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APM Case Study

Problem Statement

Employers face significant challenges in understanding the impact and costs associated with changing healthcare provider networks. Traditional methods do not capture the complexity of member-provider relationships and the true extent of disruption. Using claims data, build an AI tool that would help employers take informed decisions in case of disruptions without causing trouble to member experience.

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Problem Overview

Potential Impact of Solving the Problem

Reduced Care Disruptions: By predicting access issues, employees retain continuous relationships with essential providers, especially for chronic and mental health care.

Lower Out-of-Pocket Costs: Estimating potential cost increases allows employers to offset expenses, preventing surprise costs for employees.

Optimized Employer Costs: Proactive network management enables cost-effective healthcare planning, balancing budget and employee needs.

Regulatory Compliance: Meeting CMS and state adequacy standards helps employers avoid penalties and maintain compliance, particularly in specialty areas.

Data-Driven Benefits Planning: Actionable insights support strategic benefits adjustments, allowing HR to prioritize high-impact providers and effectively allocate resources.

Assumptions

- **Data Availability and Standardization:** Reliable claims and network data in standardized formats are accessible.
- **Privacy and Compliance:** HIPAA compliance and data-sharing agreements are in place.
- **Predictive Modeling:** AI models provide accurate predictions based on representative data.
- **Usability:** HR managers can effectively use the tool with minimal training.
- **Infrastructure:** Scalable data processing capabilities are available.
- **Business Environment Stability:** Assumes a stable regulatory environment and employer focus on balancing costs with employee satisfaction.

USA Health Care Outlook*

- United States ranks **first**, spends **$ 4.3 T** that is **19.7%** of overall GDP annually
- Per Capita Spending: **$ 12,530 / year**
- Spending is expected to grow at an CAGR of **5.4%** from **2023 - 2030**
- Healthcare **inflation** averaged **4-5%** annually, outpacing general inflation **2%**

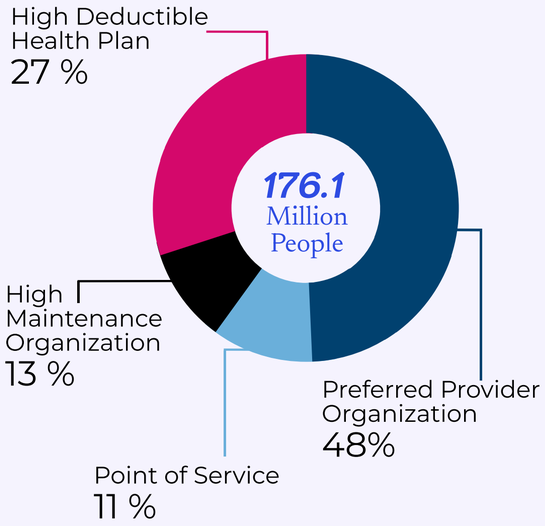
Market Share of Health Plans*

1. Employer - **48.5 %**
2. Medicaid - **21.1 %**
3. Medicare - **14.3 %**
4. Uninsured - **8.6 %**
5. Non-Group - **6.1 %**
6. US Military - **1.4 %**

- As of 2023, **92%** of the population is insured with any health insurance
- Private spending accounts for **55%** & public makes up around **45%** of total

Employer-Sponsored Plans

Share of types of ESI*



- Average annual health plan premium is **$ 23,968** for family & **$ 8,435** for single coverage in ESI.
- Average employee share for family premium is **29 %,** rest is covered by employer.
- The expected **increase** in cost of average **Employer-Sponsored** plan is by **5.4 %** in 2024.
- Around **75.3%** of eligible workers have access to ESI through their jobs.
- Employers are moving to **high-deductible plans**, with **24% firms** using high-performance networks & Centre of excellence to control costs.

