PRD: Modul Laporan & Analitik - Analisis Prestasi & KPI

Kod PRD: KLINIK-Laporan-PR2026-01-analisis-prestasi-kpi **Modul:** Laporan & Analitik **Submodul:** Analisis Prestasi **Tarikh Dicipta:** 2026-01-13 **Versi:** 1.0 **Pemilik Produk:** Pemilik Klinik **Stakeholder:** Pemilik Klinik, Pengurus Klinik, Department Heads

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1. Ringkasan Eksekutif

1.1 Objektif

Sistem Laporan & Analitik bertujuan untuk menyediakan platform Business Intelligence (BI) yang komprehensif bagi Poliklinik Al-Huda dengan dashboard interaktif, KPI tracking, data warehouse, custom report builder, dan predictive analytics untuk membolehkan pengurusan membuat keputusan berdasarkan data yang tepat dan konsisten.

1.2 Skop

- Multi-level dashboard (Executive, Operational, Department)
- Comprehensive KPI tracking (Financial, Clinical, Operational, Customer, Compliance)
- Star schema data warehouse dengan ETL jobs
- Rich data visualizations (charts, heat maps, gauges)
- Multiple report types (Daily, Weekly, Monthly, Quarterly, Annual, Ad-hoc)
- Custom report builder dengan drag-and-drop
- Period comparison dan benchmarking
- Alert system bila KPI below target
- Role-based access control
- Export to PDF, Excel, CSV
- Scheduled auto-email reports
- Mobile-responsive dashboard
- Basic predictive analytics (forecasting)
- Data governance framework
- API-ready untuk external BI tools

1.3 Out of Scope

- Advanced machine learning models (Fasa 2)
- Real-time streaming analytics
- Multi-branch comparison (single clinic focus)
- Integration dengan external accounting software
- Natural language query (ask questions in plain text)

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2. Pernyataan Masalah

2.1 Masalah Semasa

1. **Data tidak konsisten:** Data tersebar di pelbagai modul tanpa standardization, menyebabkan laporan berbeza-beza hasilnya
2. **Tiada single source of truth:** Pengurus perlu compile data manual dari berbagai sistem untuk laporan
3. **Reporting lambat:** Laporan bulanan ambil masa berhari-hari untuk siapkan secara manual
4. **Tiada real-time visibility:** Pengurusan tidak tahu prestasi semasa klinik sehingga end of month
5. **Tiada KPI tracking formal:** Tiada benchmark untuk measure prestasi klinik
6. **Data quality issues:** Missing data, duplicate entries, inconsistent formats
7. **Limited analysis capability:** Hanya basic Excel analysis, tiada advanced visualization atau predictive

2.2 Impak

- Keputusan perniagaan dibuat berdasarkan incomplete atau outdated data
- Missed opportunities untuk improve operations
- Staff spend hours compiling reports manually

- Cannot identify trends atau issues early
- Difficult to set dan track performance targets
- Compliance reporting makan masa

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3. User Stories

3.1 User Stories Utama

1. **Sebagai Pemilik Klinik**, **saya mahu** melihat executive dashboard dengan KPI utama (revenue, patient volume, collection rate) **supaya** saya tahu prestasi klinik pada bila-bila masa **bila** saya login ke sistem **saya sepatutnya** nampak overview semua metrics penting dalam satu halaman

2. **Sebagai Pemilik Klinik**, **saya mahu** membandingkan prestasi bulan ini dengan bulan lepas dan tahun lepas **supaya** saya tahu sama ada klinik berkembang atau tidak **bila** saya view monthly report **saya sepatutnya** nampak comparison charts dan percentage change

3. **Sebagai Pengurus Klinik**, **saya mahu** menerima alert bila KPI jatuh di bawah target **supaya** saya boleh ambil tindakan segera **bila** collection rate < 80% atau wait time > 30 minit **saya sepatutnya** terima email/SMS notification

4. **Sebagai Pengurus Klinik**, **saya mahu** melihat operational dashboard dengan real-time data **supaya** saya boleh monitor operasi harian **bila** saya buka dashboard **saya sepatutnya** nampak today's patient count, queue status, revenue so far

5. **Sebagai Pengurus Klinik**, **saya mahu** schedule laporan mingguan untuk auto-email kepada management **supaya** saya tidak perlu manually generate dan send setiap minggu **bila** saya setup scheduled report **saya sepatutnya** boleh pilih recipients, frequency, dan format

6. **Sebagai Pengurus Klinik**, **saya mahu** drill-down dari summary ke detail **supaya** saya boleh investigate issues **bila** saya klik pada metric yang tinggi/rendah **saya sepatutnya** dapat lihat breakdown dan detail records

7. **Sebagai Department Head (Farmasi)**, **saya mahu** melihat pharmacy-specific dashboard **supaya** saya fokus pada KPIs yang relevan dengan department saya **bila** saya login **saya sepatutnya** nampak dispensing volume, stock levels, expiry alerts, top drugs

8. **Sebagai Pengurus Klinik**, **saya mahu** buat custom report dengan memilih metrics dan dimensions **supaya** saya boleh analyse data mengikut keperluan spesifik **bila** saya guna report builder **saya sepatutnya** boleh drag-and-drop fields, apply filters, dan save template

9. **Sebagai Pemilik Klinik**, **saya mahu** melihat revenue forecast untuk bulan hadapan **supaya** saya boleh plan cash flow dan resources **bila** saya view predictive analytics **saya sepatutnya** nampak projected revenue based on historical trends

10. **Sebagai Pengurus Klinik**, **saya mahu** export laporan ke PDF dan Excel **supaya** saya boleh share dengan stakeholders yang tidak ada system access **bila** saya generate report **saya sepatutnya** boleh download dalam format pilihan saya

11. **Sebagai Pemilik Klinik**, **saya mahu** view dashboard di mobile phone **supaya** saya boleh monitor klinik walaupun tidak di office **bila** saya buka dashboard di phone **saya sepatutnya** nampak responsive layout dengan key metrics

