رواد مصر الرقمية

وزارة الاتصـــــالات
وتكنولوجيا المعلومات

Manufacturing Downtime

Presenter's Name:

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- Malak Mohamed Sayed Amin
- Eyad Mohanad Mohamed Bakry
- Anas Sayed Ali Ali
- Youmna Emad Soliman Abdeljwad

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Project Idea

Problem Statement:

- High downtime rates in assembly lines, especially during the first quarter, significantly impact productivity and operational efficiency.

Proposed Solution:

- Implement predictive analytics using machine learning models to forecast machine failures and downtime events based on operational KPIs (vibrations, voltage, torque, RPM).

Unique Value Proposition:

- Enables proactive maintenance and reduces unexpected downtime.
- Improves resource allocation and production planning.
- Integrates real-time dashboards with predictive insights for decision-making.

Project Wireframe

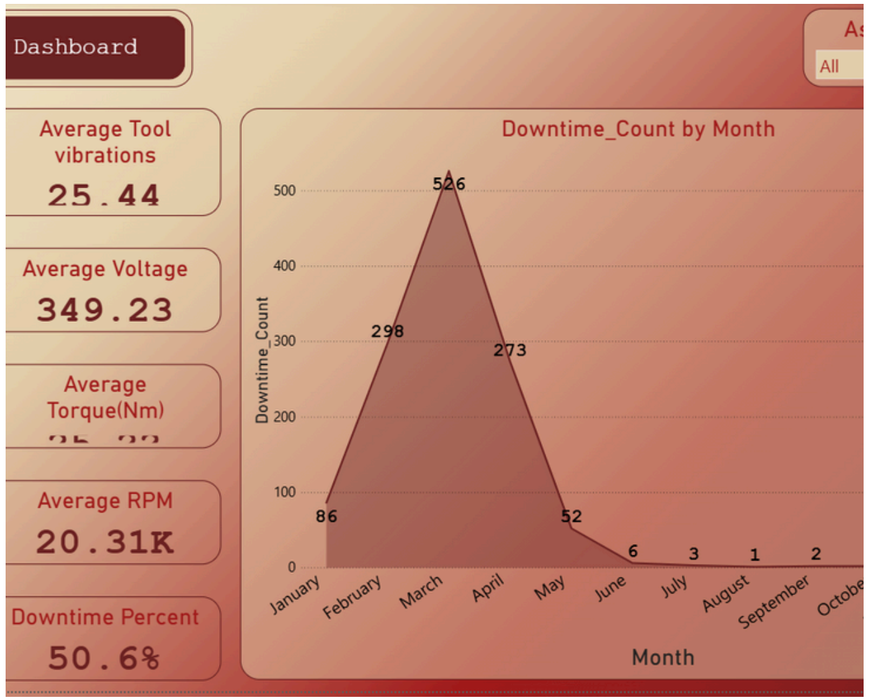
Description:

- The wireframe represents the interactive dashboard designed for monitoring and predictive analysis of assembly line performance.

Key Components:

KPIs Panel:Displays real-time metrics such as:

- Average Tool Vibrations
- Average Voltage
- Average Torque (Nm)
- Average RPM
- Downtime Percentage



Visualization Area:

- Area chart showing Downtime_Count by Month for each assembly line.
- Filter option to select Shopfloor-L1, L2, L3, or All.
- User Interaction:
- Dropdown menus for line selection.
- Dynamic updates based on user filters.

User Journey:

- Step 1: Select assembly line from the dropdown.
- Step 2: Review KPIs and downtime trends.
- Step 3: Use insights to plan preventive maintenance and reduce downtime.

Visual Element:

- Insert one of the dashboard screenshots (preferably the one showing “All” lines for a complete overview).

End Users + Features

Primary End Users:

- Production Managers: Need real-time visibility of downtime and KPIs to optimize scheduling.
- Maintenance Teams: Require predictive alerts to plan preventive maintenance and reduce unexpected failures.
- Data Analysts: Use historical and real-time data for performance optimization and forecasting.

Key Features:

- Interactive Dashboard:
- Displays KPIs (Tool Vibrations, Voltage, Torque, RPM, Downtime %).
- Visualizes downtime trends by month and assembly line.

Predictive Analytics:

- Machine learning model forecasts next-day downtime events.

Filtering & Drill-Down:

- Ability to select specific assembly lines (Shopfloor-L1, L2, L3) or view all combined.

