Disaster Dashboard

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Executive Summary

Natural disasters pose significant challenges to healthcare operations, particularly for organizations like HCA Healthcare with a substantial presence in high-risk regions. This project addresses the critical question: How can HCA utilize its internal employee data, alongside external emergency preparedness resources, to enhance patient assistance during natural disasters?

Our answer is a comprehensive, web-based platform that integrates an HCA employee dataset comprising over 200,000 records, alongside external datasets including FEMA Disaster Declaration Summaries and GeoJSON county data. Advanced data cleaning, geospatial analysis, and interactive visualization techniques were employed to transform this raw data into actionable insights, which we present to non-technical stakeholders via an intuitive user interface.

The resulting solution is an interactive platform that enables decision-makers to visualize disaster trends, allocate resources efficiently, and rapidly access critical information, enhancing patient care and operational resilience. Our project demonstrates that strategic data integration and visualization can revolutionize disaster preparedness and patient assistance in healthcare.

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Introduction & Problem Statement

Hurricanes, fires, and other natural disasters disrupt hospital operations, put strain on vital resources, and compromise patient care. This underscores the need for robust disaster preparedness strategies that both address immediate crises and streamline long-term operational resilience. In response to this ongoing threat, HCA asked a crucial question:

How can HCA Healthcare enhance patient assistance during natural disasters?

The primary aim of this project is to answer that question by transforming raw internal and external data into actionable insights. This involves:

Making Data Available

Ensure front-line employees receive timely and accurate support during crises
Facilitate rapid communication and resource reallocation in disaster scenarios

Optimizing Resource Organization

Utilizing a de-identified dataset of over 200,000 HCA employees alongside external datasets (e.g., FEMA Disaster Declaration Summaries) to identify high-risk areas
Enable data-driven decision-making regarding resource allocation and disaster response

Integrating Diverse Data Sources

Seamlessly merging internal employee data with external emergency preparedness information to provide a comprehensive view of disaster impact and response

