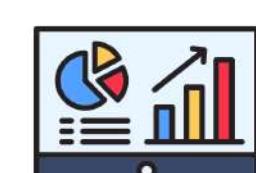


# Importance and current issues with the Data across the Network Management Value Chain

VALUE CHAIN STEP	ROLE OF DATA	PROBLEMS WITH DATA		
 Provider Identification	Identifying high-value providers across health plans and regions Determining the top providers by specialty, location, and performance metrics	<b>Data Accuracy:</b> Issues with inconsistent or outdated provider information	<b>Data Standardization:</b> Challenging to merge different formats of data	
 Data Collection & Integration	Aggregating provider data from multiple sources, including price transparency & quality ratings Ensuring consistency in provider profiles by matching across sources	<b>Data Completeness:</b> Limited or incomplete data from sources	<b>Data Integration:</b> Time-consuming and resource-intensive data	
 Provider Analysis	Calculating quality and cost-efficiency scores to rank providers Identifying gaps in network based on high-value providers and patient demand	<b>Metric Relevance:</b> Relevant and up-to-date metrics for assessing provider value	<b>Bias in Metrics:</b> Metrics may not account for all aspects of provider value	
 Network Building	Designing custom networks with high-value providers based on insurer criteria Allowing insurers to adjust networks based on changing performance data	<b>Scalability:</b> Flexible networks at scale while ensuring quality and cost-efficiency	<b>Data Maintenance:</b> Continuous update of network data with network changes	
 Performance Analytics	Developing dashboards to visualize cost, quality, and outcome trends for providers and networks Providing insights into competitive provider landscape by specialty and region	<b>Visualization Complexity:</b> Displaying complex data in a digestible, actionable format	<b>Data Update Frequency:</b> Maintaining real-time data for accurate analytics	
 Market Positioning & Outreach	Using insights to target and recruit high-value providers for network inclusion Automating provider engagement and network optimization based on performance data	<b>Recruitment Efficiency:</b> Reaching out to relevant providers while balancing provider availability	<b>Provider Engagement:</b> Ensuring response from providers in competitive	
 Compliance & Security	Ensuring all data usage aligns with HIPAA, CMS regulations, and price transparency mandates Implementing secure data access and encryption to protect patient and provider information	<b>Regulatory Challenges:</b> Adhering to evolving data protection and price transparency regulations	<b>Data Security:</b> Securing sensitive provider and patient data from unauthorized access	
 Data Accuracy <sup>1</sup>	 <b>Data Completeness</b> <sup>2</sup> <b>20%~</b> healthcare data is incomplete, affecting the ability to make informed decisions regarding provider networks	 <b>Visualisation Complexity</b> <sup>3</sup> <b>30%~</b> more time is needed by healthcare teams to extract insights due to poor visualisation tools	 <b>Regulatory Challenges</b> <sup>4</sup> <b>60%~</b> health organisations face challenges in adapting to these evolving privacy laws	 <b>Data Security</b> <sup>5</sup> <b>67%~</b> breaches involve sensitive patient information, making healthcare data a prime target, often due to ransomware attacks

## Personas

## User Profile



**Pawan Shukla**  
Health Plan Executive



**Amrita Goel**  
Provider Network Specialist



**Prashant Sharma**  
Data Analyst

## Pain Points

- Time-consuming data cleaning for network benchmarking and provider analysis.
- Limited access to competitive data on provider performance in real-time, delaying insights.

- Difficulty comparing providers across plans to ensure cost-effectiveness and quality.
- Challenge in identifying high-value providers and understanding cost-performance ratios.

- Spends excessive time cleaning inconsistent data from multiple sources, delaying insights.
- Limited real-time data and benchmarking hinders timely competitive analyses and network optimization.

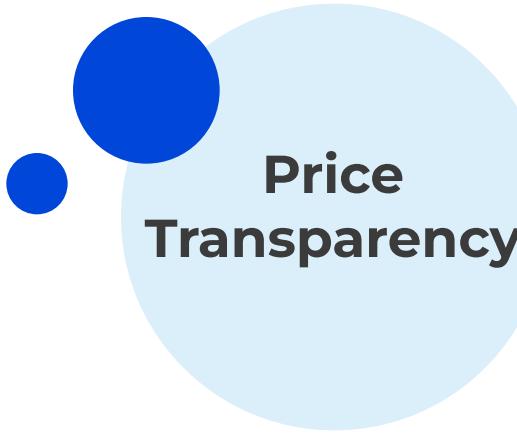
## CJM ANALYSIS

Stages	Network Setup and Configuration	Provider Comparison and Analytics	Network Optimization	Compliance & Reporting
User Goals	Quickly understand platform benefits, complete the setup, and access the dashboard	Compare and rank providers using quality, cost, and performance metrics	Recruit and monitor high-value providers for a balanced, high-performing network.	Ensure compliance with industry regulations and track network performance
Touch points	Search and filter providers, access provider performance data, and view benchmarking dashboards	Profile dashboard, profile data entry, third-party data integrations, document uploads	Ongoing performance tracking, network performance alerts, and cost optimization prompts	Compliance alerts, reporting dashboard, downloadable reports
Platform Features	Guided Walkthrough  User Roles and permission setup	Performance Analytics  Provider Quality Metrics  Cost Comparison	Provider Search and Matching  Performance Analytics  Benchmarking Tools  Geospatial Analysis	Compliance Monitoring  Custom Reporting  Audit Trail  Alerts for Regulatory Changes

## Assumptions

- Sufficient, accurate, and up-to-date provider data (e.g., pricing, quality, outcomes) from publicly available sources, as well as via web scraping, will be accessible for effective analysis and integration.
- Current regulatory requirements for data transparency and healthcare compliance (like HIPAA and CMS guidelines) will remain stable in the near term.
- AI-driven analytics and benchmarking are crucial for real-time provider performance insights.
- Users should have a baseline data literacy to effectively utilize the advanced features.
- AI models used will be assumed to generalize well across different types of providers and geographic regions.

