DATA WIZARDS

Manufacturing down time

Analysis report

DATA WIZARDS

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Manufacturing Downtime Analysis Report

1.Executive Summary

This report analyses manufacturing downtime to identify key causes and recommend improvements based on the data collected.

This report provides an in-depth analysis of manufacturing downtime data for a production facility. The analysis focuses on identifying key factors contributing to downtime, evaluating the impact on productivity, and providing actionable insights to minimize future disruptions.

The data includes information on downtime factors, batch production, line downtime, and product details, addressing these issues can significantly improve production efficiency increasing facility revenue and cost saving.

Key Objectives

1. Reduce Downtime by 20% within 6 months.
2. Decrease Operator-Induced Downtime by 30% within 4 months.
3. Implement a Preventive Maintenance Schedule within 3 months.
4. Reduce Downtime Due to Inventory Shortages by 25% within 5 months.
5. Complete Root Cause Analysis for Top 3 Downtime Factors within 2 months.
6. Enhance Operator Training Programs within 3 months.
7. Establish a Continuous Monitoring System within 4 months

Summary of Findings

Brief Insights or Preliminary Findings

1. **Most Common Downtime Factors**:
    - Machine adjustments and machine failures are the most frequent causes of downtime.
    - Inventory shortages also contribute significantly to production delays.
2. **Operator Errors**:
    - A substantial portion of downtime is attributed to operator errors, particularly in batch changes and coding.

3. **Impact on Productivity**:
    - Downtime significantly impacts batch completion times, with some batches experiencing over 100 minutes of delays.
4. **Operator Performance**:
    - Operators with the most downtime incidents require additional training and support to reduce errors.
5. **High-Downtime Batches**:
    - Specific batches (e.g., 422147, 422144, 422146) have notably high downtime and should be prioritized for root cause analysis and corrective actions.

By focusing on these key objectives and leveraging the preliminary findings, the project aims to achieve substantial improvements in manufacturing efficiency, cost savings, and overall product quality.

The Next Phases or Actions

Phase 1: Data Validation and Cleaning

Phase 2: Root Cause Analysis, analytical analysis using visualization tools.

Phase 3: Implementation of Corrective Measures

Phase 4: Monitoring and Evaluation

Phase 5: Continuous Improvement

Impact

1. Operational Efficiency

- **Benefit**: Reduction in downtime will lead to increased production capacity and more efficient use of resources.
- **Stakeholders**: Production Managers, Operations Team

2. Cost Savings

- **Benefit**: Minimizing downtime will reduce costs associated with lost production time and machine repairs.
- **Stakeholders**: Finance Department, Senior Management

3. Product Quality

- **Benefit**: Improved machine calibration and operator training will enhance product quality and consistency.
- **Stakeholders**: Quality Assurance Team, Customers

4. Employee Satisfaction

- **Benefit**: Better training and clearer procedures will improve operator confidence and job satisfaction.
- **Stakeholders**: Human Resources, Production Staff

5. Customer Satisfaction

- **Benefit**: More reliable production schedules and higher quality products will lead to increased customer satisfaction and loyalty.
- **Stakeholders**: Sales and Marketing Teams, Customers

6. Competitive Advantage

- **Benefit**: Enhanced operational efficiency and product quality will strengthen the company's competitive position in the market.
- **Stakeholders**: Senior Management, Investors

By following these next steps and understanding the potential impact, the organization can achieve significant improvements in manufacturing efficiency, cost management, and overall stakeholder satisfaction

1.Project Overview

"Manufacturing Downtime Reduction and Operational Efficiency Improvement Project"

Project Summary:

This project aims to identify, analyze, and reduce manufacturing downtime to enhance operational efficiency and productivity. By addressing key downtime factors such as machine adjustments, operator errors, and inventory shortages.

the project seeks to minimize production delays, reduce costs, and improve product quality, The initiative will involve root cause analysis, implementation of corrective measures, and continuous monitoring to ensure sustained improvements.

Background: Frequent downtime incidents have been impacting production schedules, leading to increased costs and reduced output.