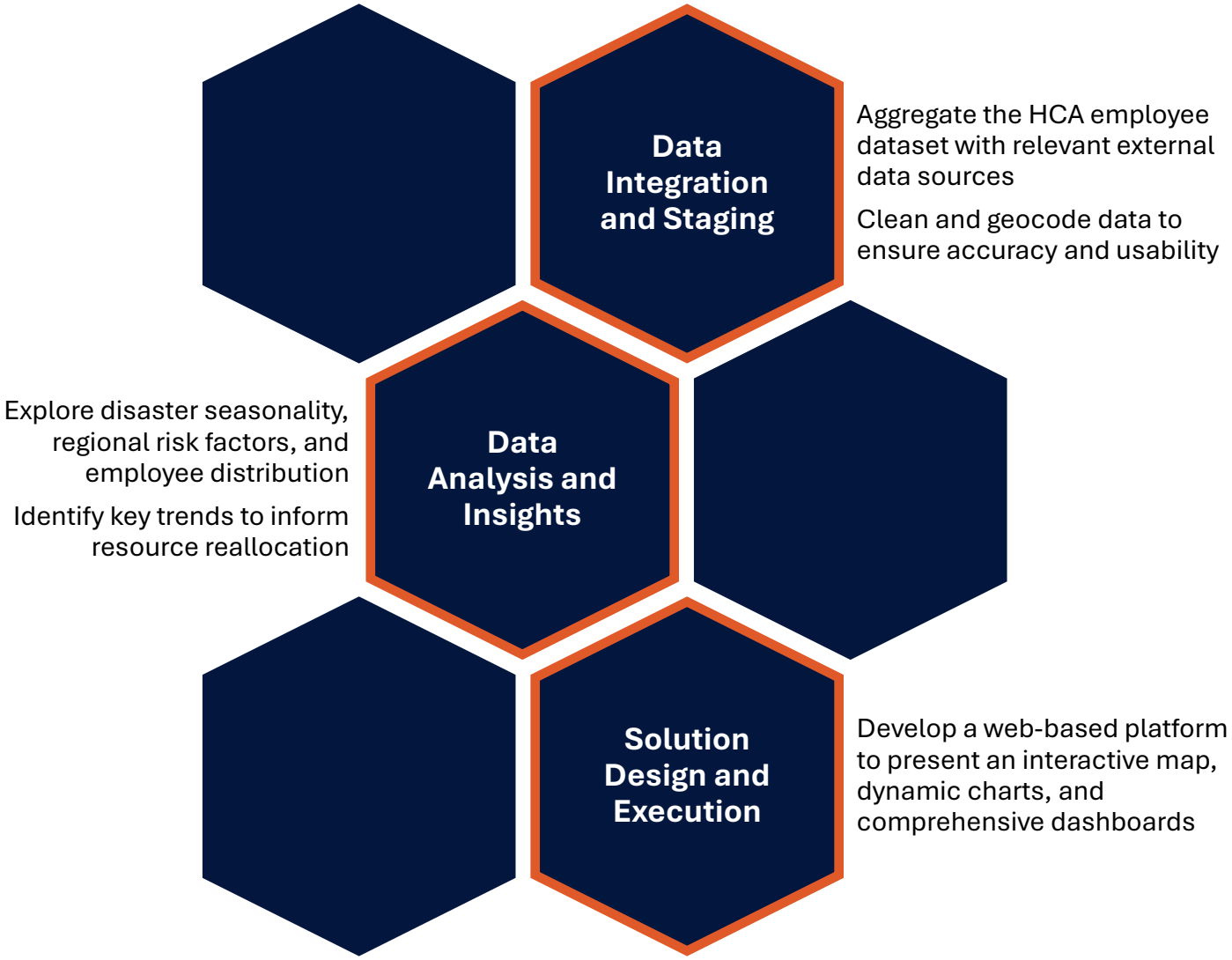
Developing a User-Friendly Platform

Build an interactive, web-based solution featuring dynamic maps, real-time alerts, and organizational charts
Cater to non-technical users by ensuring the UI/UX is intuitive and accessible

In an era marked by increasingly severe natural disasters, the ability to analyze and respond to these challenges is paramount. By addressing these questions through a combination of rigorous data analysis and interactive visualization, this project aims to empower HCA Healthcare to face disasters with confidence. The insights we enable will not only improve immediate patient assistance but will also lay the groundwork for a more resilient, data-driven approach to emergency preparedness.

Project Scope

This project encompasses the end-to-end process from data acquisition to solution deployment. This meant incorporating numerous processes, including:



Future Enhancements

Anticipated improvements include real-time weather integration and employee management features, but these are outside the current project scope.

Data Sources & Preparation

Data Sources

This project leverages both internal and external datasets to create a comprehensive view of disaster preparedness and resource allocation. The key data sources include:

Internal HCA Employee Dataset

Physical addresses, roles, employment duration, chain of command, and facility affiliations

External FEMA Disaster Declaration Summaries (JSON)

Detailed records of disaster declarations, including incident dates, designated areas, and disaster types

External US County Data (GeoJSON)

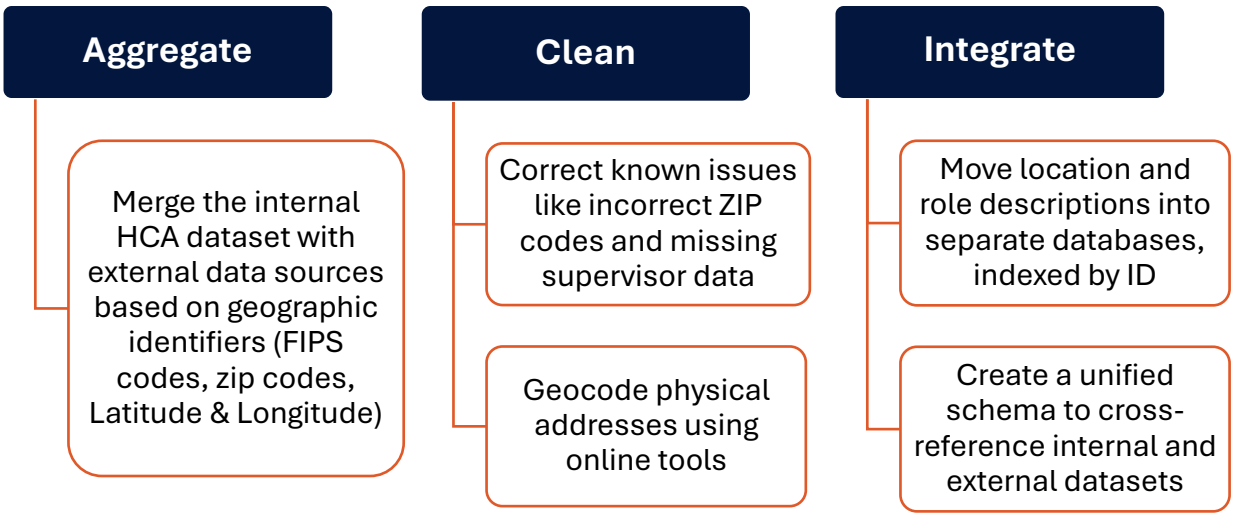
Geospatial information on county boundaries, essential for mapping disaster impacts