12. **Sebagai Pengurus Klinik**, **saya mahu** melihat data quality score **supaya** saya tahu sama ada data boleh dipercayai **bila** saya view any report **saya sepatutnya** nampak data completeness indicator dan any data quality issues

3.2 Edge Cases

1. **Sebagai Pengurus Klinik**, **saya mahu** filter reports by date range, doctor, department **supaya** saya boleh analyse specific segments **bila** saya apply filters **saya sepatutnya** results update real-time

2. **Sebagai Pemilik Klinik**, **saya mahu** share dashboard link dengan board members **supaya** mereka boleh view tanpa login **bila** saya generate shareable link **saya sepatutnya** dapat link dengan expiry date dan view-only access

3. **Sebagai Pengurus Klinik**, **saya mahu** restore deleted atau modified report templates **supaya** saya tidak hilang kerja **bila** ada versioning **saya sepatutnya** boleh revert to previous version

4. **Sebagai Admin**, **saya mahu** melihat audit trail siapa yang access apa reports **supaya** saya boleh ensure data security **bila** saya check audit log **saya sepatutnya** nampak user, report, timestamp, action
5. **Sebagai Pengurus Klinik**, **saya mahu** compare doctor performance side-by-side **supaya** saya boleh identify best practices dan areas for improvement **bila** saya select multiple doctors **saya sepatutnya** nampak comparison table dan charts

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4. Keperluan Fungsian

4.1 Dashboard Framework

FR-1: Sistem mesti support multi-level dashboards:

Dashboard Type	Target User	Refresh Rate	Key Metrics
Executive Dashboard	Pemilik Klinik	Daily	Revenue, Patient Volume, Collection Rate, NPS
Operational Dashboard	Pengurus	Hourly/Real-time	Today's stats, Queue status, Staff attendance
EMR Dashboard	Clinical Lead	Daily	Consultations, Diagnosis patterns, Doctor performance
Farmasi Dashboard	Pharmacy Head	Hourly	Dispensing, Stock levels, Expiry, Top drugs
Billing Dashboard	Finance Lead	Hourly	Revenue, Outstanding, Payment methods, Panel claims
Queue Dashboard	Operations	Real-time	Wait time, Throughput, No-show rate

FR-2: Dashboard components mesti support:

- Widget-based layout (drag to rearrange)
- Fullscreen mode per widget
- Refresh button per widget
- Date range selector (global)
- Export widget as image/PDF
- Drill-down on click

4.2 KPI Management

FR-3: Sistem mesti track KPIs across categories:

Financial KPIs:

KPI	Formula	Target	Alert Threshold
Daily Revenue	Sum of paid invoices	RM5,000/day	< RM3,000
Monthly Revenue	Sum of monthly revenue	RM150,000/month	< RM120,000
Collection Rate	Collected / Billed × 100	≥ 90%	< 80%
AR Aging (>30 days)	Outstanding > 30 days	< 10% of total AR	> 15%
Average Bill Size	Total Revenue / Patient Count	RM80	< RM60
Panel Claim Success Rate	Approved / Submitted × 100	≥ 95%	< 90%

Clinical KPIs:

KPI	Formula	Target	Alert Threshold
Daily Patient Volume	Count of unique patients	80-100/day	< 50

Average Consultation Time	Total time / Consultations	10-15 min	> 20 min
Doctor Utilization	Consultation time / Available time	70-80%	< 60%
Return Visit Rate	Return visits / Total visits	30-40%	< 20%
Prescription Rate	Visits with Rx / Total visits	80-90%	Benchmark only

Operational KPIs:

KPI	Formula	Target	Alert Threshold
Average Wait Time	Total wait / Patients served	< 15 min	> 30 min
Queue Efficiency	Served / Generated × 100	≥ 95%	< 90%
No-Show Rate	No-shows / Appointments × 100	< 10%	> 15%
Dispensing Time	Pharmacy queue wait	< 10 min	> 15 min
Staff Productivity	Patients served / Staff	Benchmark	Varies

Customer KPIs:

KPI	Formula	Target	Alert Threshold
Patient Satisfaction	Survey average	≥ 4.0/5.0	< 3.5
Net Promoter Score (NPS)	Promoters - Detractors	≥ 50	< 30
Patient Retention Rate	Returning patients / Total	≥ 60%	< 50%
Complaint Rate	Complaints / Visits × 100	< 1%	> 2%

Compliance KPIs:

KPI	Formula	Target	Alert Threshold
Panel SLA Compliance	Claims within SLA / Total	≥ 90%	< 85%
Audit Completion	Completed audits / Required	100%	< 100%
PDPA Consent Rate	With consent / Total patients	≥ 99%	< 95%
Data Completeness	Complete records / Total	≥ 98%	< 95%

FR-4: KPI configuration mesti allow:

- Set target values per KPI
- Set alert thresholds (warning, critical)
- Define calculation formula
- Set comparison period (vs last month, vs last year)
- Enable/disable alerts

4.3 Data Warehouse

FR-5: Implement star schema data warehouse:

Fact Tables:

- `fact_visits` - Patient visits with measures (revenue, wait time, service time)
- `fact_sales` - Invoice line items with amounts

- `fact_payments` - Payment transactions
- `fact_dispensing` - Pharmacy dispensing records
- `fact_claims` - Panel claims with status
- `fact_queue` - Queue tickets with times

Dimension Tables:

- `dim_date` - Date hierarchy (day, week, month, quarter, year)
- `dim_time` - Time of day (hour, AM/PM, shift)
- `dim_patient` - Patient demographics (age group, gender, type)
- `dim_doctor` - Doctor attributes
- `dim_service` - Service categories
- `dim_payment_method` - Payment types
- `dim_panel` - Insurance panels
- `dim_drug` - Drug categories

FR-6: ETL (Extract, Transform, Load) jobs:

- Nightly batch ETL for historical data
- Hourly incremental updates for recent data
- Real-time sync for critical metrics
- Data transformation dan cleansing rules
- Error logging dan retry mechanism

FR-7: Separate reporting database:

- Read replica atau separate DB instance
- No impact to production database
- Optimized for analytical queries (indexes, aggregations)

4.4 Report Types

FR-8: Pre-defined report templates:

Daily Reports:

- Daily Summary Report (revenue, patients, highlights)
- Daily Cash Report (payments by method)
- Daily Queue Report (wait times, no-shows)

Weekly Reports:

- Weekly Performance Summary
- Weekly Doctor Performance
- Weekly Pharmacy Report (top drugs, stock alerts)

Monthly Reports:

- Monthly Executive Summary
- Monthly Financial Report (P&L summary)
- Monthly Clinical Report (patient demographics, diagnoses)
- Monthly Panel Claims Report
- Monthly Staff Performance

Quarterly Reports:

- Quarterly Business Review
- Quarterly Trend Analysis
- Quarterly Compliance Report

Annual Reports:

- Annual Performance Report
- Year-over-Year Comparison
- Annual Financial Summary

FR-9: Report features:

- Date range selection
- Multiple filters (doctor, department, panel, patient type)
- Grouping options (by day, week, month)
- Sorting options
- Subtotals and grand totals
- Charts embedded in reports

4.5 Data Visualization

FR-10: Sistem mesti support visualization types:

Chart Type	Use Case	Example
Line Chart	Trends over time	Revenue trend, Patient volume trend
Bar Chart	Category comparison	Revenue by doctor, Patients by day of week
Stacked Bar	Composition	Revenue breakdown by service type
Pie/Donut Chart	Distribution	Payment method distribution
Gauge Chart	KPI status	Collection rate gauge
Heat Map	Patterns	Busy hours heat map
Data Table	Detailed data	Transaction list, Patient list
Scorecard	Single metric	Today's Revenue, Total Patients
Sparkline	Inline trend	Mini trend in table
Funnel Chart	Process stages	Patient journey funnel

FR-11: Interactive features:

- Hover tooltips
- Click to drill-down
- Zoom and pan for time series
- Legend toggle (show/hide series)
- Data point highlighting

4.6 Comparison & Benchmarking

FR-12: Period comparison options:

- This month vs Last month
- This month vs Same month last year (YoY)
- This quarter vs Last quarter
- This year vs Last year
- Custom date range comparison

FR-13: Target vs Actual:

- Display target line on charts
- Show variance (actual - target)
- Show variance percentage

- Color coding (green = above target, red = below)

FR-14: Entity comparison:

- Doctor-to-doctor comparison
- Department comparison
- Day-of-week comparison
- Shift comparison (AM vs PM)

4.7 Alert & Notification System

FR-15: Configurable alerts:

- Per-KPI threshold settings
- Warning level (yellow)
- Critical level (red)
- Alert channels: Email, SMS, Dashboard notification
- Alert frequency: Immediate, Daily digest, Weekly digest

FR-16: Alert types:

- Threshold breach (KPI < target)
- Anomaly detection (unusual spike or drop)
- Trend alert (3 consecutive periods declining)
- Missing data alert (no data for expected period)

FR-17: Escalation rules:

- Level 1: Email to Pengurus
- Level 2: SMS to Pengurus (if not acknowledged in 2 hours)
- Level 3: Email to Pemilik (if not resolved in 24 hours)

4.8 Custom Report Builder

FR-18: Drag-and-drop report builder:

- Select data source (visits, sales, payments, etc.)
- Drag metrics (measures) to report
- Drag dimensions (groupings) to report
- Apply filters
- Choose visualization type
- Preview report
- Save as template

FR-19: Report template management:

- Save custom reports
- Categorize reports (Financial, Clinical, Operational)
- Share reports with other users
- Schedule reports
- Version control (revert to previous version)

FR-20: Advanced options:

- Calculated fields (create formulas)
- Conditional formatting
- Pivot table functionality
- Cross-tabulation

4.9 Scheduled Reports

FR-21: Report scheduling:

- Frequency: Daily, Weekly, Monthly, Quarterly
- Day of week/month selection
- Time of day
- Recipients (email list)
- Format: PDF, Excel, or both
- Include/exclude sections

FR-22: Scheduled report management:

- View all scheduled reports
- Pause/resume schedules
- View execution history
- Retry failed deliveries

4.10 Export & Sharing

FR-23: Export formats:

- PDF (formatted for print)
- Excel (data with charts)
- CSV (raw data)
- Image (PNG/JPEG for charts)

FR-24: Sharing options:

- Email report as attachment
- Generate shareable link (view-only)
- Link expiry date (1 day, 7 days, 30 days)
- Password protection (optional)
- Track link access

4.11 Data Quality & Governance

FR-25: Data quality dashboard:

- Overall data quality score (0-100)
- Completeness metrics per table
- Accuracy metrics (validation rule compliance)
- Timeliness (data freshness)
- Consistency (cross-reference checks)

FR-26: Data validation rules:

- Required fields check
- Format validation (IC, phone, email)
- Range validation (age > 0, price > 0)
- Referential integrity (FK exists)
- Business rule validation (invoice total = sum of items)

FR-27: Anomaly detection:

- Statistical outlier detection
- Unusual patterns (spike in refunds, drop in patients)
- Alert for anomalies requiring investigation

FR-28: Data lineage:

- Track data source for each metric
- Show transformation steps
- Audit trail for data changes
- Impact analysis (what reports affected by data issue)

FR-29: Data dictionary:

- Definition for each metric
- Calculation formula
- Data source
- Update frequency
- Owner (who maintains)

4.12 Historical Data Retention

FR-30: Tiered retention policy:

Data Type	Detail Retention	Aggregated Retention
Transactional (invoices, payments)	3 years	7 years (monthly)
Patient visits	3 years	7 years (monthly)
Queue data	1 year	5 years (monthly)
Audit logs	7 years	Permanent
KPI snapshots	3 years	Permanent (monthly)

