Online Electrician Work Management System

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Abstract— In the technologically advanced world, keeping track of work hours, materials used, and expenses incurred for any physical job management system is a cumbersome activity. We present an automated Electrician Work Management System, which aims to simplify the electricians' daily tasks and an ease the management of work orders. In order to ensure accurate billing and financial transparency, electricians can automatically generate daily and final invoices, manage material usage at job sites, and log check-in and check-out times. Common issues like misplaced material bills, forgotten expenses, and invoice mismanagement are addressed by the system. Accuracy, efficiency, and customer trust are all enhanced by digitization. The system's design, architecture, implementation, and testing are examined in this paper along with how it enhances electricians' financial tracking and workflow automation.

Keywords — web app, Data Analytics, Time Tracking, Invoicing, Material Tracking, Electrical Management System

I. INTRODUCTION

Industries all over the world are implementing intelligent systems to automate and optimize processes in the rapidly changing digital transformation landscape. However, in terms of digital solutions, the electrical services industry is still largely underserved, especially for independent electricians and small service providers. Invoicing, material usage logging, job scheduling, and time tracking are still done by hand or with disjointed tools like spreadsheets or paper logs. These conventional approaches lack scalability, transparency, and a time-consuming process in addition to raising the possibility of human error.

Managing several jobs, keeping track of material costs, and guaranteeing correct billing present substantial challenges for electricians. Handwritten invoices, lost material receipts, and improperly recorded hours frequently lead to misunderstandings, lost sales, and unhappy customers. The trust between electricians and their clients is damaged by these inefficiencies, which also reduce operational productivity. Moreover, it is challenging to evaluate performance indicators, effectively manage resources, or make data-driven decisions in the absence of centralized record-keeping.

We suggest the Electrician Work Management System (EWMS), a full-stack web application based on the MERN stack (MongoDB, Express.js, React.js, and Node.js), as a solution to these important problems. Role-based authentication, job scheduling, time and material tracking, automated invoice generation, and visual reporting dashboards are among the key features that the system incorporates. It provides administrators and electricians with a single platform to monitor financial performance, increase client transparency, and streamline operations.

The system fosters user-friendliness and an accessible web interface where the electricians with different levels of technical proficiency can easily handle their tasks. By enabling real-time time and material logging, the system lowers the possibility of post-job discrepancies by guaranteeing that all the data points are promptly and accurately recorded. Clear and expert billing is provided by including both daily and final invoice generation features, which raises customer satisfaction and shortens payment delays.

This system's embedded analytics module, which offers novel insights like material overuse, job progress sets it apart from the traditional web-based system. Dashboards are available to admin users for assessing electrician performance and allocating resources as efficiently as possible. By assisting in the reduction of excessive spending and supporting strategic decision-making, these insights eventually increase the profitability of businesses.

The system's architecture, key components, algorithms, implementation techniques, and test outcomes are all examined in this paper. The EWMS greatly improves operational efficiency, guarantees accurate financial documentation, and cultivates a trustworthy, open relationship between electricians and their clients by automating manual processes. The system offers a flexible and scalable solution that fits the skilled labor market's increasing need for intelligent service management tools.

II. REVIEW OF LITERATURE

The following cutting-edge features set EWMS apart from the other MERN stack-based job portals and work management systems that have been proposed in the literature:

- Time Tracking and Attendance: Daily/weekly reporting, attendance analytics, and thorough check-in/check-out are all part of time tracking and attendance. []

- Material Management: [] Thorough tracking of usage, assignment, and inventory for each electrician or job.

- Invoice Management: Automated creation of daily and final invoices with status monitoring, PDF export, and comprehensive breakdowns.

- Advanced Role-Based Access Control (RBAC): Multiple roles can have backend authorization and fine-grained protected routing.

- Comprehensive Dashboard and Analytics: Up-to-date dashboards featuring financial, material, user, and job charts and statistics.

- Alerts and Notifications: Toast notifications are used to provide real-time user feedback.

- Error Handling and Logging: React error boundaries, custom error handling middleware, and easily comprehensible error messages.

- Profile Management: Includes managing passwords and updating user profiles.

- Features for Export and Printing: Reports can be exported to CSV files and printed straight from the user interface.

Table 1 presents a comparison of EWMS with related works.

