

Lessons learned from piloting decentralized, smart miniature food pantries to mitigate college student food insecurity

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Abstract

Food insecurity on college campuses is a persistent challenge that has recently emerged as significant on a national level. Campus officials across the U.S. are beginning to launch campus food pantries to mitigate food insecurity among their student populations. However, emerging scholarship suggests that many college students may not be aware of


their campus food pantry. This reflective essay presents preliminary lessons learned from an on-going pilot program at Virginia Commonwealth University (VCU) to mitigate student food insecurity. Launched in October 2021, the program

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deployed 13 miniature food pantries across both VCU campuses. These pantries allowed decentralized, anonymous access to emergency food on a 24-hour, seven-days-a-week basis. The research team developed a partnership with the regional food bank to ensure a stable pipeline of food for the pilot. A combination of service learning and work-study students restocked the pantries weekly, while simultaneously collecting observational data on pantry operations. Wi-Fi enabled door sensors built into the pantry boxes to collect anonymized data when individuals opened a pantry door. The authors reflect on the challenges to implementing the pilot program, with a specific focus on navigating the university's bureaucracy, information technology issues related to the development of the sensor network, establishing a stable pipeline of food, day-to-day management, and the difficulties of expansion. The paper ends with a number of recommendations. Higher education faculty and staff interested in deploying similar campus mutual food pantry systems may find this reflective essay informative.

Keywords

college student, food insecurity, intervention, food pantries, little pantries, implementation

Introduction

Awareness of the challenges of food insecurity for

Conflict of Interest Disclosure

The authors declare that they have no competing interests.

Author Contributions

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college students is growing nationally. Recent reporting from the U.S. Government Accountability Office (U.S. GAO) and other national studies suggests that as many as 35–45% of American college students suffer from food insecurity to some extent (Broton & Goldrick-Rab, 2017; Goldrick-Rab et al., 2017; U.S. GAO, 2018). Scholars continue to build the case that the problem negatively affects the mental and physical health and the academic performance of students (Becerra & Becerra, 2020; El Zein et al., 2019; Haskett et al., 2020; Kim et al., 2022; Kim & Murphy, 2023; Payne-Sturges et al., 2018). Davis et al. (2021) recently has called for more intervention-specific research on mitigating college student food insecurity that would encourage the development of evidence-based programming.

This work reflects upon the challenges of implementing a pilot program that used decentralized, anonymous miniature food pantries to reduce college student food insecurity at an urban public campus (Jones et al., 2024). What follows is the background of the development of the pilot, then exploration of thematic challenges as well as solutions that our team faced in implementing the pilot. Challenges included navigating bureaucratic and technical hurdles, building a stable pipeline of food, day-to-day management, and programmatic expansions and evolutions.

Background on Virginia Commonwealth University

The pilot sought to improve access to emergency food assistance on an urban public university campus and reduce the stigma associated with students seeking it. Our transdisciplinary research team included two social science faculty, the full-time staff manager of the main campus food pantry, an Engineering doctoral student, and several faculty from Engineering, Business, and Gerontology in supporting roles. More than 50 undergraduates and several graduate students engaged with the pilot in some capacity. The types of students involved include those enrolled in service-learning courses taught by the primary investigator, student workers paid through research grant funding and/or federal work study, and true volunteers interested in supporting the project.

Graduate students assisted with data collection and analysis, and all were compensated through grant funding. Several students involved with the project are co-authors of this work.

Virginia Commonwealth University (VCU) is an urban public university located in downtown Richmond, Virginia, recognized as a Minority Serving Institution (MSI) by the U.S. Department of Education. The undergraduate student body predominantly comprises Black, Indigenous, and Other people of color (BIPOC); over 30% are first-generation students. Previous research conducted by our team found that approximately one-third of VCU students experienced food insecurity during their college time and that their food insecurity was significantly correlated with other basic needs insecurity and with mental health issues. Main pantry utilization has grown rapidly, yet students also shared concerns about limited information about the campus pantry resources and with stigma associated with utilizing them (Kim & Murphy, 2024). This aligns with recent scholarship on such concerns (El Zein et al., 2018; Peterson et al., 2022).