FR-31: Archive process:

- Automated archival job
- Archive to cold storage (cheaper)
- Restore on-demand (for audits)
- Deletion after retention period (configurable)

4.13 Predictive Analytics

FR-32: Basic forecasting models:

Forecast Type	Method	Horizon	Use Case
Revenue Forecast	Moving average + Seasonality	1-3 months	Cash flow planning
Patient Volume	Time series	1 month	Resource planning
Stock Depletion	Linear regression	2-4 weeks	Reorder planning
Seasonal Trends	Pattern recognition	1 year	Capacity planning

FR-33: Forecast visualization:

- Actual vs Forecast line chart
- Confidence interval bands
- Accuracy metrics (MAPE, RMSE)
- Scenario comparison (optimistic, pessimistic)

4.14 Access Control & Security

FR-34: Role-based access:

Role	Dashboard Access	Report Access	Admin Access
Pemilik Klinik	All dashboards	All reports	Full config
Pengurus Klinik	All dashboards	All reports	Limited config

Department Head	Own department	Own department	No config
Staff	None	None	None

FR-35: Data-level security:

- Doctor can only see own performance
- Department head sees only department data
- Financial data restricted to Finance roles
- Patient-level data restricted (PHI)

FR-36: Audit trail:

- Log all report access
- Log all exports
- Log all configuration changes
- Log all data queries

4.15 Mobile Access

FR-37: Mobile-responsive dashboard:

- Simplified layout for phone
- Key metrics cards
- Touch-friendly charts
- Pull-to-refresh
- Swipe between dashboards

FR-38: Mobile-specific features:

- Push notifications for alerts
- Offline view of last cached data
- Quick filters
- Share via mobile apps

4.16 API & Integration

FR-39: REST API for data access:

- Authentication (API key or OAuth)
- Endpoints for metrics, reports, raw data
- Pagination untuk large datasets
- Rate limiting
- API documentation (OpenAPI/Swagger)

FR-40: Export for external BI tools:

- ODBC/JDBC connection (for Power BI, Tableau)
- Scheduled data export (CSV/JSON)
- Real-time webhook untuk updates

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5. Keperluan Teknikal

5.1 Arkitektur Sistem

Framework: Laravel 12 **Frontend:** Blade Templates + Bootstrap 5 + CoreUI **Charting Library:** Chart.js atau ApexCharts **Dashboard Framework:** Custom atau Laravel-based BI package **Database:** MySQL 8.0 (reporting replica) **Data Warehouse:** Star schema dalam MySQL atau dedicated analytics DB **ETL:** Laravel Jobs + Scheduler **Caching:** Redis untuk dashboard caching **Queue:** Laravel Queue untuk report generation

5.2 Struktur Database

Sistem ini memerlukan:

Data Warehouse Tables (12 tables):

- Fact tables: 6 (visits, sales, payments, dispensing, claims, queue)
- Dimension tables: 6 (date, time, patient, doctor, service, panel)

Reporting System Tables (10 tables):

1. `kpi_definitions` - KPI master
2. `kpi_targets` - Target values per period
3. `kpi_snapshots` - Historical KPI values
4. `report_templates` - Saved report templates
5. `report_schedules` - Scheduled reports
6. `report_executions` - Execution history
7. `dashboard_widgets` - Widget configurations
8. `dashboard_layouts` - User dashboard layouts
9. `alerts` - Alert definitions
10. `alert_notifications` - Notification log

Jadual: `kpi_definitions`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`code`	varchar(50) UNIQUE NOT NULL	KPI code (REVENUE_DAILY)
`name`	varchar(255) NOT NULL	KPI name
`category`	enum NOT NULL	financial/clinical/operational/customer/compliance
`description`	text NULL	Description
`formula`	text NULL	Calculation formula
`unit`	varchar(50) NULL	Unit (RM, %, count, minutes)
`data_source`	varchar(255) NOT NULL	Source table/view
`aggregation`	enum NOT NULL	sum/avg/count/min/max
`frequency`	enum NOT NULL	realtime/hourly/daily/monthly
`is_active`	boolean DEFAULT true	Active status
`display_order`	int DEFAULT 0	Display order
`created_at`	timestamp	Created timestamp
`updated_at`	timestamp	Updated timestamp

Jadual: `kpi_targets`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`kpi_id`	bigint UNSIGNED NOT NULL	FK → kpi_definitions.id

`period_type`	enum NOT NULL	daily/monthly/quarterly/yearly
`period_start`	date NOT NULL	Period start date
`period_end`	date NOT NULL	Period end date
`target_value`	decimal(15,2) NOT NULL	Target value
`warning_threshold`	decimal(15,2) NULL	Warning level
`critical_threshold`	decimal(15,2) NULL	Critical level
`created_by`	bigint UNSIGNED NOT NULL	FK → users.id
`created_at`	timestamp	Created timestamp
`updated_at`	timestamp	Updated timestamp

Jadual: `kpi_snapshots`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`kpi_id`	bigint UNSIGNED NOT NULL	FK → kpi_definitions.id
`snapshot_date`	date NOT NULL	Snapshot date
`period_type`	enum NOT NULL	daily/monthly/quarterly/yearly
`actual_value`	decimal(15,2) NULL	Actual value
`target_value`	decimal(15,2) NULL	Target for comparison
`variance`	decimal(15,2) NULL	Actual - Target
`variance_pct`	decimal(5,2) NULL	Variance percentage
`status`	enum NULL	on_track/warning/critical
`created_at`	timestamp	Created timestamp

Index: UNIQUE(kpi_id, snapshot_date, period_type)

Jadual: `report_templates`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`code`	varchar(50) UNIQUE NOT NULL	Template code
`name`	varchar(255) NOT NULL	Report name
`category`	varchar(100) NOT NULL	Category (Financial, Clinical, etc.)
`description`	text NULL	Description
`type`	enum NOT NULL	predefined/custom
`config`	json NOT NULL	Report configuration (metrics, filters, charts)
`is_public`	boolean DEFAULT false	Shared with all users

