An Resilience Research Platform:
Streamlining the Resiliency Research Workflow for Architecture Teams

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What is Resilience in Architecture

Resilience is scientifically defined as: the ability of social, economic, and environmental systems to **resist hazards and maintain essential functions**. 1

According to AIA, resilience can be represented in the built environment through five forms: Health, Social, Infrastructure, Environmental, and economic resilience. 2

From **a temporal perspective of a building facing a hazard**, resilience can be defined as the ability of a building to **prepare** for, and **resist** against (through the durability of its structure and other building system, as well as flexibility of space usage), and **recover** from nature hazard. 3

1: AR5 Synthesis Report: Climate Change 2014 — IPCC
2: Resilience Design Toolkit, Resilience Design Integration for Architectural Projects. Shams, et. al.
3: From the 3 R's Rule of Sustainability to the 4 R's of Resilience: an Architectural Approach. Di Pilla, et. al.
Image: Dozens get rescued from roof of a hospital during flooding from Hurricane Helene in Erwin, Tennessee. Source: Virginia State Police (top), USA TODAY NETWORK via Imagn Images (buttom)

Current Literature Discussion

Topic

1. Resilience **Assessment and Evaluation**: Scorecards, performance metrics, multi-dimensional indicators.
2. **Urban and Regional Planning & Policy** for Resilience: Policy integration, spatial planning, zoning.
3. **Public Health and Critical Infrastructure** Resilience.
4. Data-Driven and Technological Approaches to Resilience: **Big Data, simulations, digital modeling**.
5. **Sustainable Building and Green Infrastructure**: multi-hazard architecture, climate adaptation.
6. **Community and Stakeholder Engagement:** Participatory modeling, human-centered approaches.
7. **Disaster Recovery**: long-term resilience planning and Post-Disaster Development

Deliverables and research types

1. **Conceptual (definition & strategy) frameworks** for structuring resilience.
2. **Assessment tools and metrics** for measuring resilience (scorecards, etc.).
3. **Case studies and empirical applications** for real-world implementation.
4. Data-driven **models** and **simulations** for **predictive** resilience.
5. **Systematic reviews** and **research agendas** summarizing resilience literature and future directions.

Current Literature Discussion

A lot of them are focusing on “single-point” advancement: better modeling and prediction, better. They are about *“how to bring TASK_A to next-level”*

But, how can the design team, in daily practice, use these advanced research?

There is a gap in *“how to make everyone accessible to TASK_A”*

Research Questions

Answered by the survey

1
What are the **current resources and challenges for project teams** to implement resilient design, in various design phases, under a specific project scope?

2
What resources are used in various tasks?
What can project team benefit from a resilient design **workflow**?

A web-based platform

3
How to develop a systematic tool to support the project team throughout various phases, under a specific project scope?

Research Gap

	Research Gap	Research Opportunity	How to address
Literature -> Practice	Existing literature heavily focus on **"how to bring TASK_A to next-level". But not "how to make TASK_A accessible to everyone"**	Build an end-to-end, accessible platform to house mostly familiar tasks	Develop a web-based, interactive platform with:
Practice	Lack of structured and easy-to-onboard workflow: **free-style googling is feasible but expensive, existing workflow is sophisticated but still conceptual**	Develop an enhanced workflow with wider coverage of context and higher resolution in each step: common tasks suggested for this project context, related resource, liaison and consultants, expected deliverables, and multi-level coordination. ***"How should I start, where is supporting material, what to do now, what's next"***	A guided, easy-to-pick-up workflow
Practice	Current research material is rich, but **scattered** and **hard to navigate**.	Better Resource Navigation: Provide an outlined directory by organizing resources by type, topic, georegion, etc. This database would offer easy-to-search and contextual resource navigation. ***"what hazard, what risk, what precedent, what strategy"***	Effective resource navigation

Research Objective

This project focuses on **developing a platform** that provides project teams with a more accessible and user-friendly approach to **streamline the resilience research workflow** that can:

- Provide a guided, easy-to-pick-up **workflow**, with essential data injected
- Navigate **resource** effectively, including precedent,strategies, tools, support, etc.;
- Offer a high-level guide for new projects, incorporating precedent library, resource navigation, and existing tools to an **interactive platform.**

The workflow

Define Scope ▶	Build Team ▶	Identify who & What ▶	Assess Vulnerability & Risk ▶	Develop Strategy ▶	Evaluate & Select Strategy: CBA, BCA ▶	Evaluate after construction
Identify client expectation & deliverables, and knowledge of resilience	Assemble the team with various disciplines and expert consultants.	Identify stakeholders	Vulnerability: which stakeholders and features could be impacted	primary and secondary Impact-Asset Pair for identified hazard.	BCA: Collect and determine property value	Post Occupancy Evaluation
Educate awareness through conversation: importance, examples, cost, return, adoption, etc.	Align project delivery and minimize confusion.	Identify major hazards	Likelihood of hazard Consequence of hazard	[Hazard] - [Design Criteria, expected building performance] pair list	BCA: Characterize Impacts and Determine Damages & Hazard Mitigation Analysis	
	Set up meetings, workshops with team, analysis and document.	Identify assets, design aspects, and design expectations (criteria).	Risk Assessment for each [hazard] - [asset and stakeholder] pair	design considerations of building components	BCA: Cost analysis of each [potential strategy - damages avoided] pair	
			Prioritize hazards with Risk Assessment Matrix	design considerations of other principles	CBA: Ranking based on feasibility + impact	
			Stress vs shock: Future Projection	Strategy Library	CBA: Use Owner's rubric, pick the best one for owner	

This workflow is "almost" comprehensive, developed based on case studies of public or ZGF projects, and
AIA-HKS Resilience Design Toolkit: 2023_Resilience_Design_Toolkit_HKS_AIA_FINAL.pdf and NOAA's US Climate Resilience Toolkit: Home | U.S. Climate Resilience Toolkit

Cool!

But, this is “ideal”, or “resourceful”.

How do design team perform resilience research in their everyday practice?

Current State of Resilience Research

How can a design team use this workflow?

A survey is designed to help collect these ideas,
So that a tool can be developed from the workflow to address to designers' concern.

