Developing a Citizen-AI Street Design Assistant for Road Safety

Thesis Defense

Yun-Ching Wu

MSc Metropolitan Analysis, Design , and Engineering

Content

Research Highlights

1. *Create a Citizen-AI Educational Website* (AI Prototype)

2. *Introducing the Sustainable Safety Concept to the Chinese-Speaking World*

3. *Proposed the AI ARIE model*

4. *The Citizen-AI 3E steps for the participation ladder*
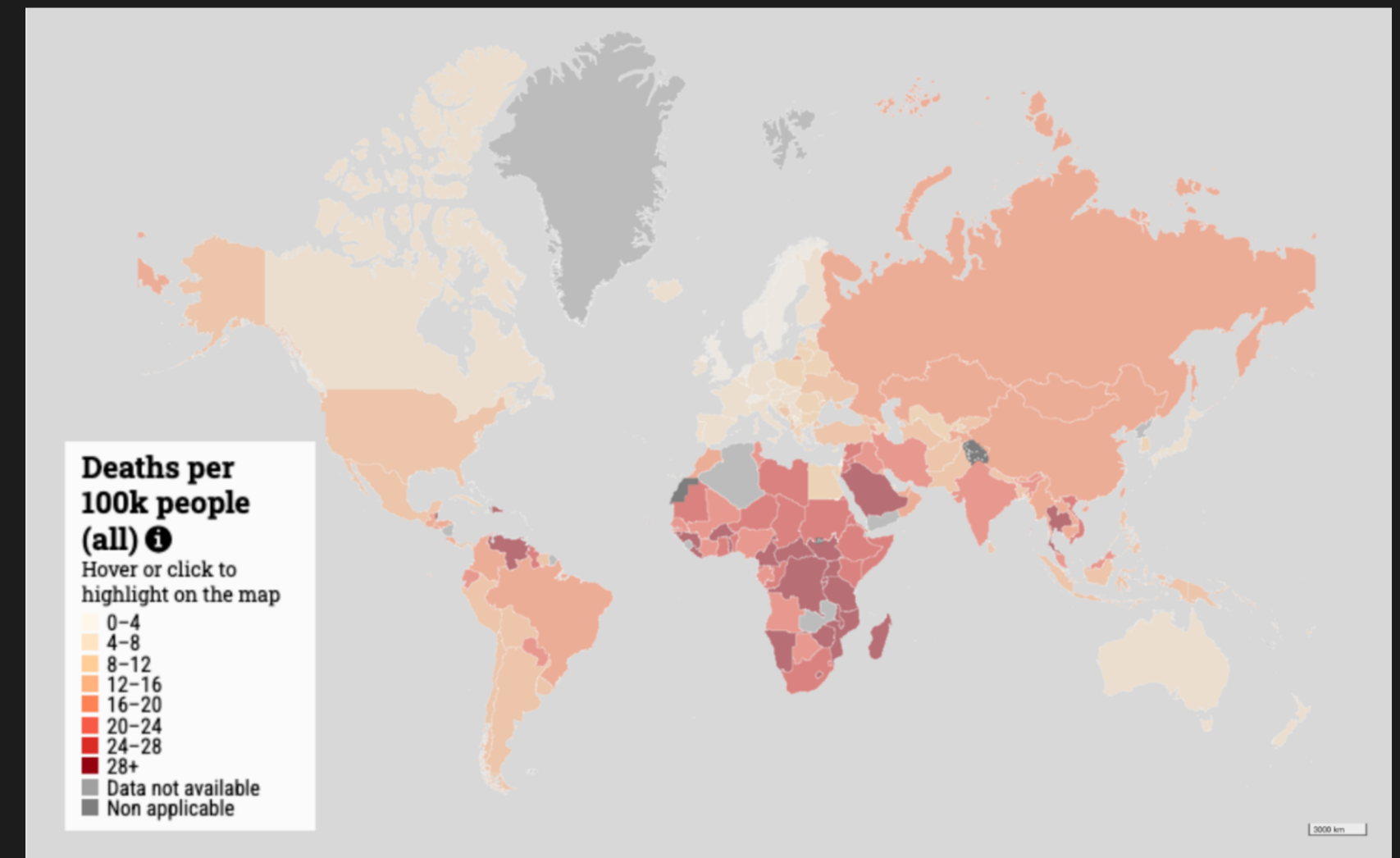
Prototype 3

- Improving the Website
  - Data visualization
  - Call to action
  - Enhancing user interactivity
  - AI page

- Prompt improvement
  - Accessibility of Knowledge Base
  - Increase the integration

English | 繁體中文 | 简体中文

Developing a Citizen AI Street Design Assistant for Road Safety

MSc MADE | AMS ADVANCED METROPOLITAN SOLUTIONS

TUDelft | WAGENINGEN UNIVERSITY & RESEARCH

Take Free AI Road Safety Assistant for a spin!

