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ijirset@gmail.com

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Smart Medicine Delivery: Integrating AI, Drones, and Manual Logistics for Timely Healthcare Access in Rural, Urban, and Underserved Regions

Mr. Dharaneshkumar M L, Sahana G, Sanjana Samaga

Assistant Professor, Department of AD, C.I.T, Gubbi, Tumkur, Karnataka, India

UG Student, Department of AD, C.I.T, Gubbi, Tumkur, Karnataka, India

UG Student, Department of AD, C.I.T, Gubbi, Tumkur, Karnataka, India

ABSTRACT: The model of hybrid medicine delivery, based on the power of artificial intelligence and multi-modal logistics, was proposed for healthcare improvement in rural and underserved areas. Using an e-commerce delivery approach, registered clients can schedule medication deliveries. Short-distance deliveries rely on manual local networks, while drones are used for long-distance deliveries, bringing down delivery times from weeks to a few hours, even in areas lacking proper roads. In instances when time-sensitive delivery is not a constraint, economical courier services are deployed. AI augments demand forecasting, route optimization, and fleet management via predictive algorithms building upon local health data to ensure timely deliveries, effective inventory management, preventing stock-outs, and aiding the delivery of the best outcomes in healthcare. The system also considers policy and operational challenges related to drone usage, prioritizing safety and confidentiality. Drones, equipped with advanced navigation and collision avoidance features, utilize GPS and sensors to safely deliver supplies, improving healthcare access and promoting equity, especially for populations in remote areas. The model's scalability and adaptability make it suitable for different geographic and socioeconomic environments, contributing significantly to global health equity.

KEYWORDS: Hybrid medicine delivery, Artificial intelligence (AI), Multi-modal logistics, Rural and Underserved regions, E-commerce medicine delivery, Drone-based long-distance delivery, Predictive demand forecasting, Route optimization, Fleet management, Real-time GPS tracking, Inventory Management, Health equity and accessibility

I. INTRODUCTION

Timely and reliable access to the most necessary medicine or healthcare supplies has lately thrown a huge gap in service delivery for this sector. While urban populations have access to existing pharmaceutical networks and quick delivery options, rural populations and communities lack the appropriate access to necessary medicines within the critical given time frame. This is even exacerbated in a vast number of areas with inadequate infrastructures, where such logistical factors have caused delays in delivering medicines, creating healthcare disparities, and additional disadvantages that persist between urban and rural communities.

The expansion of e-commerce and delivery services across the globe has ushered in new solutions for the quick accessibility of consumer goods. Through the employment of technology and optimized logistics by companies like Amazon, Swiggy, and Meesho, quick delivery has been made possible; however, such service takes an almost non-existent position in these forms of rural healthcare. Adapting these systems to suit healthcare requirements so that medicine delivery could very much promise to bridge the cancerous gap that utters from service delivery in an urban-rural setting. What often cripple present delivery structures is first either their cost or speed, and neither of these options alone is amenable in a healthcare model where they threaten lives based upon timing.

We've proposed a hybrid medicine delivery system with multiple delivery mechanisms that may include AI in logistics, trans-local distribution, drones, and courier systems. The multimodal delivery approach is keystone with speed for urgent and non-urgent medicines, based on the demands of short- and long-distance transport. Localized manual distribution is used for short distances, while drones are used for urgent cases and courier services for less time-sensitive shipping long distances.

Applying artificial intelligence is the core innovation of the proposed system; it will provide, among other things, optimizing the logistical planning of distribution. In reality, the pertinent AI algorithms will make predictions on the best-fit demand profile by analysis of the health services of the region. This leads to improved management of stock levels and, fewer occurrences of stockouts. The efficiency of operations is further enhanced by the support of route optimization and fleet management algorithms, which adjust dynamically to real-time factors like demand changes and road conditions.