## ROOT CAUSE OF PROBLEMS IN REAL-WORLD



### Price Transparency

**Fragmented Pricing Data:**  
Pricing is inconsistently disclosed and often obscured by complex formats or paywalls

Procedure prices can vary over **300%** among providers in the same region, and only **50%** of hospitals complied with the Hospital Price Transparency Rule as of February 2022 <sup>6</sup>

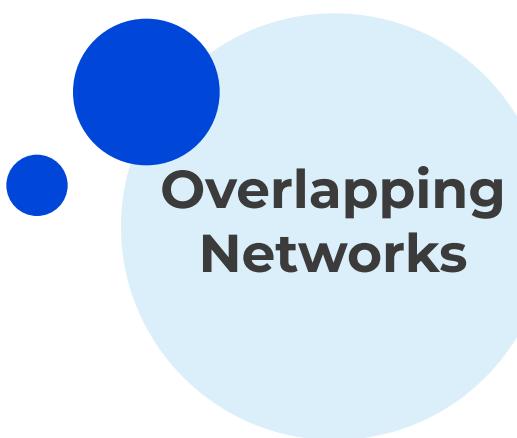


### Provider Quality

**Inconsistent Quality Metrics:**  
Quality data varies by source and is often self-reported, raising trust issues

**Lack of Comprehensive Data:**  
No centralised system consolidates provider performance data across plans, reviews, and outcomes

Only **37%** of healthcare providers consistently report quality data, and under **50%** of insurers use these metrics, potentially including underperforming providers <sup>7</sup>



### Overlapping Networks

**Data Silos:**  
Provider data on cost, quality, and outcomes is scattered, making cohesive analysis challenging

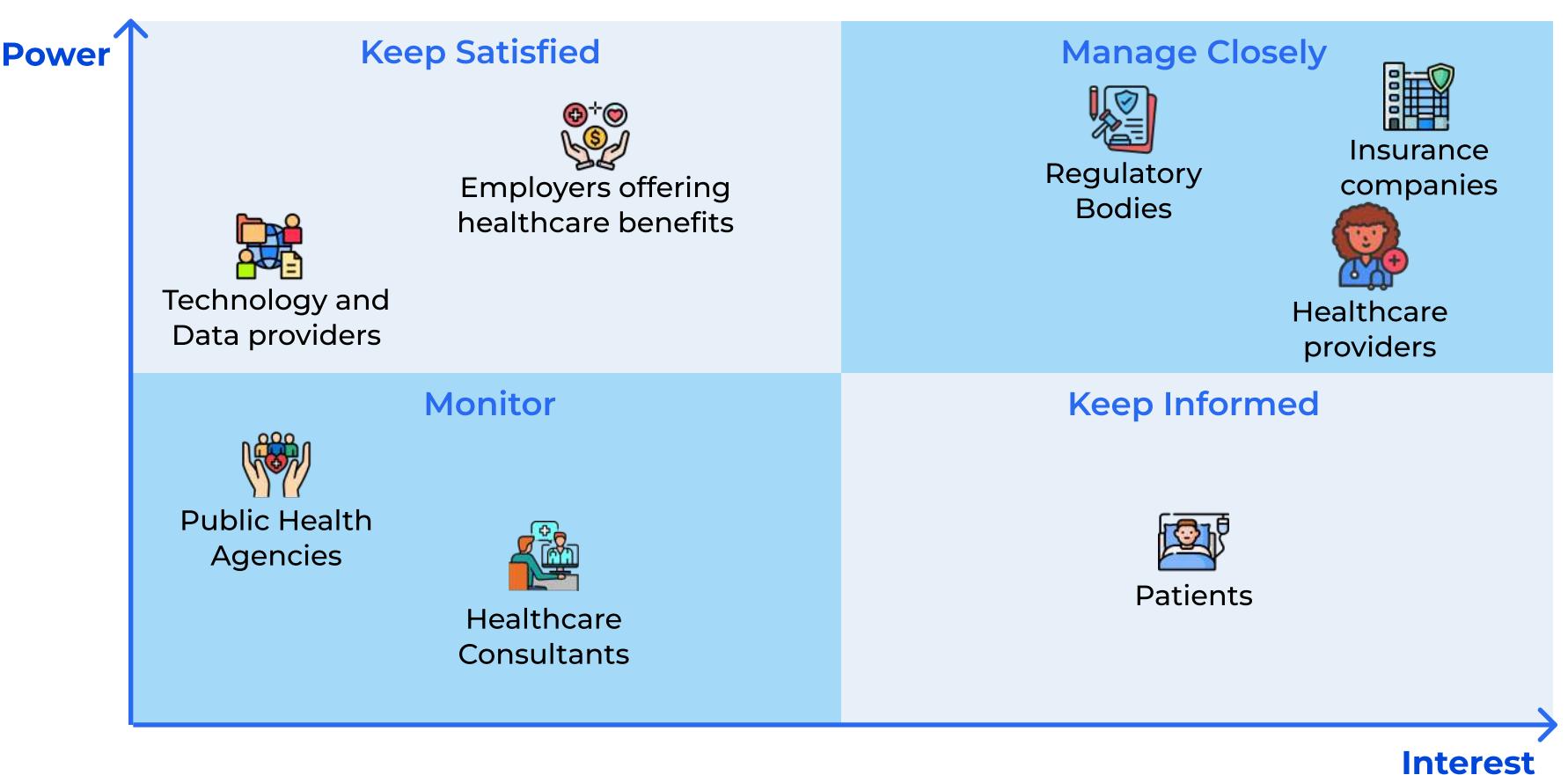
**Manual Processes:**  
Provider recruitment often relies on outdated manual methods and lacks data analytics