The need for this project arises from the necessity to maintain competitive advantage, meet customer demands, and optimize resource utilization

Stakeholders:

- **Sponsors**: Senior Management, Finance Department
- **Project Team**: Data Analytics Team (DATA WIZARDS).
- Operations Team, Quality Assurance Team, Training and Development Team
- **Departments**: Production, Maintenance, Inventory Management, Human Resources
- **External Stakeholders**: Suppliers, Customers.

Timeframe:

- **Start Date**: 2/1/2025
- **Expected Completion Date**: 29/3/2025

2. Problem Identification & Expected Outcome

Problem Statement:

The manufacturing facility is experiencing frequent and prolonged downtime incidents, which are significantly disrupting production schedules. Key issues include:

1. **Machine Adjustments and Failures**: Frequent machine adjustments and unexpected failures are causing delays, leading to inefficiencies in the production process.
2. **Operator Errors**: Mistakes made by operators during batch changes and coding are contributing to downtime, indicating a need for better training and procedural clarity.
3. **Inventory Shortages**: Insufficient inventory levels are causing production halts, as necessary materials are not available when needed.
4. **Lack of Preventive Maintenance**: The absence of a structured preventive maintenance schedule is resulting in unexpected machine breakdowns.

Impact on the Business:

1. **Reduced Productivity**: Downtime is leading to decreased production output, making it challenging to meet customer demand and delivery schedules.
2. **Increased Costs**: Prolonged downtime results in higher operational costs due to lost production time, overtime labor, and emergency repairs.
3. **Lower Product Quality**: Frequent interruptions and rushed production to meet deadlines can compromise product quality, affecting customer satisfaction and brand reputation.
4. **Operational Inefficiencies**: Inefficient use of resources and manpower due to downtime is hindering overall operational efficiency and profitability.
5. **Customer Dissatisfaction**: Delays in production can lead to missed delivery deadlines, resulting in dissatisfied customers and potential loss of business.

Addressing these issues is critical to improving the facility's operational efficiency, reducing costs, and enhancing customer satisfaction.

The project aims to implement targeted strategies to mitigate downtime and its associated impacts, ensuring a more reliable and efficient production process.

Root Cause Analysis

Creating a **Fishbone Diagram**[2] for manufacturing down time involves identifying the main categories of causes contributing to manufacturing downtime and breaking them down into specific factors. Based on the data provided

1. **Data Gaps**:
    - **Incomplete Data Collection**: There is a lack of comprehensive data on downtime incidents, making it difficult to identify patterns and root causes accurately.
    - **Inconsistent Reporting**: Inconsistent reporting of downtime incidents by operators leads to gaps in data, hindering effective analysis.
2. **Process Inefficiencies**:
    - **Lack of Standardized Procedures**: Absence of standardized operating procedures for machine adjustments and batch changes results in variability and errors.
    - **Inadequate Training**: Operators are not sufficiently trained on best practices, leading to mistakes that cause downtime.
    - **Reactive Maintenance**: The current maintenance approach is reactive rather than preventive, leading to unexpected machine failures.
3. **Inventory Management Issues**:
    - **Poor Inventory Tracking**: Inefficient inventory tracking systems result in stockouts and shortages, causing production halts.
    - **Inaccurate Demand Forecasting**: Inaccurate forecasting of material needs leads to insufficient inventory levels.
4. **Equipment and Technology**:
    - **Aging Machinery**: Older machines are more prone to breakdowns and require frequent adjustments.
    - **Lack of Automation**: Manual processes for batch changes and machine adjustments increase the likelihood of human error.
5. **Organizational Factors**:
    - **Siloed Departments**: Lack of communication and coordination between departments (e.g., production, maintenance, inventory) exacerbates downtime issues.
    - **Insufficient Resources**: Limited resources allocated for preventive maintenance and operator training contribute to ongoing problems.

