# Advanced Asset Analytics Documentation

## Overview

The Advanced Asset Analytics system provides sophisticated financial analysis, forecasting, and planning capabilities for enterprise asset management. This includes cost forecasting, lifecycle planning, ROI calculations, and depreciation analysis.

## Base URL

http://localhost:3000/api/v1/asset-analytics

## Authentication & Permissions

* **Authentication**: JWT token required
* **Permission**: asset\_analytics:read for all analytics endpoints

## Features

### 📈 Cost Forecasting & Budgeting

#### Cost Forecasting

Generate predictive cost models based on historical data with confidence intervals.

**Endpoint:** GET /forecast/{assetUuid}

**Parameters:** - forecastMonths (1-60): Forecast horizon in months - includeInflation (boolean): Include inflation adjustments - inflationRate (0-0.20): Annual inflation rate - confidenceLevel (0.90, 0.95, 0.99): Statistical confidence level

**Response Example:**

{  
 "data": {  
 "forecastPeriod": "12 months",  
 "historicalDataPoints": 24,  
 "trends": {  
 "averageMonthlyCost": 1250.50,  
 "monthlyGrowthRate": 0.02,  
 "volatility": 0.15  
 },  
 "forecasts": [  
 {  
 "month": "2025-08",  
 "forecastedCost": 1275.25,  
 "lowerBound": 1150.00,  
 "upperBound": 1400.50,  
 "confidence": 0.95  
 }  
 ],  
 "budgetRecommendations": {  
 "recommendedMonthlyBudget": 1402.55,  
 "recommendedAnnualBudget": 16830.60  
 }  
 }  
}

#### Budget Planning

Generate comprehensive budget plans with CAPEX/OPEX breakdown.

**Endpoint:** GET /budget-plan

**Parameters:** - costCenter (string): Filter by cost center - budgetYear (2020-2050): Target budget year - includeCapex/includeOpex (boolean): Include capital/operational expenses - riskBuffer (0-0.50): Risk adjustment percentage

**Key Features:** - ✅ **CAPEX/OPEX Categorization** - Automatic expense classification - ✅ **Risk-Adjusted Budgets** - Configurable risk buffers - ✅ **Multi-Year Planning** - Forward-looking budget projections - ✅ **Cost Center Analysis** - Department-specific budgeting

### 🔄 Lifecycle Planning & Replacement Scheduling

#### Lifecycle Planning

Comprehensive asset lifecycle analysis with risk assessment.

**Endpoint:** GET /lifecycle-plan

**Parameters:** - planningHorizon (12-120): Planning period in months - replacementThreshold (0.5-1.0): Lifecycle percentage for replacement - includeRiskAssessment (boolean): Include risk analysis

**Response Features:**

{  
 "data": {  
 "summary": {  
 "totalAssets": 150,  
 "assetsRequiringReplacement": 23,  
 "totalReplacementCost": 450000.00,  
 "averageAssetAge": 28.5  
 },  
 "lifecycleCategories": {  
 "new": [], // < 25% of lifecycle  
 "mature": [], // 25-75% of lifecycle   
 "aging": [], // 75-90% of lifecycle  
 "critical": [] // > 90% of lifecycle  
 },  
 "replacementSchedule": [  
 {  
 "assetUuid": "...",  
 "hostname": "server-01",  
 "replacementDate": "2025-09",  
 "estimatedCost": 15000.00,  
 "priority": "Critical"  
 }  
 ],  
 "riskAssessments": [  
 {  
 "assetUuid": "...",  
 "riskLevel": "High",  
 "riskFactors": ["High failure risk due to age", "No warranty coverage"],  
 "mitigationRecommendations": ["Prioritize immediate replacement"]  
 }  
 ]  
 }  
}

#### Replacement Schedule Optimization

Optimize replacement timing with budget constraints.