The U.S. may face a shortage of 37,800 to 124,000 physicians by 2034, especially in rural areas. Additionally, over **40%** of health plans in large cities share at least **50%** of their networks <sup>8</sup>

## POTENTIAL USERS

Potential Users	Impact	Market Opportunity
Insurance Company Executives	High: They rely on data-driven insights for strategic decisions on provider networks and cost optimization	Large market with high demand for tools that reduce costs and improve network performance
Provider Network Specialists	High: Need streamlined processes to identify, compare, and recruit high-value providers efficiently	Strong market need as network specialists aim to optimize provider networks to improve quality and cost
Data Analysts	Moderate: Require advanced analytics and clean data for accurate performance assessments	Growing market for data tools that support deep analysis, quality control, and real-time reporting
Compliance Officers	Moderate: Focus on adherence to regulatory standards, ensuring data security and transparency	Expanding due to stricter regulations, creating demand for tools that maintain compliance automatically

## STAKEHOLDER ANALYSIS



## SOLUTION

### Mantra X : Revolutionizing healthcare provider networks

The MantraX will offer insurers a comprehensive solution for optimizing provider networks. It will leverage advanced data ingestion, quality enhancement, and analytics to identify high-value providers, reduce network inefficiencies, and ensure cost-effective care.



#### Data Quality Management

Data Quality Engine integrated into each stage of the ETL pipeline to automate validation, standardization, and anomaly detection.

Rules-Based Quality Control Layer for ensuring uniformity and completeness.



#### Performance Analytics

Apache Kafka and ETL tools for real-time and batch data ingestion

Use of Spark and machine learning models to score and rank providers.



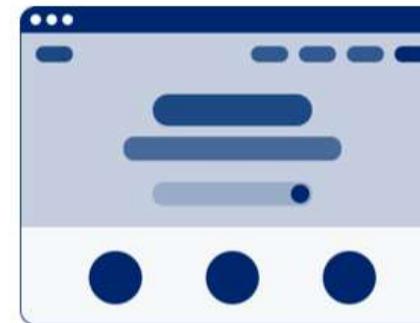
#### Bias Reduction

Use of AIF360 and Fairlearn to analyze bias metrics in raw data and model predictions

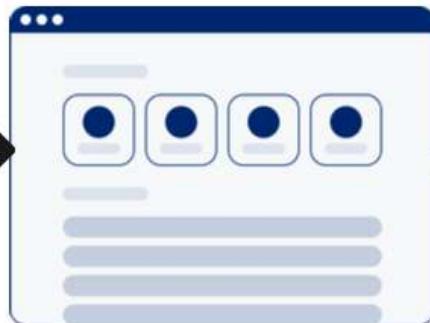
Using user feedback and demographic representation insights to recalibrate the system over time.

## User Journey

### Landing & Log-in

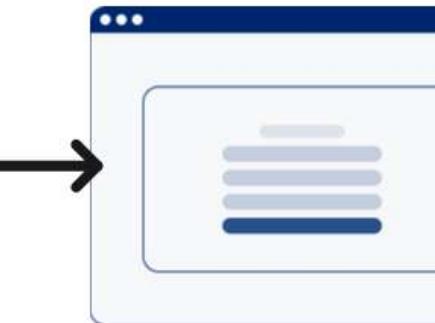


### Dashboard



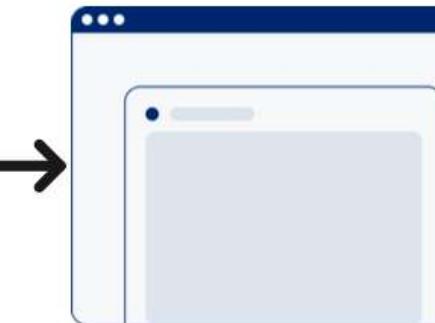
Overview of network performance, provider quality metrics, and actionable insights

### Network Configuration



User sets network parameters, defines goals, and begins provider search and comparison

### Data Ingestion & Quality Enhancement



Integrates and cleans data from various sources to ensure reliable insights

### Compliance & Reporting



Recruit Providers

Analyse market gaps

Real time update of network

Customize analysis

### Network Optimization Insights



Displays insights on high-value providers, network gaps, and optimization opportunities.

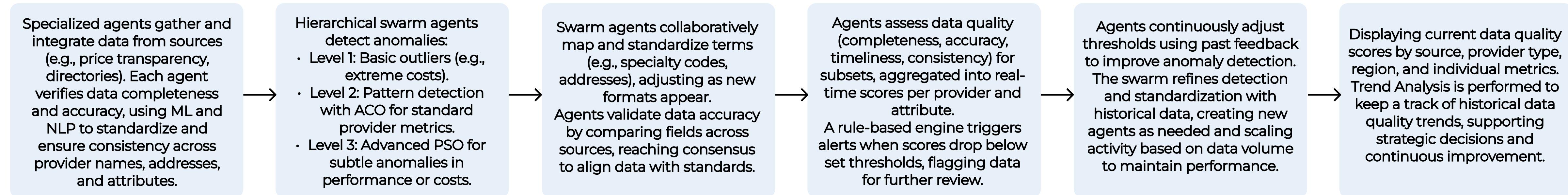
### Provider Analysis & Bias Reduction



Analyzes provider performance metrics while reducing selection biases to allow accurate comparisons