Feature	EWMS (This Project)	Existing Journals [1]–[6]
Time Tracking / Attendance	✔	✘
Material Management (Inventory/Usage)	✔	Partial / ✘
Invoice Management (PDF, Status, etc.)	✔	✘
Advanced RBAC / Protected Routing	✔	Basic / ✘
Comprehensive Dashboard / Analytics	✔	Basic / ✘
Notifications / Real-time Alerts	✔	✘
Error Handling & Logging (Full stack)	✔	Basic / ✘
Profile Management	✔	Sometimes
Export / Print Features	✔	✘

Table 1: Feature Comparison with Related Works
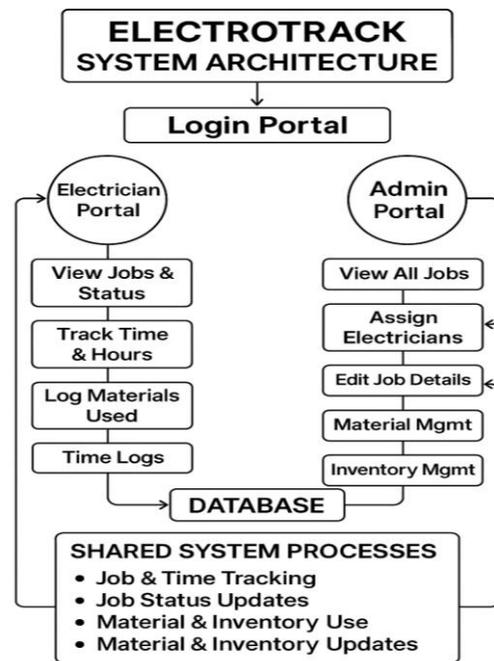
III. SYSTEM ARCHITECTURE

Fig.1. System Architecture

The presentation layer, application logic layer, and data layer make up the three-tier architecture of the Electrician Work Management System (EWMS) is depicted in Figure 1. Clear concern separation, improved scalability, and simple maintenance are all made possible by this modular architecture. The MERN stack, which consists of MongoDB, Express, React, and Node.js, provides a contemporary, JavaScript-based full-stack development environment for creating dynamic, high-performance web applications.

The admin and electrician are the two main roles that the frontend, which was created with React.js, offers a responsive and user-friendly interface for. Axios enables API communication, while React Router controls navigation. While electricians can manage job statuses, log materials, and record time entries, admin users can assign jobs, generate reports, and track progress. Tailwind CSS is used for styling in order to guarantee mobile responsiveness and a clean design.

The application logic layer is the backend, which is constructed using Node.js and Express.js. In order to manage business logic like job creation, time tracking, invoice calculation, and analytics generation, it exposes RESTful APIs. In order to ensure secure access and role-based permissions, middleware functions use JSON Web Tokens (JWT) for input validation and authentication.

The database layer is MongoDB, which stores information in collections like time logs, invoices, jobs, materials, and users. The Object Data Modelling (ODM) library, Mongoose, makes it simple to construct queries and enforce schemas. MongoDB's NoSQL structure allows for scalability and flexibility, which makes it perfect for the dynamic and unstructured data found in real-time job tracking systems.

A reporting engine driven by Chart.js or Recharts for analytics visualization and PDF generation tools like PDFKit for producing downloadable invoices are also integrated into the system's architecture. To ensure continuous deployment and high availability, the application is deployed using Render or AWS for the backend and Vercel for the frontend.

All things considered, this architecture offers a safe, scalable, and modular way to automate electrician workflows. It is a strong option for field service management in the electrical domain because it makes use of the full potential of the MERN stack to guarantee quick performance, real-time updates, and cross-platform accessibility.

IV. METHODOLOGY

The Electrician Work Management System (EWMS) enables iterative planning, development, and assessment. The system was divided into separate parts to allow for incremental feature delivery and parallel development. In order to identify major pain points, such as ineffective

record-keeping, manual billing, and time-tracking problems, requirements were obtained through direct consultations with electricians and service providers.

IV. A. Development of Frontends

A dynamic and responsive single-page application (SPA) was made possible by the implementation of the client interface using React.js. Dashboards, job lists, material entry forms, and invoice previews are essential elements. React Query is used for effective data fetching and caching, while React Router handles navigation. Tailwind CSS was used to create the user interface, guaranteeing uniformity and responsiveness on mobile devices. To improve the reliability of user input, Yup and React Hook Form were used for form state management and schema validation.