Objective 1: How designers have their current resilience research

- What is their knowledge level, experience level, and hazards faced
- Some experiences and resources to share with

Objective 2: What are the barriers

- What are the barriers, where they come from

Objective 3: Who have, and where are the barriers for them

- For a respondent as **[role]** in **[discipline]**, at which **[project phase]** they have this barrier

Objective 4: What are the improvements they want to have

- What are some helpful solutions but currently lacking

Survey Questions

Part 1: Respondent's Background

- Firm information
- Discipline
- Role
- Project Typology Experience
- Design Phase Experience

Part 2: Respondent's Resilience Experience

- Knowledge Level
- Project Experience (count)
- Hazard addressed
- Belief of "Urgency of resilience"
- Barriers
- Design Phase when having barriers
- Improvements needed but currently lacking

Part 3: Respondent's Sharing and further participation

- (Optional) story to share
- (Optional) interest in further research

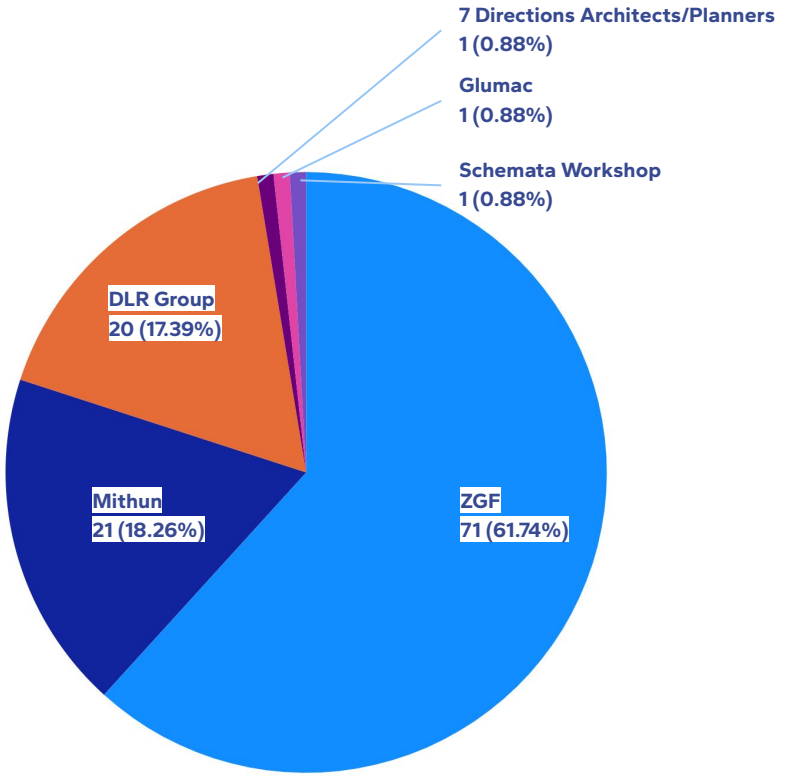
Scan this QR code or use this link to revisit the survey questions

Survey Respondents

71 Respondents from **ZGF**

44 Respondents from **other firms**

- 7 Directions (1)
- DLR Group (20)
- Glumac (1)
- Mithun (21)
- Schemata Workshop (1)



ZGF would be the main scope, given:

- Respondents represent broader audience, given proportion of respondents in their firm,
- Further research be developed, investigation and data availability

but all respondents' responses would serve for validation and further implication, and their insight on barriers and opportunities are valuable

Barrier Summary

- **Client**
  - Justification of implementing resilience: **why this is necessary, how it can be beneficial**
  - Feasibility and effectiveness consideration: **how to implement**
  - Budget consideration: **what is the cost**

- **Design Team**
  - Hard to navigate resource: **what hazard is there, what is the risk on my design, which resource should I reference**

- **Resource(s) for communication and learning**
  - Resource for hazard identification and risk assessment
  - Precedent for demonstration of resilience implementation
  - Tools for quantify cost/benefit

Opportunity Summary

- **Organize material by**
  - Typology
  - Geographic zone
  - Climate Zone
  - Design system
  - Design Material

- **Quantify cost for**
  - What if & what if not
  - Lifecycle & up-front
  - ROI

- **Learn and Communicate with distillation of the topic**
  - Impact of hazard, Successful precedent(s), benchmark
  - hazard-specific generic solutions that can be the starting point
  - Specific strategy: "Implementing XX strategy will cost approximately $XX and will be XX% impactful in XX scenarios"
  - Graphic

Scope Building

- **Stage Considered: very early phase**
  - Early engagement with client on the necessity and scope is essential for all later phases
- **Audience Considered: Design Team (maybe with limited knowledge in resilience)**
  - They are the majority in most design firms,
  - Firms may hope to see some early-stage effort **in house**.

Can we further narrow down the scenario?

“If there is such a tool, where and how you would like to use it”

The 7-step workflow is “a guide”, not a protocol user has to follow

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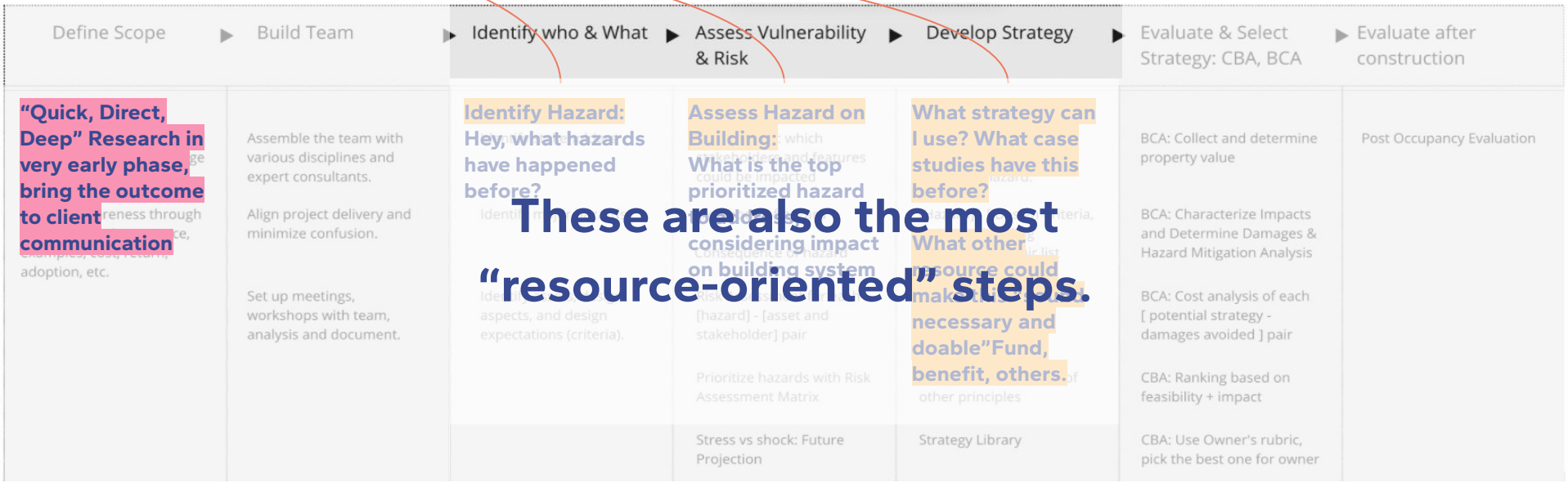
Essential Part of the workflow will be considered in the platform



