



**Pole for Doctoral Studies**  
**Center for Doctoral Studies Sciences, Technologies, and Medical Sciences**

## **ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE**



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**Will present their research work with the aim of earning a  
Doctorate**

**Doctoral program: Sciences and Technique Engineering**  
**Discipline: Electrical and Industrial Engineering**  
**Specialty: Electronics, Data Science, and Artificial Intelligence**

**On 04/12/2025 at 10H00 at the Visio Conference Hall of The  
National School of Applied Sciences of Tangier, UAE  
Under the Theme**

**A Data Driven Deep Learning Framework for Predictive  
Maintenance and Vehicle Health Monitoring**

**Front of the jury composed of :**

<b>First Name &amp; Last Name</b>	<b>Establishment</b>	<b>Designation</b>
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## Abstract

The automotive sector is rapidly evolving into a cyber-physical ecosystem, where the integration of mechanical, electronic, and software components increases system complexity. This evolution challenges traditional maintenance approaches, as unexpected failures may spread across subsystems and compromise safety. Predictive Maintenance (PdM) emerges as a crucial solution, enabling early fault detection, precise health assessment, and data-driven decision-making for intelligent transportation. This research makes a dual-contribution through two interconnected and progressive works, forming a complete PdM pipeline from data trends discovery to precise predictive patterns.

By addressing the ubiquitous challenge of unlabelled real-world vehicle data. We propose a novel, integrated deep learning model that synergistically combines K-means clustering with Long Short-Term Memory (LSTM) networks. This hybrid architecture is specifically engineered to autonomously discover latent operational patterns and temporal dependencies within multivariate time-series data streamed from On-Board Diagnostic (OBD-II) systems. By first employing unsupervised clustering to segment engine states, the model enriches the feature space, providing the subsequent LSTM network with a structured understanding of the data's trends. This approach achieves remarkable accuracy, with an  $R^2$  score of up to 97.5% in predicting critical engine parameters like load and RPM, significantly outperforming standalone LSTM, GRU, and traditional RNN models. This contribution effectively solves the initial data labelling problem and establishes a robust, unsupervised foundation for vehicle health monitoring.

Building upon this foundation, the transitions from pattern recognition to prognostics and remaining useful life (RUL) estimation. Our second work introduces a sophisticated supervised learning framework that leverages engine Health Index (HI) assessment derived from fused real-world and open-source sensor data. We develop a polynomial-fitted HI model to translate raw, multi-sensor readings into a single, interpretable metric of engine degradation, categorizing states into "Healthy," "Critical," and "Degradation" zones. An LSTM network is then trained on this hierarchical health data to learn the precise temporal degradation trajectories and accurately forecast the RUL of engine components. The model demonstrates exceptional prognostic capability, effectively tracking the non-linear degradation curve across all operational zones and providing early warnings well in advance of potential failures. This contribution moves beyond mere condition monitoring, offering a decisive, data-backed tool for maintenance planning and resource optimization. Together, this work forms a holistic and scalable PdM framework.

The thesis culminates by demonstrating how these models can be deployed for real-time, edge-computing applications, such as PdM-as-a-Service (PdMaaS), offering tangible benefits, such as unplanned downtime reduction, optimized maintenance scheduling, extended asset lifespan, and enhanced overall safety. By bridging the gap between raw sensor data and actionable intelligence, this research provides a critical pathway for the automotive industry to achieve truly intelligent, predictive, and economically sustainable maintenance operations.

**Keywords:** Predictive Maintenance, Data-Driven Approach, Vehicle Condition Monitoring, Machine Learning, Deep Learning Algorithms, Remaining Useful Life, Health Index.

