

Property Risk AI Evaluation System

AI-Driven Architecture for Multi-Domain Risk Assessment

- Legacy Risk Workflow Overhaul:** Redesigned from a monolithic .NET MVC system to a modular, AI-first architecture to handle large, complex survey data efficiently.
- Orchestrated AI Evaluation:** Integrated OpenAI agents and n8n workflows to decouple risk assessment logic and enable parallel, domain-specific analysis.
- Scalable and Maintainable:** The new system supports asynchronous operations, reduced timeouts, and a maintainable structure aligned with modern software principles.



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Executive Summary

Why We Modernized the Risk Evaluation Pipeline



Legacy Performance Bottlenecks

The MVC app struggled with large surveys and synchronous processing, creating delays and unreliability.



AI Integration Needed Structure

AI evaluations were failing due to oversized prompts and timeout constraints; parallelization was essential.



n8n Orchestration Introduced

A workflow engine was deployed to manage AI calls, batch processing, and asynchronous task handling.



Reliable and Scalable Output

With orchestration and decoupling, AI evaluations are now consistent, schema-compliant, and scalable.

Problem Definition

The Core Challenges

- Single-Threaded Processing:** Legacy system executed entire survey analysis in one pass, blocking users and overloading resources.
- Database Round Trips:** User experience was poor because the amount of processing and database round trips became time consuming.
- Computational Dependencies:** Any changes to the questionnaire would require backend computational changes This made the system brittle .
- User-Facing Failures:** Any backend error surfaced directly to users, reducing trust and usability.



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Constraints of the Legacy System

Why Fixing the Code Wasn't Enough

- **Synchronous MVC Limitations:** .NET 3.5 MVC lacked async capabilities, causing the UI to freeze during heavy operations.
- **Direct SQL Writes Blocked Requests:** Data writes were part of the same cycle as user input, introducing potential delays and lockups.
- **No Background Execution Support:** Absence of workers or task queues meant long-running tasks impacted overall performance.
- **Tight Coupling of Logic and UI:** Business logic was hardcoded in the controller layer, making maintainability difficult.



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Solution Goals

What the New Architecture Needed to Achieve

- **Asynchronous Architecture:** Decoupled AI analysis from the MVC layer to improve responsiveness and isolate computation.
- **Parallel Domain Processing:** Each risk domain is analyzed independently, enabling efficient and scalable evaluation.
- **Reliable, Schema-Compliant Output:** Introduced validation layers to ensure all AI responses produce structured JSON with strict compliance.
- **Minimal Legacy Disruption:** Changes inside the MVC application were kept minimal, focusing modernization externally.

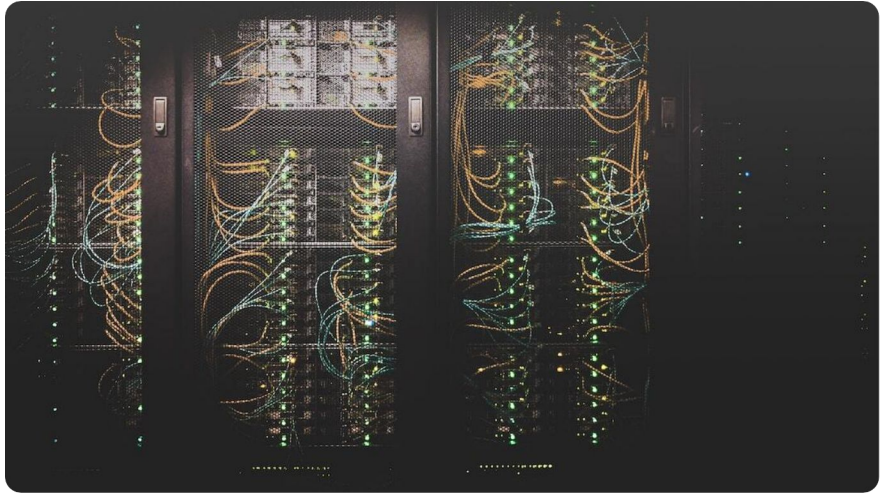


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AI-First Philosophy

How AI Shaped the Architecture



Focused Domain Reasoning

AI performs better when prompts are scoped to a specific domain with clear inputs and expectations.