***Source:** 1. KFF 2023 2. ISPOR 3. MERCER 4. AMERICAN PROGRESS 5. STATISTA (1,2,3)

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Stakeholders Mapping & Pain Points

Stakeholders	Role	Key Needs
 **Employers**	Primary users of the AI tool will evaluate healthcare plan options and understand network impacts on employees.	• **Impact Insights:** Understand how network changes will affect employee access to care, potential costs, and care continuity. • **Actionable Recommendations:** Receive suggestions for mitigating disruptions, such as alternative providers or cost-saving measures.
 **Employees**	Not direct user but employees' healthcare access is influenced by employers' network decisions.	• **Affordability:** Avoiding unexpected out-of-network costs if their preferred providers are no longer covered. • **Continuity of Care:** Ensuring continued access to providers critical for ongoing treatments or chronic care management.
 **Health Plans**	Health plans provide the provider network data and collaborate with employers in structuring plans.	• **Network Adequacy Compliance:** Ensure provider networks meet regulatory requirements (e.g. provider coverage across specialties). • **Data Exchange:** Share accurate provider information with the tool to ensure impact predictions are based on the latest network data.
 **Government**	Regulates employer-sponsored health plans to ensure compliance with health and data privacy laws, and support public health goals.	• **Compliance Assurance:** Ensuring tool compliance with data privacy laws and network standards. • **Health & Cost Outcomes:** Tools to enhance health outcomes, lower out-of-network costs, and support national cost-control and public health objectives.

Pain Point	Impact on respective stakeholder
Disruption in Employee Access to Preferred Providers	Loss of continuity in care, especially for chronic conditions, which can lead to negative health outcomes and increased dissatisfaction among employees.
Increased Out-of-Pocket Costs for Employees	Financial stress on employees and increased risk of delayed care, as employees may avoid or delay care due to cost concerns.
Employer Cost Management and Benefit Planning	Balancing cost containment with employee satisfaction is complex, especially as healthcare expenses rise (e.g., prescription drugs and specialty care costs)

USER PERSONA: A Large Employer

- Name: **Patricia Morgan***
- Position: **Health Benefits Manager**
- Company: **Manufacturing firm** with **5,000+ employees**
- Location: **Chicago, Illinois**
- Experience: **20 years in employee benefits management**

Goals:

- **Cost Management:** Keep healthcare premium increases in check while delivering high-value coverage.
- **Access to Specialty Care:** Ensure network adequacy, particularly for essential and high-demand specialties like mental health.
- **Employee Experience:** Enhance healthcare navigation for employees, reducing complexity and ensuring ease of use.

Challenges:

- **Rising Healthcare Costs:** Managing annual premium increases that outpace inflation.
- **Network Gaps:** Addressing “ghost networks” where listed providers are inaccessible, impacting employee care.
- **Employee Engagement:** Simplifying plan selection amid complex choices, as employees often feel overwhelmed by options.

Needs:

- **Predictive Analytics:** Tools to foresee cost trends and identify potential network gaps.
- **Network Adequacy Monitoring:** Real-time data on provider availability and accessibility in each geographic region.
- **Automated Communication:** AI-driven, personalized updates to inform employees about network changes and options.

*Took name to be imaginary, the information is clubbed from different sources

Source: 1.Census.gov 2.Bureau of Labor Statistics 3.CRS REPORT PDF

Proposed Solution

MCheck™ EmpCare

The tool aims to help HR/Benefits Managers in large organizations predict the impact of provider network changes on both employee satisfaction and health outcomes, using a combination of provider impact scoring, predictive health outcomes, and network simulation based on the claim data of employees. By combining these solutions, the tool offers a comprehensive platform for managing Employer-Sponsored Insurance (ESI) plans in a data-driven way.

Data Collection

Employee Claim Data

- Employee claims records contain information about **healthcare usage**, including provider visits, treatment types, costs, and frequencies.
- Claims data helps to understand which providers are **critical** for employees, especially for **high-need cases**, such as chronic care or specialty care.

Provider Directory and Network Data

- Provider information, including specialties, locations, and in-network/out-of-network status. **MCheck Provider** can be integrated.
- This data is essential for evaluating network adequacy and **identifying high-impact providers** based on specialty and geography.

Employee Sentiment Data

- Feedback from employee **surveys, reviews, cognitive assessment** and any internal support requests related to provider experiences.
- Provides qualitative insights into employee satisfaction with providers, helping to flag emotionally significant providers that contribute to satisfaction.

Data Manipulation & Engineering

Data Cleaning and Standardization

- Claims & provider data go through cleaning processes to handle null values, ensure format consistency, and standardize fields (e.g., provider names and locations).
- Using Pandas in Python, these datasets are structured to ensure consistency across all records.

