Designing an open-source application to record library gate counts in response to COVID-19

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In response to the COVID-19 pandemic, the Oklahoma State University Library developed an open-source application to record real-time building capacity. Library student security tracks building entrances and exits via the program, with current visitor numbers appearing on the library's website via an API. This effort helps administrators have a clear picture of building capacity during opening hours for data-driven decision-making and provides users information regarding the library's level of activity.

Keywords: gate counts, libraries, open-source applications, COVID-19, occupancy

Introduction

As colleges and universities started the process of reinstating in-person services after varying levels of closures due to the COVID-19 pandemic in the United States, libraries also had to navigate new safety and social distancing guidelines such as enhanced cleaning practices, material quarantine, obtaining and distributing personal protective equipment, creating barriers in public and private spaces, and in some cases reducing seating and building capacity within the library.

Although gate counts help inform the physical library's occupancy in a given time, the ability to view real-time data to monitor building capacity is an important consideration, especially with social distancing. While several vendor-based solutions meet this need, this paper highlights an open-source application that tracks real-time gate counts at the Oklahoma State University (OSU) Library in Stillwater, Oklahoma, in addition to a discussion on challenges and future directions.

Background

While the COVID-19 pandemic led to the temporary closure of the OSU Library for several months in 2020, a small team led by the Dean of Libraries met every week to review plans for the eventual reopening of the building. An idea coming out of these meetings was the possibility of developing a real-time process to count how many people enter and exit the library, with occupancy displayed on the front page of the website. While the team was aware of various vendor solutions on the market, the hope was to see if an application could be created in-house to keep costs low, speed up implementation, and improve current practices.

There are two defined entrances in the main library on the north and south sides

of the building, which are staffed by student security. Before COVID-19, security staff would only record patron exits using a hand tally counter. When students switched doors every thirty minutes, they would log the counts on paper. Then every hour, students would transfer the data from paper to an online form that tracked hourly exits. In developing a door count application, the program had to be flexible and user-friendly for student security since they are responsible for counts and overall safety. Understanding the process and needs, the library's development team started creating a prototype web application in mid-June 2020. A week later, the application was ready for initial testing and further development with a target launch of July 2020, when the library was slated for reopening.

Literature Review

According to Heady, Vossler, and Weber (2021), a high percentage of Association of Research Library (ARL) institutions reported a reduction of physical building hours during the 2020-21 academic year. Additionally, several ARL institutions employed a mix of restricted or limited access restrictions to library facilities in response to the pandemic.

Despite changes in the academic library landscape, even with the impacts of COVID-19, the physical building continues to serve as a welcome location for students, faculty, and staff. Monitoring building usage remains an important metric in academic libraries. In 2020, for example, both the Association of Research Libraries and Association of College and Research Libraries' annual surveys asked institutions to report gate count numbers. Laser counters, turnstiles, or manual counts comprise various methods libraries use in providing these statistics (Phillips, 2016).

Some academic libraries have experimented with new technologies to develop

gate count alternatives, including Raspberry Pi's coupled with sensors (Cintron, Coutier, & DeLooper, 2017). While such units are accessible and low in cost, implementation can be challenging due to physical space limitations, data validation, and all-around technical challenges. In some instances, while libraries may not upgrade their gate count system, a focus on data processing becomes increasingly important. Moving away from manually entering numbers into traditional spreadsheets can now be replaced with more collaborative tools such as Google Forms and Google Sheets, thus enhancing and expediting reporting (Laskowski, 2016).

Still, statistics generated from library gate counts can demonstrate the physical building's value to the college and university community and assist institutions in data-driven decision-making. Gate count data, for example, can inform building hours, staffing, and security. While only providing a tally of entrances and exits, it is vital to remember gate count data lacks patron movement throughout the library building (Dotson & Garris, 2008). Several researchers have examined library space usage beyond gate counts to better understand the physical library environment, improve and expand services, and drive future space planning efforts (Decker, 2020; Dominguez, 2016; Thompson, 2015; Montgomery, 2014; Stewart, 2011).