**Endpoint:** GET /replacement-schedule

**Parameters:** - budgetConstraint (number): Maximum budget available - prioritizeBy (risk/cost/age): Optimization criteria - allowBudgetReallocation (boolean): Enable budget flexibility

**Optimization Methods:** - **Risk-Based**: Prioritize high-risk assets - **Cost-Based**: Optimize for lowest total cost - **Age-Based**: Replace oldest assets first

### 💼 ROI & Depreciation Calculations

#### ROI Analysis

Multi-method Return on Investment calculations.

**Endpoint:** GET /roi/{assetUuid}

**Analysis Methods:** 1. **Simple ROI**: Basic return calculation 2. **Comprehensive ROI**: Includes all cost categories 3. **NPV ROI**: Net Present Value with discount rates

**Parameters:** - analysisMethod (simple/comprehensive/npv): Calculation method - discountRate (0-0.30): Discount rate for NPV analysis - timeHorizon (12-120): Analysis period in months

**Response Example:**

{  
 "data": {  
 "roiMetrics": {  
 "method": "Comprehensive ROI",  
 "roi": 15.75,  
 "monthlyROI": 0.26,  
 "totalCosts": 125000.00,  
 "netBenefit": 19687.50,  
 "paybackPeriod": 42.3,  
 "interpretation": "Good ROI"  
 },  
 "investment": {  
 "initialInvestment": 100000.00,  
 "ongoingCosts": 15000.00,  
 "totalOperationalCosts": 10000.00  
 },  
 "benefits": {  
 "totalBenefits": 144687.50,  
 "benefitCategories": {  
 "productivity": 57875.00,  
 "costSavings": 43406.25,  
 "riskReduction": 28937.50,  
 "other": 14468.75  
 }  
 }  
 }  
}

#### Depreciation Analysis

Multiple depreciation methods with tax implications.

**Endpoint:** GET /depreciation/{assetUuid}

**Depreciation Methods:** 1. **Straight Line**: Equal annual depreciation 2. **Declining Balance**: Accelerated depreciation 3. **Sum of Years**: Front-loaded depreciation 4. **Units of Production**: Usage-based depreciation

**Parameters:** - methods (array): Depreciation methods to calculate - decliningBalanceRate (0.05-0.50): Rate for declining balance - salvageValuePercent (0-0.50): Expected salvage value

**Response Features:**

{  
 "data": {  
 "assetDetails": {  
 "purchaseCost": 50000.00,  
 "usefulLifeMonths": 60,  
 "salvageValue": 5000.00,  
 "monthsElapsed": 24,  
 "remainingLife": 36  
 },  
 "depreciationMethods": {  
 "straightLine": {  
 "monthlyDepreciation": 750.00,  
 "accumulatedDepreciation": 18000.00,  
 "bookValue": 32000.00  
 },  
 "decliningBalance": {  
 "annualRate": 20,  
 "accumulatedDepreciation": 19200.00,  
 "bookValue": 30800.00  
 }  
 },  
 "depreciationSchedule": [  
 {  
 "month": "2025-08",  
 "depreciation": 750.00,  
 "bookValue": 31250.00  
 }  
 ],  
 "taxImplications": [  
 {  
 "method": "Straight Line",  
 "taxDeduction": 18000.00,  
 "note": "Depreciation may be deductible for tax purposes"  
 }  
 ]  
 }  
}

#### Comprehensive Financial Analysis

Combined ROI, depreciation, and TCO analysis.

**Endpoint:** GET /financial-analysis/{assetUuid}

**Includes:** - ✅ **ROI Analysis** - Multiple calculation methods - ✅ **Depreciation Analysis** - All depreciation methods - ✅ **Total Cost of Ownership** - Complete cost breakdown - ✅ **Financial Health Score** - 0-100 scoring system - ✅ **Strategic Recommendations** - Actionable insights

### 📊 Dashboard & Portfolio Analytics

#### Analytics Dashboard

Consolidated view of key metrics and forecasts.