## FEATURE 01 : Data Quality Management and Bias Reduction

### Workflow



### Semantic Data Validation

- Domain specific metrics like Patient Satisfaction Scores from CAHPS Survey, CMS Survey Scores, Network inclusivity, referral volume, etc integrated into agent swarm for validating data.
- When data is imported or updated agent action is triggered
- Validation alerts triggered for non-conforming elements

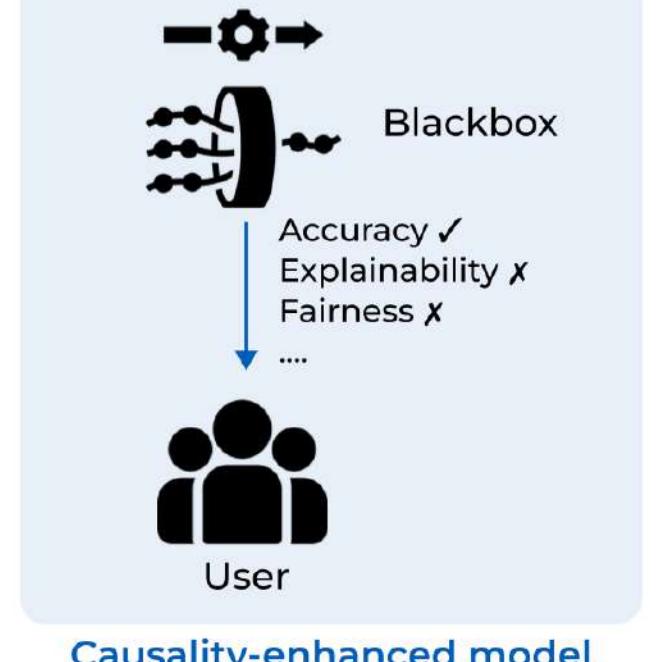
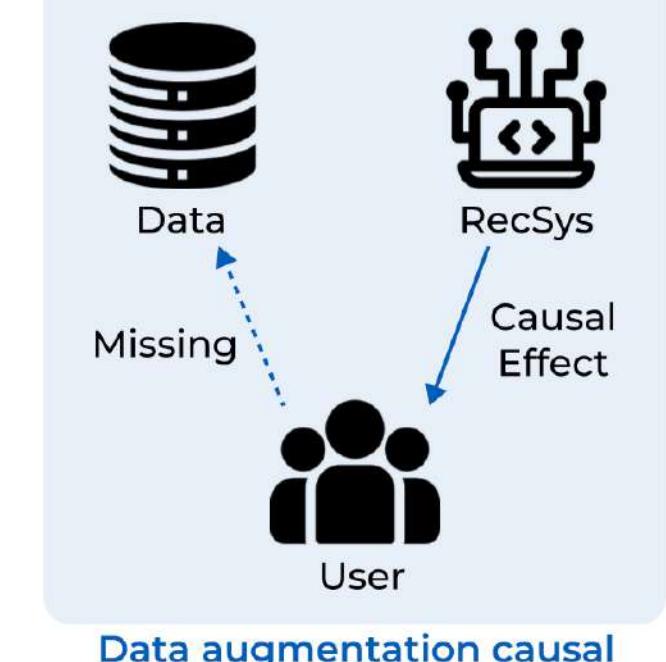
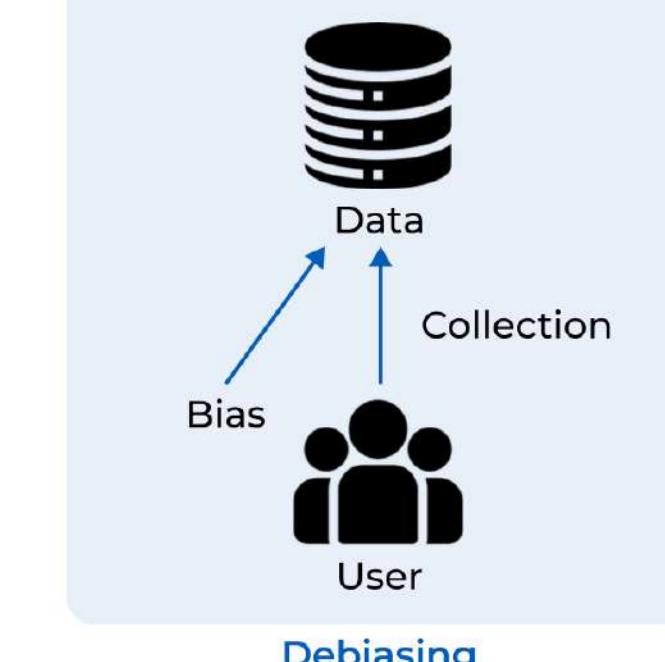
### Counterfactual Analysis Tool

- Users define counterfactual scenarios they want to analyse with conditions, variables
- Simulation engine often based on causal graphical models perform the analysis
- Outcomes for each provider based on defined scenarios is calculated and compared with actual outcome of RWD submitted by the provider as the roster

### Transparency Intelligence™

- AI-Powered Provider Insights to transform provider network management with the intelligent invoice analysis backend.
- Leveraging cutting-edge AI, the feature will automatically captures, analyze, and score provider bills, delivering unparalleled insights into financial practices.
- By transforming raw data into strategic intelligence, we help healthcare organizations curate high-integrity networks and optimize patient care decisions.

