Make in India for Unmanned Aircraft Systems

Awaiting its "Kitty Hawk" moment



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About the report

FICCI, in collaboration with EY, has developed this paper as a deep dive into the Unmanned Aircraft Systems (UAS) market, covering various facets. The paper talks about the current ecosystem, overview of the uses and potential business applications for UAS across industries in India. The paper touches upon investment in UAS technology across global, current draft regulations of India vis-à-vis other countries and the impact regulations on UAS manufacturing and operations in India. Further, the paper discuss about challenges with respect to policy, market and operations for individuals and companies before they leverage UAS and its associated technologies in their business. Finally, the paper ends by charting out the next steps based on the primary research conducted and proposes recommendations on the draft regulations.

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1. Executive summary

UAS or Unmanned Aircraft Systems are aircraft systems without a human pilot onboard. Though the technology has been present for some time now, there has been an increasing awareness about UAS in the industry and the government alike. Even though the current regulations by DGCA are in the draft phase, it has not stopped organizations to grab on this opportunity to leverage this emerging technology to utilize in its operations and evaluate its potential. India has especially seen increasing UAS adoption, especially by government bodies.

The ability of UAS to reduce the cost of compliance and cost of the technology, while also enhancing the value of the information gathered through these systems have been the key drivers for increased adoption of UAS in India and the world. Traditional ways of working, which relied upon sometimes inaccurate and time consuming procedures can now be replaced by cost-effective, information rich UAS. Coupled with the applications from other synergetic technologies like 3D modelling, Internet of Things, artificial intelligence and augmented as well as virtual reality has opened up a world of possibilities for organizations to leverage the use of UAS and its associated technologies across their operations. The paper explores opportunities for organizations in five industries: Power and Utility, Agriculture, Highways, Mining and Railways to leverage the use of UAS and its associated emerging technologies in creating value across their various activities.

Globally, countries like US and China have created a conducive environment for organizations to benefit from the applications of UAS and its associated technologies and hence these markets have seen a lot of capital invested in these systems and are driving the innovation in this market. India should create an environment for various players in this ecosystem of companies and startups to collaborate and create value for each other. Regulations will have to pave the way for such an adoption and even though the regulations are still in the draft stage, that should not deter companies from investing in India because once the regulations get formalized, the market will see a lot of industries and companies adopting UAS across their operations. To cater to the demand of the future, companies need to invest and the push has to come today from both the government and the private industry.

In order to build out this area, the current policy challenges would need to be resolved. Finalizing the policy while including considerations on a broadened classifications of UAS, enabling research and development, enabling training, enabling ease of doing business, provisioning testing sites and simplifying licensing would help provide the necessary impetus to the adoption of this technology. Apart from the policy challenges, there are still market as well as operational challenges in the way before organizations can adopt a UAS offering. Today, it is important to build an ecosystem which would help cater the multiple use cases of UAS application across industries. Building this ecosystem is critical to solving the market challenge once the policy is finalized. Also, organizations, while adopting this technology, should also consider operational challenges and organization readiness for this technology. Implementing large scale drone applications across the value chain requires good understanding of regulations, comprehensive requirements gathering and seamless project execution.

In the end, to drive utilization of UAS across industries would require action across different areas. The paper discusses some of the next steps to make a conducive environment for organizations to participate in this ecosystem for mutual benefits. The government should consider broadening the classification of drones and making the regulations less stringent to make it easier for organizations to leverage the potential of UAS. Streamlining the training and registration requirements would further enable companies to adopt these solutions faster. Simplifying and technology-enabling the process would improve the ease of doing business in this area. Attracting investments for Make in India by building a drone ecosystem is critical to solve the market challenges. Legislators would also need to assess the impact of UAS technology on other existing legal frameworks like Intellectual Property Rights, Security and Privacy and make appropriate amendments to utilize the technology responsibly.

UAS and associated technologies have a wide number of use cases across industries which can mean benefits in terms of time, money and information for organizations. There are some challenges which need to be resolved before organizations can leverage the full potential of these technologies. Government should work with the ecosystem of startups, experts and companies to take the next steps forward in making this market a conducive area for growth, investment and innovation.

2. Birds eye view

Overview of current UAS applications in India



Unmanned Aircraft Systems (UAS), sometimes also known as Unmanned Aircraft Vehicles (UAV), are simply any aircraft that does not have a human pilot. While in many contexts they are commonly referred to as drones, due to the negative connotations of that word most people who use them in a commercial setting prefer to call them either UAV or UAS[1].

UAS have a range of uses in variety of fields including recreational, commercial, or military purposes. It's important to note though that in India, all aerial vehicles, manned or not, are governed by the Directorate General of Civil Aviation (DGCA)[1].

While they can be used for several different types of inspection, UAS are primarily used for visual inspection. They tend to be equipped with incredibly high resolution cameras, which allow them to get a close up, accurate view of a structure, even from a great distance[1].

They can be used to inspect nearly any structure, both indoors and outdoors, but they are most useful in the inspection of structures that are difficult to reach by traditional means. This can include tall structures, such as flare stacks, elevated pipe trays, and cooling towers. It can include confined spaces in which space is limited for traditional inspections. It can also include structures that are over water such as bridges or the undersides of oil rig platforms[1].

Compared to traditional inspection, the use of UAS is cheaper, faster, and safer than traditional methods. For example, when inspecting flare stacks, traditional inspection is incredibly difficult and time consuming. UAS can inspect the stack in less than an hour, without requiring shutdown, the construction of scaffolding, or sending inspectors into dangerous situations[1].

[1] https://inspectioneering.com/tag/unmanned+aerial+systems

A. Current trends in India

UAS have seen an exponential growth in demand in India over the past 5 years. Primarily being used by law enforcement agencies (LEAs), UAS have seen more usage by other PSUs and government agencies. A specialized force constituted "for the purpose of specialist response to a threatening disaster situation or disaster" has been using UAS for locating victims of natural disasters, Indian Railways is using UAS for inspection and tracking of progress of its mega project and largest state-owned natural gas processing and Distribution Company has implemented UAS for surveillance of its network of gas transmission pipelines.

Adoption of UAS is increasing in India and it is projected that the value of industry and market would be around US$ 885.7 million, while the global market size will touch US$ 21.47 billion by 2021[2] .

There have been a number of Indian Governmental Agencies and PSUs that have piloted and even scaled up operations of drones for their construction and operations. A few examples are
as follows:

- An autonomous agency of the Government of India, responsible for management of a network of National Highways has employed the use of drones for 3D digital mapping for Detailed Project Report (DPR) for road widening for Raebareli – Allahabad Highway. Data collected is being utilized for calculation of compensation of citizens with property rights along the highway
- National Railway System in have used drones to monitor the construction of its railway lines by 3-D mapping of dedicated freight corridor network of 3,360 Km project is envisioned (at bid planning stage). The entire corridor will be mapped using UAS technology[3]
- An Indian state-owned electric utilities company has obtained approval and started working towards implementing UAS for project monitoring in hilly terrains. The primary reason for PGCIL investing in deploying UAS is its cost efficiency[4]
- An Indian Public Sector Undertaking, engaged in the business of generation of electricity and allied activities has undertaken the consideration of UAS for monitoring, inspection, intrusion detection and surveillance for its solar power plants[5]. The organization has planned for UAS powered execution of infrared detection in solar photovoltaics to efficiently move towards its goal of enhancing Indian solar capacity by 100 gigawatts by 2022
- Indian state-controlled coal mining company has started aerial surveys of coal blocks for assessment of greenery restoration post excavation from mines[6]
- An agency for coordinating response to natural or man-made disasters has deployed UAS for rescue and relief operations (locating of trapped citizens, providing relief packages etc.)[7]

In the next section the paper explores various drivers behind the usage of UASs in India and various business applications for UASs across some industries.

[2] https://economictimes.indiatimes.com/news/defence/india-fastest-growing-market-for-unmanned-aerial-vehicles/articleshow/63466658.cms

[3] http://economictimes.indiatimes.com/news/science/how-various-ministries-are-exploringthe-use-of-drones-for-effective-infrastructure-creation/articleshow/52919438.cms

[4] http://www.business-standard.com/article/economy-policy/eye-inthe-sky-drones-to-monitor-power-projects-116012000482_1.html

[5] http://www.wri.org/blog/2016/05/indiacharts-roadmap-achieve-ambitious-solar-targets

[6] http://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/coal-india-plans-to-use-drones-toconduct-aerial-surveys-of-exploration/articleshow/50938224.cms

[7] http://www.livemint.com/Politics/ZDib5YWR1G2Mcuth1kbwyO/Drones-scan-floodhit-Uttarakhand.html

3. Making most of the wind:

Business potential of applications for UAS



In the previous section the paper briefly touched upon the current UAS applications in India and how various government bodies in India have adopted the usage of UASs.

This section talks about the key drivers of the UAS market in India. Later, the paper discusses applications in some specific industries where UASs can be leveraged for potential benefits in these industries.

As seen in previous sections, there is an increasing trend of adopting UAS technology across industries both in India and abroad. And there are multiple drivers driving the adoption of UAS for civil and industrial applications.

Ability to reduce costs of compliance

- Reduces costs of compliance due to its ability to provide aerial visibility
- Applications have been largely driven by video monitoring and surveillance to ensure compliance, for instance, Tata Steel began using drones for their mines in 2016
- Industry applications would become broad based when the regulations are clear.

Reducing cost of technology and easy accessibility

- Easy accessibility to UAVs and reducing cost of UAVs have made this an "interesting" opportunity
- Technology driving industrial applications are fairly mature. For example, technologies like 3D modeling have stabilized
- Smaller players are realizing the potential and have built capabilities across industries

Quality and scope of information

- The quality of information that we extract from deploying a UAS is immense
- Using a UAS system opens a wide scope of applications which may not have been possible before in the same time period, for example, surveying a large piece of land

However, most applications of UAS are focusing only on providing surveillance services or real time monitoring of assets. There is a sweet spot for UASs where the business potential of UASs usage is significantly higher than traditional methods.