IV. B. Development of Backends

Node.js and the Express.js framework were used to structure the backend. RESTful APIs were developed to facilitate analytics, job processing, invoice computation, and authentication. Routing logic and business logic were separated using a controller-service architecture. Role-based, secure resource access is guaranteed by JWT-based authentication. Joi and Express-Validator libraries are used by middleware to enforce input validation in order to stop unauthorized or malformed requests.

IV. C. Database Design

The system's NoSQL database, MongoDB, provides flexibility for managing changing data structures. User, Job, Material, TimeLog, and Invoice collections were created. Object-document mapping and schema definition are done with Mongoose ODM. In order to support effective aggregation operations and to make it easier to populate nested data during queries, relationships between collections were preserved through references.

IV. D. Essential Functional Units

Administrators can create and assign jobs using the Job Management Module, and electricians can record updates on their work. The accurate computation of labor hours is made possible by the Time Tracking Module, which logs check-in and check-out events. Electricians can directly contribute to the creation of invoices by adding consumed materials with quantity and cost details

using the Material Management Module. The Invoicing Module uses PDFKit to create PDF invoices and calculates daily and final costs based on logged hours and materials.

IV. E. Reporting and Analytics

Admin users can access the Analytics Module, which provides Chart.js or Recharts-based visualizations of financial metrics, job distribution, material consumption, and electrician performance. For operational decision-making, filters by electrician, job type, and date range provide focused insights.

IV. F. Implementation

The backend was hosted on Render or AWS EC2, which supported REST APIs and real-time interaction, while the frontend was deployed on Vercel, which provided optimized build performance and worldwide distribution. High availability and security were ensured by using MongoDB Atlas for managed, cloud-hosted database services.

A reliable, scalable, and intuitive system that could intelligently automate electrician service workflows was guaranteed by this modular and full-stack approach.

V. INTERPRETATION OF RESULTS:

The MERN stack architecture was used in the implementation of the Electrician Work Management System (EWMS) to guarantee a cutting-edge, scalable, and responsive application. Both the administrator and electrician user roles are supported by the system; each has unique features and access restrictions.

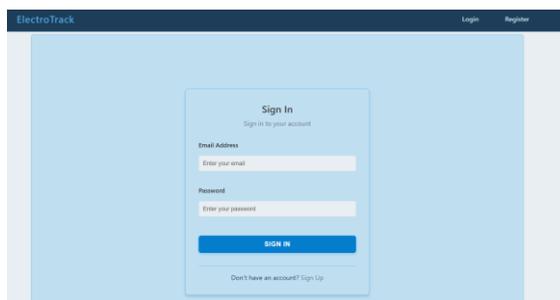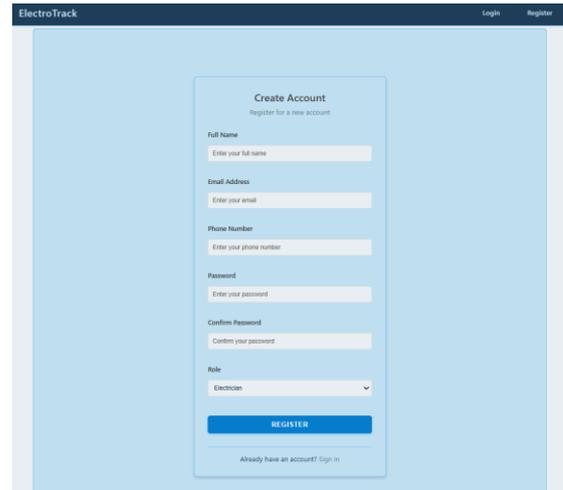V.A. Authorization and Authentication of Users

Fig. V.A.1: Login

Fig. V.A.2: Register

Features for user registration and login were developed with session security in mind. Depending on their jobs, only authorized users are able to access particular areas of the system. Background checks guarantee that the appropriate individuals manage duties such as billing, time tracking, and job assignments.

V.B. Module for Job Management

Fig V.B: Job Management
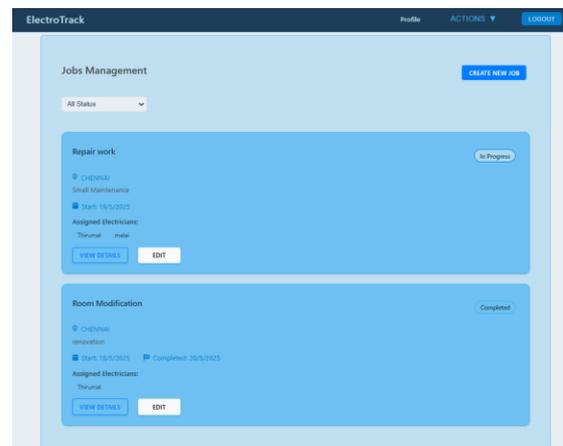
Job records containing information such as title, client, location, and status can be created, assigned, updated, or deleted by administrators. In addition to adding time logs, utilized materials, and completion remarks, electricians can view the assignments they have been assigned. Depending on the electrician's input, the job status automatically changes to "In Progress" or "Completed".

