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DEVELOPING AND EVALUATING AN INTERNET OF THINGS ECOSYSTEM FOR A LOGISTICS MANAGEMENT SYSTEM

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ABSTRACT

In real-time applications, logistics management is crucial. Logistics management has challenges in areas such as delivery delays, real-time freight vehicle identification, cargo overload, and loss or theft. Using the cargo's latitude and longitude coordinates, the Global Positioning System tracks its whereabouts. Locating the administrator is made easy with the GSM/GPRS module. Cargo can be located and positioned accurately with the help of the RFID technology. Because it is open source hardware, processing and organizing items on the web server is easy. The cargo may become too heavy to carry or reach by a certain period if additional things are added to it. Using a weight sensor prevents freight from being overloaded. For safety reasons, this system updates the web server's position on a frequent basis, and cargo data is updated in real time using open source hardware. Open source hardware, the Internet of Things (IoT), radio frequency identification (RFID), global positioning system (GPS), and GSM/GPRS all work together to produce reliable outcomes. In addition to preventing goods delivery delays caused by dynamic updates to cargo data, this system also guarantees the placement of goods trucks and removes the possibility of cargo overload.

KEYWORDS: Logistics Management, Supply Chain, GSM, GPS, Radio Frequency identification, Open source hardware, IoT.

INTRODUCTION

In modern situations, logistics are crucial. Shipping and receiving are both handled by a logistic system. The ever-increasing cost of petrol highlights the urgent need to find ways to reduce oil use while maintaining efficient transportation. Although first developed for use on aeroplanes, the vehicle tracking system has since seen several upgrades and additions made possible by technological advancements. Vehicle tracking and real-time detail updates are also supported by the system. You may find out where the vehicle is by using the goods tracking system. Using the truck's GPS coordinates, the goods tracking gadget finds its current location. When it comes to real-time localization systems, GPS and RFID technologies appear to be the best and most promising options. An intelligent transport system is put into place for the purpose of the monitoring system. One component of the GPS system is a network of satellites. The military is the primary user of the global positioning system. Based on satellites, the Global Positioning System functions. The main medium of communication between GPS and satellites is radio waves. At its core, the Global Positioning System is made up of three components. The Global Positioning System consists of three parts: the consumer system, terrestrial networks, and the satellite. The satellite constellation is a network of interconnected satellites that provide various data signaling tasks to consumer electronics.

