# Abstract

Business models and supply networks will be fundamentally altered by the fourth industrial revolution (Industry 4.0). The Internet of Things (IoT) is a relatively new technology that, when combined with other fourth industrial revolution technologies like artificial intelligence, cloud computing, and "Big data," has the potential to drastically alter the world we live in. The Internet of Things (IoT) enables organizations to implement new services more rapidly and at lower risk.

The researcher gathered information on the various public transportation bodies' functions. There were data gathering trips to several European transport authorities. Data was gathered throughout analyzing different case studies to study the impact of internet of things on the global transport system. In order to find examples of IoT technologies that may be used internationally, a literature review had been constructed based on the activities and goals of these public bodies. These included long-term parking calculation, weather monitoring, scheduling and simulation.

Aviation companies tend to use Internet of Things in its aviation operations to monitor weather, schedule and simulate flights. Using Internet of Things can help Aviation companies to stay on top of critical systems including engines, powertrains, and fuel tanks to identify and correct issues before they become potentially catastrophic, and to provide maintenance professionals with real-time data analysis capabilities.

# 1.Introduction

Business models and supply networks will be fundamentally altered by the fourth industrial revolution (Industry

4.0). The Internet of Things (IoT) is a relatively new technology that, when combined with other fourth industrial

revolution technologies like artificial intelligence, cloud computing, and "Big data," has the potential to drastically alter the world we live in. The Internet of Things (IoT) enables organizations to implement new services more rapidly and at lower risk.

As logistics industry struggles to keep pace with the global shift to a digital economy, the authors felt it was important to look at what other countries have done to address these issues according to Dlodlo (2015). Over the next decade, logistics will undergo a significant transformation thanks to the Internet of Things. Device component costs can be reduced, wireless network speeds can be increased, and the network's capacity to accept data may be expanded. This results in new commercial opportunities. Working on IoT deployment in logistics, real-world instances of its application by transport businesses, and new technological development perspectives (Dukic et al., 2021; Risman et al., 2021)

## Problem Statement

According to Gandomi (2015), wireless network communication intelligence algorithm, population growth rate, total import and export volume and other elements are taken into account to develop a generally full forecasting model of the aviation business volume La et al. (2021). This article aims to study the impact of internet of things on the smart public transportations using a comparative case study approach.

A single model's comprehensive prediction makes use of several pieces of information to provide a variety of integrated predictions according to Aryal et al. (2018). Using the economic information and forecasting viewpoint, we can improve prognostic outcomes, minimize systematic forecasting mistakes, and better comprehend the differences in predicting results brought about by various combination forecasting approaches. Using the economic information and forecasting viewpoint, we can improve prognostic outcomes, minimize systematic forecasting mistakes, and better comprehend the differences in predicting results brought about by various combination forecasting approaches.

**2. Real Time Transit Information:**

### . The Impact of Internet of Things on Global Transportation Management

Air passenger traffic forecasting in the air transportation market has always been a tough issue to tackle due to the large number of elements that influence it, as well as the unpredictability associated with these diverse aspects. The focus of this study is on an air transportation management prediction model based on an intelligent wireless network communication algorithm. According to Zhong & Xu (2017), Dudukalov et al. (2021) wireless network communication intelligence algorithm, population growth rate, total import and export volume and other elements are taken into account to develop a generally full forecasting model of the aviation business volume.

### The impact of Internet of Things on Aviation Analytics

There are a few brief experiments that gather and analyze data utilizing IoT devices (the Internet of Things). A Raspberry Pi computer, and software developed specifically for the project, as well as the free and open-source dump1090 software, are all used to gather the data. In real time, the ADS-B data is read by the RTLSDR radio and then outputted by the dump application, which is used to archive the data (Smanchat et al., 2021; Sorokina et al., 2021). Flat files are used to store the collected data. The R programming language and the R Studio environment are used for further analytics and analysis. It focuses on only a portion of the R code that was used in the study. This project's unique software may be found on GitHub.