Tools and Technologies

To achieve the project objectives and conduct a thorough analysis of manufacturing downtime, the following **tools, technologies, and methodologies** will be utilized:

1. Data Analysis and Visualization Tools

- **Microsoft Excel query**: For initial data cleaning, organization, and basic analysis.
- **Power BI**: For creating interactive dashboards and visualizing downtime trends, KPIs, and production metrics.
- **Tableau**: For advanced data visualization and reporting to stakeholders.
- **Matplotlib**: data analysis and visualization using control charts.

2. Database Management

- **SQL**: For querying and managing datasets stored in relational databases.

3. Project Management and Collaboration Tools

- **Microsoft Project**: For project planning, task management, and tracking progress.
- **Microsoft Teams**: For team communication and collaboration.

4. Root Cause Analysis Methodologies

- **Fishbone Diagram (Ishikawa)**: For identifying and categorizing root causes of downtime.
- **Failure Mode and Effects Analysis (FMEA)**: For assessing potential failure points in the production process.

5. Process Optimization Tools

- **Lean Manufacturing Principles**: To identify and eliminate waste in the production process.
- **Six Sigma (DMAIC Methodology)**: For process improvement and reducing variability in production.
    - Define, Measure, Analyze, Improve, Control (DMAIC) framework.

6. Reporting and Documentation

- **Microsoft Word/PowerPoint**: For creating project reports, presentations, and documentation.
- **LaTeX**: For professional documentation of technical findings and analysis
- **Google Docs**: For documenting and sharing code, analysis, and findings.

Research Questions:

Analytical questions

1. Productivity & Efficiency:

a. What is the average time taken to complete a batch for each product?

b. What is the OEE (Overall Equipment Effectiveness) for each product line?

c. Which products have the highest production rate and which ones consistently take longer to produce?

2. Operator Performance:

a. Which operators are processing the most batches, and how does their productivity compare?

b. Are certain operators more efficient with specific products?

c. How does downtime affect the performance of different operators?

d. How does operator performance vary across different shifts?

3. Downtime Analysis:

a. What are the top Five factors contributing to downtime?

b. What is the percentage of downtime to effectively?

c. Is downtime distributed evenly across different products and production lines?

4. **Financial Impact:**

a. What is the financial cost of downtime for each product or line?

b. How much potential revenue loss due to downtime, and which downtimes are the costliest?

Strategic Questions for Long-Term Downtime Analysis.

1. **Efficiency and Productivity Improvement**
    a. How can we reduce downtime by 20-30% over the next five years?
    b. What are the best global practices in downtime management that we can adopt?
    c. How can we design more flexible production processes to address future challenges?
2. **Digital Transformation and Technology**
    a. Can we use AI or machine learning to predict failures before they occur?
    b. How feasible is our investment in analytics systems like Power BI or ERP to accelerate downtime analysis?
3. **Maintenance and Prevention Strategies**
    a. What is the optimal maintenance model: preventive or predictive?
    b. How can we reduce reliance on emergency maintenance and increase planned maintenance?
    c. How effective is our current maintenance schedule, and does it need redesigning based on data?
4. **Financial Impact and Profitability**
    a. How can we reduce financial losses from downtime by X% in the coming years?
    b. Are there alternative ways to compensate for downtime losses?
5. **Strategic Planning and Expansion**
    a. How will downtimes affect our ability to scale production?
    b. Can we redesign production processes to be more resilient to downtimes?

Objectives:

1. **Reduce Downtime by 20% within 6 months.**
    a. **Goal**: Minimize the frequency and duration of manufacturing downtime
    b. **Outcome**: Increased production capacity and operational efficiency.
2. **Identify Root Causes within 1 month.**
    a. **Goal**: Determine the primary factors contributing to downtime.
    b. **Outcome**: Targeted strategies to address and mitigate these factors.
3. **Enhance Operator Training within 3 months.**
    a. **Goal**: Improve operator skills and knowledge to reduce errors.
    b. **Outcome**: Fewer operator-induced downtime incidents and higher product quality.
4. **Improve Inventory Management: Reduce Downtime Due to Inventory Shortages by 25% within 5 months.**

    a. **Goal**: Ensure adequate inventory levels to prevent shortages.
    b. **Outcome**: Reduced downtime due to inventory shortages and smoother production flow.
5. **Implement Preventive Maintenance Schedule within 3 months.**

    a. **Goal**: Schedule regular maintenance to prevent machine failures.
    b. **Outcome**: Fewer unexpected machine breakdowns and extended equipment lifespan.
6. **Monitor and evaluate within 4 months**
    a. **Goal**: Establish a system for ongoing monitoring and evaluation of downtime.
    b. **Outcome**: Continuous improvement and sustained operational efficiency