`created_by`	bigint UNSIGNED NOT NULL	FK → users.id
`created_at`	timestamp	Created timestamp
`updated_at`	timestamp	Updated timestamp
`deleted_at`	timestamp NULL	Soft delete

Jadual: `report_schedules`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`template_id`	bigint UNSIGNED NOT NULL	FK → report_templates.id
`name`	varchar(255) NOT NULL	Schedule name
`frequency`	enum NOT NULL	daily/weekly/monthly/quarterly
`day_of_week`	tinyint NULL	1-7 (for weekly)
`day_of_month`	tinyint NULL	1-31 (for monthly)
`time_of_day`	time NOT NULL	Execution time
`recipients`	json NOT NULL	Email list
`format`	json NOT NULL	[pdf, excel]
`filters`	json NULL	Applied filters
`is_active`	boolean DEFAULT true	Active status
`last_run_at`	timestamp NULL	Last execution
`next_run_at`	timestamp NULL	Next scheduled execution
`created_by`	bigint UNSIGNED NOT NULL	FK → users.id
`created_at`	timestamp	Created timestamp
`updated_at`	timestamp	Updated timestamp

Jadual: `alerts`

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`kpi_id`	bigint UNSIGNED NOT NULL	FK → kpi_definitions.id
`alert_type`	enum NOT NULL	threshold/anomaly/trend
`condition`	varchar(50) NOT NULL	lt/lte/gt/gte (less than, greater than)
`threshold_value`	decimal(15,2) NULL	Threshold value
`severity`	enum NOT NULL	warning/critical
`channels`	json NOT NULL	[email, sms, dashboard]
`recipients`	json NOT NULL	User IDs or emails

`message_template`	text NULL	Custom message
`is_active`	boolean DEFAULT true	Active status
`cooldown_minutes`	int DEFAULT 60	Minimum time between alerts
`created_by`	bigint UNSIGNED NOT NULL	FK → users.id
`created_at`	timestamp	Created timestamp
`updated_at`	timestamp	Updated timestamp

Jadual: `fact_visits` (Data Warehouse)

Column	Type	Description
`id`	bigint UNSIGNED PK	Primary key
`visit_date_key`	int NOT NULL	FK → dim_date.date_key
`visit_time_key`	int NOT NULL	FK → dim_time.time_key
`patient_key`	bigint NOT NULL	FK → dim_patient.patient_key
`doctor_key`	bigint NOT NULL	FK → dim_doctor.doctor_key
`service_key`	int NOT NULL	FK → dim_service.service_key
`emr_id`	bigint NOT NULL	Source EMR ID
`visit_type`	varchar(50) NOT NULL	walk_in/appointment
`wait_time_minutes`	int NULL	Wait time
`service_time_minutes`	int NULL	Consultation time
`total_bill_amount`	decimal(10,2) NULL	Total billed
`paid_amount`	decimal(10,2) NULL	Amount paid
`diagnosis_count`	int DEFAULT 1	Number of diagnoses
`prescription_count`	int DEFAULT 0	Number of prescriptions
`created_at`	timestamp	Created timestamp

Jadual: `dim_date` (Data Warehouse)

Column	Type	Description
`date_key`	int PK	YYYYMMDD format
`full_date`	date NOT NULL	Full date
`day_of_week`	tinyint NOT NULL	1-7
`day_name`	varchar(20) NOT NULL	Monday, Tuesday...
`day_of_month`	tinyint NOT NULL	1-31
`week_of_year`	tinyint NOT NULL	1-52
`month`	tinyint NOT NULL	1-12

`month_name`	varchar(20) NOT NULL	January, February...
`quarter`	tinyint NOT NULL	1-4
`year`	smallint NOT NULL	2026
`is_weekend`	boolean NOT NULL	Weekend flag
`is_holiday`	boolean DEFAULT false	Holiday flag

5.3 Models (Eloquent)

Models yang perlu dicipta:

- KpiDefinition, KpiTarget, KpiSnapshot
- ReportTemplate, ReportSchedule, ReportExecution
- DashboardWidget, DashboardLayout
- Alert, AlertNotification
- FactVisit, FactSales, FactPayment, FactDispensing, FactClaim, FactQueue
- DimDate, DimTime, DimPatient, DimDoctor, DimService, DimPanel

5.4 Services

Services:

- DashboardService - Dashboard rendering, widget data
- KpiService - KPI calculation, snapshot, comparison
- ReportService - Report generation, export
- ETLService - Data warehouse sync
- AlertService - Alert monitoring, notification
- ForecastService - Predictive analytics
- DataQualityService - Data validation, scoring

5.5 Jobs (Laravel Queue)

- `ETLDailyJob` - Nightly data warehouse refresh
- `ETLHourlyJob` - Hourly incremental update
- `KpiSnapshotJob` - Daily KPI snapshot
- `ReportScheduleJob` - Execute scheduled reports
- `AlertCheckJob` - Check alerts every 15 minutes
- `ForecastUpdateJob` - Weekly forecast update

---

6. Workflow

6.1 ETL Workflow

```
Operational Database (MySQL Production)
    ↓
ETL Job (Laravel Scheduled Job - Nightly)
    ↓
Extract data from:
    - invoices, invoice_items
    - payments
    - emr records
    - dispensing records
    - queue_tickets
    - panel_claims
    ↓
```

```
Transform:
    - Clean data (remove nulls, fix formats)
    - Aggregate (daily totals, averages)
    - Derive metrics (wait time = called_at - issued_at)
    - Link to dimensions (patient_key, doctor_key)
    ↓
Load into Data Warehouse:
    - fact_visits
    - fact_sales
    - fact_payments
    - fact_dispensing
    - fact_claims
    - fact_queue
    ↓
Update dimension tables (new patients, new doctors)
    ↓
Calculate KPI snapshots
    ↓
Check alerts
    ↓
Log ETL completion
```