This work does not include an extensive investigation. We want to demonstrate that if aircraft data were openly accessible, we could do a broad range of studies that are now impossible. First, an initial top-level study is conducted to see if low-cost hardware, software and analytic tools can be used in advisory air traffic applications, such as airspace and traffic monitoring. The Observations and Continuing Work portions of this publication provide suggestions and recommendations for further research according to Aryal (2018).

A strategy to integrating information and material flows in autonomously cooperating logistical systems is shown here. A multi-agent system (MAS) is used to depict the information flow and has the ability to operate transport logistics activities on its own. These procedures are characterized by a material flow, which includes the real physical logistical items that are involved. An Internet of Things (IoT) for transport logistics may be developed by connecting the two streams, allowing the logistics "things" to interpret information, communicate with one another, and make choices on their own. Using the EPC global Framework Architecture, the suggested solution ideas for linking the flows may be implemented in current transportation logistics infrastructures, indicating the viability of an Internet of Things for transportation according to (Tran-Dang et al., 2020).

### . IoT-based Data Acquisition Unit for aircraft

As a result of this research, a Data Acquisition Unit has been developed (DAU). A road car may also use the gadget, even though it was built especially for light airplanes (equipped with Bluetooth module to measure the engine and vehicle data from onboard diagnostics interface). The major goal of DAU is to follow airplanes operated by the University of Ilina's Air Training and Educational Center using the Internet of Things (IoT) (Smanchat et al., 2021). Flight records are tagged as non-compliance if certain parameters of the flight are outside of the acceptable range. An anti-collision system and a real-time tracker are among the functions of the gadget. A number of proof-ofconcept flights were conducted. For this purpose, the University of ilina's Department of Control and Information Systems plans to utilize the collected data to analyze localization techniques.

Transportation-related sectors, such as air travel, highway travel and rail travel are all examples of industries that benefit from big data applications. Because of the constant, real-time flow of data, transportation data is particularly challenging to assess. It's essential that you keep up with the latest innovations, given how quickly they're being developed and how they follow the same rationale. Because transportation data contains a lot of non-structural data kinds, the big data concept should be used to examine the data (Tran-Dang et al., 2020). Despite the fact that the above-mentioned sectors are interdependent, the applications vary according to the sector's specific requirements. As a result, big data applications should be used to find answers to particular challenges in many sectors.

Big data studies that offer value to the transportation industry were assessed in line with the goal of the research. According to several criteria, studies have been narrowed down based on their ability to adapt to a specific sector, their availability online in full-text, and their references from reputable sources.

All of the academy's big data application research isn’t applicable in real-world settings. Companies will lose both morale and money if they attempt to use all of the apps at once. Using this research as a reference, firms may stay abreast of the latest advancements in big data theory and choose the approach that best fits their needs. As a result, efforts were made to bridge the divide between academics and industry (Tran-Dang et al., 2020). Big data applications in the transportation industry are often mentioned in academic literature, but this research differs from others in that it particularly analyzes big data applications in several transportation businesses, including airlines, highways, and railways.

### . Excavation of the Internet of Things on Intelligent Transportation Management System

Every day, the Internet undergoes significant changes. Human is the primary Internet communication format at now. Machine-to-machine (M2M) learning may be seen as the future assessment of the Internet by the Internet of Things (IoT) according to Baalisampang & Abbassi (2018). Everyone and everything may now be connected thanks to the Internet of Things (IoT). The Internet of Things (IoT) is a network of interconnected devices that can share data, make decisions, execute commands, and offer a variety of useful services (Dlodlo, 2015). IoT's general design, differentiating characteristics, and potential future uses are all discussed in this study. Additionally, this report predicts the major hurdles that IoT development will face. Internet of Things (IoT) is becoming more popular among academics, business and the government because of its potential for personal, professional and economic advantages according to Zhong & Xu (2017).

Traffic in metropolitan areas has become very complicated owing to the enormous number of private automobiles that people use every day. Congestion and traffic bottlenecks cost time, energy, pollute the environment, and sometimes even cause accidents that weren't intended. IoT technology has recently provided an efficient and effective traffic management system, especially in transportation, due to the combined functions IoT can handle, such as management and monitoring, tracking and identification and computing (Karakuş et al., 2019).