These are also the most "resource-oriented" steps.

By Whom

Architecture design team (regardless of their experience).

As revealed in the survey, most participants have highly overlap on barriers , where they have barriers, and hazards.

What scenario?

Very early phase research: to quickly & directly understand

- What hazards are there
- What project has addressed this before, (case study)
- What action would be suitable (strategy)

So that this can be wrapped up and used to persuade the client

What is this platform? Is not?

"This research **is not producing** resilience architecture **knowledge, but build tools to bring** resilience **resource** and **knowledge**, public or within firm, **to the design team**"

Is:

A platform that users are provided

- A guided **research** for case study, strategies, and other hazard resource
- A toolkit to contribute (**upload & format)** their data.

Is not:

An expert-level resilience knowledge base

~~A state-of-the-art & closed knowledge base?~~

An open and scalable toolkit.

Users would be fully responsible for validating and uploading their data with a toolkit. (experienced designer or resilience champion can lead this)

Current data in this platform is just for demonstration of core functionality - search + contribute .
This platform can bring up resource from trusted source (FEMA, ASHE, AIA) and even organization precedent (firm's internal knowledge).

Why this is important

Public Resources are their, but they are scattered. (AIA hub, CHD, FEMA, HHS)

Google everything is still doable, but, takes a long time. (expert can be quick, but less-experienced might spend a long time)

Company knowledge usually lived in static file (text document, sheet, blogs). **Can they be more accessible** (direct, easy to get) **and interactive** (use and contribute)?

A “guided, direct”research can save time!

Essential Steps

1) Identify hazards: Search by State, County

- use FEMA api to get historic hazard
- User can select hazard

2) Risk assessment for identified hazards:

- A **step-by-step wizard**, From identity impacted system, hazard likelihood assessment, to risk score calculation
- User then select risk (hazard-system) of concern

3) Navigate Resource

- Build specific project context
- Search case study
- Search strategy
- Search other resources (fundings, best practice)

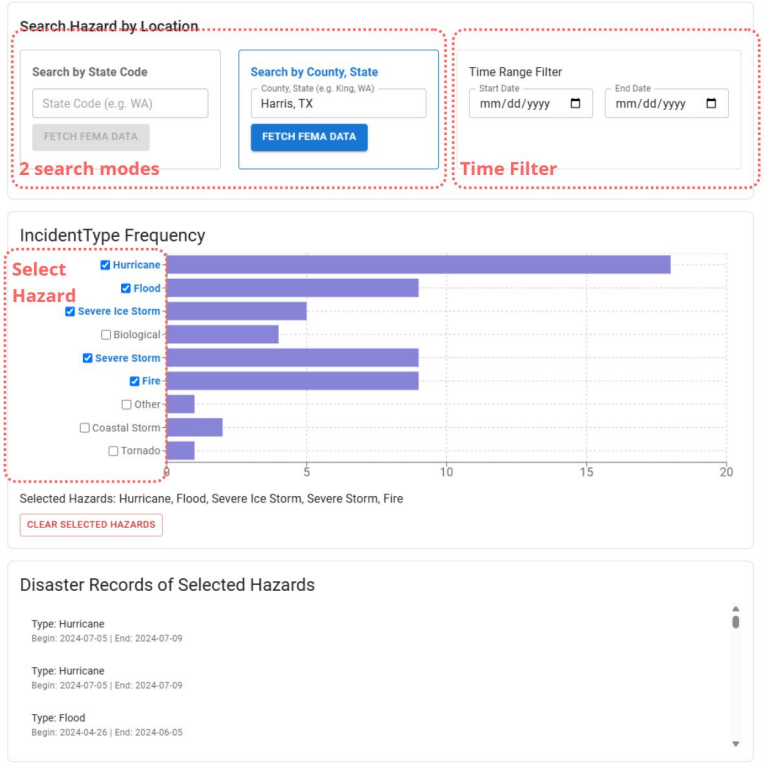
4) Summarize previous steps

- Collect previous information and documentation

Demo!

RRP_DRAFT v3B.mp4
With help from my ZGF colleague Lahmi Kim

Step 1

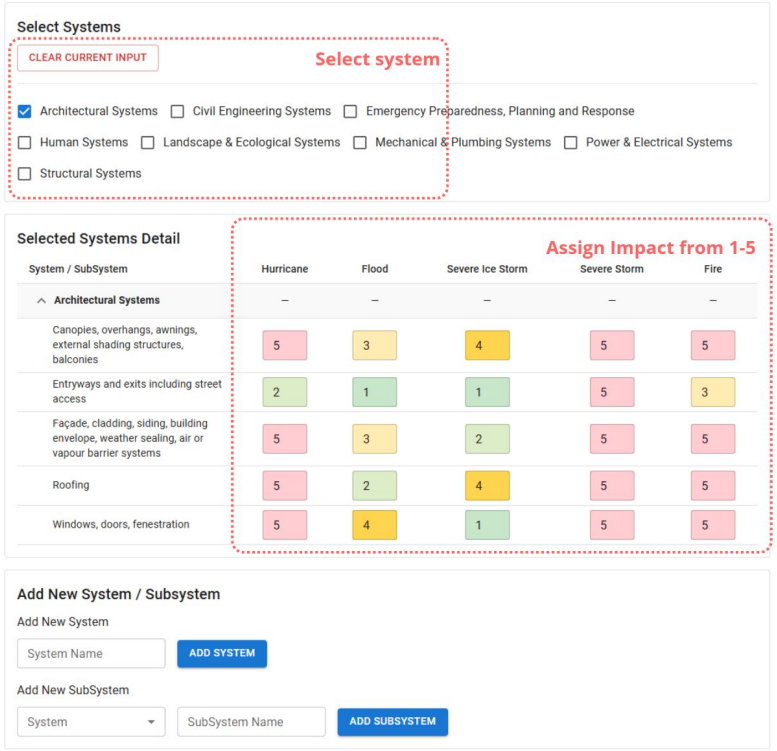


Enter a location

Filter by time (optional)

