Intern Performance Evaluation

Department name: AI Innovation

Presented by: Shruti Santosh Nimbarkar

Mentor Name: Mahima Mam

Organization Name: Millennium TechLink

Internship Duration: 21st July,2025 – 16th Jan,2026

Introduction

Objective of internship program

- To contribute consistently to ongoing engineering and development activities over a six-month period.
- To take ownership of assigned technical tasks and deliver them within timelines.
- To work alongside full-time engineers and support real project execution.
- To understand end-to-end project workflows, not limited to a single task.
- To gain hands-on experience across design, documentation, development, and monitoring.
- To build industry-ready skills through continuous involvement in live projects

Overview of Project Areas

- Handled structured data collection and system documentation tasks.
- Contributed to system architecture understanding through diagrams and analysis.
- Worked on high-power EV charging system (240 kW) study and documentation.
- Contributed to technical research and conference paper preparation (INCEMIC).
- Participated in certification documentation work (ISED).
- Supported backend foundation work for LMS platform.
- Involved in system metrics identification and monitoring analysis.

Key Projects Executed

Project 1 –

Data Collection, Block Diagrams, and Mind Maps

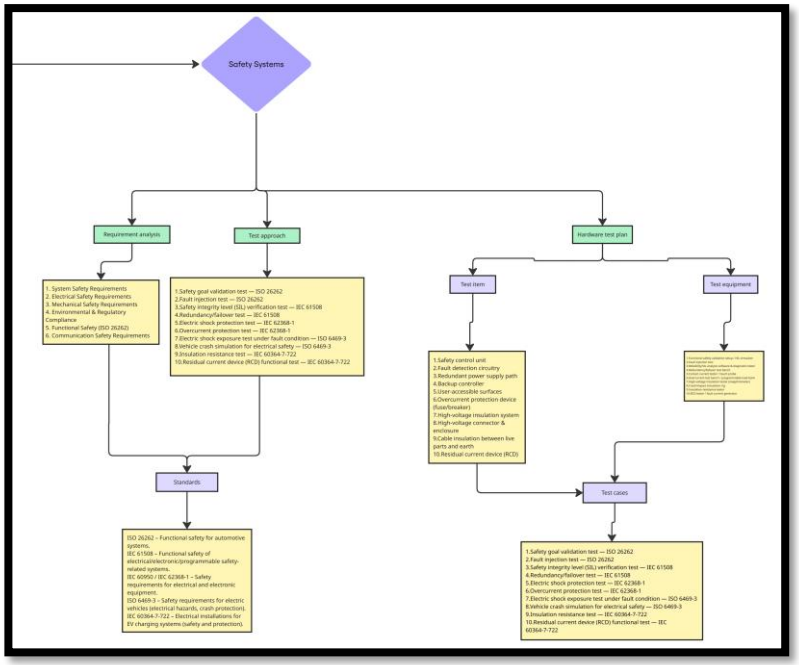
Description

- Collected and consolidated technical data from multiple authoritative sources.
- Studied system components in detail to understand functional responsibilities.
- Analyzed end-to-end system flow and inter-subsystem interactions.
- Converted unstructured technical inputs into well-organized, usable formats.
- Developed block diagrams to clearly represent system-level architecture.
- Created detailed mind maps to establish logical relationships between concepts.