IoT is an excellent computerized technology solution for all claims in the real world. This article gave an in-depth look at several IoT-based traffic control technologies that aim to reduce traffic congestion according to Queiroz & Telles (2018).

### . Internet of Things and impact on Fleet Management System

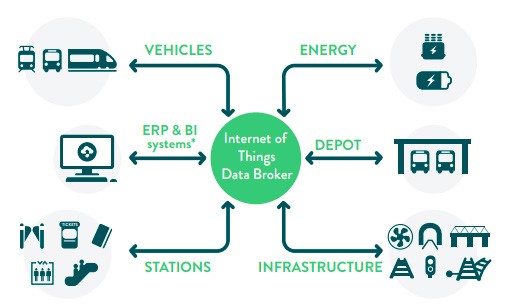


Fig. 1. Internet of Things and Fleet Management

A distributed IT system is used to manage public transportation fleets. The cars, the control center, depot management, and the road/track infrastructure features such traffic signals, switches, and so on are all part of the necessary system for operations management. In a broader sense, fleet management also includes system components for passenger guidance, information, and communications, such as information displays, public announcement speakers, passenger counting devices, gates, and turnstiles, among others according to Tran-Dang (2020).

An internal communications infrastructure underpins any modern fleet management system, and technology connects the various components. An analogue or digital radio system with a message-oriented application protocol layer was either vendor-specific or based on open standards for public transportation in the past according to Aryal (2018). No changes were made to the application protocol despite the advent of IP-based radio communication (e.g. public mobile radio).

"Request/response" or "publish/subscribe" communication patterns offered by protocols like AMQP and MQTT are game changers in this viewpoint. Middleware, or "message brokers," may be found both commercially and in the open source community according to Aslam et al. (2020). Using these technologies, a significant portion of the previous public transportation industry's domain-specific requirements will be eliminated: It is the core IoT technology that enables message transmission, transaction concepts, buffering and timeouts, IP address translation and resilience, as well as the handling of connection failures. System components from different vendors may be interoperable if they are able to recognize the payload's public transportation domain-specific features.

To illustrate this point, consider how a vehicle communicates its location to the control center. System architecture may be open, flexible, and adaptable if the components are loosely coupled according to Smanchat (2020). In order to preserve your investment, you need to use IoT technologies and IoT implementations from the massive IoT market. Every system platform, from tiny embedded devices to servers and cloud-based systems, has a communication client application available for it.

This means that the fleet management system will be able to swiftly include additional infrastructure components in the future according to Queiroz & Telles (2018).

**3. Arrival Time Prediction:**

The researcher gathered information on the various public transportation bodies' functions. There were data gathering trips to several European transport authorities. Data was gathered throughout analyzing different case studies to study the impact of internet of things on the global transport system. In order to find examples of IoT technologies that may be used internationally, a literature review had been constructed based on the activities and goals of these public bodies. These included long-term parking calculation, weather monitoring, scheduling and simulation.

### Internet of Things and Nomago Case Study

Immediately upon purchase, Nomago had the difficulty of integrating, modernizing, and simplifying 12 diverse bus operations throughout Central and Eastern Europe. Nomago is now able to manage all of its fleet operations via a single transit management platform, thanks to LIT Transit. GNSS, IMU, and CAN BUS connection, announcement systems, and passenger counts are among the IoT devices that have been placed on municipal and regional bus fleets. As a result, operational efficiency and customer happiness may be improved by using data from various devices in a single, open platform. On linked displays, vehicle position data is also utilized to produce precise route time predictions based on machine learning.

### . Internet of Things and AUTOPILOT Case Study

A variety of IoT-enabled automatic driving services, such as parking, platooning, and urban driving, have been evaluated as part of the EU-funded Autopilot project. A number of technological advancements have been identified during the pilot testing, which are projected to have a favorable influence on urban transportation in the future, primarily by boosting journey time efficiency, safety, and comfort. As the project consortium sees it, these technological advancements are also beneficial from a commercial standpoint, as they will speed up the development and time to market of new mobility services and their integration into MaaS-type services as well. IoT platform interoperability is a major component in accelerating the implementation of such services, since it saves costs and solves the vendor lockup problem.