Feature Engineering

- **Provider Impact Features:** For each provider, features like visit frequency, patient demographics, and geographic access are calculated.
- **Employee Health Features:** Claims data is used to generate health-related features, such as dependency on certain providers for chronic or specialty care.
- **Sentiment Scores:** NLP models analyze textual feedback to assign scores indicating employee satisfaction with individual providers.

Data Harmonization & Normalization

- **Semantic AI** can be used to understand the context and meaning behind different data representations and map them to a standardized format.
- eg. One employee records Tuberculosis as "TB" while another records it as "Tuberculosis" then our system would detect this and map it to our decided schema

Various website backend and frontend

- Backend with access to filtered data by the pipeline will be the server-side of the client's app/webpage dealing with data management, role management, permission handling and processing which will power user interface and experience components of the AI tool.

Proposed Solution

Key **Features** of MCheck EmpCare

Provider Impact Scoring

- Uses historical claims data to calculate an “impact score” for each provider, indicating their importance within the employee population.
- Helps HR teams identify high-impact providers whose network removal may cause significant employee disruption.
- Provides actionable insights to retain critical providers or suggest alternatives.

Health Outcome Prediction Model

- Predicts potential health impacts on employees if a specific provider is removed from the network.
- Estimates changes in health outcomes (e.g., condition progression) for employees who rely on certain providers, especially for chronic or specialized care.
- Supports proactive care management by identifying at-risk employees and offering preventive alternatives.

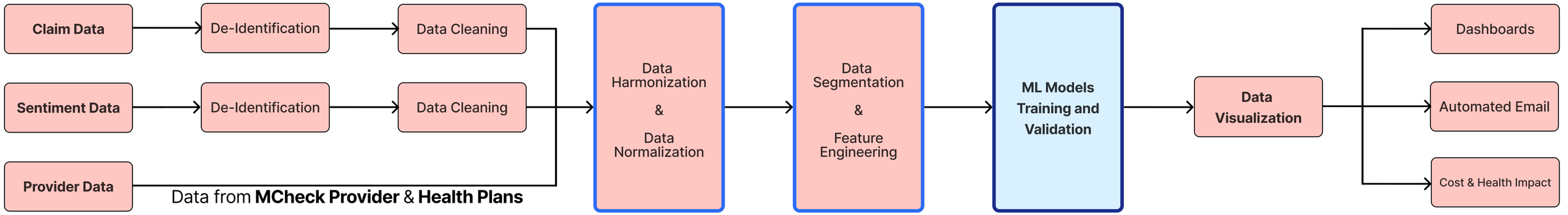
Network Change Simulation

- Simulates provider removals or additions within the network, allowing HR managers to visualize impacts on cost, satisfaction, and health outcomes.
- Enables HR managers to explore alternative scenarios before implementing network changes.
- Reduces potential negative impacts by allowing data-driven adjustments to the provider network.

AI-Driven Employee Communication

- Provides personalized communication templates that detail network changes, alternative providers, and cost implications.
- Keeps employees informed with relevant, personalized information, easing the transition when provider changes occur.
- Enhances transparency and supports employee trust by offering clear guidance on network changes.

Working Pipeline



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Proposed Solution

Technology Walkthrough

Machine Learning Models used in AI Tool

Data Ingestion

- **Apache Kafka:** For real-time data streaming from health plans, updating provider network information, claims data, and cost details.
- **ETL Pipelines:** Using Apache NiFi or Airflow for batch processing and transformation of historical claims data.

Provider Impact Scoring

- **Random Forest Model** (Scikit-Learn): A supervised learning model that calculates impact scores based on claims patterns and employee dependency levels.
- **Python** (Pandas and Scikit-Learn): Processes and cleans data

Network Change Simulation

- **K-Means Clustering** to identify gaps in specialty provider coverage, followed by **Weighted Scoring** based on network adequacy standards.
- Simulate provider network adjustments, showing cost, health, and satisfaction impacts

Output Data Handeling

- **Flask API:** Acts as a mediator between front-end React components and backend models, managing data requests and updating the UI in real-time.
- **Redis** (Caching Layer): Decreases data retrieval times for commonly accessed info, such as provider impact scores or past simulation results.