The implementation of this system opens an unprecedented avenue for closing existing healthcare delivery gaps across territories. In addition to the other challenges to be overcome, this model introduces a scalable structure that can be adjusted to serve a variety of geographic and economic contexts and significantly improve healthcare access in underserved areas. In this study, we seek to investigate the feasibility, advantages, and challenges of deploying such a hybrid system. It also aims to furnish a roadmap for further research and implementation efforts.

II. RELATED WORKS

The rapid advancement of digital health technology presents new possibilities in addressing access challenges to healthcare, especially in remote and underserved urban areas. Nevertheless, the provision of healthcare remains a challenge in timely delivery. Barriers remain, however, in the form of poor infrastructure, regulatory issues, and gaps in technology. Existing research is scattered across various fields: from e-pharmacy systems, IoT in healthcare, and drone delivery logistics to AI-driven predictive modeling. In this survey of the literature, a succinct overview of these domains will be presented to find a certain grounding for the proposed hybrid medicine delivery system combining AI, drones, and manual logistics for improving access to healthcare.

The challenge of last-mile healthcare delivery to rural populations is well-known as many studies have documented the lack of infrastructure and healthcare resources. A study argues that e-prescribing, telemedicine, and e-pharmacies have greatly enhanced healthcare accessibility, so much so that they have become life savers, particularly for people who are home-bound (MedShopp: An Online Pharmacy Solution for Crisis Management in Low-Resource Settings). Many issues remain unresolved, especially those of regulation for digital platforms and data privacy that currently makes them unattractive for financing or lending agencies, among others (A Review on an Android Application for Medicine Availability and Location Finder). As providers and funders of healthcare, and as healthcare startups working towards better healthcare access, we are motivated by these insights to propose a regulated service delivery model.

The IoT technology in healthcare is a boon for observing patient health in real-time, particularly in resource-poor settings. For instance, IoT-operated and e-pharmacy systems using sensors and cloud connectivity are known to improve treatment adherence of patients and facilitate secure real-time monitoring of medicine deliveries (Streamlining Medicine Delivery through Automation[3]). In the same line, the sensor-equipped wearable devices assist in continuously monitoring the patient's vital signs and proactive healthcare management, which is foremost important in other settings where immediate care may not be available (Integrated System for Real-Time Health Management in Rural Areas with Medicine Dispatcher Box[4]). The research, however, indicates that these systems face hurdles in power supply and internet connectivity, with large challenges in these two areas, especially in rural habitats. The void denotes the necessity for designing, adaptive, and cost-effective IoT systems so as not to dawn upon the overall utility to unattended areas.

Moreover, the introduction of drones into the health supply chains would seem to promise solutions to geographic constraints involved in rural healthcare delivery. Research has identified drones as an unorthodox solution to provide timely delivery of important medicines to predisposed areas where road infrastructures are poor and quickened delivery processes from days to hours (Integrated System for Real-Time Health Management in Rural Areas with Medicine Dispatcher Box[4]). Moreover, in the Medrone study, a UAV system is proposed to deliver medical supplies with GPS-enabled navigation and collision avoidance, providing a further illustration of how drones can operate safely and efficiently in remote areas (Evaluating Barriers to the Adoption of Delivery Drones in Rural Healthcare Supply Chains: Preparing the Healthcare System for the Future[5]). The challenges presented for the use of drones in health service delivery include the regulatory restrictions that limit them, payload constraints, and the threat for skilled personnel to control the drones. In a solution to handle these shortcomings, the proposed approach integrates AI-enabled logistics to mitigate them and optimize delivery processes, thus greatly ensuring timely and efficient delivery of medical supplies to needy areas.

Conversely, even though current literature exhibits the potential for e-pharmacies, IoT, and drones in healthcare delivery, a systems framework that integrates these technological platforms into one scalable solution remains the missing point in healthcare service delivery for underserved rural populations. Most existing literature examines separate aspects, including IoT for monitoring, drone delivery, and so forth, but predominantly lack integration of the use of AI predictive logistics. For example, while Streamlining Medicine Delivery through Automation[3] specifies the importance of GPS for real-time tracking, not many studies address demand forecasting or fleet management using AI, both real aspects crucial for Toyota and Murphy product delivery at scale in increasingly dissimilar settings. This work underscores the necessity of such a hybrid model, combining IoT monitoring, drone-based logistics, and AI-driven decision-making, as proposed in this work.

