg for non-commercial purposes. The government made it easier for drone manufacturers to obtain a certificate with the Drone Certification Scheme 2022. The new drone laws have facilitated traction in the market as numerous companies partner to disseminate technical knowledge and attract funds and government support. For instance, in June 2021, food delivery platform Swiggy (Bundl Technologies Private Limited) and the integrated airspace management company ANRA Technologies Private Limited started testing for beyond visual line of sight (BVLOS) drone food deliveries as they received clearance for testing from the Ministry of Defence, the Directorate General of Civil Aviation, and the Ministry of Civil Aviation.

3.3 Indian drone industry market potential is US$ 2.71B in CY22

The drone industry is at a nascent stage and therefore the requirements are continuously evolving. As of CY22, the potential market size for Indian drone industry was approximately US$ 2.71B. Drones now have the potential to carry everything, including vaccines and other medical supplies, and devices, for agriculture, energy utilities,

construction, and mining, passengers, public safety, and logistics are seen to have great potential and to act as modern-day use cases.



Note: The overall potential for Indian drone market is estimated assuming drones would be extensively used across each of the use case. Deep dive into each use case is mentioned in following segments.

In CY22, Defence industry has the highest potential of US$ 1.28B out of the total drone market, followed by Logistics at US$ 0.76B and Enterprise at US$ 0.48B. The Indian market potential for passenger stands at US$ 0.08B in CY22. Indian drone industry is expected to grow owing to driving factors such as the government's regulations such as New Drone Policy 2021/2022 and PLI scheme etc. to transform India into a worldwide hub for drones by creating a favorable and supportive ecosystem. Furthermore, growing drone use cases and their future applications, an upsurge in startups and investments will fuel the drone industry in India.

3.3.1. Defence

The Indian defence drone market currently has a potential of US$ 1.28B in CY22.The key use cases for drones in India defence are surveillance, precision strikes, and terrain mapping for scouting enemy troops. Indian Army is encouraging companies to develop innovative concepts for introducing modern machinery to their troops. India is looking to procure mini Remotely Piloted Aircraft Systems (RPAS), long-range surveillance systems, and inertial navigation systems. Indian Army has also issued tenders for high and medium-altitude logistics drones to boost the army's logistics chain and enhance operational preparedness.

The nation's indigenous drone program resulted from the Indina air Force (IAF) using an American drone, Northrop Chukar. With the help of this drone, the Defence Research and Development Organization (DRDO) developed the *Lakshya* target drone for practice firing beyond-visual-range missiles. Since then, the DRDO has been developing several short-range drones, such as *Nishant* and *Gagan* which are outfitted with high-technology radars that generate high-resolution 3-D photographs. The famed Medium Altitude Long Endurance UAV, Rustom 2, has auto-landing capabilities and is perfect for surveillance and reconnaissance. To target the Sino-Indian border in eastern Ladakh, a more advanced High-Altitude Long-Range drone is also being built.

Drone usage in Indian defence:

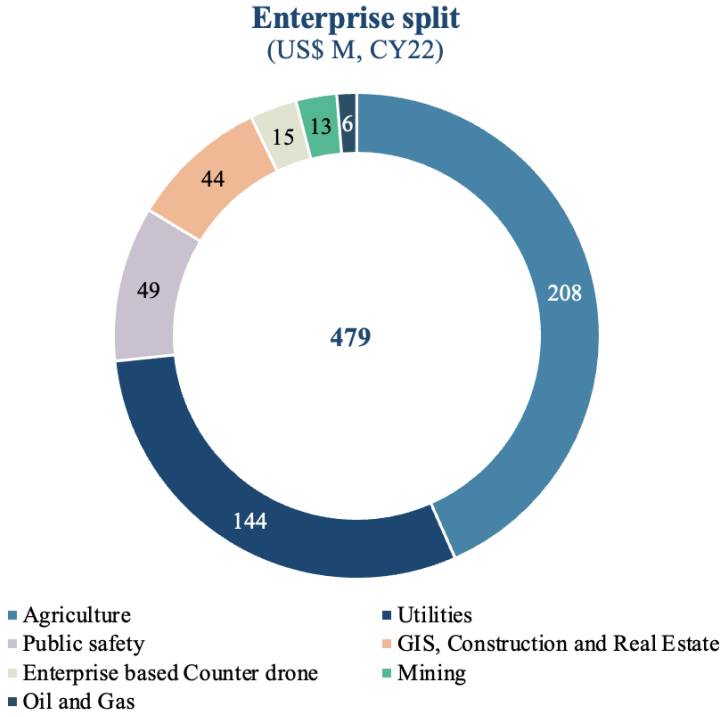
1. In August 2022, The Drone Federation of India (DFI) and the Army Design Bureau (ADB) signed an MoU, according to which they will collaborate on the roadmap planning, research, testing, manufacturing, and adoption of counter-drones among other technologies that the Indian Army will use in its operations.
2. In order to improve its monitoring along the Line of Actual Control, the Indian Army has signed a contract with ideaForge in January 2022, to purchase high-altitude SWITCH1.0 unmanned aerial vehicles (UAVs)
3. In March 2022, the Indian Army has awarded ideaForge a contract to deliver 200 drones capable of vertical takeoff and landing (VTOL).

Note: Potential is estimated basis the percentage of the drone budget to the overall defence budget of leading drone adopters like USA, UK, Australia, and France. This multiplier is used to multiply with the Indian defence budget.

Department of Defence Production (DDP) along with Ministry of Defence and GoI, shared a RFP for development, operation and maintenance of Defence Testing Infrastructure (DTI) for Unmanned Aircraft Systems (UAS) under the Defence Testing Infrastructure Scheme (DTIS) having Earnest Money Deposit (EMD) value of US$ 75,000 (INR 6M) and RFP value of about US$ 7.5-37.5 million (INR 600-3,000M)

3.3.2. Enterprise

Indian enterprise drone market has a potential of US$ 479M. Agriculture, utilities and public safety are the most significant segments for enterprise drones. Enterprises are still seeking to discover various uses for drones, data collection, and developing software to find solutions for the specific industry.



3.3.2.1. Agriculture

The agriculture-based drone market is expected to have a potential market of US$ 208M in CY22. Spraying, seeding, crop monitoring and crop insurance are key use cases for drones in agriculture. Manpower shortfall will lead to a greater reliance on precision farming instruments like drones both globally and India. The growing drone market in India is trying to incorporate indigenous advanced technology and employ them in agriculture space.
Methodology: Potential of agriculture-based drone market is if all the farmlands (above 20 hectares) in the country would use drones for spraying, seeding, insurance, and crop monitoring.

Spraying: Drone technology can usher in a new era for precision agriculture. It is used to spray chemicals as they have reservoirs, which can be filled with fertilizers and pesticides for spraying on crops in very little time. Drones' foremost advantage over manual effort is their flexibility to move around in swift motions and maneuver to the desired locations.
For instance:

1. Unnati (Akshamaala Solutions Private Limited), a FinTech-driven agriculture ecosystem, has launched a Drone Spray service for farmers. The platform will be utilizing a fleet of DGCA-approved (Directorate General of Civil Aviation) drones to offer the service. The cost of spraying insecticide using drones' is less and also takes less time. Unnati says its drones can cover an acre in under eight minutes whereas it takes at least four hours to spray an acre manually.
2. An experiment performed in Jaipur demonstrated that one acre of land can be sprayed in under ten minutes.

Seeding: Agriculture is a very labor-intensive and time-consuming industry because it needs specialized abilities to operate. In particular, seeding requires physical labor because it takes a long time to complete. Drone technology is used for sowing the seeds of a diverse variety of crops, which helps to alleviate this tedious operation. In drones, the lasers, sensors, tanks, etc., enable them to plant seedlings quickly and precisely.
For instance:

1. Drone-based tree plantation carried out in Telangana with the help of drones reduced reforestation costs by 10 times while also covering big areas more quickly and with zero risk to personnel.
2. Drones are enabling spraying of seeds, pods, and vital nutrients into the ground. This method not only reduces costs by over 85%, but it also boosts efficiency and consistency.

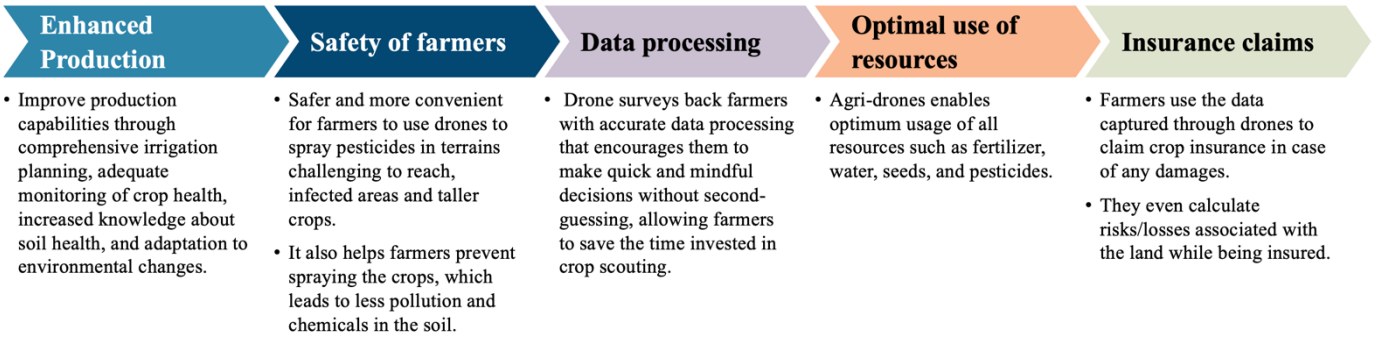
Insurance: Drones could provide accurate information to insurance companies concerning damages. It also helps to identify and quantify risks faster and more safely. The insurance companies can collect data on the damaged area using drones and creates a set of visuals based on the damage. Drones could also streamline formalities like claim submission and loss inspection processes.