Developing the Pilot

We deployed miniature food pantries inside campus buildings to provide students with 24/7 access to food with nearly complete anonymity assured. We launched the pilot in October 2021, initially with five pantries, and expanded to 12 pantries spanning both the liberal arts and medical campuses by March 2022. The team repurposed magazine vending boxes that are compliant with Americans with Disabilities Act (ADA) regulations as pantries, and added onboard Wi-Fi-linked sensors that recorded timestamp data when the pantry door was opened or closed. Signage on the physical pantry boxes indicated their intended use. Most pantries were housed in academic or communal buildings, except for one initially placed in a nearby church, but later relocated due to Wi-Fi issues. The research team used the timestamp data as a proxy variable for usage of the pantries, and we have leveraged the data to advocate for the effectiveness of the pilot to senior administration. Students were the target users of the pilot, but due to their anonymous nature we do not truly know

who patronizes them. Because of their position within campus buildings, we strongly doubt that individuals not connected with the university access them. The pantries themselves were not equipped with access control measures to restrict who could access them, nor was there a logging system to collect personally identifiable information (i.e., student access credentials).

Students may feel stigmatized to be perceived using forms of emergency food assistance (El Zein et al., 2018; Kim et al., 2022; Peterson et al., 2022). For this pilot, we sought to place the pantries in as visually prominent and high-traffic locations as possible to increase usage, with the hope that over time the pantries, and those individuals using them, might fade into the background of campus life. We are currently working to publish separate findings from earlier focus groups with student pantry users, which indicate that increasing the visibility of campus pantries may help reduce the stigma associated with their use among food-insecure students.

The team restocked the pantries weekly with shelf-stable food and hygiene products from the central campus food pantry. Most of the food used for the pilot was either donated or sourced from the regional food bank, which is affiliated with Feeding America. Individuals from the campus community were allowed to donate similar types of products directly to the pantries at any time, without separate permission. Signage on the pantries provided instructions for donations. Our research team members and the staff manager of the main campus food pantry completed the food bank's required training. Weekly distributions aimed to provide a stable variety of items, but consistency was difficult due to varying student involvement and food availability.

Data collection occurred at only eight pantries on the liberal arts campus; logistical and technological issues prevented effective data collection on the medical campus. Data collection for the pilot ran continuously from October 2021 to May 2023. We also conducted focus groups to examine students' experiences and thus inform larger-scale implementation. The VCU Institutional Review Board approved the study. We have previously published about this research in Jones et al. (2024), and have completed a study based on data from

our focus groups that is currently under review as of this writing.

Funding for the pilot totaled slightly less than \$20,000 over the pilot period. Internal funding opportunities provided all pilot funding, which includes funding from the university's transdisciplinary research office, the office of community-engaged research, and the university's office for first-generation students. Funding was spent on a combination of physical materials to create the pantries (magazine boxes, wood, and gravel to add weight and stability to the boxes), sensor equipment (Raspberry Pi microcomputers, magnet contact switches, micro-SD cards, power cables), electrical equipment, student labor costs, and compensation for research subjects. Funding was not used to financially support faculty or facilities and administrative (F&A) costs. Research funding could not be used to acquire food.

Navigating Bureaucratic Hurdles

Within the administrative structure of the VCU Facilities department, individual building managers are responsible for all activities within a particular building. Therefore, although Facilities leadership had given the pilot their blessing, the research team had to negotiate with building managers about how and where a pantry would be situated within their respective buildings.

Perceptions

In most cases, building managers were highly supportive of the team's desire and the pilot as a whole. In limited cases, building managers expressed resistance to allowing a pantry in their buildings and steered pantry locations toward less visible spots. In one case, the building manager of an academic building objected to the research team's initial desire for the pantry to be in a visible, high-traffic space within the building's lobby. As a result of these concerns, we placed the box in a less prominent area of the lobby, still accessible to students but less noticeable to individuals casually walking through the space. We believe that the less conspicuous locations reduced interactions with those pantries, as sensor data suggested highly

visible locations such as at the gym and library received the highest numbers of sensor interactions (Jones et al., 2024).

