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# DESIGNING AND VALIDATING AN INTERACTIVE USER-CENTERED DIGITAL PLATFORM FOR SEGMENTED SURPLUS FOOD MANAGEMENT AND DISTRIBUTION COORDINATION TO COMBAT HUNGER AND FOOD INSECURITY IN PAKISTAN

## AIMAN AMJAD[1], TAYYBA JILLANI AWAN[2], FARIHA SAEED[3], ANUM SHAMSHAD[3]*

[1]LECTURER, DEPARTMENT OF PRODUCT AND INDUSTRIAL DESIGN, UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE, PAKISTAN.
[2]STUDENT, DEPARTMENT OF PRODUCT AND INDUSTRIAL DESIGN, UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE, PAKISTAN.
[3]ASSISTANT PROFESSOR, DEPARTMENT OF PRODUCT AND INDUSTRIAL DESIGN, UNIVERSITY OF ENGINEERING AND TECHNOLOGY, LAHORE, PAKISTAN.
*Corresponding Author: anum.shamshad@uet.edu.pk

**Abstract**
The study will use user-centered design (UCD) method to design a digital platform, Dast-e-Barkat, an interactive food redistribution platform to solve the twin problems of high edible food waste and food insecurity in Pakistan. A mixed-methods study which involved in-depth interviews and quantitative donor surveys (N=50) empirically confirmed systemic operational problems, such as fragmented logistical coordination, low donor- NGO engagement (Median= 2.00) and critical lack of dedicated digital management tools (Median =1.00). The statistical analysis proved that there are significant distinctions in operations between donor groups, and it is important to apply a segmented approach to solve the problem effectively. Based on these insights and UX/UI principles, the suggested solution focuses more on creating a user-friendly interface, a clear tracking system, and the necessary features that build trust and responsibility during the donation cycle. The final design offers an effective and non-hurdle system of linking donors to NGOs. The research conducted in general provides evidence that Dast-e-Barkat has a great potential to make a major decrease in the edible food waste and reinforce the efficiency of the hunger relief efforts in Pakistan with an efficient and easily accessible and highly usable system which can help in making the process of giving a lot easier and more coordinated.
**Key Words:** User-Centered Design, Interactive Digital Platform Design, Food Donation App, Food Waste Reduction, Food Insecurity, Hunger, Surplus Food Redistribution,

## 1. INTRODUCTION

The wastage of food is a colossal and international challenge that raises severe concerns to the world, the economy and the hungry people. Approximately one third of all food produced annually worldwide weigh 1.3 billion tons is wasted(Food and Agriculture Orga, 2015). This food waste is a big contradiction: as we are wasting food, so are the resources that were used to produce that food (such as water and land) is wasting, and the rotting food is contributing to climate change(Amicarelli & Bux, 2021) . Meanwhile, there are more than 820 million individuals in the world who lack sufficient food to consume.(Food and Agriculture Orga, 2015) The causes of food waste are dependent on numerous factors. Food waste is usually reduced in developed countries. However, in underdeveloped countries the issue tends to occur during the supply chain, primarily due to ineffective systems of storage and transport right after harvest and a corresponding lack of awareness of food wastage on the part of the people(Aramyan et al., 2021). This implies that a significant amount of food goes to waste since it has not even made it to the market. Despite of location, in underdeveloped countries the lack in the donation system of surplus food causes the food wastage because it fails to connect the available food with the people who desperately need it (Devaraj & Balasubramanian, 2025)
As many charities and NGOs do great work to gather and distribute surplus food, their efforts tend to be small scale, manual and uncoordinated(Ganzin, 1975). With the expansion of our cities as well as the food service business, the quantity of wasted food is escalating exponentially. The existing and scattered nature of food donations just cannot

process this massive excess(Amna Memon & Yoko Okura, 2024). It is also slowed down by the logistics, lack of transparency and inadequate coordination between the food donor and the recipients (F.H. Mughal, 2018).