Application Development

The application development team at the OSU Library consists of a backend and frontend developer. Software application development followed an agile methodology or a phased process involving user interactions and participation to expedite decision-making (Cockburn & Highsmith, 2001). A small team was formed to begin the necessary planning. After the development team created an initial user interface (UI) mock-up, a usability analysis was conducted. After feedback and approval of the UI, the

development team started the design process. After each rapid development cycle, the UI was shared with stakeholders, including members of the library administration, but most importantly, targeted users of the system, specifically building security staff.

The application's home page features the building capacity based on real-time data (see Figure 1). Building security and administrators have login privileges, and once signed in, they can view the main dashboard (see Figure 2). The dashboard allows those signed in to count users entering and exiting the building, in addition to displaying a real-time count on the page. Color-coding helps system operators track patrons entering the building (green) and those leaving (red), with several numerical value options.

Users with administrator logins have additional options, as well. Administrators can reset the headcount manually if the data does not zero out when the library closes (see Figure 3). There is also a semester reset option (see Figure 4). Robust statistical reporting is also built into the system for administrators and includes daily statistics both in a text-based (see Figure 5) or graphical format (see Figure 6). The data can be downloaded as an Excel file to assist with reporting and additional analysis. To keep the local server running quickly, administrators work with the development team to transfer data for archiving at the end of each semester. This is in addition to backup protocols occurring in the server environment.

An Application Programming Interface (API) protocol built into the program feeds building capacity data to other applications, such as the main library's website (see Figure 7). This way, the campus community can see real-time updates to building usage and view contextual information in terms of building occupancy (see Figure 8).

Discussion

With the application in production since July 2020, it has seen several updates in response to real-world usage. Of particular note, there was a distinct learning curve

among the building's security team. The library's gate counts were considerably lower as the new process was rolled out. In order to compare the validity of users recorded in the application versus in the building, a floor-by-floor manual audit was performed by the security team over a designated time. After reviewing the application's logs, we found that the differences could be attributed to operator error. Some security students were not being as diligent in recording entrances and exits. While poor performance could be a factor, gate count input during class changes or other high-volume activities in the library made it challenging to keep up with mouse clicks. To help facilitate greater ease of use, keyboard hotkeys were added to the application, allowing users to avoid looking down at the computer while logging counts into the program. Now that the application has become standard operating practice, the data is more consistent, and count accuracy has improved since the initial transition and subsequent enhancements.

Another challenge encountered in this process involved the amount of data generated from the application. On high-traffic days, upwards of 40,000 records can be added to the server's database. With increased activity, the application's performance started to show signs of a slowdown. After examining the system's functionality, a solution was developed that involves regularly downloading data at the end of every semester. Once the data is downloaded, it is deleted from the application's database. This practice has resulted in reducing lag time for users.

Finally, what started in response to the COVID-19 pandemic has turned into a critical piece of library infrastructure. Gate count systems, in general, have the potential to better inform library leadership regarding building capacity and usage. Other factors, such as available seating, workstations, and study rooms, may also be potential targets for statistical tracking within the library landscape. Technologies that may prove helpful in the future include image processing, sensor technology, Wi-Fi tracking, and heat

maps, to name a few. As more intrusive ways to measure library building usage evolves, a discussion of privacy becomes essential.

Conclusions

While the pandemic led to the development of a door count application to help better track and understand building capacity, there are several tangible benefits resulting from this effort. First, the application has helped streamline a very manual process for recording door count data. Second, the availability of current visitors denoted on the library's website helps stakeholders understand how busy the building is at the point of need. And finally, creating this application as an open-source program can assist other libraries in exploring or developing low-cost solutions to improve gate count processes.