Data Storage

- **Amazon S3 /Google Cloud Storage:** For storing large datasets, including historical claims data, cost data, and network configurations.
- **Data Lakehouse**: A unified storage format for structured and unstructured data, which will support both machine learning and analytics.

Predictive Health Outcome

- **Logistic Regression & Neural Networks:** Models predict health risks by training on data to estimate condition worsening probability if a provider is removed.
- **Time-Series Analysis** (for chronic condition management)

Automated Communication

- **GPT-3 or BERT** (Hugging Face Transformers)
- **Twilio API** (for SMS) **& SendGrid API** (for Email)
- **Audit Log Database:** Maintains logs of all messages sent for compliance and transparency, enabling HR to verify that employees are informed.

Front End & Visualization

- **Material-UI:** Provides a pre-built library of UI components that are both aesthetically pleasing and functional, including buttons, sliders, charts, and modals.
- Using tools like **D3.js, Chart.js, React**

USER JOURNEY

LOGIN

Screens	Key Information on Screen	Key Buttons	
Dashboard (Impact)	Network Health Score, Provider Impact, Health Risk Segmentation, Alerts	• **View Detail** • **Explore Network Changes**	1.
Network Change Simulation	Provider List, Simulation Parameter, Simulation Preview	• **Run Simulation** & **Save** • **Add/Remove Providers**	2.
Health Outcome Analysis	Segmentation by Condition, Risk Maps, Provider Dependency Analysis	• **View Recommendation** • **Generate Report**	3.
Automated Communication	Employee Segmentation, AI Template, Provider Recommendation	• **Preview/Edit Message** • **Send Communication**	4.

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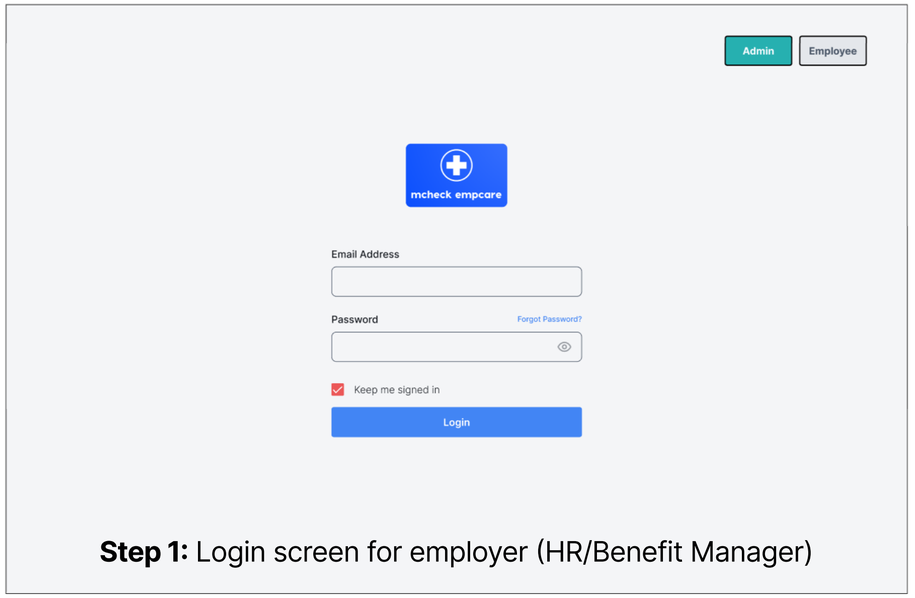
Wireframes/Mockups (Figma Wireframes Link)

1.