Crop monitoring: Monitoring of crops can be done quickly by drones to provide fertilizers at the right time, checking for pest attacks, and monitoring the effect of weather conditions. Drones could be vital, as ensuring a timely harvest is crucial, especially when working with seasonal crops. By using infrared cameras to scan the field, drones can aid in efficient crop surveillance. Farmers can then act on the information they receive in real-time to improve the health of the plants there.

Usage of drones in India's agriculture sector:

1. In August 2021, Mahindra & Mahindra Limited has been allowed to use drones for agricultural trials and precision spraying on paddy as well as hot pepper crops in Telangana and Andhra Pradesh respectively.
2. In February 2022, the Government of India flagged off 100 Kisan drones in different cities and towns of India to spray pesticides on farms across India. Kisan Drones are anticipated to promote the increasing demand for crop assessment, digitization of land records, and spraying of insecticides and nutrients.
3. In March 2022, Tamil Nadu state government has decided to procure 60 drones for holding demonstration exercises on spraying fertilizers using drones in 14,400 hectares of land under the Kisan-drone scheme of Sub-Mission on Agricultural Mechanization (SMAM)
4. In August 2022, Karnataka and Kerala witnessed heavy rainfall. ideaForge worked with DRDO coordinated surveillance efforts over agriculture lands with its indigenous drones.
5. The Rajasthan government's agriculture department recently deployed drones to spray chemicals and fight off locust swarms in the state.
6. Andhra Pradesh government plans to procure 200 Kisan Drones, which would solve the problem of labor shortage and health hazards.

Benefits of drone technology in agriculture sector



Department of Agricultural Research and Education (DARE) has floated a tender for Spraying through drones. This project will be taking place in Delhi. The EMD is given as US$ 470 (INR 37,500) and the RFP is valued at the maximum of US$ 0.23M (INR 18M).

3.3.2.2. Utilities

The Indian utility drone market is currently valued to have a potential of US$ 144M in CY22. With a growing number of inspection lines and towers, it will be impractical to maintain and examine them on such a big scale manually thus drones will prove to be a beneficial alternative for inspecting towers / power lines at once and detecting errors within the same. Drones have immense potential in use cases such as tower inspection, power transmission, wind turbines and solar panel inspection and maintenance.

Note: The potential market for the utilities sector is estimated by considering that drones are used as a service for use cases such as spraying, wind, powerline, and solar inspections for the current installed capacity

Wind farm inspection: Drone technology helps in easy detection of structural damages / issues in wind turbine blades and serve as a guide during maintenance, saving considerable costs. Drones will not only help in reducing the operational costs but also help in increasing the safety of workers.

Powerline and mobile tower inspection: Traditional power line inspections require inspectors to stand on scaffolding and cranes and use rope access to climb on poles. Drone surveying for the power grid reduces the need to put people in harm's way, and line workers can safely remain on the ground while the drone operator assesses the line. Faults can be detected by capturing the status of the grid from multiple angles to reveal any faults or defects and address them promptly. Additionally, drones can closely monitor and access hard-to-reach areas.

Spraying (Cleaning): Cleaning of panels, a key part of the operations and maintenance on any large solar plant. This cleaning is associated with large amount of water used along with less labor in some markets. Drones can provide cleaning services to solar panels leaving them completely undamaged. For emerging markets, especially India, the push from these solutions will eventually turn out to be a massive use case, as costs drop to a level where they can compete easily with labor costs on the ground and provide much-needed water savings in the drier areas where large solar parks are coming up on.

Inspection and monitoring of solar power plant: Drone solar maintenance inspection reports can provide top-down inspection data of the system that can give vital insights on faulty spare parts and defective hardware. This type of data can provide estimates for how much loss of revenue the plant could experience if the identified problems go unfixed. Drone reduces the inspection time significantly by eliminating the need to check solar panels one by one with a handheld device.

Usage of drones in utilities:

1. Telangana is leveraging drones across various use cases and the inspection of towers. Telangana used drones to inspect, monitor, and patrol Extra High Tension (power carrying) transmission towers, lines, and substations. For this, high-quality 4K resolution cameras and AI-based image recognition systems were used. The average time of inspection of the tower is ~20 minutes whereas a manual inspection could take up to 6 hours per cell tower.
2. Between November 2021 and March 2022, with two drones hired from a service provider, Tata Power took up operations and maintenance of power lines in Delhi. Additionally, it undertook GIS survey of Odisha power discoms which includes detecting power theft, and remote meter reading in rural areas.
3. Since October 2022, the state-run Madhya Pradesh Power Transmission Company Limited planning to deploy drones to monitor 10,000 high voltage towers in the state.

3.3.2.3. Public Safety

The Indian public safety drone market is expected to have an overall potential of about US$ 49M. Globally, police departments and public safety agencies have been using it to improve situational awareness, help locate missing people or suspects, combat fires and inspect damage or accidents. Likewise, India law enforcement agencies like the police force, special forces, etc., are using drones to monitor traffic, follow suspects and keep an eye on areas with high crime. The recent changes that have been made in drone policy should further unlock the positive use of this technology that would benefit the citizens.

Note: Potential is estimated basis the percentage of the drone budget to the overall Indian police budget

Usage of drones in public safety:

1. In February 2020, the Delhi police used drones during the Delhi Assembly Elections and the riots in the city
2. The UP government used drones to monitor potential protests during the foundation of the Ram Temple in Ayodhya.
3. During the COVID-19 lockdowns, Punjab central police team was able to alert nearest police officer upon detecting individuals less than six feet apart, via using a drone with high-definition cameras along with combination of artificial intelligence, location mapping
4. The Mumbai Police have also used drone technology to monitor lockdown protocols in susceptible areas.
5. Surveillance and delivery drones were deployed in Vadodara in Gujarat and in Andhra Pradesh to supplement relief and rescue efforts of the National Disaster Relief Force (NDRF) teams deployed amid floods.

3.3.2.4. GIS, Construction and Real Estate

Drone usage in Indian construction and real estate industry is estimated to have a market potential of US$ 44M. By taking high-definition pictures and videos, drones help with visual inspection processes such as area mapping,

surveying, monitoring construction work progress, equipment & material tracking on-site, inspection of buildings, finding construction flaws, and 3D modelling. Drones could help aid reduce operational costs and manual labor for property viewing and inspections.

1. Infrastructure:
    a. Road and Highways construction progress monitoring: Due to increase in number of highways and roadways across the nation, drones could be the key to sustainable and effective road construction, highway infrastructure management, bridge inspection, and road management operations. The most significant challenges for road and highway construction are time and production cost. With their rapid data collecting, quick mapping, and time-sensitive outcomes, drones may significantly cut the time and expense while providing builders with essential information they need to generate efficient strategies.
    b. Railways construction and monitoring: Drone cameras will undertake monitoring activities of relief and rescue operations, project monitoring, the progress of important works, conditions of the track and inspection-related activities. Indian Railways has decided to deploy drone cameras across all zones to enhance safety and efficiency in train operations.
    c. Detailed Project Report (DPR) for roadways, highways and highways: Using advanced data technologies such as Big data, Artificial intelligence, Internet of things (IoT) along with geospatial images captured with the drone, it is possible to curate detailed project reports.

2. Urban development: Urbanization is increasing population density, so collecting big data for resource planning and allocation is challenging. Any planning application must include massive data collection in addition to data analysis and fieldwork. Without the use of drones, it gets more and more challenging, time-consuming, and expensive. The drone is fitted with high-resolution cameras, which can map out complex areas of urban or rural terrain faster, cheaper and safer

3. Rural development: In India, the use of drones is expanding, and new uses and applications are constantly being developed. Drones have a wide range of uses in rural areas, including monitoring using cameras or other sensors, providing connectivity as a mobile gateway, or even delivering goods to inaccessible locations. In the Chamba district of Himachal Pradesh, a project was launched for beyond visual line of sight (BVLOS) trial to connect six primary health centers/community health centers and the area hospitals via multiple flights between points covering an aerial distance of 170 km

SVAMITVA scheme

SVAMITVA stands for Survey of Villages and Mapping with Improvised Technology in Village Areas. This scheme seeks to enable village household owners in inhabited areas with the "Record of Rights." The government aims to use drone technology for implementing SVAMITVA. The scheme aims to cover 6.62 lakh villages in the country from FY21 to FY25. After successful launch of the scheme during FY21 in the pilot States of Haryana, Karnataka, Madhya Pradesh, Maharashtra, Uttar Pradesh, Uttarakhand, Punjab, Rajasthan and Andhra Pradesh in Phase 1, SVAMITVA Scheme was extended throughout the country from FY22.

Usage of drones in construction and real estate:

1. The Andhra Pradesh Government is using drones to monitor the development activities of the capital city region, i.e., Amaravati, through drone-based outputs
2. As a pilot project, the Karnataka Government is using drones for property tax estimation and the creation of a base map of a city/town for detailed planning and sustainable governance
3. The Chandigarh Administration has deployed drones as part of pilot project to get an aerial view of all properties in Chandigarh.
4. Andhra Pradesh Real Estate Regulatory Authority (APRERA) and Construction Industry Development Council (CIDC) used drones for the real time monitoring of 2,950 construction projects across Andhra Pradesh resulting in the employment of 8,850 drone operators in the state. Extrapolating these numbers for Pan-India, translates into a demand for 1,68,000 drone operators for monitoring alone.

Methodology: Mapping of urban and rural development is considered along with infrastructure. Under infrastructure – Roads, railways monitoring and detailed project report of the same is taken under consideration. Factors such as surveying, monitoring, and operational costs are considered for calculating the market potential.
Southwestern Railway floated a tender for New Line Section for conducting Geo Technical Investigations, submission of reports, station building plans and drone survey in Bengaluru, Karnataka. The total RFP raised is about US$ 0.12-0.68 million (INR 9.6-54.4M) with EMD of US$ 1,375 (INR 0.1M).

Northern Railway floated a tender for Detailed Engineering Survey using Drone LiDAR in New Delhi. EMD is costing around US$ 666 (INR 53,300) and RFP is valued at around US$ 0.33M (INR 26.4M).