External FEMA ArcGIS Feeding America Food Banks (GeoJSON)

Data on food banks and their statuses, supplementing resource availability insights

Data Preparation & Cleaning

Before analysis and integration, rigorous data cleaning and preparation were essential to ensure the quality and reliability of the insights. The process involved the following steps:



Methodology & Approach

Step 1: Defining the Goal

Identifying the Focus:
- Emphasize disaster preparedness, resource organization, and impact on employees.

Establishing Goals:
- Improve communication and resource allocation during disasters.
- Enhance data-driven decision-making through interactive visualizations.

Step 2: Acquiring Data

Internal Data:
- 200,000+ employee records with locations, roles, and chain-of command

External Data:
- FEMA Disaster Declaration Summaries (JSON API)
- GeoJSON (FEMA ArcGIS Feeding America Food Banks, US County Data)

Step 3: Cleaning Data

Cleaning Procedures:
- Correct known issues (inaccurate zip codes, non-geocoded addresses, etc).
- Standardize formats for dates, names, and geographic identifiers.

Integration:
- Merge internal and external datasets with common keys to support cross-referencing.

Step 4: Analyzing Data

Analytical Techniques:
- Perform geospatial analysis to map high-risk areas and resource distribution.

Visualizations:
- Develop interactive maps (using Leaflet) to display disaster-prone areas.
- Create dynamic charts and graphs (with D3.js) to illustrate disaster trends

Step 5: Platform Design

Technical Stack:
- Blazor (C#, JS, HTML, and CSS with responsive design frameworks like Bootstrap)

Implementation Considerations:
- Ensure the platform is intuitive for non-technical stakeholders.
- Employ a physics-based layout to prevent overlapping of markers on the map.

Step 6: Testing & Review

User Testing:
- Gather feedback from non-technical front-line healthcare workers.

Validation:
- Ensure the platform reliably reflects real-world disaster scenarios.
- Iterate on the design to address usability issues and ensure clarity of visualizations

