Co-Designing A Low-Barrier Digital Platform for Culturally Diverse Communities

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***Abstract*—This paper discusses the design, development, and deployment of an iteratively designed information management and visualization platform known as the People's Market Dashboard System (PMDS) created for a subsidy-based farmers market. The platform seeks to enhance the administrative capacity, service delivery, and data-driven decision-making of participating public service organizations; improve market management quality and sustainability; and advance broader health and social equity objectives of market sponsors and managers. Exploratory interviews, participatory observations, iterative prototyping, research memos, and in-situ testing were used to design a low-barrier technology for use within predominantly low-resource, racial minority, and immigrant and refugee populations. Disrupting traditional power dynamics between institutions and community partners, the platform reflects participatory and adaptive co-design practices that put community priorities at the center.**

Keywords-participatory design; co-design; community informatics; digital innovation; public service system.

I. Introduction

Digital innovations are typically developed for mainstream, middle-class users by for-profit start-ups and established technology businesses. These innovations emerge within well-resourced contexts of relative predictability with efficiency centered performance objectives and formalized organizational policies that structure the context of development and implementation. However, the development and deployment of digital innovations within the public service sector—which consists of contexts often characterized by administrative uncertainty, organizational and cultural diversity, and resource scarcity—may be particularly important for Human-Computer Interaction (HCI) researchers to consider.

In this study, we examine the co-design, development, and implementation of a novel, low-barrier information management and point-of-sale system developed for use within a grassroots, subsidy-based community farmers' market. The market is supported through a community-institution partnership between a county government entity and a grassroots social enterprise that works with marginalized youth. The scientific goal of this applied study is to identify and examine key consideration factors that shape the process of digital technology co-design and development within low-resource communities.

The platform, referred to as the People's Market Dashboard System (PMDS), aggregates data on various market processes and interactions and displays these data as interactive visuals within a set of integrated dashboards, facilitating standardized data collection and data validity processes while democratizing the value of those data for decision-making among both high- and low-power system users. The rest of the paper is structured as follows. Section II presents the previous research that contributed to the methodology and design of the PMDS. Section III describes the context of the project and an overview of the platform. Section IV details the different phases in the co-design and development of the PMDS. Section V discusses system deployment. Section VI presents the key findings. Finally, section VII concludes the paper and outlines directions for future work.

II. Related work

A. Co-Design

Co-design is closely intertwined with Participatory Design (PD), a design practice that originated in Scandinavia in the 1970s-1980s where workers, unions, and researchers collaborated to create workplace technologies. Participatory design aims to ensure that people affected by technology have a voice in its development, through the lens of participation as empowerment [1][2]. Co-design utilizes a variety of toolkits and techniques that facilitate stakeholder collaboration. They help translate their lived experiences, knowledge, hopes, and priorities into actionable design insights. These methods are designed to lower barriers to participation. Toolkits such as sorting, collage making, design games allow participants express their creativity and needs in technology [3]. Through storyboards, sketches or cutout paper interfaces, low-fidelity prototyping enables iterative exploration, as non-technical environment makes participants more comfortable in critiquing and modifying ideas [4][5]. Buxton emphasizes the importance of sketching as a design practice, highlighting its role in generating ideas rather than validating them [4].

Conversations are themselves a powerful co-design techniques, enabling stakeholders to articulate experiences, negotiate meanings and surface tacit knowledge that may not be captured through formal methods. Conversations serve a dual role; they elicit input and cultivate a sense of ownership, making stakeholders active contributors rather than passive informants. Paired with low-fidelity artifacts (such as sketches or mock-ups), conversations can become framework for co-design, grounding abstract ideas in tangible form, sparking discussions and iteration [4]. In our work, we use sketching as a starting point for design conversation with key system users to bring to life ideas that emerge in the co-design process (Figure 1).

B. Asset-aware Design Approach

Recent work in HCI has advocated for moving beyond deficit-oriented framing of resource-constrained communities toward asset-aware design approaches. This approach situates the design on local strengths rather than deficit. Wyche et al. introduced asset-based design by emphasizing how community resilience, social network, and informal innovation serve as foundations for sustainable technology in resource-limited setting [6].