7. **Decrease Operator-Induced Downtime by 30% within the next 4 months.**
    a. Reduce downtime incidents caused by operator errors by 30%.

Expected Outcomes

1. **Reduction in Downtime**:
    - A **20% reduction in total downtime duration** across all production lines.
    - Fewer incidents of **machine failures**, **operator errors**, and **inventory shortages**.
2. **Improved Operator Performance**:
    - A **30% decrease in operator-induced downtime** through enhanced training and standardized procedures.
    - Increased operator confidence and adherence to best practices.
3. **Enhanced Machine Reliability**:
    - Implementation of a **preventive maintenance schedule** to reduce unexpected machine breakdowns.
    - Fewer incidents of **machine adjustments** and **calibration errors**.
4. **Optimized Inventory Management**:
    - A **25% reduction in downtime caused by inventory shortages** through improved tracking and forecasting systems.
    - Smoother production flow due to better material availability.
5. **Data-Driven Decision Making**:
    - Establishment of a **real-time monitoring system** to track downtime and production metrics.
    - Improved data collection and reporting for more accurate analysis and decision-making.
6. **Increased Productivity and Efficiency**:
    - Higher **production output** due to reduced downtime and smoother operations.
    - Improved **on-time delivery rates** and customer satisfaction.
7. **Cost Savings**:
    - Significant **reduction in operational costs** associated with downtime, such as lost production time and emergency repairs.
    - Improved **return on investment (ROI)** from preventive maintenance and training programs.

How Success Will Be Measured (KPIs)

1. **Downtime Reduction**:
    - **KPI**: Total downtime duration (in minutes) per month.
    - **Target**: 20% reduction from the baseline of 1,023 minutes.
2. **Operator Performance**:
    - **KPI**: Number of operator-induced downtime incidents per month.
    - **Target**: 30% reduction in operator-related downtime incidents.
3. **Machine Reliability**:
    - **KPI**: Number of machine failures and adjustments per month.
    - **Target**: 25% reduction in machine-related downtime incidents.
4. **Inventory Management**:
    - **KPI**: Number of downtime incidents caused by inventory shortages per month.
    - **Target**: 25% reduction in inventory-related downtime incidents.
5. **Production Output**:
    - **KPI**: Total number of bottles produced per month.
    - **Target**: Increase production output by 15% due to reduced downtime.
6. **On-Time Delivery**:
    - **KPI**: Percentage of batches completed on time.
    - **Target**: Achieve a 95% on-time delivery rate.
7. **Cost Savings**:
    - **KPI**: Reduction in operational costs associated with downtime.
    - **Target**: Achieve a 20% reduction in downtime-related costs.
8. **Training Effectiveness**:
    - **KPI**: Number of training sessions completed and operator performance metrics.
    - **Target**: 100% of operators trained on new procedures within 3 months.
9. **Customer Satisfaction**:
    - **KPI**: Customer satisfaction scores and feedback.
    - **Target**: Improve customer satisfaction scores by 10%

Project Milestones

Here's a detailed breakdown of the **project milestones**:

Milestone 1: Data Collection and Preparation

Tasks:

1. **Identify Sources of Data**:
    - Gather extra data for production downtime using AI tools.
2. **Collect and Clean Data**:
    - Extract data from Excel files.
    - Clean the data by removing duplicates, handling missing values, and correcting inconsistencies.
    - Validate data accuracy by cross-referencing with operational records.
3. **Tools and Techniques Used**:
    - **Data Collection**: Microsoft Excel
    - **Data Cleaning**: Power Query (Excel).
    - **Data Validation**: Statistical tools as SQL to identify outliers and anomalies.
4. **Estimated Completion Date**:
   [one week from project start till 10/1/2025]