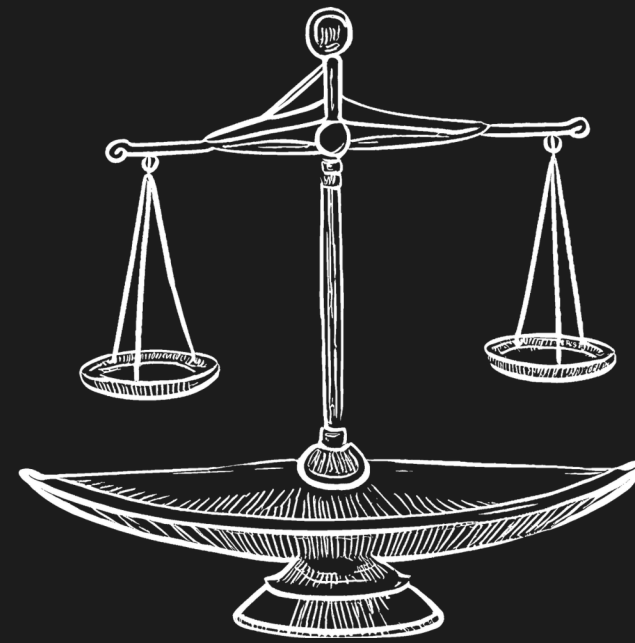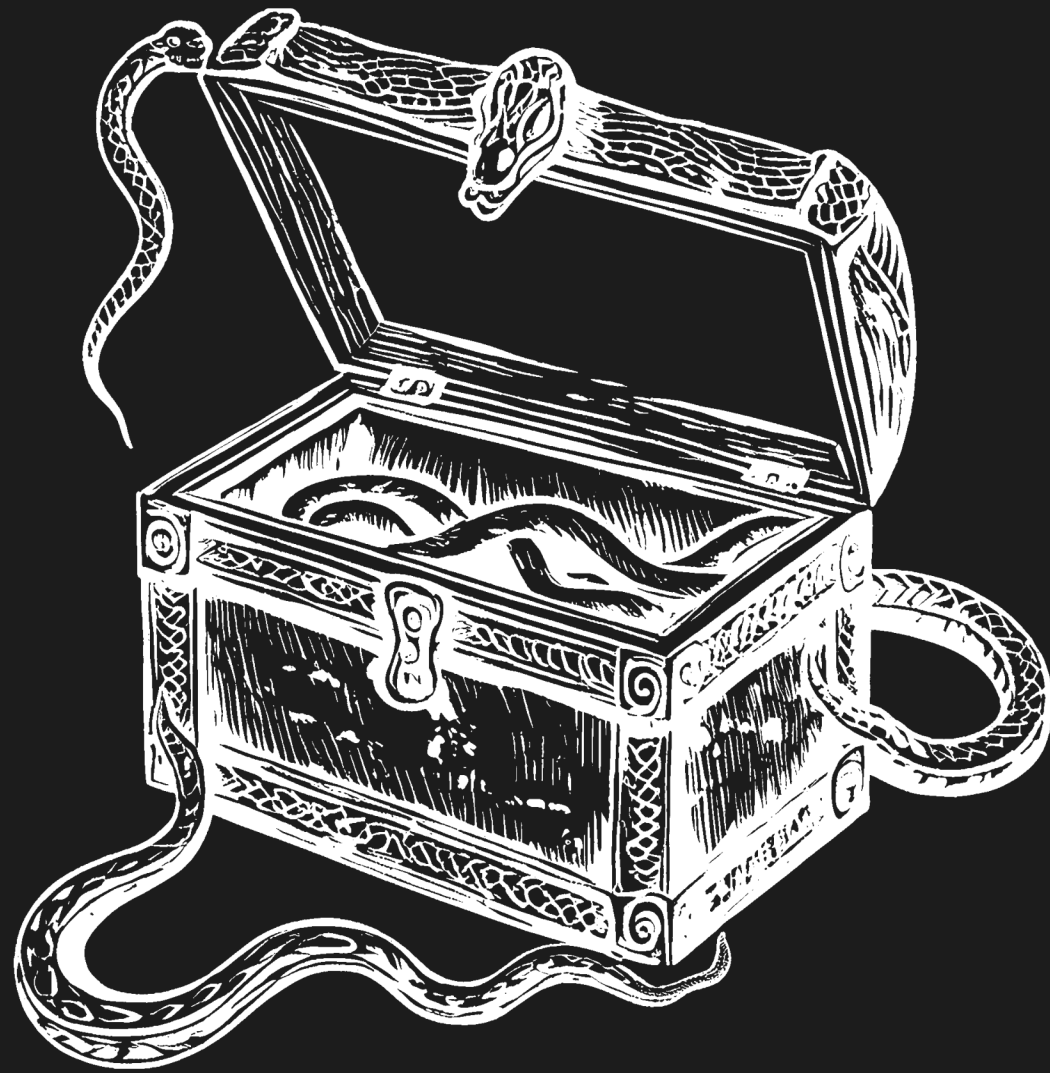**Project by YUNCHING WU**

Road safety as a global challenge

- 1.19 million fatalities, ~ 26 sec/ 1 person.

- Strive for zero deaths by 2050 (Vision zero goal)

1. *The uneven distribution of road deaths in the world*
2. *Lack of experts, knowledge, bad governance*
3. *A socio-technical challenge*
4. *Road design is an important element.*

Deaths per 100k people (all) ⓘ
Hover or click to highlight on the map

0–4
4–8
8–12
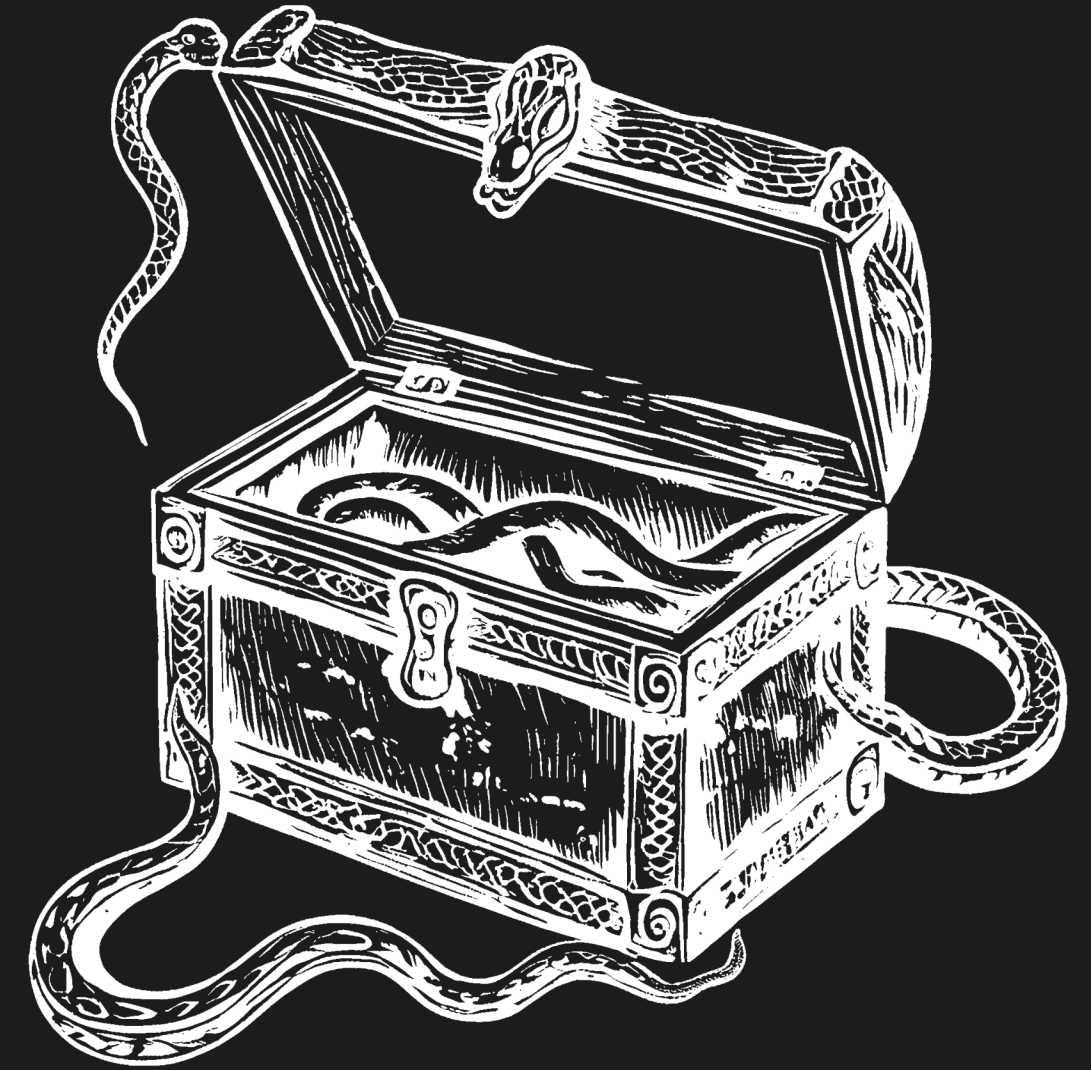12–16
16–20
20–24
24–28
28+
Data not available
Non applicable

Gen-AI Future: A Pandora or Jeffersonian Scenario?