Avoiding Overload Failures

Single, large AI prompts led to hallucinations, token overflow, and inconsistent results.



Batching + Schema Enforcement

Batched domain evaluations with strict schema outputs improved accuracy and downstream utility.



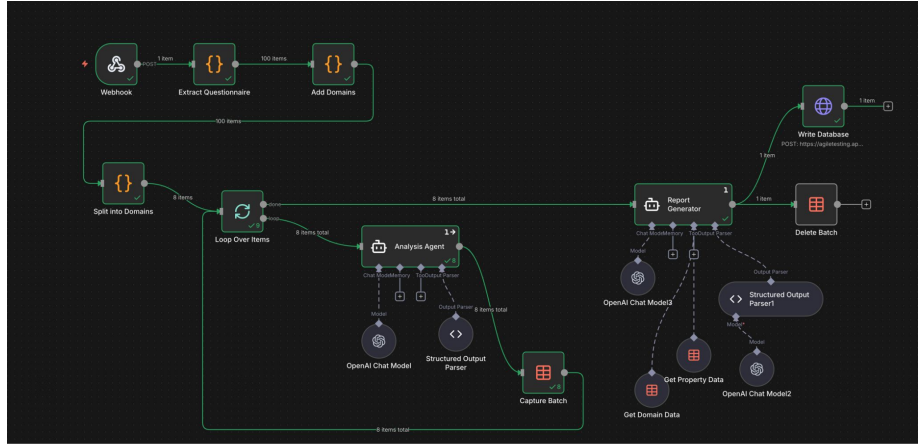
Delegated Intelligence

The orchestration layer (n8n) manages control flow, while AI handles targeted reasoning only.

High-Level Architecture

From MVC to AI-Powered Processing

- **MVC Triggers n8n Webhook:** Legacy MVC app initiates the process by posting raw survey JSON to an n8n webhook.
- **n8n Orchestrates Analysis:** JSON is cleaned, grouped by domain, and sent through a loop to OpenAI agents for evaluation.
- **Results Merged and Stored:** Processed outputs are merged into a final report and stored via a separate background workflow.
- **UI Renders Summary Only:** MVC UI now simply renders the final risk assessment, offloading all analysis to the backend.



Workflow 1 Overview

Webhook JSON → AI Analysis (Batch Mode)

- **Webhook Entry Point:** User-submitted surveys are captured via a webhook, providing an API-like intake for varied JSON formats.
- **Survey Normalization:** Unstructured input is cleaned, standardized, and reformatted into consistent question/answer pairs.
- **Domain Clustering:** Questions are grouped by risk domain, forming batches for AI evaluation.
- **Parallel AI Calls:** Each domain is independently analyzed by an OpenAI agent and results are compiled.
- **Merged Final Output:** Domain responses are aggregated into one unified JSON report for downstream use.

Workflow 2 Overview

Risk Evaluation JSON → SQL Writer



JSON Intake

Final AI-evaluated report is passed to a second workflow focused on storage.



Relational Preparation

Flattened and organized into structured formats compatible with SQL tables.



Multi-Table Inserts

Domain scores, weaknesses, and mitigation steps are stored in normalized relational tables.



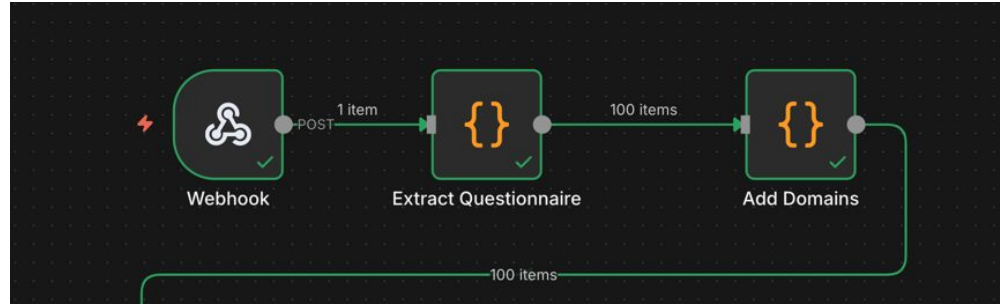
Asynchronous Operation

Runs as a background task, isolating UI response times from database latency.