Enable real time monitoring:

- Typically the most common use of UASs
- Monitoring difficult to access areas like chimney stacks etc.
- Not very amenable to drive analytics as it would require on the edge high computing power to process information in real time
- Limited by scalability; monitoring real time video feed over thousands of cameras without video analytics is a difficult task

Manage geographic spread

- Enable productivity and scalability to manage, monitor and survey assets over a wide geographic spread (e.g., monitoring transformers for utility companies, pipeline monitoring)

Establish a golden record:

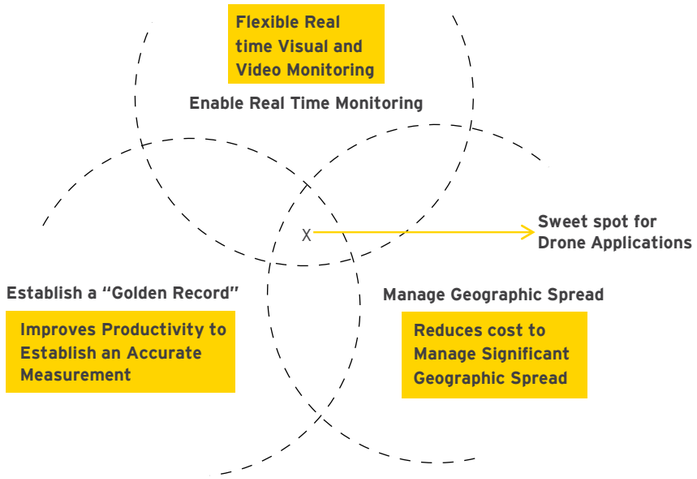
- Enables work measurement and work certification remotely and accurately (e.g., Site Audits, Civil Surveys and Measurement)
- Improves measurement accuracy and enhanced visualization (e.g., Site Surveys and Measurement, Construction progress)
- Generates 3D Digital Model for visualization and measurement

Application of Drones

UAVs, one of the most important component of the UASs, is just a platform or a medium to collect data. Leveraging other emerging technologies like Augmented Reality, Virtual Reality, Artificial Intelligence, 3D modelling and Internet of Things can enhance the output and insights that we draw from the data collected through UASs. There is a natural synergy between these technologies which complement each other when coupled with UASs to offer a rich output to the data. For example, we can stream the camera feed over the internet from the UAS to a VR headset in real time to offer an enhanced experience to the user.

The placemat on the next page explores some of the potential applications of these technologies when coupled with UASs across five key industries; Power and Utility, Agriculture, Highways, Mining and Railways. The bottom of the placemat briefly introduces these emerging technologies.

In this section, we will deep dive into each of these industries to explore the applications of UASs across different functions within each industry and how UASs along with emerging technologies can enhance the output and insights that can be drawn from such systems along with some examples from the industry.



Application of drones

Power and utility	Real time information overlaid on an AR headset when scanning gas pipes through drones	Remotely inspecting a tower from the top using drones and a VR headset	Automatically detecting corrosion on equipment on towers using a drone feed	Creating 3D models of the site from the data collected by drones before construction begins to optimize layouts	Transferring information from drone to a handheld device through IoT
Agriculture	Enhanced video output augmented with information about crop health overlaid on a drone feed	Videos and images captured through drones can be used for training farmers	Automatically identifying insects and crop NDVI using AI from a drone feed	Planning for contour trenches and estimating the scope of work through a 3d model created from drone feed	Collecting information from sensors and communicating with drone remote operating center
Highways	Information for engineers on site highlighting areas identified for maintenance through drones	Remote virtual tour of bridge construction site for higher management through drone feed	Automatically monitoring the progress by calculating the length of the road created through a drone video	Drone feeding information to create 3D models to estimate the scope of work while building a tunnel	Real time visibility to remote engineers who can assess road conditions through a drone feed
Mining	Using 3D modelling and AR, engineers can run simulations for blasts to view through AR headsets to identify risks	3D models created with the help of drone feeds can be consumed by engineers to access and monitor sections of the mine	Using drones and artificial intelligence we can detect if workers on ground are complying with regulations like wearing hard hats etc.	Using 3D models created through drones for blast planning in a mine	Drones can act as first responders to an accident site and transmit real time information to rescue agencies
Railways	Site engineers can use AR headsets to consume information captured by drones like broken bolts etc.	General managers in railways can remotely visit a site through virtual reality and inspect the site from the information captured by drones	Images and videos captured from a drone can be passed into a algorithm to count the number of sleepers laid on track	3D models prepared through drone feeds can help engineers determine the volume of a hill required to be cut to construct a railway line	Drones can transmit information through the internet in case of an accident and can help rescue teams plan the best discourse
Emerging Technologies	**Augmented Reality** AR is used to present enhanced natural environments overlaid with digital information to offer perceptually enriched experiences which can be digitally manipulated.	**Virtual Reality** VR is used to present completely immersive digital environments or situations to offer perceptually enriched experiences in a digital environment	**Artificial Intelligence** Intelligence demonstrated by machines that perceive and learn from data (Big Data) to mimic and improve upon human cognitive functions like learning and problem solving	**3D Modelling** Creating a digital model of the object in a three dimensional system by mathematically representing data points and rendering them in a three dimensional space	**Internet of Things** Network of connected devices; robots , device and instruments, embedded with sensors to communicate with other objects to exchange data and information over the internet
Problem classes	Enhanced experience	Virtual experience	Human perception	Digital model	Real time interaction
	Remote accessibility	Remote accessibility	Classification	Volumetric estimation	Visibility
	Improves productivity	Improves productivity	Prediction	Remote visibility	Gathering information
Industry examples	IKEA used AR to showcase to consumers how furniture would look in their homes	Audi is using VR to allow customers to experience new car interiors	Technology giants like Google and tesla are building self driving cars using AI	Lafarge Holcim is using 3D models for blast planning and calculating inventory volumes	GE is using IoT to monitor and collect data on its aircraft engines





A. Power and utility

Worldwide demand for energy is growing rapidly, increasing the need to optimize our existing infrastructure and build well-planned assets for the future. Infrastructure projects should leverage the use of emerging technologies for effective management of assets and UAS can provide just the same across the value chain in the power and utility industry.

Design

The planning phase plays a significant role in identifying risks associated with capital projects. Budget shortfalls, schedule overruns and additional costs have always been challenges for companies in the delivery of infrastructure projects for power and utility industry.

In the pre-construction phase, drones can speed up the design process and detect an investment's red flags more efficiently. Aerial surveys of construction sites can ensure a faster and more accurate estimation for the scope of work. For example, using the output from UAVs, architects can optimize the design for a solar power plant project. This will ensure a more accurate timeline for the project which in turn will give a more accurate estimate for the cost and time required for the completion of the project.

Leveraging associated technologies with UAVs:

- GIS data from drones to optimize tower layouts
- LIDAR for area measurements in the case of a solar power plant
- 3D models and 3D modeling for effective site planning and estimating scope of work
- AR/VR for remotely monitoring the site

Construction

[8]Another obstacle for the power and utility industry lies in monitoring the condition of construction sites which are often spread across a wide area. For example, in projects of laying a new transmission line where it is difficult to manage the geographic spread, UAVs can offer attractive opportunities for providing day-to-day progress reports since UAVs can quickly survey construction sites and deliver data to project managers in real time. Using UAVs and its associated technologies can facilitate in better scheduling of further work stages while simultaneously highlighting potential delays.

During the construction phase UAVs can help to track the progress across the project lifecycle; be it monitoring whether raw materials have reached the site or whether the tower assembly process has been completed.

Leveraging associated technologies with UAVs:

- Using computer vision in artificial intelligence to automatically provide real time updates of the progress on ground. For example, object detection models can count how many foundations have been laid for towers or how many solar panels have been installed
- IoT devices can transmit the data collected from drones to remote operating centers to track the project in real time
- Highly accurate 3D models of construction sites make it easy to track changes and progress, and to compare against plans
- Project managers can supervise the construction at each site through AR/VR without actually having to visit the site

One of the India's largest energy conglomerates used drones to monitor the progress of the construction of one of their solar power plants. They have also used thermal cameras on board UAVs to detect hot-spots on their substations

Maintenance

[9]Power and utilities companies should consider using UAVs for maintaining its infrastructure assets since UAVs offer cost-efficient monitoring of assets. UAV operations can enable energy companies to quickly detect deficiencies and risks associated with investments, allowing rapid intervention and thus minimizing additional budget expenditure with minimum personnel deployed on ground. UAVs can also cut labor costs significantly, as aerial operations substitute for dangerous work and replace ground-based teams monitoring construction sites.

For example, inspecting the health of the assets; detecting corrosion on equipment, checking for faulty connections and even vegetation growth that can prove to be a risk for the asset in the future. For wind farms, UASs can be used to check for structural integrity of the towers in use.

Leveraging associated technologies with UAVs:

- Thermal cameras can provide heat signatures from the asset which can be checked for identifying any abnormalities which may not be visible through the naked eye. For example, in the case of a solar power plant, non-functioning solar panels will have a different heat signature than a functioning one[10].
- Detecting corrosion on the equipment deployed on towers using artificial intelligence. Artificial intelligence can also be leveraged to detect abnormalities in solar power plants using heat signatures to automatically detect for non-functioning solar cells using machine learning and artificial intelligence.
- IoT devices can transmit the data collected from UAVs to engineers who can closely inspect the equipment on the power transmission lines through a live video feed which may not have been possible before
- Through IoT devices placed at the location, UAVs can even act as receivers for collecting data from the site.
- Project managers can carry out inspection at each site through AR/VR without actually having to visit the site

One of the largest Oil and Gas, PSUs has utilized UAVs to monitor its vast network of pipelines for maintenance and surveillance

Security and surveillance

The most common application for UAVs is providing real time information from the site and to act as first responders in case of emergencies. UAV can remotely cover vast areas faster than traditional methods and offer a cost effective alternative to monitoring assets.

UAVs can check for excavations and encroachments near ground assets. These pose a risk to the assets deployed in the power and utility industry; for example, an excavation near a power transmission tower can compromise the soil integrity of the site thus posing a risk to the entire structure itself. UAVs can also be used to monitor for power thefts along the power transmission line more frequently than what it would take for humans to complete the task otherwise.

Leveraging associated technologies with UAVs:

- Detecting excavations near the site or any encroachments at the time of UAV inspection through artificial intelligence
- IoT devices can transmit the data collected from drones to remote operating centers
- Video feed from a UAV can be used to assess the condition of the boundary wall for a solar power plant

[8] https://timesofindia.indiatimes.com/companies/drone-startup-ideaforge-to-make-two-uavs-for-ntpc/articleshow/59216312.cms

[9] https://energy.economictimes.indiatimes.com/news/oil-and-gas/gail-hires-drones-to-secure-gas-pipelines/61948751

[10] http://www.murcal.com/pdf%20folder/15.testo_thermography_guide.pdf



B. Agriculture

Projections show that feeding a world population of 9.1 billion people in 2050 would require raising overall food production by some 70% between 2005/07 and 2050[11].

In order to keep up with increasing demand, optimizing farm yield in a way that is sustainable and prevents environmental damage becomes critical. Challenges such as climate change make it harder to grow crops[12] due to an increasing number of unexpected weather events all over the world. As an ecosystem there is a need for close collaboration between governments, technology and industry to collectively overcome these challenges. UAVs and its associated technologies today can provide some solutions to these challenges.

Planning

Before farmers can actually sow the seeds, there is tremendous scope for increasing productivity from the same piece of land. In order to keep up with the increasing demand, we have to utilize available lands more effectively to increase production. Traditionally farmers have relied upon satellite imagery and historic land maps with contour and soil information. The challenge with these approaches is that they often don't reflect the ground reality. Manual inspections of large pieces of land can be time consuming and people often have to resort to sampling which can portray an inaccurate picture.