Compare and select hazard

Step 2.1 Assess Impact



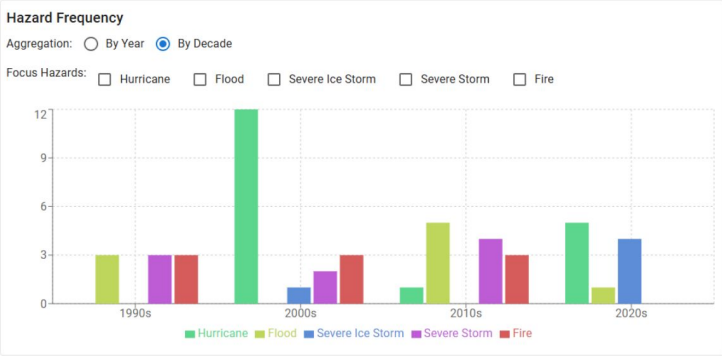
The building system-subsystem is loaded as a template,

- originally from City of Vancouver Building Resilience Planning Worksheet

The impact score still require architecture knowledge,

- Maybe “semi-auto calculator” in the future?

Step 2.2 Assess Likelihood



The previously fetched FEMA hazard data is displayed in detailed,

The likelihood score still require architecture knowledge,

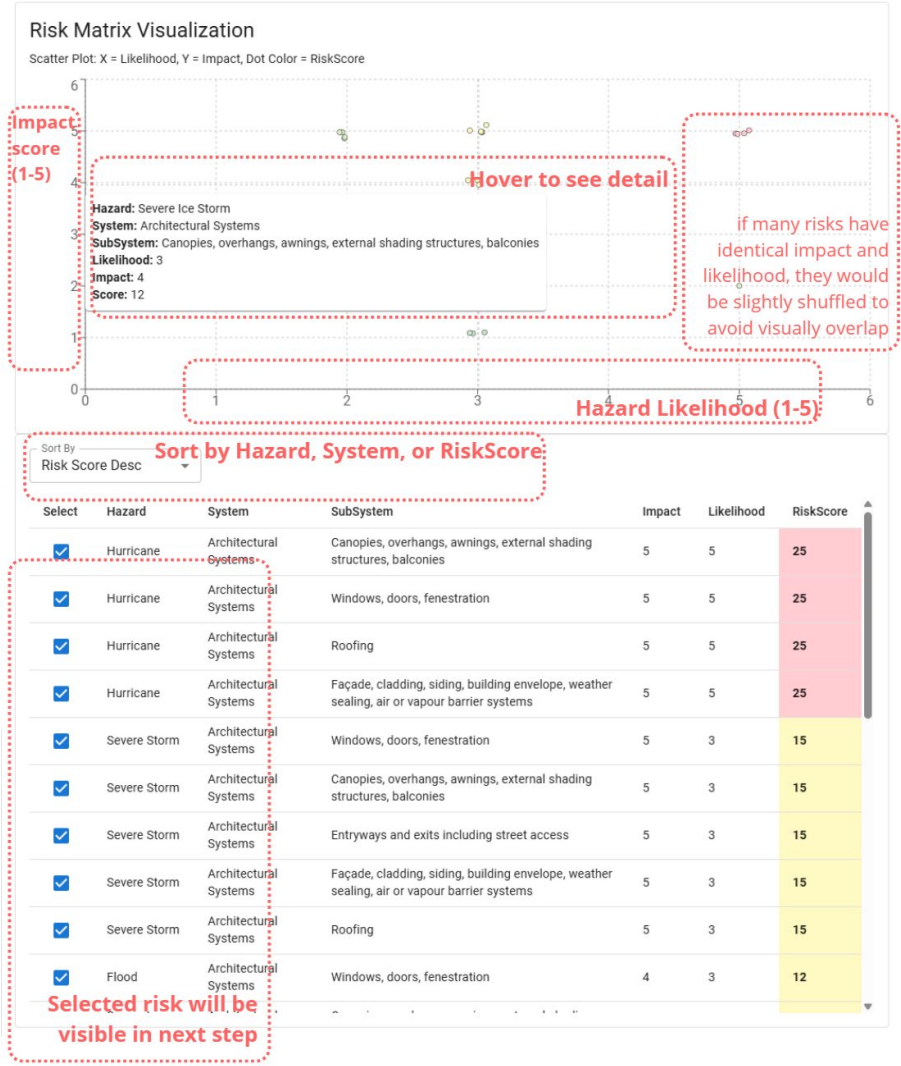
- If we can have data from insurance company...

