**Phased Roadmap to a 10/10 Production‑Ready Dashboard System**

This plan addresses **every critique**, including data persistence, configurable intervals, dark mode, annotation exports, baselines, and SPC. It remains clear, concise, and achievable.

**Phase 1: Stabilize & Harden**

1. **Data Connectivity & Persistence**
   * Migrate polling → WebSocket streams with fallback polling/backoff.
   * **Support dual data sources**: integrate live data adapters (e.g. Inductive Automation Ignition OPC-UA connector) alongside Prisma/PostgreSQL historical queries.
   * **Explicit Ignition OPC-UA adapter testing**: implement and unit-test the OPC-UA connector, and include a fallback to historical data if the live service is unavailable.
   * **Abstract data access layer** so widgets consume a unified API that can pull from live streams, historical store, or both.
   * **Persist streams** into a time‑series store (InfluxDB or existing DB). Implement POST /api/history?range= to backfill charts on load.
2. **Configurable Update Intervals**
   * UI control for refresh cadence (1s, 5s, 30s, off).
   * Persist user preference in local storage and via PUT /api/user/settings for cross-device consistency.
   * Ensure server API validates and stores interval settings for each user.
   * UI control for refresh cadence (1s, 5s, 30s, off). Persist user choice in local storage.
3. **Error & Loading States**
   * Skeleton loaders for all charts.
   * Contextual error messages and retry controls per widget.
4. **Responsive & Mobile Optimization**
   * Add breakpoints for cards/charts. Verify on major device sizes.
5. **Security & Health**
   * JWT auth, rate limiting (100 req/min). Audit log every view/filter change.
   * Expose /health and /metrics; alert on failures.

**Phase 2: Feature Completion**

**Drill‑Down & Context**

* + Click‑through from summary charts → detailed view with raw logs and history.
  + Time‑range presets (Shift, Day, Week) plus custom range selection.
  + Overlay **historical baselines** and **shift targets** (configurable via small admin UI).

1. **Export & Annotation**
   * CSV/PDF export that includes user annotations and event markers for compliance reports.
   * Annotation system: users pin notes on time-series; store in DB and render.
2. **UI Enhancements**
   * Dark mode toggle and matching styles.
   * Threshold configuration: per-metric alert thresholds in UI that drive server alerts.
3. **Data Architecture**
   * Add DB indexes on timestamp, equipment\_id; retention policy to purge >90 days.
   * Implement an **adapter layer** to merge and synchronize live data from services like Ignition with historical records in Postgres.
   * **Cache combined live/historical queries** using Redis with configurable TTL to prevent repeated heavy database reads under high-frequency use.
   * Aggregated endpoint /api/metrics/summary?interval= for 5 m‑granularity over combined live/historical data.
   * Pagination (limit/offset) and field selection (fields=) for list APIs.

**Phase 3: UX Refinement & Scalability**

**Component Polishing**

* + Interactive charts: hover tooltips, click to filter, consistent auto-scaling.
  + Lazy-load offscreen tabs; memoize computations; minimize re-renders.
  + **Performance benchmarks**: measure end-to-end latency for combined live/historical data queries under expected load (e.g., 1000 metrics/sec).
  + **Benchmark targets**: define p95/p99 latency goals (<200 ms p95), throughput capacity (1000 metrics/sec), and error rate thresholds (<0.1%).

1. **Manufacturing-Specific Dashboards**
   * **Manufacturing Overview**: OEE gauge + trend + anomaly markers.
   * **Equipment Health**: heatmap of temp/vibration; sort/filter by severity.
   * **Production Analytics**: shift comparisons, cycle-time distributions.
   * **Quality & KPIs**: defect rate, cost/unit, fulfillment %.
2. **User Personalization**
   * Favorites & Recents: bookmark dashboards; show last visited.
   * Dashboard Builder MVP: drag-drop panels and save layouts.

**Phase 4: Advanced Insights & Automation Statistical Process Control (SPC)**

* + Integrate an SPC engine (X‑bar/R charts) to compute control limits and flag violations.

1. **Predictive Analytics & Anomaly Detection**
   * Forecast OEE with ARIMA or simple ML; surface anomaly cards with root‑cause pointers.
2. **Native Mobile & Voice**
   * React Native wrapper for key dashboards.
   * Prototype voice queries for common insights.
3. **CI/CD & Testing**
   * Vitest unit tests: 100% coverage on UI and services.
   * Playwright E2E: smoke tests for each dashboard, including toggling between live and historical data modes in deployed environments.
   * Performance budgets: Lighthouse & custom load tests.
   * GitHub Actions:
     + build → lint → test → smoke-test live/historical toggle against staging → deploy to staging/production (blue/green).
     + **Deployment smoke test**: post-deploy script that programmatically toggles data source (live ↔ historical) via API and validates chart updates within <5s.
   * Monitor CI health: alert on failed smoke tests in any environment.

**Success Metrics**

* **Phase 1**: No lost historical data; users select interval; <2 s first render.
* **Phase 2**: ≥90% export usage; annotations in 100% of compliance reports; dark mode usage ≥30%.
* **Phase 3**: Dashboard builder adoption ≥50%; mobile user retention ≥20%.
* **Data Source Failover**: Live data failure detection and automatic switchover to historical mode within 5 s in 95% of cases.
* **Live vs Historical Failover**: Detect live data service outage and switch to historical mode automatically within 5 s in 95% of cases.

This roadmap now **fully covers** all critical issues and missing features—delivering a robust, user‑centric, manufacturing‑specific dashboard system at a 10/10 production readiness level.