Leveraging associated technologies with UAVs

- Creating 3D models of the terrain which can be used for
  - Drawing contour maps
  - Analyzing drainage patterns
  - Identifying slope of the land
  - Scope of work estimation for preparing the land
  - Create a repository with 100% data for future use
- 3D models can help to efficiently plan for water usage during the season by analyzing the health of existing water management assets like dams, trenches and water storage areas
- UAVs equipped with NDVI cameras to map soil fertility of the land

[11] http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

[12] http://www.bbc.com/future/story/20151228-heres-how-climate-change-will-affect-what-you-eat

Land preparation

UAVs can not only help in designing and planning to optimize the farm, they can also help in monitoring the activities for preparing the land for crop growth. UAV operations can enable farmers to quickly detect risks associated with construction activities, allowing rapid intervention and thus minimizing additional budget expenditure with minimum personnel deployed on ground.

UAVs can additionally substitute for certain time consuming tasks which were traditionally done by humans. For example, UAVs can spray fertilizers in different parts of the land. UAV operators can exactly define the path for the UAV and the amount of fertilizer to be sprayed in which area thus quantifying certain tasks which couldn't have been quantified before.

Leveraging associated technologies with UAVs:

- Creating GIS enabled 3D models of the terrain to compare against planned activities and take corrective actions
- Real time remote visibility of the site through IoT devices can help better utilize the man power of field engineers
- Using IoT to transmit the fertilizer spray patterns to a handheld device to facilitate better man and machine interactions
- 3D modeling and artificial intelligence can help monitor live progress on ground of various activities involved in land preparation like construction of continuous contour trenches and construction of water management assets

Crop growth

Once the later stage of a crop life cycle is reached, one of the main objectives of the farmer is to keep the plants alive and healthy, which requires constant field monitoring. UAV monitoring possibilities are constantly being enhanced, providing the opportunity to reduce risk of crop failure.

[13]As seen earlier, crop spraying is another area for UAV applications in agriculture. UAVs can scan the ground, and maintain the right distance from the crops to spray the correct amount of liquid, modulating spraying in real time for even coverage.

This will increase the efficiency of spraying, reducing the amount of excess chemicals penetrating into groundwater.

The Indian arm of a Global Agrochemicals and seeds manufacturer has used UAVs has partnered with UAV providers to monitor the health of its farms in the state of Andhra Pradesh

Leveraging associated technologies with UAVs

- Using multi-spectral cameras can help measure the amount of light that the crops are reflecting. Depending on this information corrective actions can be taken in precise locations using GIS coordinates
- Image classification using the output from UAVs can help identify the health of the crop
- Detecting weeds and large insects on the crops using artificial intelligence and high definition cameras on UAVs
- UAVs can even act as first responders in case of wildfires to estimate the spread of the fire and the direction of the spread to minimize damage to the crop

[13] https://factordaily.com/drones-for-precision-agriculture-in-india/



C. Highways

[14]Highway networks by design are complex linkages spread over vast areas. The nature of the assets make it difficult to monitor quickly and efficiently. Construction in difficult terrain further makes the problem complex. Currently project managers have to rely on the status updates given by contractors who may or may not always share the honest status. UASs provide a unique solution to remotely monitor all construction sites in a cost effective manner.

Design and planning

Right from the designing and planning phase of constructing highways or roads, UAS offer solutions which can better equip teams on the ground and on the project with more information. Visibility into a much more detailed scope of work will lead to accurate planning for the project which in turn will help optimize the capital that needs to be employed in the project.

The data acquired from UAS will help in better planning highway layouts and more accurate scope of work estimation at key sites like mountains etc. Such ground exploration work will lead to accurate contract valuations thus helping the exchequer reduce costs for the project.

Leveraging associated technologies with UAVs:

- 3D terrain modelling will help to draw accurate plans with information on
  - Cut and fill volumes for preparing land
  - Scope of work estimation in cutting mountains or building tunnels
- IoT devices capable of transmitting data over the internet can transmit the findings to engineers sitting in remote locations to view the site
- 3D modelling coupled with VR will allow engineers to visit the site in a virtual environment any number of times and draw insights

A large Indian autonomous agency, responsible for managing a network of roads, has employed the use of drones for 3D digital mapping for preparing a detailed project report for road widening

[14] https://economictimes.indiatimes.com/news/science/how-various-ministries-are-exploring-the-use-of-drones-for-effective-infrastructure-creation/articleshow/52919438.cms

Construction

In the construction phase, UAVs are perfect for both quick surveys of sites and for the gathering data for detailed progress reports alike. Project managers can easily monitor progress by imposing overlays of plans onto photos of the actual state of construction thus verifying contractor reports and asses the amount of work done from an independent source.

UAVs can also provide details on the amount of raw materials present on site. Further, real time monitoring allows project managers to anticipate construction challenges and reduce delays. UASs can provide ground reality across various projects to the higher management in real time.

Leveraging associated technologies with UAVs:

- Using artificial intelligence to monitor the progress of the work done
- 3D modeling can help us monitor the exact amount of work done and the exact amount of work left
- 3D modeling can also help determine the volume of raw material present on site and whether it will be enough for work to be completed on site
- IoT can transmit live feeds to remote operating centers where experts can provide insights to ground teams in real time
- GIS enabled 3D models can help compare actual construction against planned construction activities and take corrective actions if required

Maintenance

Maintenance is an inherent part of highway management. Today, most such work is performed manually, based on in-person inspections, a slow and costly process that yields incomplete and poor-quality results. Today UAVs can not only locate defects faster and more thoroughly, but also at a much lower cost. Due to advances in image processing, companies can analyze data much faster and more accurately.

UAVs can periodically assess the condition of highways and roads and highlight areas which need maintenance. UAVs can also check for structural damage identify risks on key assets like bridges and tunnels. Periodic assessment will help relevant authorities to undertake proactive maintenance drives rather than reactive ones thus increasing the lifespan of roads.

Leveraging associated technologies with UAVs

- Artificial intelligence can be used to count the number of potholes on the road
- IoT devices can transmit data from UAVs to remote centers where experts can assess the extent of structural damage to roads without actually having to visit the site in real time
- Artificial intelligence combined with GIS information can help map the location of various road signs and check for any structural damage on them as well
- 3D modeling can provide up to date contour maps which can be used to identify risks as well as provide supporting information to check whether associated assets like drainage system on the roads will be sufficient

Security and surveillance

A highway network is one of the most critical assets for an economy. Providing security along this vast complex network can pose critical challenges. It can become difficult to identify curb side encroachments on highways if not periodically checked. In addition, UAVs can help map risks to assets such as construction of an overhead bridge on a highway or condition of railway crossings and whether it is manned or not. UAVs can also help map assets along the highway network; things like emergency response shelters, toilets, bridges, tunnels, crossings etc.

Up to date information on the terrain around highways can also help mitigate natural disasters. UAVs can act as first responders in case of natural calamities to quickly assess the extent of the damage caused by the disaster.

Leveraging associated technologies with UAVs

- IoT devices can relay the information captured by UAVs to remote emergency response centers to send appropriate equipment with the emergency response team
- GIS mapping and artificial intelligence can be used to train computer vision models to map assets like emergency response centers, bridges etc. along the highway network



D. Mining

The mining industry is one of the sectors where drone usage has untapped potential to deliver significant value for businesses. Mines are spread over very large geographic areas which can become difficult to monitor using traditional methods. UAVs provide a faster and more cost efficient solution than traditional methods and hence the potential for their application in the mining industry.

UAVs are currently being tested and implemented mostly in open-cast mining, where they are replacing labor intensive methods of inspection, mapping and surveying, as well as ensuring safety on the extraction site. The paper explores applications for UAVs in the mining industry across planning, operations, environment protection and security.

Planning

Open-cast mines usually cover several square kilometers, on varying surface levels, [15]which translates into long routes for land vehicles and crew. UAVs can be used to quickly map the area, optimize hauling routes and provide control information. Such virtual copies of data can be used to visualize changes to a site over time.

Information gathered from UAVs can also assist with blast planning at the site and help minimize the risks associated with such activities. A single comprehensive source can enable mine operators to plan their activities in various parts of the mine and communicate their scope of work thus utilizing the resources more efficiently.

A large cement manufacturer is using UAS for monitoring its mine operations. UAS is used to monitor the work done by contractors on the quarry site. They are also using associated technologies for blast planning and calculating inventory volumes

Leveraging associated technologies with UAVs

- 3D modelling of the mine for blast planning and scope of work estimation
- 3D models can also be used to better design transportation routes along the mine
- High definition images can also help in analyzing the rock and soil composition in the area. UAVs can also act as transporters in this area facilitating in transfer of samples from the site location to the lab
- The information collected through site surveys can be relayed to remote operating centers through IoT devices where experts can offer their expertise

Operations

[16]UAVs can assist in traffic management at the mining site as well thus helping operators to optimize the design of haul roads, extract locations, loading floors, stockpile locations etc. Further, the information collected from UAVs can also be used to assess the degree of slopes to ensure compliance to standard operating procedures and thus ensuring safety of the crew deployed at the site.

Blast planning is another core operational activity which can be optimized using the information collected from UAVs. 3D models can help mine operators optimize blast parameters and carefully predict the extent of blasts and the volume of material that will be cleared from the blast.

Leveraging associated technologies with UAVs

- 3D modelling can be used to create models for potential blast sites and estimate the scope of work accurately
- Given the wide geographic area that a mine covers, project managers need not travel to all the locations. IoT devices coupled with UAVs can transmit real time feed to remote operating centers where mine operators can prioritize and schedule their visits to critical areas.
- Artificial intelligence and GIS mapping can be leveraged to automatically map the location of key heavy machinery equipment at the site.
- Artificial intelligence and 3D modeling can be used together to detect locations of stockpile and estimate volume of the material excavated

A large Indian steel multinational has used drones on a pilot basis to monitor mining activities.

The objective of the drone application in mine monitoring covers surveillance of the mining area, lease boundary inspection, inspection of safety zone, counting vegetation in reclaimed area and quarry and dump profiling for volume calculations

Environmental protection

One critical application of UAVs on a mining site can be to identify contour maps for identifying water drainage patterns in a site. The information collected from UAVs can assist mine operators in assessing the health of dams, watersheds, drainage systems and other water management assets based on the current topography of the site.

UAVs can also provide information to detect erosion by tracking changes in vegetation or the topographic surface of the mine. This information can help mitigate risk at the mine site and save precious time and lives as well.

Leveraging associated technologies with UAVs

- 3D modelling can help create contour maps to help identify drainage patterns and catchment areas
- 3D models can also help in detecting potential risks like soil erosion
- Remote monitoring through AR/VR IoT devices

Security and safety

Safety of the workforce deployed at the site is one of the prime concerns for any mine operator. UAVs can provide quick solution to ensure compliance at the site. For example, periodic flights can be undertaken to assess the condition of roads or the equipment deployed.

