

Exploring Rural Shrink Smart Through Guided Discovery Dashboards

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Outline

- Introduction to Rural Shrink Smart Project with Iowa State University and Open-Source Data Challenges
- Motivation - Why Use Dashboards?
- Guiding Design Principles & Dashboard Design Workflow
- Dashboard Philosophy - PCPs and the Novice User
 - Using Guided Discovery Learning (GDL)
- Dashboard Design Workflow
 - Feedback Loop (Active and Passive Data Collections)
- Future Work

Project Introduction and Open-source Data Description

Rural Shrink Smart Project



- **Project Question:** How do some cities manage to maintain quality of life for residents amid shrinking populations?
- Can this be taught?

This material is based upon work supported by the National Science Foundation under Grant No. 1952007. We would also like to thank our collaborators at Iowa State, the Iowa League of Cities, and the various Iowa government organizations which publish their data at (<https://data.iowa.gov>).

Basic Idea

- Assemble publicly available data sets
 - Available over lots of different geographic measurements
Lat/Long, Zip code (5 or 9 digit, changes over time), Address, City, Census units, School District, County
 - May not be complete for small towns
(ACS estimates aren't useful in these areas - not enough people surveyed)
- Assess usability, interpretability and adaptability to new statistical methodology.
- The Rural Shrink Smart EDA dashboard incorporates two major components:
 - Data Visualization Interface component with Guided Discovery Learning (GDL) principles
 - Exploratory Data Analysis component utilizing statistical graphical elements, such as maps and Parallel Coordinate Plots (PCPs)

Challenges

- Quality of Life is a subjective assessment
 - Iowa Small Town poll has measured subjective QOL by decade for one small town in each of the 99 counties in Iowa (same town each year)
 - Survey response rates keep decreasing over time
- There are objective measures of things that contribute to QOL available in public datasets
 - School ratings
 - Town budgets for services
 - Access to medical care, shopping, etc.
 - Transportation trends
 - Demographic shifts
 - City level cooperative agreements with other government entities and NGOs

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- There are objective measures of things that contribute to QOL available in public datasets
- **Project Question:** How do we leverage **data science** and **exploratory data methods** to inform town leaders to reduce the shrinkage and maintain reliability?
 - How does an interactive dashboard of open-source data integrate into overall decision-making?
 - Can we focus on estimating only things that objective measurements don't capture?

Motivation - Why Use Dashboards?

Identifying Key Metrics

Audience

- As small rural towns, traditionally, do not have access:
 - Data scientists
 - Ability to easily leverage data collected locally to support decisions

Our research team will provide communities with data about services in small town Iowa in order to assist with developing strategies to improve quality of life for their residents amid shrinking populations

Visualization Goals

- Create a central place for the excess of data to be conveyed in a single comprehensive visual.
 - We will utilize Parallel Coordinate Plot (PCPs)
- Create a map feature that will allow for town leaders to understand the distance of essential QoL components (e.g. Fire Dept, Schools, etc.)
- Add an overview of town general basics related to the seven QoL factors.

Engage People

- We will assess our visualizations to determine which strategies for user interface and interactive graphics design are most useful to empower town leaders to make discoveries in publicly available data assembled with a focus on items that impact rural quality of life.

Visualization

- Create a town-focused dashboard that lets leaders see how their town compares to other similar towns (geographically and as measured by the unsupervised statistical analysis)
- Goal is to help towns see what strategies for maintaining QOL work and don't
- Emphasis on things towns are empowered to change
 - Can't focus on e.g. agricultural policy
 - City budgets, partnerships with outside entities, services that matter and don't
- How do we best design charts/graphs/UI to make people feel empowered and help them explore the data with an open mind?
 - How do we incorporate statistical analyses into this? Much of the data will provide qualitative differences but not statistically significant differences.