### CAUSAL INFERENCE



Causal inference AI involves using advanced statistical and machine learning techniques to uncover cause-and-effect relationships within data, addressing issues like confounding and establishing the impact of one variable on another, helping researchers and decision-makers make more informed choices across diverse domains. The above illustration represents three typical issues of non-causality recommendation models and how causal inference addresses them

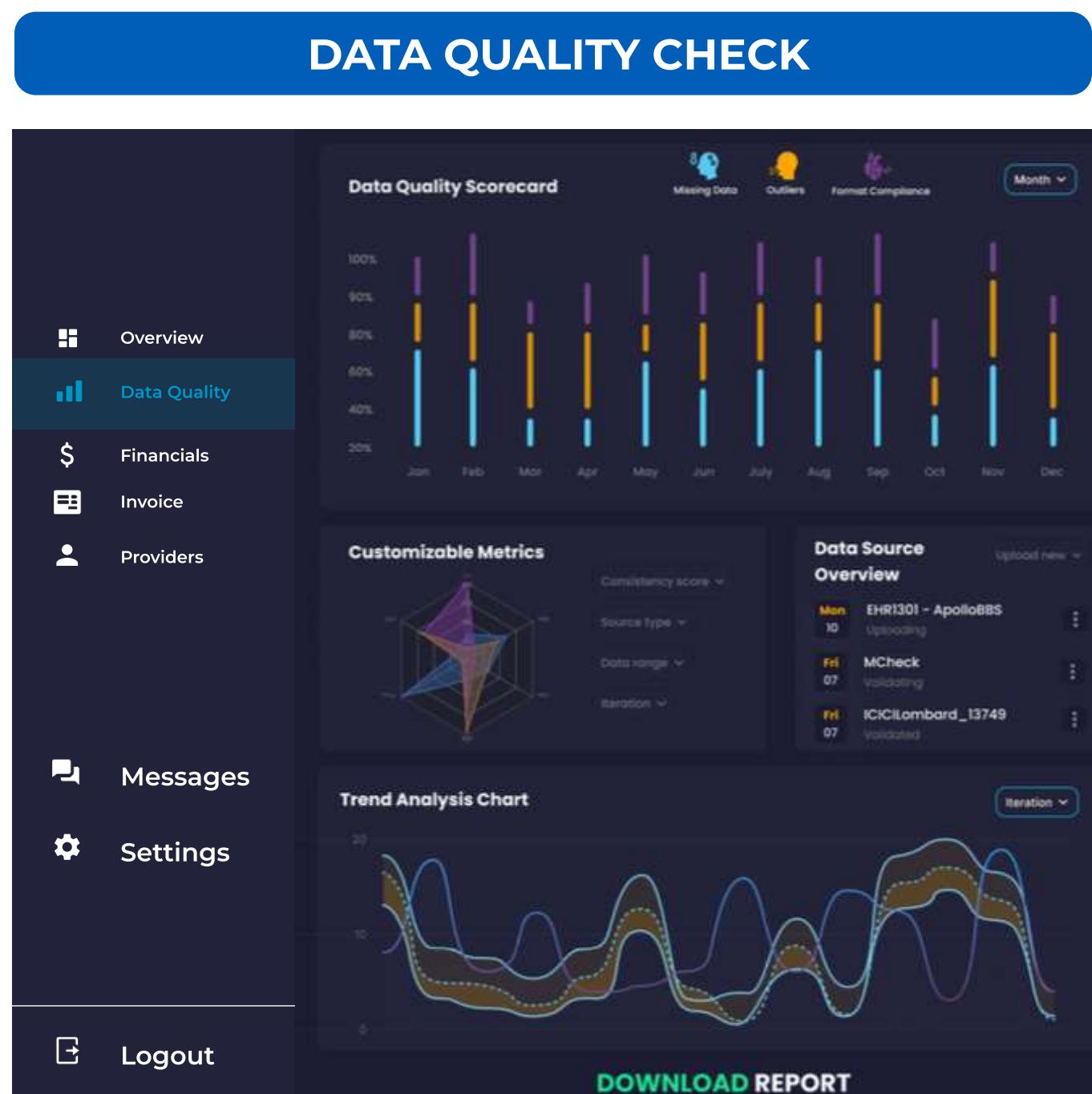
## FEATURE 02 : Performance Analytics

### DATA QUALITY CHECK

- A dedicated module for monitoring and ensuring data quality within the hospitals
- This module provides insurers with clear insights into the quality and reliability of hospital-provided data

**Metrics Monitored:** Includes tracking for Missing Data, Outliers, and Format Compliance across months

**Trend Analysis:** Monthly visualisation shows the percentage of data compliance, allowing insurers to identify months with potential data issues