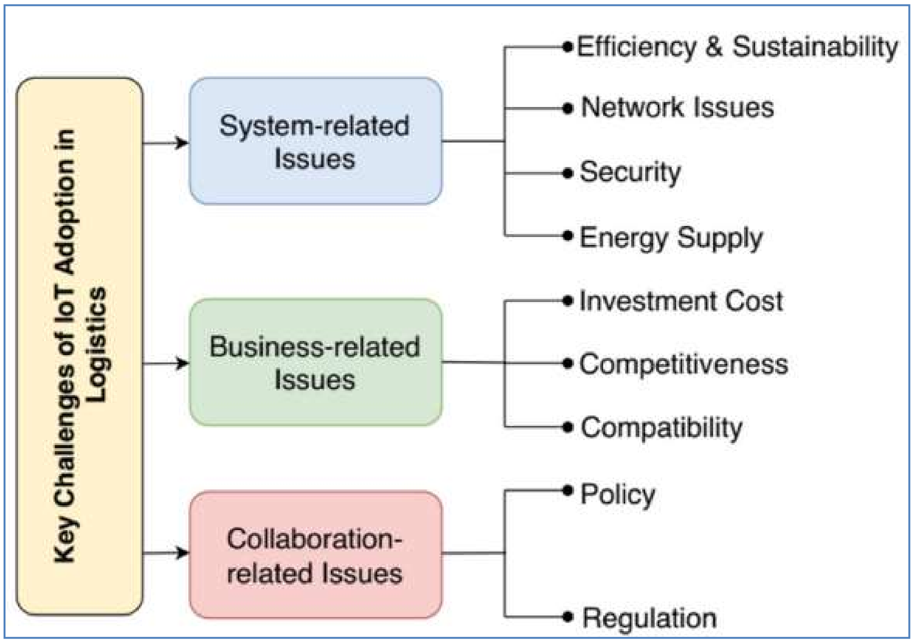

Figure1.1 Key challenges of IoT adoption in logistics

The space segment is held by the land network. After additional measurement, the user's equipment receives navigational signals from the space portion. The GSP system is responsible for receiving the radio waves that are transmitted by the satellite system. Latitude and longitude coordinates are determined using a triangulation device in a two-dimensional approach. The location's latitude and longitude coordinates dictate the device's orientation. The placement of the gadget determines both the average speed and the direction of travel. In this way, the Global Positioning System can pinpoint the precise whereabouts of any computer. This will allow for a seamless integration of the GPS system with the goods vehicle system. Typically, electromagnetic waves are emitted in order to activate the radio frequency detector. Included in the RFID device are RFID readers, RFID programming hardware, and RFID tags. Coverage, size, and cost are the three main classifications for the tags. These tags are active, passive, and semi-passive. The passive RFID tag outshines the others in terms of cost-effectiveness and ease of management during adoption. Active readers and inactive readers are the two main categories of RFID readers. An electromagnetic pulse is emitted by the Active RFID reader, which activates nearby tags and retrieves their data. Although the RFID system is compatible with low-range, high-range, and ultra-high-range systems, the programme dictates which RFID system is preferable. With RFID, the most cutting-edge logistics technology will be available in the twenty-first century. In logistics, radio frequency identification technology has mostly supplanted barcodes. The optical scanner needed to read barcodes is expensive, the stickers are easily damaged, and barcodes themselves are not secure. Connectivity among devices, individual parts, humans, and Internet protocols is efficiently activated by the Internet of Things. The main goal of the Internet of Things (IoT) is to connect physical objects and enable users to perform more activities than is possible with traditional techniques. The Internet of Things enhances the decision-making function of tangible items. With the advent of the internet, physical items are increasingly becoming connected to the web. The Internet of Things (IoT) ensures a high standard of living by performing admirably in all domains. The Internet of Things (IoT) has the potential to revolutionise the travel, robotics, and healthcare industries by removing human decision-making barriers. Management of the supply chain, treatment. Thanks to the underlying technology of IoT, the traditional approach may be transformed into a more insightful one. Internet of Things (IoT) is critically significant in many businesses. The gap between analytical and functional components is filled by the Internet of Things.

LITERATURE REVIEW

Mohammad Kamrul Hasan et al (2023), Everyday material production and storage relies on a reliable warehouse management system. Still in use are the antiquated, error-prone, and labor-intensive manual counting and operating procedures. The IoT-based warehouse management system is the primary focus of this paper. An all-inclusive warehouse management system, the system is web-based and built using radio frequency identification (RFID) technology. Web page RFID readers primarily employ MySQL and Hypertext Preprocessor (PHP). This approach is based on the incremental concept. With this technology, warehouse management may become more efficient, data loss can be reduced, and labour expenses can be cut.

Yanxing Song et al (2021), An essential factor in national and company competitiveness as well as economic progress, logistics is a game-changer. But low efficiency and excessive prices persist in today's logistics business. Smart logistics is evolving, which means there are chances to address these issues. An integral part of today's ICT, the Internet of Things (IoT) can generate massive amounts of data and, using a variety of mathematical analysis tools, reveal intricate patterns in the transactions depicted by this data. Incorporating these qualities will aid in the advancement of smart logistics. An extensive literature review of Internet of Things (IoT) technologies as they pertain to smart logistics is presented in this article. We begin with an overview of smart logistics and the relevant work. We next go over the smart logistics-related technologies that make the Internet of Things possible. We also take a look at the ways in which logistics transportation, warehousing, loading/unloading, carrying, distribution processing, information processing, and distribution all make use of IoT technology in smart logistics. At last, we cover some of the difficulties and potential next steps.