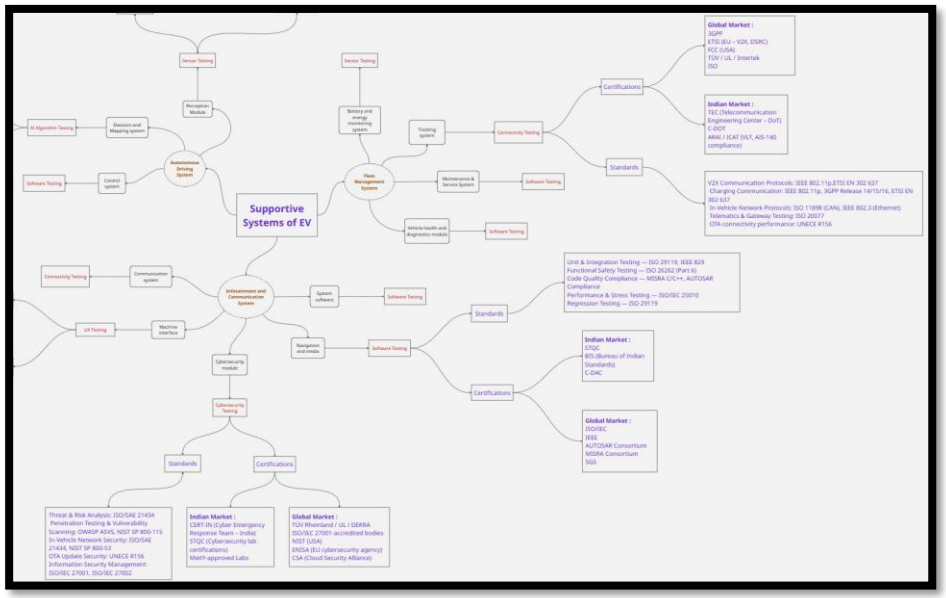
Outcome

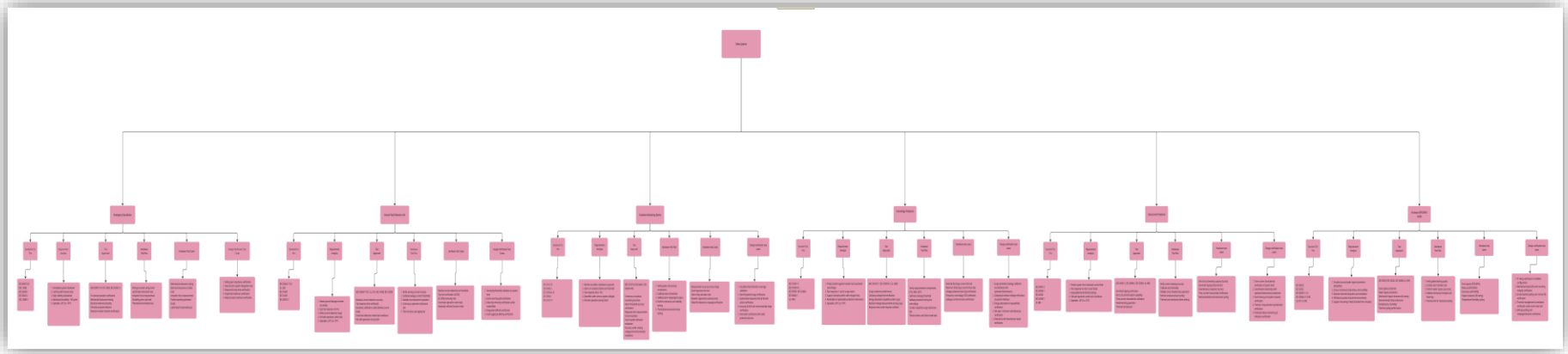
- ✓ Achieved strong understanding of overall system architecture.
- ✓ Developed ability to structure, validate, and organize complex technical data.
- ✓ Improved capability to visualize and explain complex system interactions.
- ✓ Gained clarity in interpreting engineering and technical documentation.
- ✓ Strengthened analytical thinking and technical documentation skills

Block Diagram



Mind-Map





Key Projects Executed

Project 2 –

INCEMIC Paper and Certification Work

Description

- Contributed to the preparation of a technical research paper.
- Assisted in structuring content and performing technical reviews.
- Research paper was selected for presentation at INCEMIC conference.
- Attended the conference held in Bangalore.
- Participated in technical presentations and expert discussions.
- Prepared and reviewed documentation for ISED certification requirements

Outcome

- ✓ Gained practical experience in technical research and paper development.
- ✓ Developed understanding of the research and publication process.
- ✓ Gained exposure to interaction between academic research and industry.
- ✓ Understood structure and importance of certification documentation.
- ✓ Built professional confidence through conference participation

