Drones as a Technology-Based Key Aid for the Development of Rural India

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***Abstract*: In rural development, the sole objective is to create a quality of life. In India, the majority of the population resides in rural areas. Several resource-limited countries suffered from underdeveloped infrastructures that prevented equal access to various development opportunities. Initially perceived as a toy, the drone has become one of the most essential, leading-edge, and radical inventions of the modern era. The paper reveals the necessity for drone use in the country's rural areas and presents a methodical approach to adopting drones. In addition, we discuss the newly developed uses for drones in rural areas, including their specific characteristics. This report summarises all of the essential elements of drone technology to provide a framework for utilising this technology for the development of rural areas in India.**

***Keywords:* Drone, Prior survey, Selection criteria, Rural applications.**

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INTRODUCTION

During the pre-independent era, the Indian villages were almost entirely isolated and self-contained until the mid-19th century. As all essential requirements were met in the village itself, the villagers hardly needed the assistance of outsiders. In India, the circumstances of village life began to change more rapidly than ever before due to the industrial revolution. Not all villages have experienced the same level of change. Villages near urban communities grow faster than those farther away but slower than urban communities. Urban areas are solely dependent on rural areas for agricultural products. There is always a need for rapid growth in villages, even though changes occur in various development sectors [1, 2]. A pandemic outbreak caused by the COVID19 virus has suddenly prompted development to increase. The latest technology needs to be adopted at an extremely high priority in almost all sectors of rural life.

A drone also called an unmanned aerial system (UAV-Unmanned Aerial Vehicle or UAS-Unmanned Aerial Systems), is a device that flies without an aviator or passengers (3). Therefore, radio waves are used to control them remotely. According to their applications, drones are classified as either Civil drones [4] or Warfare drones. Generally, drones are used in various fields, such as Army, Border Guard, Police, Fire Brigade, Geodesy, Agriculture, Advertising, Logistics, Energetics, and Chemicals. A drone comprises essential components such as a frame, a propeller, a control unit, and sensors. Its functions are capturing high-resolution images, viewing real-time data, and performing logistical tasks. These drones are enhanced to a great extent when they are combined with intelligent systems. The inherent characteristics of today's drones include their ability to fly about 50 - 100 meters high under any weather condition to a distance that depends on their capability and size. A drone has many electronic systems or devices, such as a power supply for its regulator, flight controller, electronic speed control (ESP), actuators and motors, digital cameras, and a SIM module.

In agriculture, drones play a prominent role in ensuring permanent monitoring of the crop in the field from planting to harvest [5,6,7]. In addition, drones can assist farmers to optimise the use of inputs (seed, fertilisers, water), to respond more effectively to problems (weeds, pests, fungi), to save time when grubbing (confirming treatment/ procedure taken), to improve variable- rate conventions in real-time, and to estimate profit from a field. Drones are becoming increasingly popular as intelligent devices for monitoring the environment and identifying potential threats [8]. It may also be used to calculate the area and volume of artificial reservoirs in rural areas [9]. Furthermore, it shows reliable results for locating animal wealth in farms, sanctuaries, and forests [10]. Using drones makes it even possible to detect underground activities and archaeological buried structures [11]. The recent developments in logistic services [12] in the trade and healthcare sectors [13-16] have demonstrated increased efficacy and cost reductions across various applications, including blood delivery, laboratory testing, medical device delivery, and drug delivery, among others. The government has taken proactive steps to shape Indian drone policies taking into account the technology's impact on the security and development of rural and urban areas. Policies include regulatory mechanisms [17] to ensure the safety and security of drone operations and technology development in collaboration with academic research institutes [18] in India. The paper mentions an Indian

village's structural characteristics. By using drone technology, villages can be developed by the local authorities. Along with their work methodology, drones can utilise various sectors in rural areas are also described.

II. Prior Survey For Adoption Of Drone To Rural Use

Around 16,265 private drone operators have registered thus far, of which 15,519 have successfully obtained their Ownership Acknowledgement Numbers (OANs). A further state-by-state breakdown of the individuals (Fig. 1) revealed that the majority originated from Maharashtra (2,564), while the second and third positions were held by Karnataka and Kerala with 1,595 and 1,472 individuals, respectively. Each of Gujarat, Tamil Nadu, and Uttar Pradesh had over 1,000 participants.