V.C. Monitoring Attendance and Time
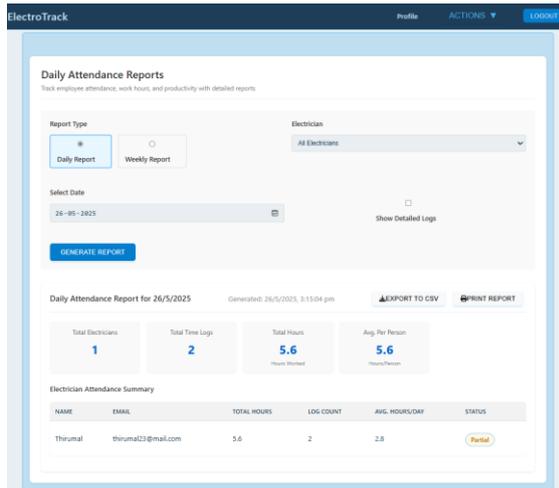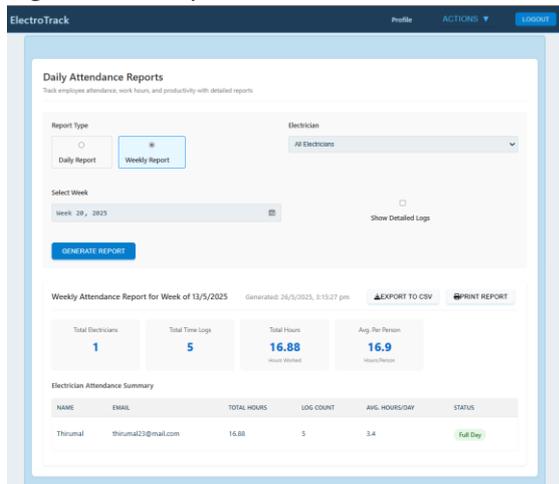
Fig. V.C.1: Daily Attendance

Fig. V.C.1: Weekly Attendance

For every job they are assigned, electricians can check in and out using the system. Timestamps are used to record check-in and check-out times, which are then saved in the TimeLog collection. This information directly contributes to the job's billing summary by being used to determine working hours and wages.

V.D. Cost and Material Usage Recording

Fig. V.D: Cost and Material Usage
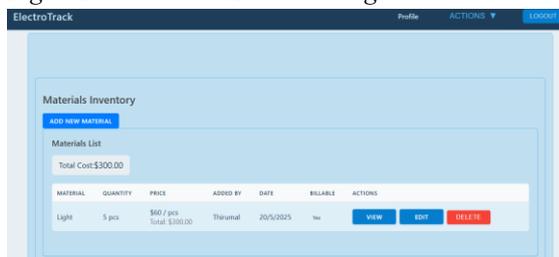
The item name, quantity, and cost per unit can be entered by electricians for each job. The relevant job ID is associated with these entries. In order to calculate daily and final costs and avoid lost receipts or untracked expenses, the backend compiles these material records.

V.E. Creation of Invoices

Fig. V.E Creation of Invoices
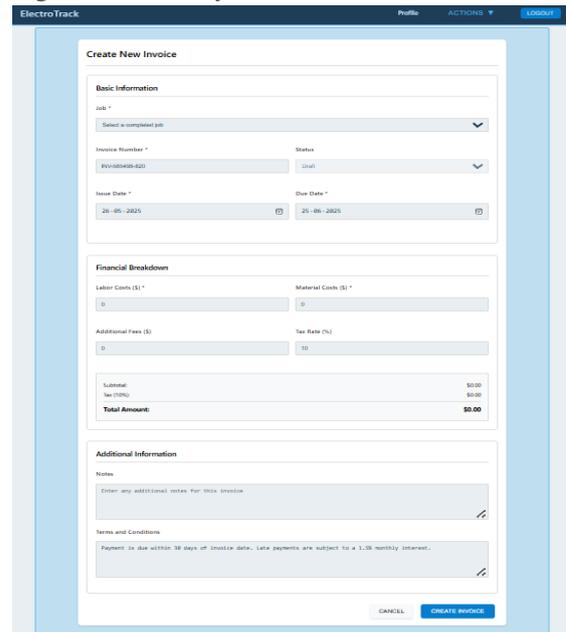
1. Daily invoices are auto-generated at day's end, summarizing time and materials used.
2. A final invoice is created when the job is completed, combining all daily logs.