3.3.2.5. Enterprise counter-drone:

The Indian enterprise counter-drone market is estimated to show a potential of US$ 15M in CY22. Since there are no standard regulations for the safety of drones is a concern. There are still no well-defined guidelines around civilian counter-drone systems. The restrictions are highly anticipated as the market situation would drive up the number of drones in the sky. Additionally, counter-drones would play a very significant role in ariel traffic management ecosystems.

As drone market in India is growing, enterprise counter drones in the market will also see a rise. Strong action plans are needed to create a robust demand for enterprise drones and also to mitigate the counter effects in India as the it aims to become the global drone hub by CY30.

3.3.2.6. Mining

The Indian mining-based drone market is current potential is US$ 13M in CY22. The drones are used primarily for mining across planning, operations, environmental protection, and security. At the time of planning, quick mapping of the area, hauling route optimization, and providing control information are all possible with drones.

These digital representations of data can be used to track how a site has changed over time. Drones also assist with blast planning at the site and calculating inventory volumes. For operations, drones aid with traffic management at the mining site by helping operators optimize stockpile locations, loading floors, designing haul routes, etc. Drones can capture high-quality thermal images for surveying and mapping. Another essential step in mining that drones can easily accommodate is stockpile management.

Use of drones in India's mining sector:

1. The Central Mine Planning and Design Institute (CMPDI) is currently assessing the viability of the wider use of drone technology for mine surveillance on behalf of Coal India Limited and its subsidiaries. In August 2022, CMPDI stated that they are conducting pilot testing in mines. If the assessment is positive and desired results are obtained, it will reach out to private drone firms to perform the work and further research.
2. The Andhra Pradesh government deployed drones for the monitoring of stockpile storage, 3D mapping, and volumetric analysis of limestone.
3. Tata Steel to deploy drones at the Noamundi iron ore mines in Jharkhand, Uttar Pradesh, for boundary and safety zone surveillance, compliance reporting, volume calculation at the dumping and quarry area.
4. The Rajasthan government has deployed drones to prevent illegal mining in the state.

3.3.2.7. Oil and gas

Drone usage in the construction and real estate is projected to have an estimated potential of US$ 6M in CY22. Drones can directly impact the inspection and monitoring of refineries, pipelines, and platforms by making it safer for labor and reducing manual effort. Upstream, midstream, and downstream are three broad segments in the oil and gas industry.

Current process of exploration is thorough land surveys of proposed locations, and strict adherence to environmental and safety regulations are necessary for the oil and gas business to operate effectively. Drones are said to reduce the inspection time by 80% compared to the manual process. Drone would help provide efficient and accurate real-time data for all the steps with the help of thermal sensors and cameras to detect the site.

Usage of drones in oil and gas:

1. Indian Aviation Ministry has allowed Indian Oil, the leading oil marketing company to use drones for aerial surveillance of its pipeline.
2. Oil India Limited (OIL) to launch advanced drone surveillance project in Assam’s Dibrugarh district. The fundamental goal of implementing the drone surveillance project is to have a total vision of crude oil delivery lines and pipelines across wide areas, enhance their operations, and ensure the security of national assets.

3.3.2.8. Logistics

In CY22, the India logistics drone market potential stands at US$ 0.76B. The current challenges faced by Indian logistics industry such as, rugged geographical terrains, higher population density, and inadequate infrastructure can be addressed through drones. Drone use cases and utilities have emerged in healthcare, agriculture, and other industries and with further advancement, drones will soon be able to cater to the logistics industry.

Note: Potential is estimated by benchmarking with estimated global drone penetration across first, middle and last mile deliveries in India and extend of drone usage in the industry

Logistics challenges that drones could solve:

1. Last-mile delivery is typically the most time consuming and comprises an estimated 50 per cent of the total logistical costs. To tackle the inefficiencies in last-mile logistics, a growing number of logistics stakeholders are turning to drone technology as it can control operational costs satisfying the customer demand and instant delivery.
2. Overcome traffic bottlenecks and reduce vehicular emissions ensuring on time delivery while being ecologically sustainable.
3. Allow companies to reach areas that cannot be accessed by other modes of transport due to difficult terrain.

With an increased number of online shoppers, trends like same-day delivery, and players shifting to delivery under 40 minutes, the need for quick delivery has increased significantly over the past few years. Drones are anticipated to transform the logistics sector in India by enabling faster, alternate delivery methods, inventory management, last-mile delivery, middle mile, short-range B2B / warehouse to warehouse delivery, and efficient operations.

Middle Mile delivery:
The demand for faster and more efficient mid-mile delivery for the e-commerce and quick-commerce industries is growing at a tremendous pace. Industries such as consumer goods and retail utilize it the most with competitive pricing and high margins, middle mile delivery can help streamline the supply chain and assist companies in exceeding the competition. Middle mile drones can reduce the hours of transportation and handoff times associated with trucks and other ground vehicles. Last-mile delivery drones have smaller payload capacities and shorter ranges than drones being developed for middle-mile logistics. Since the payloads for middle mile is comparatively higher, and for longer distances, the cost benefits of middle mile drones are higher against conventional transportation. Mid-mile delivery systems require substantial route planning and testing to be scaled.

The government of India has been taking various initiatives to encourage drone delivery experiments in the country. There is a huge opportunity in India to use drones for middle mile (hub to hub) logistics and eventually to take it global. Indian logistics companies, manufacturers and technology service providers are now in the right place to capitalize on this opportunity and contribute to the burgeoning logistics sector in the country.

Usage of drones in logistics:

1. Flipkart Health Private Ltd., the medical branch of Flipkart Private Limited tested drones with Beyond Visual Line of Sight (BVLOS) from its warehouse in Baruipur, West Bengal, to several Health Buddy OTC sites in Kolkata and its suburbs.
2. In September 2021, a drone developed for BVLOS was used to deliver life-saving medicines and vaccines in Vikarabad district of Telangana. (Collaboration of the Telangana government, HealthNet Global Ltd., NITI Aayog and World Economic Forum)
3. Swiggy (Bundl Technologies Private Limited) in India is the first in deploying drones to back its Instamart service. Instamart will commence its pilot project in the Delhi and Bengaluru, to deliver groceries between store-to-stores within the seller's network.

3.3.2.9. Consumer

The consumer market potential is expected to be ~US$ 0.10B. In addition to traditional flight enthusiasts and hobbyists, consumer drones are becoming increasingly popular among people who wish to earn a second income, explore aerial photography, or fly drones for leisure. The growing prominence of aerial photography is propelling the demand for consumer drones. Drones are being used by the media and entertainment industries for aerial photography, cinematography, and special effects.

Besides leisure use, influencers and content creators are grabbing the opportunity to create firsthand creative content for their followers' using drones. Given the government regulations and public awareness, consumers are expected to steadily adopt drones for both leisure as well aerial photography use cases.

Methodology: Sports broadcasting, aerial shots, wedding footages and influencer drone content are the major use cases considered for estimation of market. potential. Currently, aerial filming of weddings holds the highest potential for India, assuming one drone is used and that too only in urban weddings.

3.3.2.10. Passenger

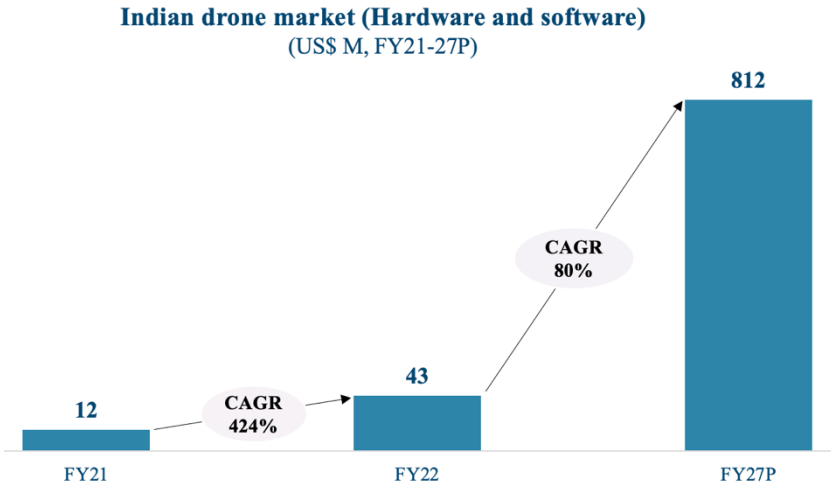
The passenger drone market potential is estimated to be ~US$ 0.08B. Many companies are currently investing in R&D for drones to transport people, mail, or carry sick people to hospitals and medical clinics during medical emergencies. The growing population, the number of vehicles, and the lack of road infrastructure will act as driving forces for the passenger drone market. Innovations in the automotive industry, such as electric vehicles and autonomous driving, will serve as catalysts for developing energy-dense batteries, improved artificial intelligence, and model frameworks for the regulatory and consumer acceptance of advanced air mobility.

Use of drones in passengers:
India's first passenger drone, 'Varuna', will soon be inducted into the Indian Navy. The drone is equipped with a ballistic parachute, which will be used in case of a malfunction. The drone has been designed to help the Navy transfer its personnel between warships, rescue operations and serve as an air ambulance in rural areas.

Note: Potential market for passenger is calculated basis considering Indian shared mobility and the extent of drone usage penetration among shared mobility commute in India.

3.4 The Indian drone industry is rapidly evolving with increased adoption drone across various potential use cases

The Indian drone market is projected to grow from US$ 43M by FY22 to US$ 812M by FY27, exhibiting a growth CAGR of 80% FY22-27. Major drivers behind drone industry growth are industry favorable policies, increased demand for monitoring and surveying, cost-effective data collection, and introduction of new use cases such as utilities and search and rescue operations.



Note: The drone market indicated compromises of only hardware and software.

The drone sector in India has experienced numerous regulatory changes. In CY14, India outlawed drones for personal use, thus stunting the growth of the sector. As a result, India's drone sector is incredibly modest when compared to the rest of the world and accounted for less than 0.1% of the overall market through FY21. Now, India is experimenting, investigating, and putting drones to use in a variety of applications across industries like defence, enterprise and consumer.

