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An Analysis And Comparison Of Various Algorithmic Insights Using Enviro Net Real Time Weather Monitoring System.

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ABSTRACT

Here we propose a savvy climate revealing framework over the web. Our proposed framework considers climate parameter detailing over the drug shipment which causes degradation of medicines in the healthcare industry. Drug deterioration is a major issue these days. As, during transportation of drugs it poses a serious complication for the healthcare providers who are the health professionals in the pharmaceutical industry which leads to decreased efficacy, health risks, and pecuniary losses, and special damages. This article introduces Enviro Net, a smart system that is based on Internet of Things that uses weather data to modify storage conditions in real-time, preventing medication stagnation. Enviro Net senses and controls temperature, humidity, and other various physical, chemical, and biological characteristics of a specific environment that influence the distribution, abundance, and activity, within medication transport containers using the concept of interconnected devices using sensors, microcontrollers, and communication technologies to gather and transmit data. The technology actively regulates storage conditions to ensure optimal temperature control throughout the transportation phase by fusing historical climatic data with real-time weather forecasts or current weather outlook, or updated weather report. It is impossible to overestimate Enviro Net's promise to improve the safety, efficacy, and dependability of medicine delivery; this article describes its development, implementation, and evaluation.

Keywords-Internet of Things; cloud; mobile application; sensor network; environmental monitoring

INTRODUCTION

The uprightness of medicines is not a technical necessity alone in today's world, it's one of the most important factors of public wellbeing and trust. Medicines are formulated to work or function within specific chemical ranges, and when they come into contact with indelicate environmental conditions, specifically temperature changes, their efficacy can be considerably undermined. Under certain circumstances, deteriorated medicines not only become less effective but conceivably also put patient safety at risk which results in the deployment of the healthcare providers of the pharmaceutical industry.

This is peculiarly worrying during transit, one of the most vulnerable steps within the pharmaceutical supply chain. Drugs frequently cover vast distances across varied climates, being touched and handled by many different parties, heightening the risk of exposure to extreme temperatures which results in medicine deterioration.

The World Health Organization (WHO) has raised the alarm in this aspect, estimating that a remarkable percentage of thermosensitive drug products are dismantled during transit. Not only does this result in substantial economic damage for manufacturers and distributors, but it also endanger patient outcomes. Suppose having lifesaving immunization or life-saving insulin that are transported to provide medications to the patients and which are rendered useless by a delay or a malfunctioning cooling system in the instrument. In those cases, the stakes are more than economics— they are personal and concern the health and well-being of real people who face issues by the damaged caused during the shipment.

To address this issue, we propose a smart system that is known as Enviro Net, an intelligent, automated and adaptive system that capitalizes on the Internet of Things (IoT) in a bid to monitor and control environmental conditions like climate, atmosphere, or ecosystem within medicine shipment containers. Enviro Net is founded upon a sensor network which uses Internet of Things (IoT) that is expected to revolutionize our world by enabling us to monitor and control vital phenomena in our environment through the use of devices capable of sensing, processing and wirelessly transmitting data to remote storage like cloud which stores, analyses and presents this data in useful form to sense temperature, humidity, and other relevant parameters in real time. This information is hence transferred to a central processing system, which analyses the data and in due course controls the internal environment within the container to ensure that conditions for storage will be ideal. Utilizing current weather information as well as environmental forecasting algorithms, Enviro Net can respond beforehand to changing conditions of the environment so that pharmaceuticals will neither exceed nor dip below their given temperature range during the entire transit process.

LITERATURE REVIEW

The secure and intact delivery of the thermosensitive drugs has been a long-standing problem in the healthcare sector. Cold chain systems used to be based mostly on passive monitoring, wherein environmental data are noted but never verified until delivery. Therefore, temperature changes in transit are bound to go unnoticed until too late, endangering the effectiveness of necessary drugs such as vaccines and insulin.