6.2 Dashboard Viewing Workflow

```
User login
    ↓
System check user role
    ↓
Load appropriate dashboard layout
    ↓
For each widget:
    - Check cache (Redis)
    - If cache valid → serve from cache
    - If cache expired → query data warehouse
    - Render visualization
    - Store in cache
    ↓
Display dashboard
    ↓
User interactions:
    - Click widget → drill-down
    - Change date range → refresh all widgets
    - Click refresh → clear cache, reload
```

6.3 Report Generation Workflow

```
User select report template
    ↓
User set parameters:
    - Date range
    - Filters (doctor, department, etc.)
    - Output format (view/PDF/Excel)
    ↓
System validate parameters
    ↓
```

```
System query data warehouse
    ↓
System apply calculations
    ↓
System render report:
    - If view → display on screen
    - If PDF → generate PDF, download/email
    - If Excel → generate Excel, download/email
    ↓
Log report execution
```

6.4 Alert Workflow

```
Scheduled job runs every 15 minutes
    ↓
For each active alert:
    - Calculate current KPI value
    - Compare with threshold
    ↓
If threshold breached:
    - Check cooldown (last alert time)
    - If cooldown passed:
        - Create alert_notification record
        - Send email (if channel enabled)
        - Send SMS (if channel enabled)
        - Display in dashboard (if channel enabled)
        - Update last_alert_time
    ↓
If alert resolved (back to normal):
    - Send resolution notification (optional)
```

---

7. Keperluan UI/UX

7.1 Key Interfaces

1. Executive Dashboard

- Hero metrics (4 large cards): Revenue, Patients, Collection Rate, Satisfaction
- Trend charts (revenue, patient volume)
- KPI scorecard (traffic light indicators)
- Comparison widgets (vs last period)
- Alert summary

2. Operational Dashboard

- Real-time metrics (today's stats)
- Queue status widget
- Active staff widget
- Hourly breakdown chart
- Recent transactions list

3. Department Dashboards

- Department-specific KPIs
- Performance charts
- Staff performance table
- Drill-down to details

4. Report Viewer

- Report header (title, date range, filters)
- Data visualization area
- Data table
- Export buttons (PDF, Excel, CSV)
- Share button

5. Custom Report Builder

- Data source selector
- Available fields panel (drag source)
- Report canvas (drop target)
- Filter panel
- Visualization options
- Preview button
- Save/Schedule buttons

6. Alert Management

- Active alerts list
- Create/Edit alert form
- Alert history
- Notification preferences

7. Admin Settings

- KPI configuration
- Target management
- Dashboard layout management
- User access management
- ETL monitoring

7.2 Design System

- Framework: Bootstrap 5 + CoreUI
- Charts: Chart.js atau ApexCharts
- Icons: CoreUI Icons / Font Awesome
- Color Scheme: Professional BI colors (blues, greens for positive, reds for negative)
- Responsive: Yes (mobile-first)

7.3 Chart Color Palette

Purpose	Color
Primary (current period)	#3B82F6 (blue)
Comparison (previous period)	#94A3B8 (gray)
Positive/On track	#10B981 (green)
Warning	#F59E0B (amber)
Critical/Negative	#EF4444 (red)
Neutral	#6B7280 (gray)

---

8. Keperluan Keselamatan

8.1 Data Protection

- Data warehouse contains aggregated data (minimize PII)
- Patient identifiable data masked in reports (unless authorized)
- Encryption for sensitive exports
- Secure shareable links (token-based, expiry)

8.2 Access Control

- Role-based dashboard access
- Data-level security (doctor sees own data only)
- Report template sharing controls
- API authentication (API key or OAuth)

8.3 Audit Trail

- Log all report access
- Log all exports
- Log all configuration changes
- Log all API calls
- Retain logs for 7 years

---

9. Keperluan Prestasi

9.1 Response Time

- Dashboard load: < 3 saat
- Widget refresh: < 2 saat
- Report generation (small): < 5 saat
- Report generation (large): < 30 saat
- Export (PDF/Excel): < 10 saat

9.2 Scalability

- Support 3 years of transactional data
- Support 10+ concurrent dashboard users
- Efficient aggregation queries
- Redis caching untuk hot data
- Pagination untuk large datasets

9.3 ETL Performance

- Nightly ETL: < 30 minit
- Hourly incremental: < 5 minit
- No impact to production database

---

10. Keperluan Ujian

10.1 Unit Testing

- KpiService::calculate() accuracy
- ForecastService::predict() accuracy
- DataQualityService::validate() rules
- Report calculations

10.2 Feature Testing

- Dashboard rendering
- Report generation all formats
- Alert triggering
- Scheduled report execution

- Export functionality

10.3 Integration Testing

- ETL job accuracy (source vs warehouse)
- Email delivery for alerts and reports
- API endpoints

10.4 Performance Testing

- Dashboard load under concurrent users
- Large report generation
- ETL job duration

10.5 UAT Scenarios

- Pemilik review executive dashboard
- Pengurus investigate KPI issue (drill-down)
- Generate monthly report and export
- Create custom report and schedule

---

11. Langkah Implementasi

Fasa 1: Data Warehouse Setup (2 minggu)

- [ ] Design star schema
- [ ] Create dimension tables
- [ ] Create fact tables
- [ ] Create ETL jobs (basic)
- [ ] Test data loading

Fasa 2: KPI Framework (1.5 minggu)

- [ ] Create KPI definitions table
- [ ] Create KPI targets table
- [ ] Implement KPI calculation service
- [ ] Create KPI snapshot job
- [ ] Build KPI management UI

Fasa 3: Dashboard Framework (2 minggu)

- [ ] Create dashboard layout system
- [ ] Implement widget framework
- [ ] Build executive dashboard
- [ ] Build operational dashboard
- [ ] Implement caching