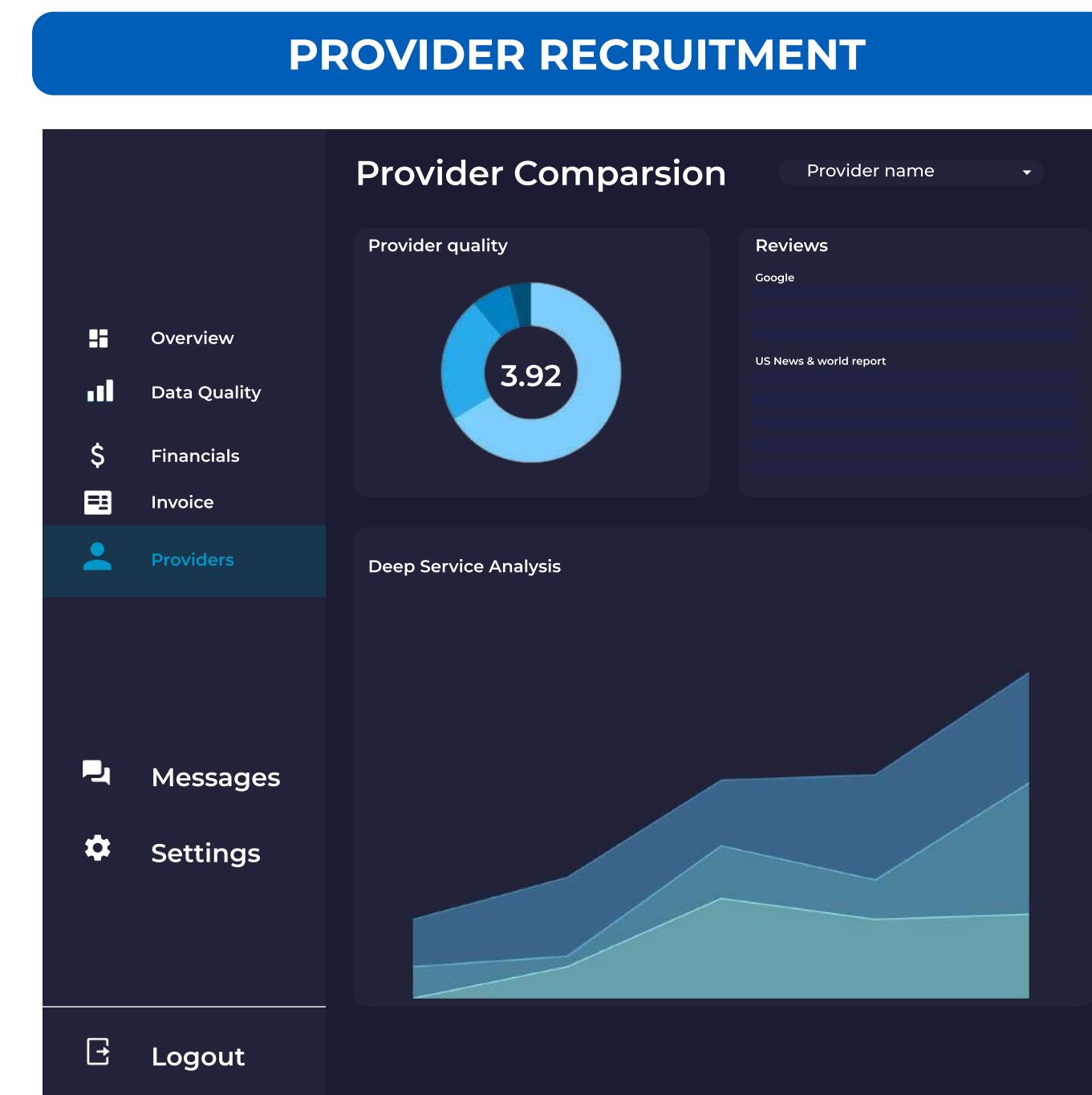


### PROVIDER RECRUITMENT

- A high-performing provider network by selecting providers with optimal performance metrics
- Leverage provider quality scores, review sources, and deep service analysis to make informed recruitment decisions

**Metrics Monitored:** Quality score reflects the provider's performance across critical factors (e.g., treatment success, patient satisfaction)

**Selection Criteria:** Only recruit providers scoring above a specified threshold to ensure high standards within the network



- **Real-Time Status:** Shows the current status of data sources, indicating whether they are uploading, validating, or have completed validation
- **Easy Navigation:** Users can click on each data source to view detailed logs or validate specific data points

### Workflow

Login → Access Dashboard → Select Data Quality Module → View Scorecard Metrics → Analyse Data Trends → Download Report