This disconnection between an enormous amount of food and the prevalent hunger is highly evident in nations that are major producers of food yet, face food insecurity. Pakistan will be a good example of this issue(Iqrar Ahmad Khan, 2024). Although Pakistan produces significant amounts of food and charity is the custom of the country, it ranks second-last in South Asia with regards to food waste(S. Kamal Hayder Kazmi, 2024). According to a report of FAO approximately 20 to 36 million tons of food are wasted in Pakistan annually. Regrettably, more than 40 percent of the Pakistani population experiences moderate and severe food insecurity (Syed Qasim Ali Shah, 2024). The majority of this wastes are generated in urban commercial industries where large quantities of food are prepared but end up being discarded since there is no effective and coordinated national system to salvage the foodstuffs (Wasting food, 2024). The enormous gap between the quantity of wasted food and various hunger indicates that it is necessary to find a solution to streamline and repair the food donation system (Arif Mahmood Chaudhary, 2025).

In this paper, we will thus take a closer examination of the issues associated with the existing informal food donation networks in urban Pakistan and will suggest that the process can be significantly improved through the use of a technology-based platform. This solution can enhance efficiency and transparency because it will create a direct linkage between food donors and local welfare organizations in real-time.

## 2. LITERATURE REVIEW

According to Global Hunger Index, Pakistan has been ranked as 106 out of 123 countries and with a score of 26.0 which implies that there is a serious level of hunger. The score is calculated based on four indicators, 16.5% of the population is undernourished, 33.6% of children below the age of five are undernourished, 10.0% of children below the age of five are wasted and 5.8% of the children are those who die before the age of five. The report is issued by Concern Worldwide and Welthungerhilfe and serves to measure and track hunger worldwide (Global Hunger Index (GHI), 2025)

Further worsening of the waste issue in developing contexts is the result of technical and logistical breakdown such as inadequate cold storage space, poor transportation networks, ineffective packaging and laxity in post-harvest managing that problem as reported in research by the Pakistan Council of Scientific and Industrial Research(PCSIR, 2023). Moreover, cultural influences are also a significant contribution such as over-cooking of social gatherings such as weddings and community meals resulting in a large amount of edible food remaining uneaten(Afzal et al., 2022). The environmental consequences of this waste are also severe since the decomposition of food in landfills produces methane, a powerful greenhouse gas, which exacerbates climate change and leads to the squandering of enormous quantities of water and energy spent on its production (Brief Policy Perspectives, 2020) This environmental vulnerability is considerably enhanced by the fact that Pakistan is already facing water shortage and power crises
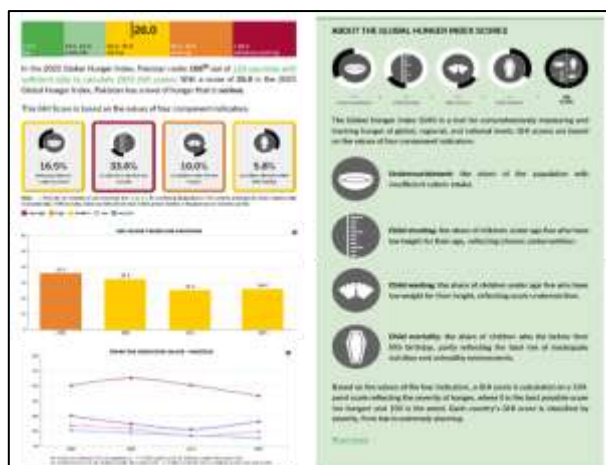