Research Paper

AI-Enhanced Borophene–Graphene Hybrid Electromagnetic Shielding for Next-Generation Helicopter Avionics Systems

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***Abstract*— Modern helicopter avionics increasingly rely on advanced communication and navigation technologies, but this evolution also amplifies their vulnerability to electromagnetic interference (EMI). This paper introduces an intelligent EMI shielding approach that integrates a borophene–graphene hybrid structure with AI-driven control. The design employs a graphene-based frequency-selective metasurface coupled with a borophene–epoxy layer to deliver lightweight, broadband, and adjustable shielding capabilities. A machine learning algorithm enables real-time adaptation by detecting and responding to the frequency profile of incoming signals. Simulations conducted in the GHz–THz spectrum indicate shielding effectiveness (SE) values exceeding 70 dB within sub-millimeter material thickness, offering up to a threefold improvement in the SE-to-weight ratio over conventional copper-based shields. The proposed system promises enhanced EMI protection, reduced structural weight, and extended operational lifespan for next-generation rotorcraft avionics platforms.**

***Keywords*— Electromagnetic interference mitigation, borophene–graphene hybrid composite, tunable frequency-selective metasurface, AI-assisted control, machine learning integration, wideband shielding, GHz–THz frequency spectrum, aerospace avionics systems.**

I. Introduction

Over the last decade, helicopter avionics have undergone substantial advancements, fueled by the adoption of sophisticated communication networks, precision navigation systems, and high-performance mission-computing platforms. Modern rotorcraft now rely on high-bandwidth data links, satellite-based connectivity, multi-sensor integration, and accurate positioning technologies to meet demanding operational requirements in both civilian and defense sectors. While these capabilities have expanded operational potential, they have also heightened the vulnerability of onboard systems to electromagnetic interference (EMI) originating from sources such as integrated power converters, high-frequency transmitters, airborne radar systems, and even electromagnetic pulses (EMP) in contested or hostile environments.

EMI can degrade avionics reliability by introducing unwanted signal noise, distorting essential data, or triggering hardware and software malfunctions. In rotorcraft missions—especially those involving low-altitude navigation, rapid maneuvers, or complex operational scenarios—momentary interference events can critically impact safety and mission success. The operational spectrum of next-generation avionics increasingly spans gigahertz (GHz) to terahertz (THz) frequencies, where electromagnetic waves penetrate materials more easily and become challenging to suppress using traditional shielding approaches. Conventional EMI mitigation methods typically employ dense metallic layers such as copper, aluminum, or conductive alloys. While these materials provide excellent shielding effectiveness (SE), their high mass imposes penalties on fuel efficiency, payload capacity, and endurance. Moreover, their static shielding characteristics are ill-suited for scenarios requiring adaptive, frequency-selective protection in variable electromagnetic environments.

Breakthroughs in two-dimensional (2D) nanomaterials have led to a new generation of lightweight, tunable EMI shielding technologies. Graphene, a single layer of carbon atoms, offers outstanding conductivity, high tensile strength, and a tunable electromagnetic response, making it ideal for frequency-selective protection. Borophene, composed of a single atomic layer of boron, provides metallic-level conductivity, directionally dependent transport properties, and exceptional mechanical resilience. When combined into a borophene–graphene hybrid composite, these materials offer complementary advantages—achieving wideband shielding with minimal weight.

Additional performance gains can be achieved by integrating artificial intelligence (AI) into shielding systems. AI-driven adaptive control enables continuous monitoring of the surrounding electromagnetic spectrum, rapid identification of interfering frequencies, and dynamic adjustment of the shield's operational parameters—such as the resonance profile of metasurfaces or the electrical conductivity of shielding layers—to suppress interference without disrupting essential avionics signals.