Fasa 4: Department Dashboards (1.5 minggu)

- [ ] Build EMR dashboard
- [ ] Build Farmasi dashboard
- [ ] Build Billing dashboard
- [ ] Build Queue dashboard
- [ ] Role-based access

Fasa 5: Pre-defined Reports (1.5 minggu)

- [ ] Create report template system

- [ ] Build daily reports
- [ ] Build weekly reports
- [ ] Build monthly reports
- [ ] Export to PDF/Excel

Fasa 6: Custom Report Builder (2 minggu)

- [ ] Build drag-and-drop interface
- [ ] Implement field selection
- [ ] Implement filters
- [ ] Implement visualizations
- [ ] Save/load templates

Fasa 7: Alert System (1 minggu)

- [ ] Create alert definitions
- [ ] Implement threshold checking
- [ ] Build notification system (email, SMS)
- [ ] Alert dashboard
- [ ] Escalation rules

Fasa 8: Scheduled Reports (1 minggu)

- [ ] Create scheduling system
- [ ] Implement execution job
- [ ] Email delivery
- [ ] Execution history
- [ ] Management UI

Fasa 9: Comparison & Benchmarking (1 minggu)

- [ ] Period comparison logic
- [ ] Target vs Actual visualization
- [ ] Entity comparison
- [ ] Benchmark indicators

Fasa 10: Predictive Analytics (1 minggu)

- [ ] Revenue forecast model
- [ ] Patient volume forecast
- [ ] Stock depletion forecast
- [ ] Forecast visualization

Fasa 11: Data Quality & Governance (1 minggu)

- [ ] Data quality scoring
- [ ] Validation rules
- [ ] Anomaly detection
- [ ] Data dictionary
- [ ] Data lineage

Fasa 12: Mobile & API (1 minggu)

- [ ] Mobile-responsive dashboards
- [ ] Push notifications
- [ ] REST API endpoints

- [ ] API documentation

Fasa 13: Testing & UAT (1.5 minggu)

- [ ] Unit tests
- [ ] Feature tests
- [ ] Performance tests
- [ ] UAT dengan management
- [ ] Bug fixes

Fasa 14: Deployment (0.5 minggu)

- [ ] Deploy to production
- [ ] Configure ETL schedules
- [ ] Training untuk users
- [ ] Monitor performance

Anggaran Masa: 18 minggu (4-4.5 bulan)

---

12. Kriteria Kejayaan

12.1 Metrics

1. Report generation time: 80% reduction dari manual process
2. Data freshness: Dashboard data < 1 hour old
3. KPI visibility: 100% of defined KPIs tracked
4. User adoption: 80% of management using dashboard weekly
5. Alert effectiveness: 90% of alerts actioned within SLA

---

13. Risks & Mitigation

Risk	Impact	Probability	Mitigation
ETL impact production DB	HIGH	MEDIUM	Use read replica; run during off-hours; optimize queries
Data quality issues	HIGH	HIGH	Data validation rules; data quality dashboard; cleansing jobs
Complex report builder	MEDIUM	MEDIUM	Start with simple version; iterate based on feedback
Forecast accuracy low	MEDIUM	MEDIUM	Clear accuracy indicators; disclaimer on forecasts; manual override
Performance issues with large data	HIGH	MEDIUM	Proper indexing; aggregation tables; caching; pagination

---

14. Acceptance Criteria

14.1 Functional

- ✅ Multi-level dashboards display correctly
- ✅ All defined KPIs calculated accurately
- ✅ ETL jobs run successfully and on schedule
- ✅ Reports generate in all formats (PDF, Excel, CSV)
- ✅ Custom report builder works
- ✅ Alerts trigger and notify correctly
- ✅ Scheduled reports delivered on time

- ✅ Comparison features work accurately
- ✅ Basic forecasts available
- ✅ Data quality score visible

14.2 Non-Functional

- Performance: Dashboard < 3 saat
- Security: Role-based access enforced
- Mobile: Responsive dashboards work on phone
- Availability: 99% uptime