Guiding Design Principles and Dashboard Design Workflow

Guiding Design Principles

Our initial set of dashboard design principles are:

- The town leaders are the focus audience (central focus of the app)
 - Local Map (Local Essential Services)
 - Vital Statistics
- Facilitate comparisons with other towns in order to allow the user to explore other potential solutions
- Present the user with peer comparisons in order to widen the scope of exploration beyond the initial set of obvious peers in the local region.
 - PCP to compare the towns with varying similar features (e.g. economy, population, rurality or user input)
- Allow for more detailed data and feature requests to improve the dashboard design over time.

Dashboard Design Workflow

- Compile a single data set
 - rows: Each town
 - columns: Each variable with appropriate spatial aggregation
 - e.g. distance to service instead of lat/long
- Unsupervised Analysis
 - Which towns are most similar based only on the public data?
- Dashboard Layout
 - Which layout will allow the user to engage the most without overwhelming their curiosity?
- Dashboard Feedback
 - What elements on the dashboard are useful, confusing, misleading or incorrect from town leaders?

Dashboard Design Workflow

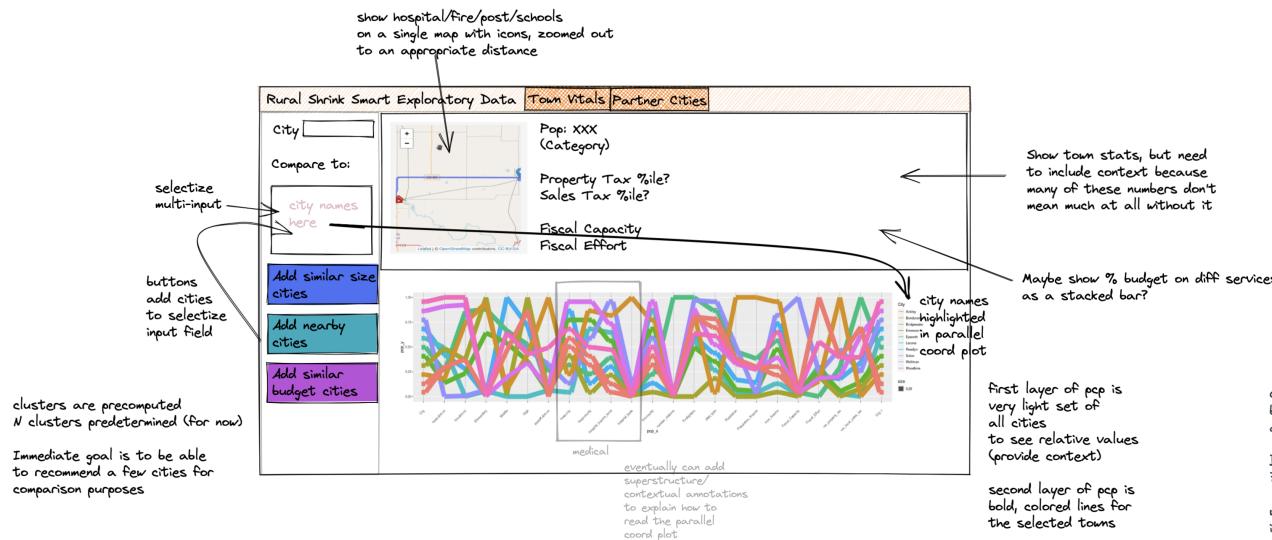
Unsupervised Analysis

- Unsupervised clustering methods were used to determine data quality
- During the process, we found that schools, fire departments, post offices and hospitals were missing from our open-source data
- Resulted in finding other open-source data that were used for sanity checks along with adding information of missing data

Dashboard Design Workflow (Layout)

