

Insurance Products & Pricing Engine

Complete Implementation Plan - Critical Module

Based on Deep Analysis of cardinsa_21_09092025.sql Database






Executive Summary

This document outlines the complete implementation strategy for the **Products & Pricing Engine** module - the most critical component of the insurance management system. Through comprehensive analysis of the database schema, we've identified all essential components required for a production-ready insurance pricing engine.

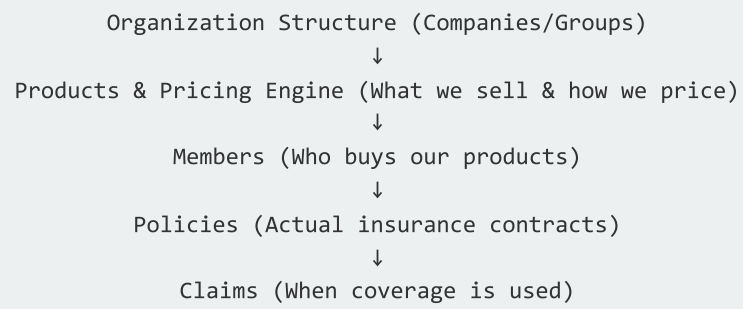
CRITICAL IMPORTANCE

This module is the **foundation of all insurance operations**. Without accurate product definitions, benefit structures, and pricing calculations, no other insurance module can function properly. Every quote, policy, and claim depends on the components built in this phase.

Module Dependencies Status

-  **FastAPI Core Infrastructure** - Database, settings, middleware, logging
-  **Authentication & Authorization** - User management and security
-  **Employee Management** - Workforce and skills management
-  **Organization Structure** - Companies, departments, units, groups
-  **Products & Pricing Engine** - Current focus (this document)

Business Logic Flow



Implementation Steps

Step 1: Product Catalog Foundation

Tables: product_catalog, product_features, plan_types, actuarial_tables

Why First:

- **Foundation Layer:** Core product definitions that everything else builds on
- **No Dependencies:** Independent of other modules
- **Business Prerequisites:** Must define what you're selling before configuring it
- **Actuarial Foundation:** Statistical data essential for risk assessment and regulatory compliance

What to Build:

- Product catalog CRUD operations
- Product feature management and optional add-ons
- Plan type categorization (Medical, Motor, Life, etc.)
- Actuarial table management for risk calculations
- Product lifecycle management (active/inactive states)

Step 2A: Reference Data & Medical Codes

Tables: cpt_codes, icd10_codes, motor_exclusion_codes, motor_exclusion_categories

Why Critical:

- **CPT Codes:** Medical procedure codes for accurate coverage determination and billing
- **ICD10 Codes:** Diagnosis codes for underwriting decisions and medical exclusions
- **Motor Codes:** Vehicle insurance exclusions and coverage specifications
- **Regulatory Compliance:** Required for proper medical insurance operations

What to Build:

- Medical procedure code management (CPT)
- Diagnosis code management (ICD10)
- Motor vehicle exclusion categorization
- Code validation and lookup services
- Multi-language code descriptions

Step 2B: Benefits Foundation

Tables: benefit_categories, coverage_options, coverages

Why Here:

- **Benefits are Core:** Insurance products are meaningless without defined benefits
- **Categorization First:** Organize benefits before creating specific schedules
- **Multi-language Support:** Arabic/English benefit category names
- **Coverage Options:** Define what can be covered under each insurance type

What to Build:

- Benefit category management (Medical, Dental, Vision, Life, etc.)
- Category hierarchy and display ordering
- Coverage option definitions with pricing formulas
- Multi-language category descriptions
- Category activation/deactivation workflows

Step 2C: Plans & Coverage Structure

Tables: plans, plan_coverage_links, plan_exclusions, plan_exclusion_links

Why After Benefits Foundation:

- **Depends on Step 1:** Plans reference product_catalog.id
- **Depends on Step 2B:** Will link to coverage options and benefit categories
- **Core Plan Structure:** Defines the sellable insurance products
- **Exclusion Management:** Critical for risk management and claims

What to Build:

- Plan creation and management with company associations
- Coverage type definitions and plan linkages
- Plan-coverage relationships with specific limits
- Plan exclusions and limitations (medical and motor)
- Plan versioning and lifecycle management

Step 2D: Plan Benefit Schedules

Tables: plan_benefit_schedules, benefit_conditions

Why Critical Here:

- **Defines Plan Value:** Benefits are what customers actually receive
- **Pricing Foundation:** Cannot price what isn't properly defined
- **Dependencies Ready:** Plans + Benefit Categories + Coverage all available
- **Complex Conditions:** Age, gender, diagnosis-based benefit eligibility

What to Build:

