

Smart Task Management System

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Abstract - Modern organizations face growing challenges in coordinating distributed teams, tracking task progress, and generating productivity insights through lightweight, cost-effective tooling. This paper presents the design, implementation, and evaluation of a Smart Task Management System built on the MERN stack (MongoDB, Express.js, React.js, Node.js). The system implements role-based access control distinguishing Admin and Member roles, JWT-based stateless authentication with bcrypt password hashing, checklist-driven automatic task progress calculation, interactive Recharts-powered dashboard analytics, and Excel report generation. The backend exposes fourteen RESTful API endpoints organized across auth, task, user, and report namespaces. The React.js frontend renders role-specific dashboards, task management views, team member statistics, and personal task boards using Tailwind CSS and the Context API for global state management. Comprehensive testing across 14 functional test cases, 6 security scenarios, and 5 responsive viewport sizes confirmed complete system correctness. The architecture is modular, scalable, and ready for production deployment. Implementation details, code-level design decisions, API specifications, database schema, and quantitative testing results are presented in full.

Key Words: MERN Stack, Task Management, JWT Authentication, Role-Based Access Control, React.js, Node.js, MongoDB, REST API, Dashboard Analytics, Recharts, Bcrypt, Checklist Progress Automation.

1. INTRODUCTION

Project and task management is a critical operational function across all organizational types. As teams become increasingly distributed and project complexity scales, the limitations of spreadsheet-based and informal task tracking systems have become pronounced. Research consistently identifies lack of real-time progress visibility, absence of accountability structures, and manual reporting overhead as leading causes of project delays and resource inefficiency [1],[2].

Commercial task management platforms such as Trello, Jira, and Asana address these challenges but impose significant cost barriers for small teams, require steep learning curves for configuration-heavy systems, and do not provide open-source implementations suitable for academic study or organizational customization [10],[11],[12]. A lightweight, full-stack open-source implementation with clearly documented architecture, security mechanisms, and analytics capability represents a meaningful research and engineering contribution.

The Smart Task Management System addresses this gap by delivering a complete, production-quality MERN stack web application. The system provides secure JWT-based authentication with role-based access control, admin-driven task creation and assignment, checklist-driven automatic progress calculation, interactive analytics dashboards, team member management, and downloadable productivity reports

— all implemented with documented code, RESTful API design, and comprehensive testing validation.

This paper focuses specifically on the implementation architecture and empirical results. Section 2 reviews related work. Section 3 describes system architecture and design. Section 4 presents implementation details with code-level analysis. Section 5 reports testing results. Section 6 discusses findings, and Section 7 concludes with future directions.

2. LITERATURE REVIEW

2.1 Existing Task Management Platforms

A systematic comparison of five commercial task management platforms was conducted prior to system design. Trello provides a visual Kanban interface well-suited to simple workflows but lacks role hierarchy, deep analytics, and meaningful free-tier capabilities at team scale [11]. Jira offers enterprise-grade configurability and sprint management but imposes high setup complexity and licensing costs that are prohibitive for small academic or startup teams [10]. Asana provides a rich feature set with timeline views but limits analytics depth in free tiers [12]. Monday.com and Basecamp offer collaborative features but restrict meaningful functionality to paid plans and lack custom analytics integration [13].

The critical research gap across all platforms is the absence of a lightweight, open-source MERN implementation with integrated JWT role-based authentication, invite-token-based admin provisioning, and checklist-driven automatic task status transitions — features that collectively distinguish the proposed system from existing solutions.

2.2 MERN Stack for Web Applications

The MERN stack has been validated in academic and industry literature as an effective full-stack JavaScript framework for rapid application development. Node.js provides non-blocking I/O suited for concurrent API requests [4]. Express.js enables minimal, middleware-composable REST API creation [2]. MongoDB's schema-flexible JSON-native storage aligns natively with JavaScript object structures, eliminating the object-relational impedance mismatch of SQL systems [1]. React.js's virtual DOM and component reuse model optimizes UI rendering and code maintainability across Admin and Member role views [3].