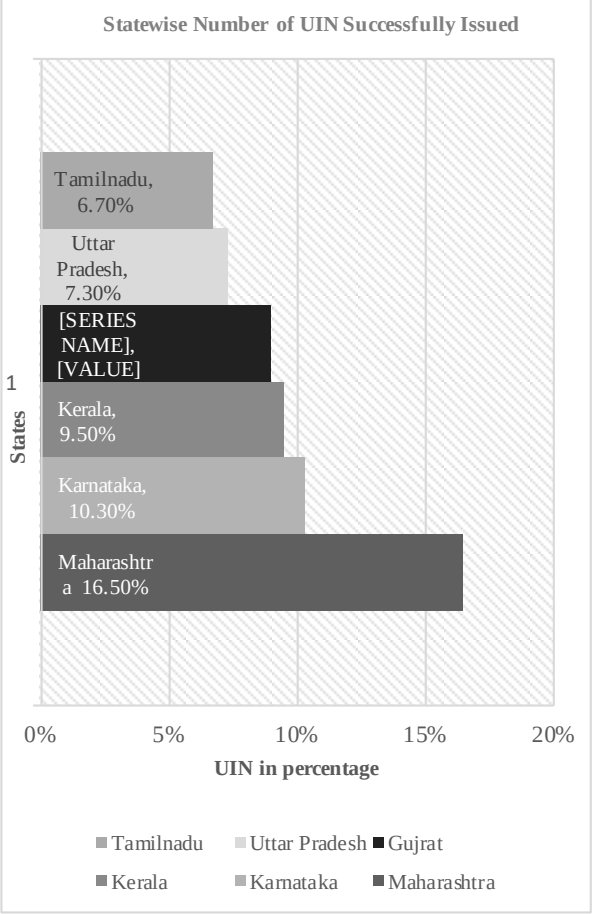


Fig.1 A state-wise break up for the UIN in percentage

The introduction of drones for rural purposes will require some prior research as a basis for calculating the return on investment. The following lines address some of the necessary surveys with their due importance.

The literacy rate and level of education in rural areas is greatly influenced by the ratio of men to women and the age group of the rural population. This in turn affects the level of awareness about drone technology. Figure 2 illustrates the gender and age distribution of primary awareness of drones in the village.

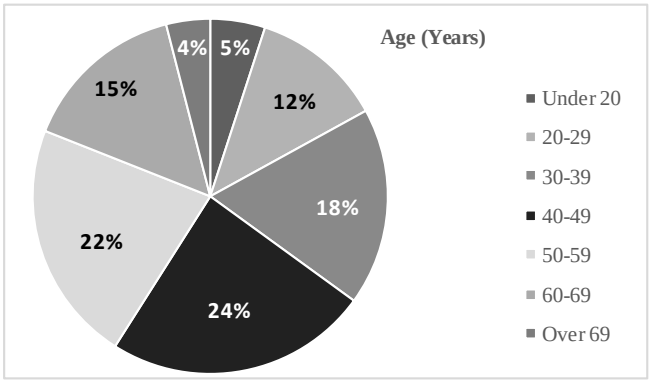


Fig. 2 Gender and age-wise primary drone awareness

As more people become aware of drone technology, they are inclined to purchase drones according to their purposes and the brands currently available on the market. In Figure 3, the various reasons for purchasing drones are shown along with their most popular brands.

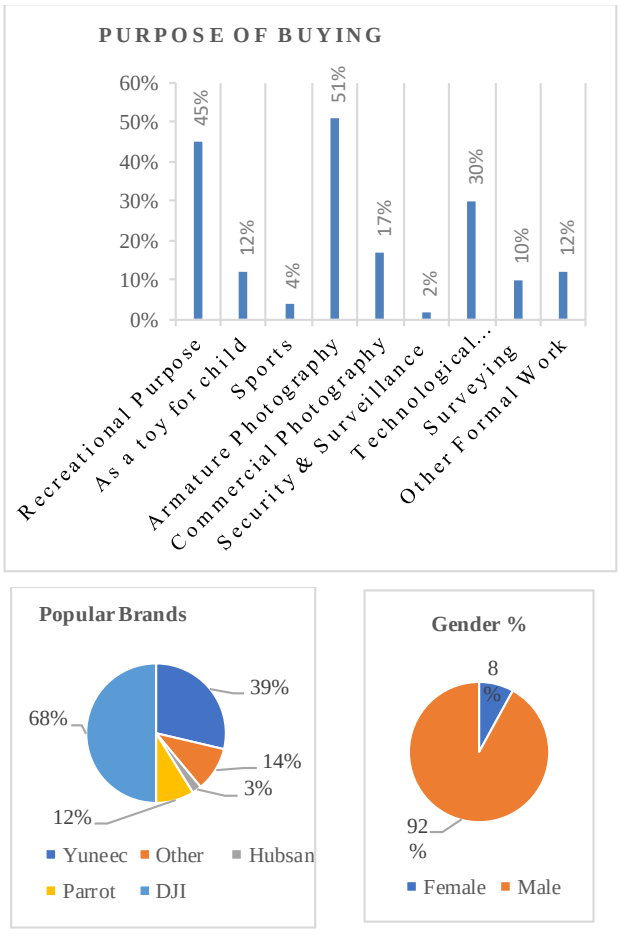
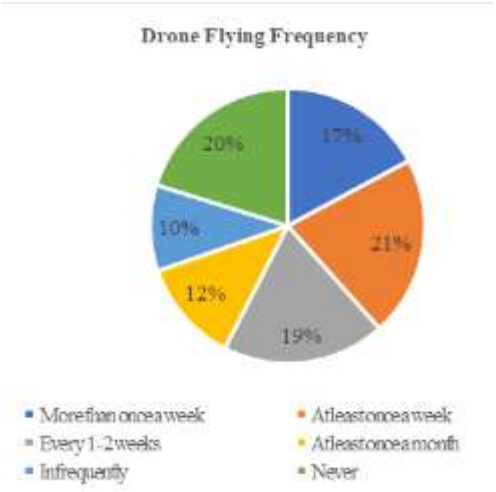