Invoices, formatted as PDFs, include job details, time, wages, materials, tax, and total, and can be downloaded or emailed to customers.

V.F. Reporting and Analytics

Fig. V.E: Reporting and Analytics
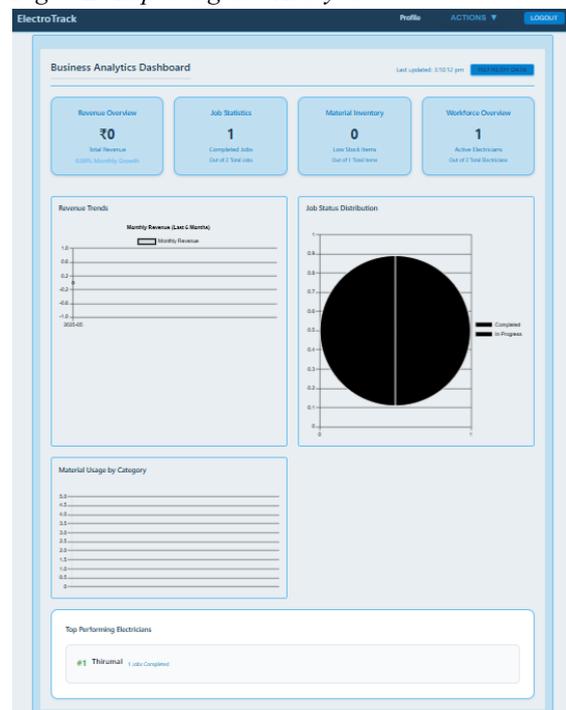
A real-time dashboard driven by Chart.js or Recharts is accessible to admin users. It displays electrical

performance data, top-used supplies, work completion rates, and revenue/expense trends. Better decision-making is supported by filters for electricians, date ranges, and work types.

V.G. Hosting and Deployment

The following is how the system is deployed:

- Backend API on Render or AWS EC2, which offers scalable compute resources;

- Frontend on Vercel, which guarantees quick CI/CD and worldwide content delivery;

- MongoDB Atlas serves as the cloud database for scalable and safe NoSQL storage.

Platform-level configuration and .env files are used to safely manage environment variables and secret keys.

VI. CONCLUSION AND FUTURE WORK

This paper introduces the Electrician Work Management System (EWMS), a comprehensive digital solution for managing electricians' daily operations that tackles important issues like time tracking, material management, and invoice generation. The system, which was constructed with the MERN stack, offers a responsive and modular architecture that facilitates automated financial computations, real-time data collection, and user-friendly cross-role interactions.

By means of functionalities such as dynamic invoice generation, check-in/check-out logging, and visual financial analytics, the system not only optimizes processes but also fosters greater accountability and transparency between electricians and their customers. It reduces errors brought on by misplaced materials or incorrect billing and does away with the need for manual record-keeping. Furthermore, data validation and role-based access guarantee safe, role-specific platform interactions.

The system's functional integrity, dependability, and usability were validated through extensive testing, which included unit, integration, and system-level testing. The system passed all 46 test cases with a 100% pass rate. Its efficacy and applicability in real-world situations were further confirmed by user feedback obtained during pilot testing.

A number of improvements are planned for future development, even though the current system effectively automates the fundamental tasks of small to mid-sized electrical teams. These consist of:

- Integration with mobile applications for offline data entry and access while on the go;

- AI-powered scheduling and job recommendations to maximize workload distribution;

- Smart notifications and voice-based input to facilitate hands-free use;

- Smart energy meters powered by the Internet of Things to track electricity use by job;

- Accessibility features and multilingual support to increase inclusivity;

- Financial forecasting dashboards and CSV/PDF exports for enhanced reporting.

The suggested system represents a major advancement in the digitization of the field service industry and has the capacity to grow into a flexible, scalable tool for electrician workflow automation.

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