

# A STUDY ON THE IMPACT OF INTRODUCTION OF UNMANNED AERIAL VEHICLES (DRONE) IN THE FIELD OF LOGISTICS IN INDIA

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## ABSTRACT

The utilization of drones in strategies can possibly alter how products are moved because it will accelerate delivery times, set aside cash, and give you greater adaptability. Notwithstanding, there are a few troubles related with foundation, guidelines, and public insight that emerge from the presentation of drones. This paper takes a gander at the benefits and disadvantages of involving drones in planned operations and how they can be incorporated into existing organizations. We additionally contemplate ways of decreasing the adverse consequences that drone use has on society and the climate. At long last, we take a gander at the ongoing drone technology patterns and what they could mean for coordinated operations later. We trust that this study will help policymakers, operations suppliers, and other partners go with better choices by giving a far-reaching understanding of the benefits and burdens of involving drones in strategies.

## Key words

- Unmanned Aerial Vehicle
- Drones
- Drone Capacities
- Logistics
- E-commerce
- Last Mile Delivery
- Sustainability
- Infrastructure

## CHAPTER-1

### 1.1 INTRODUCTION:

#### 1.1.1 LOGISTICS

Logistics is the control of supply and movement to ensure that the things are followed through on time and in great condition. Operations handling is a component of the logistics area, and in the present profoundly serious world, the need to handle operations economically and proficiently is urgent.

Getting assets, putting them away, and conveying them to their objective are portions of logistics. Logistics management incorporates finding expected wholesalers and providers and deciding how compelling and easy to contact they are. Supervisors of logistics are alluded to as "logisticians."

At the point when the expression "logistics" was initially utilized, it alluded to the acquisition, storage, and transportation of military supplies and hardware. Nowadays, organizations every now and again utilize this articulation to discuss how assets are overseen and moved along the supply chain, prominently by producers.

Observing inventory and guaranteeing that orders are satisfied are key parts of dealing with a stockroom or warehousing. Furthermore, it involves regulating the foundation and operations of stockrooms, for example, those at satisfaction focuses where orders are taken, handled, and shipped off clients. To work the distribution center successfully, most warehousing operations utilize programming like ERP. The logistics area incorporates the warehousing area.

In view of the documentation expected at worldwide boundaries and transportation ports to show that lawful necessities are being satisfied, customs management, otherwise called "worldwide trade management," is in some cases viewed as a part of logistics.

Future improvements in independent vehicles and man-made reasoning (artificial intelligence) are anticipated to affect logistics. A couple of logistics organizations presently utilize computer-based intelligence to upgrade delivery tracking and predict issues utilizing their calculations. It is currently practical to estimate future challenges and find arrangements beforehand by utilizing refined calculations.

In the meantime, forklifts, delivery trucks, and drones will progressively be seen on thruways, in distribution centre yards, and in stockrooms.

### 1.1.2 DRONES/ UAV'S:

(Sam Daley, Mar. 23, 2023, built-in)The term "drone" is regularly used to portray any unmanned aircraft. These aircraft, otherwise called unmanned aerial vehicles (UAVs), can play out a different assortment of obligations, from military operations to bundle conveyance. Drones can go in size from the size of your hand's palm to that of a plane.

Drones were first made for the aviation and military ventures, but since to the expanded degrees of effectiveness and security they give, they have entered the general population. These mechanical UAVs fly autonomously and with fluctuating levels of independence.

How much independence for a drone can change from remotely directed, where an individual controls its movements, to cutting edge independence, where it utilizes a network of sensors and LiDAR detectors to decide its development.

### 1.1.3 DRONES CAPACITY & THEIR USAGE:

Different UAV'S can fly at various altitudes and distances. Most amateurs use extremely close-range UAV'S, which can frequently arrive at up to three miles. The scope of close-range UAVs is around 30 miles. Drones with a short reach might go up to 90 miles and are mostly used for spying and knowledge assortment. Mid-range UAVs have a 400-mile working reach and might be used for meteorological research, scientific investigations, and insight assortment. The "perseverance" Uav's, which have a greatest scope of 400 miles and the ability to fly up to 3,000 feet in the air, are the longest-range drones.

### 1.1.4 DRONES INTRODUCTION IN THE FIELD OF LOGISTICS:

(Viikram Vijay Kumar, September 8, 2020, LinkedIn) These autonomous passenger drones, which can fly without a pilot, are developed utilizing blockchain innovation. This innovation serves different capabilities, including forestalling impacts between the vehicles and other aircraft. These eVTOLs(electric Vertical Take-Off and Landing aircraft) likewise utilize artificial intelligence (simulated intelligence) as a power source. Noteworthy, with a 550-mile range and a conveying limit of 900 pounds. These autonomous passenger drones will be a critical industry with a feasible marketable strategy.