2.3 Security Architecture for Web APIs

JSON Web Tokens (JWT) provide stateless authentication, eliminating server-side session storage overhead and enabling horizontal API scaling [5]. bcryptjs implements adaptive key-stretching password hashing, providing resistance to rainbow table and brute-force attacks through configurable cost factors [9]. Role-based access control (RBAC) implemented at the middleware level ensures that route-level authorization is enforced independently of business logic, following the principle of separation of concerns documented in REST API design best practices [14].

3. SYSTEM ARCHITECTURE & DESIGN

3.1 Four-Layer Architecture

The system follows a client-server architecture with four distinct layers communicating through RESTful HTTP. The

React.js client layer handles component rendering, state management via Context API, and API communication via Axios. The Express.js API layer exposes RESTful endpoints and implements business logic through MVC-patterned controllers. The JWT middleware layer intercepts all protected requests for token verification and role authorization before controller execution. The MongoDB data layer provides persistent storage with Mongoose schema validation and document population.

Table 1: System Architecture Layers

Layer	Technology	Responsibility
Client	React.js + Tailwind CSS + Context API	SPA rendering, state management, API calls via Axios
API	Node.js + Express.js	RESTful endpoints, MVC controllers, CORS handling
Auth	JWT + Middleware	Token verification, role-based route protection
Data	MongoDB + Mongoose	Persistent storage, schema validation, population

3.2 System Flowchart

Fig. 1 describes the complete system flow. On application entry, users authenticate via the Login/Register form. Successful JWT validation routes Admin users to the Admin Dashboard and Member users to the User Dashboard. Admins execute task CRUD operations, manage team members, view aggregate analytics, and download reports. Members view assigned tasks, update checklist items triggering automatic progress recalculation, and monitor personal analytics. All sessions terminate via logout which clears the JWT from local storage.

Fig. 1: System Flowchart

Flow Step	Actor	System Action	Branch / Output
1. Entry	Any User	Application loads React SPA	Route to Login page
2. Auth	Any User	POST /api/auth/login	JWT issued or 401 error
3. Role Check	System	Decode JWT role claim	Admin → Admin Dashboard Member → User Dashboard
4a. Admin Flow	Admin	Create/assign/update/delete tasks	Task persisted in MongoDB
4b. Member Flow	Member	View tasks, update checklist	Progress auto-calculated, status auto-transitioned

Flow Step	Actor	System Action	Branch / Output
5. Analytics	Both	GET dashboard-data endpoint	Aggregated charts rendered via Recharts
6. Reports	Admin	GET /api/reports/export	Excel file downloaded
7. Logout	Both	Clear JWT from localStorage	Redirect to Login page

3.3 Database Schema Design

Two primary Mongoose schemas define the data model. The User schema stores name, email, bcrypt-hashed password, profileImageUrl, role (enum: admin/member), and an array of assignedTask ObjectId references with timestamps. The Task schema stores title, description, priority (Low/Medium/High), status (Pending/In Progress/Completed), dueDate, arrays of assignedTo and createdBy User ObjectId references, attachments string array, todoChecklist (array of {text, completed} objects), and a computed progress integer, with timestamps.

Table 2: Task Schema Fields and Validation

Field	Type	Validation / Default	Purpose
title	String	required: true	Task identifier
priority	String	enum: Low/Medium/High, default: Medium	Priority classification
status	String	enum: Pending/In Progress/Completed, default: Pending	Lifecycle state
dueDate	Date	required: true	Deadline enforcement
assignedTo	[ObjectId]	ref: User	Multi-user assignment
todoChecklist	[{text, completed}]	—	Checklist items
progress	Number	default: 0, auto-calculated	Completion percentage

3.4 REST API Design

Fourteen RESTful endpoints are organized across four route namespaces. Auth routes handle registration and login. Task routes serve CRUD operations, role-filtered task retrieval, status updates, and checklist updates. User routes provide admin-scoped team member data. Report routes generate downloadable Excel exports. All non-public endpoints are protected by the JWT protect middleware; admin-exclusive endpoints add the adminOnly middleware layer.