Safety and Liability Concerns

The team sought approval from university legal counsel and risk management before launching the pilot. Approval was not without contention, with counsel adopting an expected position of protecting the institution by not wanting to assume any manner of risk. While caution over potential food safety is obviously prudent, members of the team felt a gap in comprehending the necessity of the pilot far outweighed the potential legal risk, especially considering the liability protection for food donations made in good faith granted through the Good Samaritan Food Donation Act.¹

Two significant modifications to the pilot occurred as a result of these discussions. First, we added fifty pounds of gravel to the bottom of each pantry to better stabilize them. Second, the team implemented a safety inspection process performed at each pantry by a team member or other volunteers during each week of the school year. The team created a Google Form to standardize collecting this data that included questions and removal instructions regarding the presence of damaged or improperly handled food (e.g., an item lacking required refrigeration, such as cheese or a piece of produce) in the pantries. Removal of damaged or improper items was largely left to the discretion of the inspector, but items included any non-shelf-stable items or anything that appeared visually damaged or tampered with.

Over the nearly two school years duration of the pilot, we discovered inappropriate food fewer than ten times, and none of those items were imminently dangerous due to being stored in an unrefrigerated pantry. Examples included a sack of potatoes, roughly a pound of rice in a tied plastic grocery bag, a similarly tied bag of dried pasta, and a single orange. To our knowledge, no individual was injured through any interactions with the pantries during the pilot.

¹ P.L. 104-210 (1996)

Americans with Disabilities Act

The team consulted with the university ADA coordinator for specific advice and approval of the physical pantry boxes. Initially, the pilot's Principal Investigator (PI) intended to build the first boxes out of wood, but the ADA coordinator was able to identify prefabricated magazine vending boxes that complied with ADA regulations for visual and physical impairments, especially distance from and potential obstruction to hallway access as well as ability of wheelchair-based individuals to open the boxes. The ADA coordinator shared the concern of legal counsel about the need to provide box stability, achieved as stated by adding gravel to the bottom of the pantry boxes. Interactions with the ADA coordinator were not especially onerous or time-consuming but represented additional steps that delayed the beginning of the initial stage of the pilot.

Navigating Technical Hurdles

Quantitative sensor data for tracking usage and determining high traffic sites for pantry placement was essential for proving utilization, tracking access times, and offering insights into trends of interaction. However, it was paramount to create a system that was anonymous and unrestrictive on usage.

Utilizing University Network Services

Quantitative sensor data for tracking usage and determining high traffic sites for pantry placement was essential for proving utilization, tracking access times, and offering insights into trends of interaction. However, it was paramount to create a system that was anonymous and unrestrictive on usage. We used Raspberry Pi microcomputers, a cheap computer smaller than a cell phone, to construct our sensor system because of their Wi-Fi connectivity and general robustness. Despite their price point, even the lower-end Raspberry Pi computers (~US\$20) are physically sturdy, have multiple connection points resistant to wear-and-tear, and are generally tolerant to unexpected loss of power. When the Raspberry Pis are powered on, a time delay is enabled to allow for login to the University Wi-Fi with stored account credentials designated by the University IT specifically for the pilot. After the delay period, an auto-running program begins

collecting timestamp data whenever someone interacts with a pantry door. Data collecting was triggered only by either opening or closing the pantry door. Wi-Fi was vital for remote data collection and afforded us a limited amount of functionality monitoring (Jones et al., 2024).

However, permanently connecting our sensors to the university network was more complicated than expected. To connect to the university Wi-Fi, credentials similar to those used by faculty and students were required, due to how University IT manages user devices and security. While the Raspberry Pis could be connected to guest wireless accounts, these accounts had timed access and were less secure. When we used the university's primary wireless network, which required verified university credentials, we sought to use an alternative to existing student and faculty accounts for several reasons: the Raspberry Pi stores Wi-Fi credentials as plain text, which would leave account security vulnerable to unauthorized access if someone were to access the Raspberry Pi; the university required periodic password updates, so the Raspberry Pi would need to be updated manually; and student credentials were locked to their primary campus. To address these issues, we eventually convinced University IT to issue us non-expiring Wi-Fi credentials.

A second set of issues with wireless connectivity became apparent after we set up the sensor systems and deployed the initial pantries. Despite our valid Wi-Fi credentials, the Wi-Fi coverage tended to cut out when pantries were deployed in one location for extended periods (e.g., weeks to months). High-traffic locations had repetitive service drop issues, while other locations on the edge of campus either completely failed to connect or would disconnect after less than an hour. These dead spots were unknown before deployment because they only became apparent with long-term usage in a single location. We considered installing Wi-Fi extenders or other access points, but the cost of labor and materials for such a change was untenable during the pilot. Furthermore, the pantries deployed on the medical campus failed to connect. We suspect, but have not been able to fully confirm, that this is a continuation of the "dead zone" connectivity issue: that is, the devices drop-

ping from the network after long periods of connectivity but little network activity (i.e., no measurements taken and transmitted due to pantry inactivity).