UAVs can also act as first responders to locations which can be difficult to access in a mining site. For instance, roads are often long and winding in any mine site and it can take hours to go from one location to another in a mining site. The information collected through drones as first responders will help deliver the right aid at the location in the very first time thus saving precious time.

Leveraging associated technologies with UAVs

- Using artificial intelligence to automatically detect if the personnel deployed at the mining site are wearing hard hats or not. Further, face recognition can help identify the people who are not complying with the protocol.
- 3D modelling of the site can help us ensure compliance of roads; whether the roads are wide enough or whether the slope of the road is under the limit
- In case of disasters, UAVs can provide real time feed to emergency personnel to better prepare their response to the emergency
- Thermal payloads on UAVs can detect encroachments or illegal mining activities at night

[15] http://waypoint.sensefly.com/lafargeholcim-drones-stockpile-efficiency-video/

[16] https://www.thehindubusinessline.com/companies/tata-steel-using-drones-to-monitor-jharkhand-mine/article9483156.ece



E. Railways

Like highways, UAVs have a natural application in managing and providing insights across the life cycle of a railway network. Railway networks are often complex, spread almost in the entire country through plains and mountains alike. UAVs become the natural choice for the platform to provide information about this system in a quick cost effective manner.

The paper explores applications of UAVs in railways across layout design, construction, maintenance and security.

Layout design

Preparing a DPR in railways is a tedious task as rail lines can spread over thousands of kilometers and the process can take several months. UAS offer a unique solution which can better equip teams on the ground and on the project with more information. Visibility into a much more detailed scope of work will lead to accurate planning for the project which in turn will help optimize the capital that needs to be employed in the project. Using the feed from the UAV, project managers can identify risks or potential delays in the project before the construction begins.

Leveraging associated technologies with UAVs

- 3D models can help engineers identify curvatures of tracks that need to be built
- 3D terrain modelling can help to draw accurate plans with information on
- Cut and fill volumes for preparing land
- Scope of work estimation in cutting mountains or building tunnels
- IoT devices capable of transmitting data over the internet can transmit the findings to engineers sitting in remote locations to view the site
- 3D modelling and VR, can allow engineers to visit the site in a virtual environment any number of times for review and analysis

Construction

In any railway line construction the most critical asset that you have is the track laying machine. Most project managers would aim to run their operations in such a way that the track laying machine never stops. Through the information captured from a UAV, project managers can track the status of the various construction[17] activities while constructing a railway track, for example, whether the formation has been built, ballasting has been completed, steel rails have been laid, etc.

UAVs can provide details on the amount of raw materials present on site to ensure that there are no delays in construction due to unavailability of raw materials. Further, real time monitoring allows project managers to anticipate construction challenges and reduce delays. UAVs and its associated technologies can provide ground reality across various projects to the higher management in real time.

Leveraging associated technologies with UAVs:

- Using artificial intelligence and GIS mapping to detect the location of the track laying machine and hence calculate the length of track laid
- Artificial intelligence can also be used to count the number of sleepers that have been laid on site or the number of bolts attached to the rails
- 3D modeling can also help determine the volume of raw material present on site and whether it will be enough for work to be completed on site
- Using IoT to transmit live feeds to remote operating centers where experts can provide insights to ground teams in real time
- GIS enabled 3D models can help project managers map potential risks to construction, for example a bridge or a big rock much before so that adequate measures can be taken

Maintenance

[18]Since railway tracks have a much longer lifecycle, maintenance is a critical part of running a rail network. Today, most such work is performed manually, based on in-person inspections which is a slow and costly process. Today UAVs can not only locate defects faster but also at a much lower cost. For example, UAVs can monitor the status of electrical works along the railway track and check for anomalies. UAS can also check the state of the railway lines to check for corrosion and vegetation growth.

UAVs can periodically assess the condition of railway lines and highlight areas which need maintenance by leveraging associated technologies along with UAVs. UASs can also check for structural damage identify risks on key assets like bridges and tunnels. Periodic assessment will help relevant authorities to undertake proactive maintenance drives rather than reactive ones thus reducing the downtime due to maintenance and mitigating risk.

Leveraging associated technologies with UAVs:

- Using artificial intelligence to detect structural damage on bolts attached to sleepers on railway tracks
- IoT devices can transmit data from UAVs to remote centers in real time where experts can assess the extent of structural damage without actually having to visit the site
- Thermal cameras can detect if there are any locations where tracks are getting overheated due to friction or corrosion

Security

[19]The rail network in India is one of the largest in the world and monitoring such a vast network can pose serious challenges. Periodic inspections by UAVs can help cut down the time required to monitor rail assets. In addition, UAVs can help map risks to assets such as construction of an overhead bridge on a railway track or condition of railway crossings and whether it is manned or not.

UAVs can act as first responders in case of natural calamities to quickly assess the extent of the damage caused by the disaster on a railway network. The information gathered through the UAV can provide crucial insights to emergency personnel so that they can better respond to the disaster.

Leveraging associated technologies with UAVs

- IoT devices can relay the information captured by UASs to remote emergency response centers to send appropriate equipment with the emergency response team
- Artificial intelligence can help train computer vision models to identify encroachments near the railway network
- In the next section the paper explores why "Make in India" makes sense for UAS in India. The paper delves into some key drivers and comparisons between Indian trends with the west.

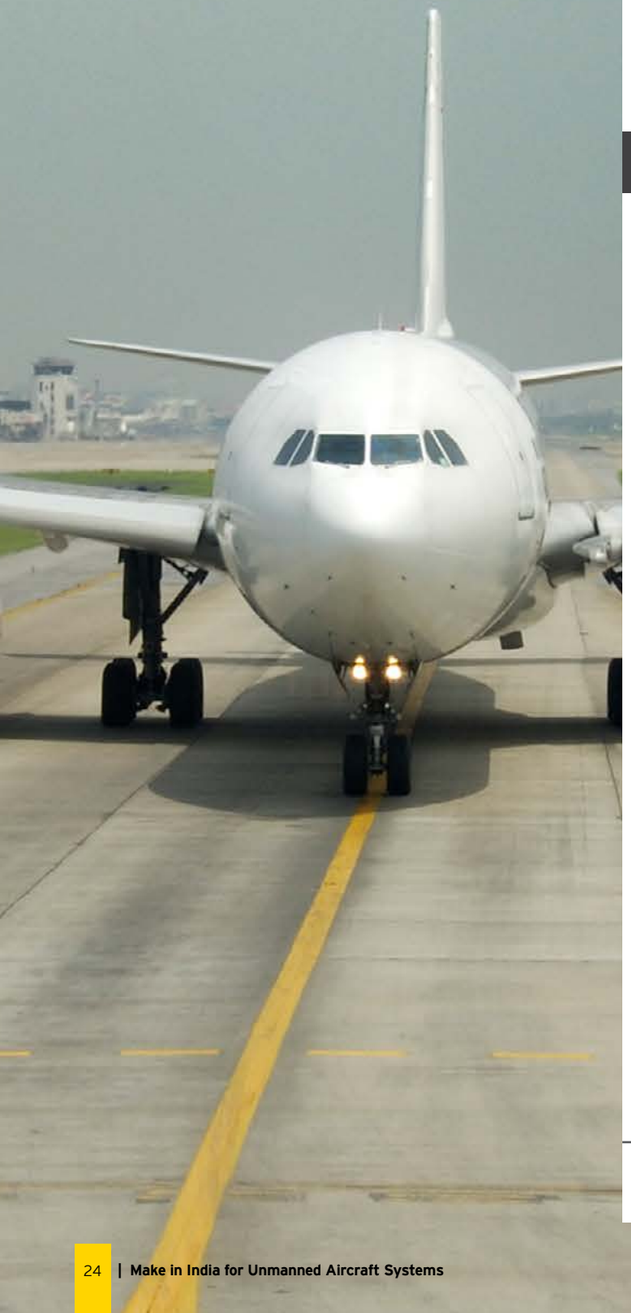
[17] https://yourstory.com/2018/01/railways-use-drones-monitor-projects/

[18] https://www.smartrailworld.com/it-and-wifi/how-drones-are-already-being-used-by-railways-around-the-world

[19] https://www.smartrailworld.com/it-and-wifi/how-drones-are-already-being-used-by-railways-around-the-world

4. Taking flight:

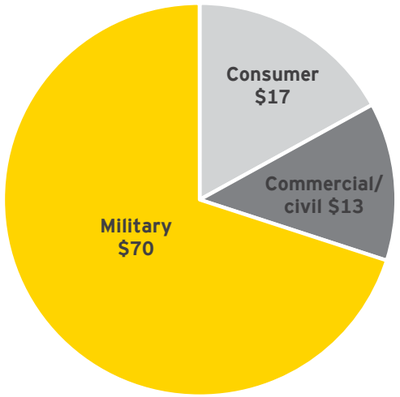
Why make in India for UAS?



As seen in the previous section, there are a lot of opportunities to leverage UAS systems and associated technologies across some key industries. In this section the paper looks at global and Indian trends in this market as well as compare regulations with a couple of key markets and how India needs to create that environment for UAS companies to "Make in India". In the end the paper looks at some of the companies who are ahead of the curve and have already started making UASs or components of UAS in India.

A. Global investments

The commercial drone market has experienced substantial growth as a result of growth in the range of civil applications. UAVs have been leveraged by different industry sectors, such as Agriculture, Mining, Power and Utilities, Railways, Construction, Highways, Delivery and Media. Goldman Sachs estimates that drone technologies will reach a total market size of US$100 billion between 2016 and 2020. Though 70% of this figure would be linked to military activities, the commercial business represents the fastest growth opportunity, projected to reach US$13 billion between 2016 and 2020[20].



[20] http://www.goldmansachs.com/our-thinking/technology-driving-innovation/drones/

McKinsey reports also estimate that by 2026, the commercial drones—both corporate and consumer applications—will have an annual impact of US$31 billion to US$46 billion on the USA GDP[21]. As per the report, some of the most innovative drone applications may take years to develop, stakeholders—government officials, investors, regulators, members of the UAS industry, and corporate adopters—must understand how the landscape is evolving and begin refining their UAS strategies now if they want to branch beyond their current uses and capture additional value.

An increasing number of countries are allowing the commercial use of UAS. Countries like USA, Canada, UK, Australia and New Zealand have come up with varied approval procedures governing the use of unmanned aircraft systems.

The market opportunity outside the US has attracted a number of new, early-stage (seed/angel or Series A) drone companies, many of which have launched in different markets that span across at least 11 countries outside of the US[22]. There are over 23 countries around the world that are home to drone companies with disclosed funding[22]. Private active drone companies outside the US have US$1M+ in total disclosed funding and that have raised an equity round since the start of 2015[22].

When combining total funding of all private drone companies within a country, China is far and away the most well-funded with nearly US$262M in collective disclosed equity funding since 2015[22]. Canada falls second with just over US$90M, Israel third with close to US$37M, and the UK took fourth with a mere US$37.56M, across the same time period[22].