Step 2.3 Prioritize Risk

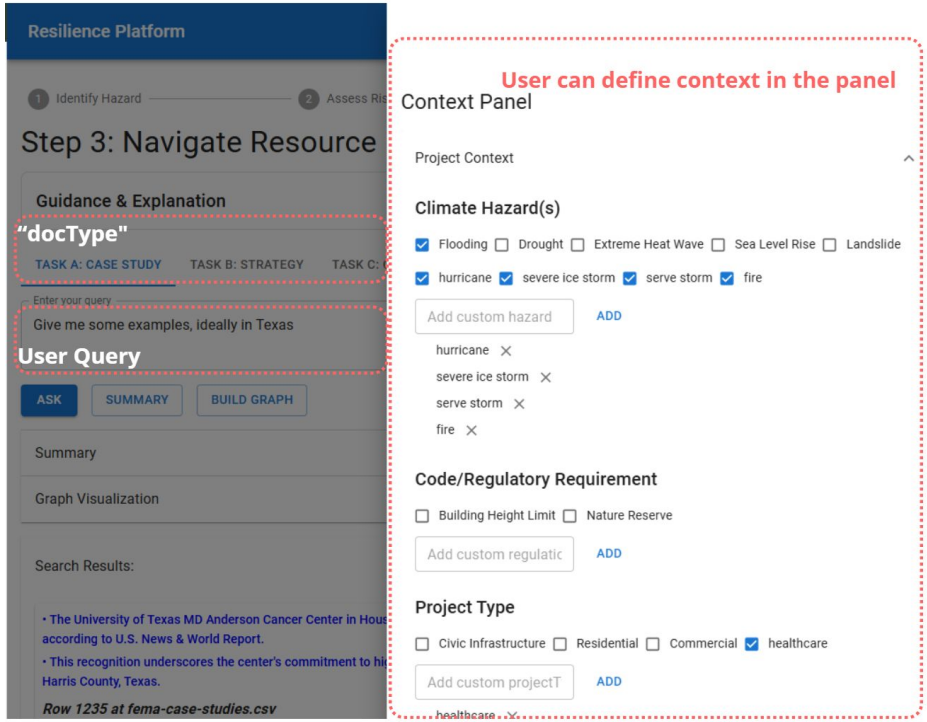
Risk = Exposure x Consequence x Likelihood
0 or 1 1 to 5 1 to 5

Select risks that should be prioritized

- City of Vancouver suggested that any risk >=10 should be considered



Step 3 Send better (structured) question to AI

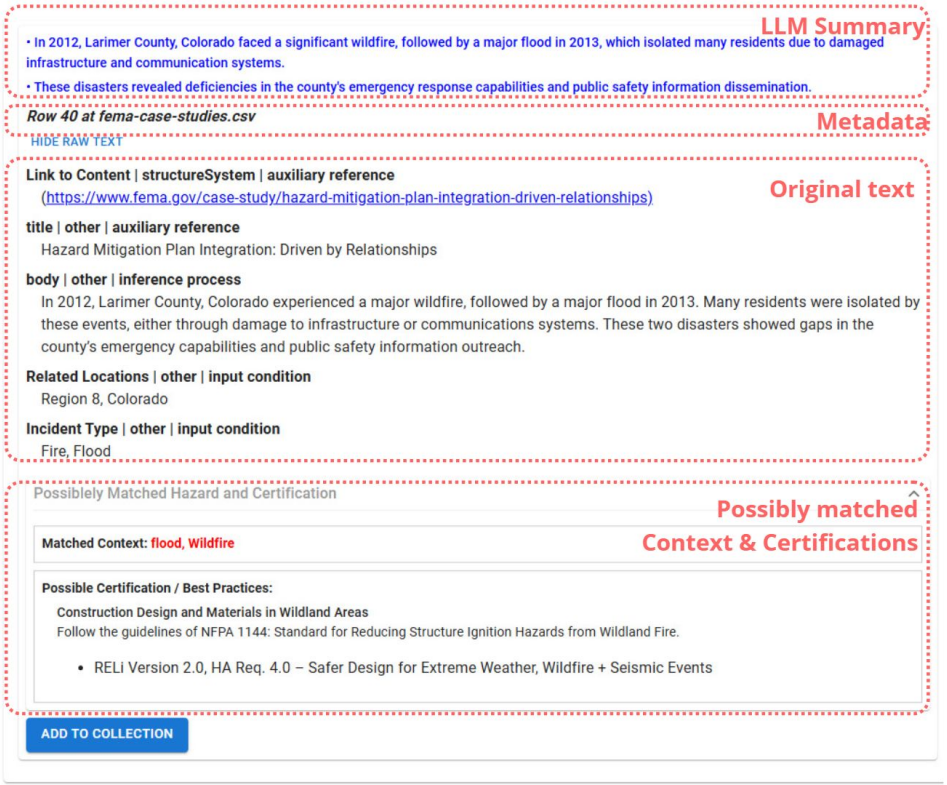


A combined message

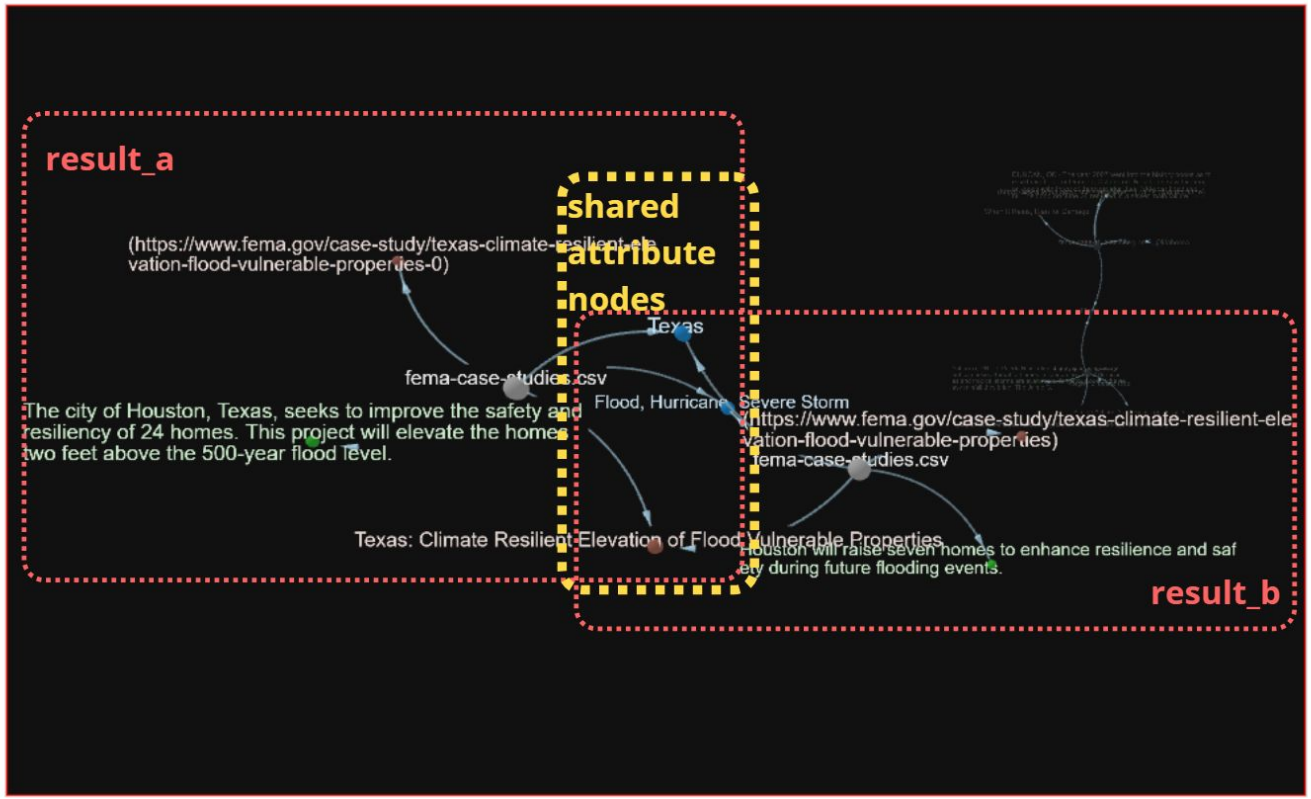
docType: *Which type of file*
Context: *What is the project context*
User Query: *What do you want to know*