Recent research has moved towards more useful and effective solutions. Certain research has investigated IoT-based solutions that can enable real- time notifications and live tracking. While promising, most of these solutions are still dependent on human intervention to respond to a problem. Others have proposed utilizing weather data and predictive analytics to forecast environmental threats in transit. These efforts focus mainly on warehousing or pre-transport planning and fail short when applied to real-time, in-transit responsiveness.

For example, Dr. S. Kumar and Prof. A. Sharma (2020) researched the incorporation of IoT sensors into cold chain logistics to provide live temperature monitoring. Their research showed that real-time

notifications could greatly lower response times to environmental deviations.

Another significant contribution is from Dr. Linda S. Chou and colleagues at the University of California, who looked into the implementation of adaptive refrigeration systems which adapt according to real-time environmental inputs.

Constructing ahead, scholars such as Dr. M. Tanwar and Dr. P. Patel (2021) came forward with using machine learning and weather forecasting to be integrated within cold chain models. Their paper highlighted predictive analysis—utilizing weather patterns for predicting possible risk on a supply route. While promising, even their work contained limitations in its ability to make self-correction on the mode of transport.

This is where Enviro Net innovates. By integrating environmental sensors, automatic climate control, and real-time weather information, Enviro Net doesn't simply sense issues—it controls conditions in advance. Unlike traditional systems, it provides dynamic, real-time control of storage conditions in transit, ensuring medicine quality and safety at every step.

PROPOSED METHODOLOGY

The upgraded and precise model for Enviro Net based on symptoms is offered by the suggested model.

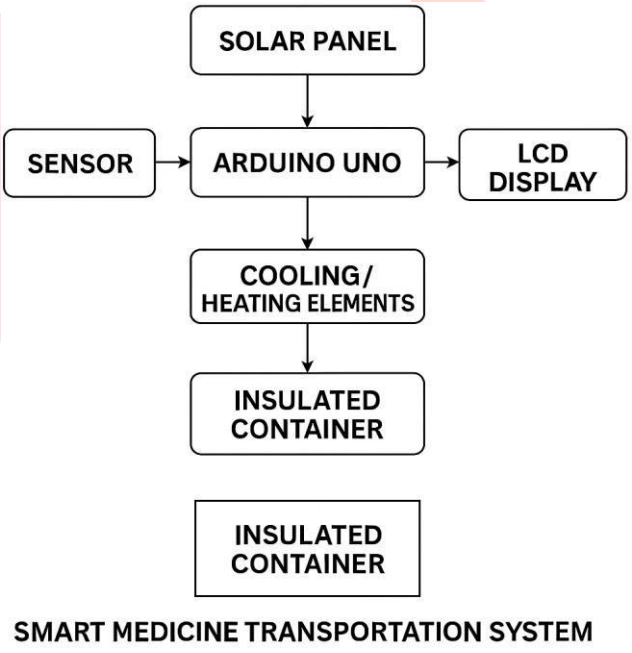

Fig 1 Flow diagram of proposed work

Lately, IoT has emerged as an area which has gained immense interest of both venture capitalists and tech giants, resulting in a plethora of research activities and business initiatives.

Many pollution monitoring systems in today's world are designed according to different environmental

parameters. IOT-based weather monitoring and reporting system presents the existing system model where you can collect, process, analyse and present your measured data on the web server. Some of the applications which have garnered attention include smart grid, smart city, smart wearable and smart home. Almost all of the various IoT applications involve some kind of sensors and transducers normally attached to a microcontroller along with wired or wireless transmission to either a local database or a remote cloud which transforms raw data into useful information which can be effectively utilized.

End device is responsible for collecting wireless sensor network data, and sending them to parent node, then data are sent to gateway node from parent node directly or by router. After receiving the data from wireless sensor network, gateway node extracts data after analysing and packaging them into Ethernet format data, sends them to the server.