This research introduces an AI-assisted borophene–graphene hybrid shielding solution tailored for advanced helicopter avionics. The design features a graphene-based frequency-selective metasurface integrated onto a borophene–epoxy substrate, with AI algorithms governing real-time optimization of shielding performance based on detected interference patterns. Simulations conducted across the GHz–THz range show that this structure consistently delivers SE values above 70 dB while maintaining sub-millimeter thickness, offering over 50% weight reduction compared to conventional copper enclosures. The remainder of this paper is structured as follows: Section II examines existing EMI shielding technologies and adaptive metasurface concepts. Section III describes the hybrid material and proposed system configuration. Section IV details the AI-based control mechanism. Section V presents simulation outcomes and performance evaluation, and Section VI summarizes conclusions and outlines directions for future research. This approach offers a flexible shielding solution for emerging aerospace needs. By combining cutting-edge materials science with intelligent control strategies, the proposed system bridges the gap between static shielding and real-time EMI suppression.

ISED Certification

ISED (Innovation, Science, and Economic Development Canada)

ISED

1. Certification Mark & Scope

- ISED issues certification for **radio**, **wireless**, and certain **electromagnetic-interference-causing electronic devices**. This is similar to the FCC in the U.S., but FCC certification alone does not satisfy Canadian regulatory requirements.
- Equipment under ISED falls into two categories:
  - **Category I**: Requires a **Technical Acceptance Certificate (TAC)** and certification by ISED's Certification and Engineering Bureau (CEB) or a recognized Certification Body (CB). These products are listed in the Radio Equipment List (REL).
  - **Category II**: Exempt from certification but must comply with applicable standards; a test report must be retained and may be requested by ISED.

2. Standards Covered

- **Radio Standards Specifications (RSS)**: Examples include RSS-Gen, RSS-247 (Wi-Fi/Bluetooth), RSS-119 (licensed transmitters), RSS-210, and more.
- **Interference-Causing Equipment Standards (ICES)**: E.g., ICES-003, as well as general compliance requirements under ICES-Gen.

3. Agencies Involved

- **ISED's Certification and Engineering Bureau (CEB)**: Manages TAC issuance, technical standards, registrations, and market surveillance.
- **Foreign Certification Bodies (FCBs)**: Accredited bodies outside Canada that can evaluate and certify equipment per ISED's standards.

4. Procedures for Registration/Certification

1. **Identify applicable standards** (RSS, ICES, etc.) for your device.
2. **Testing**: Submit your product to an **ISED-recognized testing laboratory** for evaluation.

Key Projects Executed

Project 3 –

Metrics Monitoring

Description

- Studied system performance monitoring frameworks and concepts.
- Identified key performance indicators relevant to system operation.
- Understood the importance of real-time monitoring in live systems.
- Analyzed how performance metrics contribute to system reliability.
- Reviewed reporting mechanisms and data analysis workflows

Outcome

- ✓ Developed understanding of performance monitoring methodologies.
- ✓ Gained ability to identify, interpret, and analyze system metrics.
- ✓ Improved analytical, observation, and evaluation skills.
- ✓ Developed awareness of data-driven decision-making processes.
- ✓ Understood the critical role of monitoring in production systems