will be sent to AI

Step 3 Display a single result



Step 3 Compare Multiple Results



Still beta version

Step 3 Summarize Multiple Results

1 *** Global (multiple results from multiple files)**

Summary of All results

+

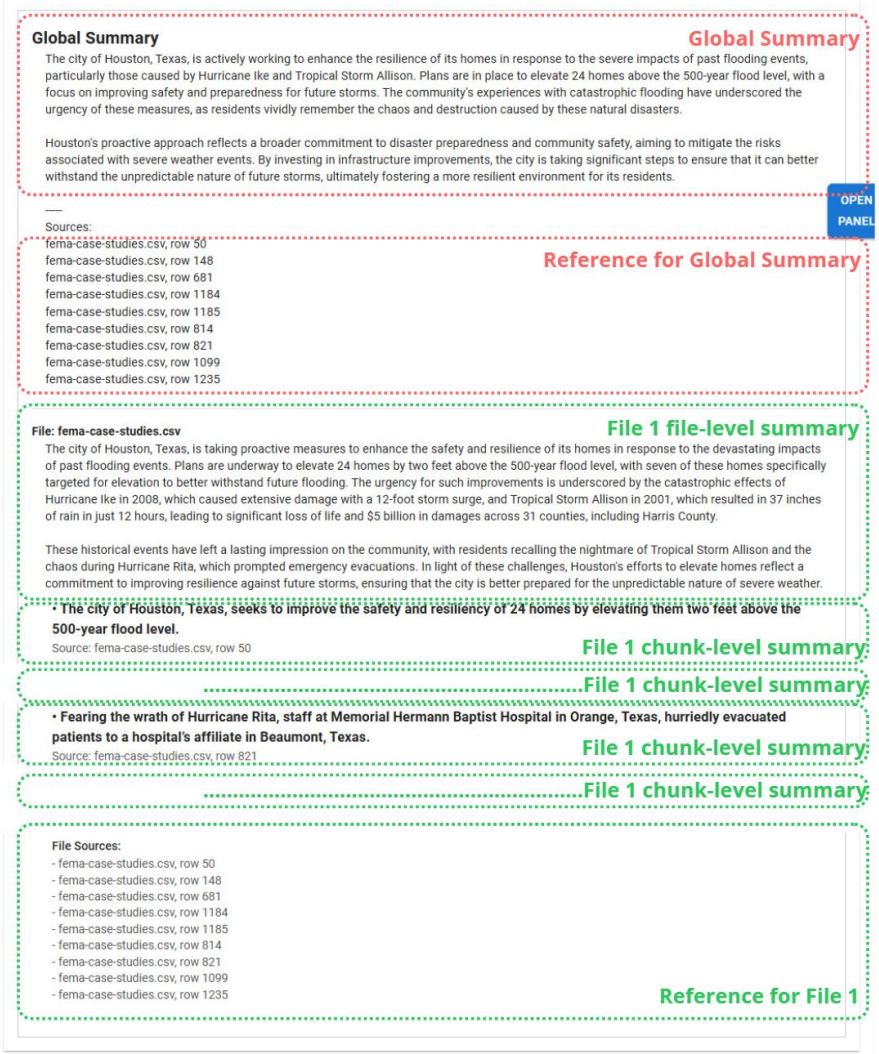
Reference of All results

n *** File-level (multiple results from one file)**

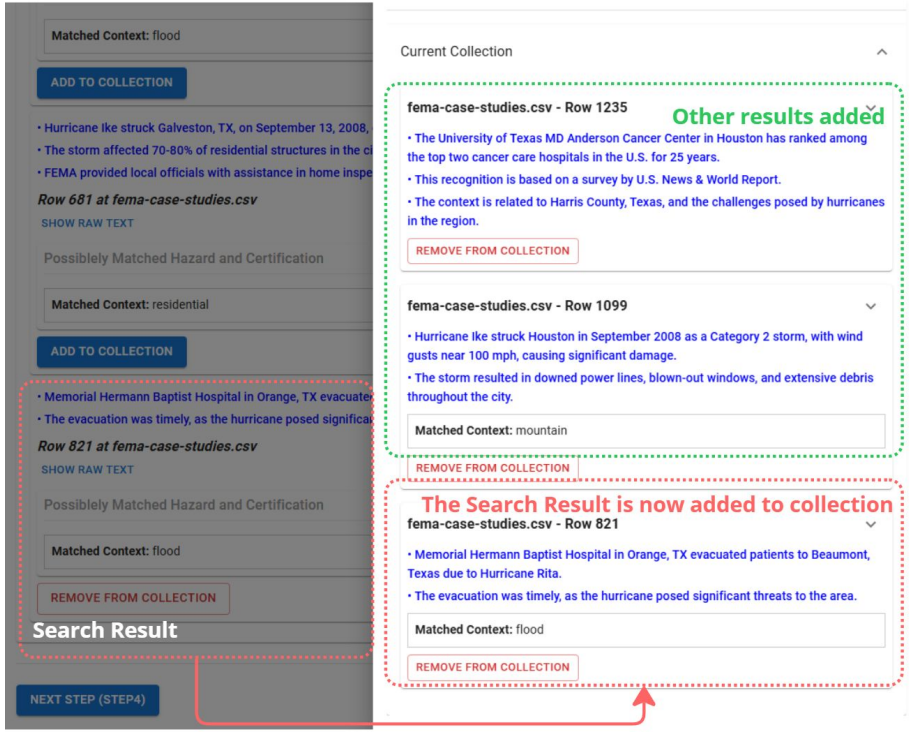
Summary of All results in this file

+

k ***** Description of each result

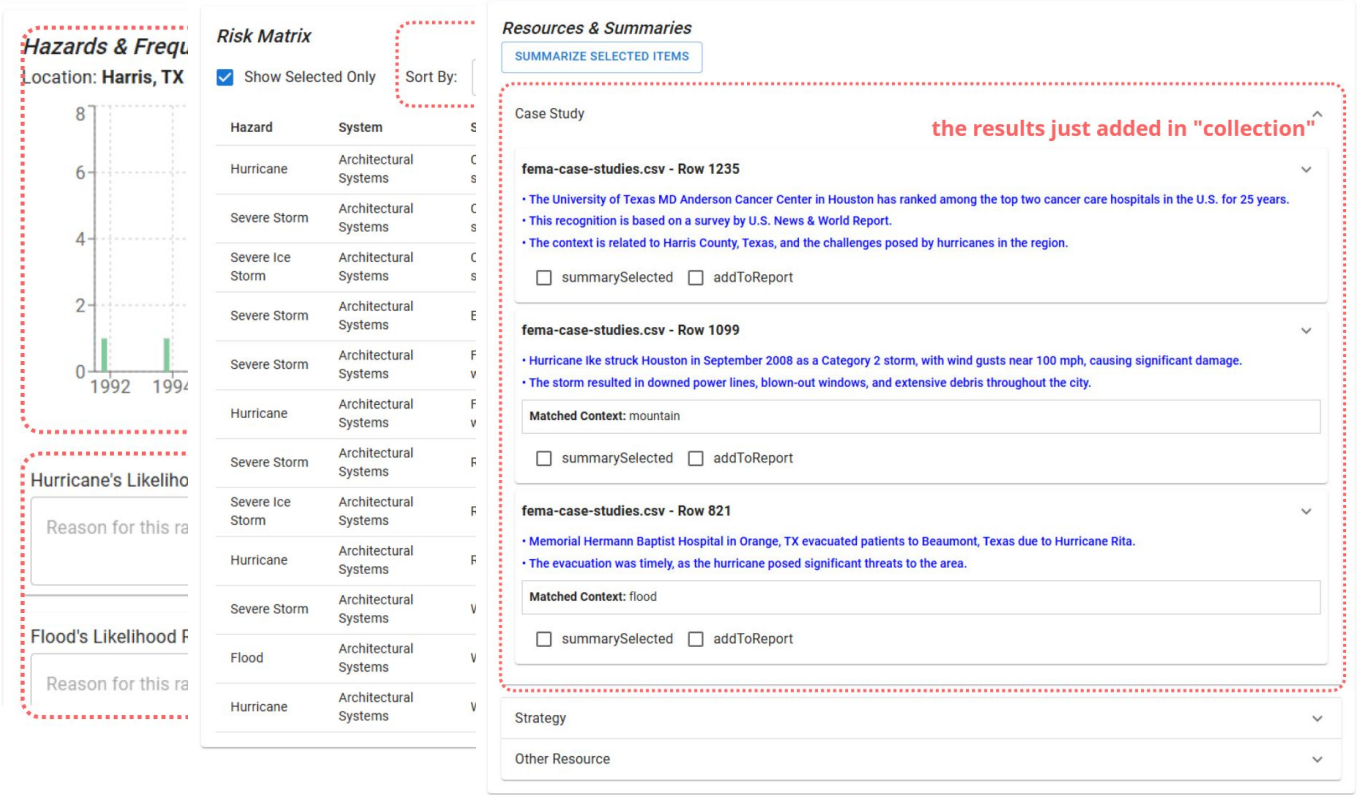


Step 3 Collection



Save your search and,
Prepare for later documentation

Step 4 Documentation



Technology

Framework:
Frontend: React.js, Backend: Node.js,

Information Retrieval:
LangChain (RAG) , gpt 4-mini (OpenAI),

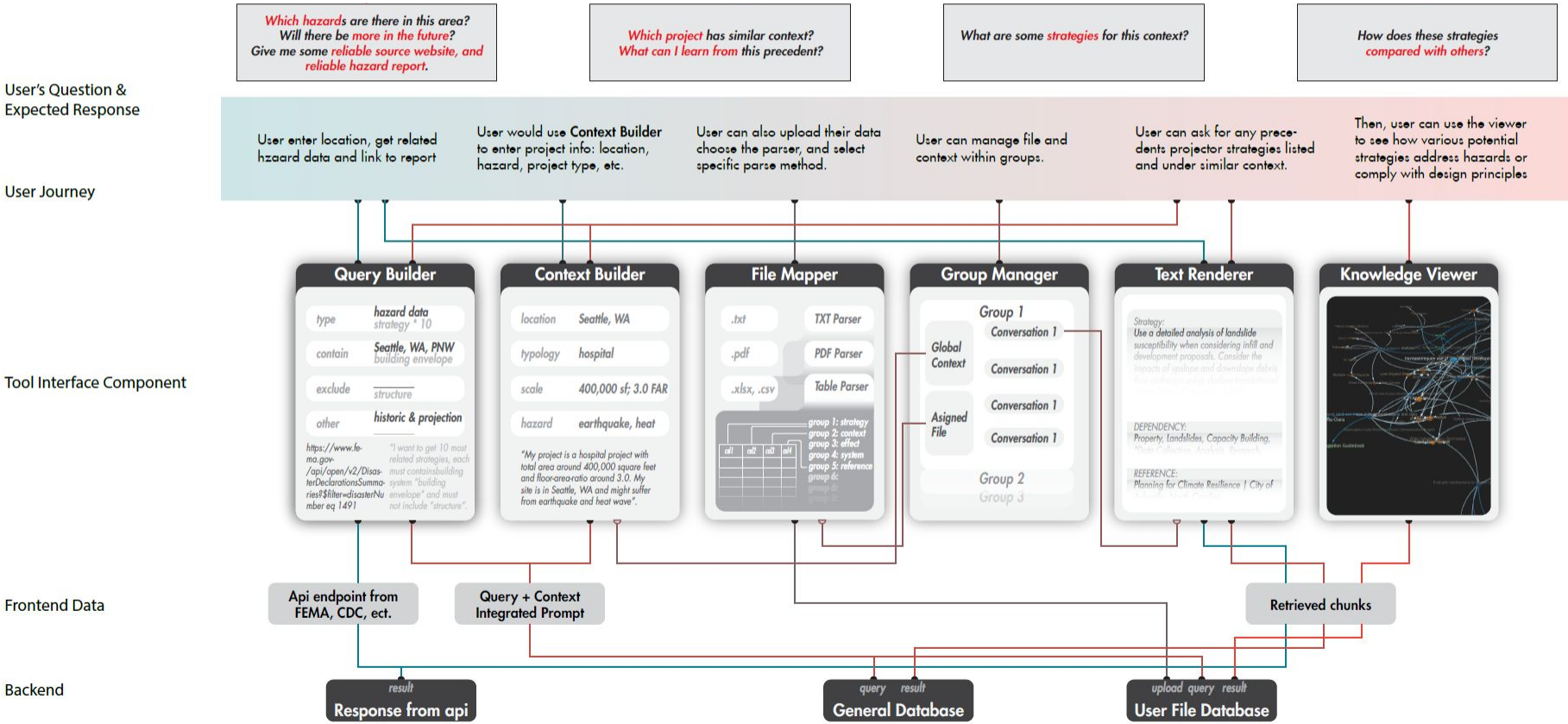
Visualization:
Three, react-force-graph-3d, etc.

UI:
Material UI

Technology

User's Question & Expected Response	*Which hazards are there in this area? Will there be more in the future? Give me some reliable source website, and reliable hazard report.*		*Which project has similar context? What can I learn from this precedent?*		*What are some strategies for this context?*	*How does these strategies compared with others?*
User Journey	User enter location, get related hzaard data and link to report	User would use **Context Builder** to enter project info: location, hazard, project type, etc.	User can also upload their data choose the parser, and select specific parse method.	User can manage file and context within groups.	User can ask for any precedents projector strategies listed and under similar context.	Then, user can use the viewer to see how various potential strategies address hazards or comply with design principles

Technology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User can manage file and context within groups.
User can ask for any precedents projector strategies listed and under similar context.