(Arjun Naik, Founder CEO, Scandron, January 18, 2023, The Times of India) Drone technology, perhaps of the most state of the art development, has tracked down broad use in different areas, and planned operations is no special case. Drones were first utilized for fighting, yet as they become all the more generally utilized, the coordinated factors area is going to go through an unrest. Drone use in this industry has expanded due to mechanical improvements like VTOL, IoT, AI, and ML as well as lower handling and assembling costs. Markets and Markets predicts that the market for drone bundle delivery will

increment from USD 228 million out of 2022 to USD 5,556 million by 2030, at a compound annual growth rate (CAGR) of 49.0% from 2022 to 2030.

The broad lockdowns and social disengagement regulations introduced a significant business potential for the drone delivery area. Policing utilize drones to consistently screen Coronavirus areas of interest and constraint zones to ensure severe adherence to lockdown mandates.

At the point when merchandise were overwhelmingly popular and delivery people were hard to come by, drone bundle delivery initially became well known. Following this, the Ministry of Civil Aviation and the DGCA loosened up their restrictions on the utilization of drones to give government organizations "conditional exemptions" to convey them regarding the pandemic. The Ministry likewise supported a pilot project with the Telangana government to test a few calculated courses for conveying secure, accurate, and dependable Drone-based pickup and delivery of clinical supplies in remote spots.

In 2021, in light of the developing number of area wide applications, India sent off its Drone Advancement Policy, which expected to accelerate the business and modern utilization of drones. The Indian government has approved the production-linked incentive (PLI) plan for drones and drone parts as well as requiring an adjustment of policy. The arrangement denied the import of drones to aid native production. Drones are now being created rapidly in India accordingly, and coordinated factors organizations are thinking about utilizing them to advance their activities.

## CHAPTER-2

### 2.1 OBJECTIVES

- To check the benefits and challenges of using drones in logistics
- How can drones be integrated into existing logistics networks, and what changes to infrastructure and regulations would be necessary to support this integration.
- What are the current trends in drone technology and how might these impact the future of logistics.
- What are the current policies & regulations that were impacting the introduction of drones in the field of logistics in India.
- Evaluating the possible effects of drone delivery on the Indian economy, including the possibility for employment development and the creation of new positions.



## CHAPTER-3

### 3.1 LITRATRURE REVIEWS

#### 3.1.1 Implementing Delivery Drones in Logistics Business Process: Case of Pharmaceutical Industry

This research is about feasibility of implementing unmanned aerial vehicles, also known as 'drones', in logistics.

Research is based on available information about current incentives and experiments in application of delivery drones in commercial use.

we will present a conceptual model of business process that implements delivery drones in business-to-business logistic operations.

The work will outline the main advantages and disadvantages of implementing unmanned aerial vehicles in delivery services as a supplementary distribution channel along the supply chain

#### 3.1.2 Applications of drones in warehouse operations.

This paper reports 12 identified use cases of indoor drone applications in warehouses. We classify three different application areas: inventory management, indoor intra-logistics and inspection & surveillance.

The analysis indicates that using drones for inventory management applications have the highest potential in warehouses.

Indoor intra-logistics is not yet entirely feasible due to current technological limitations in power supply and payload.

#### 3.1.3 A Literature Review of Drone-Based Package Delivery Logistics Systems and Their Implementation Feasibility

This paper provides a comprehensive literature survey on a set of relevant research issues and highlights the representative solutions and concepts that have been proposed thus far in the design and modelling of the logistics of drone delivery systems, with the purpose of discussing the respective performance levels reached by the various suggested approaches.

The paper also investigates the central problems to be addressed and briefly discusses and outlines a series of interesting new research avenues of relevance for drone-based package delivery systems.

### 3.1.4 Truck-drone team logistics: A heuristic approach to multi-drop route planning

PL Gonzalez-R, D Canca, JL Andrade-Pineda have given in the present work, we focus on the resolution of the truck-drone team logistics problem. The problems of tandem routing have a complex structure and have only been partially addressed in the scientific literature.

The use of UAVs raises a series of restrictions and considerations that did not appear previously in routing problems; most notably, aspects such as the limited power-life of batteries used by the UAVs and the determination of rendezvous points where they are replaced by fully-charged new batteries.

These difficulties have until now limited the mathematical formulation of truck-drone routing problems and their resolution to mainly small-size cases.

This process is orchestrated by a global optimization scheme using a simulated annealing (SA) algorithm. We test our approach in a large set of instances of different sizes taken from literature. The obtained results are quite promising, even for large-size scenarios.

### 3.1.5 Managing the drone revolution: A systematic literature review into the current use of airborne drones and future strategic directions for their effective control

Commercial and private deployment of airborne drones is revolutionising many ecosystems. To identify critical issues and research gaps, our systematic literature review findings suggest that historic issues such as privacy, acceptance and security are increasingly replaced by operational considerations including interaction with and impacts on other airspace users.

Our review of current regulatory approaches shows a need for further policy and management response to both manage rapid and efficient drone usage growth, and facilitate innovation (e.g. intraurban package delivery), with one promising strategic response being low altitude airspace management (LAAM) systems for all drone use cases.