RESEARCH METHODOLOGY & RESEARCH DESIGN

Wireless sensor networks, big data, and cloud computing are all parts of the Internet of Things, which is an interconnected system of intelligent devices. Studies carried out by Cisco indicate that the number of interconnected things has exceeded the global population. With the help of the Internet of Things' billions of smart items, countless opportunities are created. Traditional civilization has been ushered into a new era of information and connectivity by the introduction of IoT technology. The first inspiration for the name "Internet of Things" came from RFID, which has now expanded to encompass embedded technologies placed in actual objects to solve specific issues or boost efficiency. With the advent of real-time monitoring at every point of the chain, the Internet of Things has played an indelible role in supply chain management, facilitating the smooth flow of goods and information. The initial use of the Internet of Things (IoT) in the supply chain was to manage the movement of tangible goods and data by means of item identification and tracking using sensors and portable electronic devices. With the massive amounts of data produced by big data, the supply chain decision-making process has been greatly enhanced. Decisions are being made more efficiently and in less time as a result. Supply chain issues of yesteryear have given way to more modern concerns with systems, technology, and business modelling. Overuse in other industries has also contributed to a decrease in the price of information and communication technology (ICT) and smart equipment. The Internet of Things (IoT) has three fundamental effects on supply chain management, and these are as follows.

Intelligent

Machines, rather than humans, will make the bulk of the organization's choices. These judgments are made rather quickly, in real-time, and they leave opportunity for predictions about the future. With the help of its modeling and simulation skills, the system's intelligence carries out its given mission as a predict-and-act system. Executives are finding this option to be quite helpful when it comes to dividing apart repetitious tasks. From suppliers and manufacturers to distribution and the delivery of things to clients through smart devices, the whole network of the Internet of Things (IoT) has become more interconnected than ever before. Even on a worldwide scale, cooperation can expand the breadth of corporate activities, replacing interconnectivity in some situations. Internet of Things (IoT) based supply chain systems generate and interpret real-time data obtained from sensors, actuators, GPS, and RFID tags at each different stage, making them more visible than traditional systems. The level of human intervention in the process of keeping tabs on goods, services, vehicles, and containers is drastically diminished in this specific case.

IoT TECHNOLOGIES

Wireless Sensor Networks (WSN)

Interconnected with smart devices, transceiver modules, processor storage units, power sources, and analog-to-digital converters, sensor networks are geographically dispersed systems of wireless communication. It operates by adjusting the current levels in response to data gathered from the surrounding environment. For more effective processing, the analogue current is transformed into digital form. Data is routinely integrated by a multitude of sensor nodes into the base station, which is then sent on to the end user. The outstanding sensing, wireless communication, and computing capabilities belie the little size. While the military has long made use of wireless sensor networks (WSNs), similar technology is increasingly finding use in many other fields as well. It is widely believed that the sensory network will play an important role in logistical and industrial applications. Keeping an eye on the surroundings in real time and making sure products are handled safely during delivery are the major reasons. A thorough system of supply chain management is fine-tuned to incorporate WSNs. Among the most notable aspects of WSN in the transportation sector is the provision of affordable, high-quality services throughout the supply chain, from producers to processors, wholesalers, retailers, and consumers. Figure 2 shows that WSN is a great option since it allows for the management of several environmental parameters, including temperature and humidity, which are important for foodstuffs and pharmaceuticals during long-distance transportation. Additional benefits of the ZigBee ad hoc network-modeled WSN are available to cold chain logistics. For the purpose of real-time monitoring, commodities that are to be delivered to remote areas are outfitted with GPS and linked to a cloud service platform.