Then, user can use the viewer to see how various potential strategies address hazards or comply with design principles
Tool Interface Component
Query Builder
type
hazard data
strategy * 10
contain
Seattle, WA, PNW
building envelope
exclude
structure
other
historic & projection
https://www.fema.gov-/api/open/v2/DisasterDeclarationsSummaries?$filter=disasterNumber eq 1491
"I want to get 10 most related strategies, each must contain building system "building envelope" and must not include "structure".
Context Builder
location
Seattle, WA
typology
hospital
scale
400,000 sf; 3.0 FAR
hazard
earthquake, heat
"My project is a hospital project with total area around 400,000 square feet and floor-area-ratio around 3.0. My site is in Seattle, WA and might suffer from earthquake and heat wave".
File Mapper
.txt
TXT Parser
.pdf
PDF Parser
.xlsx, .csv
Table Parser
group 1: strategy
group 2: context
group 3: effect
group 4: system
group 5: reference
Group Manager
Group 1
Global Context
Conversation 1
Conversation 1
Asigned File
Conversation 1
Conversation 1
Group 2
Group 3
Text Renderer
Strategy:
Use a detailed analysis of landslide susceptibility when considering infill and development proposals. Consider the
DEPENDENCY:
Property, Landslides, Capacity Building,
REFERENCE:
Planning for Climate Resilience 1 City of
Knowledge Viewer
Frontend Data
Api endpoint from FEMA, CDC, ect.
Query + Context Integrated Prompt
Retrieved chunks
Backend
result
Response from api
query
result
General Database
upload
query
result
User File Database

Integration

"One goal of **building integration**, therefore, is to **reduce the amount of time, material, and space employed in a building** while **increasing the number of activities that can take place within it**. The result is a balance. The task is to abstract the notion of building systems integration with the purpose of achieving the goal." (*Building Systems Integration Handbook* 317).