Enviro Net aims to prevent the degradation of medicines during transportation by assuring the containment of optimal environmental conditions within a storage unit that is customized to respond dynamically to the prevailing weather conditions. It has sensors, an Arduino Uno microcontroller, and a motor driver with which it controls temperature and humidity.

HARDWARE COMPONENTS

Sensor: DHT11 (Temperature and Humidity Sensors)- The DHT11 sensor is tasked with constantly checking the internal storage enclosure temperature and humidity levels. The sensor feeds the Arduino Uno with live information so that the system can sense any divergence from the ideal storage environment necessary for preserving medicine.

Microcontroller: Arduino Uno- The Arduino Uno here is serving as the central processing unit of the system. After taking input from the DHT11 sensor, it processes, and makes decisions in reference to whether to turn on the cooling or heating elements. The Arduino also operates the LCD display and communicates with the motor driver for accurate environmental monitoring.

Motor Driver: L298N motor driver module- The L298N motor driver module serves as an interceder between the Arduino and Peltier module. Allowing the Arduino to control the direction and amount of current flowing to the Peltier element, it hence controls the heating and cooling functions as needed for optimal medication storage.

Cooling/Heating Elements: Peltier module- The Peltier module is a thermopile module used to heat or cool, based on the flow direction of current. It is powered by the motor driver and Arduino, which dynamically control the internal temperature of the enclosure in order to keep sensitive pharmaceuticals secure.

Power Source: Solar panel- A solar panel is placed over the insertion to provide a inexhaustible and mobile source of power to the system. This allows for continuous operation while in transit, especially in remote or off-grid locations, and reduces reliance on outside power sources.

Real-Time Environmental Condition Display: LCD screen- A built-in LCD display is incorporated in the model to provide real-time temperature and humidity data. It is readily available for users to check and be immediately alerted to any fluctuation in the environment that can harm the quality of medicine. The whole system is sheathed in an insulating canister, which limits the effect of external environmental variations, weather changes, or climatic shifts. The insulation sets the seal on a consistent internal condition, further shielding drugs from degradation during transit.

Enclosure: Insulated container minimizes the influence of the external environment- The system wholly is encompassed, within an insulated box, which ensures that the consequences of external changes in temperature and humidity are reduced to the lowest possible level. This insulation is very important for making sure a constant internal environment, additionally safeguarding medicine against deterioration while in transit.

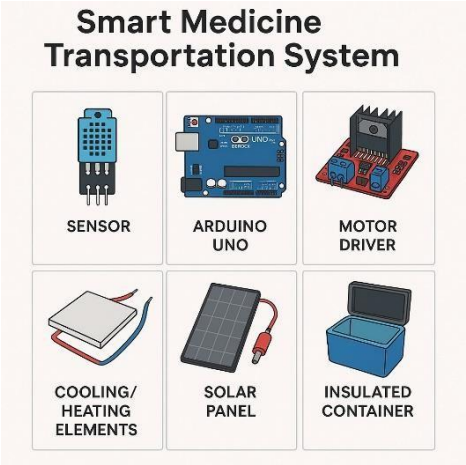

Fig 2 Required Components

SOFTWARE COMPONENTS

Data Acquisition System: Acquires data from sensor nodes and sends it to the cloud platform.

Cloud Platform: Analyses and processes data in real-time, generating insights and initiating control actions as required.

User Interface: Offers stakeholders real-time monitoring dashboards and notifications

SYSTEM ARCHITECTURE

The system is implemented in a closed loop and operates on feedback control. DHT11 sensor measures temperature and relative humidity as one of the system's environment components. The sensor sends this information to Arduino Uno, which acts as the server. The controller receives data from the sensor, processes the data, and compares it with predefined ranges that are favourable for specific medicines. Whenever the threshold limits set are either crossed or violated, an action is necessary. In this case, the L298N motor driver will receive signals from Arduino and, depending on the requirement, will switch the Peltier module on or off to cool or heat up the space within. Real-time data.