### . Internet of Things and ATM Case Study

The city of Milan, Italy's ATM, the city's public transportation authority, and the municipality are all dedicated to bettering the lives of the city's residents. There are a large number of Internet of Things (IoT) systems in the region, including AVM systems and parking sensors. With the use of beacon Bluetooth Low Energy (BLE) technology, PoCs have been created to deliver specific information on congested metro stations. Users will soon be able to get timely information and their chosen routes through new apps. At addition, CCTV is utilized in metro stations, trains, buses, trams, and trolleybuses to identify crowded areas or conduct people counts via the use of photos and video analysis. GPS-based ATM systems have also been deployed for MaaS (Mobility as a Service) purposes. With the use of the MaaS, stakeholders and public transport operators may share trip information and data for integrated ticketing fare collection throughout the area (Ticketing as a Service)

**4. Ridership Monitoring in IOT:**

Aviation companies tend to use Internet of Things in its aviation operations to monitor weather, schedule and simulate flights. Using Internet of Things can help Aviation companies to stay on top of critical systems including engines, powertrains, and fuel tanks to identify and correct issues before they become potentially catastrophic, and to provide maintenance professionals with real-time data analysis capabilities.

Furthermore, Aviation companies can benefit from the Internet of Things to hover a mouse over the symbols on an airport parking map and by that helping the plane to reveal the best spots to park. The wireless interface between the map and the parking bays identifies the locations of available parking spaces and their GPS coordinates. Passengers' departure and arrival dates are entered into the parking calculator, which then calculates the cost of parking.

Another advantage for Aviation companies to use Internet of things is to make significant progress in forecasting and reporting weather conditions, thanks to advanced weather modelling and vast volumes of data and it is processed through weather forecasting algorithms. Air traffic controllers are informed via networks and connections, which in turn inform the pilots. Using the technology, sensors for airport weather monitoring and air traffic management may be installed to get weather reports, and control tower workstations to make safety judgments.

At last, Aviation companies can benefit from the internet of things to schedule flights and reservations throughout the smartphone, as well as the ability to purchase a boarding permit. The flight database at the airport or agency may be accessed wirelessly through smart phones.

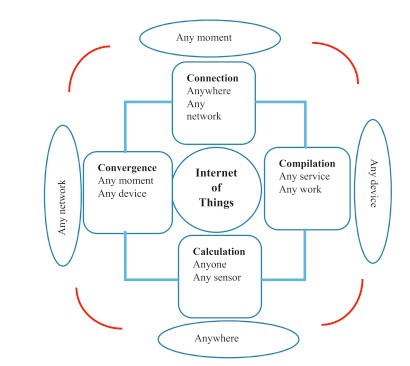


Fig. 2. Internet of Things Framework

The Internet of Things consists of sensors, network connection devices, online storage, and data processing software (IoT). Sensors capture and gather the most critical data.. The network components send and receive data to and store it on the cloud servers. These techniques are employed by online storage systems to extract the most relevant information from a large volume of data. Programs operating on physical devices subsequently make use of this processed data to carry out different activities. Figure 2 depicts some of the players in the IoT.

Companies engaging in the Internet of Things must have device-specific embedded software, sensors, and network support components (IoT). Device-specific functionality is provided by embedded software. In order to identify other things in the environment, sensors on physical devices are used to gather information. It is possible to remotely monitor and operate various kinds of physical equipment owing to the Internet, which acts as a communication link between these devices. One must have adequate resources to make the best choice while being more capable of making choices than other animals.

Concerns concerning the security of IoT technology's information are growing because of the relevance of information in strategic decision-making and in obtaining a competitive advantage. When it comes to safety, the Internet of Things (IoT) relies on both physical equipment and service applications. IoT applications include a lot of benefits and disadvantages that should be taken into account.