Dashboard Layout Iterations

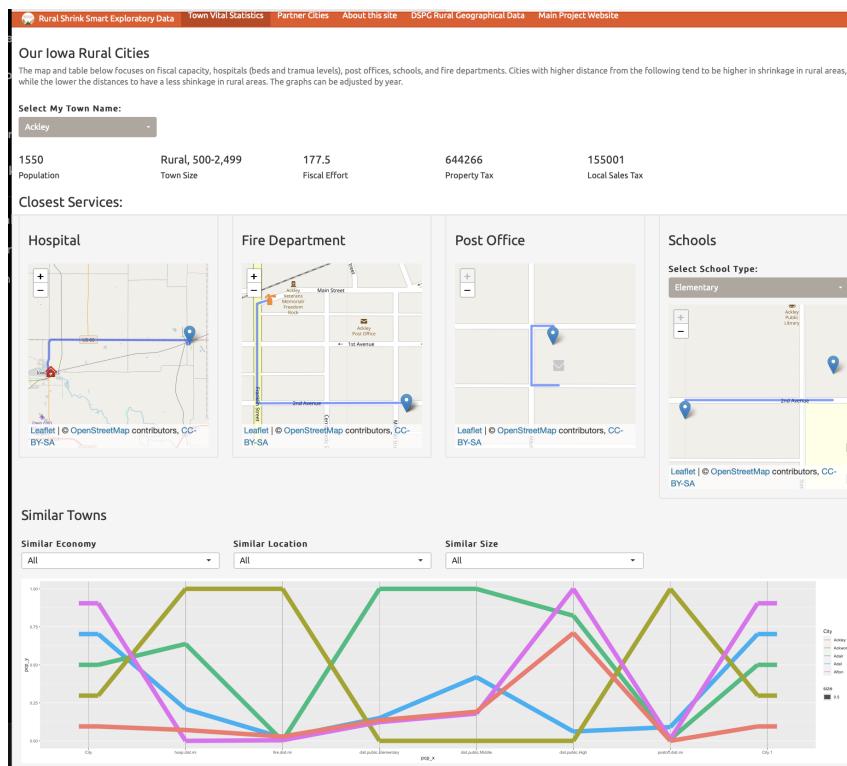
- Version 1: An idea without limitations of the actual implementation pieces.



Dashboard Design Workflow (Layout)

Dashboard Layout Iterations

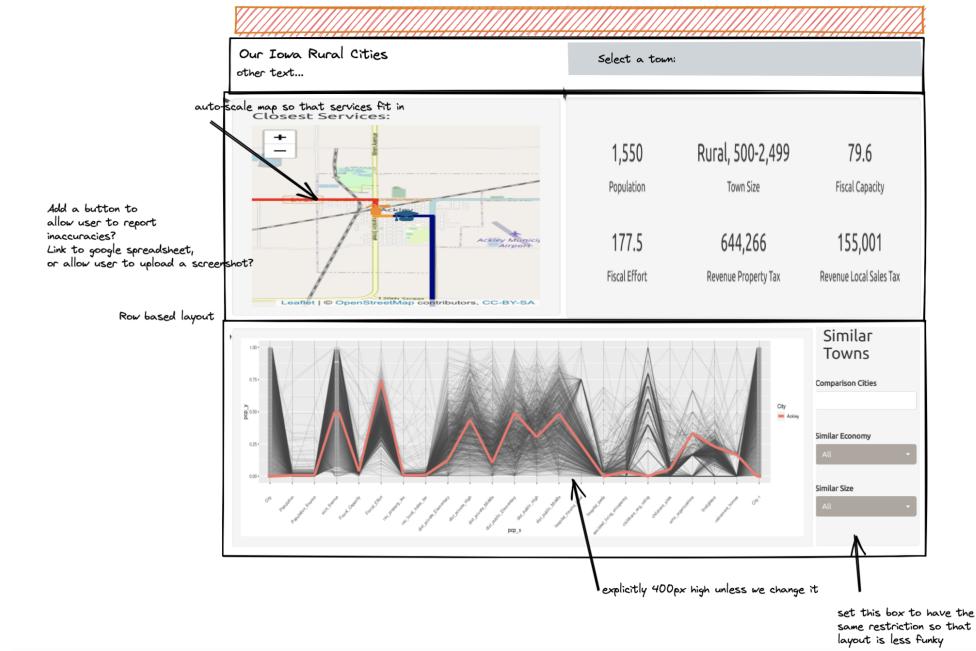
- Version 2: After implementation has been completed and the team notes limitations, we change the interface.