### 3.1.6 The concept of logistics

The aim of this paper is to present modern logistics trends, digitization of logistics and description of the concept of Logistics 4.0. The basic components of that concept are: automatic identification, real-time localization, automatic data collection, connectivity and integration, data processing and analysis and business services.

The paper presents and describes some of the most important Logistics 4.0 technologies: Internet of Things, wireless sensor network, Cloud Computing, Blockchain, Big Data, robotics and automation, augmented reality, drones, 3D printing and automatic guided vehicles.

### 3.1.7 Improved Compact Cuckoo Search Algorithm Applied to Location of Drone Logistics Hub

In this paper implements a compact cuckoo search algorithm with mixed uniform sampling technology, and, for the problem of weak search ability of the algorithm, this paper combines the method of recording the key positions of the search process and increasing the number of generated solutions to achieve further improvements, as well as implements the improved compact cuckoo search algorithm.

this paper uses 28 test functions to verify the algorithm. Aiming at the problem of the location of drone logistics hubs in remote areas or rural areas, this paper establishes a simple model that considers the traffic around the village, the size of the village, and other factors.

It is suitable for selecting the location of the logistics hub in advance, reducing the cost of drone logistics, and accelerating the large-scale application of drone logistics.

This paper uses the proposed algorithm for testing, and the test results indicate that the proposed algorithm has strong competitiveness in the proposed model.

### 3.1.8 Industry 4.0 Disruption and Its Neologisms in Major Industrial Sectors: A State of the Art

The study aimed at identifying industry 4.0 neologisms, understanding the industry 4.0 disruption and illustrating the disruptive technology convergence in the major industrial sectors.

A total of 99 neologisms of industry 4.0 were identified

The convergence of 12 disruptive technologies including 3D printing, artificial intelligence, augmented reality, big data, blockchain, cloud computing, drones, Internet of Things, nanotechnology, robotics, simulation, and synthetic biology in agriculture, healthcare, and logistics industries was illustrated.

The study divulged the need for extensive research to expand the application areas of the disruptive technologies in the industrial sectors.

### 3.1.9 A Comparative Analysis of the Environmental Benefits of Drone-Based Delivery Services in Urban and Rural Areas

The purpose of this study is to evaluate the environmental impacts of drone versus motorcycle delivery and to compare the expected environmental improvements due to drone delivery in urban and rural areas.

the potential environmental contributions of electric motorcycles were assessed to determine the effects of introducing this new type of vehicle. Changes in the national electricity generation plan were also examined.

The results showed that global warming potential (GWP) per 1 km delivery by drone was one-sixth that of motorcycle delivery, and the particulates produced by drone delivery were half that of motorcycle delivery.

Increasing the use of environmentally friendly electricity systems, such as solar and wind power, would further enhance the environmental effects of a drone delivery system.

### **3.1.10 Last mile delivery by drones: an estimation of viable market potential and access to citizens across European cities**

The study have presented a modelling framework using EU-wide high-resolution population and land-use data to estimate the potential optimal location of drone-beehives based on economic viability criterion.

It estimates the potential number of EU28 citizens that could potentially benefit from last mile-drone delivery services under four scenarios. The performed analyses indicates that under the scenario considered as the most technologically realistic, up to 7% of EU citizens could get access to such services.

When considering technological improvements scenarios, the share reaches 30%. Furthermore, results suggest that due to the differences in population and land-use patterns in the different Member States, the potential drone coverage across Europe could be very heterogeneous, with the UK, Germany, Italy and France appearing as the most likely countries where drone-beehives may have the most efficient development.

### **3.1.11 Coordinated logistics with a truck and a drone**

The study have explored the efficiency of a delivery system in which an unmanned aerial vehicle (UAV), or a fleet of UAVs, provides service to customers while making return trips to a truck that is itself moving.

Although the hardware for such systems already exists, it is not yet understood to what extent such an approach can actually provide a significantly improved quality of service. By combining a theoretical analysis in the Euclidean plane with real-time numerical simulations on a road network,

we conclude that the improvement in efficiency due to introducing a UAV is proportional to the square root of the ratio of the speeds of the truck and the UAV.

### **3.1.12 Comparison of energy demands of drone-based and ground-based parcel delivery services**

In this paper an energy consumption model for drones is proposed to describe the energy demand for drone deliveries depending on environmental conditions and the flight pattern. The model is used to simulate the energy demand of a stationary parcel delivery system which serves a set customer from a depot.



The energy consumed by drones is compared to the energy demand of Diesel trucks and electric trucks serving the same customers from the same depot.

The results indicate that switching to a solely drone-based parcel delivery system is not worthwhile from an energetic perspective in most scenarios. A stationary drone-based parcel delivery system requires more energy than a truck-based parcel delivery system particularly in urban areas where customer density is high and truck tours are comparatively short.

### 3.1.13 Vehicle Routing Problem with Drones

The vehicle routing problem with drones (VRPD) is an extension of the classic capacitated vehicle routing problem, where not only trucks but drones are used to deliver parcels to customers. One distinctive feature of the VRPD is that a drone may travel with a truck, take off from its stop to serve customers, and land at a service hub to travel with another truck as long as the flying range and loading capacity limitations are satisfied.

