

## UNIVERSITY RESEARCH PARK – PROBLEM STATEMENT

### **Design and Development of Cognitive Multimodal Cargo Integrity & Inspection System**

#### **Detailed Problem Statement:**

Multimodal cargo transport across road, sea, and air corridors continues to face systemic integrity risks that existing tracking mechanisms fail to address comprehensively.

The industry faces recurring challenges including:

- Unauthorized access and tampering during transit
- Improper or partial unloading at intermediate checkpoints
- Product substitution and pilferage
- Undetected environmental exposure (temperature, humidity)
- Cargo damage due to shock, vibration, or accidents
- Limited forensic evidence for insurance validation
- Manual inspection processes prone to human error

Traditional sealing mechanisms provide only passive tamper indication without time-stamped authentication. Vehicle tracking systems monitor movement but not cargo integrity. Environmental data is often reviewed post-delivery rather than in real time. As a result, deviations are discovered late, liability attribution becomes complex, and insurers lack reliable digital evidence.

With increasing regulatory requirements in pharmaceuticals, perishables, defence logistics, and high-value exports, there is a critical need for a research-driven, industry-validated cargo product and environmental integrity inspection system that ensures authenticated loading/unloading, real-time condition monitoring, and traceable digital inspection records.

This problem directly aligns with focus of University Research Park, Tamilnadu Research Park Foundation, Government of Tamilnadu on translational, industry-defined R&D challenges with commercialisation potential.

### **Current Development Stage**

The Company has successfully developed and validated an Electronic Intelligent Lock with tamper indication capability, with functional Intelligent IoT hardware platform with mechanical system and cloud solutions are already developed. Event logging architecture is integrated within the device with battery-operated standalone operation has been demonstrated successfully. The system needs to undergo undergone:

- (1) Integrated multimodal cargo deployment
- (2) Environmental sensing integration
- (3) Real-time remote inspection framework

### **Technology Readiness Level (TRL)**

The system currently stands at TRL 5

### **Gap to be Addressed Under URP with the Collaboration of the Institute**

While the tamper-aware electronic lock is operational, the following advancements are required for full cargo integrity validation:

1. Integration with product-level tagging mechanisms
2. Environmental monitoring system integration
3. Unified inspection event correlation engine
4. Scalable cloud-based compliance and forensic reporting