Dashboard Design Workflow (Layout)

Dashboard Layout Iterations

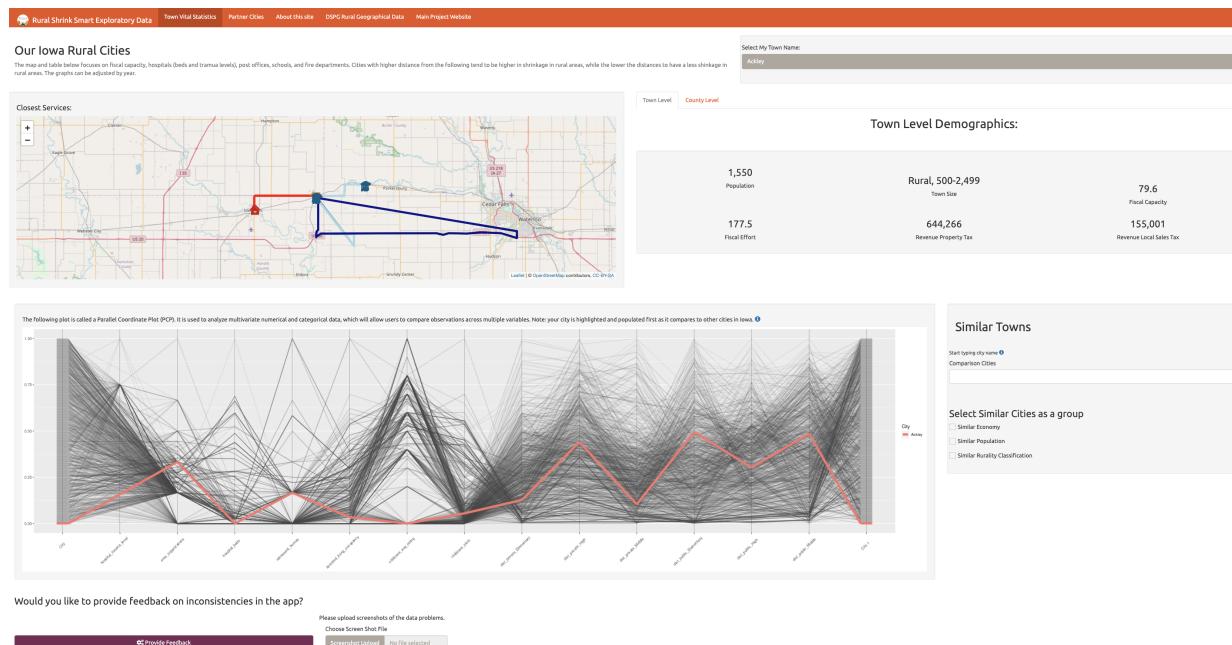
- Version 3: Now incorporate more literature on dashboard design and user experience, which removes some of the "cool" implementations



Dashboard Design Workflow (Layout)