In conclusion, the literature suggests the requirement of a methodological hybrid health infrastructure by taking advantage of IoT, AI, and drone technologies to cater to the healthcare demands of remote, isolated communities. A lot of great work has been done and keeps coming up with either technology individually but this research tries to fill the service gaps by coming up with an integrated, dynamic, competitive healthcare institutional infrastructure service that addresses the unique geographical and regulatory constraints. This research integrates all the work together by adding unique healthcare solutions to enhance accessibility, availability, equity, and sustainability for needy communities.

Objectives:

- **Feasibility Appraisal:** Study the right potentiality of integrating an AI-and-drone-human logistics hybrid delivery system in its entirety.
- **Efficiency Improvement:** Nordic solutions through AI on demand forecasting, route optimization, and fleet management to improve delivery time and inventory management.
- **Health Equity Promotion:** Address healthcare disparities using timely access to medicines for rural and disadvantaged communities.
- **Challenge:** The identification involves exploring the operational, regulatory, and logistical challenges of the use of drones in health delivery.
- **Implementation:** An implementation roadmap follow-up on guidelines for further research and practical realizations of the hybrid delivery model adaptable to various contexts.

III. METHODOLOGY**1. Literature Review Process**

- **Purpose:** This work is devoted to a thorough literature review for the construction of rich knowledge associated with the technical aspects of medicine delivery: AI, drone logistics, and manual delivery.
- **The Scope:** This review attempts to cover research on:
 1. Application of AI in logistics for healthcare regarding demand forecasting, route optimization, and fleet management.
 2. Drone technology, particularly its use in healthcare for reaching underserved regions with challenging infrastructure.
 3. Hybrid models in logistics combine manual, AI-driven, and drone-based deliveries for improved healthcare access.
- **Selection Criteria:** Sources were selected based on their relevance, recentness (emphasis on studies from the last five years), peer-reviewed status, and focus on rural and underserved healthcare logistics.
- **Databases and Keywords:** Databases like IEEE Xplore, PubMed, Google Scholar, and Scopus were used with keywords such as “AI in healthcare logistics,” “drone delivery in medicine,” “rural healthcare delivery,” “hybrid logistics model,” and “predictive demand forecasting.”

2. Data Extraction:

- **Information Extraction:** For each included study, relevant information was extracted in order to summarize the paper, the methodology, the major findings, the range of challenges identified, and the recommendations of research drawn from the healthcare logistics study.
- **Organization of Themes:** The data organization theme was based on categorizing the information versus AI-driven logistics optimization, challenges and solutions in deploying drones, manual vs. automated logistics, and health equity.

- **Synthesis of Findings:** Some studies provided an analysis into gaps, redundancies, and complementary insights so far as hybrid logistics in healthcare were concerned. The literature review captures where AI, drone, and manual logistics have found successes, and where challenges are still present, especially in denying service areas.

3. Feasibility study:

- **Feasibility Framework:** The structured framework was designed and built for the evaluation process with respect to the implement ability of the hybrid model. In view of such features:
- **Technical Feasibility:** Considering the technological scenario of AI and drones, guided particularly by AI great advances in demand forecasting, route optimization, and fleet management in areas of varied geographical conditions.
- **Operational Feasibility:** Rated very highly for this analysis, based upon infrastructure requirements for drone landing sites, regulations for drone use, and availability of the necessary skilled personnel for system management.
- **Economic Feasibility:** This involves an economic analysis based on AI development, drone procurement and maintenance, and manual logistics labor, compared with utilities and costs attached to creating other ways by healthcare delivery.
- **Regulatory and Ethical Considerations:** Examination of the continued regulations of drone delivery services and of the use of AI in the healthcare setting and with respect to data privacy, security, and compliance to local and international health policies.

