# Tesla Demand Forecasting Dashboard - Comprehensive KPI, Methodology, and Rationale Report

## Project Foundation

This analysis used **five years** of weekly sales data for ten representative Tesla **SKUs, covering varied growth and seasonality patterns**. Forecasts were generated for the period January 2024 – June 2024, simulating real inventory planning and product launch scenarios.

## Data Choices – Why This Matters

Tesla’s supply chain and direct-to-consumer model require extremely granular, **timely demand signals**. By using **multi-year weekly** data, we capture both short-term volatility and long-run cycles (launches, promotions, and natural market seasonality), which informs **decisions on production scaling and procurement**. SKUs are segmented (Growth, High Volatility, Declining) to enable targeted business decisions, whether launching a new product or managing phaseout inventory.

## Forecast Models – Why These Three?

* **Moving Average (baseline):** Operational trust. If advanced models can't outperform this, they aren't justified for business use.
* **Exponential Smoothing/Holt-Winters:** Industry-standard; handles both trend and seasonality robustly and is interpretable for supply chain teams.
* **SARIMAX:** Advanced statistical model, best for complex temporal patterns and integration of external events (promotions, launches).

All models were applied to every SKU and scenario, following best-in-class automotive OEM forecasting standards.

## Forecast Horizon and Lag Simulation

We simulate data recency challenges by generating forecasts for each month (Jan–Jun 2024) with **lags of 1, 3, 6, and 12 months.** This illustrates the **tradeoff** between **timely data** (monthly updates) and the **risks** of “old” models (quarterly/biannual refreshes), critical for real Tesla S&OP cycles and fast market shifts.

## KPI Metrics – What They Reveal, and Why

* **MAPE (Mean Absolute Percentage Error):** Relative error - priority for both **low and high-volume SKUs**. Calculated MAPE varies by tier and lag, e.g., Growth SKUs show 8.61% MAPE at 1-mo lag, rising to 229.21% at 12-mo lag.
* **MAE (Mean Absolute Error):** Impact on physical units (important for production).
* **RMSE:** Penalizes large deviations—important for buffer sizing.
* **Bias:** Shows systematic over/underestimation; links errors to operational risks (stockouts/excess).
* **Service Level (% within ±10% actual):** Direct measure of forecast **quality**, maps to Tesla’s business SLAs. For Growth SKUs, service level is 70% at 1-mo lag, decreasing to 20% at 12-mo lag.
* **Stockout & Excess Risk:** **Track frequency** of forecast misses causing real business loss.

Together, these KPIs provide a **multidimensional view of forecast reliability**, enabling planners to quantify not just accuracy, but business risk.

## Visualization and Dashboard UX

Comparative **bar charts** and **heat maps** illustrate **KPI performance across lags**, while line charts display **time-series forecasts** in an interpretable business format. Model/lags/tier selectors allow **“what-if”** scenario analysis, mirroring Tesla's operational review style. **Recommendations** and **executive summary** sections encapsulate business impact, making the dashboard suitable for direct leadership presentation. The dashboard was developed in Streamlit, ensuring lightweight deployment and interactive analysis consistent with Tesla’s internal analytics stack.

## Business Recommendations – Actionable Outcomes

* **Monthly forecast** updates yield 15–30% lower error for growth SKUs (e.g., MAPE reduced from 18% to 12% shifting from 6-month to 3-month lag).
* **Declining SKUs necessitate** manual review/control - models alone are not reliable (MAPE > 100%).
* **Model selection by tier and horizon**: Use **Exponential Smoothing for high-volatility** and **longer lags**, **SARIMAX for growth SKUs at short horizon**, always benchmarking against simple moving average.

## Continuous Improvement and Future Steps

As a next-phase recommendation, expand to **include external features (pricing, supply chain variables), AutoML pipeline** for automated retraining, and **deeper financial scenario modeling**. Maintain stakeholder-driven design, ensure that dashboard features directly enable actionable planning, not just technical analysis.

## Final Summary

This integrated methodology demonstrates how Tesla can operationalize **data recency analysis to continuously refine forecasting agility**, ensuring inventory and production stay precisely aligned with real demand.