### HOW ARE THESE METRICS CALCULATED ?

#### 1. Provider Quality Score

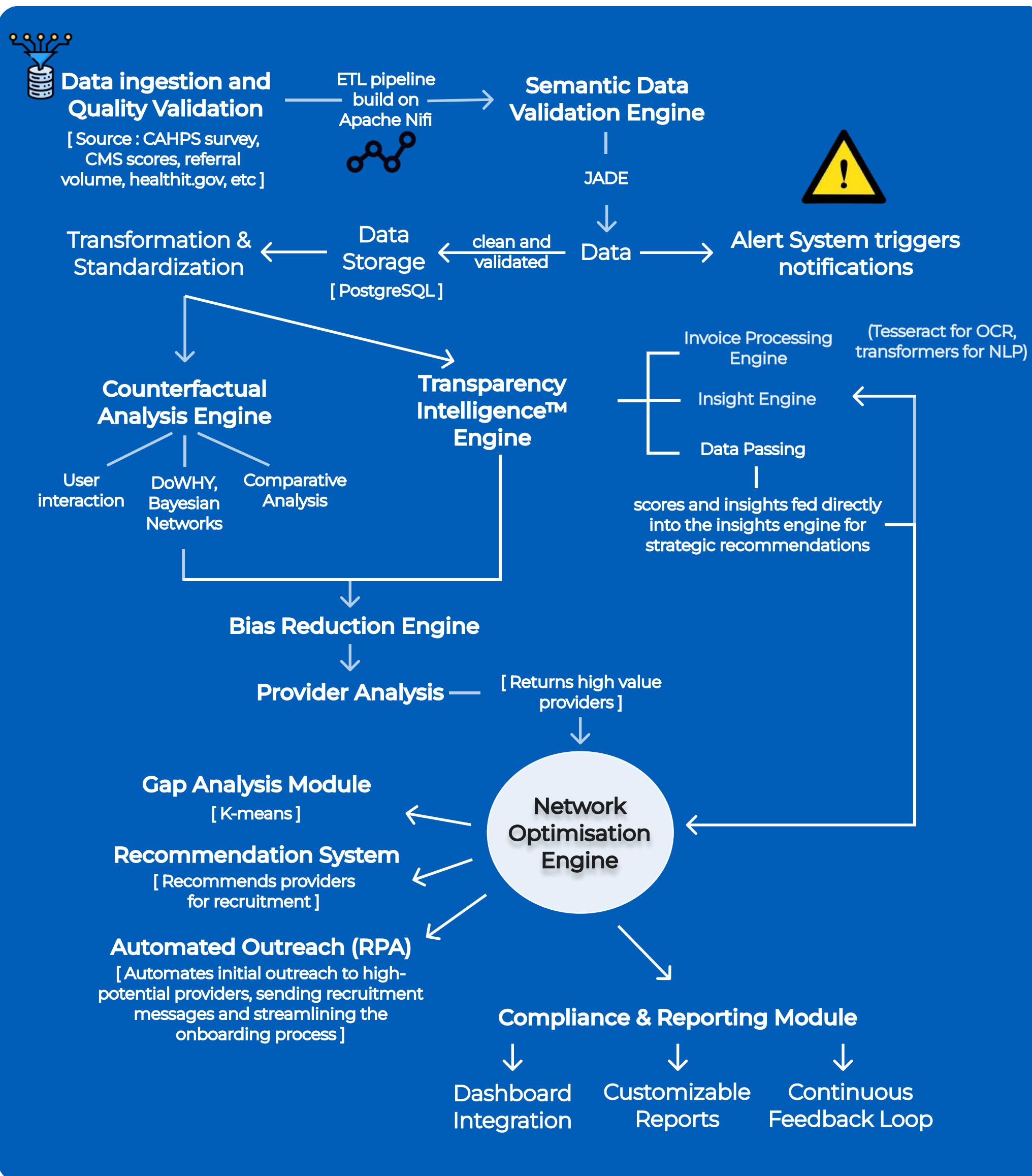
Components: Patient Satisfaction, Treatment Success rate, Readmission rate, Mortality Rate  
Calculation: Combine these factors into a weighted average

$$\text{Quality Score} = (w_1 \times \text{Patient Satisfaction}) + (w_2 \times \text{Treatment Success Rate}) + (w_3 \times (1 - \text{Readmission Rate})) + (w_4 \times (1 - \text{Mortality Rate}))$$

#### 2. Deep Service Analysis

Components: Service Utilisation Frequency, Cost Efficiency, Health Outcomes  
Trend Analysis: Historical Data, Rolling Average or Moving Median