Project 4 –

240 kW EV Charging System

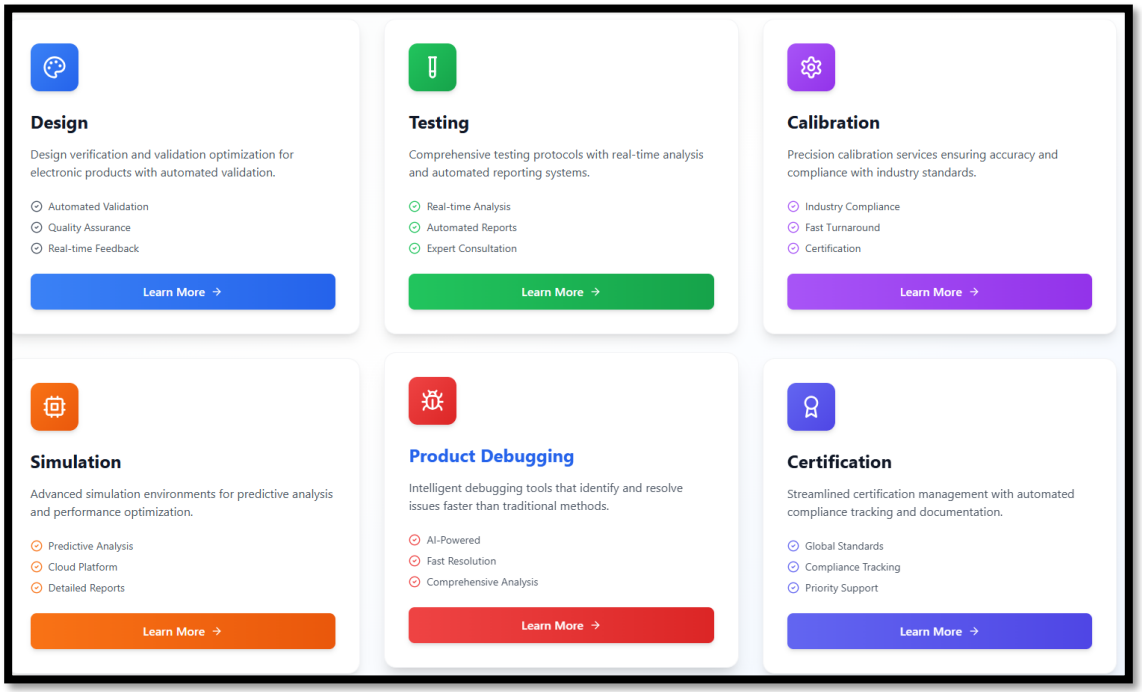
Description

- Designed and developed software modules for the 240 kW project.
- Frontend modules created to support 240 kW system workflows and users.
- Backend modules initiated to handle data, logic, and integration for 240 kW platform.
- Studied system architecture to align software modules with 240 kW requirements.
- Integrated laboratory testing workflows required for 240 kW system validation.
- Ensured frontend and backend modules support end-to-end 240 kW project processes

Outcome

- ✓ Clear understanding of 240 kW system requirements and workflows.
- ✓ Practical exposure to building software modules for a live industrial project.
- ✓ Experience in frontend–backend integration for a high-power EV platform.
- ✓ Improved system-level thinking across hardware, software, and testing.
- ✓ Understanding of how digital platforms support deployment of 240 kW systems.
- ✓ Strong foundation for continued development within the 240 kW ecosystem

AI Platform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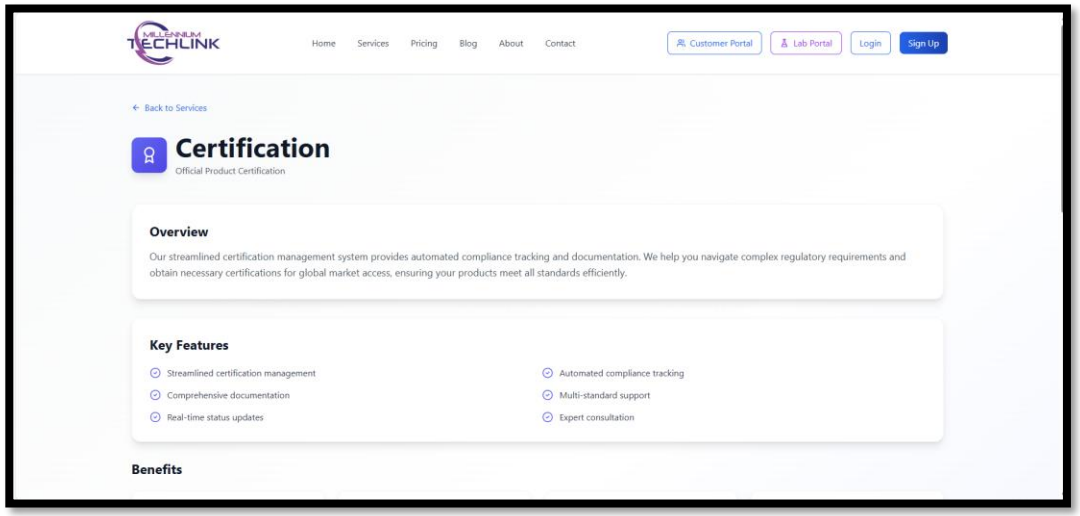
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Overview
Our streamlined certification management system provides automated compliance tracking and documentation. We help you navigate complex regulatory requirements and obtain necessary certifications for global market access, ensuring your products meet all standards efficiently.
Key Features
Streamlined certification management
Comprehensive documentation
Real-time status updates
Automated compliance tracking
Multi-standard support
Expert consultation
Benefits