C. Adaptive, In-situ Testing

When designing technologies for resource-constrained populations, it is often necessary to use methods that extend beyond traditional laboratory-based evaluations, since community members may face limitations related to time, transportation, or financial resources, as well as challenges like limited or unstable connectivity, shared devices, or low literacy. By refining features in context, technologies become more usable, resilient, and aligned with the lived realities of marginalized communities [7]. Previous HCI research shows that in situ methods surface contexual factors that remain visible in controlled settings, such as workarounds that users develop to cope with resource limitations [6][8].

D. Low-barrier Technology Design

The development of low-barrier technology has emerged in HCI as a critical approach to designing systems that are accessible to communities facing socioeconomic, linguistic, or infrastructural constraints [9]–[12]. This approach prioritizes simplicity, affordability, low entry threshold for participation in digital technology. The research of Talhouk et al. with refugees underscores the need for minimal hardware and literacy demands. They designed health technologies in Lebanon to operate on low-cost mobile platforms and to enable multilingual interaction [7].

III. Context and Platform Overview

In this research project, we co-designed and implemented PMDS as a novel, low-barrier information management and point-of-sale system developed for use within a grassroots, subsidy-based community farmers' market. The market is supported through a community-institution partnership between a government entity (primary funder) and a grassroots, social enterprise (hereafter referred to by their role as "market manager") that works with marginalized youth for agricultural and entrepreneurial skill-building. The purpose of the farmers' market is to expand access to fresh, affordable and culturally-specific foods for residents living in a limited food access, high poverty region of the city. Corollary purposes of the market include creating economic opportunities for small businesses of all kinds with limited market access and reducing nutrition-related health inequities in the region. The platform has several system user groups, including the market manager staff and volunteers who manage all check-in and registration processes for vendors and attendees as well as subsidy reimbursement processes for vendors (see Figure 2). Vendor types are subdivided based on what they sell at the market and, concomitantly, the types of market subsidies they can receive in payment from attendees.

The platform aggregates data about various market processes (e.g., registration, transaction), inputs them into a database through a series of interconnected HTML forms completed by various market actors such as the market manager staff and vendors, and displays this data as interactive visuals within a set of Tableau dashboards. In this way, the designed platform facilitates standardized data collection and data validity processes which concomitantly supports market compliance and sustainability. It also democratizes the value of that data for decision-making by enabling all system users to access these dashboards.

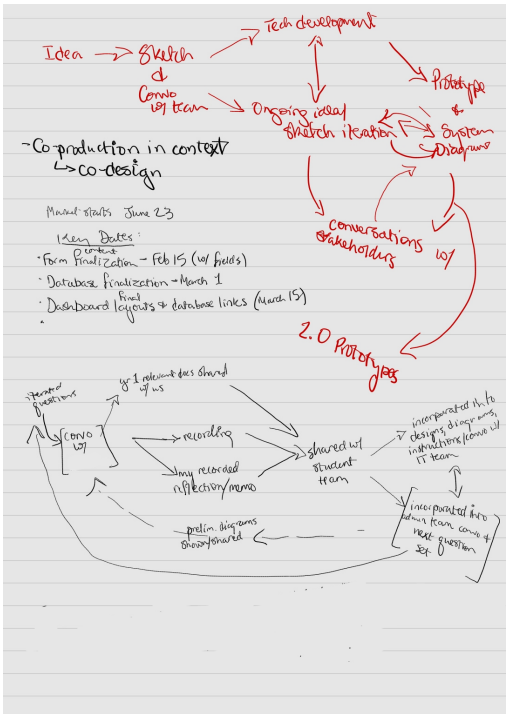

Figure 1. Initial sketch of PMDS co-design process illustrating early system ideation and stakeholder collaboration.