Routing trucks and drones in an integrated manner makes the problem much more challenging and different from classical vehicle routing literature. We propose a mixed integer programming model, and develop a branch-and-price algorithm.

We also conduct sensitivity analysis on a key factor that may affect the total cost of a solution.

### 3.1.14 Replicators, Ground Drones and Crowd Logistics A Vision of Urban Logistics in the Year 2030

Oliver Kunze presented the pros and cons of these different operations are set out. Based on these findings a partial qualitative systemic model is presented which shows how these operations are influenced by global and logistics trends on the one hand and by delivery service requirements on the other hand.

Based on this model a vision of urban logistics in Europe in the year 2030 as well as the concept of “Post 4.0” is presented.

### 3.1.15 Unmanned aerial vehicles/drones in vehicle routing problems: a literature review

In this paper, the academic contributions on drones routing problems are analysed between 2005 and 2019 to identify the main characteristics of these types of problems, as well as the research trends and recent improvements.

The literature is classified according to the objectives optimized, solution methods, applications, constraints, and whether they use a complementary vehicle or not. Finally, a discussion for trends and future research is presented.

### **3.1.16 International Journal of Logistics Research and Applications**

Sah et, al, (2021) explained that in order to be responsive and effective in the logistics industry, businesses are implementing novel techniques. Drone use in the logistics industry is a step in the right way. Analysing potential barriers to the seamless use of drones in the logistics industry is essential. The fuzzy Delphi approach and the analytic hierarchy procedure are used in the current study to identify and rank the obstacles to drone logistics implementation in accordance with their criticality. First, based on professional judgement and a thorough literature analysis, 34 impediments are identified. This analysis shows that the biggest obstacles to the use of drones in the logistics industry are laws and threats to security and privacy. In decreasing order of importance, public perception, environmental concerns, technological challenges, and economic reasons are other significant impediments.

### **3.1.17 Using Unmanned Aerial Vehicles—Drones as a Logistic Method in Pharmaceutical Industry in Germany.**

Güner, Seda, et, al, (2017) studied that although drone use began in the military, it is now also becoming more common in the commercial sector. As a result of demographic shifts and an expanding global population, the demand for pharmaceuticals is continuously rising on a global scale. The pharmaceutical industry in Germany has been described in order for people to understand the significance of using drones in this industry. Demand for pharmaceuticals is also constantly rising in Germany, primarily due to improved health awareness as well as the rise of chronic and age-related illnesses as a result of longer life expectancies. With a market size of between €35 and €46 billion, Germany is the largest pharmaceuticals market in Europe.

### **3.1.18 Logistic deliveries with drones: State of the art of practice and research**

Facilities and vehicles are being transformed into intelligent systems by new technology, which will drastically alter logistics deliveries. Automated vehicles have opened up a wide range of new technical possibilities for delivery tasks. One illustration is the usage of Unmanned Aerial Vehicles (UAV), sometimes known as Drones, which may spark new delivery networks or businesses. The use of UAVs for logistical delivery will be the main emphasis of this endeavour, which will include both a research state of the art and a state of practise. Numerous academics have already looked into a number of optimisation issues that may arise during drone-assisted delivery.

### **3.1.19 Shaping the role of drones in UK logistics**

The experimentation in the transport sector is often driven by goals for climate emission reductions and sustainability transformation, many experimental initiatives have only very tenuous connections to specific emission reduction targets. This book has focused on experimental spaces, which are today often

framed as possible - and promising - ways of working to provide knowledge for breaking path dependencies and enacting transformations of transport and mobility systems.

### **3.1.20 Proceeding's 7th International Conference on Information Systems, Logistics and Supply Chain**

Start-ups and established corporations like Google, Amazon, and UPS are paying close attention to unmanned aerial vehicles (UAV) or drone last mile delivery. There are already examples of small-scale drone delivery operations that have been effective around the world. Surprisingly little research has been done to comprehend the capabilities and technical trade-offs among the drones that are now on the market, despite all the hype and enthusiasm surrounding the subject. This paper's objective is to assess the multicopter drones that are currently on the market and evaluate them in terms of their potential for last-mile and last-yard delivery. We give new information and linear connections between the multicopter payload, take-off weight, and energy efficiency. The examination of trade-offs among variables in this study is a fresh contribution.

### **3.1.21 Applications and Research avenues for drone-based models in logistics**

Moshref-Javadi, Mohammad, and Matthias Winkenbach (2021) introduce a well-organized and adaptable framework to categorize the different models used for drone-based logistics planning and operations. Our framework aims to provide a clear structure for classifying various drone-based delivery systems and the routing challenges they encounter. Additionally, we conduct a thorough examination and amalgamation of existing academic research in this field. Our classification system not only defines the scope of different drone-based logistics setups but also makes it easier to compare them. Furthermore, our extensive literature review serves the purpose of pinpointing areas in research that require further exploration and prioritization in future studies.