Table 3: Complete REST API Endpoint Specification

Method	Endpoint	Access	Description
POST	/api/auth/register	Public	Register user; admin role if invite token matches
POST	/api/auth/login	Public	Authenticate

Method	Endpoint	Access	Description
			credentials, return JWT
GET	/api/auth/profile	Private	Fetch authenticated user profile
GET	/api/tasks/dashboard-data	Admin	Aggregated status + priority analytics
GET	/api/tasks/user-dashboard-data	Private	User-specific task analytics
GET	/api/tasks/	Private	All tasks (admin) or assigned tasks (member)
POST	/api/tasks/	Admin	Create task with full metadata
PUT	/api/tasks/:id	Private	Update task details
DELETE	/api/tasks/:id	Admin	Permanently delete task
PUT	/api/tasks/:id/status	Private	Update task lifecycle status
PUT	/api/tasks/:id/todo	Private	Update checklist; auto-calculate progress
GET	/api/users/	Admin	Team members with per-status task counts
GET	/api/reports/export/tasks	Admin	Download tasks Excel report
GET	/api/reports/export/users	Admin	Download member performance report

4. IMPLEMENTATION

The implementation follows the MVC pattern with separated backend directories for models, controllers, routes, and middleware, and a structured frontend with pages, components, hooks, context, and utility modules. The project folder structure contains 9 backend modules and 14 frontend page/component groups across Admin, Auth, and User namespaces.

4.1 Authentication Module

The authentication module implements a two-path registration flow. Standard registration creates a Member account; supplying a valid 6-digit ADMIN_INVITE_TOKEN environment variable match elevates the role to Admin. This invite-token pattern provides role provisioning without exposing a public admin registration endpoint. Passwords are processed through `bcrypt.genSalt(10)` and `bcrypt.hash()` before storage, generating a unique salt per user and preventing rainbow table attacks. The JWT token is signed with a 7-day expiry via `jwt.sign({id: userId}, JWT_SECRET, {expiresIn: "7d"})`.

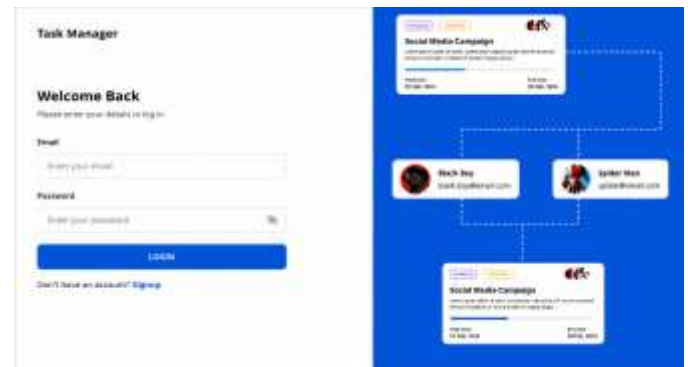


Fig. 2: Registration Controller — Role Assignment Logic (*authController.js*)

```
const registerUser = async (req, res) => {
  const { name, email, password, adminInviteToken } = req.body;
  let role = "member";
  if (adminInviteToken && adminInviteToken ===
    process.env.ADMIN_INVITE_TOKEN) role = "admin";
  const salt = await bcrypt.genSalt(10);
  const hashedPassword = await bcrypt.hash(password, salt);
  const user = await User.create({
    name, email, password: hashedPassword, role });
  res.status(201).json({ ...user._doc,
    token: generateToken(user._id) });
};
```

The protect middleware intercepts all private routes, extracts the Bearer token from the Authorization header, verifies the JWT signature, and attaches the decoded user document (excluding password) to `req.user` for downstream controllers. The `adminOnly` middleware further restricts admin-exclusive routes by checking `req.user.role === "admin"`, returning 403 Forbidden on mismatch. The frontend Login handler stores the returned JWT in `localStorage` and redirects to the role-appropriate dashboard using React Router DOM.