AI's Pandora Scenario

AI brings all evils to humanity and weaken democracy.

- Facilitates centralization of control over information
- Fake vocal political support
- Create the illusion
- Reinforce 'filter bubbles'

Savaget et al. (2019). Note: definitions based on Barber (1998).

AI's Jeffersonian Scenario

AI brings all virtues to humanity
and enhance democracy.

- Permit marginalized people's participation
- Engage and inform voters about political issue
- Increase people's voices
- Auditing for transparency

Savaget et al. (2019). Note: definitions based on Barber (1998).

RQ: *"How can we develop an AI-driven tool that uses Gen-AI to assist in a safer street redesign process for citizens?"*

Social Aspect

- *What effective road safety methods or guidelines worldwide can inspire countries and communities in need?*

- *How can AI better enhance civil society's response to road safety challenges?*

Social Aspect

- *What literature on AI's societal impact can help design applications for social welfare while preventing misuse?*

- *What gaps exist in discussions about optimizing AI for civil society?*

Technical Aspect

- *How can this AI prototype be made user-friendly and accessible for citizens, allowing them to address street design issues effectively?*

- *What are the current limitations of frequently used AI applications (in this case, ChatGPT-4) in contributing to safer street design?*
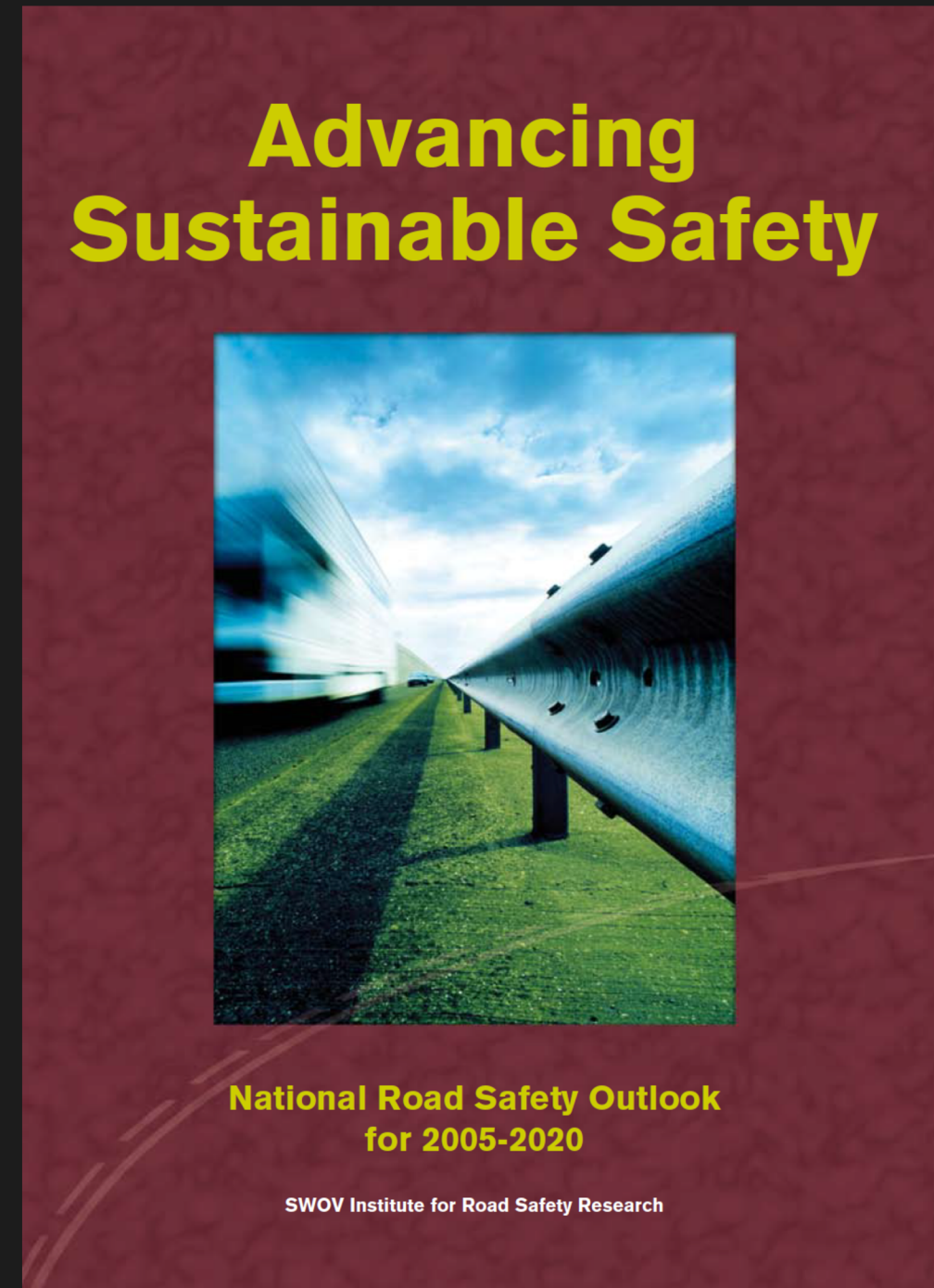
II. Literature Review:
Road Safety

II. Literature Review

Purpose	1900–1920	1920–1950	1950–1970	1960–1985	1985/1990–Now
Crash	**<u>Chance phenomenon, bad luck</u>**	Road devils, accident-prone drivers	Road user or vehicle or road	Multi-causal approach	***Result of the integral road system***
Measure	On an ad hoc basis	**<u>Educate, punish</u>**	**Choice from the 3E's**	Technical solutions for vehicle & road	***Adapt road system to road user***

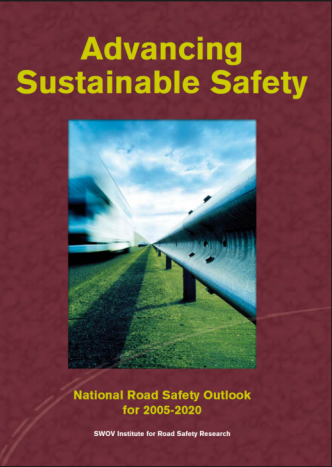*Source: Hagenzieker et al (2014), adopted from OECD transport research*

Sustainable Safety, NL

1. ***Functionality*** *of roads*
2. ***Homogeneity*** *in mass, speed, and direction*
3. ***Forgiving Road Design***
4. ***Predictability*** *of traffic behavior by a recognizable road design*
5. ***State Awareness***