### **3.1.22 Retail deliveries by drones: how will logistics networks change?" Production and Operations Management**

Technologies like drone delivery services are changing the game for retailers, enabling them to offer incredibly fast and flexible delivery options using dedicated aerial vehicles for each order.

### **3.1.23 JRCS: Joint routing and charging strategy for logistics drones." IEEE Internet of Things Journal**

The study explains the topic of extending drone flight time by utilizing charging stations and ensuring the completion of multiple deliveries within a single mission. When dealing with multiple long-distance deliveries, it becomes imperative to employ optimization techniques to design efficient networks encompassing customer locations, charging stations, and delivery routes. To address this challenge, we introduce a comprehensive strategy called the Joint Routing and Charging Strategy (JRCS), which

consists of three distinct phases aimed at accomplishing multiple deliveries seamlessly within a single mission.

#### **3.1.24 Coordinated logistics with a truck and a drone." Management Science**

Carlsson, John Gunnar, and Siyuan Song (2018) studied about the efficiency of a delivery system that incorporates unmanned aerial vehicles (UAVs), or a fleet of UAVs, in serving customers while making return trips to a moving truck. In this scenario, a UAV retrieves a package from the truck, which continues its route, and after delivering the package, the UAV returns to the truck to pick up the next package. While the necessary hardware for such systems is available, it is essential to understand the extent to which this approach can genuinely enhance the quality of service.

#### **3.1.25 The use of drones in oil and gas logistics.**

The paper studied about the contemporary technologies, particularly digital and information systems like drones, are poised to shape the future of the oil and gas industry significantly. They offer the potential for substantial enhancements in existing processes and information management within the exploration and production sector. The widespread adoption of drones across various stages of the value chain and within different management levels plays a crucial role in defining a company's image and competitiveness in the industry.

#### **3.1.26 Drones for supply chain management and logistics: a review and research agenda." International Journal of Logistics Research and Applications**

The potential strengths of applying drones in SCM and logistics are: (1) support of humanitarian logistics, (2) reduced delivery time, (3) reduced cost, (4) improved flexibility, and (5) increased sustainability. In addition, the challenges posed by drones in SCM and logistics are grouped into technical, organisational, safety-related, and regulatory issues. This study also investigates real-life drone deployments in SCM and logistics and sets forth an agenda for future research.

#### **3.1.27 The application of drones in city logistics concepts." Promet-Traffic &Transportation**

With the rise of city logistics (CL) problems in the last three decades, various methods, approaches, solutions, and initiatives were analysed and proposed for making logistics in urban areas more sustainable. The most analysed and promising solutions are those that take into account cooperation among logistics providers and consolidation of the flow of goods.



### 3.1.28 Drones in production, supply chain and logistics

Lokhande, Akshay P., Arman N. Shaikh, and Omkar S. Patil studied about the drones in Production, Supply Chain and Logistics. First there was discussed construction of the drone, which the most important elements are frame, propellers, engine and system of power the electronic control. Then there were discussion about drones used for Military, Agriculture, Delivery system in Germany, Police, for taking photos and filming etc.

### 3.1.29 Application of unmanned aerial vehicles in logistics: a literature review.

Li, Yi, Min Liu, and Dandan Jiang(2022) studied that the growth of e-commerce has presented numerous challenges to the logistics sector. To ensure the long-term viability of the logistics industry, it's imperative to take into account the influence of environmental and social sustainability factors on its development. Unmanned Aerial Vehicles (UAVs), also known as drones, have gained traction in the logistics arena due to their adaptability, cost-effectiveness, environmentally friendly attributes, and energy-saving advantages. These qualities enable the achievement of both economic and societal benefits through their use.

### 3.1.30 Replicators, ground drones and crowd logistics a vision of urban logistics in the year 2030

The overview of different existing and emerging transport logistics operations is provided, the pros and cons of these different operations are set out. Based on these findings a partial qualitative systemic model is presented which shows how these operations are influenced by global and logistics trends on the one hand and by delivery service requirements on the other hand. Based on this model a vision of urban logistics in Europe in the year 2030.

### 3.1.31 Algorithms for Solving the Vehicle Routing Problem with Drones

Vehicle Routing Problem with Drones (VRPD), an extension of the classical Vehicle Routing Problem (VRP) that integrates autonomous drones in parcel delivery. Notably, companies like Amazon, UPS, and Deutsche Post AG have expressed interest in this application. The authors propose two heuristic algorithms for solving VRPD and evaluate their performance through numerical experiments on large-scale instances. The study demonstrates the potential benefits of incorporating drones in parcel delivery, aiming to enhance efficiency and reduce delivery times.