The Internet of Things (IoT) is a strategic competitive weapon that should not be seen only as a technical achievement. The Internet of Things (IoT) has the potential to help companies overcome technical, societal, and competitive challenges.

Internet of Things (IoT) is an umbrella term for a wide range of topics, including goods, industrial processes, infrastructure, and technology in academic and corporate contexts. Outside of academics, the Internet of Things (IoT) has been largely neglected as a tool for service innovation. As a consequence, the service may be used across the board by the business. The organization gains a strategic advantage by improving customer comprehension of service upgrades. Economic and political arguments suggest that countries are increasingly reliant on service innovations to improve living standards, increase employment and boost productivity. It is for these reasons that this research intends to evaluate the usage of IoT technology in civil aviation. The expansion and progress of aviation technology throughout the globe has hastened the introduction of Internet of Things (IoT) applications into the aviation industry. In today's aviation, the Internet of Things (IoT) has a significant influence, despite its relative rarity.

In the aviation sector, where production, maintenance, and safety operations are critical, the IoA has been recognized and several applications have been implemented. Using IoT, for example, reduces the amount of time and manpower required to manage and quickly integrate aircraft components. RFID instructions and specified commands may be used to control and connect items that interact with one another and communicate with one another. In the past, real-time Internet of Things (IoT) technologies were exceedingly expensive and challenging for airplane maintenance staff. A smart airport might employ IoA as well. The airports' usage of Internet of Aviation technology such as passenger tracking, baggage systems, and management systems benefit both passengers and airport managers tremendously from these applications' ease of use and financial incentives. Our objective is to help passengers not only at the airport, but also when they arrive in their destination cities. In the aviation business, the Internet of Aviation (IoA) has great promise, but it hasn't been completely used yet.

As the globe becomes more interconnected than ever before, our research aims to find new ways to use the Internet of Things (IoT) in the air transportation industry to benefit education, commerce, and tourism worldwide. Services Provided by Civil Aviation Authorities Around the World Improve Operations with Internet of Things (IoT) Apps To secure the airport's long-term profitability, aviation also relies on it.

Additionally, airlines may employ IoT advancements to improve passenger experiences. 90 percent of passengers consider that traveling with technology is a benefit, according to SITA Aero There is a lot of space for growth for airlines and airports because of the new technology. It is possible to summarize the use of IoT in the aviation sector as follows: Tracing Services for Lost or Stolen Baggage Transporting luggage costs the industry $31 billion, according to SITA Aero, while misplacing luggage costs $2.3 billion each year. IATA's "Resolution 753," a new effort, will go into effect on June 1st, 2018, as a consequence of this development. Efforts are being made to curb baggage misuse by monitoring each piece of luggage as it travels through the airport. According to it, airlines must track bags at four important locations when baggage is carrying as follows:

Passenger handover to airline

Loading to the airplane

Deliver to the transfer place

Return to the passenger

There can be no real-time flight information without knowing exactly where your luggage is and how long it will take to reach the baggage carousel, which is why luggage tracking is so important. For airlines and airports, baggage tracking saves around 0.11 US dollars each passenger. Since 2007, the mishandling rate per thousand passengers has decreased by 70.5 percent. It will allow airlines and airports to reduce ground handling costs and taxes for passengers as a result of industry expenditure. Passengers may get the most important information using the smartphone application. 52 percent of all passengers want to know the status of their baggage through smart phones while they're on a trip. It is the first time an airline has used RFID baggage monitoring technology, which was used by Aviation companies.

The RFID chip in the luggage tag will be read by scanners that use radio waves to gather just the relevant information. " In addition, travellers would have the option of receiving push notifications on their smartphone app to monitor their luggage's progress during the journey. A 99.9 percent success record for luggage tracking indicates more than just consistent baggage handling for passengers.

### **5. Enhanced Public Transportation Services:**

Predictive analytics is popular among organizations, and if they own costly linked gear, they want to know when a machine will break. Whether it's an elevator or an aircraft engine, they want to know before there's an issue. We see a lot of predictive technologies in supply chain management as a result of this. Forecasting demand situations and determining how much of each item the company may be selling in each location is important to managers. In order to service their consumers more effectively and ensure that they receive precisely what they want at the right time, businesses must be able to accurately predict demand.