Electrical Access

Our sensors inherently required a functioning nearby electrical outlet, restricting where potential pantries could be placed. The team used three- and six-foot micro-USB power cords, the same cords used to power cell phones, to plug the sensors into the wall outlets. Initially, the team used a combination of micro-USB power cords and separate wall adaptors, a common pairing used to charge cell phones. However, over time the team observed that unknown individuals were taking the separate wall adaptors, or in some cases the power cords. These thefts occurred six times over the study period in high-traffic areas, typically, in academic buildings where pantries were next to study areas. Additionally, weekly observations often discovered that power cords were becoming unplugged for unknown reasons. To mitigate this, the team worked with Facilities to purchase and install USB-enabled electrical outlets, bypassing the need for wall adaptors without reducing the number of outlets available for shared usage. Nevertheless, two subsequent thefts of micro-USB cords occurred and cords were still unplugged. Recently the team has tied small laminated signs to the cords indicating they were for a research project. As of this writing, no additional cords have been stolen.

A Stable Pipeline of Food

We sought to deliver the same basic menu of food to each of the pantries throughout the pilot, which

was not always possible. Table 1 shows our preferred ideal weekly packing list for each location. However, we frequently lacked many of these stable products due to limited availability at the main pantry, and we decided early in the pilot that we would not deprive the main pantry of important items. Often, we simply did our best to stock the pilot pantries. While we certainly recognized the importance of providing foods that are appropriate to other culinary traditions than standard American, our logistical and sourcing challenges often forced us to focus on the lowest common denominator of foods, that were available and usable by the largest number of students (Jones et al., 2022).

Partnership with Regional Food Bank

Early in the planning phase, we recognized that the pilot could deplete food from the central campus pantry to an unacceptable level. The PI resolved to forge a more stable pipeline for food by partnering with our regional food bank. Food pantries that partner with regional food banks share handling and delivery costs to help offset the food bank's overhead logistical and storage costs for donated food. It is often dramatically more cost-effective for a campus food pantry to acquire food from a partner food bank than to pay retail prices. This arrangement took nearly two years to establish. What eventually resulted was a tri-party arrangement between the university, the university foundation, and the regional food bank.

The PI encountered two major hurdles in creating this partnership. First, when creating the pilot, the PI and others on the team had limited work experience at the university and were unsure which senior administrators had the authority to

Table 1. Ideal Packing List for Weekly Distribution to Each Little Pantry, by Category and with Quantities

Carbs (x6)	Protein (x6) + vegetarian option	Fruits and vegetables (x3)	Fats (x2)	Snacks (x3)	Hygienic products (x2)
Rice	Canned beans	Tomato sauce	Peanut butter	Protein bars	Pads/tampons
Pasta/Macaroni and cheese meals	Dried lentils	Potatoes	Nuts	Popcorn	Toothpaste
Cereal	Canned chickpeas	Onions	Cooking oil	Goldfish crackers	Deodorant
Crackers	Canned tuna	Canned corn			Hand sanitizer
	Canned chicken	Applesauce			Bar soap
	Soups	Fruit cups			Shampoo
	Beef jerky				
	Shelf-stable dairy				

formalize such a partnership. Many allies of the team were equally unaware. The PI made significant progress while attending an invitation-only faculty mixer at the university president's box during a basketball game. The PI asked the president for assistance, who then facilitated needed introductions to senior leadership.

Second, Internal Revenue Service rules require regional food banks to formally partner only with 503(1)c non-profit organizations. VCU is not a 503(1)c organization, but the university's foundation is a 501(c)3. After several months, several senior administrators and legal counsel along with staff from the regional food bank were able to create a tri-party agreement with the food bank formally partnered with the university foundation for financial purposes.

Day-to-Day Management

Our pilot heavily depended on a blend of undergraduate student service learners, volunteers, and paid students to handle packing and distributing food to each pantry site every week. Paid students received at least \$12/hour for their labor, funded through a combination of federal work study and grant funds. Although many students engaged in the project with enthusiasm and occasionally contributed to its design, their lack of professional experience and transient involvement significantly complicated operations. This was true even for paid students. We suspect that higher pay for students may mitigate this problem, but not completely. None of the following challenges should be surprising for individuals familiar with student-faced aspects of higher education, especially service learning (Tryon et al., 2008).

