



RESEARCH ARTICLE

THREAD LINK: AN IOT-ENABLED SMART CLOTH DONATION SYSTEM WITH GSM-BASED SMS NOTIFICATIONS

Dr. Mondikathi Chiranjeevi¹, Chittam Venkata Lohitha², Shaik Roshni², Golla Ganesh²,
Bommanaboyina Naga Anjaneyulu² and Kanakapudi Gopinadh²

1. Assistant Professor, Department of ECE, QIS College of Engineering and Technology (A), QIS College of Engineering and Technology (A), Ongole, Andhra Pradesh, India.
2. UG Student, Department of AI&ML, QIS College of Engineering and Technology, QIS College of Engineering and Technology (A), Ongole, Andhra Pradesh, India.

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Abstract

The rapid expansion of the fashion industry has significantly increased global textile waste, emphasizing the urgent need for sustainable, technology-driven donation systems. Thread Link is an IoT-enabled smart cloth donation platform designed to promote responsible clothing redistribution through intelligent automation and inclusive communication mechanisms. The proposed system integrates a web-based platform and an IoT-based GSM SMS notification module to streamline the donation process, connect donors with orphanages and organizations, and ensure accessibility even in low-connectivity regions. Key modules such as donation tracking, recipient matching, geolocation mapping, and realtime impact analytics enable transparency and accountability throughout the donation lifecycle. To enhance user engagement, the platform incorporates gamification and community-driven features that encourage continuous participation and social responsibility. By combining sustainable design principles, intelligent technologies, and inclusive communication strategies, Thread Link establishes a scalable and socially impactful ecosystem for promoting circular fashion and global humanitarian outreach.

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Introduction:-

The fashion industry is among the largest contributors to environmental degradation, generating millions of tons of textile waste annually. According to global estimates, approximately 92 million tons of textile waste are produced each year, much of which ends up in landfills or incinerators [1], [2]. Clothing production consumes vast amounts of natural resources, including water, energy, and raw materials, and contributes significantly to greenhouse gas emissions [3]. Despite growing awareness of sustainable fashion, many individuals discard garments prematurely due to rapidly changing trends, personal preferences, or lack of convenient donation mechanisms [4], [5]. At the same time, charitable organizations and orphanages often face shortages in receiving adequate clothing to meet community needs [6], [7]. Several studies have explored digital solutions for donation management and textile

reuse. Web-based platforms, mobile applications, and AI-assisted systems have demonstrated the potential to improve transparency, tracking, and donor engagement in charitable activities [8], [9]. However, many existing systems involve direct interactions between donors and recipients, which can create inefficiencies, miscommunication, or delays in the delivery process [10], [11]. Furthermore, platforms often lack mechanisms to support users in low-connectivity areas, limiting their overall accessibility and impact [12]. Thread Link is designed to address these challenges by providing a smart cloth donation system with an admin-mediated workflow. Donors submit donation details through a user-friendly web interface, and only after verification and approval by the admin are the donations displayed on the orphanage dashboard. This workflow ensures ethical distribution, reduces logistical errors, and enhances accountability, providing a reliable bridge between surplus clothing and those in need [9], [10].

The platform leverages advanced AI-driven matching algorithms that connect donations with recipients based on clothing type, size, urgency, and location. Integration with interactive maps facilitates optimized pickup and drop-off locations, reducing transport inefficiencies. Gamification features, such as points, badges, and leaderboards, motivate donors to contribute actively and maintain long-term engagement, while educational modules promote awareness of sustainable fashion practices [6], [11].

To ensure inclusivity and reach underserved communities, Thread Link incorporates an IoT-enabled GSM SMS notification system, which delivers real-time alerts to donors, orphanages, and administrators regarding donation requests, approvals, and delivery schedules. This module allows users in areas with limited internet connectivity to participate seamlessly, bridging the digital divide and extending the platform's social impact [12].

By combining technological innovation, administrative oversight, and social responsibility, Thread Link envisions a scalable, global ecosystem that promotes textile reuse, reduces environmental impact, and empowers underserved communities. The platform aims not only to facilitate donations but also to instill a culture of sustainable fashion, ethical giving, and community engagement. This paper introduces a hybrid IoT-web platform that addresses all these limitations by combining intelligent automation, ethical validation, and inclusive GSM communication.