3.5 By CY27, drone software and services are expected to hold a larger share of the drone market than drone hardware

By business model, the drone market is made up of drone hardware, software, and services. Drone hardware can be procured or leased, the software can be bought or used on a subscription basis, and services can be availed. In CY22, drone hardware procurement constitutes a large chunk of the drone market due to defence contracts. Even in the enterprise segment, end users and service providers are first expected to build their fleets. Consumers also purchase

drones for recreational and entertainment purposes. In CY21, the Indian government launched financial incentives, such as the PLI scheme, for businesses to make drone hardware, highlighting its desire to increase domestic manufacturing and transform the nation into a hub for global manufacturing by CY30. This move will significantly contribute to global hardware market as it has gained momentum since past year as a result of supply-chain dynamics that have been affected by the epidemic as well as geopolitical unrest.

By CY27, drone software and services are expected to be a larger market than drone hardware, as software and service solutions are expected to pick up once drone fleets are maintained in the enterprise segment. Software and services are being tailor-made to use cases. Drone videography/ photography services in the consumer segment are also expected to contribute to the growth of drone software and services. In India, logistics and passenger use cases are still in a nascent stage with companies testing their capabilities. If drones are deemed safe and reliable for logistics and travel, they are expected to behave like the enterprise segment, wherein service providers would build their fleets first and then end users would avail services.

Drone software allows for the precise collection, processing, and analysis of data in real-time. This is enabled by a combination of technology, including the global positioning system (GPS), geographic information system (GIS), and advanced AI software.

The drone service market enables customers to maintain a lean operating model by providing end-to-end services of drone-based operations without the purchase of any hardware / software. The drone service provider would focus on the drone program, while the company would focus on its core business. As a result, they no longer need to use their own funds to pay for drone hardware, software, pilots, and pilot training programs. The drone services market is segmented into three categories:

- Drone platform services / Drone-as-a-Service (DraaS)
- Drone training and education services
- Drone maintenance, repair, and overhaul (MRO)

DraaS is a ready-to-fly network of drones which allows users to schedule or request on-demand flights, without the hassle of owning hardware, software or trained manpower. Customers can avail the DraaS service as per 'pay per use' model which helps reduce their initial investment and increases adoption rate. DraaS is used in urban environments for police and paramilitary services, fire brigade services, public asset inspection, public survey application, urban waste volumetric analysis, urban disaster assessment, pick-up or delivery of goods, rail infrastructure security. DraaS may also be utilized for pesticide and fertilizer spraying, as well as crop evaluation, to assist the farming community.

Defence

Currently, the defence sector spends the most on drones. The defence sector spending is majorly made up of large government contracts. Since capital-intensive businesses rely on large cash inflows to build reliable and scalable technologies, the defence sector is a significant contributor to hardware solutions in the drone market. These large government contracts have allowed the defence sector to be an early and crucial innovator of drone technology.

Going forward, the global defence sector spending as a percentage of the total drone market is expected to reduce from 48% in CY22 to 34% in CY27 due to increased spending by the enterprise and logistics segments. Even then, in CY27, the defence sector would contribute US$ 17B to a US$ 50B drone market, with a sizable portion of that spending expected to be on the procurement of hardware and domestic development of autonomous systems.

Enterprise

The enterprise segment contributed 33% of the total drone market in CY22. Enterprises spend on drone hardware, software, and services like other use cases. The proportion of each depends on the operating model of the company. Following are the models a company may choose to adopt for their drone program:

- **In-house development model:** A company develops proprietary drone hardware and software systems.
- **Hybrid model:** A company either develops drone hardware or software and enters a strategic partnership for what it cannot make in-house. E.g., a drone software-based company can test its software by leasing drones from a drone original equipment manufacturer (OEM) without making high investments in procurement. In this case, the OEM will provide drone-as-a-service (DraaS) to a drone software-based company. Once tested, the drone software might be used by another company making it a software-as-a-service (SaaS) product.
- **Outsourcing model:** A company chooses to outsource their drone program by partnering with service providers for their hardware and software.

Drone software and services in the enterprise segment vary based on the use cases. To put this into perspective, the software required to inspect a building versus a railway line with the help drones would be different as the AI would need to detect and highlight different aspects. Even within these sub-use cases, there are multiple methods for inspection which would be desired by a company. As a result of this, drone software and services tailor-made to use cases are growing. Hybrid and outsourcing models allow end users to remain asset-light and are therefore expected to be preferred operating models for drone programs.

Many businesses in India have begun providing services across industries in order to take advantage of the rising drone services market. For example, a Bengaluru-based DraaS provider offers 'pay per use' drone services for agriculture, survey/mapping, surveillance, inspection of manufacturing units, the oil and natural gas industry, solar panels, windmills, and real-estate construction projects. By lowering the initial investment required, users can more easily adopt and benefit from this new technology. Additionally, by deploying 6 lakh drones in 6 lakh villages in India by CY25, a Chennai-based DraaS business hopes to empower Indian farmers and the agriculture sector.

With the implementation of Drone Shakti initiative, Atal Mission, PLI scheme and the SAMITVA scheme, favorable policies by the Indian government have enabled increased investments and focus on R&D in the drone software and services market. The PLI incentive launched by the Government of India has motivated businesses are motivated to invest in drone software and services, which has numerous applications in many areas, particularly for India's agriculture and security. According to a GoI estimate, these policies might encourage over US$ 0.625 million (INR 5 Cr) in investments in the drone and drone manufacturing industries over the next three years.

Consumer

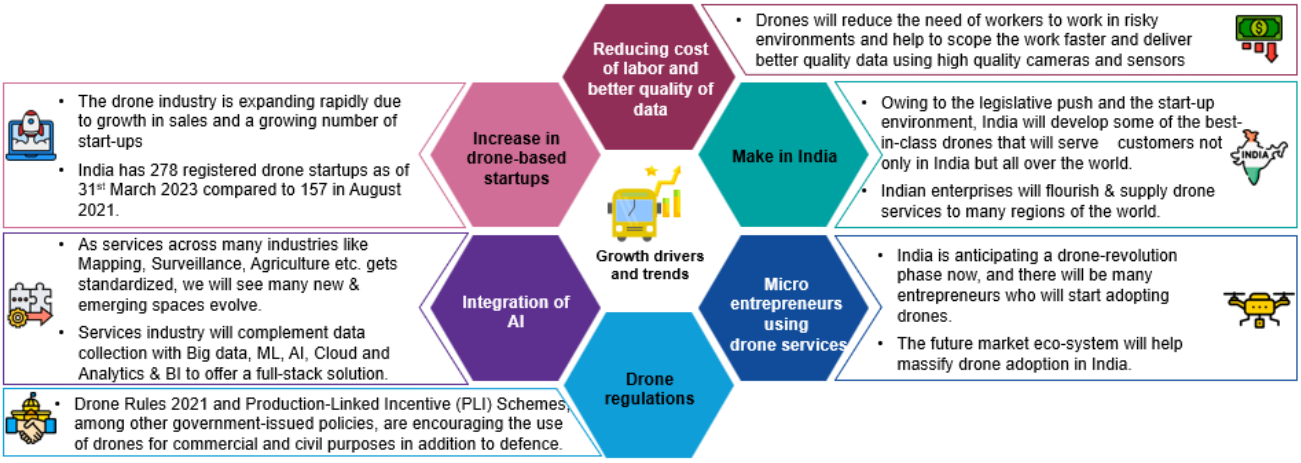
Apart from defence, another key contributor to the spending on drone hardware procurement is the consumer segment. Companies manufacturing drones for consumers often try mixing hardware available at a low cost with software that can be generic for everyone or highly suitable for certain users. Similar to how the smartphone market with consumers works today, in the drone market, drone hardware is the product the consumer purchases, while drone features and software act as key price differentiators for drone manufacturers.

Going forward, the recreational drone market is expected to witness a fall in the share of the overall drone market, while videography is expected to rise. Since recreational drones only contribute to the drone hardware market, and drones made for videography/ photography contribute to both hardware and services, the consumer drone software and services market is likely to grow at a faster pace than the consumer drone hardware market.

While the early adopters of recreational drones were majorly hobbyists, and the current users are not limited to those drone hobbyists and drone enthusiasts. This is because for consumers, the functionality of drones has not generally gone beyond flying them for fun or using it as a camera in the air. In the case of videography/ photography, drone usage has evolved from being used as an alternative to a helicopter to being used for the versatility of shots that can be taken. Relaxations of federal and local regulatory restrictions on when and where drones fly have fueled the growth of drone videography/ photography.

3.6 Key trends and growth drivers, including recent policy changes

Made in India, government regulations and increasing drone-based start-ups are vital factors contributing to the growth of the Indian drone industry. Along with Government's aim to turn India into a hub for drone technology, increased use cases and emerging applications in drone sector are some of driving factors, among others.



3.7 Drone manufacturing value chain and equipment infrastructure in India

Under the Indian drone ecosystem, the companies are active across all segments, i.e. Hardware, operations, and services. The various components are described in the value chain and compromises of the following:

Hardware: Construction and maintenance of UAS-related infrastructure

Operations: Operations included the physical arrangements for drones to take off and land vertically, professionals to operate them, and counter-drone facilities.

Services: Includes the software used to manage the information collected by drones and services post-sale.