Actionable Insights:

- Recommendations for preventive maintenance based on patterns and predictions.

How Features Solve Problems:

- Dashboard: Provides transparency and quick decision-making.
- Forecasting: Reduces unplanned downtime and improves resource allocation.
- Insights: Helps prioritize maintenance tasks and avoid costly breakdowns.

Data Structure

Data Source:

- Operational datasets from assembly lines containing:
- Date
- Downtime Count
- Tool Vibrations
- Voltage
- Torque (Nm)
- RPM

Data Shape:

- Rows: Daily records for each assembly line.
- Columns: KPIs + target variable (Downtime).

Additional Features:

- Lag variables (Lag_1, Lag_2, Lag_3) created for time-series forecasting.

Data Flow:

- Collection: Extracted from machine logs and operational systems.

Preprocessing:

- Handling missing values.
- Feature scaling and encoding.

Techniques Used:
Random Forest Regressor for prediction.
Evaluation metrics: MAE and R^2.

Model Input:
Train/Test split (80/20).
Features: Lag variables and KPIs.

Output:
Predicted downtime for the next day.

Programming Languages + Frameworks

Programming Language:

- Python – Used for data preprocessing, feature engineering, and predictive modeling.

Frameworks & Libraries:

- Pandas – Data manipulation and cleaning.
- Scikit-learn – Machine learning model development (Random Forest Regressor).
- Matplotlib / Seaborn – Data visualization for trends and model performance.

Supporting Tools:

- Power BI – Dashboard creation for real-time KPI monitoring and downtime analysis.
- Excel – Initial data storage and integration with Power BI.

Additional Techniques:

- Lag feature engineering for time-series forecasting.
- Evaluation metrics: MAE and R^2 for model performance.

Live Application + Test

Current State of Application:

- A prototype dashboard built in Power BI for real-time KPI monitoring and downtime visualization.
- Predictive model implemented in Python using Random Forest Regressor for next-day downtime forecasting.

Testing Phases:

- Unit Testing: Verified data preprocessing steps (handling missing values, lag feature creation).
- Integration Testing: Ensured smooth data flow between Excel, Python scripts, and Power BI dashboard.

Model Evaluation:

- Mean Absolute Error (MAE): 1.43
- R^2 Score: -1.79 (indicates low predictive accuracy, needs improvement).

User Feedback:

- Dashboard provides clear visibility of KPIs and downtime trends.
- Predictive insights are promising but require additional features for better accuracy.

Deliverables

Reports & Documentation:

Analytical Report:

- Detailed analysis of downtime trends across assembly lines.
- KPI performance summary (vibrations, voltage, torque, RPM).

Predictive Model Report:

- Model architecture and feature engineering (Lag_1, Lag_2, Lag_3).
- Evaluation metrics (MAE = 1.43, R^2 = -1.79).

Dashboard Documentation:

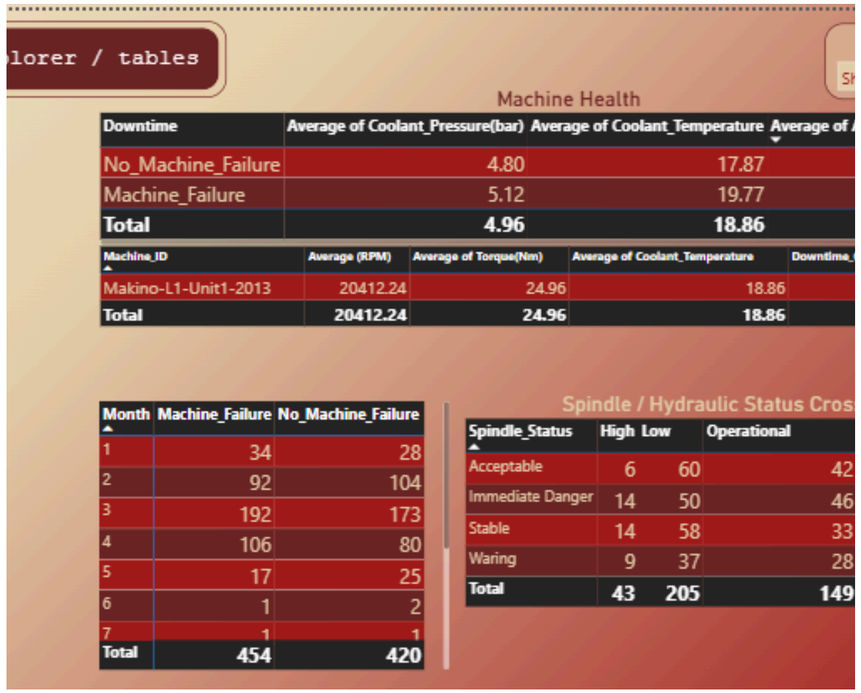
- Power BI dashboard design and usage guide.