RFID

Both the reader (the master of communication) and the tag (the related electronic identifier) are commonly referred to by this word. The reader sends out radio frequency signals, and the tags, which have embedded sensors, receive identifying codes. Tags can get their juice from the reader's radio frequency signals or from a battery. Security, asset identification, actuation, and user engagements to connect with centralised IoT systems are just a few of the many uses for radio frequency identification (RFID). They offer a wide range of sensing applications, especially in IoT systems, and may be classified as either analogue or digital varieties. Despite its inexpensive price, the analogue RFID system has a major communication/sensing trade-off. Digital RFID devices, on the other hand, are impervious to environmental interactions; however, they generate accuracy and selected output while using a lot of energy.

RESULT AND DISCUSSION

A new method of data collecting, analysis, and decision-making has become possible thanks to the Internet of Things (IoT) integration at universities. One of the greatest opportunities for institutions to optimise operations, increase security, and improve the campus experience as a whole is the capacity to harness massive volumes of data from a variety of sources, including structured and unstructured data. There is a lot of promise in the Internet of Things (IoT) paradigm for universities in terms of collecting and making sense of massive statistics. In order to extract useful insights from the indexed data, the system employs cutting-edge analytics tools and complex algorithms. Examples of things that have been uncovered by machine learning models include trends in energy use, equipment utilisation, and student attendance. Not only can these patterns help in making decisions in real-time, but they may also be used to forecast trends. Students have been categorised using clustering and other techniques, and relationships between variables, such attendance and grades, have been better understood via regression analysis.

Processing and indexing streaming data

Integrating the Apache Kafka-based streaming API Kafka Streams proved the system could handle unstructured streaming data. A TensorFlow-based machine learning model was used to analyse video feeds obtained from various campus cameras. In order to enable real-time identification, this model was trained utilising photos of both students and staff. Specifically, any unidentified people seen on video were marked as new entries. There was an index in the central data lake that included their pictures and the time they were taken. Students, faculty, and guests alike might benefit from the indexing that followed, as it revealed their whereabouts and what they were up to at all times.

Biometric authentication and data indexing

Fingerprint scanners and other biometric equipment were deployed at key locations across the campus. These gadgets verified the identities of students and employees and allowed them entry to restricted areas including the library, cafeteria, and offices. The data lake was used to index every authentication event, which included the person's identity, location, and date. All the campus population's daily activities and whereabouts may be seen in this data. Biometric data is extremely sensitive, so we've taken extra precautions to keep it safe. When data is encrypted before being stored or sent, it becomes impossible for unauthorized parties to access the data. In order to find and fix such security flaws, regular audits are carried out. Furthermore, data anonymization approaches are utilised to guarantee that the data cannot be linked to specific individuals, even in the event that it is obtained. In addition, the organization follows international data privacy rules, which prevent the exploitation or abuse of personally identifiable information.

Structured data from key departments

It shows how important departments within the organization provided structured data, which is described by a preset schema. To provide a smooth and independent data flow, a message queuing system was used to incorporate data from each department into the central data lake. At its heart, the system was an indexing data lake that tracked activities inside individual departments. For example, in order to get insight into the health state and medical history of faculty and staff, we indexed health information from the campus hospital.

Deriving insights from indexed data

There was a wealth of information about the institution's activities and the inner workings of each department in the data lake's indexed data. The system's potential was shown in many scenarios: a. If you look at the attendance records of your employees, you could see patterns, as when one person is chronically absent. b. Misconduct caught on camera might lead to disciplinary measures against pupils. c. To find out how often certain people come and who they are, study their behavior patterns. The administration of the institution was able to make well-informed decisions because to these insights obtained from the extensive data architecture shown in Figure 2. It shows the whole data flow and system processes, giving a comprehensive perspective of the integrated IoT system.

Anticipated advancements and prospective real-world scenarios

The implementation of the IoT framework at the school is set to bring about several observable improvements, shaping an innovative and adaptable learning environment for the future. Attendance Analytics and Intelligent ID Scanners: The installation of Smart ID scanners all across campus is a major change that is anticipated with the advent of the IoT framework. The laborious and inaccurate traditional methods of keeping track of attendance will most certainly become outdated. Instantaneous and precise attendance may be recorded when students quickly scan their IDs upon entering lecture rooms or labs. The use of proxy attendance is expected to decrease significantly as a result of this simplified procedure. A genuine attendance record will be generated by the system because of its capacity to immediately compare the scanned data with the student's biometric database, preventing any kind of attendance fraud. Teachers will have a better picture of student attendance with this improved method, and they will be better able to help children who show signs of irregular attendance.