	Hardware		Operations				Services	
	Components	OEM	Physical infrastructure	Operators	Counter Drone	Navigation and UTM	Data Management	Support Services
Description	• Components used on a UAV platform	• Entire UAV system manufacturing and/or assembly	• Physical infrastructure for UAV takeoff, landing, recharging	• Professtional operators for UAV • Remote pilots	• Threat prevention and mitigation	• Systems designed to navigate airspace	• Software and analytics to digitize the information collected by UAS	• Services supporting the UAS ecosystem
What's included	• Batteries • Sensors • Payloads • Motors • Propellers	• UAV systems as per usage	• Launch pads • Charging station • Verti-ports	• Photography • Mapping • Inspections and survey • Picking and dropping items	• UAV guns • Shields • Nets • Lasers	• AI software • Route planning • GPS devices • Unmanned traffic management	• Image processing software • UAS mapping software	• Insurance • Retail and distribution • Training and consulting

Notes: OEM stands for Original equipment manufacturer, UTM stands for Unmanned traffic management

As part of Atmanirbhar Bharat, India intends to develop the whole value chain by cutting down on import dependence while improving the quality and safety standards of made-in-India drones to enter the global value chain. Advancements in robotics, artificial intelligence, miniaturization, automation, thermal imaging, materials science, etc., will support various commercial and civilian usage of drones in sectors like utilities, agriculture, infrastructure, telecom, and mining, undertaking different activities with substantial enhancements in cost and efficiency. India's drone ecosystem is advancing, driven by the rise in manufacturers / service providers in the market and relevant laws to support the growth.

3.8 Drone company benchmarking

In comparison to domestic and international players, ideaForge drones features a variety of use cases across defence and civil. Additionally, compared to other Indian drone pure play drone manufactures, ideaForge has the highest revenue of US$ 22M in FY22. In comparison to global peers, basis the available data, ideaForge registered the highest EBITDA margin of 33.7%.

		ideaForge	asteria aerospace	sde	AUS	TUNGA	DCM SHRIRAM	adani Defence and Aerospace	newspace	TATA	RAPHE mPHIBr	DUMS
Year of establishment		2007	2011	2015	2013	2020	2021	2017	2017	2012	2017	2019
Defence		✓	✓	✓	×	✓	×	✓	✓	✓	✓	✓
Enterprise	**Agriculture**	✓	✓	×	✓	×	✓	✓	×	×	×	✓
	Energy and utilities	✓	✓	×	×	✓	×	×	×	×	×	✓
	GIS, construction & real estate	✓	✓	✓	✓	✓	✓	×	×	×	×	✓
	Mining	✓	✓	×	✓	×	×	×	×	×	×	✓
	Oil & gas	✓	✓	✓	×	✓	×	×	×	×	×	×
	Public safety	✓	✓	✓	×	✓	✓	✓	×	✓	×	✓
Logistics		×	×	×	×	×	✓	×	×	×	✓	✓
Passenger		×	×	×	×	×	×	×	×	×	×	×
Financials	**Revenue from operations (US$)**	21.8M (FY22)	2.6M (FY22)	1.0M (FY22)	0.8M (FY21)	NA	1.1B (FY21)	9.3B (FY22)	0.03M (FY22)	40.6B (FY22)	0.1M (FY20)	0.6M (FY22)
	EBITDA margin (%)	44.8% (FY22)	9.5% (FY22)	14.8% (FY22)	67.2% (FY21)	NA	13.4% (FY21)	6.8% (FY22)	-6,333% (FY22)	23.8% (FY22)	-508.9% (FY20)	20.8% (FY22)
	PAT margin (%)	33.7% (FY22)	-23.8% (FY22)	8.6% (FY22)	4.9% (FY21)	NA	8.0% (FY21)	0.7% (FY22)	-8.666% (FY22)	13.4% (FY22)	-600.0% (FY20)	0.5% (FY22)

		ideaForge	dji	AUTEL Skydio	LOCKHEED MARTIN	TELEDYNE FLIR	AV AeroVironment	quantum systems	wingtra	senseFly	Aero Sentinel
Year of establishment		2007	2006	2014	2014	1995	1978	1971	2014	2016	2009	2007
HQ		India	China	China	USA	USA	USA	USA	Germany	Switzerland	Switzerland	Israel
Defence		✓	×	✓	✓	✓	✓	✓	✓	×	✓	✓
Enterprise	**Agriculture**	✓	✓	×	×	×	×	×	✓	✓	✓	✓
	Energy and utilities	✓	✓	✓	✓	×	×	×	×	×	×	✓
	GIS, construction & real estate	✓	✓	✓	✓	×	✓	×	✓	✓	✓	✓
	Mining	✓	×	×	×	×	×	×	✓	✓	✓	✓
	Oil & gas	✓	✓	✓	×	×	×	×	×	×	×	×
	Public safety	✓	✓	✓	✓	✓	✓	×	✓	×	✓	✓
	Counter Drones	×	×	×	×	×	✓	×	×	×	×	×
Logistics		×	×	×	×	×	✓	×	×	×	×	×
Passenger		×	×	×	×	×	×	×	×	×	×	×
Financials	**Revenue from operations (US$)**	21.8M (FY22)	NA	NA	NA	66.0B (CY22)	5.5B (CY22)	445.7M (FY22)	NA	NA	12.5M (CY20)	NA
	EBITDA margin (%)	44.8% (FY22)	NA	NA	NA	11.2% (CY22)	18.3% (CY22)	-3.1% (FY22)	NA	NA	NA	NA
	PAT margin (%)	33.7% (FY22)	NA	NA	NA	8.7% (CY22)	14.4% (CY22)	-0.9% (FY22)	NA	NA	NA	NA

3.9 Drone product benchmarking

	Parameters	 ideaForge Netra V4 Pro	 Tunga Drishya Pro	 Asteria A410	 FLIR SkyRaider	 Lockheed Martin Indago	 DJI Matrice 300 RTK
Benefits	Company Headquarters	ideaForge India	Tunga Aerospace India	Asteria Aerospace India	Teledyne FLIR USA	Lockheed Martin USA	DJI China
	Application	• Defence • Public safety • Emergency response • Mapping	• Rescue and damage assessment • Crowd control, management • Target monitoring • Vegetation and wildlife survey	• Military ISR • Homeland security • Law enforcement • Surveillance and security	• Immediate ISR clandestine operations payload delivery situational awareness • Beyond line-of-sight reconnaissance • Force protection • Target recognition • Manned/unmanned air strikes	• Expeditionary intelligence, surveillance • Reconnaissance (ISR) applications	• Firefighting, search and rescue • Law enforcement • Powerline inspection • Oil and gas • Geomatics
Performance	Weight (Kg)	< 6 Kg	6 Kg	< 5 Kg	5 Kg	2 Kg	6.3 Kg
	UAV size	<1.5 m x 1.5 m	Data not available	Data not available	Propeller tip to propeller tip : 1.35 m	0.8 x 0.8 x 0.2 m	0.81 × 0.67 × 0.43 m
	Endurance	Over 90 minutes	Over 60 minutes	Up to 45 minutes	Over 40 minutes	50 - 70 minutes	Up to 55 minutes
	Range of transmission	15 Km	6+ Km	5 Km	Data not available	10 – 12 Km	15 Km
	Cruise speed	14 m/s	7 m/s	12.5 m/s	14 m/s	Data not available	23 m/s
	Propulsion	Battery Powered Electric Propulsion	Electric Battery Operated	Data not available	Data not available	Data not available	Data not available
	Maximum operating altitude (AGL)	1,000 m	Data not available	500 m	Data not available	~150 m	Data not available
	Maximum launch altitude (AMSL)	4,000 m	1,500 m	4,000 m	Data not available	5,500 m	7,000 m
Reliability	Functional Temperature Range	-20°C to +55°C	-10ºC to 55ºC	-20 to +55 C	-20°C to 50°C	Not available	-20°C to 50°C
	Dust & Drizzle Resistance	IP54 rating	Data not available	Data not available	Tested to IP-54 and military standards	IP 54 (pursuing IP 67)	IP45 rating
	Technical Life of UAV (Landings)	Minimum 2,000 landings (OEM Certification)	Minimum 500 landings	Not available	Data not available	Data not available	Data not available
Autonomy	Launch & Recovery	Autonomous Vertical Take-Off & Landing (VTOL)	Autonomous (VTOL)	A Vertical Take-Off and Landing small RPAS	Group 1 VTOL aircraft	Autonomous VTOL	Data not available
	People Detection @ day	✓	✓	Data not available	✓	✓	Data not available
	People Detection @ night	✓	✓	Data not available	✓	✓	Data not available
TCO	Payload Characteristics	• Electronic and Gimbal stabilization of video output at all zoom levels in real-time	Data not available	• 1920 x 1080 (Full HD) 10x zoom daytime video camera • 640 x 480 night time infrared video camera • Three-axis gimbal stabilized payload	Ability to carry and deliver multiple payloads up to 3.5 Kg	Data not available	• Maximum payload capacity of 2.7 kg • Single Downward Gimbal • Dual Downward Gimbals • Single Upward Gimbal, • Upward and Downward Gimbals • Triple Gimbals • Resolution - 960p • FOV - 145° • Frame rate - 30 fps
	Payload Options	• Daylight HD (1920X1080) with 20x optical zoom video payload • FOV: 54-2.7° • Thermal 640X480 video payload (Optional) • FOV: 12 degrees • 24 MP Photogrammetry payload • High accuracy L1 & L2 Frequency Band Enabled PPK X, Y Accuracy: <10 cm (0.32ft) at 120m (400 ft) AGL (with 95% confidence interval) Z Accuracy: < 20 cm (0.65ft) at 120m (400 ft) AGL (with 95% confidence interval) Onboard Storage: Minimum 64 GB (expandable) – Optional	Data not available	Data not available	• Hot-Swappable payload • Custom payload supported through the Payload Development Kit (PDK)	• Multiple hot-swappable payload options • Gross take-off weight of 2.2 Kg with payload included (2,268 grams)	Data not available

ideaForge's Netra V4 pro is one of few multi-rotor UAVs with total flight time (Endurance) of more than 90 minutes. It is one of the few UAVs that guarantees full support upto a maximum of 2,000 landings, as per the OEM (Original equipment manufacturer) certification.

The Netra V4 pro is one of the few drones that provide multiple failsafe features. It is programmed to auto return to home location and land on low battery, other circumstances for return include communication failure, exceeding wind limit of the system or other UAV health parameters. It is also one of the few drones which has the ability of target tracking with an enhanced 'moving target' indication feature as well.