Project 5 –

LMS(Labs Management System)

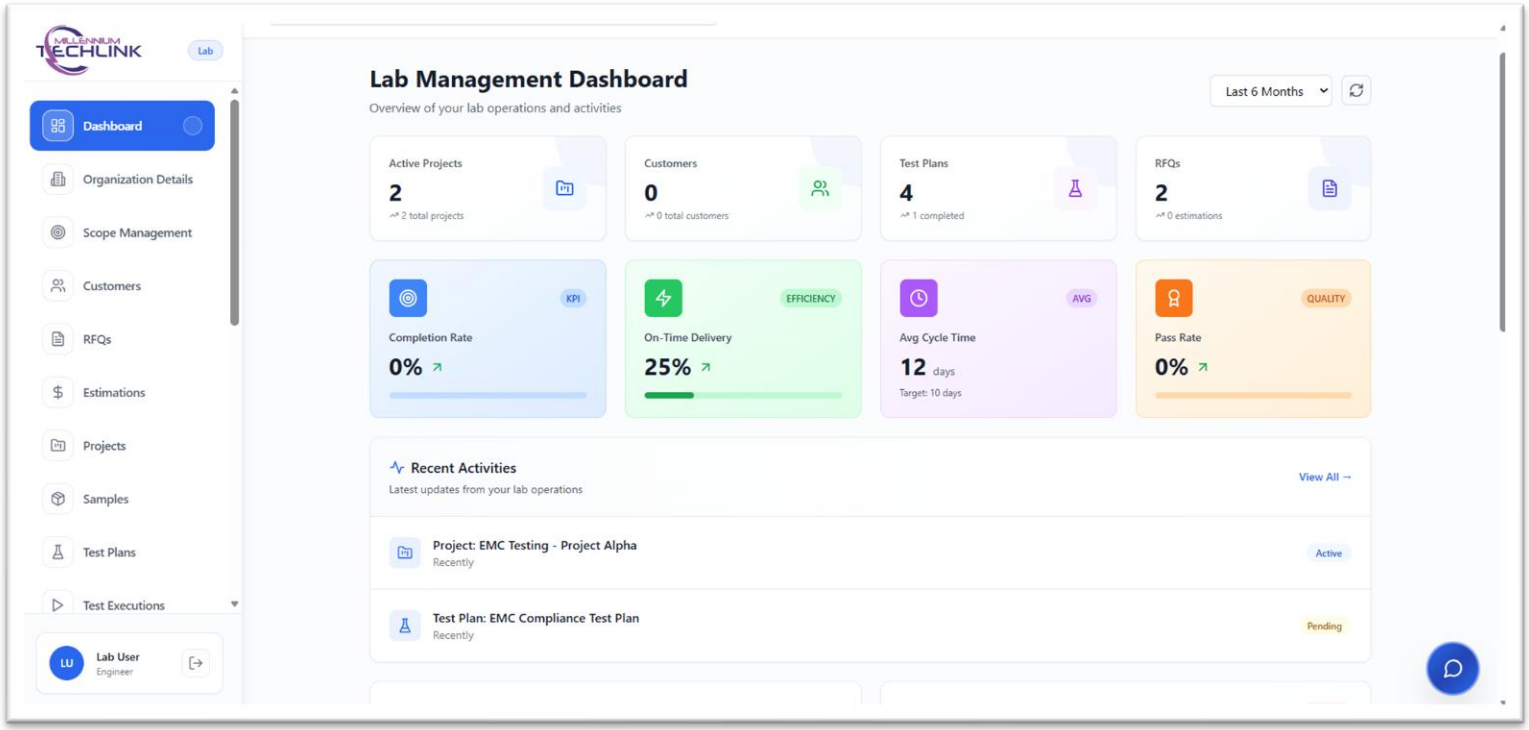
Description

- LMS is being developed as part of the 240 KW project platform.
- My role focused on backend development for LMS.
- Worked on connecting frontend modules with backend logic.
- Implemented backend functionality to store and manage system data.
- Ensured data flow between frontend and backend for smooth module operation.
- Supported execution of complete LMS module through backend integration

Outcome

- ✓ Practical experience in backend development for a live platform.
- ✓ Understanding of frontend–backend integration workflows.
- ✓ Improved knowledge of data handling and storage.
- ✓ Exposure to building backend systems that support complete application flow.
- ✓ Foundation created for further LMS backend development

LMS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Lab User
Engineer
Lab Management Dashboard
Overview of your lab operations and activities