Proposed Solution & System Design

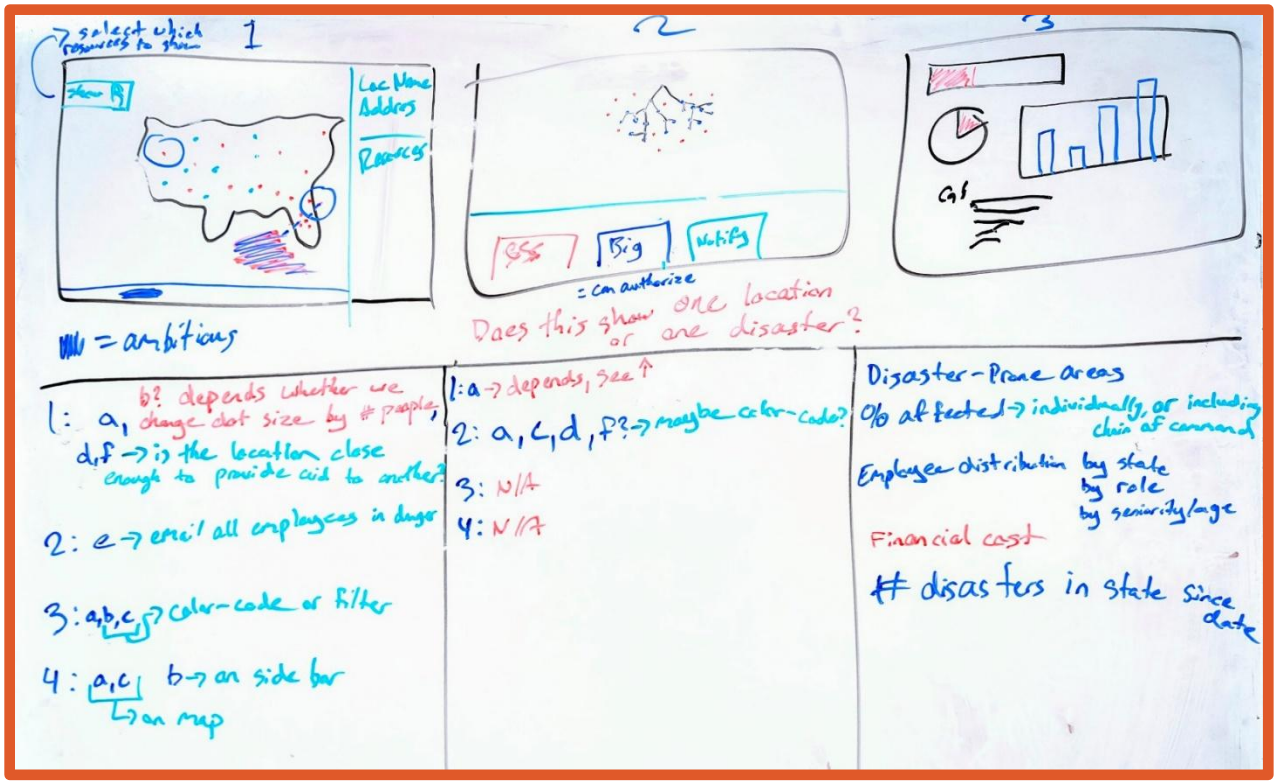
Key Features

Interactive Mapping — Visualize disaster-prone areas, facility locations, and resource availability

Dynamic Dashboards — Display charts and graphs that highlight trends such as disaster seasonality and high-risk regions

User-Friendly Interface — Ensure non-technical users can easily navigate and interpret the data