The public repository for the OSU Library's door count application code can be found on GitHub, https://github.com/okstate-library/door-traffic-counter, licenced under Creative Commons, CC-BY-NC-2.0.

Figures

Figure 1: Application home page with real-time data.

Figure 2: The dashboard of the application with real-time data.
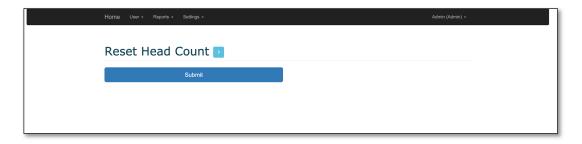

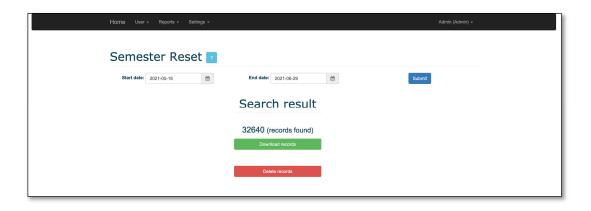Figure 3: Headcount reset option for administrators.

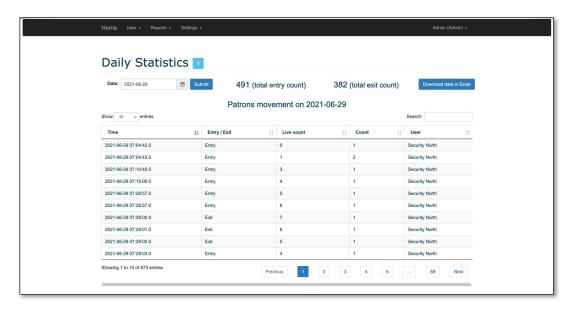Figure 4: Semester headcount reset for administrators.

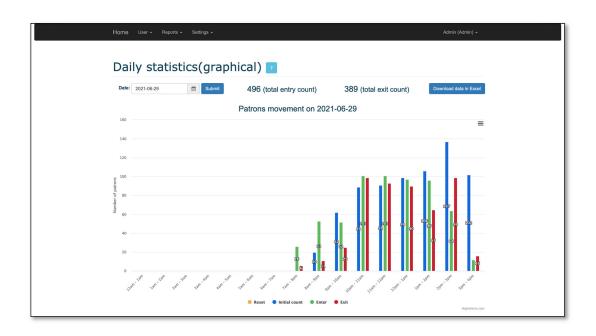Figure 5: Administrator's daily statistics screen with the ability to download files.

Figure 6: Graphical view of daily statistics from the Administrator's login, which illustrates entrances and exits per hour.
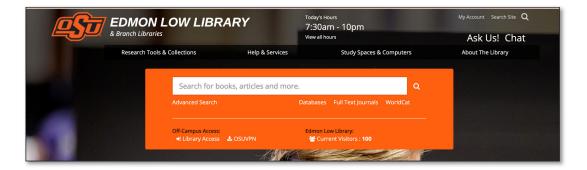

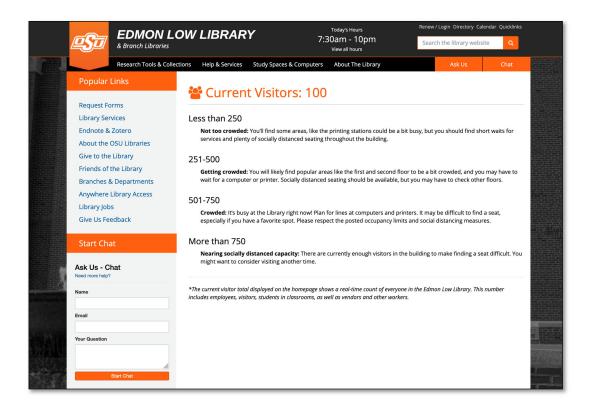Figure 7: Current visitors displays the building's capacity via an API.

Figure 8: A description of building occupancy for users.

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