Literature Review:-

In recent years, sustainable fashion and digital donation systems have attracted significant research attention due to their potential for reducing textile waste and promoting social welfare. Several studies have proposed various approaches to optimize donation management, community engagement, and resource allocation. Below is a detailed review of relevant works:

In [1], this study proposes a web-based donation system that facilitates the collection and management of clothing and essential items. Donors submit contributions which are verified and approved by an admin before appearing on the recipient dashboard, ensuring transparency and reducing misallocation. The system also integrates inventory tracking and dashboards to streamline donation management.

In [2], the objective of this work is to analyze donor behavior and the intention behind second-hand clothing contributions in developing regions. The study identifies motivational factors influencing donors and emphasizes structured mechanisms to enhance consistent participation in donation programs.

In [3], an approach was developed to centralize donation management, allowing efficient tracking of donors and recipients. The system incorporates online listings, inventory monitoring, and distribution management, improving operational efficiency and ensuring resources reach intended beneficiaries.

In [4], it was observed that clothing recycling and reuse practices can be optimized through digital platforms. The review highlights challenges in accessibility, real-time coordination, and equitable distribution that must be addressed to enhance sustainability.

In [5], this research employed a web-based charity management system to handle various donations such as food, clothing, and medicines. Admin-controlled approvals and transparent workflows improve accountability, ensuring proper allocation of contributions.

In [6], the methodology focuses on developing a web application for donors to contribute medicines, food, books, and clothing. The system integrates notification mechanisms to keep donors and administrators informed, increasing efficiency and reducing manual intervention.

In [7], the work is designed to create a scalable donation platform supporting multiple organizations and donation types. Emphasis is placed on usability and transparency, enabling donors to monitor contributions while promoting equitable distribution.

In [8], intelligent algorithms were applied to match donor contributions with recipient requirements. Parameters such as item type, quantity, urgency, and location are analyzed to optimize allocation, reducing waste and ensuring donations reach appropriate recipients.

In [9], a geo-location-based donation system was implemented to enhance delivery efficiency. By leveraging location-awareness, the platform minimizes transportation requirements and ensures timely distribution of resources to nearby communities.

In [10], AI and machine learning techniques were employed to automate the matching of donations to recipient needs. Feature extraction from donor inputs and recipient requirements allows precise distribution and reduces human error.

In [11], a framework integrating circular business models in fashion and textiles was recommended. By combining technical, social, and business innovations, the study demonstrates systematic ways to promote sustainability and enhance social impact in donation practices.

In [12], a resource-sharing platform was developed with automated notifications and admin-controlled workflows. The system ensures inclusivity by enabling participation in low-connectivity regions and verifies donations before they appear on the recipient dashboard.

From these studies, it is evident that while digital donation platforms have significantly improved transparency, efficiency, and engagement, there remain gaps in scalability, real-time coordination, and accessibility. Specifically, most existing systems either require direct interaction between donors and recipients or lack intelligent distribution mechanisms, which limits their impact. This sets the stage for developing a robust, admin-mediated donation platform that integrates AI, geolocation, and gamification for optimized, ethical, and sustainable distribution of clothing and other essentials.

Problem Statement:

The primary challenge addressed in this study is the inefficient and fragmented clothing donation process. While millions of garments are discarded annually, orphanages and charitable organizations continue to face shortages, highlighting a disconnect between donors and recipients [1], [2]. Existing platforms often lack mechanisms for verification, prioritization, and optimized distribution, resulting in delays, uncoordinated donations, and underutilization of resources [3], [9].

Moreover, direct donor-recipient interactions can lead to logistical complications, inconsistencies in clothing quality, and challenges in reaching underserved or rural areas [4], [12]. There is also a gap in maintaining donor engagement and sustaining long-term participation, which is essential for building a robust donation ecosystem. To address these challenges, this study proposes Thread Link, a digital platform that mediates between donors and recipients via an admin-controlled workflow. Donors submit clothing details, which are approved by administrators before appearing on orphanage dashboards. This approach ensures ethical distribution, accountability, and proper allocation of donated items.

The platform integrates AI-based matching algorithms to pair donations with recipient needs based on clothing type, size, urgency, and location. Interactive maps and optimized drop-off points enhance logistical efficiency, while gamification mechanisms incentivize donors for sustained engagement. To ensure inclusivity, the system incorporates IoT-enabled GSM SMS notifications, allowing real-time updates in regions with limited internet connectivity.