4. Analyze the challenges and opportunities:

- **Operational and Logistical Challenges:** Key challenges to be identified will include infrastructure limitation, the payload of drones, a need for skilled drone operators, and real-time GPS and data connectivity in the rural areas.
- **Issues on regulation:** There are legal constraints about the airspace rules and permission to fly their drones, especially with respect to health data privacy, even in the underserved regions.
- Based on the researches and case studies, some possible solutions could be the engagement of regulatory bodies to collaborate with the company in revising policies, investment in strong communication systems that could track GPS in real-time, and flexible hybrid models that adapt to local needs.

5. Recommended Roadmap for Rollout:

- Gradual rollout of the hybrid model: AI-driven demand forecasting and route optimization could first be implemented, with permission granted, pilot programs for drone delivery in selected areas once permission is granted.
- Healthcare providers, local government officials, drone technology specialists, and AI developers would be engaged to ensure the long-term sustainability of the adapted model.
- Reductions in delivery times, efficiency in the management of the inventories, easier access to health services, and satisfaction levels of the underserved populations are some of the measures that will be used to gauge the performance of the model.

6. Limitations and Future Research:

- **Acknowledgment of Limitations:** The proposed methodology has some limitations. It does not have empirical testing with its regions and relies on secondary sources of data.
- **Areas of Future Study:** More research should include the validation of AI predictions via empirical methods across several regions, pilot testing of drone logistics in underdeveloped areas, and finding policy reforms in rural areas integrating health technology.

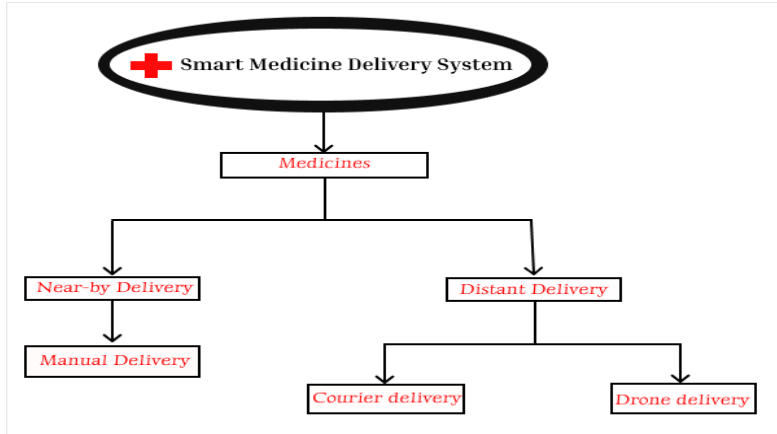


Fig (a). Smart Medicine Delivery System

IV. RESULTS

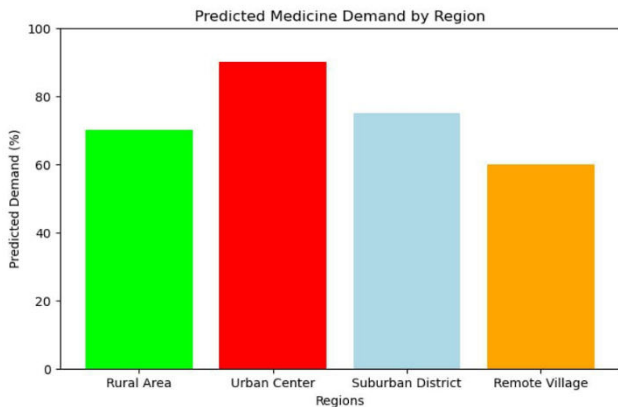


Fig (b) Visualization

Predicted demand for Rural Area: 70%
 Predicted demand for Urban Center: 90%
 Predicted demand for Suburban District: 75%
 Predicted demand for Remote Village: 60%

Fig (c) Predicted results

V. CONCLUSION

This hybrid medicine delivery model brings AI, drones, and manual logistics together into a single framework of accessing healthcare, thus improving and bridging the health disparities gap in rural and underdeveloped areas as much as in urban centers. Integration of predictive AI models could help with demand forecast modeling, optimize routes in this model, and allow it to efficiently manage the distribution process, reducing delivery time for critical medicines while consistently being able to restock all necessary inventory. These drones have features, for efficient delivery in most locations that are enhanced by using extra navigational features combined with local networks, whose coverage mainly does last-mile delivery and enhances overall safety in navigation and goods delivery.