IV. Co-design and Development Process

A. Needs Assessment

Co-design of the platform began through a series of exploratory, unstructured interviews with the market manager. The initial needs assessment revealed many pain points in the current market processes that could be aided through a digital platform. We will discuss two of those challenges here. First, there were serious communication challenges across the many community-institution partners involved in market implementation. Language barriers were a concern among market vendors with limited English proficiency; however, it was difficult to determine the extent to which language barriers would continue to be a problem as related to system use given that the market manager reassured our team that language

barriers were not a major concern. Another important challenge was the lack of clear communication among stakeholders and the inconsistent implementation of market policies. We began to envision opportunities for the platform to support greater policy transparency and enforcement between managers and vendors.

The second identified issue was that vendors had previously not always received timely payment for items purchased by attendees through subsidy-based benefits. Vendors who did not receive payment at the end of the market day or shortly thereafter were left in very difficult situations affecting their personal finances, as most operated on tight margins. This reimbursement challenge was due to several contingent reasons; however, we believed that our system could support more timely repayment and greater accuracy in tracking those balances owed to vendors.

These challenges were initially revealed through a virtual conversation involving the project sponsor, market manager, and market vendors. However, this conversation revealed that ongoing conversations with market vendors would not be possible due to both their time constraints, the optional nature of their participation in dialogue with our team, and the significant language barriers of the vendors with the highest likelihood of participation. Their input was later incorporated into the iterative design of the high fidelity prototype during the training and early implementation processes.

Several other operational challenges were identified through a series of follow-up conversations with the market manager and review of both observational and secondary data from the previous year's market. The notes and memos generated from these conversations were collectively analyzed and the policy design considerations were concurrently translated into prospective technical functionalities.

This preliminary information gathering process was extraordinarily important because it allowed the development team to understand the system pain points and to begin to determine what types of system designs would be needed. Working within many constraints including a relatively short design-to-deployment timeline, our team leveraged its technical, administrative, and food systems expertise to conceptualize and create a mobile wallet based system which would enable point-of-sale tracking and standardization of the market benefits allocation processes while accounting for important differences in the allocation policies. This mechanism became the basis on which PMDS was designed and developed, ultimately revealing the high level of interdependence between market policy design and the technical design of the platform. The timeline for this project was approximately 8-10 months with the first stage (needs assessment) lasting about 5 months and occurring concurrently with the low-to-moderate fidelity prototyping (approximately 2 months).