Milestone 2: Exploratory Data Analysis (EDA)

Tasks:

1. **Identify Patterns, Trends, and Anomalies**:
    - Analyze the data to uncover patterns in downtime causes, frequency, and duration.
    - Identify trends over time (e.g., specific days, shifts, or batches with higher downtime).
2. **Conduct Univariate, Bivariate, and Multivariate Analyses**:
    - **Univariate Analysis**: Examine individual variables (e.g., downtime duration, machine failures).
    - **Bivariate Analysis**: Explore relationships between two variables (e.g., downtime vs. operator errors).

- **Multivariate Analysis**: Analyze interactions between multiple variables (e.g., downtime, machine type, and operator experience).

3. **Generate Visualizations and Descriptive Statistics**:
   - Create visualizations (e.g., bar charts, scatter plots, heatmaps) to illustrate findings.
   - Calculate descriptive statistics (e.g., mean, median, standard deviation) for key metrics.
4. **Document Key Findings**:
   - Summarize insights from the EDA phase in a report or presentation.
5. **Tools and Techniques Used**:
   - SQL, Power BI, Tableau.
6. **Estimated Completion Date**:
   [till 17/1/2025]

Milestone 3: Model Development

Tasks:

1. **Build and Test Models**:
   - Develop predictive or diagnostic models to address research questions (e.g., predicting downtime revenue loss, identifying root causes).
   - Test models using historical data and validate their accuracy.

2. **Validation and Accuracy Metrics**:
   - We suggest to Use metrics like **Mean Absolute Error (MAE)**, **Root Mean Squared Error (RMSE)**, or **Accuracy Score** to evaluate model performance.
   - Perform cross-validation to ensure model robustness.
3. **Tools and Techniques Used**:
   - SQL, Power BI, Tableau.

4. **Estimated Completion Date**:
   [till 25/1/2025]

Milestone 4: Insights and Recommendations

Tasks:

1. **Translate Findings into Actionable Recommendations**:
    - Use insights from EDA and modeling to propose solutions (e.g., operator training, preventive maintenance, inventory improvements).
    - Prioritize recommendations based on impact and feasibility.
2. **Align Insights with Business Objectives**:
    - Ensure recommendations support key business goals (e.g., reducing costs, improving productivity, enhancing customer satisfaction).
3. **Prepare a Draft Report**:
    - Document findings, insights, and recommendations in a draft report.
    - Include visualizations, statistical summaries, and actionable steps.
4. **Tools and Techniques Used**:
    - Microsoft Word, Microsoft project sheets, SQL, PowerPoint, Tableau, Power BI.
5. **Estimated Completion Date**:
   [3/3/2025]

Milestone 5: Final Delivery

Tasks:

1. **Review and Finalize Project Deliverables**:
    - Review the draft report and incorporate feedback from stakeholders.
    - Finalize all deliverables, including the report, dashboards, technical report and presentations.
2. **Conduct Stakeholder Presentation**:
    - Present findings, insights, and recommendations to key stakeholders.
    - Use visual aids (e.g., slides, dashboards) to communicate effectively.
3. **Collect Feedback and Incorporate Changes**:
    - Gather feedback from stakeholders and make necessary adjustments to the report and recommendations.
    - Ensure all deliverables meet stakeholder expectations.

4. **Tools and Techniques Used**:
    - PowerPoint, Tableau, Power BI, Microsoft Teams (for presentations).
5. **Estimated Completion Date**:
   [29/3/2025]

Summary of Milestones

1. **Milestone 1: Data Collection and Preparation** – Gather and clean data for analysis.
2. **Milestone 2: Exploratory Data Analysis (EDA)** – Identify patterns, trends, and anomalies in the data.
3. **Milestone 3: Model Development (if applicable)** – Build and test models to address research questions.
4. **Milestone 4: Insights and Recommendations** – Translate findings into actionable recommendations.
5. **Milestone 5: Final Delivery** – Present and finalize project deliverables.

