# ENT9099ME08 - Implementation of intelligent time monitoring system for various manufacturing and fabrication processes using machine Learning

## Principal Investigator


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| **Programme** | ENT9099 Master of Science by Research in Mechanical Engineering |
| **Research Area and Specialization**: | Specializes in the fields of Manufacturing, Design, and Composite Materials, with a particular focus on the development and analysis of composite structures and expertise extends to Finite Element Analysis, Project Management, Quality and Reliability Engineering, and Energy Policy and Economics and AI basic tools. My research encompasses innovative manufacturing techniques, material characterization, and the application of computational modeling to enhance the performance and reliability of engineering materials and systems. And actively contributes to advancing knowledge in these areas through his scholarly publications, funded research projects, and collaborative initiatives |
| **Company Endorsement** | RAMSIS |
| **Industry mentor** | Sayed Hadi |

## Background of the problem

Efficiency, quality, and responsiveness are becoming increasingly important in the manufacturing and fabrication sectors. Due to their frequent lack of realtime insights, traditional process monitoring techniques frequently result in delays, bottlenecks, and inefficient use of resources.

To solve this, a thorough data collecting system that records environmental parameters pertinent to different production processes, machine operational data, and real-time process metrics must be developed and put into place. Predictive models that precisely estimate process durations can be created by analyzing past process data using machine learning techniques. Continuous tracking of ongoing activities, early detection of deviations from anticipated timetables, and automated notifications to prevent potential delays are all made possible by integrating these models into a real-time monitoring platform.

This proactive strategy improves overall operational efficiency, streamlines workflow, and enables prompt interventions. System insights can also help detect bottlenecks, enhance resource allocation, and facilitate data-driven decision-making, all of which can result in higher production output, less downtime, and lower costs. To develop such an integrated solution, issues with data accuracy, system scalability, and real-time processing must be resolved to turn industrial activities into an ecosystem that is more intelligent, adaptive, and efficient.

## List of publications related to the field

Zero

## Research Objectives and Expected Outcomes

Aim : Implementation of intelligent time monitoring system for various manufacturing and fabrication processes using machine Learning

• Research Objectives:

1. To collect real-time process metrics, machine operational data, and environmental parameters relevance to different manufacturing and fabrication processes, design and execute a complete data collecting system.

2. Using machine learning approaches to analyze past process data, develop models that can accurately anticipate the time required for different manufacturing and fabrication processes.

3. Incorporate the predictive models into a real-time monitoring platform that tracks ongoing processes, detects deviations from anticipated durations, and generates alerts in order to optimize workflow and prevent delays.

4. Utilize system insights to pinpoint bottlenecks, maximize resource distribution, and facilitate data-driven decision-making targeted at boosting production, decreasing downtime, and enhancing efficiency.

**Expected Outcomes:**

The goal of this research is to develop and implement effective time study techniques that accurately capture the time taken for various manufacturing and fabrication processes in RAMSIS Engineering (Estimation department) with the following outcomes.

1. More efficient use of time and resources might result from comprehending and locating bottlenecks in manufacturing processes.

2. Gaining knowledge of how to predict labor and material requirements using past usage trends and production schedules.

3. learning about the cost-benefit analysis of putting in place a smart monitoring system.

## Research Design & Methodology

1.System Design

• Identify critical process metrics, machine operational data, and environmental parameters relevant tom different manufacturing activities

• Design a scalable framework for data collection, storage, processing, and visualization.

2.Data collection

• Choose appropriate sensors (e.g., temperature, humidity, vibration, machine status) and integrate them with manufacturing equipment.

• Develop interfaces (using PLCs, IoT devices, or SCADA systems) to capture real-time data.

3. Data Analysis & Model Development

• Extract and organize past process data for analysis.

• Experiments with machine learning algorithms such as Random Forests, Gradient Boosting, Neural Networks, or Support Vector Machines to predict process times.

• Use techniques like cross-validation, hold-out testing, and performance metrics (MAE, RMSE) to evaluate accuracy.

4. Integration into Real-Time Monitoring Platform & Testing

• Develop a dashboard for visualization of ongoing processes, predicted vs. actual durations, and alerts.

• Integrate trained models into the platform to provide real-time process duration estimates.

• Conduct pilot runs to validate system performance and reliability.

## Significance and potential impact of research in Bahrain

The study highlighted has the potential to transform Bahrain's manufacturing and fabrication industries by creating innovative data-driven strategies.

Through the development of a comprehensive system for collecting real-time process measurements, machine operating data, and environmental indicators, this research will enable accurate monitoring of manufacturing processes. Better operational openness and better decision-making will follow from this. Using machine learning approaches to analyze past process data would facilitate the development of accurate predictive models that can accurately forecast process durations. This will reduce uncertainty and increase planning accuracy.

Manufacturers will be able to dynamically analyze ongoing operations, quickly identify deviations from anticipated deadlines, and rapidly give alerts to prevent delays by integrating these models into a real-time monitoring platform. This will ultimately streamline workflows. Additionally, a more effective production environment will be fostered, downtime will be reduced, and productivity will be maximized by using system insights to identify bottlenecks and optimize resource allocation. All things considered, this research has the potential to improve Bahrain's manufacturing capacity, boost its competitiveness in regional and international markets, and aid in the continuous digital transformation of its industrial sector, establishing the nation as a pioneer in cuttingedge manufacturing techniques in the GCC countries.

## Alignment with Bahrain’s national research strategy

The overarching goal is to establish a comprehensive, data-driven manufacturing optimization system that aligns with Bahrain’s national research strategy.

This involves collecting real-time process metrics, machine operational data, and environmental parameters to create a complete and accurate data collection infrastructure. Leveraging advanced machine learning techniques, the system will analyze historical process data to develop predictive models capable of accurately estimating process durations. These models will be integrated into a real-time monitoring platform that tracks ongoing operations, detects deviations from expected timelines, and generates timely alerts to prevent delays and optimize workflow. By utilizing insights derived from this platform, the system will identify bottlenecks, facilitate optimal resource allocation, and support data-driven decision-making aimed at boosting production efficiency, reducing downtime, and fostering continuous process improvement. Collectively, these efforts will advance Bahrain’s strategic objectives of promoting Industry 4.0 adoption, enhancing manufacturing competitiveness, and driving sustainable industrial growth through innovative, intelligent, and automated solutions.