# AI-Powered Industrial Automation for the Manufacturing Sector of Pakistan

University of Gwadar  
Department of Computer Science  
Final Year Project  
  
Team Lead: Iqra Rashid  
Team Members: [Add other names]

## Abstract

This project introduces an AI-based automation system designed to address the key operational challenges in Pakistan’s manufacturing industry — production defects, machine breakdowns, and inventory inefficiencies. By integrating Computer Vision, Predictive Maintenance, and Time-Series Forecasting models, we developed a three-tier AI ecosystem capable of improving quality control, reducing downtime, and optimizing supply chains.

## Project Overview

The system is divided into three interconnected models:  
1. Fabric Defect Detection (Computer Vision)  
2. Predictive Maintenance (IoT + ML)  
3. Inventory Demand Forecasting (LSTM)  
Together, these form a complete AI-powered industrial automation solution.

## Model 1 — Fabric Defect Detection (Computer Vision)

Uses Vision Transformer (ViT) to detect fabric or surface defects in textile manufacturing. Trained on merged Kaggle datasets with AdamW optimization and data augmentation. Achieved over 85% accuracy.  
Impact: Reduces manual inspection effort and improves quality control.

## Model 2 — Predictive Maintenance (IoT + Machine Learning)

Predicts machine failures using IoT sensor data (temperature, vibration, current). Random Forest and Gradient Boosting models trained after feature scaling and balancing. Achieved ~92% accuracy with Gradient Boosting as best performer.  
Impact: Prevents unplanned downtime and extends machine lifespan.

## Model 3 — Supply Chain Forecasting (LSTM)

Forecasts sales and inventory demand using LSTM neural network on cleaned and aggregated e-commerce data. Achieved Mean Squared Error ≈ 5555.74 with forecast error ≤10%. Detected clear seasonal demand patterns.  
Impact: Reduces overstocking and shortages through accurate forecasting.

## Technical Summary

Tools & Frameworks: TensorFlow, PyTorch, Scikit-Learn, Pandas, NumPy, Seaborn, Matplotlib  
Hardware: GPU-enabled Kaggle/Colab environment  
All models achieved or exceeded their target metrics for reliability and accuracy.

## Relevance to Pakistan’s Industry

The project addresses real industrial inefficiencies by promoting AI adoption in textile and manufacturing sectors. Benefits include reduced human error, lower maintenance cost, higher product quality, and improved global competitiveness.

## Implementation Plan

Phase 1 — Data Integration & Collection  
Phase 2 — Model Deployment  
Phase 3 — Testing & Calibration  
Phase 4 — Training & Handover  
Phase 5 — Full-Scale Implementation

## Conclusion

This project successfully combines Deep Learning, Machine Learning, and Time-Series AI into one automation ecosystem for Pakistan’s industrial sector.  
Core achievements include defect detection with >85% accuracy, predictive maintenance with >90% reliability, and inventory forecasting with <10% error.  
Result: Factories become smarter, faster, and globally competitive through AI.