These milestones provide a clear roadmap for the project, ensuring that each phase is completed on time and delivers measurable results.

Setting Up Regular Monitoring of Control Charts for Continuous Improvement

To effectively monitor the production process and track improvements over time

we recommend a comprehensive approach to implement regular control chart monitoring:

1. Establish a Monitoring System

Automated Data Collection & Reporting

- **Integrate with existing systems**: Connect the Excel data to a BI tool (Power BI, Tableau) or database
- **Automated data feeds**: Set up scheduled imports from production systems to an analysis platform
- **Template dashboards**: Create reusable templates for your control charts that update with new data

2. Create a Monitoring Schedule

Frequency Guidelines

Chart Type	Monitoring Frequency	Responsible
Batch Time Efficiency	Daily (per shift)	Shift Supervisor
Production Output	Weekly	Production Manager
Downtime Analysis	Weekly	Maintenance Lead
Operator Performance	Bi-weekly	HR/Training Manager

Review Meetings

- **Daily**: Quick 15-min huddle to review critical deviations
- **Weekly**: Departmental meeting to analyze trends
- **Monthly**: Cross-functional review with action plans

3. Standardize the Process

Control Chart Maintenance Checklist

1. Verify data completeness for the period
2. Check for any new special causes
3. Update control limits if process improves
4. Document all out-of-control points
5. Assign investigation responsibilities
6. Archive previous period charts

4. Implement Continuous Improvement

PDCA Cycle Integration

Improvement Metrics Dashboard

Create a companion dashboard tracking:

- % Reduction in out-of-control points
- Downtime minute trends
- Production efficiency over time
- Operator error rates

5. Technology Implementation Options

Low-Tech Solution

- **Excel-based system**:
    - Power Query to auto-import data
    - PivotTables for summary stats
    - Conditional formatting for control limits
    - Shared network drive for access

6. Training & Documentation

Training Materials to Develop

1. Control chart interpretation guide

2. Deviation response protocol
3. Data entry standards
4. Escalation procedures

Sample Alert Response Protocol

1. **Identify**: Flag out-of-control point
2. **Classify**: Common or special cause?
3. **Investigate**: Root cause analysis
4. **Correct**: Immediate action
5. **Prevent**: Systemic solution
6. **Verify**: Confirm effectiveness

7. Continuous Refinement

Monthly Audit Checklist:

- Are control limits still appropriate?
- Are we capturing all relevant variables?
- Is the monitoring frequency effective?
- Are improvement actions producing results?
- Do operators understand the charts?

By implementing this structured approach, you'll transform your control charts from static reports into dynamic tools for continuous process improvement saving cost and increasing revenue .

Project Deliverables

The following are the **key deliverables** for the project, categorized into documentation, visualizations, presentations, data files, and other artifacts

1. **Documentation**:
    - Detailed project report include:
        - Executive Summary
        - Problem Statement
        - Methodology (data collection, cleaning, analysis)
        - Key Findings
        - Insights and Recommendations
        - Conclusion and Next Steps.
    - Technical documentation of scripts and workflows.
2. **Visualizations**:
    - Dashboards, charts, and infographics.
3. **Presentations**:
    - Slide deck and stakeholder presentation.
4. **Data Files**:
    - Processed datasets and analytical results.
5. **Other Artifacts**:
    - Documentation of assumptions, constraints, and additional resources.

These deliverables ensure that the project's findings, insights, and recommendations are effectively communicated to stakeholders and that all relevant data and resources are properly documented for future reference.

References

- Montgomery, D. C. (2020). *Introduction to Statistical Quality Control* (8th ed.). Wiley.

- PMI (2021). *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (7th ed.).

- All insights were derived from your provided Excel file
- Industry Standards ISO 13053: Quantitative methods in process improvement
- AI tools as: deep seek, perplexity

Attachments

- root cause analysis
- pareto chart
- RACI Model
- control charts
- technical report
- visualization report
  -Tableau dashboard
  -Power BI dashboard
- PowerPoint presentation