- **Financial Structures:** Benefit limits, cost-sharing (coinsurance, copays, deductibles), alert thresholds
- **Operational Rules:** Authorization requirements, network tiers, frequency limits, waiting periods
- **User Experience:** Display grouping and ordering, multi-language descriptions, AI-generated summaries
- **Benefit Conditions:** Complex eligibility logic with AND/OR operators, condition groups, priority ordering

Step 3A: Provider Network Infrastructure

Tables: provider_types, providers, provider_networks, provider_network_members, provider_service_prices

Why Before Pricing:

- **Network Tiers:** In-network vs out-of-network pricing significantly affects premiums
- **Provider Costs:** Negotiated rates with providers impact overall plan costs
- **Service Pricing:** Provider-specific pricing determines benefit cost calculations
- **Geographic Coverage:** Provider availability affects plan viability in different areas

What to Build:

- Provider type categorization (hospitals, clinics, garages, etc.)
- Provider registration and profile management
- Network creation and provider assignment
- Service pricing agreements by provider
- Network tier management (Tier 1, Tier 2, Out-of-Network)

Step 3B: Age & Demographic Foundations

Tables: age_brackets, premium_age_brackets

Why Critical:

- **Age-Based Pricing:** Fundamental to all insurance types - health risks increase with age
- **Risk Categories:** Age brackets determine basic risk classification
- **Premium Multipliers:** Each age group has different pricing factors
- **Regulatory Requirements:** Age-based pricing must be actuarially justified

What to Build:

- Age bracket definition and management
- Age-specific premium multipliers
- Insurance type-specific age brackets
- Effective date management for age bracket changes
- Integration with actuarial tables

Step 4: Basic Pricing Profiles

Tables: quotation_pricing_profiles, quotation_pricing_rules (basic)

Why After Complete Product Definition:

- **Needs Complete Product Info:** Including all benefits, conditions, and provider costs
- **Actuarial Basis:** Benefit limits and structures inform pricing calculations
- **Risk Assessment:** Benefit conditions affect premium calculations
- **Network Economics:** Provider costs integrated into pricing

What to Build:

- Pricing profile management with benefit value consideration
- Base premium calculations incorporating benefit exposure
- Currency and premium boundaries management
- Risk formulas incorporating benefit exposure and network costs
- Profile versioning and approval workflows

Step 5: Advanced Pricing Components

Tables: premium_deductibles, premium_copay, premium_coinsurance, premium_copayment, discounts_promotions, premium_industries, agent_commissions

Why Critical:

- **Cost-Sharing Structures:** Deductibles, copays, and coinsurance directly affect member costs and plan pricing
- **Industry-Specific Pricing:** Different business sectors have different risk profiles
- **Discount Calculations:** Marketing promotions and volume discounts affect final pricing
- **Commission Structures:** Distribution costs must be factored into pricing

What to Build:

- Deductible management by service type
- Copay and coinsurance percentage configuration
- Discount and promotion engine with eligibility rules
- Industry loading factors for risk adjustment
- Agent commission calculation and tracking

Step 6: Advanced Pricing Rules Engine

Tables: quotation_pricing_rules, quotation_pricing_rule_age_brackets, quotation_pricing_profile_rules

Why After Basic Pricing:

- **Complex Risk Factors:** Age, benefit utilization patterns, coverage combinations
- **Benefit-Specific Adjustments:** Different rules for medical vs motor vs life insurance
- **Multi-factor Pricing:** Considering benefit conditions from Step 2D
- **Rule Orchestration:** Multiple pricing rules working together with priority ordering

What to Build:

- Advanced pricing rule engine with complex conditions
- Age-based pricing calculations linked to benefit eligibility
- Benefit-specific adjustments (dental vs medical pricing differences)
- Risk factor calculations considering complete benefit exposure
- Rule orchestration with priority and sequencing

Step 7: Premium Calculation Engine

Tables: premium_calculations

Why Separate Step:

- **Complex Calculation Logic:** Combines all pricing factors from previous steps
- **Calculation Audit Trail:** Regulatory compliance requires detailed calculation records
- **Manual Override Capabilities:** Underwriters need ability to adjust calculated premiums
- **Approval Workflows:** Premium calculations may require management approval

What to Build:

- Premium calculation engine integrating all factors
- Detailed calculation breakdown and audit trail
- Manual override capabilities with justification requirements
- Calculation approval workflows
- Performance optimization for complex calculations

Step 8: Quotation Engine

Tables: quotations, quotation_items, quotation_factors, quotation_coverage_options

Why After Complete Pricing Setup:

- **Integrates Everything:** Products, benefits, pricing rules, provider networks
- **Customer-Facing:** Generates quotes with detailed benefit breakdowns
- **Benefit Display:** Shows specific benefits and their individual costs
- **Coverage Comparison:** Enables side-by-side plan comparison

What to Build:

- Quote generation with benefit-level detail
- Quote calculation incorporating all pricing components
- Benefit presentation in quotations with clear explanations
- Coverage option comparison with benefit differences highlighted
- Quote versioning and management system