**Endpoint:** GET /dashboard

**Features:** - **Time-based Analysis** (30d, 90d, 1y, 2y) - **Cost Center Filtering** - **Integrated Forecasts** - **Lifecycle Summaries**

#### Portfolio Summary

Enterprise-wide analytics aggregation.

**Endpoint:** GET /portfolio-summary

**Capabilities:** - **Multi-Asset Analysis** - **Portfolio-wide ROI** - **Risk Aggregation** - **Budget Consolidation**

## Advanced Features

### 🔍 Predictive Analytics

* **Trend Analysis**: Historical pattern recognition
* **Seasonal Adjustments**: Account for cyclical variations
* **Confidence Intervals**: Statistical uncertainty quantification
* **Inflation Modeling**: Economic factor integration

### 📈 Financial Modeling

* **Multi-Method ROI**: Simple, comprehensive, and NPV calculations
* **Depreciation Compliance**: Multiple accounting standards
* **Tax Optimization**: Depreciation tax implications
* **Risk Assessment**: Financial risk quantification

### 🎯 Optimization Algorithms

* **Budget Constraint Optimization**: Maximize value within limits
* **Multi-Criteria Decision Making**: Balance risk, cost, and age
* **Resource Allocation**: Optimal replacement scheduling
* **Scenario Planning**: What-if analysis capabilities

## Usage Examples

### Generate 12-Month Cost Forecast

curl "http://localhost:3000/api/v1/asset-analytics/forecast/550e8400-e29b-41d4-a716-446655440000?forecastMonths=12&includeInflation=true&confidenceLevel=0.95" \  
 -H "Authorization: Bearer YOUR\_TOKEN"

### Create Annual Budget Plan

curl "http://localhost:3000/api/v1/asset-analytics/budget-plan?budgetYear=2026&includeCapex=true&riskBuffer=0.15" \  
 -H "Authorization: Bearer YOUR\_TOKEN"

### Analyze Asset ROI

curl "http://localhost:3000/api/v1/asset-analytics/roi/550e8400-e29b-41d4-a716-446655440000?analysisMethod=npv&discountRate=0.08" \  
 -H "Authorization: Bearer YOUR\_TOKEN"

### Calculate Depreciation

curl "http://localhost:3000/api/v1/asset-analytics/depreciation/550e8400-e29b-41d4-a716-446655440000?methods=straight\_line,declining\_balance" \  
 -H "Authorization: Bearer YOUR\_TOKEN"

## Best Practices

### 📊 Data Quality

1. **Historical Data**: Ensure 12+ months of operational cost data
2. **Accurate Lifecycle Info**: Maintain current purchase dates and EOL data
3. **Cost Categorization**: Use consistent cost types and billing cycles
4. **Regular Updates**: Keep asset and cost data current

### 🎯 Analysis Configuration

1. **Appropriate Time Horizons**: Match analysis period to business cycles
2. **Realistic Assumptions**: Use market-appropriate inflation and discount rates
3. **Risk Buffers**: Include appropriate contingency factors
4. **Confidence Levels**: Choose statistical confidence appropriate for decisions

### 💡 Strategic Application

1. **Budget Planning**: Use forecasts for annual budget development
2. **Replacement Timing**: Optimize replacement schedules for cost efficiency
3. **Investment Decisions**: Apply ROI analysis for capital allocation
4. **Risk Management**: Use lifecycle analysis for proactive planning

## Integration Points

### Financial Systems

* **ERP Integration**: Budget and cost data synchronization
* **Accounting Systems**: Depreciation schedule export
* **Procurement**: Replacement cost estimation
* **Treasury**: Cash flow planning

### Business Intelligence

* **Dashboard Integration**: Embed analytics in BI tools
* **Report Automation**: Scheduled analytics reports
* **Alert Systems**: Threshold-based notifications
* **Data Warehousing**: Historical analytics data storage