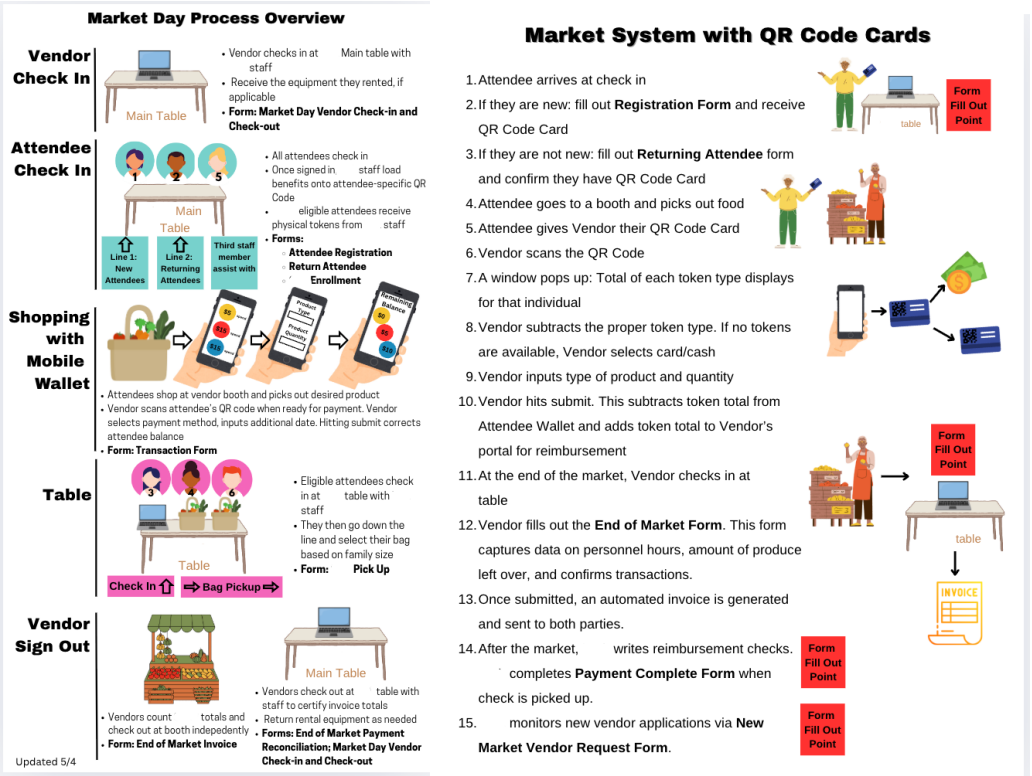

Figure 2. Overview of key market processes and system interactions.

B. Low-Fidelity Prototype

Informed by the insights from the initial needs assessment, the team created early system diagrams to model information flows, user interactions, and user access levels. These diagrams served both as internal tools for development clarity and as communication artifacts for aligning with non-technical system users including the primary funder and market manger. These initial diagrams were primarily based on the expected data needs and interests of the key system users, which enabled a backwards mapping from data visuals to needed fields and forms. Apart from the technical expertise of our team, we have both theoretical and practical food systems expertise within our team that informed these preliminary sketches, which were iteratively modified through conversation with the system users. The ongoing communication of the development team with the market manager about their needs and the evolving decisions and contingencies of market management enabled iterative development of both the preliminary sketches and the platform through Spring 2025.

Simultaneously, the database schema was iteratively constructed using Smartsheet, with particular focus on relational logic between vendors, market attendees, and transaction records (see Figure 4). This database was selected because the primary funder already used this software, and the original plan was to develop and deploy the system for use within the funder's IT environment. The process emphasized modularity to accommodate evolving market workflow and market management policies. Tableau was selected as the data visualization software because it was familiar to the project director, highly rated for its user-friendly interface, and its practicality as our team has institutional access to a secure Tableau server which enabled cost containment for our end users.

Next, the development process moved into early-stage prototyping and database schema design. This phase was characterized by the development of low- to mid -fidelity prototypes created to visualize and refine potential system functionality, which was guided by the preliminary system architecture and design requirements (see Figure 3). Components of these sketches reflected market manager objectives and plans for the upcoming market expressed in the unstructured interviews. For example, graphics selected for the dashboards addressed expressed data needs of the market manager required for funder compliance and future grant writing purposes. The types of graphics used were based on data visualization best practices for low-moderate data literacy communities, and the data fields and forms used were and mapped onto market workflow processes.

During this phase, the technical team also began sketching interface components as reflected in the ongoing conversations with the market manager, including the intake form fields and dashboard structures, based on the following:

- Potential data input fields expressed or implied by market manager as data needs and/or interests
- Anticipated data categories and field values
- Administrative workflows

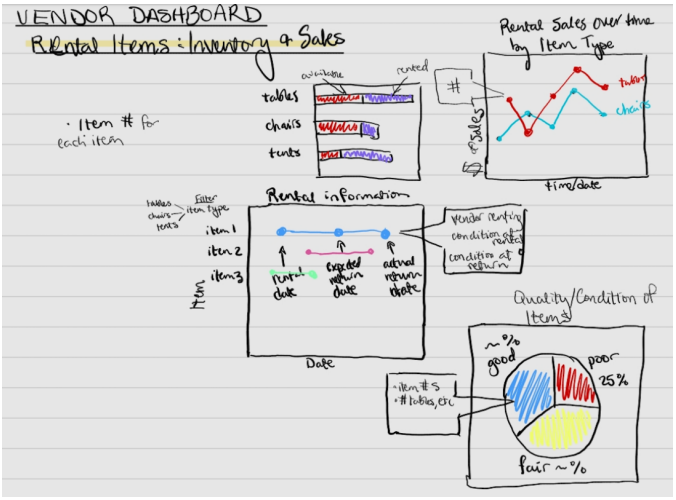

Figure 3. Low-fidelity prototype sketch of a vendor dashboard.