Node-Level Walkthrough

- Primary Intake Point:** Webhook acts as the gateway for receiving survey JSON from the MVC application.
- Payload Validation:** Immediately checks the JSON structure for syntactic correctness before workflow processing.
- Async Pipeline Initiation:** Transfers the data into n8n's asynchronous processing sequence, decoupling UI delays.

Security is protected by authentication (demo uses a username and password, production would use an API secret key)



Database Model Overview

Storing Final Risk Results

- **Normalized SQL Structure:** Final report is decomposed into multiple relational tables supporting full queryability.
- **Job-Level Indexing:** Each submission is stored as a Job record with foreign key links to all domain entries.
- **Separate Domain & Mitigation Tables:** Domains, weaknesses, and mitigation steps are split to enable structured analysis.
- **Analytics-Ready Design:** Model supports trend tracking, dashboards, and cross-property analytics in BI tools.

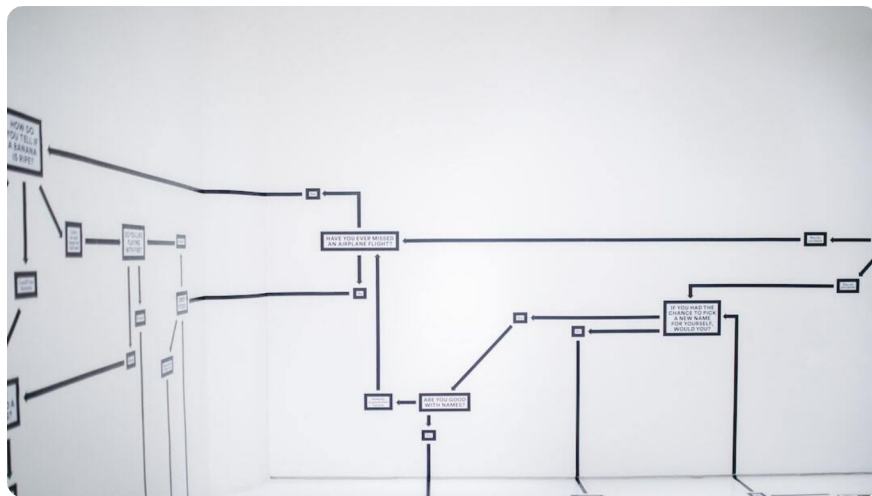


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Operational Benefits

Why the New Architecture Works Better



Batch Processing

Domains are processed independently in a batch, improving speed and fault isolation.



Timeout-Free Execution

No monolithic prompts mean AI runs are shorter and more consistent.



Decoupled SQL Writes

Storage runs asynchronously, preserving UI responsiveness and eliminating bottlenecks.



Schema-Validated Outputs

All AI results are forced into a clean format, reducing parsing errors and manual corrections.

Risks & Trade-Offs

What We Accept to Gain Scalability



AI Model Dependency

Reliance on OpenAI agents introduces external service risk and requires prompt maintenance.



Workflow Complexity in n8n

Centralized orchestration demands careful monitoring and ongoing tuning.



Eventual Consistency

Asynchronous writes may delay final database visibility, trading speed for isolation.



Rule Maintenance Burden

Domain classification logic must evolve with survey changes to preserve accuracy.

Future Enhancements

Where We Can Grow Next



Voice-Based Survey Intake

AI agents that clients can speak to for dynamic, real-time data collection.



AI-Driven Insurance Alignment

Models trained to compare risks against policy guidelines for coverage optimization.



Follow-Up Automation

System-generated clarifications and deeper analysis prompts for incomplete or risky responses.



Cross-Property Analytics

Pattern discovery across risk profiles to guide portfolio-level decisions and mitigation strategies.

Conclusion

A Stable, Scalable, AI-Powered Risk Platform

- **Legacy System Preserved:** Modernization enhanced functionality without disrupting existing MVC workflows.
- **Modular AI Integration:** Domain-specific AI agents support parallel processing and consistent evaluation.
- **Reliable and Responsive:** Decoupled workflows reduce timeouts and maintain fast UI feedback.
- **Extensible and Maintainable:** Architecture supports future domain additions and evolving business requirements.



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