Netra V4 pro's packaging provides waterproof backpacks to carry all mission critical components with IP54 rating for dust and drizzle protection. It takes less than five minutes to swap out any payload that can be fitted with Netra V4 pro UAV. ideaForge's UAVs are equipped with industry leading specifications and capabilities, comparable to those of other established global players in the UAV industry, thus making ideaForge one of the leading design and technology players in the UAV market.

	Parameters	 Switch	 Asteria AT-15	 Paras Defence FIXAR 007	 Tata Rakshak	 Autel Dragonfish - Standard	 Lockeed Martin Stalker XE
Benefits	**Company**	ideaForge	Asteria Aerospace	FIXAR tie-up with Paras Aerospace	Tata Advanced Systems	Autel Robotics	Lockheed Martin
	Headquarters	India	India	India	India	China	USA
	Application	• Security and surveillance • Anti-terror • Border security • Crime control	• Security and surveillance • Power asset inspections and renewable energy • Logistics	• Aerial photography • Laser scanning • Real-time video monitoring • Multispectral imaging • Delivery	• Security and surveillance	• Public Safety, forest fire prevention • Powerline inspection • Traffic law enforcement • Coastal patrol and security • Agriculture monitoring	• Defence and security
Performance	**Weight**	< 7 Kg	<10 Kg	7 Kg	Not available	9 Kg	~11 Kg
	UAV size	<2.6 x 1.8 m	Data not available	Wingspan - 1.620 m	Data not available	1.290 x 2.300 x 0.460 m	Length - ~2 m Wing span - 3.6 m
	Endurance	Over 120 minutes	Up to 120 minutes	Up to 60 minutes	80 to 120+ minutes	126 minutes	Up to 120 minutes
	Range of transmission	15 Km	20 Km	40 Km	15-50 Km	~30 Km	Data not available
	Cruise speed (meter/sec)	~13 m/s	16.5 m/s	18-20 m/s	Data not available	17 - 30m/s	15.5 m/s
	Propulsion	Battery Powered Electric Propulsion	Data not available	Data not available	Electric motor	Data not available	Hybrid Power System Propane/ Rechargeable Battery
	Maximum operating altitude (AGL)	1,000 m	1,000 m	Data not available	1,000 m	Data not available	3,650 m
	Maximum launch altitude (AMSL)	4,500 m	3,000 m	6,000 m	1,000 – 4,000 m	6,000 m	6,000 m
Reliability	**Functional Temperature Range**	-20°C to +55°C	-10ºC to 55ºC	-20 to +55 C	-20°C to 50°C	Not available	-20°C to 50°C
	Dust & Drizzle Resistance	IP54 rating	Data not available	Data not available	Tested to IP-54 and military standards	IP 54 (pursuing IP 67)	IP45 rating
	Technical Life of UAV (Landings)	Minimum 2,000 landings (OEM Certification)	Minimum 500 landings	Not available	Data not available	Data not available	Data not available
Autonomy	**Launch & Recovery**	Autonomous Vertical Take-Off & Landing (VTOL)	Autonomous (VTOL)	A Vertical Take-Off and Landing small RPAS	Group 1 VTOL aircraft	Autonomous VTOL	Data not available
	People Detection @ day	✓	✓	Data not available	✓	✓	Data not available
	People Detection @ night	✓	✓	Data not available	✓	✓	Data not available
TCO	**Payload Characteristics**	• Electronic and Gimbal stabilization of video output at all zoom levels in real-time	Data not available	• 1920 x 1080 (Full HD) 10x zoom daytime video camera • 640 x 480 night time infrared video camera • Three-axis gimbal stabilized payload	Ability to carry and deliver multiple payloads up to 3.5 Kg	Data not available	• Maximum payload capacity of 2.7 kg • Single Downward Gimbal • Dual Downward Gimbals • Single Upward Gimbal, • Upward and Downward Gimbals • Triple Gimbals • Resolution - 960p • FOV - 145° • Frame rate - 30 fps
	Payload Options	• Daylight HD (1920X1080) with 20x optical zoom video payload • FOV: 54-2.7° • Thermal 640X480 video payload (Optional) • FOV: 12 degrees • 24 MP Photogrammetry payload • High accuracy L1 & L2 Frequency Band Enabled PPK X, Y Accuracy: <10 cm (0.32ft) at 120m (400 ft) AGL (with 95% confidence interval) Z Accuracy: < 20 cm (0.65ft) at 120m (400 ft) AGL (with 95% confidence interval) Onboard Storage: Minimum 64 GB (expandable) – Optional	Data not available	Data not available	• Hot-Swappable payload • Custom payload supported through the Payload Development Kit (PDK)	• Multiple hot-swappable payload options • Gross take-off weight of 2.2 Kg with payload included (2,268 grams)	Data not available

ideaForge's Switch UAV is one of the only UAVs which offer endurance of more than 120 minutes in <7 kg weight globally. It can even operate at maximum launch altitude of 4,500 meters. Further, it is one of the lightest weighing machines, with a total weight of less than 7 Kgs. Similar to Netra V4+, ideaForge's Switch UAV is also installed with failsafe features such as auto return to home location and land on low battery, communication failure, exceeding wind limit of the system or other UAV health parameters. It also offers target tracking with enhanced moving target indication feature.

Switch UAV is a first-of-its-kind VTOL and fixed-wing hybrid UAV that can load with publicly available open-source maps. It also has the capability to incorporate geo-referenced maps in at least one of the generally used digital map formats (e.g., GIF, TIFF) as well as shape files (.shp). For 3D Maps, Switch can incorporate elevation data from SRTM and DTED into 3D Maps. It included packaging provides waterproof backpacks to carry all mission critical components with IP66 or better rating for dust and drizzle protection, similar to Netra V4+. Each payload that can be attached to the Switch UAV can be swapped out in less than five minutes. ideaForge faces competition from companies such as Asteria Aerospace Private Limited, DCM Shriram Limited, Adani Defence and Aerospace (Adani Enterprises Limited) as well as other international companies such as Lockheed Martin Corporation and Autel Robotics Corp. Limited which operate in the same line of business as ideaForge and offer similar products.

04

Company and parentage analysis

4.1 ideaForge history and timeline

Founded in 2007, ideaForge is the fastest growing and most profitable player (among PLI eligible players) in the UAV industry as of FY22. ideaForge is the pioneer and the pre-eminent market leader in the Indian unmanned aircraft systems ("**UAS**") market, with a market share of 50+% in FY22. Being among the first few players in India to enter the UAV market, ideaForge has first-mover advantage and also has the distinction of being the first company to indigenously develop and manufacture Vertical Take-off and Landing (VTOL) UAVs in India in 2009. The company is the largest drone manufacturer in India as of September 30, 2022. ideaForge had the largest operational deployment of UAVs across India given its early establishment in 2007 compared to its peers and the revenue market share that the company holds.

ideaForge has filled more than 30 patents, deployed over 1,500 systems and trained over 3,200 pilots in governmental organizations and defence forces as of FY23. ideaForge has built a strong foundation on the basis of its industry leading design and technology capabilities and vertically integrated operations, enabling it to secure numerous contracts for defence and homeland applications, among them being a US$ 20M contract with the Indian Army for its SWITCH 1.0 UAVs, which it delivered on time in November 2021.

ideaForge also stands to benefit from the ban on import of drones in completely-built-up (CBU), semi-knocked-down (SKD) or completely-knocked-down (CKD). With the recent "Atmanirbhar Bharat Abhiyan" efforts from the Government of India, where the emphasis has been on indigenization, ideaForge plans to capitalize on such programs and lessen its dependence on imports, hence lowering their import expenditure.

The founders of ideaForge, back in 2004 (in IIT, Mumbai) built one of the first quadrotor drones (in India) to enter a college fest. Following this, in 2009, ideaForge demonstrated Netra UAV in DEFEXPO, exhibiting the product launch of India's first quadracopter drone at DEFEXPO. In addition, in 2009, ideaForge developed one of the world's smallest and lightest autopilot. An early prototype of ideaForge's VTOL UAV was featured in the Bollywood movie '3 Idiots', in 2009.

In 2010, ideaForge's co-founder Ashish Bhat won the award for *'Best Autonomous Hovering Vehicle'* amongst 16 global competitors and was mentioned in the Massachusetts Institute of Technology's '*Technology Review list of 35 Innovators under 35'*.for developing the world's smallest and lightest autopilot for drones (ideaForge drones) weighing 10 grams

During the 2015 earthquake, ideaForge UAVs were used for site monitoring in Kathmandu, Nepal, and other locations to aid with the search and rescue activities. During the 2016 terrorist incident in Pampore, ideaForge UAVs were able to deliver crucial intelligence by revealing the precise locations of the terrorists. ideaForge's Ninja UAV was utilized to curb theft and pilferage cases with its partnership with railways to boost their surveillance operations.

Furthermore, in fiscal year 2017, ideaForge developed the first hybrid VTOL drone with fixed wings in India, known as the SWITCH UAV. This drone was equipped with additional fail-safes and enhanced safety features. In CY21, the NETRA UAV was utilized to aid rescuers in search and rescue efforts during the floods in Uttarakhand. ideaForge is among the first few drone companies selected for survey grade mapping for Survey of Villages Abadi and Mapping with Improvised Technology Village Areas (SVAMITVA) by Survey of India (SOI). ideaForge became one of the few drone company to be featured on the New York Times Square as of CY21. In FY22, ideaForge has established market leadership with more than 50% market share in India drone space in terms of revenue.

4.2 Innovation in products

With its innovation driven focus, ideaForge has superior quality drones for various applications and functions. ideaForge's provided capabilities such as take-off area suitability check, coverage area check and target location coverage check for off-site mission planning prior to deployment are unique in the industry. As a part of the end-to-end solution provision, customers are enabled with their 'BlueFire Live!' platform, which enables live streaming of the UAV video feed and payload control from anywhere in the world over the internet. The BlueFire Live! Platform is offered as a software-as-a-service ("SaaS"). Further, MapAssist, ideaForge's software, seeks to make geotagging simple and intuitive. It not only enables safe and autonomous mapping operations with the ground control station BlueFire Touch (BFT) but also optimises the data captured and reduces the processing

time. As a result, the drones are suitable for large-area mapping operations, with the lowest Total Cost of Ownership (TCO), which is critical for these projects.