Continuing the co-design process, the team organized a design feedback session with stakeholders (manager and primary sponsor), aimed at introducing stakeholders to the emerging features and functionalities of the platform under design. Vendors were not present at this feedback session due largely to scheduling and timing difficulties. This session provided a crucial sounding board for exploring the system's scope and usability. Although not a technical walk-through, the session helped align expectations and generated feedback on high-level goals and constraints. It also improved system users' ability to understand what the platform was that the team was developing. Up until this point, system users with less direct involvement in the development process had a very limited understanding of what this prospective digital platform was. The feedback session provided system users with greater clarity about the system structure and its purposes.

C. High-Fidelity Prototype

This phase marked the evolution from conceptual sketches and diagrams to functional system modules (see Figure 5). The technical team built interactive prototypes that incorporated the following:

- Dynamically validated forms that ensured data accuracy at point-of-entry
- Dynamically updated visualization dashboards to convey market trends
- Unique identifiers to track vendor and attendee records between system components
- Role-based access flows

1) The Dashboard: In order to facilitate the ongoing dialogue with system users and co-design activities, our team designed image-based dashboard mockups derived from earlier sketches. The dashboard design process involved navigating the tension between accurate *data representation* (e.g., specifying exact charts, metrics, and data sources) and *data comprehensibility* (including data visualization best practices regarding visual layouts, color composition, data literacy and clear communication standards). These decisions were made

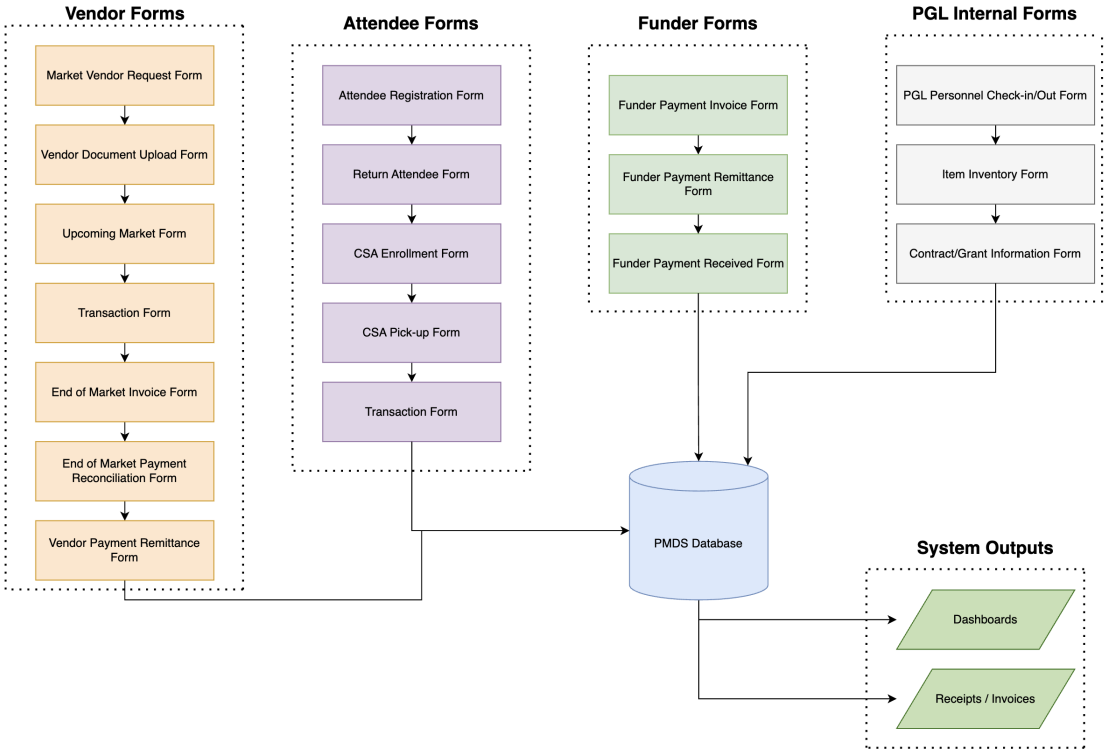

Figure 4. System diagram illustrating the interaction between input forms, database schema, dashboards, and receipt generation modules.

collaboratively with the expertise of both the technical and practical (e.g. public administration, food systems) members of our team.