Last 6 Months
Active Projects
2
2 total projects
Customers
0
0 total customers
Test Plans
4
1 completed
RFQs
2
0 estimations
KPI
Completion Rate
0%
EFFICIENCY
On-Time Delivery
25%
AVG
Avg Cycle Time
12 days
Target: 10 days
QUALITY
Pass Rate
0%
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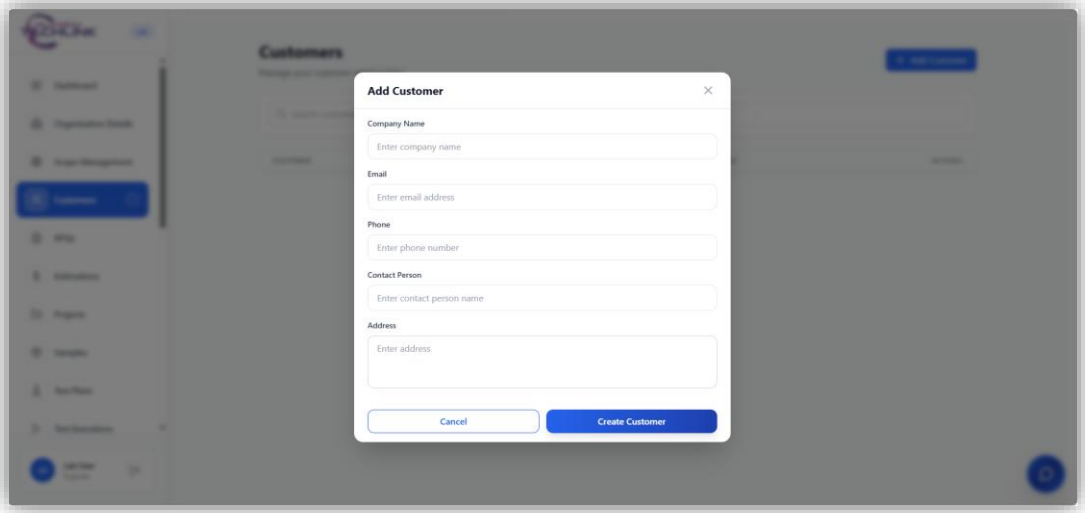
Active
Test Plan: EMC Compliance Test Plan
Recently
Pending


Customers
Add Customer
Company Name
Enter company name
Email
Enter email address
Phone
Enter phone number
Contact Person
Enter contact person name
Address
Enter address
Cancel
Create Customer

Deliverables Completed

- AI-Platform
- Blockdiagram-Miro
- Mindmap-Miro
- Shruti_EM_Shielding Materials.pdf
- Figma
- ISED certification.docx

Tools and Stack

- ✓ Code editor: Vs code
- ✓ Frontend development: HTML,CSS, Javascript
- ✓ Backend development: Node JS, FastApi
- ✓ Repositories: Github
- ✓ UI Designing: Figma
- ✓ Creating Workflows: Miro, Canva, Excel, Powerpoint

Thank You