### 3.1.32 Drone location and scheduling problems in humanitarian logistics

The challenges in the timely delivery of aid for humanitarian relief, specifically exploring the use of drones for delivering medical and relief packages to hard-to-access locations. The objective is to design logistics management for a drone fleet to ensure the prompt delivery of items in both emergency and non-emergency situations. The introduction highlights the difficulties associated with reaching such

remote areas and emphasizes the need for drone-based delivery to overcome these challenges. Drones, not constrained by land-based road networks and pilot requirements, are considered promising alternatives for swift and efficient delivery to inaccessible locations. The dissertation cites successful examples of delivery drones in commercial sectors and humanitarian logistics, laying the foundation for the subsequent chapters' exploration of drone-based aid delivery.

### **3.1.33 A systematic literature review on drones' application in last-mile delivery**

The paper investigated the application of drones in last-mile delivery, prompted by the challenges faced by companies like Amazon and DHL in managing terminal-to-customer deliveries amid growing e-commerce and urban traffic congestion. The research employs a systematic literature review across major databases, followed by a descriptive analysis incorporating bibliometrics and thematic analysis. The findings highlight drones' potential to reduce costs, delivery time, emissions, and energy consumption in last-mile delivery. However, significant barriers, such as governmental regulations, need careful consideration for successful implementation. The thesis concludes by identifying gaps in existing literature and asserts its relevance for both managers and researchers, offering a comprehensive perspective with theoretical, managerial, and societal implications.

### **3.1.34 Vehicle Routing Problem with Drones**

Vehicle Routing Problem with Drones (VRPD) extends the traditional capacitated vehicle routing problem by incorporating drones alongside trucks for parcel deliveries. This introduces a unique challenge as drones can take off from trucks to serve customers and land at service hubs to join other trucks, subject to flying range and loading capacity constraints. To address this, the paper presents a mixed-integer programming model and introduces a branch-and-price algorithm. Computational experiments on practically generated instances showcase the algorithm's strong performance. Additionally, sensitivity analysis is conducted on a critical factor influencing total solution cost, providing insights into the solution's robustness.

### **3.1.35 Delivery Drones: Inapt for Application of Current Negligence Theory**

Hyewon Hannah Choi (2021) explained about the concerns arise regarding liability for personal injury or property damage. The current negligence theory lacks clarity on allocating liabilities, prompting the suggestion of alternative theories like strict liability or negligence per se. The paper recommends revisiting the earlier draft of the Drones Act by NCCUSL, emphasizing the need for clearer standards and recovery methods. Legislative and FAA actions are essential for addressing these issues and establishing guidelines for operators and injured parties.

## CHAPTER-4

### 4.1 HYPOTHESIS

#### 4.1.1 Hypothesis-1:

A considerable reduction in delivery time compared to current practises would result from the use of drones in logistics operations, according to hypothesis 1.

#### 4.1.2 Hypothesis-2:

The use of drone technology in logistics will increase operational effectiveness and cost-effectiveness in comparison to traditional delivery techniques.

#### 4.1.3 Hypothesis-3:

The use of drones in logistics will improve last-mile delivery capabilities, especially in difficult or remote areas.

## CHAPTER-5

### 5.1 RESEARCH METHADODOLOGY

#### 5.1.1 Research Design

The questions the researcher will pose are outlined in the research design. It lays forth the measurement protocols, sample plan, analytical framework, and time frame in a logical order. Three categories of study designs exist.

The data collection methods for this study include:

- Questionnaires,
- Document analysis, and
- Observation.

Questionnaires was circulated among various professionals who are involved in the field of logistics & SCM. We had collected data from them in this format. Document analysis will be used to collect information from relevant reports, articles, and websites. Observation will be used to collect data on the impact of introduction of unmanned aerial vehicles in the field of logistics in India.

The theoretical framework for this study is the sustainable development framework. This framework provides a holistic approach to understanding the relationship between economic development and social justice.

### 5.1.2 Data collection Method

There are two methods of gathering data: primary and secondary. We used the Google Forms platform, a free web-based survey tool, to administer surveys and gather the core data. We looked through other research papers on related themes and spoke with other people about the impact of using or the concerns regarding the introduction of drones in the field of logistics to gather secondary data.

Exploratory research is defined as an analysis conducted to investigate a challenging problem that isn't clearly defined. It leads to a better understanding of the existing problem, but it won't produce results that are compelling. Usually, this kind of analysis is conducted when the problem is still in its early stages.

### 5.1.3 Sampling Design

Sample universe: - The sample universe includes Supply chain & logistics professionals working in various companies like Flipkart, Safe Express etc...

Sample size: - The sample size will be 50.

### 5.1.4 Questionnaire Design

The type of question used in questionnaire are structured multiple choice question. This is done so that we can find, is there any impact on the introduction of drones in the field of logistics in India.

## CHAPTER-6

### 6.1 Scope of Research

Considering the goals of the research, it would be reliable to conduct the study from the mindset of the logistics, supply chain professionals & also the customers who are frequently using last mile delivery. We are conducting this study to identify the importance & also the impact of using or introduction of drones in the field of logistics in India. The research also aims to assist potential readers in understanding the significance of last mile delivery in case of some exceptional goods like lifesaving drugs by the introduction of drones in the last mile delivery. The research focuses on the impact of the introduction of drones in the last mile delivery specially in case of life saving drugs & some other exceptional goods.