Source: Sustainable Safety 3rd edition - The Advanced Vision for 2018-2030

Sustainable Safety, NL

	1992	2006	2018
Year	1992	2006	2018
Pages	185	215	35
Language	Dutch	English/ Dutch	English/ Dutch

1992

1. **Functionality** of roads
2. **Homogeneity** in mass, speed, and direction
3. **Predictability** of traffic behavior by a recognizable road design

2006

1. **Functionality**
2. **Homogeneity**
3. **Forgiving Road Design**
4. **Predictability**
5. **State Awareness**

2018

1. **Functionality**
2. **(Bio)mechanics**
3. **Psychologists**
4. Allocating **Responsibility**
5. **Learning and innovating**

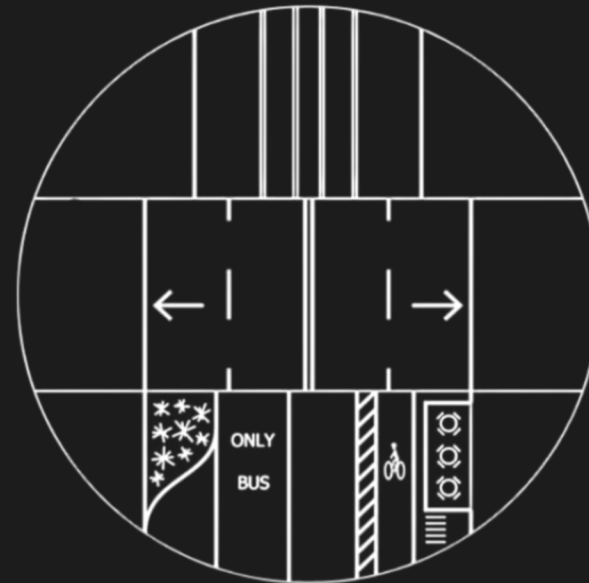*Source: Sustainable Safety 3rd edition - The Advanced Vision for 2018-2030*

Street Design Guide, US & Global

Streets Are Public Spaces
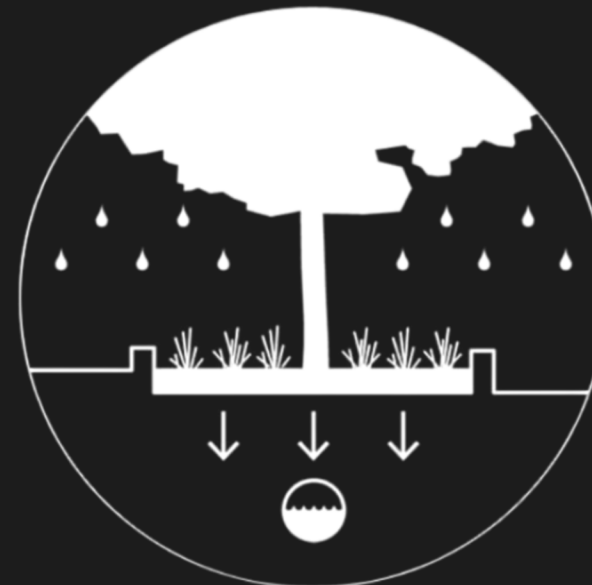
Great Streets are Great for Businesses

Streets Can Be Changed

Design for Safety

Streets Are Ecosystems

Act Now!

Urban Street Design Guide
National Association of City Transportation Officials

Global Street Design Guide
Global Designing Cities Initiative
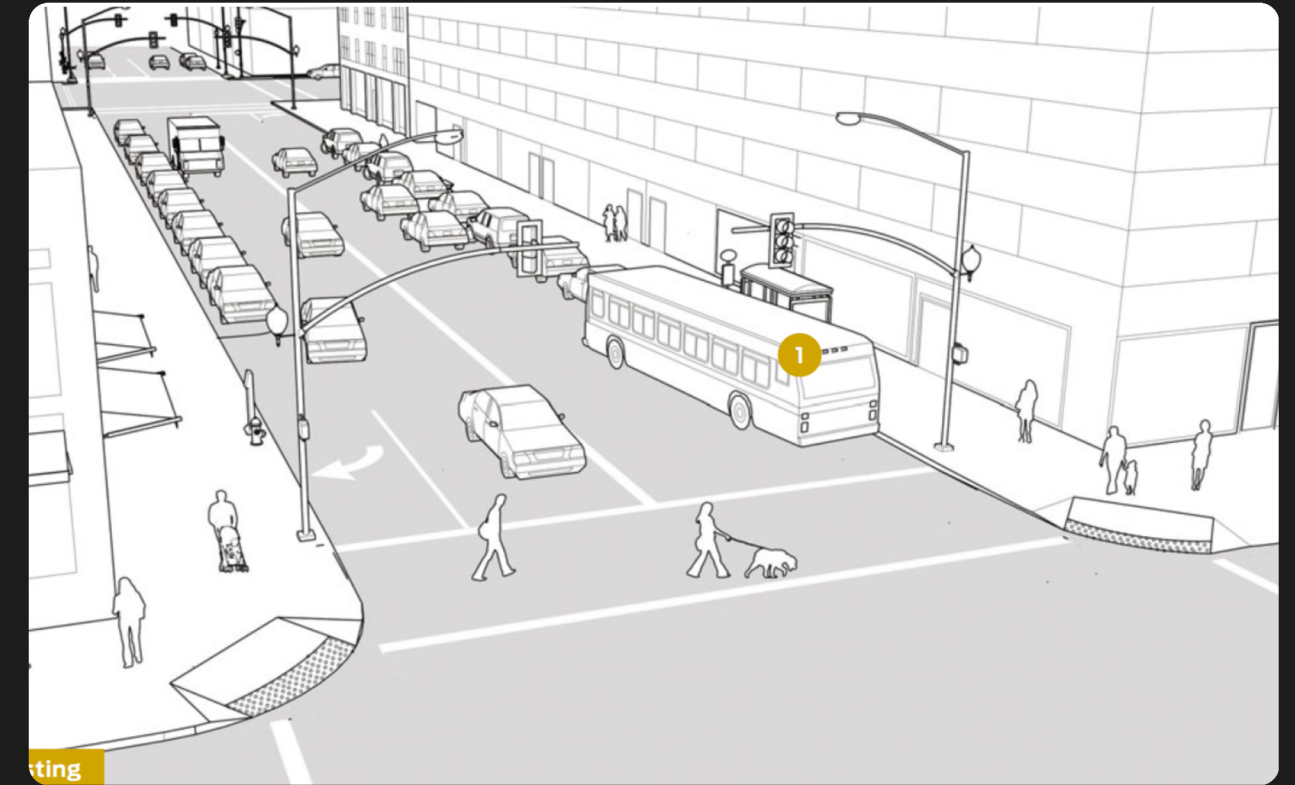
Source: Urban Street Design Guide (NACTO, 2013)