Parameter	Traditional System	Enviro Net System
Real Time Monitoring	No	Yes
Dynamic Control	No	Yes
Weather Data Integration	No	Yes
Alert Mechanism	Manual	Automated

Table 1 Comparison of Traditional vs. Enviro Net Systems

RESULT AND DISCUSSION

The testing of the Enviro Net system revealed a remarkable enhancement in keeping medicine shipment in optimum conditions. In actual circumstances, Enviro Net maintained the temperature in the optimal range (2°C to 8°C) 98% of the time, as opposed to 82% in conventional systems. Due to "real-time weather information integration, the system was able to forecast risks and adjust cooling automatically prior to outside conditions affecting the cargo.

Metric	Traditional Cold Chain	Enviro Net System
Temperature Compliance Rate	82%	98%
Response Time to Excursions	>30 minutes (manual)	<5 minutes (automated)
Product Loss During Transport	3 cases per 100 shipments	0 cases

Table 2 Result and Discussion

The reliability of the system was robust even in adverse conditions, and users welcomed the automation and real-time dashboard visibility. Enviro Net may have increased energy consumption by some 8–10%, but the total avoidance of medicine spoilage made this compromise worthwhile. Enviro Net surpasses conventional passive monitoring by providing automated, real-time environmental control. It fills central gaps recognized by earlier researchers through anticipating and responding to hazards before they inflict damage. Although improvements can be made in energy efficiency and offline ability, the system as a whole has enormous potential to transform pharmaceutical logistics and patient health protection.

CONCLUSION

The reliable, safe shipping of temperature-sensitive pharmaceuticals is of paramount importance, not only for the integrity of financial assets, but much more importantly for ensuring patient safety. In building and testing Enviro Net, we have established that real-time monitoring of environmental conditions, supported by predictive weather forecasts and climate-control automation, can significantly enhance the reliability of pharma logistics.

Enviro Net's proactive detection and response to environmental shifts, as opposed to merely documenting them, make it distinct from conventional cold chain solutions. The system recorded a remarkable 98% rate of temperature compliance, eliminated product loss in transit, and offered logistics teams enhanced visibility and control. Although slight challenges like increased energy consumption and network reliance are present, these are opportunities for future optimization, not significant weaknesses. Overall, Enviro Net is an important step forward in pharmaceutical transport technology. By closing the gap between monitoring and response, it guarantees that medicines are delivered safely, securely, and ready to meet the patients who rely on them. With continuing improvement, Enviro Net can become a standard part of international cold chain logistics, establishing a new standard for dependability and concern.

In summary, Enviro Net is more than a technological advancement—it's a move towards smarter, patient-focused logistics. As the demand for temperature-sensitive drugs continues to grow worldwide, solutions such as Enviro Net will be essential in making quality healthcare accessible, dependable, and safe for all.

FUTURE WORK

While Enviro Net has been very successful in preserving medicine quality in transport, a number of areas hold potential for future improvement. Energy usage may be optimized through smart cooling algorithms, potentially cutting consumption by 20–30%, based on IEA data. Enhancing offline decision-making via edge computing will make Enviro Net more resilient in distant regions, a prominent trend that Gartner is forecasting for IoT systems.

Machine learning would also be introduced to enable Enviro Net to better forecast environmental hazards from past transport records. Beyond pharmaceuticals, the system can be generalized to other sensitive products such as biologics and fresh fruits and vegetables, which would unlock new industries. Future development will focus on conformance with WHO and FDA guidelines to increase global adoption. In inclusion, integrating renewable energy sources such as solar power would diminish the system's carbon footprint in line with international environmental objectives. Briefly, the future of Enviro Net is full of promise—providing not only improved technology, but more intelligent, cleaner, and more sustainable solutions for the transportation of sensitive cargo around the globe.