The Building Systems Integration Handbook. Edited by Richard D. Rush, American Institute of Architects, 1986.

"One goal of **workflow integration**, therefore, is to **reduce the amount of time, resource, and cognitive load employed in a each task** while **increasing the depth of existing knowledge that can construct a new solution**.

Yongqin Zhao, 2025

Contribution

For Design Team

- **Streamline resilience workflow, from 1-day Googling to 30-min exploration**
- **Get concrete examples at early phase, show client, set alignment on resilience**

For Industry and Academia

- **End-to-end application of LLM** in **production**, not just a script in IDE
- Existing building resilience research mainly focus on "*how to bring TASK_A to next-level*". **This research is about "*how to make everyone accessible to TASK_A*"**

For Firm

- **For mid-large firm: A truly accessible Knowledge Sharing library (as long as resilience champion maintain the knowledge, and DT maintain the tech).**
- **For small firm: Easy access to data (assuming this would get support from industry leaders and researcher)**

Limitation

Data Source

- Step 1 Hazard Data: Only US (some mentioned CA). Only historic (no future projection)
- Step 2 Automation: still need to manually fill out hazard's impact on system
- Step 3 Resource: Only Demo data

Technology

- Only Table file (csv) and PDF. Image is not currently supported
- Naive RAG, and not as good as SOTA RAG (like GraphRAG)
- Cheap LLM (GPT-4 mini)
- Context Matching is based on keywords matching. Not dynamic

Further Development

Support from industry organizations, institution, and leading firms is needed

- **I want to maintain this project, but would need support on the knowledge side**

Support from Tech and Infrastructure

- **LLM**
- **Hosting**

Developing is Fun (?)

Code

-> Bug -> Code -> Bug -> Code