Existing

Redesign

Source: Urban Street Design Guide (NACTO, 2013)

Features	Sustainable Safety	Urban Street Design Guide
Editors/ Authors	SWOV *Institute for road safety research*	NACTO and GDCI
Publication Year	1992, 2006, 2018	2013, 2016
Primary Focus	Road safety through systematic risk reduction, focused on road safety	Redesign urban streets for safety and livability, also integrating the public transit system
Target Audience	Policy Makers, **Traffic Planners**, and Road Engineers	Policy Makers, **Urban Designers**, Cycling, and Pedestrian Advocates
Road/Street Design Principles	Functionality, Homogeneity, Forgivingness, Predictability, State awareness (Based on 2006 version)	Streets Are Public Spaces; Streets can help with urban vitality Streets need to be reconfigured to meet new needs; Design for safety; Streets are ecosystem; Using a phased approach to major redesigns

Source: Edited and organized by this research (based on SS and USDG)
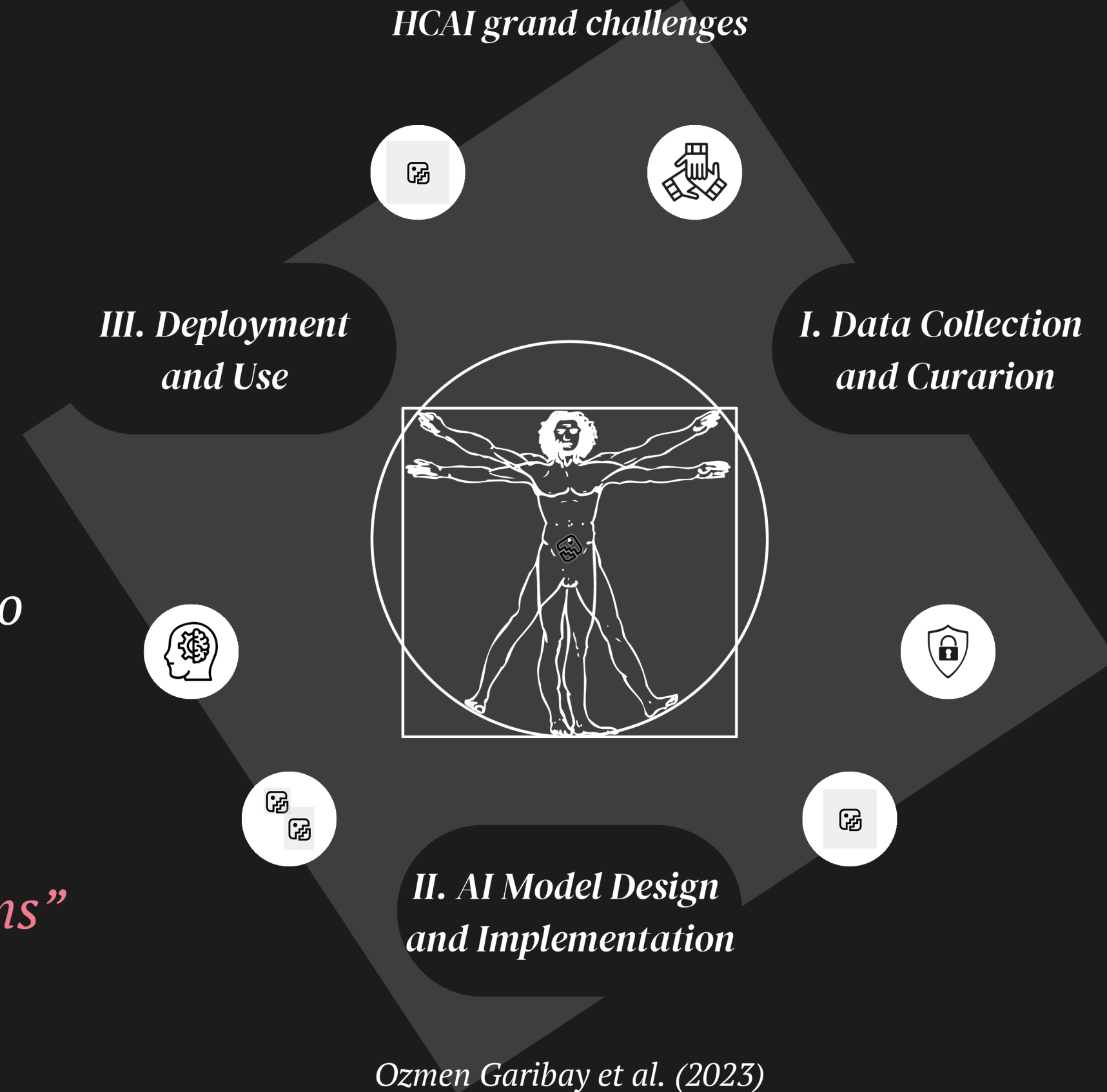
II. Literature Review
AI and Human Cetered AI

Human-centered AI (HCAI)

Emergence of the Human-Centered Artificial Intelligence (HCAI) concept in 2019

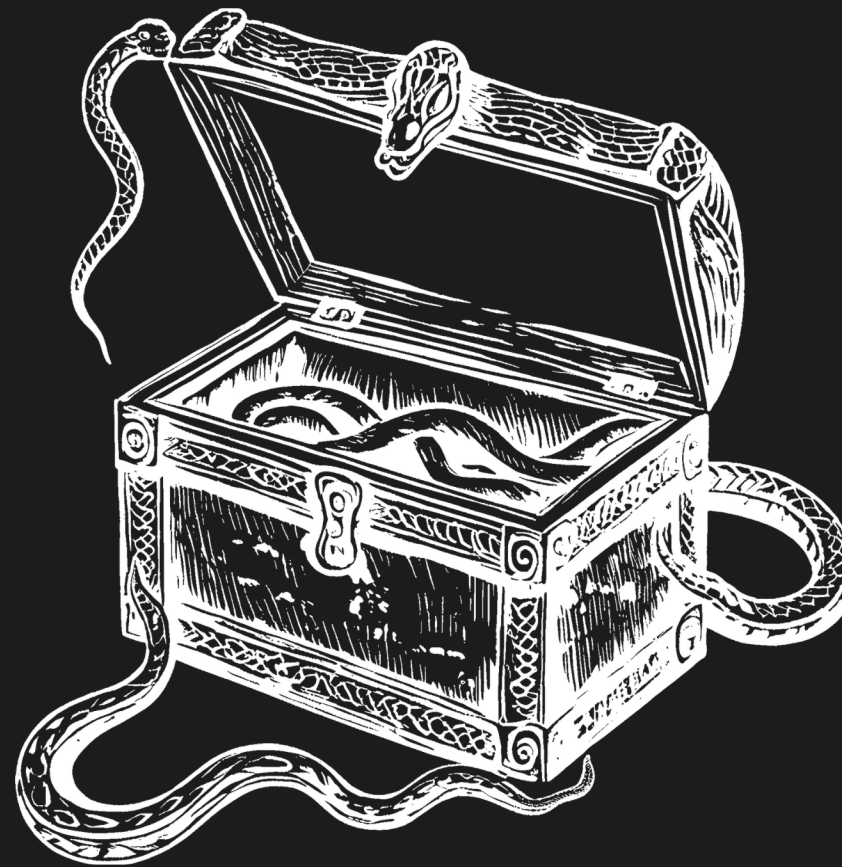*Riedl (2019) noted that scientists anticipate HCAI to possess two key abilities:*