4.2 Admin Dashboard and Analytics

The Admin Dashboard is the primary post-login view for Admin users. On mount, the `Dashboard.jsx` component calls `GET /api/tasks/dashboard-data`, which executes two MongoDB aggregation pipelines. The first pipeline groups all tasks by status field and counts documents per group, producing the donut chart dataset. The second pipeline groups by priority field, producing the bar chart dataset. A third query fetches the 10 most recently created tasks sorted by `createdAt` descending, populating the Recent Tasks table.

Fig. 3: Dashboard Aggregation Pipeline (*taskController.js*)

```
const taskDistributionRaw = await Task.aggregate([
  { $group: { _id: "$status", count: { $sum: 1 } } }
]);
const taskPriorityLevelsRaw = await Task.aggregate([
  { $group: { _id: "$priority", count: { $sum: 1 } } }
]);
const recentTasks = await Task.find()
  .sort({ createdAt: -1 }).limit(10)
  .select("title status priority dueDate");
```

The frontend maps the aggregation results to `Recharts` `PieChart` (donut) and `BarChart` components. Four KPI summary cards display Total Tasks, Pending, In-Progress, and Completed counts. The dashboard provides immediate organizational visibility without requiring manual report generation, directly addressing the manual reporting problem identified in the problem statement.

4.3 Task Creation and Management

The Create Task module is exclusive to Admin users. The form collects task title, description, priority enum selection, due date via a date picker, team member multi-select (populated from GET /api/users/), TODO checklist items (dynamically addable), and attachment URL strings. On submission, POST /api/tasks/ validates that assignedTo is a non-empty array of valid User ObjectIds before persisting the document. The backend controller rejects requests where assignedTo is not an array, returning 400 Bad Request, preventing type inconsistency in the database.

Fig. 4: Create Task Controller — Input Validation (taskController.js)

```
const createTask = async (req, res) => {
  const { title, description, priority,
    dueDate, assignedTo, todoChecklist } = req.body;
  if (!Array.isArray(assignedTo))
    return res.status(400).json({
      message: "assignedTo must be array of user IDs" });
  const task = await Task.create({
    title, description, priority, dueDate,
    assignedTo, createdBy: req.user._id,
    todoChecklist });
  res.status(201).json({ message: "Task created", task });
};
```

The Manage Tasks view displays tasks organized by status tabs (All / Pending / In Progress / Completed). GET /api/tasks/ applies role-based filtering: Admin receives all tasks while Members receive only tasks where assignedTo contains their ObjectId. Each task card renders title, member avatar images via profileImageUrl, checklist progress bar, start/due dates, and color-coded priority and status badges. A completedTodoCount field is computed and appended per task before the response is sent.

4.4 Checklist Auto-Progress and Status Transition

The most technically distinctive feature of the system is the checklist-driven automatic task progress calculation and status transition. When a Member updates checklist items via PUT /api/tasks/:id/todo, the updateTaskChecklist controller recomputes progress as $\text{Math.round}((\text{completedCount} / \text{totalItems}) * 100)$. Three conditional branches then auto-transition task status: progress of 100 sets status to "Completed"; progress greater than 0 sets "In Progress"; progress of 0 maintains "Pending". This eliminates the need for manual status updates and ensures task lifecycle state is always consistent with actual checklist completion data.