One of the most important problems that many institutions have is finding ways to make the most of their laboratory equipment. Lab reservation approaches are expected to undergo a revolutionary shift due to the projected IoT system's capacity to continuously monitor equipment utilization. A thorough evaluation of equipment usage patterns, peak demand periods, and trends in probable equipment malfunctions will be conducted in order to greatly improve lab scheduling and maintenance processes. A 20% increase in equipment accessibility is anticipated as a result of this data-driven restructure, guaranteeing that students will benefit from improved equipment availability. In addition, the system's proactive maintenance insights will most likely reduce equipment downtime, leading to more efficient and smooth lab operations.

Reducing Energy Consumption with the Help of Environmental Sensors: The planned installation of environmental sensors has the opportunity to revolutionize campus sustainability. It is expected that these sensors, when placed appropriately, will continually measure things like the surrounding temperature, humidity, and illumination. After that, the compiled data will connect to the main Internet of Things (IoT) system, which will subsequently coordinate HVAC system optimisations in real time. On days when it's expected to be cooler, the system may adjust the heating in areas with fewer people, or it can control the lights depending on how much sunshine is expected to reach certain areas. We anticipate a 15% drop in energy costs as a whole as a consequence of these automated calibrations. In addition to signalling potential cost savings, this energy efficiency measure will highlight the institution's dedication to environmental preservation and sustainability.

Implications and future prospect

The findings highlight how the Internet of Things (IoT) has the ability to revolutionise higher education. Institutions may improve the experience for both students and employees by using real-time data to proactively handle security issues, allocate resources more efficiently, and more. Institutional operations may be made more efficient and successful with the help of strategic planning informed by the capacity to analyse patterns and trends. Even though we are seeing encouraging outcomes thus far, we are only at the beginning of the road towards full

Internet of Things inclusion in universities. Virtual reality (VR) for experimental simulations, deep learning models for administrative duties, and augmented reality (AR) in the classroom are all very promising areas. But there are difficulties that come along with progress. Stronger data management systems are going to be required to handle the data explosion that will occur as a result of the increasing number of gadgets. With biometric devices becoming more integrated, protecting personal information will be of the utmost importance. Another issue that will require continual attention is interoperability, considering how quickly technology is advancing.

CONCLUSION

There are clear social, economic, and ecological advantages to implementing and using the IoT. As a whole, the supply chain is now more adaptable and dynamic, allowing for the delivery of services at cheap cost without sacrificing quality. In order to go forward with the industrial revolution, this report gives policymakers and managers of supply chains the information they need. More precision and accuracy is required in the packaging of manufactured goods before they are transported to the distribution centre. A good approach in this case would be to link the distribution centre for early readiness with supply chain-based sensory networks, radio frequency identification, and bar codes. Strict cargo and vehicle surveillance, secure item delivery to the distribution point, and regular location record updates may drastically cut down on loss on the distribution side of the supply chain management system. Smart warehousing is also essential for optimizing space and managing products better over time. Warehouse, loading, and unloading systems that are interconnected and based on the Internet of Things can improve operational efficiency while reducing operational time. The store's layout has been fine-tuned and changed to encourage more consumers to shop there and encourage them to spend more money. By acquiring customer-specific data using Wi-Fi technology, purchasers are further monitored. Many believe that the Internet of Things (IoT) will soon be a game-changer in many current industries and even in people's homes. In addition, the linked devices will be data-driven, extremely responsive, and equipped with an effective feedback mechanism. With this new technology, we can finally say goodbye to wasteful energy use and hello to complete autonomy.

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