Drone activity currently spans four of the seven continents, with Europe having the most active countries[22].

Civilian drones potential growth in India

The immense potential of drones has led to their increasing adoption in India, too. Though both the industry and the market in India are at a very nascent stage at the moment, there is immense growth potential for both. A major thrust will be given by the willingness of the present Indian government to use drones for a variety of purposes, including crop mapping and surveillance of infrastructure projects, pushing the projected value of the domestic industry to approximately US$421 million by 2021[23]. According to 6Wresearch, the Indian Unmanned Aircraft Vehicle market is projected to grow at a CAGR of 18% during 2017-23[24].

[21] https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are -here-the-future-of-unmanned-aerial-systems

[22] https://www.cbinsights.com/research/most-well-funded-private-drone-companies/

[23] https://carnegieindia.org/2017/03/10/civilian-drones-and-india-s-regulatory-response-pub-68218

[24] http://www.6wresearch.com/press-releases/india-uav-market-unmanned-aerial-vehicle-share-trends-forecasts-size-growth-opportunity-media-news.html



B. Comparing Indian and Global Regulations

We think proactive regulations will support the drone technology to enter various industries which could enhance safety, reduce disputes and identify pilots' obligations.

Analysis of India's draft policy for civil RPAs with an equivalent policy in the US and China for small UAS

The US Federal Aviation Administration (FAA) on its part published its final operational rules for the commercial use of small drones weighing under 55 pounds[25]. In December, 2015 China's civil flight regulatory body Civil Aviation Administration of China (CAAC) published an Interim Provisions on Light and Small Unmanned Aircraft Operations (UAS Operation Provisions) to regulate the operation of unmanned aircraft systems (UAS) with a maximum empty weight of 116 kilograms or less, or a maximum take-off gross weight of 150 kilograms or less, and a calibrated air speed of no greater than 100 kilometers per hour[26]. The following is the comparison of the salient features of the India's draft policy with the policies existing in a couple of other countries on a few parameters:

	India's RPA Policy	US's small UAS Policy	China's UAS policy
Applicability for now	All RPAs	Only small drones weighing under 55 pounds (including attached systems, payloads and cargo)	For small drones weighing between 1.5KG to 150 KG (including attached systems, payloads and cargo) and calibrated air speed not greater than 100km/h25[26]
Categorization	Based on Maximum Takeoff Weight (MTOW)	Based on MTOW	Based on MTOW
Security or Safety Aspect	DGCA should be informed prior to sale or disposing of the RPA or in case of damage	License holder is required to cancel registration through the FAA's online registration system in case of sale, loss or transfer of UAS	Manufacturer and owner to register through CAAC online portal to obtain license. Account holder is required to cancel registration through the CAAC's online registration system in case of sale, loss, damage, discarded, stolen or transfer of UAS[26]
Training requirement for remote pilots	▶ Minimum age requirement – 18 years ▶ Practical training with a proportion of simulated flight training ▶ No-fly zone awareness ▶ Safe recovery mechanisms ▶ Not applicable for nano and micro category RPAs	▶ Minimum age requirement – 16 years ▶ Remote pilot airman certificate with a small UAS rating or under the direct supervision of a person who holds a certificate	▶ Minimum age requirement – 16 years (14 years with adult supervision) ▶ Practical and Theoretical knowledge training ▶ Safety operation skill assessment method ▶ Training on aircraft aerodynamics and flight principles ▶ Training on Aviation regulations and flight around the airport ▶ No-fly zone awareness ▶ Universal emergency operation procedures ▶ Training on UAV system features and components[27] ▶ Not applicable for drones weighing less than 1.5 KG

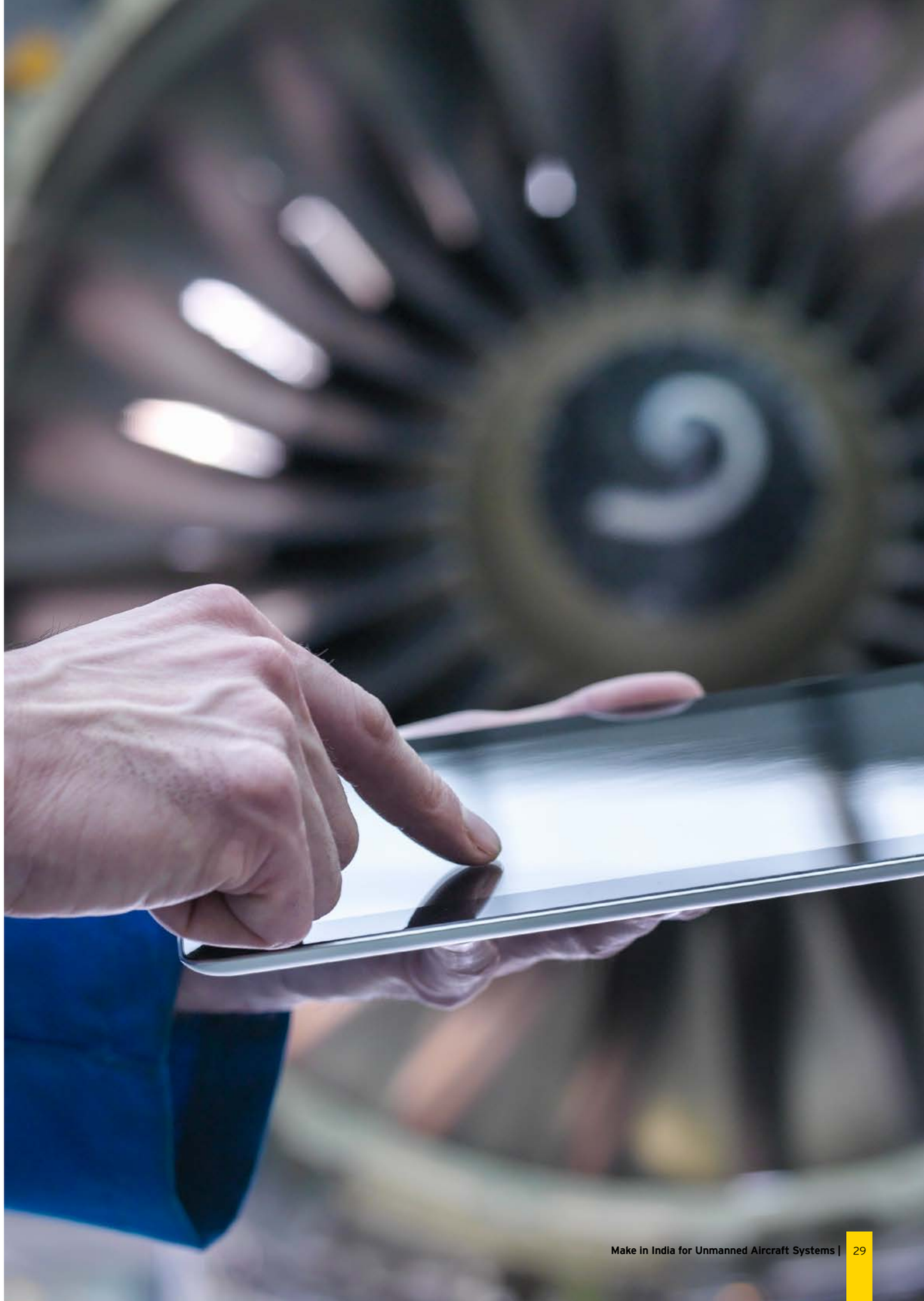
[25] thttps://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22615

[26] https://www.loc.gov/law/help/regulation-of-drones/china.php

[27] http://www.caac.gov.cn/HDJL/YJZJ/201606/P020160602508407084069.pdf

	India's RPA Policy	US's small UAS Policy	China's UAS policy
Requirements for operation of RPA*	▶ Nano and Micro RPA operative up to 50 feet and 200 feet respectively above ground level exempted from filing flight plan and obtaining Air Defense Clearance ▶ Only during daylight (between sunrise and sunset) ▶ All RPA operations to be day operations and within visual line of sight only ▶ Minimum ground visibility of 5 km ▶ No RPA shall be flown from a mobile platform ▶ RPA shall not discharge or drop objects unless specially cleared via UAOP ▶ Only nano RPA exempt from informing local police authority prior to commencing operations ▶ No specifications yet on the speed of the RPA	▶ Maximum altitude of 400 feet above ground level or higher (only if it remains within 400 feet of the a structure) ▶ Operations in Class G airspace allowed without any air traffic control permissions ▶ Day light only operations/ civil twilight (30 minutes before sunrise and 20 minutes after sunset) ▶ With the visual line of sight only of the remote pilot in command/ visual observer ▶ Minimum weather visibility of 3 miles from the control station ▶ No operation from a moving vehicle unless the operations are over a sparsely populated area ▶ Not faster than 100 miles per hour	▶ Maximum altitude of 120 meter (~400 feet) above ground level or higher ▶ Real-time online systems to record flight data and prevent flight into prohibited areas ▶ UAS flying within visual line of sight (VLOS) must be operated in the daytime ▶ UAS flying beyond visual line of sight (BVLOS) is not restricted with operating times, but a certain regulatory framework for addressing emergencies applies to BVLOS flights ▶ Both UAS flying within VLOS and BVLOS must give way to manned aircraft ▶ Air speed of no greater than 100 kilometers per hour ▶ UAS operators to buy insurance for UAS covering liability for third parties on the ground[26]
Enforcement action	Cancellation of UAOP if the performance is no longer acceptable or if there is a breach of the compliance that may attract penalties	FAA may impose civil sanctions in instances of fraud and falsification for matters within its jurisdiction	CAAC will impose limitations with respect to the use of UAVs and punishment by regulatory authorities in accordance with relevant regulations[26].

As seen in the comparison above, the market regulations in US and China are both conducive towards leveraging UAS applications to maximize the benefit which organizations can get from such operations. For example, allowing higher altitude flights would mean that more area can be scanned in a shorter flight. Further, allowing heavier payloads without much restriction allows organizations to carry out operations for a longer duration with the desired payloads. Lastly, streamlining the process with fewer touchpoints with the government and taking the process online reflects the ease with which businesses can leverage the applications of UAS. All these factors reflect in the amount of investments that people have put in this market as highlighted in part A of this section. This capital is further reflected in the innovations driven by companies from these two nations.