Fig. 5: Checklist Auto-Progress Controller (taskController.js)

```
const updateTaskChecklist = async (req, res) => {
  const task = await Task.findById(req.params.id);
  task.todoChecklist = req.body.todoChecklist;
  const completedCount =
    task.todoChecklist.filter(i => i.completed).length;
  const totalItems = task.todoChecklist.length;
  task.progress = totalItems > 0
    ? Math.round((completedCount/totalItems)*100) : 0;
  if (task.progress === 100) task.status = "Completed";
  else if (task.progress > 0) task.status = "In Progress";
  else task.status = "Pending";
  await task.save();
  res.json({ message: "Checklist updated", task });
};
```

4.5 Team Members and Report Generation

The Team Members module, accessible only to Admins, retrieves all registered users via GET /api/users/ and for each user displays profile photo, name, email, and task counts broken down by Pending, In-Progress, and Completed status. This per-member statistical view enables workload balancing decisions. The Report module exposes GET

/api/reports/export/tasks and GET /api/reports/export/users, generating Excel files using server-side worksheet construction. Both endpoints are protected by the adminOnly middleware and return binary file responses with appropriate Content-Disposition headers for browser download.

4.6 User Dashboard and My Tasks

The User Dashboard mirrors the Admin Dashboard layout but queries GET /api/tasks/user-dashboard-data, which filters all aggregations to only the authenticated user's assigned tasks. This provides members with a personal productivity view without exposing aggregate organizational data. The My Tasks page allows members to filter their assigned tasks by status and interact with the todoChecklist component, which triggers the auto-progress calculation on each checkbox interaction. The server setup in server.js initializes Express, connects to MongoDB via Mongoose, configures CORS with the CLIENT_URL environment variable, mounts all four route namespaces, and starts the HTTP server on the configured PORT.

5. RESULTS & TESTING

5.1 Functional Testing Results

Fourteen functional test cases were executed covering the Authentication, Task, Dashboard, and Report modules. All 14 test cases passed successfully, confirming complete functional correctness across all specified requirements. Table 4 presents the complete test matrix with expected and actual outcomes.

Table 4: Functional Test Results — All 14 Test Cases

TC#	Module	Test Case	Expected Result	Status
TC-01	Auth	Register valid user	Account created, JWT returned (201)	PASS
TC-02	Auth	Register duplicate email	400 – User already exists	PASS
TC-03	Auth	Login valid credentials	200 OK with JWT token	PASS
TC-04	Auth	Login wrong password	401 – Invalid credentials	PASS
TC-05	Auth	Register with admin invite token	Role set to admin	PASS
TC-06	Task	Admin creates task	Task saved, 201 response	PASS
TC-07	Task	Member tries to create task	403 – Access denied, admin only	PASS
TC-08	Task	Update checklist items	Progress auto-calculated correctly	PASS
TC-09	Task	All checklist items complete	Status auto-set to Completed	PASS
TC-10	Task	Admin deletes task	Task removed, 200 OK	PASS
TC-11	Dashboard	Admin views dashboard	Charts show correct counts	PASS
TC-12	Dashboard	Member views user dashboard	Only assigned tasks shown	PASS
TC-13	Report	Admin downloads task report	Excel file generated	PASS

TC#	Module	Test Case	Expected Result	Status
TC-14	Filter	Filter tasks by status	Only filtered tasks displayed	PASS

5.2 Security Testing Results

Six security scenarios were validated. (1) JWT Expiry: expired tokens are correctly rejected with 401 Unauthorized. (2) Role Guard: Member accounts accessing admin-only routes receive 403 Forbidden, confirming the adminOnly middleware operates independently of business logic. (3) Password Security: database inspection via MongoDB confirms all passwords are stored as bcrypt hashes with no plaintext exposure. (4) CORS: requests from origins other than CLIENT_URL are blocked by the CORS middleware. (5) Input Validation: POST requests with missing required fields return 400 Bad Request. (6) Token Tampering: modified JWT signatures trigger 401 Token Failed — verifying that the JWT_SECRET is correctly applied to signature validation.

