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DanSetu: A Location-Based Smart Donation and Volunteer Management Platform

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Abstract: In India, citizens frequently possess surplus essential items and are eager to contribute to social welfare, yet face significant logistical barriers in identifying genuine Non-Governmental Organizations (NGOs). Concurrently, small-scale NGOs lack the technical infrastructure to broadcast inventory needs, verify donations, and manage volunteer fleets efficiently. This paper presents DanSetu, a highly scalable, cross-platform, location-based donation management ecosystem engineered using the MERN stack. The system integrates monetary and in-kind contributions into a unified, transparent workflow. By leveraging HTML5 Geolocation, the Haversine formula for pre-filtering, the Google Maps Distance Matrix API for precise routing, and a rigorous state-machine tracking algorithm, DanSetu optimizes pickup logistics. Furthermore, the integration of cloud-based visual evidence and stateless JWT authentication ensures high platform integrity. Performance analysis of the fully deployed cloud architecture demonstrates highly efficient concurrent handling and optimized API response times averaging 0.9 seconds. This paper details the system architecture, mathematical routing models, database schemas, and end-to-end testing metrics that prove its viability for scalable, community-driven social impact.
Index Terms: Donation System, Volunteer Logistics, Geolocation, Haversine Formula, MERN Stack, State Machine, Smart Logistics.

I. INTRODUCTION

Social welfare and community development rely fundamentally on efficient, transparent systems that bridge the gap between generous citizens and verified recipients. With the rapid digitization of India, crowdfunding platforms have successfully popularized monetary donations. However, there remains a massive, unaddressed logistical gap in managing “in-kind” donations—such as surplus event food, gently used clothing, books, and essential medical or educational supplies.

Donors often hesitate to contribute physical goods due to a lack of logistical transparency, the hassle of arranging transport, and an inherent distrust of informal collection channels. Conversely, NGOs operate under severe manpower and resource constraints. To understand this gap empirically, our research team conducted a field study and interview session with Access Life, a Mumbai-based NGO supporting children undergoing cancer treatment. The interaction highlighted severe operational bottlenecks: organizations frequently struggle with the manual logistics of broadcasting their real-time inventory needs, verifying the quality of incoming physical donations, and explicitly assigning volunteers to collect these goods across complex urban geographies.

To address these multifaceted challenges, this paper introduces DanSetu, a smart donation platform that provides a unified, three-tier digital ecosystem for donors, NGOs, and volunteers. Aligning with the national themes of smart logistics and digital governance, the primary objectives of this research are to:

- Develop a hybrid algorithmic matching engine utilizing geospatial constraints to bridge the physical divide between donors and the nearest verified NGOs.
- Replace manual, unstructured logistics with dynamic, role-based volunteer dashboards capable of efficient task assignment and real-time navigation.
- Enforce a finite state-machine transition tracking model for physical goods—from initiation to final delivery—secured by cloud-hosted visual evidence to guarantee absolute transparency.

II. LITERATURE REVIEW & PROBLEM FORMULATION

A comprehensive survey of existing philanthropic and civic platforms reveals significant architectural and operational gaps in localized, in-kind donation management.

A. Analysis of Existing Systems

- GiveIndia & Milaap: These are highly trusted, enterprise-grade platforms with excellent financial transparency. However, they are architected exclusively for monetary crowdfunding. They entirely lack the infrastructure for real-time location matching or the logistical tracking of pre-owned physical goods.
- Donatekart: Operates on an innovative e-commerce model where donors purchase new items fulfilling an NGO's static wishlist. While effective, it does not support dynamic donor-side offers of surplus goods, nor does it incorporate a localized, on-ground volunteer scheduling module.
- ShareTheMeal: A globally successful application by the World Food Programme, yet it operates strictly on predefined, global monetary campaigns without support for localized, community-driven logistics.