Fig. 3. Various purposes for buying the drones, popular brands users, and Gender wise users

Drones are used by their owners exclusively for the purpose for which they were acquired. This means that they can be employed in a number of locations. Figure 4 shows

the frequency and number of different locations from which drones are taken out.



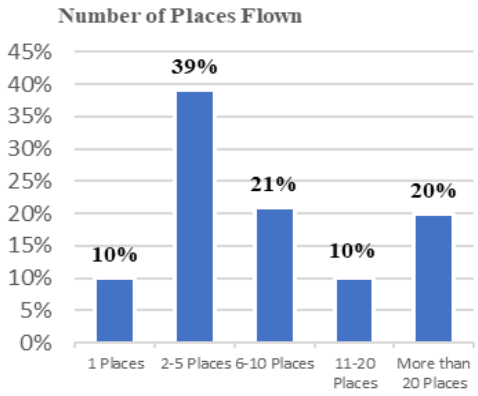


Fig. 4 Drone flying frequency and the number of locations flown

In order for a drone to be used for a specific purpose, certain major parameters need to be considered. Figure 5 provides a description of these parameters and their percentage effects.

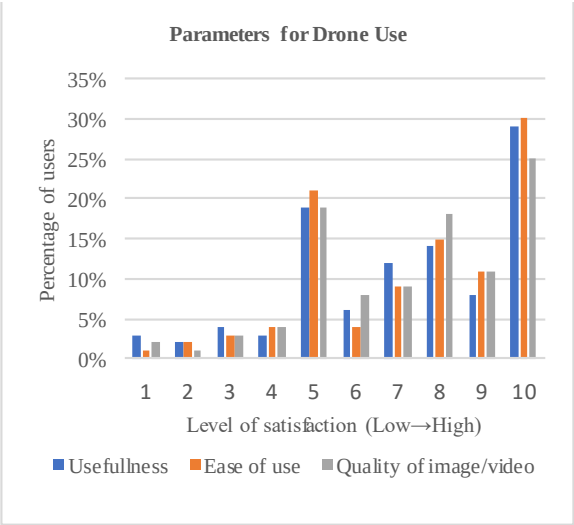


Fig. 5 Parameters for drone use for specific purposes

It is possible for drones to crash while in use. The following Figure 6 illustrates the various reasons estimated with their percentage frequencies.

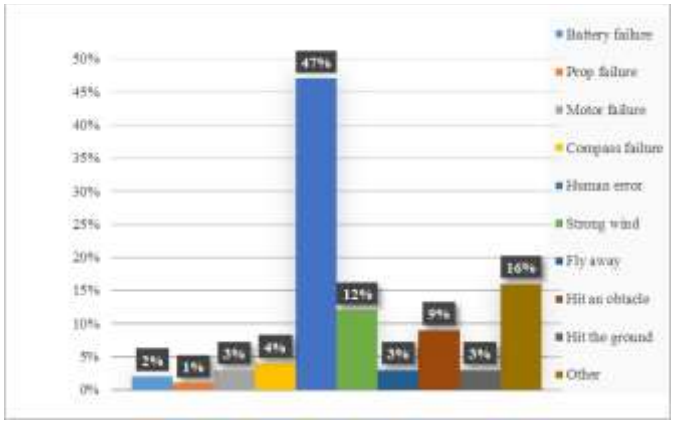


Fig. 6 Drone crash reasons

To facilitate drone manufacturing and servicing, a state or district-based drone corporation must be established [4]. In collaboration with the Anna University, the Tamil Nadu government initiated this activity as a priority. The use of such indigenous drones can be successful in many fields, such as disaster management, traffic management, urban development, education, forest and wildlife management, agriculture, mining, and other applications.