---

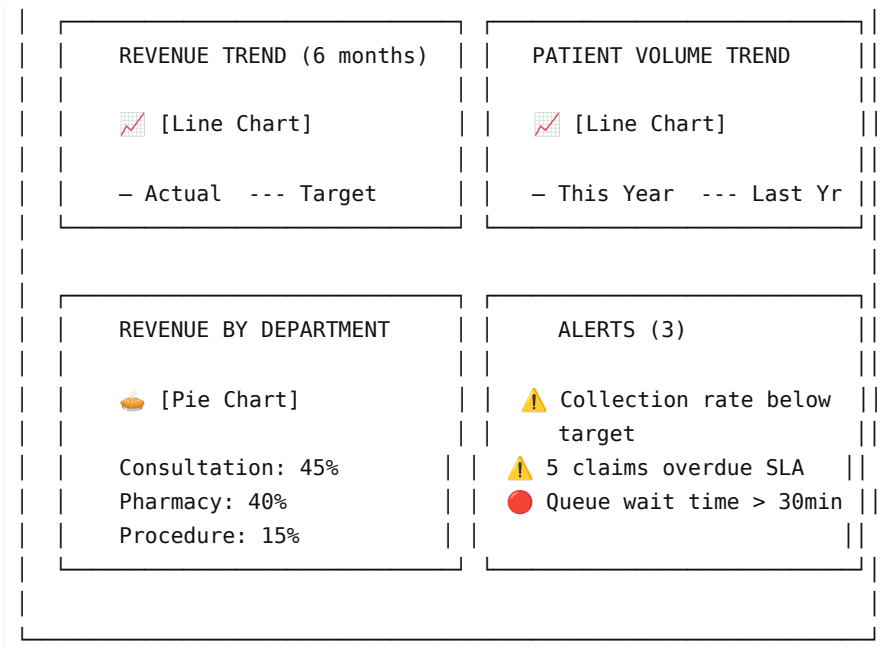
15. Lampiran

15.1 Sample KPI Scorecard

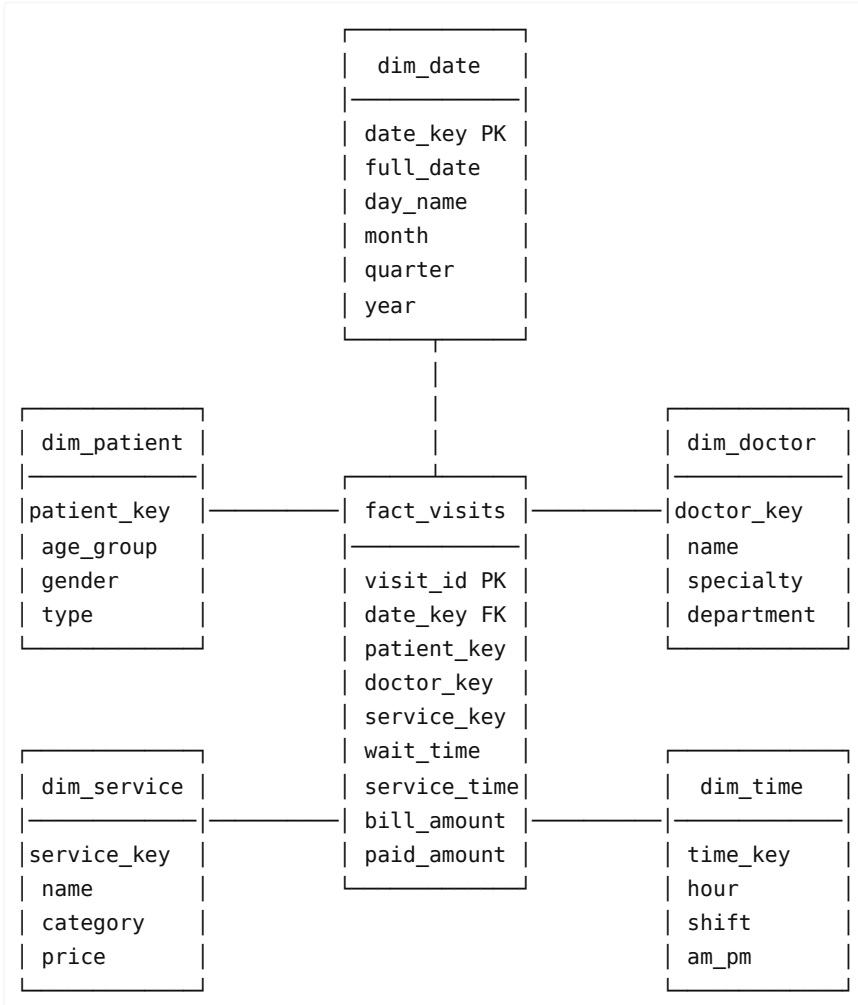
```
╔═══════════════════════════════════════════════════════════════╗
║                  KPI SCORECARD - January 2026                 ║
╠═══════════════════════════════════════════════════════════════╣
║                                                               ║
║  FINANCIAL                                                    ║
║  ┌──────────────────┬──────────┬──────────┬────────┬────────┐  ║
║  │ KPI              │ Target   │ Actual   │ Status │ Trend  │  ║
║  ├──────────────────┼──────────┼──────────┼────────┼────────┤  ║
║  │ Revenue          │ RM150K   │ RM142K   │ 🟡     │ ↗️     │  ║
║  │ Collection Rate  │ 90%      │ 88%      │ 🟡     │ →      │  ║
║  │ Avg Bill Size    │ RM80     │ RM85     │ 🟢     │ ↗️     │  ║
║  │ AR Aging >30d    │ <10%     │ 8%       │ 🟢     │ ↘️     │  ║
║  └──────────────────┴──────────┴──────────┴────────┴────────┘  ║
║                                                               ║
║  CLINICAL                                                     ║
║  ┌──────────────────┬──────────┬──────────┬────────┬────────┐  ║
║  │ Patient Volume   │ 2000     │ 1850     │ 🟡     │ ↗️     │  ║
║  │ Avg Wait Time    │ <15 min  │ 12 min   │ 🟢     │ ↘️     │  ║
║  │ Doctor Util      │ 75%      │ 72%      │ 🟡     │ →      │  ║
║  │ No-Show Rate     │ <10%     │ 8%       │ 🟢     │ ↘️     │  ║
║  └──────────────────┴──────────┴──────────┴────────┴────────┘  ║
║                                                               ║
║  🟢 On Track    🟡 Warning    🔴 Critical                     ║
║  ↗️ Improving  → Stable    ↘️ Declining                       ║
║                                                               ║
╚═══════════════════════════════════════════════════════════════╝
```

15.2 Sample Executive Dashboard Layout

```
┌─────────────────────────────────────────────────────────────────┐
│  POLIKLINIK AL-HUDA - Executive Dashboard        📅 Jan 2026    │
├─────────────────────────────────────────────────────────────────┤
│                                                                 │
│  ┌──────────────┐ ┌──────────────┐ ┌──────────────┐ ┌──────────┐ │
│  │   REVENUE    │ │  PATIENTS    │ │ COLLECTION   │ │   NPS    │ │
│  │              │ │              │ │    RATE      │ │          │ │
│  │  RM142,500   │ │    1,850     │ │    88%       │ │    52    │ │
│  │   ↗️ +5%     │ │   ↗️ +8%     │ │   → 0%       │ │  ↗️ +4   │ │
│  │  vs last mo  │ │  vs last mo  │ │  vs last mo  │ │vs last mo│ │
│  └──────────────┘ └──────────────┘ └──────────────┘ └──────────┘ │
│                                                                 │
```



15.3 Data Warehouse Star Schema



END OF PRD

Appendix: Change Log

Version	Date	Author	Changes
1.0	2026-01-13	System	Initial PRD creation