Dashboard Layout Iterations

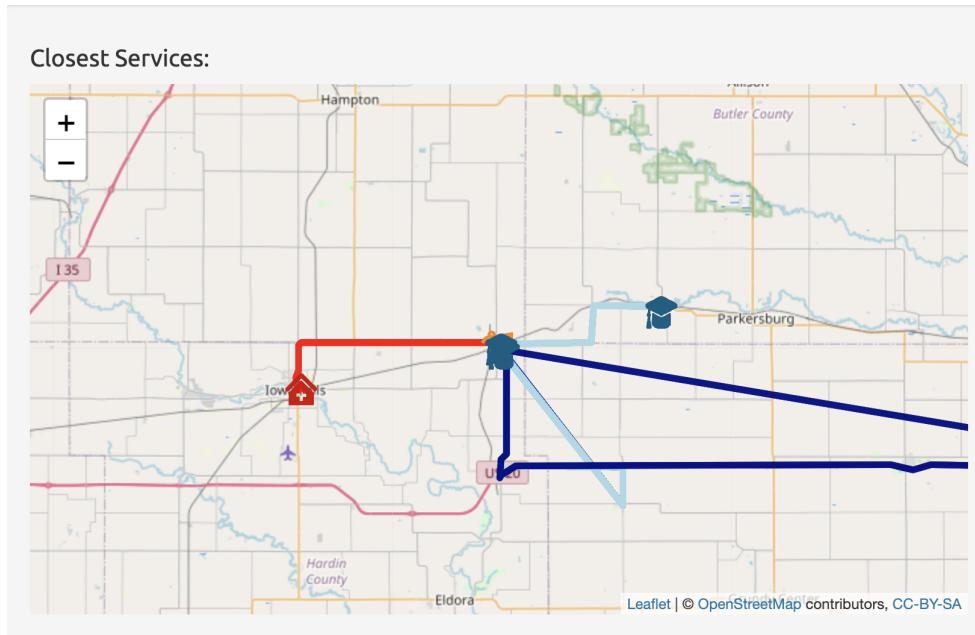
- Version 4: Finally incorporate a collective feedback from team-leaders that suggests lack of understanding of information



Dashboard Design Workflow (Layout)

Dashboard Components

- Map (Town's closest services)



Dashboard Design Workflow (Layout)

Dashboard Components

- Vital Statistics (Town-centric and county level)

The dashboard displays two main sections: Town Level Demographics and County Level Demographics.

Town Level Demographics:

Population	Town Size	Fiscal Capacity
1,550	Rural, 500-2,499	79.6
177.5	Revenue Property Tax	155,001

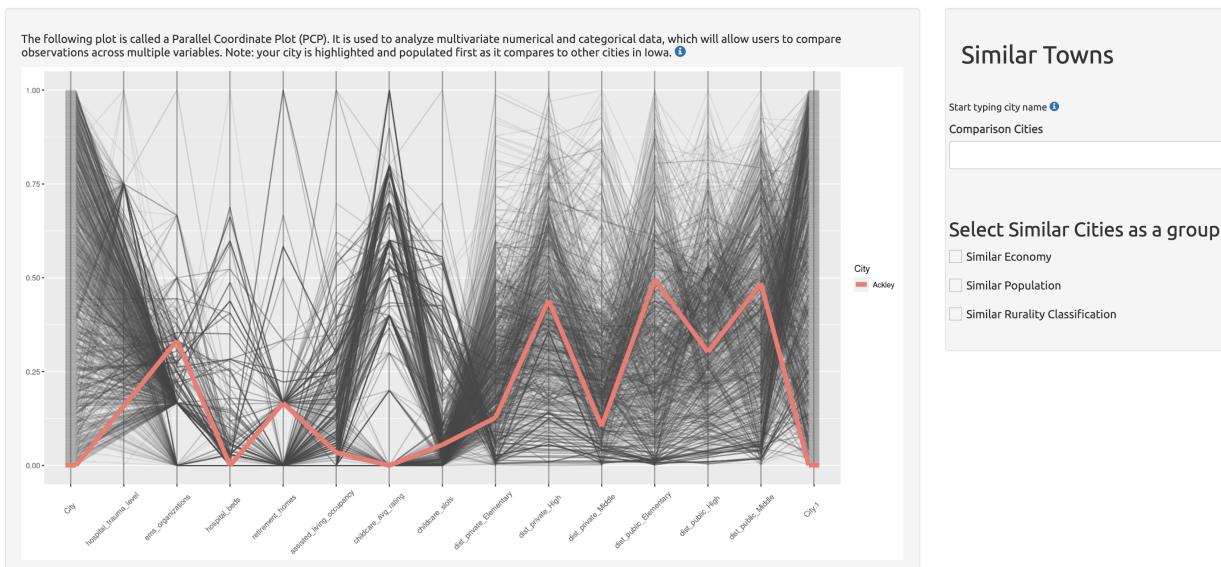
County Level Demographics:

Town Description	Rural-Urban Commuting Area	Urban-Influence Code
Rural areas: primary flow to a tract outside a UA or UC	Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area	Noncore adjacent to a small metro with town of at least 2,500 residents

Dashboard Design Workflow (Layout)

Dashboard Components

- Parallel Coordinate Plot with objective measures related to the QoL Survey



Smart Connected Communities Dashboard

Dashboard Philosophy - PCPs and the Novice User

Dashboard Philosophy

PCPs Effectiveness & Novice Users

Who? Sukwon Lee, et al. wrote "How do People Make Sense of Unfamiliar Visualizations?: A Grounded Model of Novice's Information Visualization Sensemaking"

What? Propose a grounded model of NO vice's information VIualization Sensemaking (NOVIS model)

- Framework for assessing a person's ability to interpret a new graphical map
 - Two Basic Components:
 - Visual Object (textual objects and non-textual objects)
 - Frame (frame of content and frame of visual encoding)

Why? Advantages of using NOVIS model includes a reproducible framework of understanding graphics.

Findings The PCP in this study were found to be promising for novice users, when comparing to the Treemap and Chord Diagram.

Dashboard Philosophy

PCP in Dashboard Develop Reasoning

- The large set of publicly available data we have assembled is useful, but we must be careful with how we present this data because it would be easy to overwhelm the user with small details that mask the bigger picture.
 - A small subset of variables of interest to start with, and then
 - Allow the user to increase the complexity of the display in accordance with their interest
- This avoids some of the pitfalls of dashboard design that can easily lead to user overload **Few**

Dashboard Philosophy

Background of Guided Discovery Learning

Who? Michael A. DeDonno wrote "The Influence of IQ on pure discovery and guided discovery learning of a complex real-world task."

What? To investigate the predictive ability of IQ on pure discovery and guided discovery learning of a complex real-world task.

How is this useful? As mentioned previously, we not only want to present a complex graphic for novice users, we also want to empower the town-leader users to explore the dashboard, comprehensively. We would like to use the general principles by making sure that the users understand what is being presented to them.

Experimentation We will collect how the users are clicking on the app. This will help us understand if the users are getting better understanding of the app over time.

Dashboard Philosophy

Guided Discovery Learning with Dashboard Design

We leverage the framework of Guided Discovery Learning (GDL) to guide the town leaders to make discoveries using our interactive visualization. By leveraging:

- hints
- feedback
- other helpful information to guide users in interactive exploration e.g. user ignoring the radio buttons to compare similar cities, etc.

Dashboard Design Workflow - Feedback Loop (Actively & Passively)

Dashboard Design WorkFlow (Feedback)

Background of User Feedback Questionnaire

Who? Young & Kitchin wrote "Creating design guidelines for building city dashboards from a user's perspectives"

What? To help summarize a users concerns, Young & Kitchin utilize six main critiques, which are framed into questions.

How is this useful? We will adapt these questions to better help the town leaders communicate clear feedback for our team to use.

Experimentation We will collect how the users are experiencing the app with these set questions:

- Is the information the dashboard presents clear? (*Scope*)
- Is the dashboard easy to navigate? (*Usability*)
- Is the dashboard used in a socially responsible manner? (*Ethics*)
- Do you believe that you can trust the Rural Shrink Smart dashboard? (*Validity*)
- Do you find value in the Rural Shrink Smart dashboard? (*Utility*)

Dashboard Design WorkFlow (Feedback)