Innovation in products	
 RYNO	• RYNO, the micro-category drone has advanced mapping payload and state-of-the-art PPK module • Owing to its high accuracy in mapping applications, RYNO is the only drone approved by SOI for Swamitva Yojana, one of the biggest drone mapping projects in the world
 Q6 UAV	• Q6 Mapping UAV, the small category drone optimizes survey grade outputs while minimizing piloting workload. • PPK antenna delivers continuous survey grade performance even over difficult terrain
 NINJA UAV	• NPNT compliant autopilot, flight area breach prevention, independent GPS-tracking, built-in RFID Tag, fire resistant UIN plate
 Q4i	• With its high zoom payloads, Q4i offers the situational awareness and clarity • Unique snap fit mechanism Q4i is small category VTOL UAV build and tested military operations
 NETRA V4+	• IP54 ingress certified, NETRA V4+ is fully autonomous with target tracking capability and versatile features to delivery outcomes in defence and civil applications
 NETRA V4 Pro	• NETRA V4 Pro is an upgraded version of Netra V4+ which is capable to provide an extended flight time of 90 minutes and operational range of 10 miles
 SWITCH UAV	• SWITCH UAV is a new age VTOL and fixed wing hybrid UAV • Return home on low battery, high winds options available • Multiple GPS for redundancy
 BlueFire Live	• Bluefire is a state-of-the-art real time video streaming solution to integrate drones' real time speed with the control center • Remote users can have secured access to encrypted live-stream of drone's feed video and work on open-protocols which are easily integrated into Video Management Systems

ideaForge has diversified product portfolio of UAVs built for multiple use cases and has one of the industry's leading product portfolios for civil and defence applications (dual use). ideaForge is one of the top vendors globally for dual use drones (civil and defence), this encompasses a wide range of products from light micro drones used for advanced mapping, to megaphone drones equipped with HD camera for surveillance and public announcement, ideaForge drones have advanced technical capabilities, covering distances up to 15 km with 120 minutes flying time and, 1,000 meters operating altitude. ideaForge also has a custom in-house battery management system, ensuring higher life cycle of batteries, optimizing UAV operations. ideaForge is one of the first UAV manufacturers to receive the BIS certification for its in-house developed batteries.

ideaForge's multipurpose drone successfully showcased a supply drop simulation with commands from a distant command center over a 5G network, making it the first company to participate in the demonstration of 5G enabled

UAVs at Indian Mobile Congress in 2018. Drone usage will be accelerated by 5G technology in disaster management, agriculture, crowd surveillance, traffic control, internet connectivity, and many more sectors. In March 2022, ideaForge's SWITCH UAV won the largest mini-VTOL UAV contract against global competitors from Russia, Israel, France, Ukraine, and other countries.

ideaForge is one the few players to adopt VARs and distributors channels to reach customers across India and globally, which was distinctive for PLI scheme eligible manufacture, ideaForge has partnered with distribution networks such as Savex Technologies Private Limited (India's third largest information and communication technology distributor), PV Lumens LLP, and Ingram Micro Inc. (Global technology and supply chain services provider). Given the reach of its distribution network, ideaForge has one of the best distribution network networks in India for UAVs. ideaForge offers a premier support package called 'ideaForge Care', which is renowned for replacement option of the comprehensive UAV system, in the event of any hardware or software issues, which is a unique offering in the Indian drone industry. 'ideaForge care' plan is one of the first-of-its-kind subscription-based support package in the Indian UAV industry.

A recent request for proposals (RFP) issued by the Ministry of Defence and the Government of India for the Indian Army to procure surveillance quadcopters in November 2022 stipulated that the UAV system need landing count of at least 500 times. The RYNO UAV from ideaForge is capable of performing four times as many landings as desired by the Indian Army, some of ideaForge UAVs have flown more than 4,500 flights as against the minimum requirement specified in RFPs for 500 flights under warranty.

4.2.1 Drone research and development

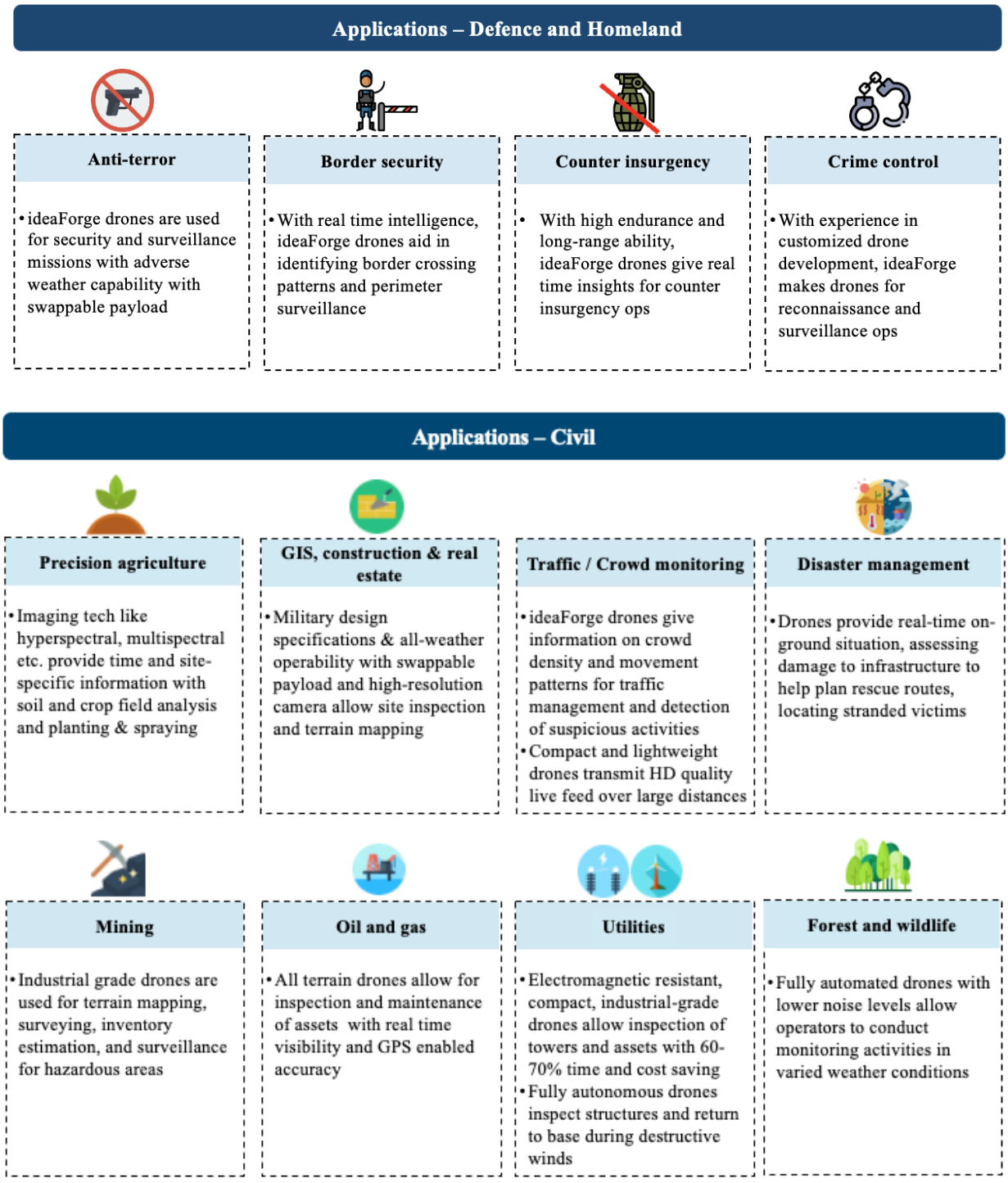
The government of India aims to promote domestic drone research, development, and manufacturing by promoting creation of drone infrastructure and ecosystem. Continuous product development by way of product and market research is integral for growth in the UAV industry and consequentially, many drone manufacturers are laying emphasis on product development and testing. Some of the legacy Indian defence players such as Bharat Electronics Limited and Hindustan Aeronautics Limited are currently spending between 6% and 8% of their revenue from operations on R&D related activities and investments.

INR (Cr.)	FY22	FY21	FY20
Bharat Electronics Limited			
Revenue from operations	15,044	13,818	12,608
R&D Investments	1,045	873	947
% of Revenue from operations	6.94%	6.31%	7.50%
Hindustan Aeronautics Limited			
Revenue	24,620	22,882	21,445
R&D Investments	1,967	1,687	1,232
% of Revenue from operations	7.98%	7.37%	5.74%

4.3 Product applications

With over 30+ patents filled domestically and internationally, ideaForge has vertically integrated to maintain the quality of its products. ideaForge's customers have completed 350,000+ flights using their UAVs as of 31st March 2023. With an ideaForge manufactured drone taking off every 5 minutes on average for surveillance and mapping as of 31st March 2023, it had the largest operational deployment of indigenous UAVs across India. ideaForge has provided drones for both civil and defence use to both national and international customers. Drones made by ideaForge cater to various activities in defence and civil (such as homeland security, agriculture, construction and real estate, mining, oil and gas, and power transmission, amongst others), drone-as-a-service (DraaS), and geographic mapping.

Given its reliability, ideaForge caters to domestic as well as international customers across various sectors. ideaForge drones have an ergonomic design and have been tested in extreme weather conditions and high altitudes across India from deserts to glaciers and offers the highest technical life of 2,000+ landings. While the UAVs are mission oriented and requires minimum training, ideaForge provides its customers with the basic training required for operating the UAVs and their functionality.