- *"Make AI Understanding humans"*
- *"Facilitating human understanding of AI systems"*

- *"Fairness, Explainability, and Transparency"*

HCAI grand challenges

III. Deployment and Use

I. Data Collection and Curarion

II. AI Model Design and Implementation

Ozmen Garibay et al. (2023)

Gen-AI Concerns and Challenges

Human well-being oriented

Harmful content

Privacy and security

Inappropriate content

Authenticity

AI-Misuse

Copyright

Bias

Data Quality

Over-reliance

Prompt engineering

Digital and AI divide

Transparency and explainability

Hallucination

Ethics and governance

AI literacy and intelligence augmentation

II. Literature Review:
Citizen Participation

Arnstein's Citizen participation ladder

Arnstein (1969)

Citizen Power
Degree

Tokenism
Degree

Non-
participation

Citizen control

8

Delegated power

7

Partnership

6

Placation

5

Consultation

4

Informing

3

Therapy

2

Manipulation

1
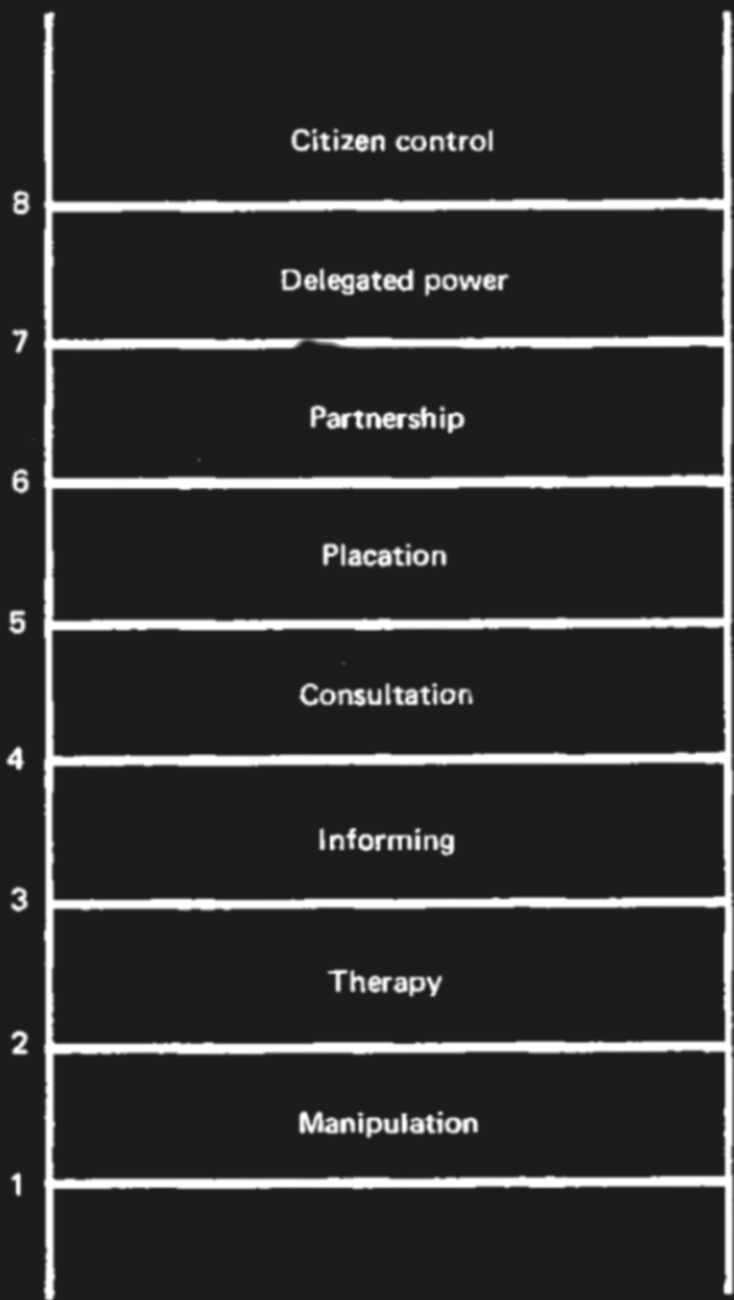
CITIZEN PARTICIPATION
- SHERRY R ARNSTEIN, 1969

je participe
tu participes
il participe
nous participons
vous participez
ils profitent

FIGURE 1   *French Student Poster. In English, I participate;
you participate; he participates; we participate;
you participate . . . They profit.*

Participation ladder in AI era?

Tritter's suggestion:

- Incorporating citizens into the evaluation cycle
- Increase mutual trust between users and professionals
- Strengthen "Professional Development"

Rung	Citizens vs. AI Developers
6. **Partnership**	1. Citizens collaborate 2. Co-policy-making 3. Problem-solving
7. **Delegated Power**	1. Citizens serve as key decision-makers 2. Overseeing plans and resources within specific limits.
8. **Citizen Control**	1. Citizens act as complete controllers, 2. Holding all policy and management decision-making power.