After refining the dashboard layout and features, the team developed Tableau visualizations for process-related outcomes such as market performance, payment remittance, and benefits utilization. The backend development included establishing connection between the HTML forms and Smartsheet through Google Apps Scripts. Tableau was ultimately selected as the data visualization software because it was a practical solution that produces high quality, dynamic data visuals with a wide range of functionalities and graphic types available. System users would be accessing all dashboards through the website, so there was no concern about inaccessibility or functional use challenges when viewing dashboards through a mobile app. The website was determined to be the most appropriate modality for housing the PMDS given our study timeline and budget. High fidelity prototyping and iterative development lasted approximately 4 months, while initial user training and implementation (beta testing) occurred over a 3-6 month period. These two study phases where overlapping and included copious amounts of informally gathered user feedback and observational data (back-end observation of database entry and "front-end" observation onsite at the market) gathered by our team.

We also developed and deployed a web interface for a unified appearance and a single access point of the platform that supported convenient access for system users (see Figure 6). This, along with the logo that we developed, helped to create an polished identity for the platform that system users could learn to recognize and see themselves reflected in.

There were many cycles of internal testing and ongoing iterative feedback solicitation from system users involving the following areas:

- Form interfaces (e.g., auto-fill logic, field hiding based on conditions)
- Dashboard hierarchy (e.g., utility of filters and information visibility)
- System documentation (e.g., tooltips, form labels)
- "Virtual ID card" (QR code generated to access mobile wallet)

D. Beta-Testing

Once the working platform was almost complete, the focus shifted to beta testing and capacity building. In the weeks leading up to the market opening, the team tested the system with a limited group of stakeholders. The development team members and stakeholders participated in structured walkthroughs to assess usability and data integrity across different system entry points.

Initial testing focused on form functionality and the mobile wallet mechanism, with the goal of identifying usability issues and testing edge cases. As the testing progressed, the emphasis shifted toward robustness testing — purposely attempting to "break" the system through unanticipated inputs, duplicate entries, or timing-based conflicts. Our team continuously looked