4.4 Technology and manufacturing

ideaForge has designed and developed UAV technology in-house, and is one of the few vendors globally to have a full stack UAV solution along with a Ground Control Software ('BlueFireTouch'), firmware and solutions as well as robust after sales support. ideaForge also has one of the best support networks in India for UAVs. The airframe and autopilot sub-system software have been developed in-house along with full communication systems and a command center. It has a 21,000 square foot, 600-person capacity facility to cater to the growing demand. ideaForge is one of the few OEMs globally to have its own proprietary autopilot sub-system and ground control software.

As per the latest report published by Drone Industry Insights in December 2022, ranking of best drone manufacturers worldwide. ideaForge was ranked 7th globally in the Dual-Use category (Civil and Defence) drone manufacturers.

4.4.1. BlueFire Touch Ground Control Software

The in-house built BlueFire Touch Ground Software has advanced mission replay and allows for Pre-emptive checks for take-off and target location for off-site mission planning. ideaForge drones provide terrain data support with in-built data to protect UAV from rough terrains in situations where terrain data is low resolution.

There are in-built capabilities for target tracking and a moving target indication and support for MAVLink Commands. Multi UAV support and support for handheld Ground Control Software such as iPads are in the works.

Note(s): COTS – commercial-off-the-shelf, EO / IR – Electro-Optical and Infrared sensors, ONVIF – Open Network Video Interface Forum

05

Financial benchmarking with listed Indian peers

5.1 Financial benchmarking

ideaForge has demonstrated strong financial performance compared to its peers. It has showcased the highest revenue growth of ~137% CAGR over FY23-20. Furthermore, with a gross margin of 68.4%, an EBITDA margin of 25.3% and a PAT margin of 17.2% in FY23, ideaForge is among the most profitable player among the analyzed peers.

Note: There are currently no listed pure play drone manufacturing companies in India. The below peers were chosen as proxy comparables basis defence being a key application, as well as being involved in the manufacture of electronics, both of which are applicable to drones.

Financial – Revenue and profit metrics

Parameters	Company	FY20	FY21	FY22	FY23
Revenue from operations (INR M)	ideaForge	140.0	347.2	1,594.4	1,860.1
	Hindustan Aeronautics Limited	2,14,451.6	2,28,823.2	2,46,200.2	2,69,274.6
	Bharat Electronics Limited	1,29,676.7	1,41,086.9	1,53,681.8	1,77,344.4
	MTAR Technologies Limited	2137.7	2,464.3	3,220.1	5,737.5
	Astra Microwave Products	4,672.2	6,409.1	7,504.6	8,155.2
	Data Patterns	1,561.0	2,239.5	3,108.5	4,534.5
COGS (INR M)	ideaForge	65.3	183.0	412.2	588.6
	Hindustan Aeronautics Limited	93,873.6	1,11,914.1	1,00,012.2	1,01,021.1
	Bharat Electronics Limited	70,972.8	78,260.4	88,971.6	98,275.6
	MTAR Technologies Limited	721.7	801.5	1,162.5	2,695.1
	Astra Microwave Products	2,652.7	4,458.7	5,272.1	5,182.8
	Data Patterns	560.9	704.1	860.7	1,709.1
Gross Profit (INR M)	ideaForge	74.7	164.2	1,182.2	1,271.5
	Hindustan Aeronautics Limited	1,20,578.0	1,16,909.1	1,46,188.0	1,68,253.5
	Bharat Electronics Limited	58,703.9	62,826.5	64,710.2	79,068.8
	MTAR Technologies Limited	1,416.1	1,662.8	2,057.6	3,042.4
	Astra Microwave Products	2,019.5	1,950.4	2,232.6	2,972.4
	Data Patterns	1,000.1	1,535.4	2,247.8	2,825.4
EBITDA (INR M)	ideaForge	-125.1	-108.7	731.2	470.9
	Hindustan Aeronautics Limited	49,031.1	53,362.6	54,085.6	66,791.5
	Bharat Electronics Limited	27,544.6	32,105.1	33,408.8	40.858.8
	MTAR Technologies Limited	579.7	830.8	944.3	1,539.7
	Astra Microwave Products	824.9	789.7	892.2	1,476.2
	Data Patterns	431.7	919.9	1,410.4	1,718.3
PAT (INR M)	ideaForge	-134.5	-146.3	440.1	319.9
	Hindustan Aeronautics Limited	28,826.5	32,455.5	50,798.8	65,095.0
	Bharat Electronics Limited	18,247.2	20,997.6	24,002.2	29,862.4
	MTAR Technologies Limited	313.2	460.7	608.7	1,034.2
	Astra Microwave Products	440.4	288.5	378.7	698.3
	Data Patterns	210.8	555.6	939.7	1,240.0

Financial – Revenue and profit growth:

Company	Revenue from Operations CAGR (FY20-23)	EBITDA CAGR (FY20-23)	PAT CAGR (FY20-23)
ideaForge	136.9%	-	-
Hindustan Aeronautics Limited	7.9%	10.9%	31.2%
Bharat Electronics Limited	11.0%	14.0%	17.8%
MTAR Technologies Limited	39.0%	38.5%	48.9%
Astra Microwave Products	20.4%	21.4%	16.6%
Data Patterns	42.7%	58.5%	80.5%

Financial – Profit margins:

Parameters	Company	FY20	FY21	FY22	FY23
Gross Margin (%)	ideaForge	53.4%	47.3%	74.1%	68.4%
	Hindustan Aeronautics Limited	56.2%	51.1%	59.4%	62.5%
	Bharat Electronics Limited	45.3%	44.5%	42.1%	44.6%
	MTAR Technologies Limited	66.2%	67.5%	63.9%	53.0%
	Astra Microwave Products	43.2%	30.4%	29.7%	36.4%
	Data Patterns	64.1%	68.6%	72.3%	62.3%
EBITDA Margin (%)	ideaForge	-89.4%	-31.3%	45.9%	25.3%
	Hindustan Aeronautics Limited	22.9%	23.3%	22.0%	24.8%
	Bharat Electronics Limited	21.2%	22.8%	21.7%	23.0%
	MTAR Technologies Limited	27.1%	33.7%	29.3%	26.8%
	Astra Microwave Products	17.7%	12.3%	11.9%	18.1%
	Data Patterns	27.7%	41.1%	45.4%	37.9%
PAT Margin (%)	ideaForge	-96.0%	-42.1%	27.6%	17.2%
	Hindustan Aeronautics Limited	13.4%	14.2%	20.6%	24.2%
	Bharat Electronics Limited	14.1%	14.9%	15.6%	16.8%
	MTAR Technologies Limited	14.7%	18.7%	18.9%	18.0%
	Astra Microwave Products	9.4%	4.5%	5.0%	8.6%
	Data Patterns	13.5%	24.8%	30.2%	27.3%

Financial – Ratios

Parameters	Company	FY20	FY21	FY22	FY23
ROE (%)	ideaForge	-19.7%	-24.5%	26.9%	9.9%
	Hindustan Aeronautics Limited	21.7%	21.0%	26.3%	27.6%
	Bharat Electronics Limited	18.1%	19.0%	19.5%	21.5%
	MTAR Technologies Limited	13.9%	9.7%	11.7%	16.7%
	Astra Microwave Products	8.2%	5.2%	6.5%	10.9%
	Data Patterns	13.7%	26.7%	16.4%	10.6%
ROCE (%)	ideaForge	-22.2%	-14.8%	37.6%	10.4%
	Hindustan Aeronautics Limited	17.7%	15.9%	12.9%	13.5%
	Bharat Electronics Limited	19.7%	22.3%	20.5%	24.5%
	MTAR Technologies Limited	19.7%	14.2%	14.2%	18.7%
	Astra Microwave Products	10.4%	9.9%	10.6%	17.2%
	Data Patterns	21.1%	33.6%	22.3%	12.5%

Gross fixed Assset Turnover	ideaForge	2.7	2.0	7.3	NA
	Hindustan Aeronautics Limited	1.8	1.7	1.7	NA
	Bharat Electronics Limited	3.2	3.2	3.1	NA
	MTAR Technologies Limited	1.1	1.0	1.1	NA
	Astra Microwave Products	1.8	2.2	2.4	NA
	Data Patterns	5.0	6.2	5.4	NA
Cash Conversion Cycle (Days)	ideaForge	824.7	622.1	413.3	675.9
	Hindustan Aeronautics Limited	793.1	560.6	499.1	389.6
	Bharat Electronics Limited	266.8	247.6	236.3	260.5
	MTAR Technologies Limited	332.3	423.1	509.8	360.5
	Astra Microwave Products	500.8	390.9	351.7	389.8
	Data Patterns	674.9	574.2	579.0	627.9
Cash Flow from Operations (INR M)	ideaForge	-164.7	-308.1	655.2	-532.3
	Hindustan Aeronautics Limited	15,273.9	151,170.0	100,327.8	151,170.0
	Bharat Electronics Limited	25,704.1	50,932.2	42,072.2	12,668.6
	MTAR Technologies Limited	562.2	86.1	-298.0	74.1
	Astra Microwave Products	-72.8	-246.0	1146.7	-217.7
	Data Patterns	134.5	549.0	521.9	-172.4

Notes:

Gross Profit = Revenue from Operations – (Cost of Materials Consumed + Changes in Inventories)

EBITDA = Profit Before Tax + Finance Cost + Depreciation and Amortization – Other Income

Gross Margin = Gross Profit / Revenue from Operations

EBITDA Margin = EBITDA / Revenue from Operations

PAT Margin = PAT / Revenue from Operations

ROE = PAT / Shareholder's Equity

ROCE = EBIT / (Total Assets – Current Liabilities); EBIT = EBITDA – Depreciation and Amortization

Gross Fixed Assets Turnover = Revenue from Operations / (Gross Property Plant and Equipment + Gross Intangible Assets)

*Cash Conversion Cycle = Days Receivable (Trade Receivables / Revenue from Operations * 365) + Inventory Days (Inventory / Cost of Goods Sold * 365) – Days Payable (Trade Payables / Cost of Goods Sold * 365)*

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Director
Gurugram

Kiran Achanta
Project Manager
Bengaluru


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