#### 6.1.1 TARGET POPULATION

The group of people or things that are the focus on research area is known as the target population. The following are my target populations in case of using drones in logistics:



**Logistics Companies:** Companies involved in shipping, transportation, and delivery who might be interested in incorporating drones into their operations fall under this category.

**Drone producers:** Insights into the capabilities and limitations of drone manufacturers can be gained by comprehending their point of view.

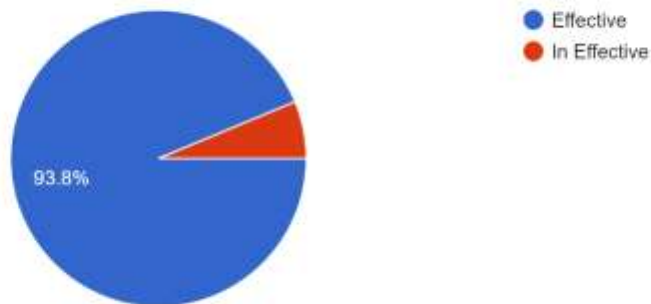
**Regulatory bodies:** Organizations in charge of enforcing airspace regulations and safety considerations.

**End clients:** E-commerce platforms, retail stores, and customers are examples of individuals or businesses that receive or rely on logistics services.

All these are our main target population in the case of research on the impact of introduction of drones in the field of logistics in India. These can help us to make our research complete easily.

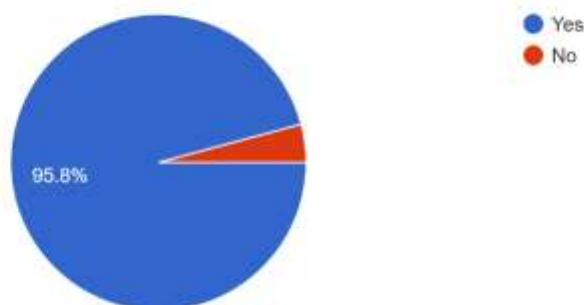
### 6.1.2 Analysis & interpretation

Your perspective on the application of drones in the logistics industry  
48 responses



The pie outline that 93.8% of respondents accept that drones are viable in the logistics business. This is an exceptionally high rate, and it recommends that there is an inescapable conviction that drones can be a significant instrument for logistics companies.

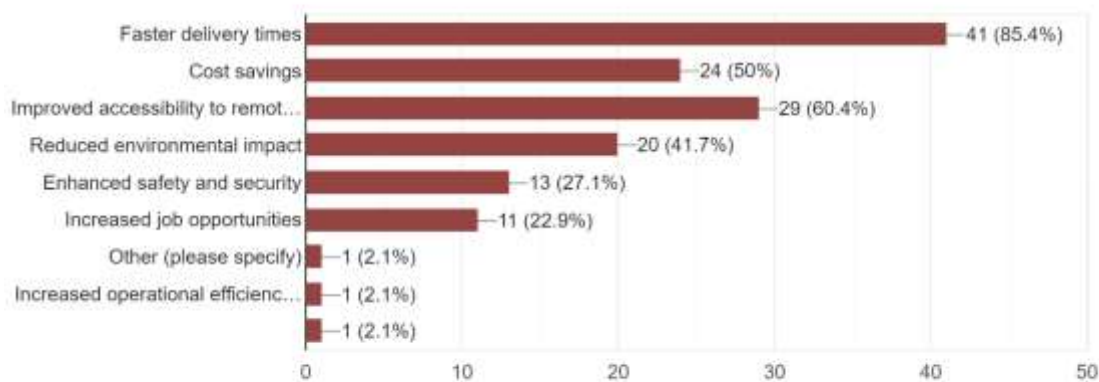
Do you think drones will boost production and efficiency in the logistics industry?  
48 responses



This shows that a larger part of individuals, 95.8%, accept that drones will help creation and proficiency in the logistics business. This proposes that there is an inescapable conviction that drones can possibly be an important instrument for logistics companies.

What possible advantages do you see for employing drones in the logistics sector?