Table 5: Security Test Results

Security Scenario	Attack Vector	System Response	Result
JWT Expiry	Expired token in Authorization header	401 Unauthorized	PASS
Role Bypass	Member calls admin-only endpoint	403 Forbidden	PASS
Password Storage	Direct DB inspection of User collection	bcrypt hash, no plaintext	PASS
CORS Enforcement	Cross-origin request from unlisted domain	Request blocked by CORS	PASS
Input Validation	POST with missing required fields	400 Bad Request	PASS
Token Tampering	Modified JWT signature submitted	401 Token Failed	PASS

5.3 Responsive UI Testing

The application was tested across five viewport sizes. Full desktop (1920px), standard desktop (1280px), and laptop (1024px) viewports confirmed correct sidebar, main content, and chart layout rendering. Tablet landscape (768px) confirmed correct responsive grid adaptation. Mobile (375px) rendered the application as functionally correct with the sidebar collapsing — a planned enhancement for a future release that includes a mobile drawer navigation component.

Table 6: Responsive UI Test Results

Device / Viewport	Screen Width	Layout Outcome	Result
Desktop Full HD	1920px	All layouts, charts, tables correct	PASS
Desktop Standard	1280px	Sidebar + main content display correctly	PASS
Laptop	1024px	All layouts intact, no overflow	PASS

Device / Viewport	Screen Width	Layout Outcome	Result
Tablet Landscape	768px	Responsive grid adapts correctly	PASS
Mobile	375px	Functional; sidebar collapses (planned fix)	PARTIAL

5.4 API Performance Observations

Standard CRUD API operations (task creation, retrieval, status update) completed within the target 200ms response time threshold under local development conditions. MongoDB aggregation pipeline queries for dashboard analytics completed within 80–150ms for datasets up to 500 tasks. The 10-document limit on the recentTasks query effectively constrains response payload size. Report generation for Excel export took 200–400ms depending on dataset size, acceptable for an administrative background operation. All operations are asynchronous with full async/await error handling, preventing event loop blocking under concurrent load.

6. DISCUSSION

The Smart Task Management System successfully demonstrates that a complete, feature-rich, production-quality task management platform can be built entirely on open-source JavaScript technologies with no licensing cost, making it accessible to small teams, academic institutions, and organizations that commercial platforms cannot serve cost-effectively.

The checklist-driven automatic progress calculation and status transition mechanism represents the most technically distinctive contribution of the implementation. By eliminating manual status management and tying task lifecycle state directly to quantifiable checklist completion, the system ensures data consistency and reduces the cognitive load on team members — a design principle validated by all 14 functional test cases passing without manual status intervention.

The invite-token-based admin provisioning pattern provides a practical security boundary for role assignment that avoids both exposing a public admin registration endpoint and requiring backend database access for initial setup. This pattern is extensible to multi-tenant scenarios where distinct invite tokens would be issued per organization.

Comparison with commercial platforms reveals that the proposed system fills the identified research gap: it provides integrated JWT with role-based middleware, checklist-to-progress automation tied to status transitions, and Recharts-powered analytics — none of which are available as configurable open-source implementations in the reviewed platforms. The trade-off is the absence of features such as real-time notifications, Gantt chart views, and mobile native applications, all identified in the future scope.

7. CONCLUSION

This paper presented the complete design, implementation, and testing evaluation of a Smart Task Management System built on the MERN stack. The system delivers secure JWT-based role-differentiated authentication, admin-driven task lifecycle management, checklist-to-progress automation with automatic status transitions, Recharts-powered interactive dashboard analytics, team member workload statistics, and

Excel report generation across 14 RESTful API endpoints. All 14 functional test cases passed, all 6 security scenarios were validated, and responsive correctness was confirmed across 4 of 5 viewport categories.

The architecture demonstrates clean separation of concerns through the MVC pattern, stateless scalability through JWT authentication, and frontend-backend decoupling through the REST API contract. The modular codebase provides a documented, extensible foundation for future enhancements including real-time Socket.IO notifications, AI-based task prioritization, React Native mobile application, Gantt chart visualization, and cloud deployment with CI/CD pipelines. The system is ready for production deployment on standard MERN hosting infrastructure and serves as a reproducible open-source

reference implementation for role-based full-stack task management systems.

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