III. CRITERIA FOR SELECTION OF A DRONE FOR AN APPLICATION

Choosing the best drone for certain purposes raises a number of questions. In the case of large farm lands or pastures, for example, when using drones for agricultural purposes, the most important factors for selection are the flight efficiency and the range provided by the fixed-wing drone. On the other hand, if the farmland is small and insufficient to allow the drone to navigate or the possibility of being obstructed by harsh elements, a multi-rotor drone would be the most suitable due to its nimble and versatile nature.

As such, prior to inspecting the drone specifications in detail, it is necessary to pay close attention to the following factors.

A. Form factor

In the context of drones, form factor can be defined as the structural identity of the drone, which may be used to differentiate multirotor, fixed-wing, or vertical take-off and landing (VTOL) drones. The multi-copter or multi-rotor drone consists of four to eight rotors and flies similarly to a helicopter, while the flight of a fixed-wing drone is similar to that of an airplane. When VTOL is used, the rotors are positioned so that it can take off as a multirotor drone and fly as a fixed-wing aircraft.

B. Range (Wireless)

Depending on where the drone pilot is located, or where the wireless controller is located, it can fly the furthest distance measured on earth's surface. The range value is considerably less than that of physical distance. It is

prohibited to cross the visual line of sight (VLOS) line in a country such as the United States of America, and it is illegal to do so without an appropriate permission. This limitation limits the range of the drone to just a half mile, which is too short when compared with that of standard commercial drones. Farmers who have large fields, therefore, should be aware of all the rules and regulations related to range during drone operations.

C. Flight time with sensor payload

During a single flight, this is the maximum amount of time the drone (with all sensors and camera payloads on board) is capable of remaining in the fly mode.

D. Payload capacity

It is the maximum weight at which a drone is capable of flying. This term is important when determining which sensors can be mounted on the drone. It is recommended to use high capacity drones in cases where heavy sensors are involved, such as hyperspectral or LiDAR.

E. Range (Physical)

Range can be defined as the distance a drone can fly, measured on the ground from the position of the pilot, while reaching its maximum height and speed.

F. Cruise speed

It is the maximum optimal velocity of the drone during its flight.

IV. DRONE FOR PRECISION AGRICULTURE

Many types of drones are available for precision agriculture, but Multirotor and Fixed-Wing models are the most popular. The drone manufacturers provide the farmers with training about drone operations, but they prefer to hire skilled personnel to review their crops. It is now feasible to hire professionals and certified drone operators. The drone collects data on vegetation and plant health indices (Fig. 7). Analysing this data will allow appropriate decisions to be made regarding gross profit. The various sub-activities involved in the agricultural field include counting plants and estimating yields, measuring tree health, field performance, water pond mapping, measuring nitrogen content in wheat, measuring chlorophyll to assess plants, drainage mapping, and assessing drought stress.

Fig. 7 Farm data collection using drone *(Courtesy by DATAQUEST)*

The farmer should be very cautious in selecting the drone from the various widely-used models. Below is an example of a popular drone.

DJI drones are among the most popular drones used in agriculture. There are either multirotor aircraft or fixed-wing aircraft equipped with various sensors. There are multiple sensors on DJI drones that are capable of a wide range of tasks, including counting plants, yield prediction, tree health, height measurement, field performance, water ponding mapping, measuring nitrogen content in wheat, measuring chlorophyll to assess plants, drainage mapping, drought stress, and more. Data is collected using various sensors, such as LIDAR, 3-Band, and 5-Band. DJI drones are characterised by their performance characteristics such as intelligence and awareness, flight planning, flight control and sensors, mapping, and analysis. In Table 1, a few models' specifications are outlined.