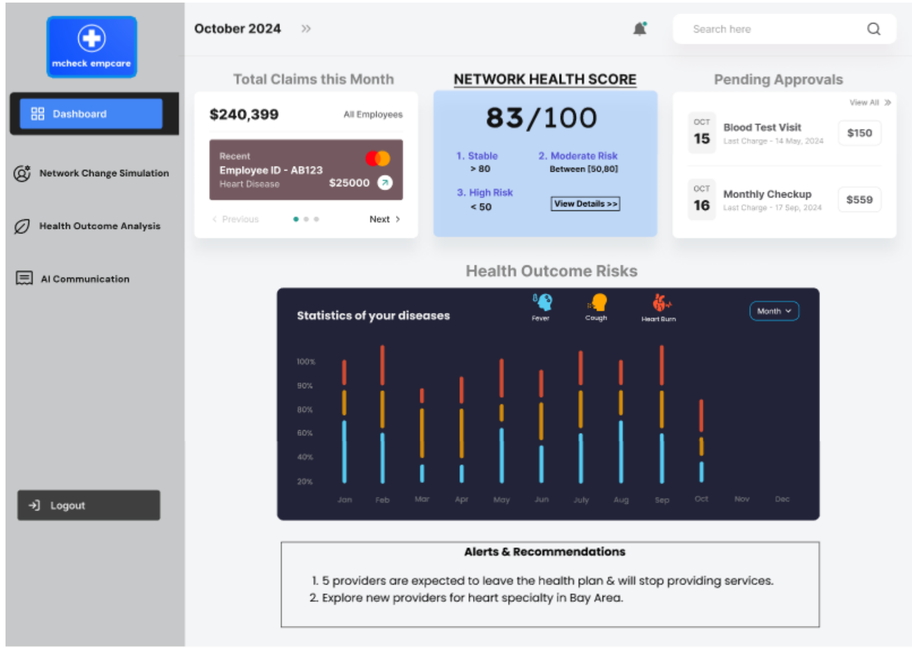


Step 1: Login screen for employer (HR/Benefit Manager)

Step 2

- Dashboard for employees claims (approved/pending)
- Overall network score and health risk chart
- Alerts & Recommendations regarding network & employees

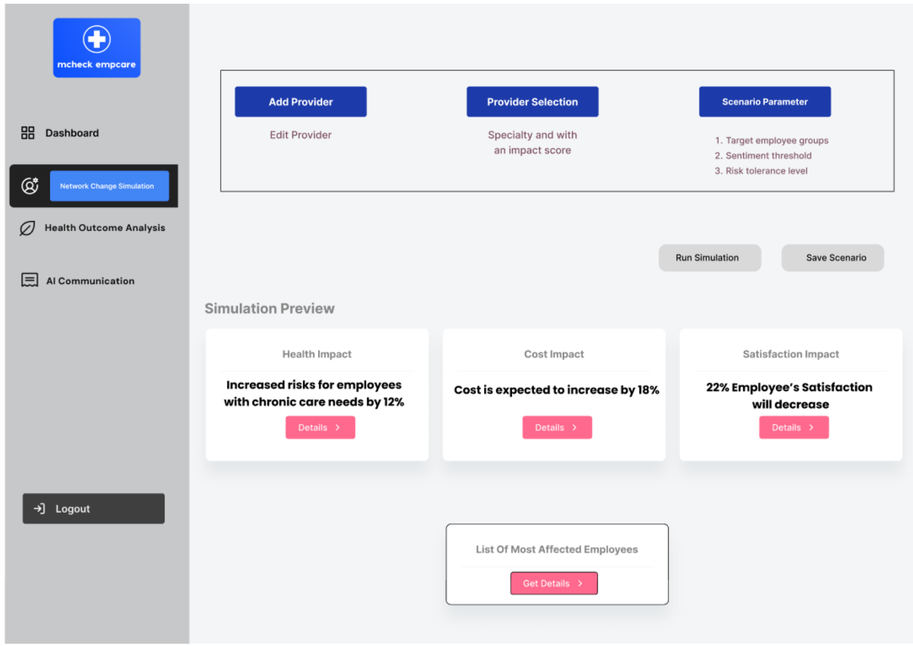
2.



Step 3

- Network Simulation by Provider details and different scenario (Risk, Sentiments, groups)
- AI Tool modelling and prediction of Impact (Cost & Health) and Satisfaction of employees