Those are all relatively regular occurrences, and their application is rather widespread. Knowing your customers and making suggestions that are relevant to them is a better awareness of what people desire when they use your goods. The application of artificial intelligence and machine learning in the workplace is becoming more frequent, and this is one of the most prominent examples. Even the concept of artificial intelligence (AI) used to be met with skepticism because of its technological implications. Change in attitude to embrace these things is driven by more active and accurate knowledge of how the items are going to behave and better service the consumer. That's why it's so appealing to others. It is the goal of the engineers who do engine maintenance on aviation engines to ensure that they are constantly in the finest possible condition.

The ability to accurately forecast how the equipment and engine would behave so that pilots may get feedback and better grasp the situation is another regular occurrence. They are continuously weighing the efficiency of fuel consumption against the precision with which they can land the aircraft. In order to assess how well they are doing this, they might look at their patterns and actions and provide feedback. There's also Schneider electric, which provides global power control. Their solar arrays are so large that they can provide electricity for anything from cities to distant villages, even in the most inhospitable areas. In the past, they've had an issue with dust landing on the solar panels. It would reduce the efficiency of the solar panels, and they wouldn't know whether a panel had cracked or if it was just a dust storm.

Knowledge of the difference between a simple sweep of the sidewalk, and the dispatch of an actual repair vehicle. " With the appropriate knowledge, they can save a lot of money while still being able to provide these folks with dependable electricity. This technique has a wide range of applications. Microsoft's Cortana Intelligence Suite may be used to merge augmented reality with AI so that enterprises can better perceive what they are seeing inside the machine. It's possible to notice overlaid hotspots if certain engine components are damaged.

Using the tool, you can observe the most frequent regions of failure and even get suggestions on how to fix the engine based on the most prevalent patterns that are recognized and visible. You can't help but be awestruck by the sheer magnitude of this. When it comes to making their customers happy, both company growth and higher customer satisfaction are excellent results that firms may achieve. They can't always foretell the future, but that's the one thing they're aiming towards. An organization's ability to perceive things is facilitated by a shift in the way it works, which is aimed at raising the number of experiments that push the experimentation up higher and higher. Finding patterns that might otherwise go unnoticed with the use of technology.

### **6. Conclusion**

Advanced services may be developed using Internet of Things technology. The quality and efficiency of public transportation may be improved via the flexible use of current data made possible by Internet of Things services. Customers know exactly when and where their transportation will arrive, and operators may inform the public of any delays. Passengers and operators alike gain from the Internet of Things.

It is apparent that IoT technologies are being used in a number of ways in the transportation industry, from passenger information to data management and new services. Even while IoT technologies and services are being heavily invested in by the ICT sector, more components and "glue technologies" will be accessible in the future, making it easier for large-scale IoT deployments to occur. IoT in public transportation will ultimately need system integration skills and ready-to-go' solutions in order to realize all of its potential advantages.

**Implementation using Python:**

import random

import time

import requests

# Simulated GPS sensor

class GPSSensor:

def get\_location(self):

# Simulate GPS coordinates

latitude = round(random.uniform(37.0, 38.0), 6)

longitude = round(random.uniform(-122.0, -123.0), 6)

return latitude, longitude

# Server to receive and process IoT data

class Server:

def \_\_init\_\_(self):

self.data\_store = []

def receive\_data(self, data):

self.data\_store.append(data)

print(f"Received data: {data}")

def process\_data(self):

# Implement data processing logic here

pass

def send\_data\_to\_server(server, sensor):

while True:

latitude, longitude = sensor.get\_location()

data = {

"sensor\_type": "GPS",

"latitude": latitude,

"longitude": longitude,

"timestamp": int(time.time())

}

server.receive\_data(data)

time.sleep(5) # Simulate data sent every 5 seconds

if \_\_name\_\_ == "\_\_main\_\_":

server = Server()

sensor = GPSSensor()

# Simulate sending IoT data to the server

send\_data\_to\_server(server, sensor)