In summary, the problem involves designing a scalable, transparent, and user-friendly donation platform that maximizes the social and environmental impact of clothing reuse. Thread Link aims to create a sustainable ecosystem where surplus clothing is efficiently repurposed, thereby reducing textile waste, empowering underserved communities, and fostering a culture of responsible consumption and social responsibility.

Proposed Solution:-

To address the challenges of textile waste, inefficient donation workflows, and the lack of equitable access between donors and recipients, we propose a comprehensive web-based donation platform, provisionally named Thread Link, integrated with IoT- enabled notifications. This solution is developed in two synergistic layers: software and hardware, ensuring both efficiency and inclusivity.

Software Implementation (Web Platform using MERN Stack)

The core of the platform is a responsive and secure web application, developed using the MERN stack (MongoDB, Express.js, React.js, Node.js). The home page of the Thread Link web platform is shown in Figure 1. This technology stack ensures scalability, real-time interactions, and seamless experiences across devices, making it suitable for diverse user demographics. The platform supports multiple user roles, including donors, recipients such as orphanages or NGOs, and admins, which allows for controlled access and effective workflow management. Donors can list surplus clothing or essential items, specifying type, quantity, and condition, while recipients can submit requests based on their needs, which are reviewed and approved by the admin before appearing on the recipient dashboard. The admin dashboard, shown in Figure 7, provides administrators with an overview of donation requests, approvals, and status updates.

The platform incorporates intelligent matching mechanisms that analyze parameters such as item type, size, urgency, and geographic proximity to optimize allocation and minimize wastage. In addition, location-based services provide guidance for drop-offs and pickups, streamlining logistics and improving operational efficiency. To enhance user engagement, the platform implements gamification elements such as reward points, badges, and leaderboards, fostering continuous participation. Furthermore, real- time dashboards track donation status, history, and overall impact, ensuring transparency, accountability, and trust between all stakeholders.



Figure 1: Home page of the Thread Link web platform.

Hardware Integration (IoT GSM SMS Notification Module)

To ensure inclusivity and accessibility, particularly in regions with limited internet connectivity, Thread Link incorporates an IoT- based GSM SMS Notification Module. This hardware integration enables real-time alerts via SMS, informing donors and recipients about donation requests, approvals, and delivery schedules. By extending communication beyond internet-reliant users, the platform effectively bridges the digital divide and reaches rural and underserved communities. The hardware setup for the IoT GSM SMS notification module is illustrated in Figure 2, showing how the microcontroller communicates with the GSM unit to send SMS alerts.

Through the combination of a robust web platform and IoT-enabled SMS notifications, Thread Link delivers a scalable, transparent, and inclusive solution that maximizes both environmental sustainability and social impact, creating a seamless bridge between surplus clothing and those in need.

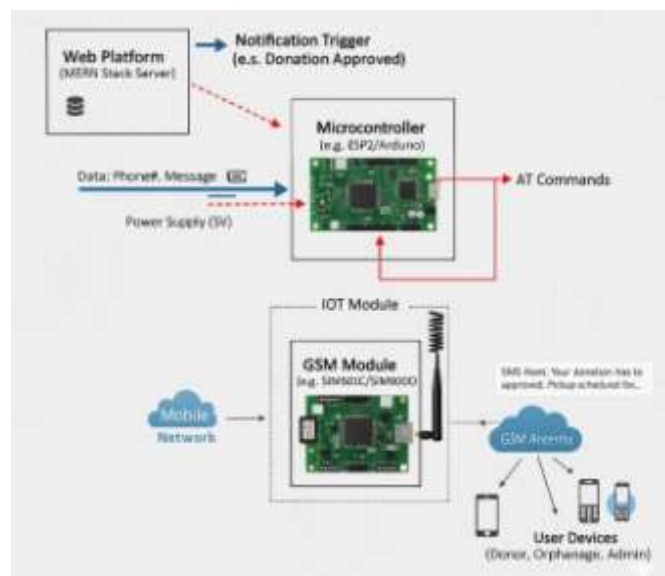


Figure 2: IoT GSM module circuit diagram for SMS notification system

Key Advantages of the Proposed Solution

The integration of a robust web-based platform with IoT-enabled notifications makes Thread Link a scalable, transparent, and inclusive solution for managing clothing donations. Automation and smart matching mechanisms reduce administrative overhead and optimize resource allocation, leading to more efficient operations. By connecting verified donors with recipients, the system maximizes social impact, particularly for orphanages and underserved communities that rely on timely and adequate donations. Facilitating the reuse of clothing and essential items also promotes environmental sustainability, reducing textile waste and encouraging responsible consumption. Additionally, SMS notifications ensure participation across demographics, including rural and low-connectivity areas, fostering inclusivity and accessibility.