C. Government bodies leading the way

When it comes to India, government bodies have been leading the way when it comes to applications of UAS with several large India government bodies and PSUs leveraging the use of UAS in their operations. The variety of applications is already deeply diverse:

- As part of the road-widening project executed by the Highways Authority of India, several Indian start-ups are assisting in the 3-D digital mapping of the Raebareli–Allahabad highway. The data gathered by UAVs are playing an incremental role in the computation of compensation for those whose property rights are affected by the project[23].
- Similarly, Railways in India is planning the bidding process for 3-D video mapping of the entire dedicated freight corridor network of 3,360 kms (roughly 2,000 miles) using drone technology[28].
- The state-owned power corporation has obtained approval from a committee representing the Ministry of Defence, Ministry of Home Affairs, and Power to use drones for monitoring project development. The organization believes that this can render the monitoring of projects in hilly terrains particularly cheap and efficient[29].
- The ability of drones to monitor surface integrity, take measurements, and assess wear and damage has prompted the thermal power corporation to consider their deployment for solar panel inspection, predictive maintenance, and surveillance and intrusion detection in solar power plants[30]. Drone-powered execution of infrared detection in solar photovoltaics can have monumental positive benefits for India[31], as the country attempts to achieve its stated goal of 100 gigawatts of solar capacity by 2022[32].
- An Indian state-controlled coal mining company has applied for permission from the Ministry of Home Affairs and the Ministry of Civil Aviation to start using drones for aerial surveys of coal blocks that come up for exploration, in order to assess the extent of greenery to be restored after mines are closed[33].
- An agency for coordinating response to natural or man-made disasters has already been relying on the delivery and tracking capabilities of drones to handle disaster relief and rescue in India[34]. Similarly, during elections in the State of Chhattisgarh, the Central Reserve Police Force used UAVs for patrolling an area of 40,000 square kilometers and providing round-the-clock surveillance[35]. The Government of Uttar Pradesh has used drones for maintaining law and order at the Kumbh Mela festival, and so have the police during the grandiose Ganapati festival[36]. Drones helped the police identify seventy bags of bricks stocked for use as projectiles by rioters during the riots in 2014, and they could take pre-emptive action[37].

UAS market in India has a lot of potential. As seen in previous sections there is clearly a lot of scope for UAS application and adoption in India. We have seen how global regulations induce a market for growth for UAS companies as well as allow companies to reap maximum benefits from UAS. Today, in India there are very few players in the market that can provide such services and cater to such a large market. Regulations will have to pave the way for such an adoption but that shouldn't deter companies from investing in India and in this market because once the regulations get formalized, we will see a lot of industries and companies adopting UAS across their operations. Importing UAS to keep up with demand at that time may not be possible as there are countries which have put drones on an export blacklist. To cater to the demand of the future, companies need to invest and the push has to come today from both the government and the private industry.

In the next section the paper will touch upon some of the challenges that companies are facing today and discuss some key considerations for companies before adopting a UAS offering.

[28] https://economictimes.indiatimes.com/news/science/how-various-ministries-are-exploring-the-use-of-drones-for-effective-infrastructure-creation/articleshow/52919438.cms

[29] https://www.business-standard.com/article/economy-policy/eye-in-the-sky-drones-to-monitor-power-projects-116012000482_1.html

[30] Rahul Wadke, "With Drones, Energy Firms Get an Eye in the Sky," Hindu Business Line, June 16, 2016, http://www.thehindubusinessline.com/companies/with-drones-energy-firms-get-an-eye-in-the-sky/article8737622.ece

[31] Electric Power Research Institute, "Utilizing Unmanned Aircraft Systems as a Solar Photovoltaics Operations and Maintenance Tool," Transmission and Distribution World, August 2015, http://tdworld.com/site-files/tdworld.com/files/uploads/2015/06/epriuav.pdf.

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[33] Debjoy Sengupta, "Coal India Plans to Use Drones to Conduct Aerial Surveys of Exploration," Economic Times, February 11, 2016, http://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/coal-india-plans-to-use-drones-to-conduct-aerial-surveys-of-exploration/articleshow/50938224.cms

[34] Neha Sethi, "Drones Scan Flood-Hit Uttarakhand," Livemint, June 24, 2013, http://www.livemint.com/Politics/ZDib5YWR1G2Mcuth1kbwyO/Drones-scan-floodhit-Uttarakhand.html.

[35] Monika Chansoria, "Proliferated Drones: A Perspective on India," Center for a New American Security, June 2016, http://drones.cnas.org/wp-content/uploads/2016/06/A-Perspective-on-India-Proliferated-Drones.pdf.

[36] Nidhi Singal, "FIying Outlaws," Business Today, October 25, 2015, http://www.businesstoday.in/magazine/special/technology-special-2015-unmanned-aerial-vehicles-have-huge-potential/story/224416.html.

[37] Pranav Dixit, "Something in the Air: Drones Finally Making a Comeback to Indian Skies," Hindustan Times, April 6, 2015, http://www.hindustantimes.com/tech/something-in-the-air-drones-finally-making-a-comeback-to-indian-skies/story-Ka0UCL1nwB9ONoRU4Nuw4M.html.

5. Head winds before take-off:

Current challenges and considerations

This section of the report talks about some of the challenges which companies and UAS service providers are currently facing when it comes to executing a UAS project. Later the report will look at some of the considerations that companies should think about while evaluating a UAV offering.

A. Policy challenges

Current regulations of Government of India

Director General of Civil Aviation (DGCA) has issued draft guidelines on UAS through the circular titled "Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS)". The intent of the government is clear – to put in place a regulatory framework in order to encourage the commercial use of drones in areas as diverse as industrial monitoring to disaster management. The draft policy is expected to be formalized soon. Once approved, it would provide the existing players a momentum to further their scope of activities. It would, however, be a boost to the segment if a few basic points, including the ones below, are considered while formulating the final policy.

Broadening the classification

The current draft policy classifies UAS as Micro (< 2 kgs), Mini (>2 kgs, <20 kgs), Small (>20 kgs, <150 kgs) and Large (>150 kgs). Given that Micro and Mini classifications encompasses a wide range of toys and mini drones. As this is a low risk category, there is scope for further re-categorizing Civil RPA in accordance with Maximum Take-off Weight (MTOW). The current draft policy enumerates an MTOW-based classification where the micro category comprises UAVs weighing up to 2 kg and the mini category consists of UAVs weighing up to 25 kg.

AGL restrictions

The policy proposes that for operations at or above 200ft Above Ground Level (AGL) in uncontrolled airspace, the Unmanned Air Operator shall file a flight plan and obtain necessary clearances with concerned Air Traffic Services (ATS) unit. In many applications, for example in Power and Utilities, transmission towers have a height of upto 350 feet. A limit of 400 feet AGL is more practical threshold than the current 200 feet levels. A 60-meter ceiling level is a bare minimum and might restrict the application for UAVs. This would then also be in line with the policies of other countries like US, Which has 400 feet AGL threshold.

Research and development

The draft circular should also include a separate class of RPAS to be created for research and development purposes. Experimental and under-development technologies do not always fall under previously established norms and will require a special class permitting operations.

Ease of Doing Business

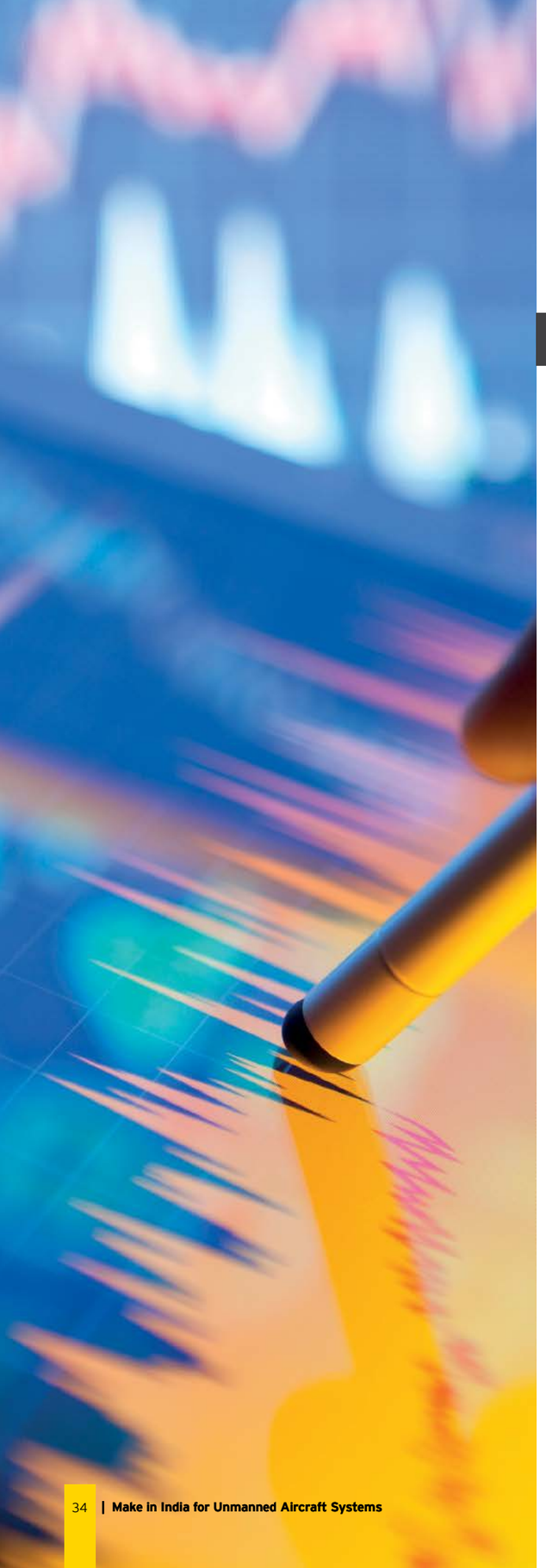
The draft policy should also promote the concept of ease of doing business. The mechanism of single window is not encouraged and the users are required to approach multiple government agencies such as Wireless Planning & Coordination Wing, Ministry of Home Affairs, Local Police, ATS provider etc. to take approvals and clearances.

Training

In order to enable the market and resolve the supply challenges, the draft policy should indicate setting up of a training institutes in partnership with Defense and security Forces and Foreign Institutes which can generate employment opportunities for Indian youth and provide skilled manpower in this booming sector.

Responsibility

As per the draft policy, owner/ operator will be held responsible for the safe custody, security and access control of the RPAS. Role of other stakeholders such as RPAS Manufacturers, Importers, DGCA, Security Agencies for implementing Anti-Drone technologies etc. are not clearly highlighted in ensuring Security/ Safety aspect of RPAS operations.



B. Market challenges

As seen in the previous sections, there are policy challenges which are hindering organizations from maximizing their utilization of UASs in India currently. Once the draft policies get finalized, a lot more organizations will explore the usage of UASs in their operations. However, the market needs to be ready to satisfy the demand which will be created.