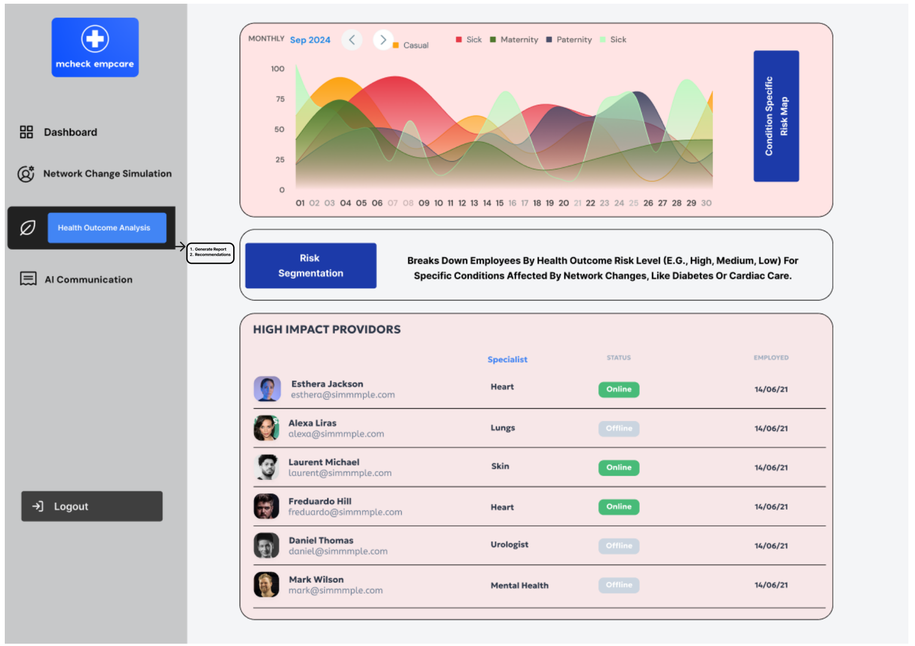
3.



Step 4

- Health outcome analysis by condition and risks segmentation
- High Impact providers details and current status with their bond with network
- Last page is for communication to employee regarding change of provider or any other change in network

4.



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Metrics, Pitfalls & Future Enhancements

North Star Metric

Avoided Health Disruptions Rate = $\frac{\text{Avoided High-Impact Provider Changes X 100}}{\text{Total Planned Provider Changes}}$

Other Supporting Metrics

Average Employee Satisfaction Score = $\frac{\Sigma(\text{Employee Sentiment Scores per Provider}) \times 100}{\text{Total Providers Rated}}$

Reduction in Costs Out-of-Network = $\frac{(\text{OON Costs Before Tool Use} - \text{OON Costs After Tool Use}) \times 100}{\text{OON Costs Before Tool Use}}$

Network Change Success Rate = $\frac{\text{Successful Network Changes before disruption} \times 100}{\text{Total Network Change Implemented}}$

Other Important KPIs

Employee Retention Rate
Usage Rate of Simulation Feature
Accuracy of Health Outcome Predictions

Pitfalls	Mitigation Strategy
Data Privacy and Compliance Risks	• **End-to-End Encryption:** Encrypt data at rest and in transit to protect it from unauthorized access or breaches. • **Regular Compliance Audits**: Schedule periodic audits to ensure adherence to HIPAA and internal data security standards.
Model Bias and Accuracy	• **Continuous Model Retraining:** Update models periodically with recent data, which helps to reflect the latest health trends and reduce bias over time. • **Diverse Training Data:** Use a diverse dataset that represents various demographics, conditions, and employee needs to minimize bias in predictions.
Sentiment Analysis Data Gaps	• **Manual Overrides:** Allow HR teams to manually input or adjust sentiment scores based on qualitative insights gathered from employees, improving sentiment accuracy. • **Data Quality Filters:** Set minimum data thresholds for sentiment analysis scores to ensure insights are based on reliable information
Dependence on Accurate Real-Time Data	• **Scheduled Data Refreshes:** Automate frequent data refreshes to minimize lag in claims and provider network data. • **Real-Time Monitoring Tools:** Use data monitoring tools to flag any disruptions in data feeds and ensure continuous real-time ingestion.

Future Enhancement

Self-Service Employee Portal

Allow employees to view network options, alternative providers, and associated costs, along with a feature to provide direct feedback on providers.

Wearable Device Data Integration

Integrate anonymized data from wearable health devices (e.g., Fitbit, Apple Health) to capture real-time health metrics and monitor trends.

Health Program Recommendations

Use predictive analytics to recommend preventive care programs based on employee health trends (e.g., mental health programs if stress indicators increase).

Automated Network Optimization

Extend the tool to provide proactive network configuration suggestions, such as adding high-need providers in certain locations based on employee demographics