Managing Student Workers

Student turnover, whether due to graduation or completion of a course, necessitated frequent recruitment and training. Students frequently failed to prioritize project-related tasks, even when employment or grades depended on it. This was particularly evident among student volunteers. Student schedules were ever-changing and commonly misaligned with the restocking schedule on Wednesdays. Frequent problems occurred, such as undelivered food, sensors left unplugged, and incomplete

observational data collection, as discussed in Jones et al. (2024).

Some students were physically unable to move large amounts of food, especially at more remote locations due to the sheer weight involved. Totes delivered often weighed about 40 pounds. The team sought to work around this, including buying handcarts, but sometimes food would continue to be undelivered.

Storage and Packing

Throughout the pilot, storage and packing for weekly distribution occurred at the main campus pantry. This proved a challenge, as the main pantry space measured roughly only 10 x 30 feet and included storage racks and a double-bay commercial refrigerator. Students supporting pilot operations often were in the pantry at the same time as the pantry's normal student workers, creating crowded conditions. Spatial limitations became more apparent when we transitioned to plastic totes to store food, as they also needed to be permanently stored in the main pantry.

Students working for the main pantry and not the pilot nevertheless were supposed to pack food for weekly distribution. But the main pantry was often short-staffed for a variety of reasons, and students working for the pilot would often have to pack all the food before weekly distribution. This was a frequent problem, as the two groups of students didn't communicate effectively as they reported to two different supervisors, the staff manager of the pantry and the PI.

Challenges of Decentralization

While deliberately designed for enhanced user accessibility, the decentralized nature of the pilot posed significant challenges. The VCU liberal arts campus spans approximately half a mile in a densely populated urban area, with campus buildings interwoven through public streets that are heavily trafficked throughout the day. Walking across campus can take 10 to 15 minutes and these distances added up over the nearly two school years of the pilot distribution model. Traffic conditions on campus are so hazardous that two pedestrian students were recently killed by being struck by vehicles. Thankfully, none of our team suffered acci-

dents, although traffic remains a safety concern.

During the pilot period, our students often used bags or backpacks to haul food for weekly distributions. In some cases, a student would drive between locations for delivery so the process would be more efficient and a single student could manage all the boxes for all locations. However, the use of student-owned vehicles to transport food was unsustainable in the long run.

Expansions and Evolutions of Adopt-a-Pantry

Beginning with the fall 2023 semester, and after the conclusion of the data collection period for our initial pilot, the team began altering the distribution system towards an “Adopt-a-Pantry” model. An administrative group within the university would agree to adopt a pantry located near or within their office space. The administrative groups include academic departments, the central administration of the campus library, and the dean’s office of one college.

Our team distributed an entire month of food to that partner around the first day of the month, generally in a large plastic tote containing four bags, each with a week’s worth of food. Someone from the administrative group, usually a student worker under the supervision of a full-time staff member, would add one-quarter of the plastic tote contents during the Wednesday restock, and also complete our virtual safety form. Around the first of the next month, a student worker on the research team exchanged the empty tote with another tote with the next month of food. The two totes would be labeled with signage specific to that location (e.g., MCALC, University Commons) to ensure totes would

not get lost (Figure 1).

This logistics change in distribution successfully reduced the logistical burden of weekly distributions for the research team. As of the writing of this essay, early 2025, the entire pilot system has moved to the “Adopt-a-Pantry” model, with an administrative office adjacent to a pantry “adopting” it by agreeing to receive monthly shipments of food. Students now use a five-foot flatbed cart to haul food totes. We believe this system is dramatically superior to the weekly distribution we used during the pilot study, while still allowing for a larger, decentralized system across campus.

Expansion to the Medical Campus

Roughly two miles of downtown Richmond separates VCU’s liberal arts campus from the medical campus. Senior administrators at the medical campus requested the research team to expand the pilot to the medical campus, and we sought to respond. In total, we deployed five pantries at the medical campus, mostly in educational buildings. However, for several reasons, the physical distance proved quite difficult to overcome. Our undergraduate workers were not able to move food that distance using hand carts. The team could sometimes use cargo vans belonging to the PI’s college, but

Figure 1. Label for Plastic Tote Dedicated to the Life Sciences Building



they were only intermittently available and required specific safety training. Sustaining weekly deliveries to these locations almost immediately became unrealistic. The main campus food pantry briefly operated a walk-in pantry location at the medical campus, but the limited space did not allow much food to be stored for subsequent distribution. Furthermore, none of the research team had any reason to regularly travel to the medical campus and we were unable to find a member of the medical campus faculty interested in supporting this project within the pilot period, so any trip there had to occur specifically in support of the project.