Adapted from Arnstein (1969), by this research

II. Literature Review:
The outcome

The ARIE (Aria) Model

By this Research

Avoid

Harmful content
Inappropriate content
AI-Misuse

Reduce

Bias
Over-reliance
Digital and AI divide
Hallucination

Insist

Human well-being oriented
Privacy and security
Authenticity
Copyright

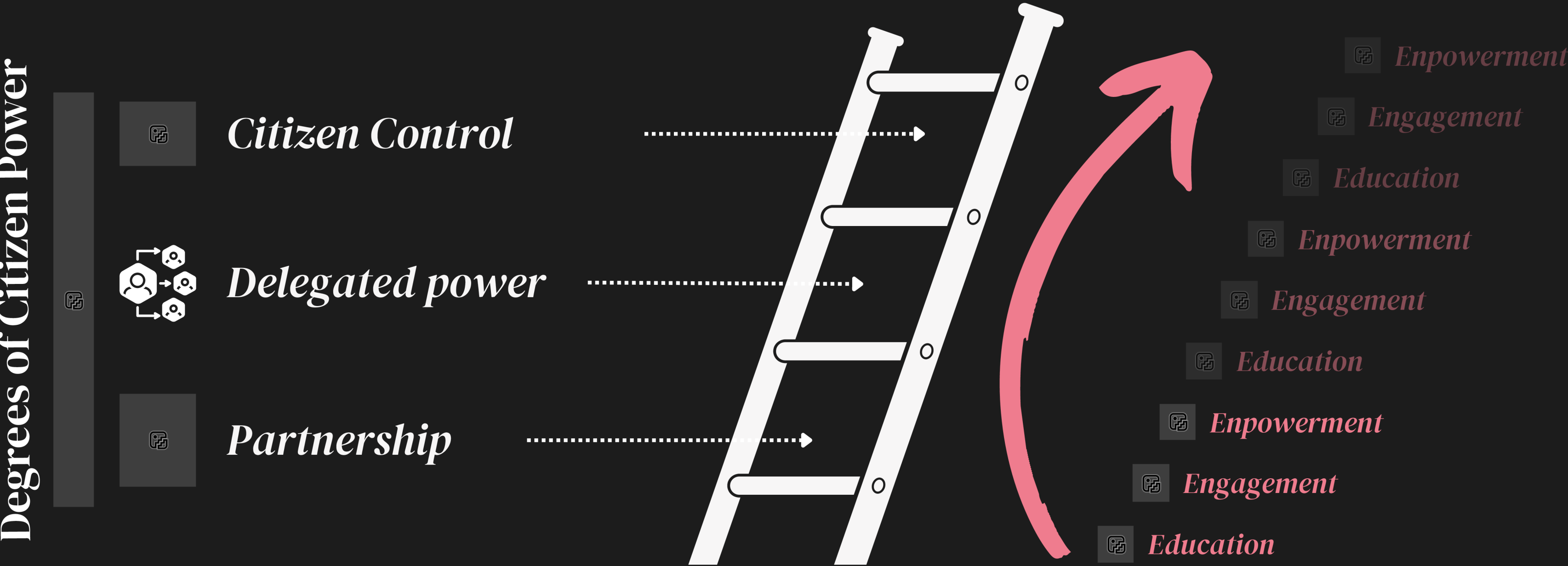## **Encourage**
(Advocate)

Citizen-AI 3E practice
Data Quality
Prompt engineering
Transparency and explainability
Ethics and governance
AI literacy

Inspired by Fui-Hoon Nah, Ozlem Ozmen Garibay et al. (2023), developed by this research

III. Methodology & Participation

- Prototyping
- Workshop and Questionnires

III. Methodology

Prototyping Method (Camburn et al., 2017)
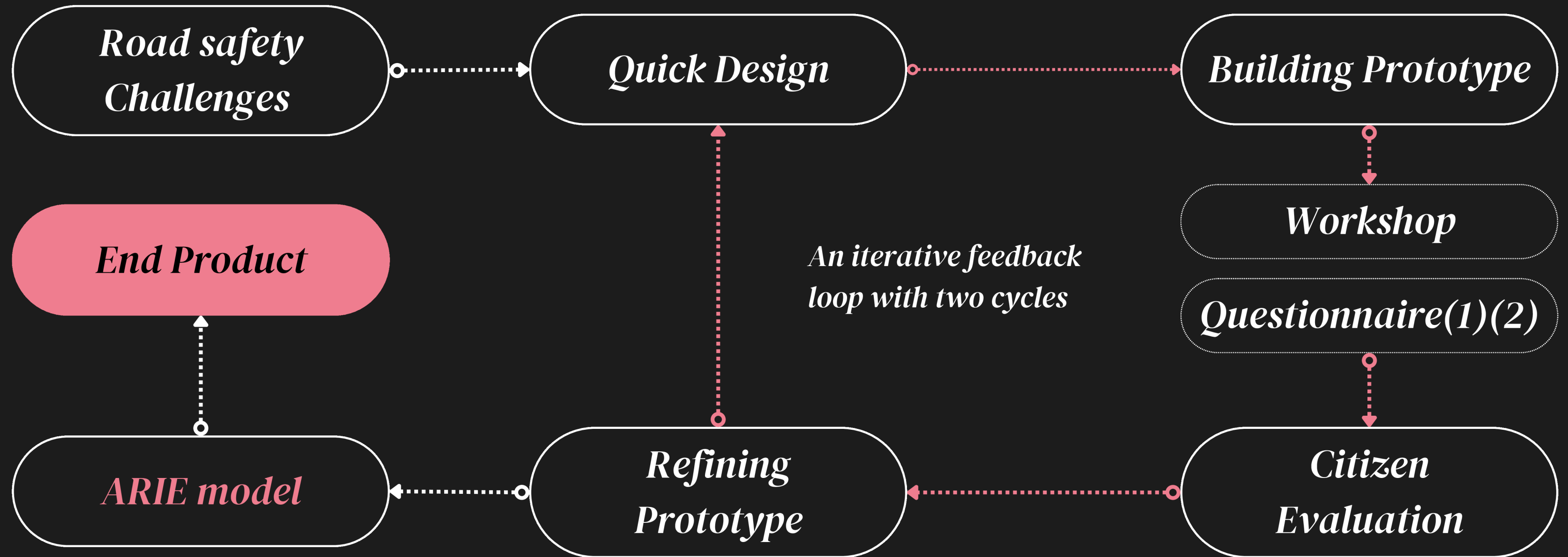
Workshop and Questionnaires