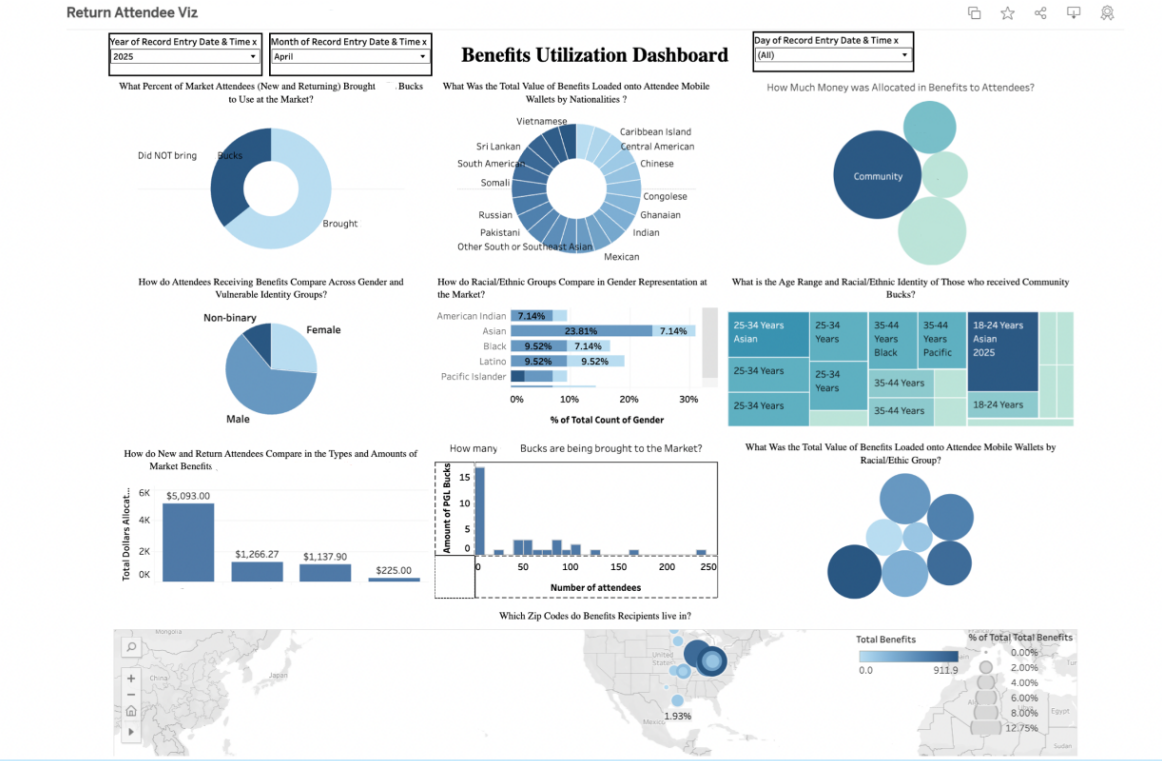

Figure 5. High-fidelity dashboard prototype illustrating refined visualization modules and reduced cognitive load (redacted for confidentiality).

for ways to enhance the platform for user needs and the User Experience (UX). For example, we created a live mobile wallet view of current balance of benefits for each customer, and later a similar vendor wallet providing the same so vendors could track their expected reimbursement income during the market.

Concurrently, training materials and hands-on walkthroughs were provided for stakeholders, focusing on operational workflows such as:

- Registering new attendees and vendors
- Processing market transactions and reimbursing vendors for subsidy-based transactions
- Monitoring benefit distributions in real-time

The final rounds of beta-testing were constrained by real-world operational timelines. As the market season approached, safeguards were implemented to prevent test data from mixing with actual attendee and vendor information, which limited certain test scenarios. In these cases, validation relied on simulated runs using dummy datasets. System performance, feature gaps, and final usability concerns were logged for post-season reflections and revisions.

V. Deployment and Adaptations

The platform was deployed approximately one week before the first day of the market. Onsite participatory observation occurred during the first market days, which were characterized by a hectic market environment as system users adjusted to using a new platform and adapted market policies and procedures as technical challenges arose.

One key issue identified was the lack of a strong, central Wi-Fi connection, which hindered registration and transaction processing and resulted in initial data loss. Adaptive modifications were made to the form submission process, including disabling submit buttons, and adding success messages. However, the negative impact of the initial data loss on system users' confidence in the platform was significant. Gradually, their confidence in the platform and their ability to use it successfully was rebuilt through continuous practice, ongoing onsite technical assistance, and iterative system modifications.

VI. Key Findings

Several important findings about the opportunities and limitations of co-designing digital innovations within limited-resource community contexts were identified in this study.

A. User Engagement in Co-Design and Implementation

First, close attention to the needs, capacities, and concerns of all types of system users during the co-design and testing phases can greatly support implementation success. Due to logistical and linguistic constraints, we were not able to engage with vendors during the co-design process; we primarily engaged them during training and in situ testing during implementation. Earlier and ongoing exposure of the vendors to the platform would have helped to avoid many of the technical challenges experienced and would likely have fostered early confidence in the system among end users. In turn, these factors would likely have reduced the heavy reliance of system users on technical assistance provided by our team. These considerations are