Step 9: Underwriting Rules Engine

Tables: underwriting_rules, underwriting_decision_matrix, underwriting_workflow_steps

Why After Quotation Engine:

- **Risk Assessment:** Evaluates benefit eligibility and coverage risks
- **Benefit-Based Decisions:** Some benefits require medical underwriting
- **Automated Benefit Approval:** Rules for automatic benefit authorization
- **Quote to Policy Conversion:** Underwriting gates the conversion process

What to Build:

- Underwriting rules considering benefit-specific risks
- Benefit eligibility assessment automation
- Medical underwriting for high-value benefits
- Automated decision logic with manual review triggers
- Risk scoring incorporating complete benefit exposure

Step 10: Quote Management & Workflow

Tables: quotation_logs, quotation_versions, quotation_workflow_logs, quotation_documents

Why Last:

- **Operational Layer:** Managing complete quotes with all benefits included
- **Benefit Documentation:** Generating comprehensive benefit summaries and schedules
- **Workflow Integration:** Complete quote-to-policy conversion process
- **Audit and Compliance:** Complete documentation for regulatory requirements

What to Build:

- Quote status management with benefit tracking
- Benefit schedule generation (PDF documents)
- Quote workflow automation with approval gates
- Benefit change tracking and version control
- Complete audit trails for regulatory compliance



Critical Components Identified Through Database Analysis

1. Medical/Clinical Infrastructure:

- **CPT Codes:** Medical procedure codes for accurate coverage determination and billing
- **ICD10 Codes:** Diagnosis codes for underwriting decisions and medical exclusions
- **Essential for:** Medical insurance accurate pricing and coverage decisions

2. Actuarial Foundation:

- **Actuarial Tables:** Statistical data for risk assessment and regulatory compliance
- **Age Brackets:** Demographic risk categorization with premium multipliers
- **Industry Tables:** Sector-specific risk factors and loading

3. Provider Network Economics:

- **Provider Networks:** In-network vs out-of-network pricing tiers
- **Provider Service Prices:** Negotiated rates affecting overall plan costs
- **Network Assignments:** Member access rights and restrictions

4. Cost-Sharing Precision:

- **Premium Deductibles:** Patient financial responsibility before coverage begins
- **Premium Copay/Coinsurance:** Shared cost structures between insurer and member
- **Critical for:** Accurate quote generation and member cost prediction

5. Commercial Factors:

- **Discounts & Promotions:** Marketing-driven pricing adjustments and eligibility rules
- **Agent Commissions:** Distribution cost calculations affecting final pricing
- **Industry Loading:** Business sector-specific risk adjustments

6. Motor Insurance Specifics:

- **Motor Exclusion Codes:** Vehicle-specific exclusions and coverage rules
- **Motor Categories:** Vehicle type-based coverage and pricing rules

Implementation Benefits

1. Regulatory Compliance

- **Medical Codes:** Ensure proper billing, coverage determination, and regulatory reporting
- **Actuarial Tables:** Meet regulatory pricing requirements and rate filing justifications
- **Audit Trails:** Complete documentation for regulatory examinations and compliance

2. Accurate Pricing

- **All Cost Factors:** Complete premium calculations including every cost component
- **Network Economics:** Provider costs and network tiers properly reflected in pricing
- **Age/Demographic Risk:** Actuarially sound risk assessment and pricing

3. Competitive Positioning

- **Discount Structures:** Flexible pricing for market competitiveness
- **Commission Models:** Attractive compensation for distribution partners
- **Industry-Specific Pricing:** Targeted pricing for different market segments

4. Operational Efficiency

- **Complete Quotation Engine:** All factors integrated for accurate quotes
- **Automated Underwriting:** Efficient processing with proper risk assessment
- **Provider Integration:** Seamless network management and cost control

Success Criteria

Technical Success Metrics:

- ☒ All database tables implemented with proper relationships
- ☒ Quote generation time under 3 seconds for complex plans
- ☒ 99.9% calculation accuracy verified against actuarial models
- ☒ Complete audit trail for all pricing decisions

Business Success Metrics:

- ☒ Ability to generate quotes for all insurance types (Medical, Motor, Life)
- ☒ Support for complex benefit structures with conditions
- ☒ Provider network integration for accurate cost calculations
- ☒ Regulatory compliance for all pricing and coverage decisions

Risk Mitigation

IMPLEMENTATION RISKS & MITIGATION

Risk 1: Incomplete Product Definition

Mitigation: Complete Step 1-2 thoroughly before proceeding. Ensure all benefit structures are properly defined.

Risk 2: Inaccurate Pricing Calculations

Mitigation: Implement comprehensive testing with actuarial validation at each step. Build calculation audit trails.

Risk 3: Performance Issues with Complex Calculations

Mitigation: Design for performance from the start. Implement caching strategies and optimize database queries.

Risk 4: Regulatory Non-Compliance

Mitigation: Include all required medical codes, actua