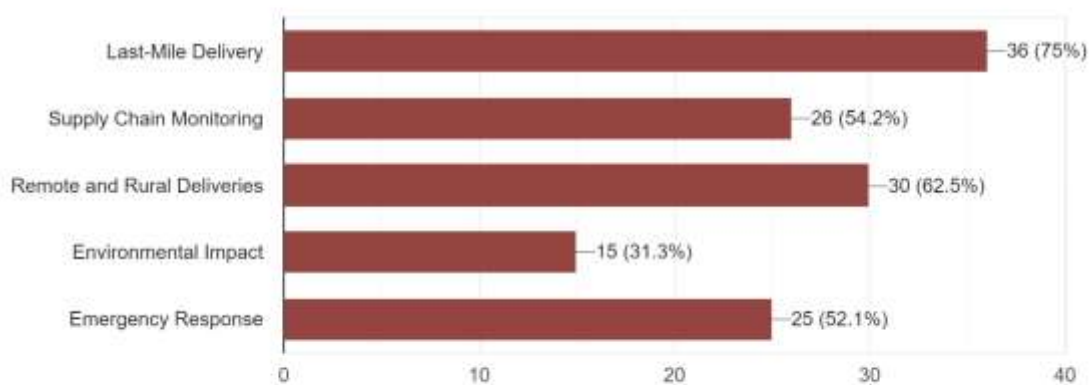
48 responses



The graph suggests that there are a few expected benefits to involving drones in the logistics area, with quicker conveyance times being the most referred to benefit at 85.4%. Other potential benefits incorporate expense investment funds (half), further developed openness to distant areas (60.4%), diminished natural effect (41.7%), and expanded open positions (22.9%). While there are additionally possible downsides, for example, wellbeing and security concerns, the general opinion appears to be positive with respect to the likely effect of drones on logistics.

What specific logistics-related elements do you think drone use may enhance?

48 responses

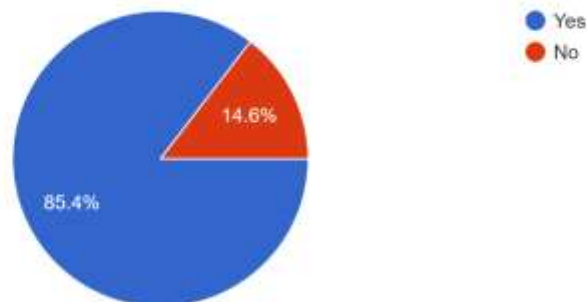


The graph shows that individuals accept drone use can improve a few logistics-related components, with last-mile conveyance (75%) and remote and rustic conveyances (62.5%) being the most well-known decisions. This proposes that individuals view drones as having the capacity to further develop conveyance effectiveness, particularly in testing areas. Production network checking (54.2%) and crisis

reaction (52.1%) were additionally viewed as regions where drones could be valuable. While natural effect (31.3%) wasn't positioned as profoundly, it's as yet striking that an impressive part of individuals see drones as possibly assuming a part in making logistics more eco-accommodating.

Do you believe drones might have an impact on traditional logistics job roles?

48 responses



The pie diagram shows that 85.4% of individuals accept that drones will decidedly affect conventional logistics occupations. This recommends that there is a far and wide conviction that drones will make a greater number of occupations than they dispose of in the logistics business. There are various motivations behind why individuals could figure this, for example, the requirement for individuals to work, keep up with, and direct drones. Also, drones might set out new position open doors in regions like information examination and programming advancement. Notwithstanding, taking into account the possible adverse consequences of drones on positions in the logistics industry is likewise significant. For instance, certain individuals stress that drones will robotize assignments that are right now performed by people, which could prompt employment misfortunes. By and large, the pie diagram proposes that there is an uplifting perspective on the effect of drones on positions in the logistics business, yet there are likewise potential provokes that should be tended to.

## CHAPTER-7

### 7.1 Conclusion

Drones are poised to become significant assets in the logistics sector due to their potential to enhance efficiency and effectiveness. Anticipated advantages include quicker delivery times, improved accessibility, cost savings, and environmental benefits. However, the adoption of drone technology presents various challenges. Safety and security concerns, job displacement, and cost optimization are key considerations. Proactive measures such as robust regulations, retraining programs, and sustainability initiatives are necessary to address these challenges. Additionally, establishing ethical standards is crucial for fostering public trust and ensuring responsible deployment. Despite these hurdles, drones offer the promise of transforming logistics, providing faster, more sustainable deliveries and creating new job

opportunities. Continued research and innovation will be essential for maximizing their potential while navigating regulatory complexities and promoting ethical usage.

## CHAPTER-8

### 8.1 Recommendation for Business

We should Conduct practicality studies to evaluate the likely advantages of involving drones for logistics operations. Think about elements like the expense of drones, the expense of preparing pilots, the administrative environment, and the expected effect on conveyance times and expenses.

We shall Start small and scale up gradually ,Try not to attempt to convey an enormous fleet of drones overnight. Begin with a pilot project in a limited region to test the innovation and gain from your experience.

We can Partner with experienced drone operators or manufacturers ,This will assist us with staying away from normal pitfalls and guarantee that you are utilizing the latest and safest technology.

We shall develop a comprehensive safety plan for your drone operations, this plan ought to resolve issues, for example, pilot training, maintenance procedures, and emergency response protocols.

### 8.2 Recommendation for Further Research

Conduct more studies on the economic impact of drone logistics in India ,This will assist with quantifying the potential advantages of this innovation for businesses and the economy as a whole.

Investigate the social and environmental impacts of drone logistics. This could include studies on noise pollution , security concerns, and the possible effect on jobs in the customary logistics sector.

Develop new advancements that can work on the proficiency and wellbeing of drone logistics operations. This could remember research for independent flight control frameworks, sense-and-keep away from innovations, and longer-range battery arrangements.



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