A Tool to Track U.S. Infrastructure Maintenance

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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ABSTRACT

A surge in finances from the Infrastructure Investment and Jobs Act will require many agencies, states, and localities to coordinate and identify projects to fund as well as require the creation of new federal programs.

I propose a tool civil engineers and government agencies can use to improve bookkeeping on work that has been done on construction projects. This tool can be a website or smartphone application where a civil engineer can view and catalog necessary information on projects.The application can be programmed in the Django web framework and hosted on Heroku, using continuous integration with GitHub. The tool will need to be updated consistently, so an agile approach will be ideal.

Such a tool would allow more appropriate allocation of funds for current and long-term maintenance. Furthermore, a centralized location for such data will streamline communications between agencies. This tool can be expanded in the future to include more types of infrastructure, greater information detail, additional cross-platform capabilities, and, most importantly, more robust security.

1. INTRODUCTION

Infrastructure is necessary to run almost every aspect of daily life. The roads, tunnels, and bridges transport energy, food, and people to fulfill our basic wants and needs. It is important to be cognizant of the state of our public infrastructure and to keep that infrastructure well-funded and up to date.

The problems with the world's and, more specifically, U.S. infrastructure were most directly felt with the supply chain issues created as a result of a rapid increase in demand for goods following the easing of COVID-19 restrictions. That and the Infrastructure Investment and Jobs Act, made it fitting and timely to propose a tool for information on infrastructure projects.

2. RELATED WORKS

According to a report by the American Society of Civil Engineers (2021), 42% of all bridges in the United States are 50 years old, and about 7% are structurally deficient. ASCE gave overall U.S. infrastructure a C- in its infrastructure report card, citing the lack of significant U.S. investment in maintenance for over 50 years and an over $2.5 trillion spending shortfall over the next ten years. They estimate that these issues will cost the United States over $10 trillion in economic growth by 2039. This information partially inspired the infrastructure tracking tool as there is a clear need for the monitoring of and investment in

U.S. infrastructure. By centralizing the data, the tool can also serve to streamline information for use by agencies in reports like these.

With over $1.2 trillion in new spending announced in 2021, Tomer et al. (2022) reports that this surge in spending will require many agencies, states, and localities to coordinate and identify projects to fund. The act will also require the establishment of many new federal programs that will also need further planning for new labor, public review, and supply chains. This article was the main inspiration for the proposed tool, which directly addresses the issue of planning and coordination with a centralized location for infrastructure data. The availability of the information, such as specific vulnerabilities in infrastructure projects, provided by the tool would allow for a more efficient and appropriate allocation of funds for current and long-term maintenance, as well as streamline communications between agencies.

3. PROPOSED DESIGN

This section will explain the overarching technical design of the application.

3.1 Review of System Architecture

The web application will follow the standard Model-View-Controller pattern implemented through Python's Django framework. Put briefly, the pattern allows for the compartmentalization of an application's functions, with the "Model" handling the interaction with the database, the "View" handling the user-interface, and the "Controller" handling the connection between user input and the application's database.

The application will be hosted on Heroku, a service that allows developers to host and run their projects on the cloud. The database will be managed with PostgreSQL, a tool that allows developers to manipulate their database using the language SQL and allows the database to be easily expanded. Any future changes to the application will be automatically deployed using GitHub through its continuous integration.

3.2 Requirements

This section will provide the expectations and limitations of the application.

3.2.1 Client Needs

The expected clients for this project are U.S. citizens and residents, government agencies in charge of infrastructure projects, and the contractors those agencies hire. The needs of a U.S. citizen or resident are not as strict as those for government agencies and their contractors. The app will start as a simple browsing application for residents to be aware of infrastructure projects nearby and the state of the infrastructure projects already completed. As time passes, extra functionality and detail can be added so that government agencies are able to make future decisions based on the application alone.

For example, the app can initially contain brief information on a local bridge, such as the date the bridge was built and the last time it was inspected. The information included later can be the budget of the bridge's construction, the budget of the bridge's renovation and maintenance, the bridge's known vulnerabilities, and any information that can aid in a government agency's analysis for future budget allocations.

3.2.2 System Limitations

The application will initially use Heroku's "Eco" tier, consisting of a single "Dyno," which, according to the Heroku Team (2023), allows the application to process thousands of requests a second. While this may seem like a lot, the application's ability to handle many

concurrent users is dependent on the language and frameworks used. Python is known to be a versatile but slow language, which will affect the performance of the application and reduce the max amount of concurrent users. This limitation can be fixed in the future by purchasing a more advanced Heroku tier that provides more processing power.

3.3 Key Components

This section will explain the contents of the application and the challenges and solutions of acquiring and displaying said content.

3.3.1 Specifications

The database for the application will need to be populated with basic information on infrastructure projects, past and present. This is accessible through the Department of Transportation's Data catalog: https://catalog.data.gov/organization/dot-gov This website provides information on roads, bridges, and tunnels as well as information on maintenance and costs. Another such resource is the Federal Infrastructure Permit website found here: https://www.permits.performance.gov/projects The website lists specific names and locations of potential government projects as well as the agency and sector they fall under.

The data from both of these websites will need to be properly aggregated for a specific infrastructure item to be presented clearly. The website will also need to have a map that highlights the location of an infrastructure item of interest. The end product should allow a user to type in an address or search through the map itself to find the name of, the year built, the dates inspected, and other information on any particular road, bridge, tunnel, etc.

3.3.2 Challenges

The main challenge will be locating relevant data to populate the application with. Despite the DOT data catalog being extensive, a lot of the information is outdated. For example, https://catalog.data.gov/dataset/national-bridge-inventory-system-nbi provides important information on bridge inspections and costs but only has information leading up to 2013.

Furthermore, the lack of APIs in these government websites makes it difficult to extract information in a timely manner. This may require someone to either manually enter data or create a program that scrapes these websites, which will prove to have its own programming challenges.

3.3.3 Solutions

There are no optimal solutions to these challenges given that if there were, there would be no need to create the proposed application. The difficulty lies in the lack of centralization. The only solution will have to be a manual scan through the Department of Transportation Catalog and Federal Permit websites.

There may be hope in the future that an API will be created for the Department of Transportation as there are for some other government agencies listed here: https://api.data.gov/, but that is a very large uncertainty.

4. ANTICIPATED RESULTS

The initial results will be minimal but will allow the average citizen or resident to be easily informed on the state of the infrastructure in their community, or anywhere else they wish to learn about. This information is currently decentralized and organizationally inaccessible. The hope is that citizens will be able to better petition their lawmakers for necessary policy with the information provided.

As more information gets added and the scope of the application increases, the application can be used by lawmakers and government agencies themselves to better communicate amongst each other for planning on new labor, public review, and supply chains and allowing for more efficient allocation of funds.

5. CONCLUSION

The proposed project is a tool used to track U.S. infrastructure and its maintenance. More specifically, it is a bookkeeping application that government agencies and contractors can use to document all work on infrastructure projects. This information will also be publicly available in order to better inform the public and lawmakers as well as speed up communications between relevant agencies. The ultimate expectation is that the tool will streamline infrastructure maintenance and create a better use of and distribution of funds.

6. FUTURE WORK

The proposed work will most likely begin as a simple browsing application for infrastructure projects. Its initial primary users will be the general public. Further updates, such as greater detail in information, will be developed once that minimum viable product has been completed. The success of future iterations will rely on the availability of data from government agencies and the main challenge of development will be congregating this data in an effective manner.

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