Workshop: 6 participants

Questionnaires (40 min): 25 participants

- Diverse backgrounds
- Prototype testing
- Focused on qualitative feedback

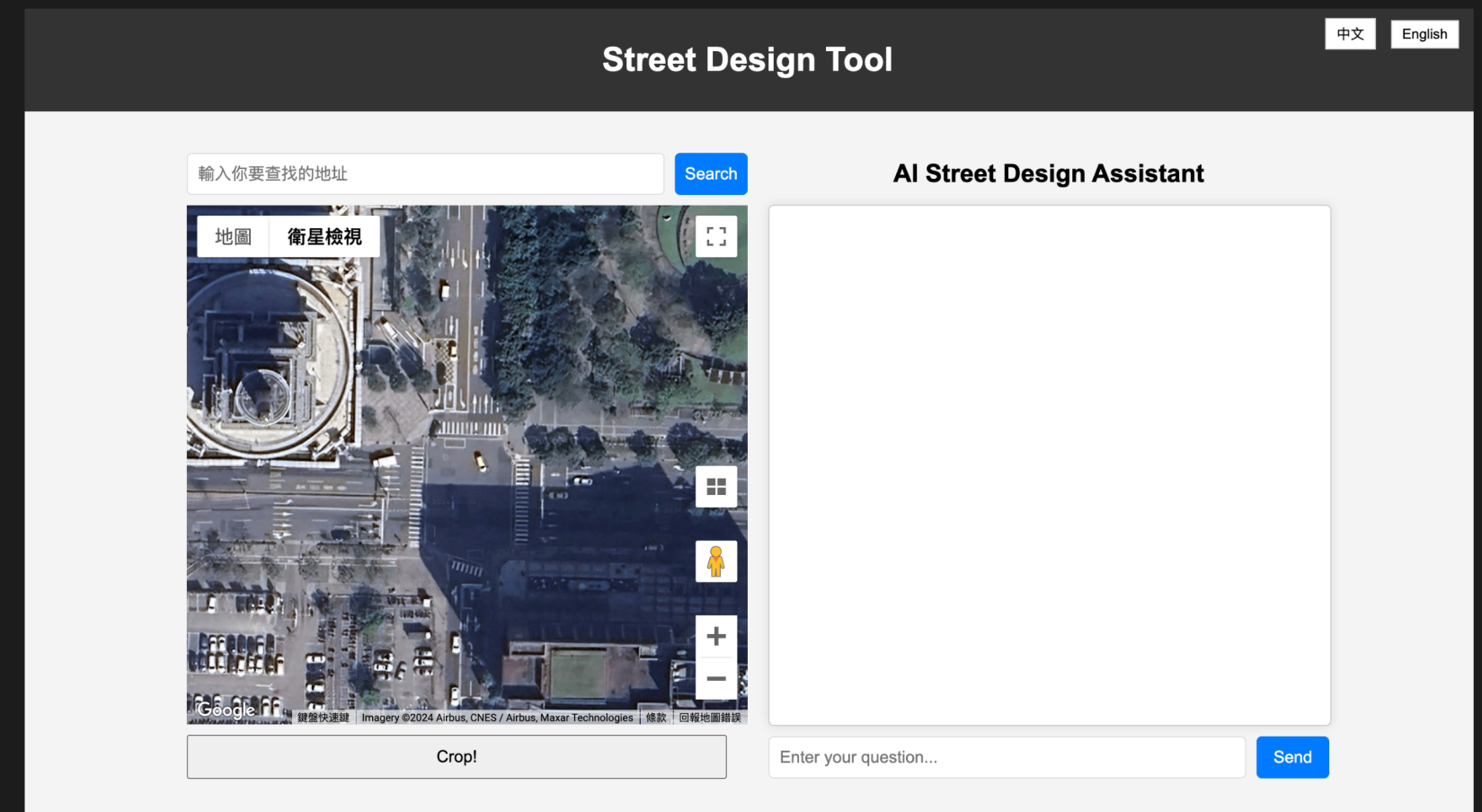Road safety ratings(1-10, unsafe-safe): 4.08 (W)/ 4.2 (Q)

Frequency of using Gen-AI (days/ week): 5 Days (W)/ 3.2 Days (Q)

Prototype 0

Google maps API + Open AI API

- Language (En/ TC/ SC)
- Computer/ Smart phone interface
- Google map and search bar
  - Bug - streetview
- Chatbot
  - Bug
    - GPT Response format
    - Image upload function

Prototype 1

Customized GPT

- **Prompt**
  - Citation
  - User's Checklist
  - User Interaction
    - Satellite maps or street-view images
  - Concise:
    - No longer than 150 words.
  - Accuracy:
    - 100% aligned with the knowledge base.

AI Street Design Assistant (English)
By YUN-CHING WU

AI street design assistant for enhancing road safety and urban livability through citizen participation.

| What are the principles of road design in... | Diagnose the road environment of my neighborhood. | Current state of road safety in the world? | What type of intersection this is? |

Message AI Street Design Assistant (English)

ChatGPT can make mistakes. Check important info.

Workshop and Questionnaires Feedback

Concerns, Suggestions, and Criticisms	Improvement measures
• Lacks appeal for general users • Need visual support • Knowledge Base • Data Transparency • Too vague • Outdated data	• visualized webpages • Include a clear list of references • Prompt adaption: linked to documents and websites • Continuously update and maintain the prototype and website based on the latest research.
• Spatial scale is imprecise	• The limitation of the LLM model • The importance of expertise • Include this in the suggestions for future research.

Prototype 2

Integrated Website + Customized GPT (Semi-AI)

- **Website**
  - Presenting the concept of Sustainable safety
  - Linked to Urban Street Design Guide

- **Prompt improvement**
  - Invite users to share street views
  - Provide link attachments

English   繁體中文   简体中文

Welcome!
Urban Street Design Assistant for Road Safety
Inspired by Sustainable Safety & Urban Street Design Guide

Sustainable Safety(SWOV) | NACTO | Open AI | YUNCHING WU

Workshop and Questionnaires (2)

Summary of the Feedback on Prototype 2

- Motivation for Engagement
  - Negative view of road safety
  - Not everyone is inspired by the prototype
  - The government bears all the responsibility

- Limitation in local context
  - May neglect the local context
  - The answer from the chatbot is too general

	Average Rate	Median Rate
Prototype1 - AI Chatbot	7.12	7
Prototype2 - Integrated Website	7.72	8

Prototype 3

- Improving the Website
  - Data visualization
  - Call to action
  - Enhancing user interactivity
  - AI page

- Prompt improvement
  - Accessibility of Knowledge Base
  - Increase the integration

Developing a Citizen AI Street Design Assistant for Road Safety

IV. Discussion

Q:
"How can we develop an AI-driven tool that uses Gen-AI to assist in a safer street redesign process for citizens?"

- *Prototyping Methodology*
- *Human-Centered AI (HCAI), ARIE model*
- *Civil society*

Social Aspect

- *What effective road safety methods or guidelines worldwide can inspire countries and communities in need?*

  - *Road safety principles: SS and USDG*

- *How can AI better enhance civil society's response to road safety challenges?*

  - *Using Customized Chatbot as a user-friendly tool*
  - *Knowledge base and prompting methods*
  - *Citizen-AI 3E model*

Social Aspect

SQ2:

- What literature on AI's societal impact can help design applications for social welfare while preventing misuse?

  - The Human-Centered AI (HCAI) principles

- What gaps exist in discussions about optimizing AI for civil society?
  - the ARIE model
  - Citizen AI, the 3E steps practice

Technical Aspect

Q1. How can this AI prototype be made user-friendly and accessible for citizens, allowing them to address street design issues effectively?

- ○ Visualization
- ○ Interactive features and prompt design
- ○ Multilingual support
- ○ Citizen's Feedback

Q2. What are the current limitations of frequently used AI applications (in this case, ChatGPT-4) in contributing to safer street design?

- Limitation:
  - ○ AI-generated visuals and Spatial precision
  - ○ Expert indispensability

Conclusion

1. *Create a Citizen-AI Educational Website* (AI Prototype)

2. *Introducing the Sustainable Safety Concept to the Chinese-Speaking World*

3. *Bridging the Gap Between Urban Design and Road Safety*

4. *Proposed the AI ARIE model*

5. *The Citizen-AI 3E steps for the participation ladder*

VII. Conclusion

Future Study:

    a. *Technical: Numerous AI applications can enhance road safety, and innovation is important.*

    a. *Social:*
        i. *Engaging citizens in the development process is crucial.*
        ii. *An extended study of the ARIE model is potential.*

Thank you!