## FEATURE 03 : Automation

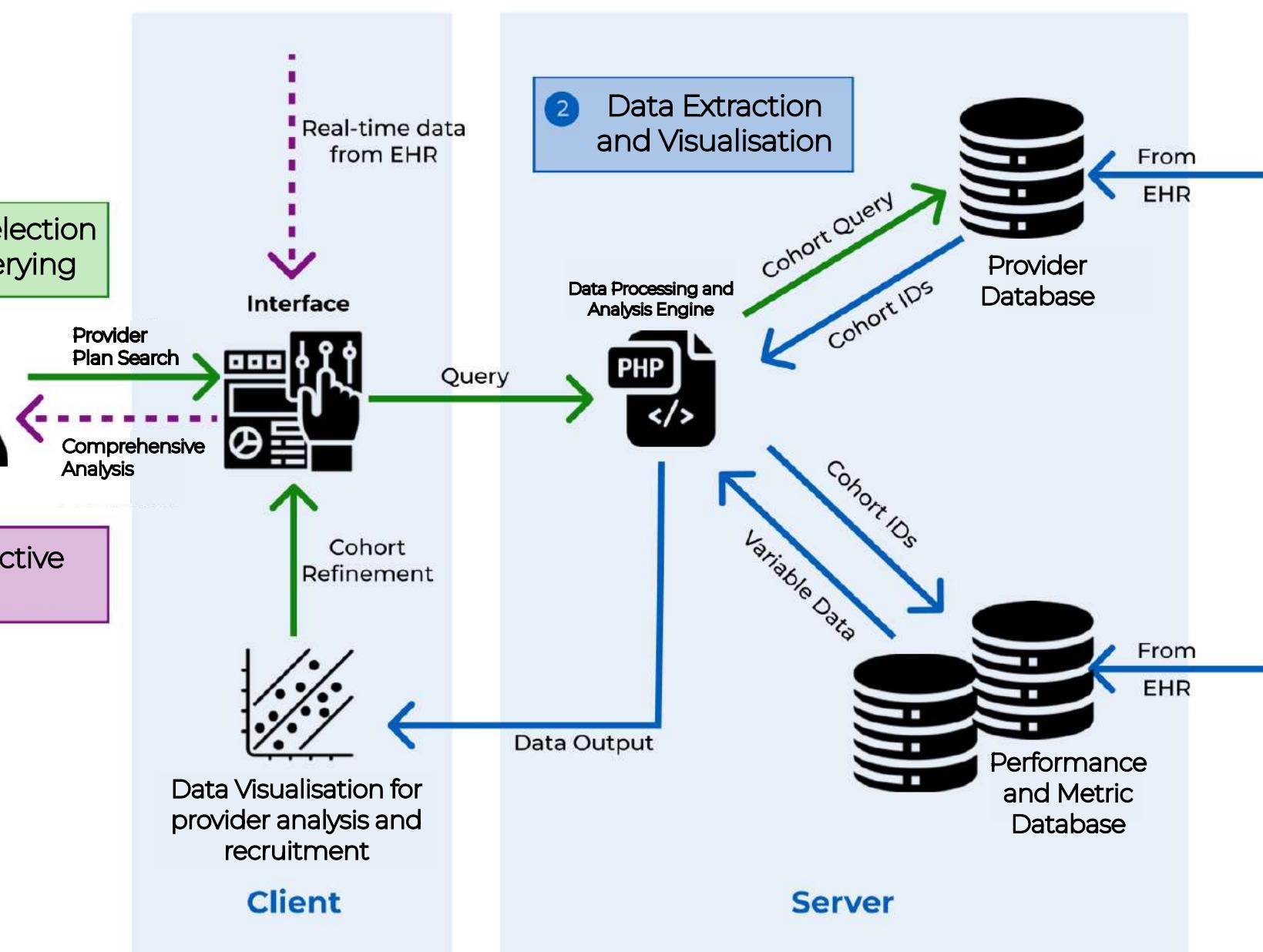


### Core Technologies and Infrastructure

- Data Orchestration: Apache Nifi for sequential task automation and coordination between engines.
- Database: PostgreSQL for secure, scalable data storage.
- Workflow Automation: UiPath (RPA) for automating repetitive tasks, particularly in recruitment.
- Analytics and Visualization: PowerBI / Tableau for visualizing performance insights and network gaps.
- APIs & Integrations: REST APIs for interoperability between the engines, ensuring modular and scalable architecture.

Users will be able to define “what-if” recruitment scenarios (e.g., the impact of recruiting a provider with high patient satisfaction vs. one with lower costs). Automatically simulate these scenarios to predict outcomes on the network’s overall performance, cost, and patient satisfaction.

ML algorithms analyse provider metrics, assess gaps, and make recruitment predictions. Output is sent back to the client for visualization, with insights into potential new providers.



## METRICS TO MEASURE SUCCESS OF FEATURES

	Measures the accuracy of the <b>predicted outcomes</b> in "what-if" recruitment scenarios, comparing predictions to real-world results (e.g., <b>cost savings, quality improvements</b> ). Success Indicator: <b>High alignment</b> between scenario predictions and actual network performance changes would validate the <b>predictive accuracy</b> of the scenario simulation
	This is the <b>aggregated quality score</b> (completeness, accuracy, timeliness, consistency) of the <b>provider data</b> , tracked over time to identify improvements due to the DQM feature. An <b>increase in average data quality scores</b> and a <b>decrease in flagged anomalies</b> would show that the data collection, validation, and quality assurance processes are performing effectively
	This metric measures the percentage of <b>high-value providers recruited</b> over time, compared to <b>total provider recruitment attempts</b> . A <b>high rate of successful recruitment</b> with improvements in <b>network quality</b> (e.g., quality scores, patient satisfaction) would indicate the tool's effectiveness in identifying and attracting high-value providers.

## FEATURE PRIORITIZATION

	Impact on ROI	Development Complexity	User Value	Compliance & Data Reliability	Total Score
Data Quality Management and Bias Reduction	★★★★★ ★★★	★★★★ ★★	★★★★★ ★★★	★★★★★ ★★★	1
Performance Analytics	★★★★★ ★★★	★★★★★ ★★★	★★★★★ ★★★	★★★★★ ★★★	2
Automation	★★★★★ ★★★	★★★★★ ★★★	★★★★★ ★★★	★★★★★ ★★★	3

## POTENTIAL PITFALLS AND WORKAROUNDS

Variability in data formats across providers creates inconsistencies, complicating the validation, standardization, and quality management processes.	<ul style="list-style-type: none"> <li>Implement a metadata-driven tool (e.g., Apache NiFi) for dynamic schema matching and versioning.</li> <li>Automatically detect schema changes, log them, and apply data mapping rules.</li> </ul>
Provider performance models may overfit the training data, reducing their generalizability to new providers and data variations.	<ul style="list-style-type: none"> <li>Use regularization (L1/L2) and cross-validation to prevent overfitting.</li> <li>Employ SHAP to ensure model interpretability and validity of predictions.</li> </ul>
Real-time orchestration can suffer latency when pulling from multiple sources or running complex automation scripts, slowing "what-if" modeling and workflow responsiveness.	<ul style="list-style-type: none"> <li>Leverage a microservices architecture with message queues (e.g., Kafka, RabbitMQ) for parallel tasks.</li> <li>Enable low-latency, asynchronous processing to enhance workflow automation.</li> </ul>
Automated recruitment scenarios can lack transparency, making it difficult for users to understand and trust recommendations, especially in regulated industries.	<ul style="list-style-type: none"> <li>Integrate explainable AI (XAI) methods like LIME for interpretable decision-making.</li> <li>Ensure users understand and trust system recommendations, especially in regulated areas.</li> </ul>
Provider performance data may contain regional or demographic biases, which can lead to skewed recruitment and retention decisions, impacting network quality.	<ul style="list-style-type: none"> <li>Apply re-weighting to adjust for underrepresented demographics in the data.</li> <li>Use adversarial debiasing to reduce bias in models, ensuring fair provider evaluation.</li> </ul>

## FUTURE ADVANCEMENTS

- Predictive and Prescriptive Analytics :** Leverage advanced ML models, minimizes resource gaps, and optimizes provider selection based on forecasted demand
- Blockchain Integration :** Can streamline compliance verification with transparent record of provider data, significantly reducing administrative overhead
- Context-Aware Automation :** Implement context-aware adaptive AI that adjusts automation workflows via seasonal trends or changing user preferences