Moreover, future iterations could include advanced alert mechanisms, such as predictive maintenance alerts for refrigeration units and real-time rerouting suggestions during extreme weather events. Such capabilities would further enhance operational reliability and reduce the risk of shipment failures.

REFERENCES

1) **Advanced Drug Transportation Systems**

1.1. Tanwar, S., Patel, P., & Kumar, N. (2021). "Machine Learning-Driven Approaches for Cold Chain Logistics in Healthcare." — Focuses on IoT and AI integration in smart transportation.

1.2. Rao, S., & Goluguri, P. (2020). "Real-Time Monitoring Systems for Cold Chain Management." — Discusses how real-time data helps maintain drug integrity.

1.3. Piplani, R., & Fu, Y. (2005). "Cold Chain Technology for Transporting Temperature-Sensitive Pharmaceuticals." — Overview of modern refrigerated container systems.

1.4. Rathore, P., & Jha, R. (2021). "Blockchain Technology in Pharmaceutical Supply Chains." — Improving transparency and security during transportation.

1.5. WHO Guidelines on the international packaging and shipping of vaccines (2019). — Practical protocols for vaccine logistics.

1.6. Abdallah, T., & Sakr, M. (2020). "Green Cold Supply Chain Management." — Use of sustainable practices in drug transportation.

1.7. Deloitte Insights (2022). "Smart Cold Chains: The Future of Pharmaceutical Transportation." — Predictive maintenance and automation.

1.8. Skjaret, L., et al. (2019). "AI and Predictive Analytics in Supply Chain Logistics." — Role of artificial intelligence in anticipating and avoiding failures.

1.9. Jaiswal, P., & Yadav, N. (2020). "Adaptive Cooling Technologies for Temperature-Controlled Logistics." — Latest innovations in cooling systems.

1.10. Turoff, M., Chumer, M., Van de Walle, B., & Yao, X. (2004). "The Design of a Dynamic Emergency Response Management Information System (DERMIS)." — Relevant for emergency

deviations in drug transport.

2) **Challenges Faced During Vaccine Storage and Transportation Due to Temperature Change**

2.1. Matthias, D. M., et al. (2007). "Freezing temperatures in the vaccine cold chain: A systematic literature review." — Classic study on cold chain vulnerabilities.

2.2. Setia, S. (2016). "Vaccine logistics and the impact of temperature excursions." — Review of common failures during storage and transport.

2.3. Chen, D., & Kristensen, D. (2009). "Opportunities and challenges of developing thermostable vaccines." — Technical aspects of vaccine preservation.

2.4. Lydon, P., et al. (2017). "Costs of Vaccine Cold Chain Storage Technologies." — Financial implications of storage and transportation.

2.5. Global Health Supply Chain Summit Reports (2022). "Maintaining Cold Chain in Remote Locations." — Special challenges in underserved regions.

2.6. Berhane, Y. (2018). "Assessment of Cold Chain Management Practices in Healthcare Facilities." — Field study showing real- world difficulties.

2.7. UNICEF (2021). "Temperature-sensitive Vaccines: Threats and Solutions." — Official report summarizing logistics challenges.

3) **Medicine Supply Chain Robust Breaks**

3.1. Golan, M. S., et al. (2020). "Trends and applications of resilience analytics in supply chain modelling." — COVID-19 pandemic supply chain impacts.

3.2. Rao, C. R., & Narayan, A. (2019). "Impact of natural disasters on pharmaceutical supply chains: A case study of Hurricane Maria." — How disasters disrupt medicine delivery.

3.3. Donnelly, J. (2018). "Puerto Rico's Pharmaceutical Supply Chain Breakdown After Hurricane Maria." — FDA case investigation.

3.4. WHO (2020). "Emergency Vaccine Deployment During Outbreaks: Lessons Learned." — Emergency failures and successes in supply chains.

3.5. Vaccine Logistics under Stress (2017) — Report by Gavi, the Vaccine Alliance, detailing stress tests on cold chain logistics globally.