**Supplier Quality Analysis Report**

**1. Executive Summary**

The report provides a critical analysis of supplier performance regarding defect quantities, downtime, and quality improvement opportunities. Basically, the report aims at improving quality manufacturing by identifying key causes of downtime and defects, along with vendors and material performance.

**Key Findings:**

-The average quantity of defects per period is 9166. More than 54 million defects were recorded in total.

-Different processes contribute to total downtime, amounting to 138,251 minutes, in which logistics contributes the most: 55,849 minutes.

-The top three vendors contributing to downtime are **Reddot** with 26,185 minutes, **Sanlab** with 10,275 minutes, and **Plustax** with 10,270 minutes.

-The highest number of minutes of downtime from corrugated materials amounts to 52,726 minutes.

**Recommendations:**

-Ingress quality control of raw material and better vendor relationships.

-Periodic audit of high defect vendors like **Solholdings** and **Plustax** is necessary to reduce recurring quality issues.

-Target high-impact defect categories, such as Mechanical and Packaging, for major reduction in defects and improvement in quality.

**2. Introduction**

The objective of this analytics case study is to analyze defect rates and its related downtime for several suppliers, various material types, and different plants with a view to help maximize supplier performance, reduce defects, and minimize operational downtimes.

**Problem Statement:**

The high level of defects and downtime realized in production, accompanied by inefficiency and quality issues, is the main problem. The project aims at identifying areas that are crucial for improvement.

**Data Sources:**

Analysis will be based on data obtained from various reports on vendors, defects, and performance from plants, with key emphasis on defect types, contributions by vendors, downtime, and material characteristics.

**3. Data Exploration**

**Data Sources:**

Information in the dataset refers to many suppliers, several plants, and categories of defects. The data were preprocessed: removing missing values and dropping columns related to vendor IDs, material IDs, and defect IDs to make the data clearer.

**Main Characteristics:**

- Dimension: the dataset is a table of 5950 rows; each row represents a record of defect quantity, downtime of plant, and vendor performance.

- Data Types: The dataset contains date fields, categorical variables such as vendor and material type, and numerical fields like defect quantity and time losses in minutes.

**Preprocessing Steps:**

- Handling missing values and removal of irrelevant fields.

- Derived-time-related fields (month, year) were created in order to enable the possibility of time-based analysis.

**4. Data Analysis**

**Summary of Findings**

**1. Downtime Analysis:**

- Logistics and Mechanical Issues will lead in contributing minutes to the causes of downtime, with 55,849 minutes and 34,208 minutes, respectively, while the top vendors will be Reddot and Plustax.

- The corrugated material type contributed to 52,726 minutes of downtime, followed by raw materials with 23,568 minutes.

**2. Defect Analysis**

- Major defects are categorised as Impact, No Impact, and Rejected, with Impact defects leading in contributing to an average of 54.75 minutes of downtime.

The highest defect contributing vendors are pointed out as Solholdings and Plustax, with defect quantities of over 4 million and 3.8 million defects, respectively.

**3. Vender Performance:**

Top 10 vendors on defect quantity contribution comprise the lion's share in defect contribution, with Solholdings and Plustax leading the lot in defect contribution.

**4. Material Type Contribution:**

Raw materials produced the largest numbers of defects with over 13 million defects, followed by Labels and Cartons.

**5. Insights and Recommendations**

**Key Insights:**

-The primary sources of defects are related to mechanical and packaging issues, which together are responsible for more than 60% of all defects.

-The high-impact defects-misaligned components and improper assembly-contribute to high quality concern.

-Defects from a few vendors always weigh heavier, highlighting the need for increasing quality control on vendor contributions.

**Recommendations:**

**1. Improvement in Quality Control:**

- Stringent quality checks are highly necessary for mechanical and packaging processes.

**2. Vendor Audits**

- Quarterly review to be conducted with heavy-defect contributing vendors like Solholdings and Plustax for a reduction of 20% in their defect contribution.

**3. Preventive Maintenance:**

- Predictive maintenance is also to be instituted on machinery so that mechanical failures and consequent lines stoppages or down times are at a minimum.

**4. Material Handling Improvements:**

- Key areas of material handling are raw materials, labels and films, which generally bear high defect rates.

**5. Real Time Monitoring:**

- Create a real-time monitoring dashboard for defects and downtime to enable timely interference.

**6. Limitations and Future Work Limitations:**

**Limitations:**

-The analysis focuses on historical data and does not bring in real operational conditions which could influence defect rates and downtime.

- vendor performance metrics can be refined further by incorporating cost and delivery time data to get a comprehensive overview of the performance.

**Future Work:**

-The future defect rate and its linkage with operational variables, such as machine maintenance schedules and employees' ability, may be considered for further analyses.

-Real-time defect tracking may further reduce defect rates through quicker responses to emerging issues.

**7. Conclusion**

This analysis identifies ample opportunities to strengthen quality control, reduce downtime, and improve supplier performance. By addressing high-impact areas in mechanicals and packaging, looking at ways to develop close vendor relationships, defect rates can be reduced by up to 20%, along with significant operational savings. Real-time monitoring systems are necessary to sustain continuous improvements with immediate rectification of quality-related issues.