The “Adopt-a-Pantry” model and the change to monthly deliveries allowed for a return to the medical campus. One administrative partner agreed to use their cargo van to pick up all totes for the medical campus and then store them at their location on the medical campus. The other four administrative partners then had a worker travel to the centralized building to exchange totes, which worked fairly well.

Technological Upgrades

Our team is working on improving the stability of the sensor network as well as developing a way to mount inward-facing cameras inside the pantries. To protect user identity, cameras would take pictures only after a time delay from the closing of the pantry door. The pictures could be invaluable to

operators and researchers seeking to understand the inventory and use patterns of each pantry. We also intend to have the most recent inventory picture for each pantry available on the program website, allowing potential users to examine the contents of a pantry before going to it. Figure 2 is a sample image from one camera.

Structural Reflections

Our work on this project has led us to reflect on the role and responsibility of the research team in working to reduce food insecurity among our students.

Role of the University in Mitigating College Student Food Insecurity

As members of our team have written about previously, the role of food pantries on college campuses sits at a fraught position (Jones et al., 2024). On the one hand, there is a real need among our students for food assistance, and there are both humanitarian and as well as practical reasons for mitigating food insecurity for students. We have found that a mix of practical arguments, generally centered around student success and graduation metrics as well as welfarist arguments, are effective when lobbying administrators for more support. Welfarist arguments emphasize the institution’s ethical responsibility to support student well-being by ensuring access to basic needs and fostering an

environment where all students can thrive.

On the other hand, the best that a campus food pantry, or any food pantry, can do is mitigate food insecurity for a target population. Eliminating food insecurity either on campuses or across society will take significant realigning of social, economic, and agricultural policies at the national level. Many actors within

Figure 2. Sample Image from an Inward Facing Camera



the national food system are invested in keeping the current version of the emergency food system in place, and the current status quo is inherently resilient to change (Fisher, 2017; Poppendieck, 1999; Winne, 2008).

This research, while we believe it is impactful both to the students served by it as well as for its utility in highlighting issues of student food insecurity to administrative leaders, is still very much a band-aid solution to a problem well outside of the scope of our team to completely address. Furthermore, we deliberately approached this pilot with an eye toward quantitative measurement through the development of our sensor network. This is appropriate for our role as scientists, but in view of the societal scope and the full impact of food insecurity at times this method felt insufficient. We have considered that a more effective approach to mitigate food insecurity on our campus could be to use the salary paid to team members as well as the other pilot costs to buy or discount meal plans for needy students. While this would not advance knowledge about the potential efficacy of a pilot of this nature or have the potential to create long-term change, it would likely have a greater impact on student food insecurity in the short term. Finally, we are cognizant of using unpaid volunteer labor to partially support this research, and hope that through this research we can advocate for greater resources from university leadership to support a more fiscally robust and just food pantry on campus.

Our team believes that colleges do and should have a role in mitigating food insecurity for their vulnerable populations. This can be understood from a humane point of view, but perhaps aligning food security with improvements to student outcomes and graduation rates is likely a more effective pathway to lobbying senior administration for more resources. This is especially true considering how many institutions, including ours, are moving towards a greater focus on recruiting first-generation students to help blunt the fallout from the looming so-called “enrollment cliff” (Bauman, 2024). Unsurprisingly, food insecurity is a challenge for first-generation students, and any school considering a first-generation recruitment strategy should also develop an emergency food assistance

program for them (Olfert et al., 2021; Tanner et al., 2023; Wolfson et al., 2022). In addition, administrators and supporting faculty should seek to obtain culturally appropriate foods for their food insecure students, or this disconnect can lead to wasting food and other campus resources.

Long-Term Sustainability of This Manner of Research

With limited exceptions, this research was conducted by faculty and students associated with the research side of the university. The Division of Student Affairs, part of the administrative side of the university, supports the partial Full-Time Equivalent (FTE) staff manager of the main campus food pantry as well as employing the student workers who manage the daily activities at the food pantry. While the staff manager is a co-author of this research, they also stand somewhat separate from the rest of the research team due to the division between the research and administrative sides of the university. As of this writing, they support continuing the pilot into its next iteration.