TABLE I. COMPARISON OF DJI MAKE DRONE MODELS

Parameters	DJI Phantom 4 Pro V2.0	DJI Mavic Pro Fly More Combo	DJI Mavic Mini Fly More Combo	DJI Mavic mini	DJI Phantom 4	DJI Phantom 3 with screen
Flight Time	Approx 30 min	31 min	30 min	30 min	30 min	up to 25 min
Weight	1375 g	907 g	249g	249g	905 g	365 g
Speed	20 m/s	20 m/s	1.8 m/s	1.8 m/s	20 m/s	1.6 m/s
Distance	7 Km	18 km	4 Km	4 Km	8 km	2km
Height	128 m	6000 m	3000 m	3000 m	5 km	1 km
RTH mode	Available	Available	Available	Available	Available	not Available
Sensing	Available	Available	no sensing technology Available	no sensing technology Available	omnidirectional	no sensing technology Available
Max wind speed resistance	10 m/sec	8 – 10 m/s	8 m/s	8 m/s	8 m/s	8 m/s
Resolution	20 m	4k	2.7 k at 30fps	2.7 k at 30fps	4k at 120fps	4k

zoom	upto 2x	2x optical zoom, 2x digital zoom	upto 2x optical zoom,	upto 2x optical zoom,	upto 2x optical zoom	upto 2x optical zoom
hyperlapse	available	available	not available	not available	available	available
camera	20 m	20 m	12 m	12 m	20 m	20 m
Approx. Price(INR)	1,80,000	!,70,000	60000	50,000	1,25,000	75,000

Other accessories: - Remote Controller, intelligent flight Battery, Charger, Power cable, 4x propeller (pair), Gimbal clamp, micro-SD card (32GB), Micro USB cable, Carrying case etc.

V. DRONES FOR PANDEMIC OR NATURAL CALAMITY SITUATIONS

A drone may be useful in a pandemic situation due to the limited number of health personnel and allied systems. Drones can play a significant role in controlling the disease due to limited resources.

Drones can be equipped with various sensors and computer vision systems that are highly sensitive, delicate and precise. Thus, health monitoring tasks such as gauging heart rates, body temperatures, and breathing can be easily accomplished from 190 feet in the air. It is also possible to perform other similar activities, such as identifying COVID-19 public norm defaulters, identifying those who sneeze and cough, etc. In this case, no information about an individual is collected or identifiable. Although it takes population samples, it provides this anonymised data to the relevant public health and safety authorities. So the authority will have precise data with a clear indication of population health based on which it can make informed decisions.

A prevalent subject these days is natural calamity and drones. Drones have proven to be a highly effective tool in controlling the effects of situations such as earthquakes and tsunamis. Rural areas are where primary and effective support systems are a constant concern.

Furthermore, drones can carry out continuous monitoring activities, such as gathering crowd temperature and detecting a specific disease-related symptom, which will ease the spread of disease, the distribution of medicines, Personal Protection Equipment Kit, and other essential services, in the event of a severe emergency.

VI. CONCERNING THE PROTECTION OF CATTLE WEALTH AND BIRD SANCTUARIES

Cattles are considered a source of wealth for a farmer, and their count is a symbol of social standing. Many instances of missing cattle arise frequently. Therefore, locating them on time becomes exceptionally difficult. Drones equipped with artificial intelligence and data analysis platforms can perform these tasks. During the flight period, it provides the computing power necessary for applying Convolutional Neural Networks (CNN). So, the application of CNN with a drone platform allows detecting and locating cattle (with 3.2 seconds of delay).

Using drones with thermal imaging cameras and automatic recognition software to identify particular birds allows the surveying work to be done even at night. A user-friendly system is developed for park rangers. As a general practice, the video is analysed on the fly so that the ranger can look at a screen and see a square around the bird or its mob or whatever object needs to be inspected. As a result, this system will react much faster to potential threats than it could with other systems. Besides improving the environment, the project will contribute significantly to the village's tourism and economy.

VII. CONCLUSION

Today, the development of the rural part is determined by the adoption of new technology. Drone technology used in dense residential areas such as urban or metro cities creates a high risk of accidental damage. However, this is not the case in rural areas. A novel methodical approach to developing rural areas using drone technology is presented. To begin with, a brief description of Indian villages and their development over the past many years is given. This article discusses the significance of drones and their possible role in rural applications. Before preparing the plan for its adoption, the essential surveys based on the most critical parameters are prepared as prime data. The criteria for selecting, comparing, and purchasing drones are described based on the application chosen for the rural part.

Furthermore, two more applications where this technology can demonstrate its high value are outlined. Initially, the various sequenced activities are described for situations involving epidemics or catastrophes. Another important aspect of rural life is the protection of livestock and birds. Therefore, a road map for the development of rural India with the help of drones is provided in this study, and it begins with the decision to adopt it and ends with its systematic implementation.

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