# **Recommendations Based on Correlation**

## **1. Correlate Defect Quantity and Downtime for Key Material Types**

* **Observation**: The Scatter Matrix reveals that some materials (e.g., Controllers, Electrolytes) have high defect quantities (up to 500k units) correlated with significant downtime.
* **Action**:
  + Prioritize improvements in handling and processing materials with the highest defect-downtime correlation.
  + Implement additional inspections for Controllers and Electrolytes before and during production.
  + Schedule more frequent preventive maintenance on equipment used for these materials to reduce downtime.
* **Expected Impact**: Reducing downtime for these critical materials could result in a 15-20% decrease in associated defect quantities.

## **2. Address Low Correlation Between Defect Qty and Downtime**

* **Observation**: The Heatmap of Correlation between Defect Qty and Downtime indicates a weak correlation of 0.0739, suggesting that defects may not be solely causing downtime.
* **Action**:
  + Separate downtime issues from defect sources.
  + Identify non-defect-related causes of downtime, such as equipment failure, staffing issues, or supply chain delays.
  + Implement separate KPIs for downtime and defect rates to monitor and improve them independently.
* **Expected Impact**: By distinguishing between downtime causes, an estimated 10% improvement in overall operational efficiency can be achieved.

## **3. Plant-Specific Strategies to Improve Quality**

* **Observation**: The Facet Grid by Plant State shows variability in defect quantities and downtime across states. OH and IL exhibit higher defect quantities (up to 400k units).
* **Action**:
  + Tailor quality control measures to each plant state.
  + For plants in OH, increase quality checks on materials like Electrolytes and Controllers.
  + In IL, implement stricter adherence to operational procedures and machinery maintenance to decrease downtime.
* **Expected Impact**: A targeted improvement program can lead to a 20% reduction in defects in OH and IL, saving around 80k units per plant.

## **4. Improve Quality Control During High Defect Months**

* **Observation**: The Heatmap of Defect Quantities by Month and Year indicates that May-June 2014 has the highest defect quantities, with over 14M units.
* **Action**:
  + Enhance quality checks and staff training leading up to high defect periods.
  + Conduct pre-season quality control drills and equipment maintenance in April to prepare for the spike in May-June.
  + Increase staff training focused on defect identification and handling.
* **Expected Impact**: Preventive actions before high-defect months can reduce defect quantities by 20% in peak periods, saving up to 2.8M units.

## **5. Address Defect Quantity Outliers in Each Quarter**

* **Observation**: The Box Plot of Defect Quantities by Quarter shows outliers above 400k units, especially in the second and third quarters.
* **Action**:
  + Target root causes for outliers.
  + Investigate specific batches or product lines that contribute to these outliers.
  + Increase supervision during production peaks in Q2 and Q3.
* **Expected Impact**: Reducing these outliers by 50% could save around 200k-250k defect units per quarter.

## **6. Improve Processing of Critical Material Types**

* **Observation**: The scatter plots indicate Raw Materials, Controllers, and Cartons have the highest defect quantities combined with downtime.
* **Action**:
  + Implement special handling and processing improvements for these materials.
  + For Raw Materials, establish temperature and moisture-controlled storage areas.
  + Introduce automated quality checks for Cartons.
* **Expected Impact**: Improved processing of these materials can lead to a 15% reduction in defects, saving approximately 1.5M defect units annually.

## **7. Leverage Heatmap Insights to Improve Seasonal Defect Management**

* **Observation**: The heatmap shows an increasing trend in defect quantities in 2014 compared to 2013, particularly in the middle months.
* **Action**:
  + Align production schedules to balance workloads and avoid spikes in defect rates.
  + Implement flexible workforce planning, adding shifts in high-defect months.
  + Use historical data to anticipate high-defect periods.
* **Expected Impact**: Balanced production across seasons can reduce defect quantities by 10-12%.

## **8. Improve Multi-Material Production Efficiency**

* **Observation**: The scatter matrix and facet grid reveal that mixed material types processed together (e.g., Film, Corrugate, Electrolytes) contribute to increased downtime and defect quantities.
* **Action**:
  + Streamline production lines for specific material types.
  + Designate separate lines for high-risk materials like Electrolytes and Films.
  + Train staff to specialize in handling one type of material.
* **Expected Impact**: By reducing mixed-material defects, an estimated 20% improvement in overall defect quantities can be achieved.

## **9. Enhance Early Detection of Defects to Reduce Overall Quantity**

* **Observation**: The Box Plot of Defect Quantities reveals a wide spread of defect values, indicating variability in quality detection.
* **Action**:
  + Implement early detection systems and quality feedback loops.
  + Use real-time defect monitoring systems with AI-based image recognition.
  + Implement employee feedback systems for reporting defects.
* **Expected Impact**: Early detection can reduce total defect quantities by around 25%.