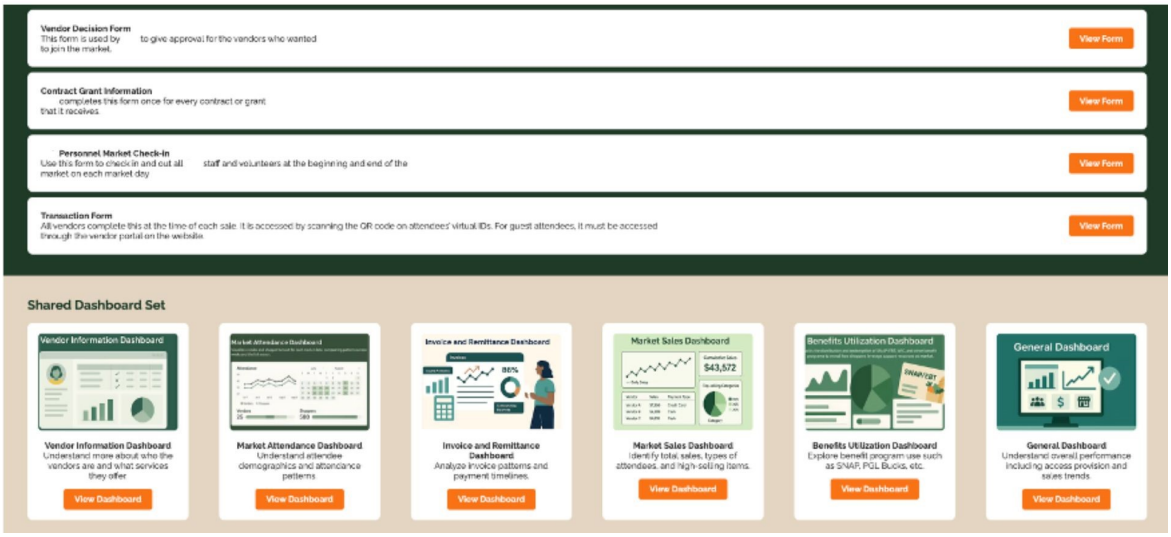

Figure 6. Web interface portal view providing a unified access point for system users.

being thoroughly incorporated within the platform design and implementation timeline of the next phase of this study.

B. User Trust and Proximate Support During Implementation

Additionally, trust and proximity were essential elements of the success of this implementation, despite the myriad challenges experienced. When implementation challenges arose in the first weeks of the market, it was invaluable that the lead author had an established relationship with the market manager and was present onsite helping system users navigate through those challenges in the first weeks of the market. She was able to help distinguish challenges that were caused by technical glitches from those that were merely system use errors. Together, she and the development team were able to determine which of the latter warranted technical modifications and adjustments to meet system users' needs and thus distinguish those needs from supplemental user training on correct system use. Intensive technical assistance was provided through phone calls, text messages, and later through a Discord-based "help desk" chat between the market manager and our student-based developer team. These regular, direct interactions between our team and the market manager helped to minimize the physical, temporal (time zone), cultural, and expertise differences between their team and ours. These interactions also provided invaluable learning opportunities for both groups, which collectively enhanced the use and improvement of the platform.

C. Prioritizing User Privacy and Security by Design

Ensuring privacy and security, even when not explicitly requested by system users, was central to maintaining trust and platform integrity. Our team prioritized encryption and other data security processes to ensure the security and privacy of data at all times. This included awareness of the socio-political context in which both the platform and the market were being implemented, which directly impacts system design and project related decision-making. Consideration of these contextual factors and their implications on system users sense of safety and security continue to be of the utmost importance to our team.

VII. CONCLUSION AND FUTURE WORK

This project illustrates how understanding dynamic public service contexts as common situational parameters can elicit effective co-design and adaptive development practices. Digital innovations designed for resource-limited and culturally diverse communities should always be rooted in proximity, alignment of priorities, and trusting relationships with system users. These socio-relational factors enable digital tools to be effectively designed to support end users' goal achievement and sustainable use. Co-designing digital innovations with system users requires direct engagement of development teams within social and administrative contexts that are often characterized by frequent changes, contingent decision-making, and multi-layered politics. Future work on this platform includes adapting PMDS into a multi-user system to support other types of related programs for similar networks of diverse local food systems actors. This includes expanding the platform into a mobile application, building a technical assistance and training infrastructure with dynamic, gamified learning elements, and redesigning the data architecture—along with input forms—to enable AI-driven insights and seamless system integrations. Engaging interdisciplinary development teams with diverse technical and domain expertise enables the proactive development of solutions to address these and other implementation challenges. Without these relational elements, digital innovation risks exacerbating mistrust and reinforcing existing social inequities. This work offers practical insights for researchers and practitioners designing human-centered digital platforms for public service delivery.

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