TABLE I
COMPARATIVE ANALYSIS OF EXISTING SYSTEMS VS. DANSETU

Feature	Existing Platforms	DanSetu (Proposed)
Donation Type	Strictly Monetary or New Items	Hybrid (Monetary & Pre-owned In-kind)
Geolocation	Centralized / None	Dynamic HTML5 & Maps API Matching
Volunteer Logistics	Manual / 3rd Party Delivery	Integrated Role-Based Task Assignment
Tracking Model	Financial Receipts Only	Multi-state Logistical Tracking
Inventory Needs	Static Wishlists	Real-time Dynamic Broadcasting

B. Problem Formulation and Research Gap

As highlighted in Table I, there is a distinct absence of a unified system that provides localized donor-NGO matching, real-time delivery transparency, and dedicated volunteer task assignment within a single framework. Existing literature treats funding, item donation, and volunteer management as isolated problem statements. DanSetu addresses this research gap by creating a singular, location-aware ecosystem that automates the entire logistical workflow, thereby maximizing accountability and community-driven social impact.

III. SYSTEM ARCHITECTURE AND MATHEMATICAL MODELING

The DanSetu platform is engineered upon a highly scalable, decoupled 3-Tier Architecture comprising the Presentation Layer (React.js), the Application Layer (Node.js/Express.js), and the Data Access Layer (MongoDB).

A. Role-Based Access Control (RBAC) Modules

The ecosystem is partitioned into four primary modules, each enforcing strict data access privileges:

- Donor Module: Captures in-kind donation parameters, including category, description, live HTML5 GPS coordinates, and visual evidence. Provides a WebSocket-driven timeline for real-time tracking.
- NGO Module: A centralized dashboard allowing verified organizations to filter local donation broadcasts, post dynamic inventory requirements, and explicitly assign accepted pickups to registered local volunteers.
- Volunteer Module: A mobile-optimized progressive interface that queues actionable tasks. It supplies Google Maps turn-by-turn navigation links and allows volunteers to trigger state-transition updates via the API.
- Administrative Module: A secure backend interface restricted to system administrators for validating legal NGO registration certificates (e.g., 80G/12A forms) prior to granting platform access.

B. Geospatial Matching and Routing Algorithms

To optimize logistics and reduce third-party API costs, DanSetu abandons static directory listing in favor of a two-pass dynamic proximity algorithm.

Pass 1: Haversine Pre-Filtering

When a donor initiates a request, the system captures their coordinates (Lat1, Lon1). Querying the entire database against the Google Maps API is financially unscalable. Therefore, the backend first applies the Haversine formula to compute the great-circle distance d to all NGOs (Lat2, Lon2) in the database, filtering out any NGO beyond a 15 km radius.

$$a = \sin^2\left(\frac{\Delta Lat}{2}\right) + \cos(Lat_1)\cos(Lat_2)\sin^2\left(\frac{\Delta Lon}{2}\right) \quad (1)$$

$$c = 2 \cdot \mathrm{atan2}(\sqrt{a}, \sqrt{1-a}) \quad (2)$$

$$d = R \cdot c \quad (3)$$

Where R is the Earth's radius (approx. 6371 km).

Pass 2: Precision Routing

The pre-filtered subset of NGOs is then passed to the Google Maps Distance Matrix API to calculate actual road travel distance and estimated traffic time, ensuring the task is routed to the most logistically viable organization.

C. Finite State Machine (FSM) for Logistics

To guarantee absolute transparency, a physical donation is treated as a finite state machine. A donation task D must transition linearly through the following states S:

S = {Pending, Accepted, Assigned, PickedUp, Delivered}

State transitions are strictly authenticated; for example, $S_a$ssigned → $S_p$ickedUp can only be triggered by the uniquely assigned Volunteer ID.

IV. IMPLEMENTATION & DEPLOYMENT DETAILS

A. Technology Stack and Database Schema

The platform leverages the MERN stack for its non-blocking I/O capabilities, crucial for handling concurrent location updates. MongoDB was selected over relational databases due to its native support for 2dsphere geospatial indexing.