Mockup

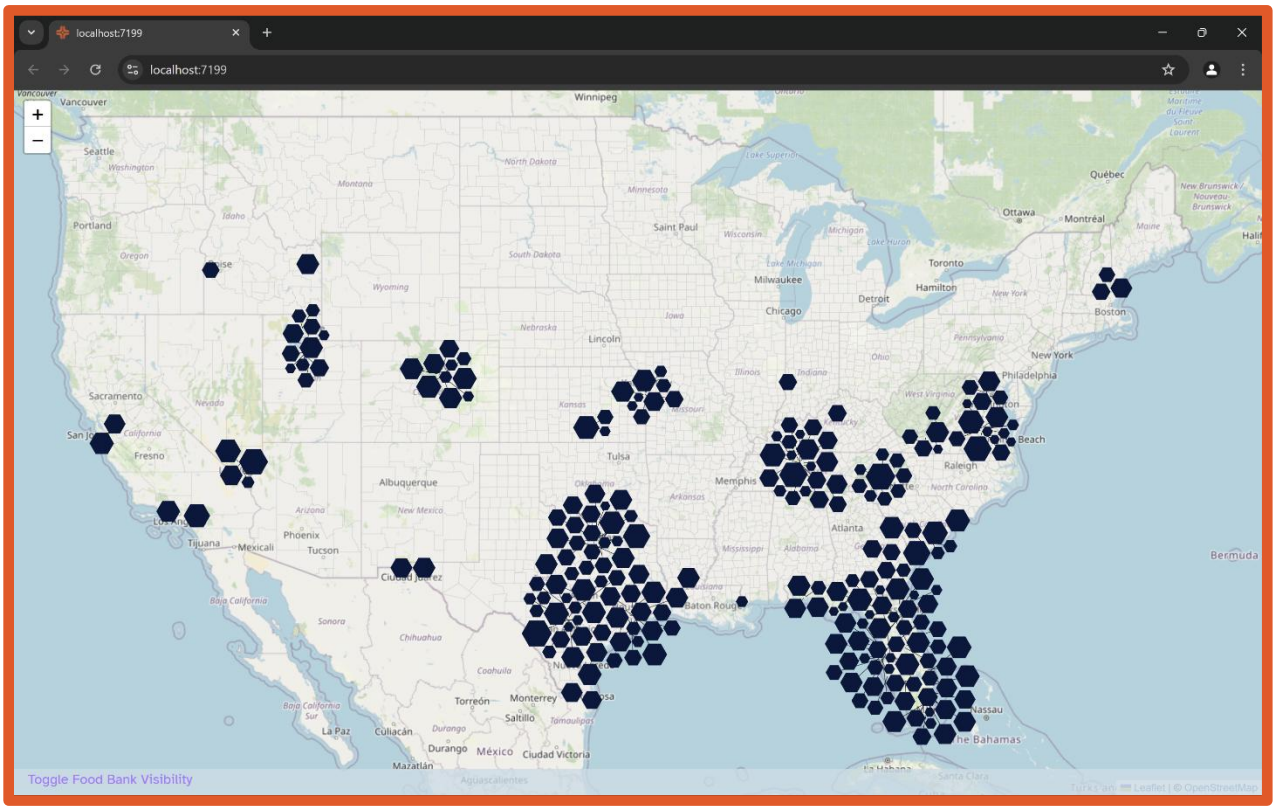


Design Principles

Simple	Responsive	Accessibile
Clear visual hierarchy with intuitive controls	Adaptable layouts for various devices	Easily digestible for non-technical users

Technical Implementation

Final Product



Implementation Process

Fetch disaster data from FEMA's Disaster Declaration Summaries API

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Clean the data to remove duplicates and ensure validity

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Store the data locally for fast loading times

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Process data using algorithms for visualization

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Connect counties via FIPS codes using GeoJSON for mapping

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Display visualizations with D3.js for dynamic graphs and charts

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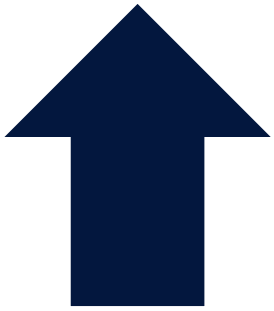
Use Bootstrap for a responsive, user-friendly page layout

Evaluation & Future Direction

Evaluation of the Proposed Solution



Strengths & Successes

Comprehensive Data Integration

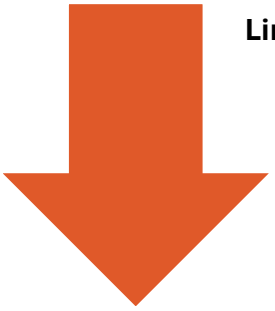
Combined internal and external data to generate meaningful insights

User-Friendly Interface

Interactive map and dashboards provide access to critical information

Scalability & Adaptability

Designed with additional data sources in mind



Limitations & Challenges

Data Accuracy & Completeness

Some HCA employee data fields contained missing or inconsistent values, requiring manual adjustments

Real-Time Data

Current implementation does not include live weather alerts from NWS

Future Directions & Enhancements

As technology and data sources evolve, there are several areas where this project could be expanded to provide an even greater value.

Real-Time NWS Alerts

Enhance the system with real-time emergency alerts

Provide information of the severity and impact of a potential disaster

Employee Role-Based Filtering

Allow users to view disaster impact specifically relevant to their position and responsibilities within the company

Dynamic Resource Allocation Dashboard

Track medical supply levels and adjust inventory in real time.

Optimize personnel relocation strategies based on disaster severity.

Conclusion

At the outset of this project, we sought to answer a vital question: “How can HCA utilize its internal employee data, alongside external emergency preparedness resources, to enhance patient assistance during natural disasters?”

The product we developed provides a scalable, data-driven framework that significantly enhances HCA Healthcare’s disaster preparedness. By integrating numerous data sources, we designed a powerful tool, which equips decision-makers with critical insights to guide disaster response and emergency planning. With its ability to visualize trends, allocate resources efficiently, and streamline access to essential information, this platform is poised to make a tangible impact on HCA’s operations.

Looking ahead, its potential can be expanded even further with additional capabilities that enhance disaster response efficiency. Incorporating real-time weather data will provide proactive insights, enabling earlier interventions and improved preparedness. An employee management and search function will facilitate rapid personnel deployment based on location, specialty, and availability. Additionally, the ability to dynamically reallocate resources from partner organizations will bolster resilience by optimizing supply distribution and staffing. By evolving into a more adaptive and intelligence-driven system, this platform can redefine how healthcare organizations respond to natural disasters, ultimately improving patient outcomes and operational stability.