Though this model has very few operational, regulatory, and logistical issues such as airspace restrictions, infrastructure requirements, and individual data protections, this model offers a flexible structure that is scalable, adaptable, and fit for multiple regions and settings. It fosters health equity and access and enables a vision-driven sustainable infrastructure for immediate medical interventions thus creating a healthier and more resilient world community through a hybrid approach.

REFERENCES

1. H. Prajapati and S. Akwafuo, "MedShopp: An Online Pharmacy Solution for Crisis Management in Low-Resource Settings," 2024 10th International Conference on Control, Decision and Information Technologies (CoDIT), Valletta, Malta, July 2024, pp. 1679-1683, doi: 10.1109/CoDIT62066.2024.10708232(IEEE1730474915335).
2. S. Ghodeswar, P. Gawali, S. Chaudhari, M. Jawade, M. Gawande, and S. Sawwashere, "A Review on an Android Application for Medicine Availability and Location Finder," IEEE Conference on Computing and Communication Technologies, 2024, pp. 1-6, doi: 10.1109/ICOCIT.2024.10698531(IEEE1730474915335).
3. Siji Sivanandan, P. Anandan, V. Muthukumar, G. Suresh, "Integrated System for Real-Time Health Management in Rural Areas with Medicine Dispatcher Box", 2023 2nd International Conference on Edge Computing and Applications (ICECAA) | 979-8-3503-4757-9/23/\$31.00 ©2023 IEEE | DOI: 10.1109/ICECAA58104.2023.10212228
4. Panjavarnam B, Kaushik Johnson M, Praneshvaran K T, Pravin Kumar S, "MEDRONE", 2024 IEEE International Conference for Women in Innovation, Technology & Entrepreneurship (ICWITE) | 979-8-3503-8328-7/24/\$31.00 ©2024 IEEE | DOI: 10.1109/ICWITE59797.2024.10503579
5. Nitin Koshta, Yashoda Devi, and Chetna Chauhan, "Evaluating Barriers to the Adoption of Delivery Drones in Rural Healthcare Supply Chains: Preparing the Healthcare System for the Future", 1558-0040 © 2022 IEEE. Personal use is permitted, but republication/redistribution requires IEEE permission. See <https://www.ieee.org/publications/rights/index.html> for more information.
6. Devulapalli Praneetha, Suryadevara Kranthi, Goriparthi Aashritha, Chennu Deepthi, Nandigama Sushma, "Streamlining Medicine Delivery through Automation", 2023 7th International Conference on Computing Methodologies and Communication (ICCMC) | 978-1-6654-6408-6/23/\$31.00 ©2023 IEEE | DOI: 10.1109/ICCMC56507.2023.10084238
7. G. Parthasarathy, T. R. Soumya, P. Ramesh, and L. Ramanathan, "Doctor on Net with Effective Medicine Dispatcher in Medical Analysis," Intelligent Systems and Computer Technology, vol. 37, pp. 64-71, 2020.
8. K. P. Kumar, S. Sangeetha, T. R. Kumar, B. R. D. Rasi and M. R, "Monitoring, Tracking and Fighting Pandemics using Drone-based Artificial Intelligence in IoT," 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2023, pp. 2182-2188, doi:10.1109/ICACCS57279.2023.10112840
9. Nicola, Maria, et al. "The socio-economic implications of the corona virus and COVID-19 pandemic: a review." International Journal of Surgery, 2020.
10. "AI and IoT for Future Generation of Medical Delivery with Drones," 2023 Signal Processing: Algorithms, Architectures, Arrangements, and Applications (SPA), Poznan, Poland, 2023, pp. 10-10, doi:10.23919/SPA59660.2023.10274445.



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