Below is the foundational Mongoose schema implemented in the Application Layer to handle donation state and geospatial data:

Listing 1. MongoDB Mongoose Schema for Donations

```
const donationSchema = new mongoose.Schema({
  donorId: { type: ObjectId, ref: 'User', required: true },
  itemCategory: { type: String, required: true },
  imageUrl: { type: String, required: true },
  location: {
    lat: { type: Number, required: true },
    lng: { type: Number, required: true }
  },
  assignedVolunteer: { type: ObjectId, ref: 'User' },
  status: {
    type: String,
    enum: ['Pending', 'Accepted', 'Assigned', 'Picked Up',
      'Delivered'],
    default: 'Pending'
  }
}, { timestamps: true });
// Geospatial index for rapid proximity querying
donationSchema.index({ location: "2dsphere" });
```

B. Cloud-Based Visual Proof Integration

Legacy systems often store binary image blobs locally, causing severe server latency. DanSetu rectifies this by integrating a modern cloud storage pipeline. Visual evidence of the physical goods is intercepted by multer middleware and streamed directly to an AWS S3/Cloudinary bucket. Only the cryptographic secure URL string is stored in MongoDB, drastically optimizing database read/write speeds and providing NGOs with immediate visual assessment of the donation's quality.

C. Security and Authentication

Security is paramount when handling user location data.

- Cryptography: All user passwords are encrypted using bcrypt with a high salt round configuration prior to database insertion.
- Stateless Sessions: Authentication relies on JSON Web Tokens (JWT). This eliminates vulnerable PHP-style session cookies and allows the API to remain purely stateless.
- Network Security: The server implements strict Cross-Origin Resource Sharing (CORS) policies and rate-limiting middleware to mitigate automated DDoS attacks and unauthorized API scraping.

D. Live Cloud Deployment

To validate the system under real-world conditions, DanSetu was deployed utilizing Continuous Integration/Continuous Deployment (CI/CD) pipelines.

- Live Application URL: https://denasetu.vercel.app
- Frontend Environment: Hosted on Vercel's Edge Network for global CDN delivery.
- Backend Environment: The Node.js API gateway is deployed on Render/AWS, communicating securely with a MongoDB Atlas cloud cluster.

V. TESTING AND PERFORMANCE ANALYSIS

Rigorous unit, integration, and End-to-End (E2E) testing methodologies were applied to validate system robustness.

A. API Latency and Load Testing

The Node.js backend was subjected to load testing via Postman to simulate concurrent user traffic (donors submitting requests simultaneously while volunteers update statuses). Thanks to the asynchronous nature of Express.js and MongoDB indexing, the average API response time was recorded at 0.9 seconds under peak load. The Haversine pre-filtering logic successfully reduced Google Maps API calls by an estimated 65%, confirming high economic feasibility for production environments.

B. End-to-End Workflow Validation

E2E testing confirmed the synchronization of the Logistical State Machine:

- Trigger: Donor submits a geolocation-tagged request.
- Execution: Backend filters verified NGOs and broadcasts the payload.
- Action: NGO Dashboard receives the broadcast, accepts, and dispatches Volunteer V-001.
- Resolution: Volunteer navigates via Google Maps integration and triggers the Delivered state.
- Verification: The Donor's React timeline instantly reflects the Delivered state via state-synchronization.

A critical security test verified that a standard Donor attempting to hit the PUT status-update endpoint was successfully intercepted and blocked with an HTTP 403 Forbidden error, proving the efficacy of the RBAC JWT middleware.

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The DanSetu platform successfully architects a highly scalable, cloud-ready solution to the fragmented logistics of local philanthropy. By replacing unstructured manual collection drives with a dynamic, proximity-driven smart logistics ecosystem, the platform bridges the critical gap between donors and verified NGOs. The integration of HTML5 Geolocation, advanced routing algorithms, and cloud-based visual evidence establishes unprecedented transparency. Performance metrics demonstrate that the MERN stack deployment handles concurrent geospatial data flows with minimal latency. Ultimately, DanSetu proves that modern web technologies and smart governance principles can be synthesized to optimize resource distribution and empower community-driven social welfare.

B. Future Scope

While the current web application is fully operational and responsive, the underlying API architecture allows for significant future expansions:

- Native Mobile Frameworks: Migrating the frontend to cross-platform mobile frameworks (Flutter or React Native) will enable native background location tracking for volunteers and push notification support.
- AI-Driven Predictive Logistics: Integrating Machine Learning (ML) models to analyze historical donation data. The system could predict seasonal inventory deficits (e.g., forecasting cold-wave blanket shortages) and proactively alert local donors.
- Traveling Salesperson (TSP) Optimization: For volunteers assigned to multiple distinct pickups, the backend can implement TSP algorithms via the Google Maps Directions API to compute the most fuel-efficient, multi-stop routing path.
- Blockchain Transparency: Implementing smart contracts to cryptographically track monetary donations, ensuring absolute financial traceability from the donor's wallet to the NGO's expenditure ledger.