Final Products:

- Interactive dashboard for real-time monitoring.
- Python scripts for data preprocessing and forecasting.
- Presentation slides summarizing insights and recommendations.

Timeline:

- Week 1–2: Data collection and preprocessing.
- Week 3: Model development and evaluation.
- Week 4: Dashboard integration and final reporting



Machine Performance

Assembly Line
Shopfloor-L2
Shopfloor-L1
Shopfloor-L2
Shopfloor-L3

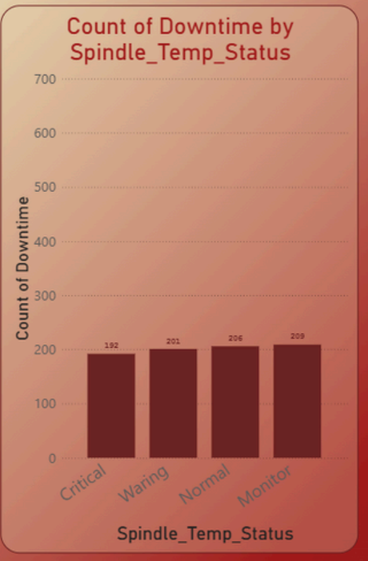
Average Tool vibration
25.43

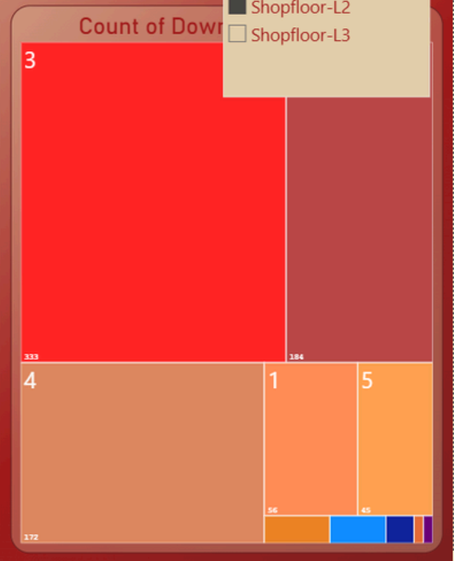
Average Voltage
347.16

Average Torque(Nm)
25.23

Average RPM
20.27K

Downtime Percent
49.0%





Overview Dashboard

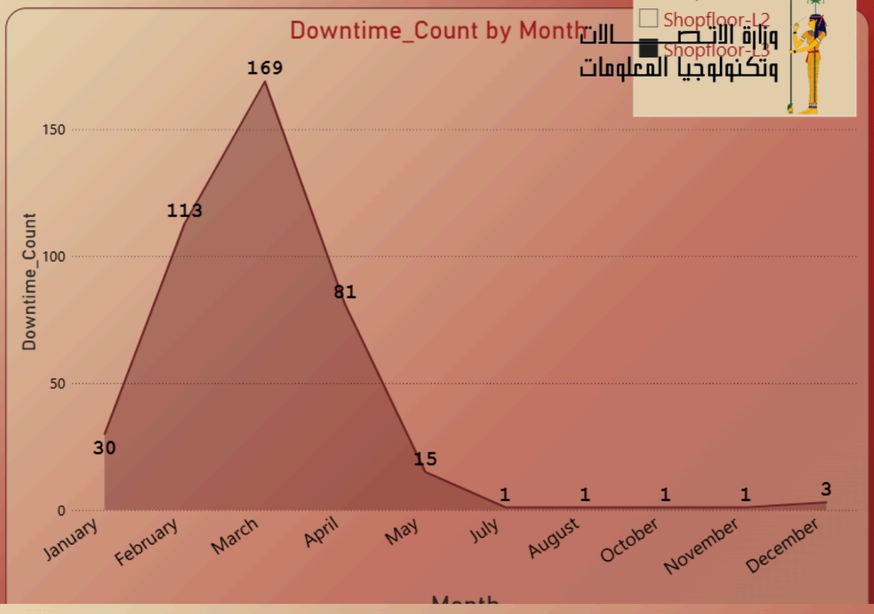
Average Tool vibrations
25.50

Average Voltage
350.54

Average Torque(Nm)
25.50

Average RPM
20.25K

Downtime Percent
50.7%



Assembly Line
Shopfloor-L3
Shopfloor-L1
Shopfloor-L2
Shopfloor-L3

Data Explorer / tables

Assembly Li
All
Shopfloor-L1
Shopfloor-L2
Shopfloor-L3

Machine Health

Downtime	Average of Coolant_Pressure(bar)	Average of Coolant_Temperature	Average c
Machine_Failure	5.12	20.00	
No_Machine_Failure	4.76	17.12	
Total	**4.94**	**18.58**	

Machine_ID	Average (RPM)	Average of Torque(Nm)	Average of Coolant_Temperature	Downtime_Count	Downtime_Pe
Makino-L1-Unit1-2013	20412.24	24.96	18.86	454	
Makino-L2-Unit1-2015	20269.48	25.23	18.19	396	