Building an ecosystem

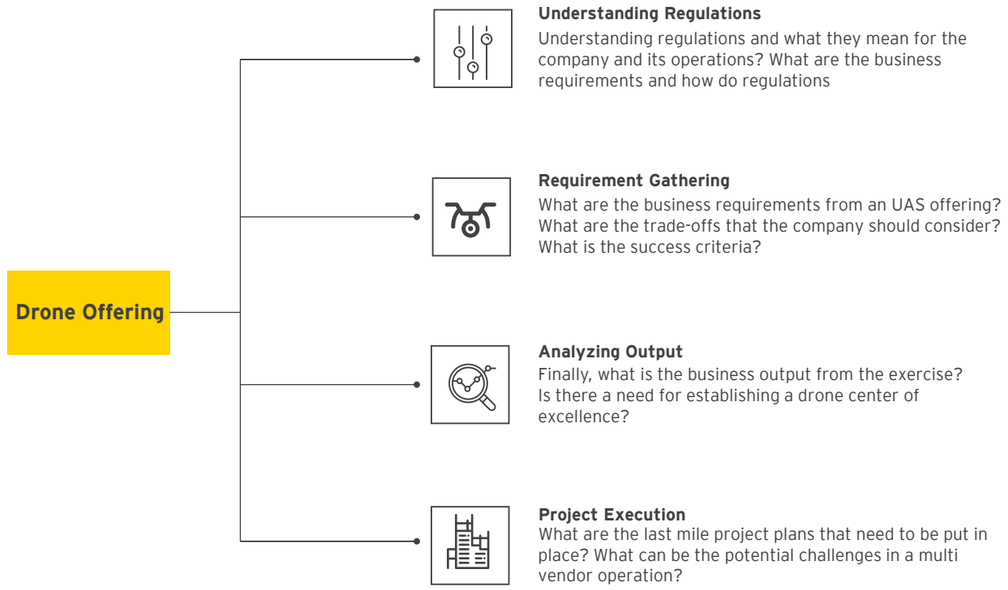
As seen before, today, only a handful of companies are manufacturing UAV in India. These companies may not be able to meet the demand once UAS regulations get finalized. Further, these companies have not yet fully explored the usage of UAS across industries leveraging emerging technologies like AI, AR/VR, IoT and 3D modelling. UAS companies are still focusing on primary applications for UASs such as real-time monitoring which involves communicating information in real-time. UAS companies should extend their capabilities and build that ecosystem of UASs and emerging technologies to fully utilize the potential of UAS.

Training

Apart from building an ecosystem of equipment and technology providers, it is also important to set up training institutes and certification courses which impart the necessary skills to operate the UAS technology. It is important to build up this infrastructure to ensure that the industry is not bottlenecked with supply issues once the policies are finalized.

C. Operational challenges

There are four considerations that companies should evaluate before adopting a UAS offering



Understanding regulations

It is important organizations adopting UAS technologies to understand the regulations which are currently being proposed. These regulations would impact the implementation of applications in different industries. This is the foundation to any large scale implementation of UAS technology.

Requirement gathering

Implementation of large scale UAS technology applications would require gathering the right set of requirements across the value chain of the industry. Organizations should look at the potential of UAS technology in conjunction to other emerging technology areas, like 3D modelling, AR, etc. (as indicated in Section III). The right combination of UAS specifications along with the emerging technologies provides the optimized benefit for each use case.

Project execution

Next, companies should evaluate and create an operational plan to integrate UASs in its operations. There are four key dimensions that companies should evaluate; platforms for acquiring data, ways to monitor the data, frequency and accuracy of data collection and finally, feasibility of these options.

1	2	3	4
Data Acquisition Before deploying a UAS, one should evaluate whether a UAV is the ideal method for data collection or not. There are places where a UAV may not be required.	**Monitoring the data** The data collected either through UAVs or any other platform will have to be monitored to draw insights. There are several approaches that you can take to monitor and analyze the data	**Frequency and Accuracy** Organizations should also evaluate what is the desired frequency for collecting and monitoring the data. There might be a tradeoff between the frequency and the accuracy of the data collected across different platforms.	**Feasibility** The most important consideration will be to evaluate the feasibility of the entire initiative across platforms and geographies.
Buy UAVs and train pilots in-house	Establishing a Centre of Excellence	Design and Construction	Capability of the platform
UAVs as a Service	Business Intelligence as a Service	Maintenance and Security	Geographic challenges
CCTV	Technology capabilities for monitoring	Accuracy of the data collected	Return on Investment
Manual	Expected output of the exercise	Frequency for analyzing data	Government regulations

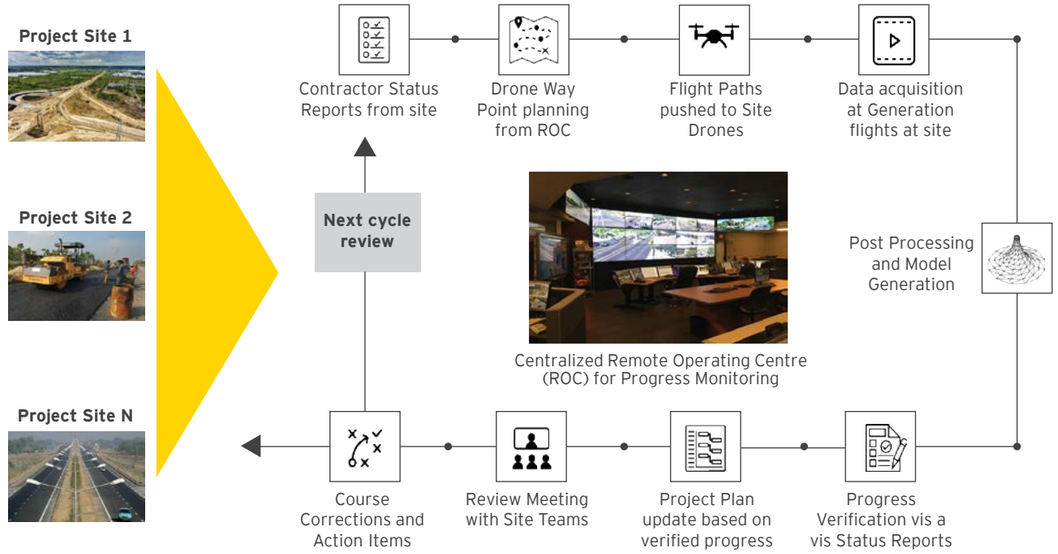
Executing a project can pose many operational challenges which one may not be able to anticipate no matter how much you plan.

Analyzing the output

UAS technologies along with other emerging technologies enables collection of rich contextual and visual data from the site. It is important for organizations to embed analytics elements while designing large UAS technology projects. Organizations would require to invest in artificial intelligence models, image processing, cloud portals and visualization technologies like AR and VR to bring the entire project together. For example, for the Power and Utilities industry, organizations would have to develop image processing models to identify power transmission system components from visual UAS feed.

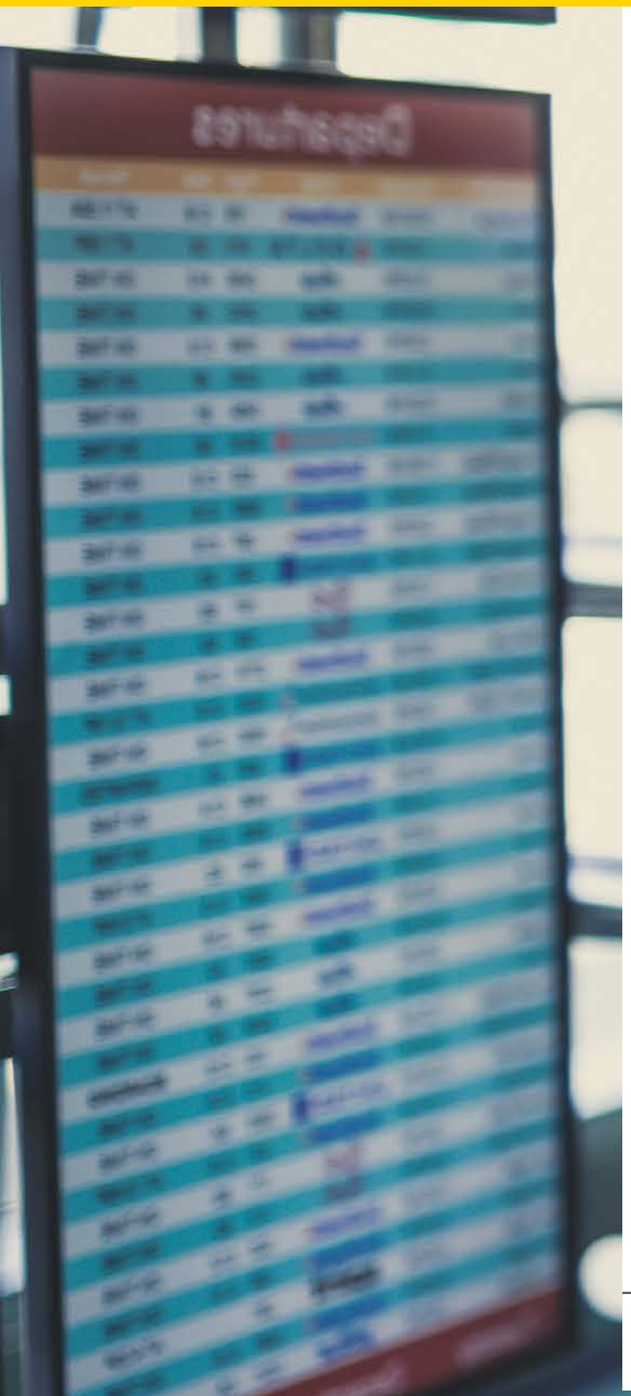
In order to bring all this data and analysis together, Organizations should think about whether there is a need to setup a centralized remote operating center that will act as a single platform for monitoring progress across a portfolio of projects and act as an internal governing body for all the projects. For example, the image below shows the schematic of how UAS technology along with other emerging technologies can be integrated together to set up a Remote operating command center for progress monitoring across multiple project sites.

The last section of this paper attempts to offer insights on the current policy along with recommendations on how the current policy can be adapted to create an environment for using UAS across industries in India for potential business benefits.



6. Charting the flight:

Next steps



The application of UAS technology has great economic value and social benefit in areas such as agriculture, aerial surveillance, research, disaster relief, environment monitoring and more. The expected introduction of rules and regulations by the Government of India as suggested below, would promote its usage in the civil application sector

Broadening the classification:

Categories beginning from mini UAS are required to meet all operational and mandatory equipment requirements. Given that 2 kg payload is lesser side, it would benefit to have another category between the micro and mini categories so as to broaden the scope of activities and also save on the restrictive mandatory requirements with respect to the classifications.

Research and development:

Government should also look at creating a separate class of UAS for research and development purposes. Experimental and under-development technologies do not always fall under previously established norms and will require a special class permitting operations. This will enable local development and testing of unmanned systems and promote indigenous research and manufacturing[38].

Sites for Testing/ Demonstration:

Government must also notify the testing / demonstration sites mentioned in the draft DGCA Circular on Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS) at the earliest

Ease of Doing Business:

An online portal for applications and approvals would make the process more efficient and transparent, thereby generating more interest and encouraging more usage. Government should also relook at the proposed procedure of issuance of Unmanned Aircraft Operators Permit (UAOP) specified in the draft DGCA circular. It is suggested that a more efficient, transparent and time bound clearances should be provided to the companies coming forward in this segment. This would also avoid any administrative delays. It is also recommended to reduce the advance time of 90 days prior to actual conduct of Unmanned Aircraft (UA) operations to 30 days to permit industry in shaping up its products in a faster way.