As the pilot stage at least of this research has moved towards a close, the research team spent significant time considering the long-term sustainability of the model. Because of the positive results, we believe there is a strong argument for adapting the pilot into the normal operations of the main campus pantry. Thus far, however, except for staff time from the staff manager of the main pantry, funding and effort for this project have come from the research side of the university. The research team, while committed to the overall mission of the pilot, is not able to assume administrative management of the pilot in the long term. Thankfully, the research team continues to refine the next iteration of the pilot, such as the development of cameras inside the pantries. But that said, who within the administrative side of the university should pay for maintaining the expanded reach of the pilot is an important point.

As of this writing, the research team is advocating for expanding the 25% FTE allocated by the Division of Student Affairs for the management of the main pantry to include the little pantries. The team has also recently successfully advocated for a dedicated, albeit temporary, funding stream from

the administration to acquire food for the entire campus food pantry system. This is the first time the university will use funds to acquire food for the pantries. Previously, all food was purchased through either direct food donation or purchases using funds donated through the university foundation.

Recommendations

We offer recommendations for institutions seeking to create similar programs on their campuses. We assume that likely readers are staff and faculty of higher education institutions, but some of the following may be relevant to other organizations.

Monthly Deliveries to Adopt-a-Pantry Partners

Shifting toward the Adopt-a-Pantry model, and the delivery of food on a monthly basis rather than weekly distribution to each pantry, is the superior distribution model in our eyes. If the program's reach extends across multiple campuses, identifying one distribution node on those campus(es) where the main campus pantry is not located is desirable. This allows adoptive partners on the other campus(es) to travel to the distribution node to pick up their monthly totes or boxes with their allocation of food and hygiene items. As previously described, using a two-box system for each location allowed one box to be "in the field" while the other box remained at the central pantry for repacking. Figure 1 shows the labeling system we used.

Using Student Labor

Volunteers and service-learning students seem to be the most inconsistent form of student labor. Service-learning students would do better if the faculty member had sufficient time to provide good weekly oversight. Paid students are a strong preference but their reliability may still be questionable. Using the Adopt-a-Pantry distribution model, however, reduces the number of opportunities for student workers to deviate from what they are supposed to do. Many elements of the labor involved in the pilot are sustained and regular, but involve very short bursts of time. Therefore, some faculty and staff might be willing to assist, if presented to them correctly.

Structuring Data Collection to Reduce Concerns over Liability

Publicly sharing data in formats like Google Sheets without access controls can create significant liability risks, especially when real-time location and activity information is displayed. While we secured our original implementation for storing the timestamped sensor data for the pilot by limiting viewing and editing permissions, this was not a scalable solution considering a growing interest by other universities and organizations who wished us to help them implement similar systems on their campuses. In late 2023, we upgraded our back-end data management to use Amazon Web Services (AWS), which improved our data security and scalability while adding features for data processing and analysis. This potentially allows us to stream real-time usage of pantries to a website, but we decided that any such data that is even remotely viewable publicly should operate on a time delay to reduce the risk of bad actors interacting with students accessing pantries at non-typical hours (e.g., late night, early morning).

Managing Internal Public Relations

Early in the pilot development the PI cultivated relationships with internal communications and public relations personnel across the university, including departmental and college-level public relations staff, university-wide Public Relations and Development, and the Division of Student Affairs, as well as the student newspaper. Most were very interested in creating positive press about various developmental milestones of the pilot. Many of these stories took a "feel good" tone, especially in the immediate aftermath of the COVID-19 pandemic. The university-wide news service, which publishes internally focused stories about the university several times a week through an email blast, was especially interested in writing stories about the pilot. The PI specifically and proactively pitched stories as the pilot approached new milestones, such as the initial launch, the expansion to the medical campus, and its one-year anniversary.

Leveraging the pilot's preliminary results encouraged more administrators to care about student food insecurity on campus. The PI received invitations to speak at three on-campus small-scale

research symposiums, two sponsored by the university's first-generation student office, which funded much of the pilot. Presentations at those meetings increased the exposure of the pilot's effort, leading to introductory meetings with more and more senior administrators interested in the work, eventually including the Vice President of Administration.