Makino-L3-Unit1-2015	20254.56	25.50	18.66	415	
Total	**20314.51**	**25.22**	**18.58**	**1265**	

Month	Machine_Failure	No_Machine_Failure
1	86	89
2	298	299
3	526	510
4	273	241
5	52	67
6	6	6
7	3	3
Total	**1265**	**1235**

Spindle / Hydraulic Status Cross Table

Spindle_Status	High	Low	Operational	Overpressure	Tota
Acceptable	26	161	120	34	3
Immediate Danger	27	153	109	34	3
Stable	33	140	96	53	3
Waring	28	117	93	41	2
Total	**114**	**571**	**418**	**162**	**12**

Machine Performance

Assembly Line
Shopfloor-L3

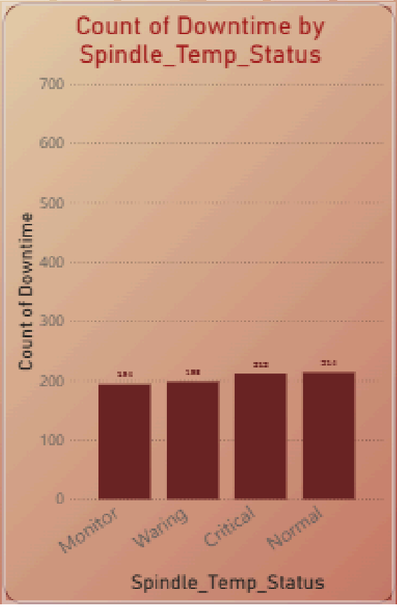
Average Tool vibration
25.50

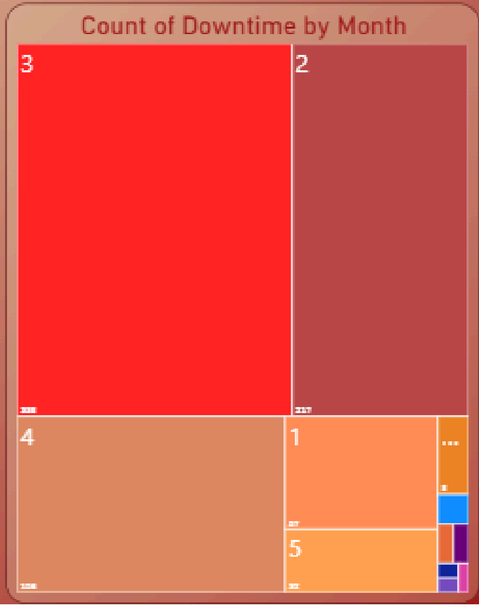
Average Voltage
350.54

Average Torque(Nm)
25.50

Average RPM
20.25K

Downtime Percent
50.7%





Project Team + Roles

Group Members & Roles:

- Rana Essam Eldean Taha Abdelaal – Data Modeling & Structure Analyst
- Malak Mohamed Sayed Amin – Data Visualization & Reporting Analyst
- Eyad Mohanad Mohamed Bakry – Exploratory Data Analyst (EDA Specialist)
- Anas Sayed Ali Ali – Predictive Analyst (Forecasting Specialist)
- Youmna Emad Soliman Abdeljwad – Data Acquisition & Preparation Analyst

Team Leader:

- Rana Essam Eldean Taha Abdelaal

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thank you

We appreciate your time and attention, Looking forward to your insights and suggestions!

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