## **10. Utilize Correlation Insights for Process Improvement**

* **Observation**: Although the correlation between Defect Qty and Downtime is low, specific material types (e.g., Molds, Batteries) show local patterns.
* **Action**:
  + Apply Six Sigma or Lean Manufacturing principles to these material types.
  + Use process mapping and value stream analysis.
  + Encourage cross-functional teams for continuous improvements.
* **Expected Impact**: Streamlined processes could lead to a 15% reduction in downtime-related defects.

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# **Recommendations for Defect Reduction Based on Trends**

## **1. Address Daily Spikes in Defect Quantity**

* **Observation**: The Daily Defect Quantity Over Time line chart reveals several spikes exceeding 800k units, especially in March 2013, July 2013, January 2014, and July 2014.
* **Action**:
  + Investigate these daily spikes.
  + Identify specific products, batches, or operations occurring on these high-defect days.
  + Introduce real-time monitoring systems to detect when defects exceed a threshold (e.g., 500k units) and trigger immediate corrective actions.
* **Expected Impact**: A reduction in daily spikes can decrease the total defect quantities by at least 10-15% during peak days, preventing 80-120k defective units.

## **2. Optimize Quality Control During High Defect Months**

* **Observation**: The Monthly Defect Quantity Over Time chart shows peaks in April, July, and October 2014, with quantities reaching 5M units.
* **Action**:
  + Implement increased quality assurance efforts before high-defect months.
  + Conduct pre-month inspections and heightened quality checks in March, June, and September to prepare for upcoming peaks.
  + Use historical data to anticipate defect trends and increase workforce capacity accordingly.
* **Expected Impact**: Reducing defect quantities during high-defect months by 20% could save approximately 500k-1M units.

## **3. Act on the Increasing Trend of Defect Quantities Over Time**

* **Observation**: The Monthly Defect Quantity with Trend Line chart indicates an upward trend in defect quantities over 2013 and 2014.
* **Action**:
  + Implement a continuous improvement cycle to counter the rising trend.
  + Regularly analyze the trendline data and perform root cause analysis to understand why defects are rising.
  + Deploy Lean Manufacturing practices to improve efficiency, reduce waste, and maintain consistent quality.
* **Expected Impact**: A proactive response to the increasing trend can stabilize and potentially reverse the rise in defects, aiming for a 10% overall reduction year-over-year.

## **4. Compare Seasonal Trends Year Over Year**

* **Observation**: The Monthly Defect Quantity Over Time (Yearly Comparison) chart shows an increase in defects for almost every month in 2014 compared to 2013. Notably, September and October 2014 defects are 2M units higher than the same months in 2013.
* **Action**:
  + Investigate the root causes of increased defect quantities in 2014.
  + Review operational changes, staffing, supply chain issues, and any new processes introduced in 2014.
  + Implement changes based on findings to improve defect quantities in 2015 and beyond.
* **Expected Impact**: Stabilizing the defect rates by implementing these changes can save at least 1-2M units in the affected months.

## **5. Optimize Downtime to Control Defects**

* **Observation**: The Monthly Downtime Over Time chart highlights that October 2014 experienced a significant increase in downtime (over 10k minutes).
* **Action**:
  + Reduce equipment downtime through scheduled maintenance.
  + Align downtime maintenance schedules with low-production months or non-peak times.
  + Implement predictive maintenance using equipment data to preemptively address potential breakdowns.
* **Expected Impact**: Reducing downtime by 30% in peak months can significantly improve defect-related productivity and save around 200k units in defective output due to equipment failure.

## **6. Monitor Monthly Patterns for Specific Improvement Opportunities**

* **Observation**: Both June and October show consistent spikes in defect quantities across both years.
* **Action**:
  + Implement process improvements focused on these specific months.
  + Increase quality control checks and workforce training sessions in May and September to prepare for upcoming defect peaks.
  + Introduce incremental process changes to gradually reduce defect spikes.
* **Expected Impact**: By reducing spikes in defect quantities by 15-20% in these months, the company can see a reduction of around 300k-500k units annually.

## **7. Conduct Daily Monitoring for High-Risk Production Days**

* **Observation**: High daily fluctuations in defects (up to 800k units) can cause resource strain and impact production schedules.
* **Action**:
  + Introduce a daily monitoring and alert system.
  + Use a defect monitoring dashboard that flags days with defects exceeding 500k units for rapid response.
  + Establish a rapid response team to address high-defect days by adjusting production, halting processes, and conducting immediate inspections.
* **Expected Impact**: Rapid responses to daily defect spikes can reduce overall defect quantities by 5-10%, potentially saving around 200k units annually.

## **8. Improve Cross-Year Defect Management**

* **Observation**: The Yearly Comparison shows that defects consistently increased in the latter half of each year, particularly in Q3 and Q4.
* **Action**:
  + Implement cross-year process reviews to understand why defects increase.
  + Compare production, operational, and quality data across Q3 and Q4 for multiple years.
  + Establish preventive measures, such as higher staffing levels or focused quality training, to mitigate increasing defects in these quarters.
* **Expected Impact**: A consistent year-over-year strategy can prevent seasonal defect increases, leading to a 15% decrease in end-of-year defects.