Training:

Government should streamline and channelize the issuance of drone pilot licenses. Pilot's operating drone in the 'min and above' category and some other use cases are required to get an Unmanned Aircraft Operator Permit (UAOP)[39]. DGCA should also consider providing a mandatory trainings in aviation regulations and navigations and certifications programs based on the UAS Class (weight based)[27]. DGCA may consider setting up Centre of Excellence in partnership with Defence & security forces and foreign institutions to provide state-of-the art training to the remote pilots[40].

License:

The Unique Identification Number (UIN) should act as a unique identifier for an organization who is submitting the UAOP for multiple drone manufacturing in the country. Nationwide operation except restricted areas and controlled zones should be allowed within same permit. Until the final issuance pf UAS usage policy, an interim usage approval on a case-by-case basis may be created.

Responsibility:

- It is also suggested that any company which has been issued license to manufacture and sell sensitive class UAs must maintain complete information related to "End Use Customers" and UAs
- It should be made mandatory to file a flight plan above 400 ft. and limitations on area of operations of UAS be restricted as per airspace class with zones being allocated for usage

Make in India:

Government should attract and promote foreign direct investment in order to supplement domestic capital, technology and skills, for accelerated economic growth. Government has taken a good step towards legalizing the civil use of drones but to make it an attractive destination for FDI they should revisit the FDI regulation and sectorial cap for civilian drones. Relaxations of FDI regulations coupled with legalization of drones in India, is likely to record heavy foreign investment in the drones industry.

Government should also extend the "Make in India" initiative to drones and not just import the entire requirement in the coming years. Government should also look at providing special benefits under various Make in India initiatives such as Skill India program which will help build Institutional capacity. The Government may promote R&D under the MAKE procedure which has been promulgated with provision for 90% funding by Government. The Bureau of Indian Standards (BIS) may also develop standards for UAS which will ensure that quality product is manufactured in the country under Make in India program.

Legal regulation:

Although India does not have any concrete laws vis- à-vis drones yet, there are various legal implications the existing laws may have on the operation of drones. Therefore, the legislators should also take into account different concerns, which may be presented due to the prospective regulations' interaction with the existing legal framework, such as Intellectual Property Rights, Security and privacy concerns and tax and work to incorporate them into the necessary legislations.

It is therefore becomes pertinent for the Government in India to move beyond existing conventional regulatory paradigms. A combined view of all stakeholders from Policy, FDI, Finance and other agencies involved in Make in India to be undertaken before finalization of the draft policy[41].

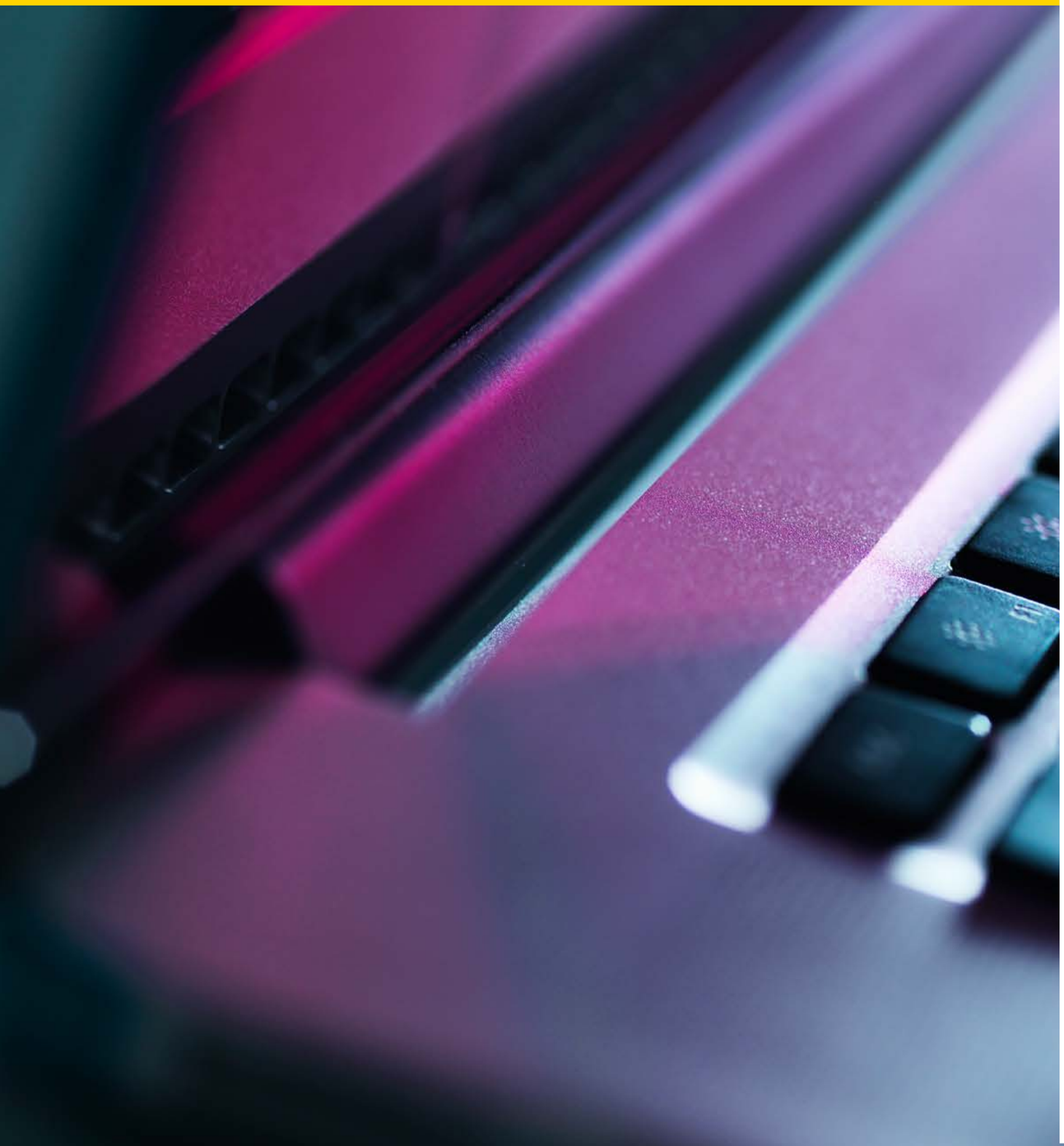
[38] FICCI RECOMMENDATIONS ON DGCA'S Draft Circular on guidelines for obtaining Unique Identification Number (UIN) & Operation of Civil Unmanned Aircraft System (UAS), May 2016

[39] https://factordaily.com/india-digital-sky-drone-regulation-industry-reaction/

[40] FICCI Survey based Recommendations on the draft DGCA circular on Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS), November 2017

[41] https://carnegieindia.org/2017/03/10/civilian-drones-and-india-s-regulatory-response-pub-68218

Abbrivations



AGL	Above Ground Level
ATS	Air Traffic Service
AR	Augmented Reality
AI	Artificial Intelligence
BVLOS	Beyond visual line of sight
CAGR	Compound Annual Growth Rate
CAAC	Civil Aviation Administration of China
DGCA	Directorate General of Civil Aviation, Government of India
DPR	Detailed Project Report
DIPP	Department of Industrial Policy & Promotion
EY	Ernst and Young LLP India
FAA	US Federal Aviation Administration
FDI	Foreign Direct Investment
FICCI	Federation of Indian Chambers of Commerce & Industry
GDP	Gross Domestic Product
GIS	Geographic Information System
IoT	Internet of Things
LIDAR	Light Detection and Ranging
LEAs	Law Enforcement Agencies
MTOW	Maximum Takeoff Weight
MHA	Ministry of Home Affairs
NDVI	Normalized difference vegetation index
PSUs	Public Sector Units
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
UAOP	Unmanned Aircraft Operator Permit
UIN	Unique Identification Number
VLOS	Visual Line-Of-Sight
VR	Virtual Reality

FICCI Homeland Security Department

FICCI has many specialised committees where key concerns of the industry are debated and discussed with the specific aim of presenting the recommendations to the Government for favourable decisions.

Considering internal security is the backbone of growth and overall development of the nation, FICCI has constituted a Committee on Homeland Security (HLS), which is working towards bridging the gap between policing and technology.

Some of the focus areas:

SMART Policing: FICCI has instituted the first ever SMART Policing Awards in India for best practices in SMART Policing, with the objective to promote initiatives taken by the Police for safety and security of Indian citizens. This can change public perception and build positive and progressive image of the police among people. FICCI SMART Policing Awards provide a platform to police officials across India to learn from the experiences of other states and also for possible adoption of the best practices to further enhance policing in their respective states.

Police Modernisation: FICCI is working towards bridging the gap between policing and technology. We engage with various enforcement agencies and provide them a platform to interact with industry, to articulate their requirements and to understand new technologies for security. This initiative is under our umbrella theme of "Modernisation of India's Internal Security Mechanism".

Smart Border Management: FICCI is working towards addressing the emerging challenges faced by India in smart border management, by bringing stakeholders together to discuss how India can create smart borders that, on the one hand, allow enhanced trans-border movement of peoples, goods and ideas, and on the other, minimise potential for cross-border security challenges.

Indian Unmanned Aerial Vehicle (UAV) Policy & Regulations: FICCI has set-up Working Groups in areas of: (a) enabling regulations for developmental use of UAVs, and prevention of rouge UAVs; (b) framework for permission and licencing for manufacturing of UAVs; and (c) technological structure for detection and neutralisation of unidentified UAVs. FICCI has recently submitted its preliminary suggestions and recommendation for Indian UAV Policy & Regulations to the NITI Aayog, Ministry of Home Affairs and Directorate General of Civil Aviation.

Policy for Public Procurement in Internal Security: FICCI is working towards advocacy for bringing well-defined procedures for fair and transparent procurement of security products and solutions, so as to provide level playing field to the industry. Although the Central Armed Police Forces (CAPFs) and State Police Forces are guided by the same policies and guidelines for public procurement as other government organizations, the nature and requirements of public procurement process for police forces is different from that of the general government departments. FICCI has provided policy inputs to the Government of India for numerous challenges in regard to procurement by Internal Security forces, in the areas of policies and regulations, processes, technological advancements and capacity-building.

Cyber Crime Management: FICCI has initiated working towards promoting development and implementation, of systems and concepts to combat cyber-crime as well as improve cyber security.

Road Safety: United Nations has proclaimed 2011-20 as the Decade of Action on Road Safety. FICCI feels that the Indian Industry can play a significant role in addressing the issue of road safety.

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Federation of Indian Chambers of Commerce and Industry

Industry's Voice for Policy Change

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Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialisation, and its emergence as one of the most rapidly growing global economies.

A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. From influencing policy to encouraging debate, engaging with policy makers and civil society, FICCI articulates the views and concerns of industry. It serves its members from the Indian private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies.

FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.

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