Upon analysis of the complete set of pilot data in mid-2023, the team wrote an executive summary of the pilot results and sent it to all senior administrators who had expressed some interest in our findings. Two major positive results came from this action. First, the administration decided for the first time to provide dedicated short-term funding to the main food pantry to purchase food. This was a major win as previously all food passing through the food pantry, and subsequently this pilot, was donated either directly or indirectly through the university foundation, a 501(c) entity.

Second, and perhaps more important, increased visibility of the pilot led to university Dining Services agreeing to join members of the faculty team in applying for a U.S. Department of Agriculture grant to mitigate and/or divert food waste at the university's main all-you-can-eat dining hall. As part of the large application, food diverted from the dining hall would be channeled to our team's newly expanded community refrigerators targeted for soft launch in Fall 2024. They work in a similar manner to the pilot, but are temperature controlled and will eventually contain our sensor package. During the writing of this manuscript, we learned that we were selected for funding by USDA. We believe there is a direct throughline from our success with advocating for this pilot internally to the ability to apply for, and in this case win, substantial external funding that seeks to dramatically transform the campus's food system.

Resist Calls to Create Barriers to Entry

During the development of the pilot, several administrators questioned the possibility of restricting access to the pilot to those students who "truly need it," or some similar turn of phrase. While the motivations behind such comments are unknown, we assume that preconceived notions may be present about who are "deserving poor" and therefore

worthy of access to emergency food assistance (Bridges, 2016; Iceland, 2013). The research team believes that food is a universal human right and sought to structure the pilot to affirm that right (United Nations, 1966). Additionally, such restrictions would be functionally impossible because of the pilot's budget. We envisioned possibly building a scanner that would allow students who had fully registered in some way to scan their ID cards to unlock the pantry's door, but this solution is quite technologically involved and therefore expensive.

Even if budget constraints were not present, actively requiring students to approach an administrator to self-identify as sufficiently poor that they needed access to the pantries would itself be a barrier to usage. We believe that the shame of needing to self-identify would likely drive so many food insecure students away from the pilot that it would become functionally unusable. Such a policy is also ethically dubious in our eyes. As such, we encourage other teams who consider creating similar programs on their campuses to resist calls to restrict access to "deserving" students.

Furthermore, technological barriers need to be considered when implementing similar programs as there are implications for both the campus teams and pantry users. The use of technology to collect data, such as RFID systems or QR code scanning, can inadvertently create obstacles for users. For instance, if access to the pantry is gated by RFID key-fobs or requires QR code scans, students might find these extra steps cumbersome and discouraging. While these technologies offer valuable data for ongoing studies and operational efficiency, they may also hinder ease of access and deter users from utilizing the resources effectively. Privacy concerns further complicate this, though assigning anonymous IDs to devices like key-fobs could help mitigate personal data issues. Despite efforts to mitigate privacy issues, if accessing food requires users to engage with these devices, it might still present a barrier if the technology feels intrusive or overly complex.

Relationship between Engagement and Technology

"Invisible" or "unspoken" barriers can emerge from the ways technological systems are presented.

If the integration of tracking and measurement technologies appears overly complex or intimidating, users might be hesitant to engage fully. For example, if the pantry system includes overt sensors or other measurement tools, users may worry about inadvertently disrupting these systems, leading to reluctance in using the pantry altogether. Such perceptions can make the pantry seem less approachable, as users might fear that interacting with the technology could have adverse consequences, like “breaking” the equipment. This could undermine the effectiveness of the program by creating an environment where users feel uncertain or uncomfortable, and affecting their willingness to access the resources provided.

Conclusion

While at times our model was challenging to implement, we believe that our model is replicable and likely to be effective in general at mitigating college student food insecurity. In this reflective essay, we have presented our major barriers to implementation and our steps to mitigate them during the development of the pilot program. Several barriers, such as working with the ADA compliance office

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and our Facilities teams, while necessary to comply with legal and accessibility guidelines, were navigable even if not completely transparent initially. We have chosen readily available, cost-effective materials and software tools for collecting our quantitative data to focus our efforts on the human and material logistics of the pilot development. Finally, we found that minimizing the role of students, due to their unreliable nature, in favor of systematic effort from university staff is likely required for sustainable operations of a campus food pantry over time. We hope to launch a website with our best practices and technical information in the near future. In the meantime, please feel free to contact the corresponding author for more information about our pilot. We hope this reflective essay is helpful to organizations launching similar initiatives on their campuses!

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