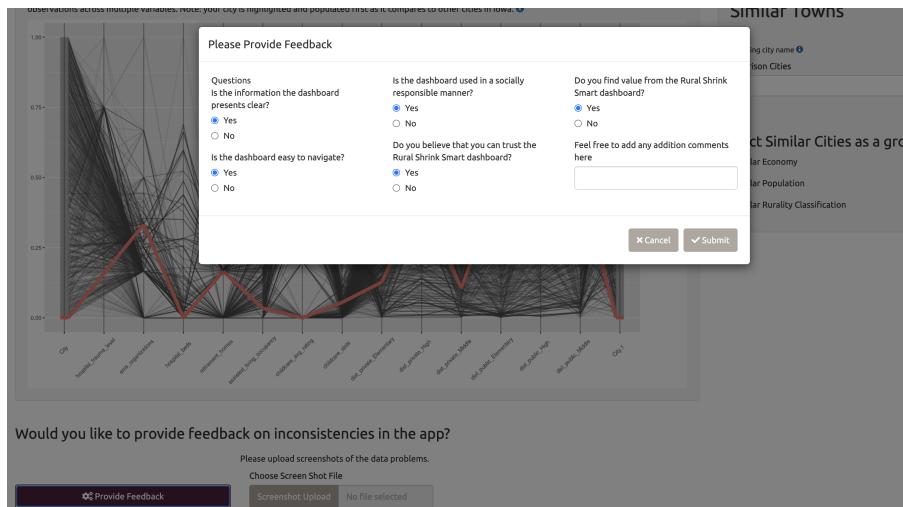
User Testing in Beta

- Groups of Users:
 - Graphics Group Members (Users know Statistical Graphics)
 - Rural Shrink Smart Project Members (Users know the project with little background in Statistical Graphics)
 - Others (Member of doctoral community that has background in educational adaptivity)

Dashboard Design WorkFlow (Feedback)

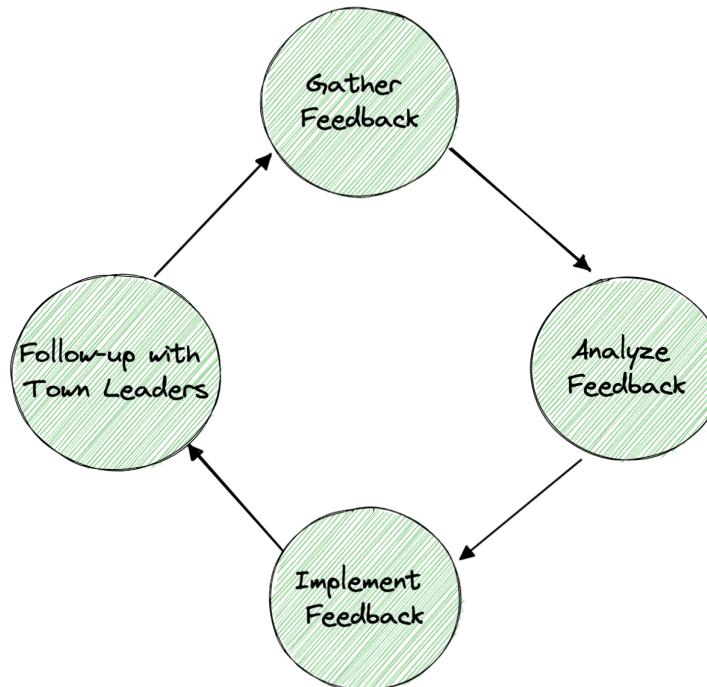
Dashboard Feedback

- Our feedback from users has two components:
 - User prompted (using a survey and screenshots)
 - User behaviors being record in the background:
 - This will help validate issues that are being mentioned in the survey.
 - e.g. "I'm having a hard time understanding the PCP information", we will see that users are not spending any time on the PCP.



Future Work

- Comparatively look at the cities town leaders used to compare to other towns to the USDA rurality index classifications. **Rural-Urban Continuum Codes**
 - If results are correlated, making an argument for a proxy
- Continue to incorporate feedback from town leaders.



Thank you!

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