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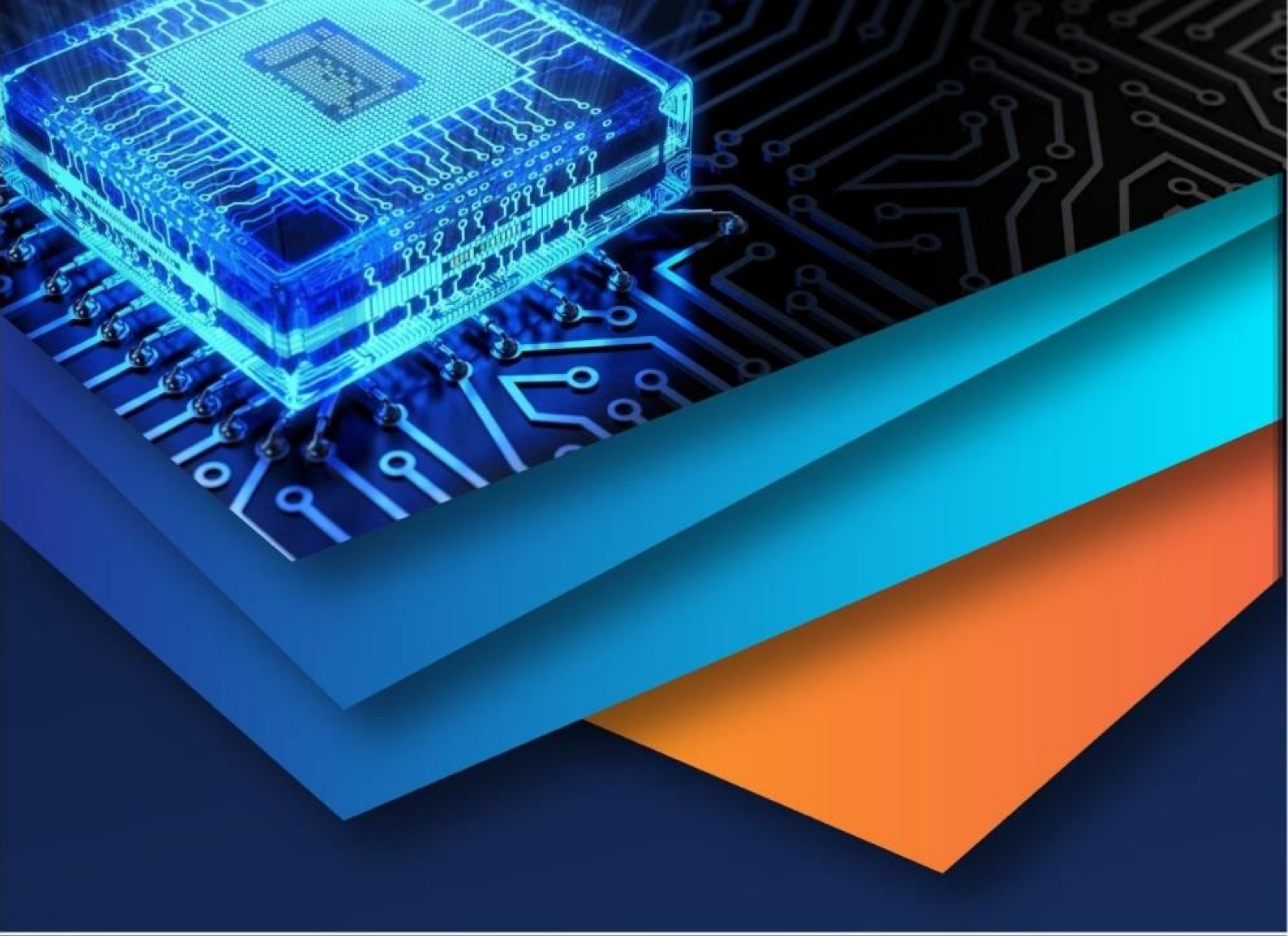

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