Overall, this integrated framework bridges the gap between digital innovation and social responsibility, establishing Thread Link as a reliable, user-friendly, and ethically responsible platform that addresses both social and environmental challenges in modern donation management. The working procedure of the Thread Link system is outlined in Figure 4, presenting the overall process flow from donation submission to delivery.

Methodology:-

Thread Link follows a comprehensive, technology-driven approach to achieving its goals by employing advanced algorithms and user-centric design principles to streamline the donation process. As shown in **Figure 3**, the user registration page allows both donors and orphanages to sign up and access their personalized dashboards. The platform offers a user-friendly, web-based, and mobile-responsive interface that allows donors to list clothing items with images, descriptions, and conditions, making it easy for users to register, donate, and request items. To enhance efficiency, AI-driven algorithms categorize and sort clothing based on size, condition, and type, while image recognition verifies clothing quality, reducing the workload for volunteers. Advanced matching algorithms ensure that donors and recipients are connected based on factors such as location, clothing type, and urgency, while search and filter functions allow users to find specific items quickly. Integrating Google Maps API, the platform optimizes routes for donation drop-offs and pickups,

identifies nearby donation centers, and enables real-time tracking of donations from donor to recipient.

To encourage engagement, Thread link incorporates gamification features such as reward points, badges, leaderboards, and a social feed for sharing impact stories. Transparency is reinforced through real-time donation tracking, recipient feedback, and partnerships with verified NGOs to ensure ethical distribution. The platform sustains itself through collaborations with sustainable fashion brands, sponsored advertisements, premium features for large organizations, and affiliate marketing with eco-friendly partners, ensuring long-term viability while maximizing its social and environmental impact.

IoT GSM SMS Notification Module Integration: To further enhance accessibility and inclusivity, Thread Link integrates an IoT based GSM SMS notification module. This hardware component ensures that both donors and recipients receive real-time updates about donation activities even without constant internet access. The module is connected to the system's database and automatically triggers SMS alerts for key events such as:

New donation requests and approvals Pickup and drop-off scheduling Delivery status updates Urgent clothing requirements in nearby areas

The IoT GSM module communicates via mobile networks, making the platform usable in rural and semi-urban areas where internet connectivity may be limited. This ensures last-mile communication, enabling timely coordination between donors, recipients, and administrators. By combining digital platform efficiency with GSM-based notifications, Thread Link bridges the digital divide and extends its impact to a wider population.



Figure 3: User registration page for donors and orphanages.

Thread link employs a comprehensive, technology-driven approach to achieving its mission of sustainable clothing donation by integrating advanced algorithms, AI-powered automation, and user centric design principles. The platform is designed to simplify and enhance the donation process, making it seamless for both donors and recipients. The donor dashboard interface, displayed in **Figure 5**, enables users to submit, view, and track their clothing donations in real time. At its core, Thread link is a web-based and mobile responsive platform that provides an intuitive interface, allowing users to register, list their clothing donations with images, detailed descriptions, and condition specifications, and easily request items when needed. This streamlined user experience ensures accessibility and encourages wider participation from individuals, organizations, and charities.

To optimize the efficiency of donation management, Thread link utilizes AI-driven algorithms that categorize and sort donated clothing based on multiple parameters, including size, condition, and type. This automation significantly reduces the burden on volunteers and ensures that donated items are efficiently processed and distributed. Additionally, image recognition technology is implemented to verify clothing quality, helping maintain high standards while minimizing manual intervention. The use of these technologies ensures that the right items reach the right recipients while reducing logistical inefficiencies.



Figure 4: Flow Chart of Working Procedure.

The platform further enhances the donation experience through its sophisticated matching and search algorithms. These advanced algorithms connect donors with recipients based on specific factors such as location proximity, clothing type, and urgency of need. This ensures that donations are directed to those who require them the most in a timely manner. Users can also benefit from powerful search and filter functionalities, enabling them to quickly find items that meet their specific needs, whether they are looking for winter clothing, children's apparel, or professional attire.

Thread link integrates location-based services and route optimization through the Google Maps API, significantly improving the logistics of the donation process. The platform provides donors and recipients with optimal routes for donation drop-offs and pickups, ensuring that transportation efforts are efficient and cost-effective. Additionally, users can identify nearby donation centers where they can contribute clothing directly. Real-time tracking capabilities further enhance the transparency of the donation journey, allowing both donors and recipients to monitor the status of their contributions from start to finish.

