Business Case Report

An Agentic AI Framework for Medical Imaging and Report Analysis for Health

Insurance Claim Validation

Group 3

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1. Executive Summary

Health insurance providers routinely evaluate hospitalization claims supported by medical imaging and laboratory reports. These scans provide the base for determining whether the diagnosis, medical procedure and submitted claim is medically justified. In the insurance investigation process, while simple cases are approved by predefined rules and algorithms the more complex cases are sent for human review for claim justification, a process which remains largely manual, inconsistent, costly and time-intensive.

This project proposes an AI-assisted decision support system focused on pneumonia-related claims, using chest X-rays and hematology reports to generate explainable medical insights from submitted reports and imaging. The system supports insurance agents and doctors by improving review efficiency, consistency, and transparency, while keeping humans fully responsible for final claim decisions.

2. Problem Statement

Current claim validation workflows for very small claims are processed automatically via algorithmic rules whereas more complex cases for higher amounts require medical reviewers to manually interpret chest X-rays, examine hematology reports, and correlate findings with the claimed diagnosis and treatment. The lack of standardized formats and structured medical evidence further increases review effort and contributes to errors and rework. Despite widespread adoption of electronic medical records, insurers and providers continue to rely on partially manual processes such as document uploads and emails for key adjudication-related activities, including benefit verification and prior authorization. This continued reliance on manual steps slows down claim processing, increases operational costs, and makes it difficult to consistently and efficiently assess medical justification across

complex claims. As claim volumes increase, insurers face longer processing times and higher operational costs leading to customer dissatisfaction and internal inefficiencies.

3. Proposed Solution

The project involves developing an agent-based AI system that has individual agents with expertise in analyzing chest X-ray images and hematology reports for pneumonia-related claims. Specialized agents extract clinically relevant findings from submitted reports and generate an explainable summary indicating whether the submitted medical evidence supports a pneumonia diagnosis and related treatment. This approach reduces the time reviewers spend manually interpreting and correlating reports, fast-tracking claim approval for justified claims, improves consistency in medical assessment, and allows the system to provide decision-support insights without performing any automated approvals or rejections.

4. Vision, Goals, and Objectives

The vision of this project is to improve medical claim evaluation through responsible AI assistance. The primary goals are to reduce claim processing time, improve consistency in medical justification review, and enhance transparency for both reviewers and customers. Key objectives include developing specialized agents for X-ray and hematology analysis, generating explainable medical summaries, and integrating human-in-the-loop review at every decision point.

The vision of this project is to create an end to end pipeline for the medical claim evaluation process by introducing responsible and explainable AI assistance within the insurance claim review pipeline. The system aims to support human reviewers by providing

structured medical insights based on the submitted reports to add consistency in the medical justification offering process of the submitted claim.

The primary goals of the project are to reduce the time required to review medical claims, improve consistency in how medical evidence is interpreted across similar cases, and increase transparency in claim evaluation for both insurance reviewers and policyholders. By standardizing the analysis of medical reports, the project seeks to reduce variability and delays in claim processing, particularly for claims that require medical justification.

Key objectives include developing specialized AI agents for analyzing chest X-ray images and hematology reports in pneumonia-related claims, generating explainable medical summaries that clearly relate clinical findings to diagnosis and treatment, and integrating human-in-the-loop review at each decision stage to ensure trust, accountability, and alignment with regulatory and ethical requirements.

5. Benefit Analysis

The system delivers measurable operational benefits by reducing manual review effort and shortening claim processing cycles. Today around 25-50% of the submitted insurance claims require manual review and through this pipeline reviewers can handle higher claim volumes and add explainability to automated adjudication pipelines reducing the actual claims sent for manual review which will involve the additional processing cost incurred for very complex cases. Customers benefit from faster, clearer claim decisions and reduced uncertainty during hospitalization or recovery. The system improves service quality without increasing risk.

6. Financial Appraisal

From a financial perspective, It has been analysed that using only the real-time adjudication process where claims are processed electronically upon submission has been shown to reduce administrative burden and saving insurers an estimated average of around $15 per claim and reducing turnaround times. Building on these insights, our AI-assisted medical report analysis capability goes beyond standard rule-based adjudication by bringing structured, clinically meaningful interpretation of chest X-rays and hematology reports into the pipeline.

Because these reports are a primary reason complex claims require manual review, enhancing the adjudication process with AI support enables more claims to be evaluated faster and more consistently, thereby lowering operational costs associated with extended manual review cycles while laying the groundwork for more comprehensive electronic processing based on richer clinical data.

7. Project Success Criteria

The project will be considered successful if it demonstrates the ability to reduce the time required to review claims by assessing the quality of medical justification in submitted reports. Success will also be measured by the system's ability to generate medical justification insights that align with expected outputs from the test dataset, indicating potential usability as a decision-support tool for insurance agents and doctors.

8. Implementation Plan

The implementation of the proposed AI-assisted claim justification system will follow a phased approach for final capstone project delivery..

The first phase focuses on data preparation and model development. Publicly available pneumonia datasets containing chest X-ray images and associated hematology reports and discharge summaries will be curated and preprocessed. Specialized AI agents will be developed and trained separately: one agent dedicated to identifying pneumonia-related patterns in chest X-rays, and another focused on extracting relevant clinical indicators from hematology reports. These agents will be validated against known clinical labels to ensure their outputs are reliable and clinically meaningful.

The second phase involves agent integration and workflow simulation. The trained agents will be combined into a unified decision-support pipeline that mirrors a real-world insurance claim review process. In this phase, the system will accept simulated claim submissions and generate explainable summaries that correlate imaging findings with laboratory results.

The third phase will involve integrating agents into a claim dashboard for simulating an e2e claim submission and processing pipeline.

The final phase will focus on analysis and validation of the system against simulated dataset to assess its effectiveness in providing usable and accurate justification of claim procedure for reference. Performance metrics such as processing time reduction and reviewer effort savings will be measured to demonstrate business value.

9. Risk Assessment

One potential risk is limited model performance due to the use of publicly available datasets, which may not fully represent real-world insurance claim data. This risk is addressed by clearly defining the scope of the project, focusing only on pneumonia-related cases and using standardized chest X-ray and synthetically generated hematology data to demonstrate the feasibility of AI-assisted report analysis.

Another risk involves the interpretation of AI-generated outputs. Since the project does not involve real insurance claims or decision-making, there is a possibility that the explainable summaries may oversimplify complex medical scenarios. This is mitigated by designing the system strictly as a decision-support prototype and by emphasizing that outputs are illustrative rather than authoritative.

There is also a risk related to overextending the project scope. To manage this, the project intentionally limits itself to a single disease and two types of medical reports, ensuring that development and evaluation remain achievable within the timelines and resources.