To foster long-term engagement and encourage participation, Thread link incorporates gamification and community-driven features. The platform rewards users with points and digital badges for regular contributions, fostering a sense of accomplishment and social responsibility. Leaderboards and milestone achievements recognize top donors, encouraging friendly competition and sustained involvement. A dedicated social feed allows users to share their impact stories and experiences, creating a vibrant community of like-minded individuals who are passionate about sustainability and charitable giving.



Figure 5: Donor dashboard interface for submitting clothing donations.

Thread link prioritizes transparency by implementing real-time donation tracking, ensuring that donors have visibility into where their contributions are going. The orphanage dashboard for viewing and requesting approved clothing donations is presented in **Figure**

Recipients are also given the opportunity to provide feedback on the received items, fostering trust and accountability. To maintain ethical distribution practices, the platform collaborates with verified NGOs, charities, and social welfare organizations, ensuring that donations are directed to genuine causes and not misused.



Figure 6: Orphanage dashboard for viewing and requesting approved clothing donations.

To sustain its operations and expand its impact, Thread link employs a monetization and sustainability model that aligns with its mission of promoting sustainable fashion. The platform collaborates with eco-conscious fashion brands, enabling them to reach an audience that values sustainability. Revenue streams include sponsored advertisements for ethical fashion brands, premium features for large organizations managing bulk donations, and affiliate marketing partnerships with sustainable clothing retailers. These funding strategies allow Thread link to scale its operations while staying true to its core mission of reducing textile waste and supporting underserved communities. By leveraging smart technology, gamification, and transparent donation tracking, Thread link provides a scalable and efficient solution to the global issue of textile waste. Its innovative approach not only facilitates responsible clothing redistribution but also promotes a culture of generosity, environmental consciousness, and social impact. With its robust technological infrastructure and community-driven model, Thread link has the potential to transform the way people donate and receive clothing, making fashion more sustainable and accessible to all.

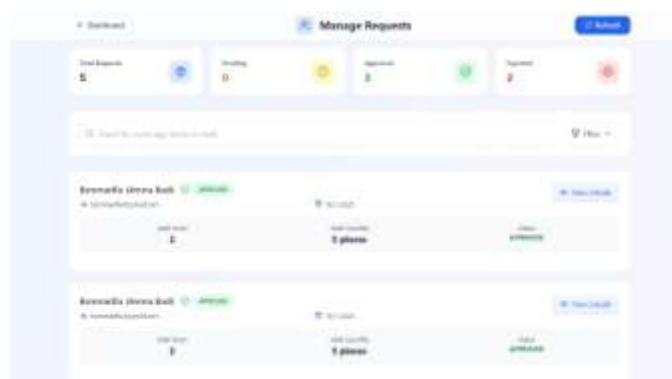


Figure 7: Admin Dashboard showing donation request status overview.

Conclusion:-

Thread Link successfully bridges the gap between donors and orphanages through a unified, transparent, and technologically advanced donation management system. By leveraging AI-driven matching algorithms, location-based logistics, and IoT-enabled GSM notifications, the platform ensures that clothing donations are efficiently distributed and accessible across all regions, including areas with limited internet connectivity. Its integration of gamification and community engagement fosters sustained donor participation while encouraging a culture of ethical giving and sustainable fashion.

Through intelligent automation, transparency, and inclusivity, Thread Link demonstrates a transformative approach to reducing textile waste and advancing environmental and social sustainability. The proposed framework not only streamlines donation workflows but also empowers communities to contribute actively toward a circular and responsible fashion ecosystem.

Future Work:

Future developments of the Thread Link platform will focus on enhancing efficiency, intelligence, and inclusivity within clothing donation management. Integration of AI-based demand prediction models can help forecast orphanage clothing needs based on seasonal trends, demographics, and local conditions. Implementing computer vision for clothing quality assessment can ensure better categorization and fair distribution. Additionally, blockchain technology can be explored to maintain transparent donation records and build trust among users. The inclusion of IoT-based smart bins for automated collection and data analytics dashboards for administrators can further streamline operations. A dedicated mobile application with multilingual and offline support is also planned to extend accessibility to users in remote areas. These advancements will further strengthen the platform's sustainability objectives, enhance its scalability, and expand its measurable real-world impact.

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