*Figure 2: Global Hunger Index Pakistan*
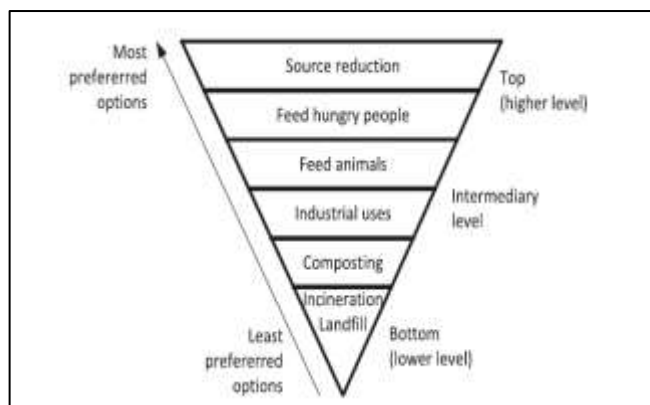*Source: (Global Hunger Index (GHI), 2025)*



*Figure 21: Food Recovery Hierarchy*
*Source: (Sulis et al., 2024)*

(Adnan et al., 2024)

On the same note, the food recovery hierarchy (figure 2) gives priority to interventions that reduce food waste at the source, then there is the redistribution to human consumption and finally, disposal (Sulis et al., 2024).The implementation of these models in the socio-economic context of Pakistan would enhance a more sustainable and just food system. Circular economy model also provides a good theoretical basis to solve food waste(Ellen MacArthur Foundation, 2019).It puts a strong focus on the lifecycle extension of materials and resources by means of reuse and

regeneration a strategy which is quite compatible with redistribution in food, where excess food is re-purposed to those in need rather than being thrown away(Santagata et al., 2021).

Considerations of research and practice have some serious gaps, regardless of the continued efforts. To begin with, no detailed information exists regarding the generation of food waste, sources, and patterns in Pakistani cities, which impedes evidence-based policymaking(Afzal et al., 2022). Second, lack of a centralized digital infrastructure results in lack of efficiency in coordination among stakeholders. Third, food donations are deterred by poorly developed policy backing and inadequate legal frameworks that lack liability protection and tax incentives protecting the donor. Finally, people are not so aware of the problems concerning food waste reduction, and commercial donors are afraid to participate because of the food safety and logistical issues (Mahmood et al., 2023).

In order to overcome this issue, a number of non-governmental organizations (NGOs), run critic (Mumtaz Alia & Maya Khemlani Davidb, 2021; Maya Khemlani Davidb, 2021). Such efforts are however constrained by the fact that they are still manualized in terms of coordinating these activities using traditional means such as phone calls and social media (Md. Moniruzzaman, 2025). This traditional system leads to delays in the communication process, ineffective logistics, scale weaknesses, and lack of donor interaction. These key efforts are not running with the efficiency and the breadth required to address the magnitude of the surplus food problem due to the lack of centralized digital systems (Aamir et al., 2018).

Unlike this, international online platforms have managed to show the disruptive nature of technology in food redistribution(Grace O'Sullivan, 2024). Such applications as Too Good to Go in Europe and MealConnect in the United States form real-time digital platforms that effectively connect donors, NGOs, and occasionally consumers. Such platforms bring AI and mobile technology to use, streamlining collection routes, automating communication, and tracking donations, which will result in less waste and a higher level of transparency (Katie Balevic, 2024). These are positive success stories around the world, which confirm that the integration of digital technologies is one of the elements that help encourage the idea of social responsibility and enhance the accountability of food rescue work (Alejandro Enamorado, 2022).

These online platforms use information and communication technology to make resources more productive and coordinate food chains more effectively, which can result in more efficient surplus food recovery, especially at the retail level (Sanyal et al., 2021). The strategy will support the logistical issues of perishable products and short fuses by offering coordinated processes and actions to the food waste recovery within the food enterprise, which resolves the communication barrier and distribution delays (Ciulli et al., 2019). These platforms commonly apply web and smartphones applications to assist in creating a structured process and activity in relation to the food waste recovery in the food business (Aloysius & Ananda, 2023). As an example, in Belgrade, Foodshare uses mobile applications to match excess food donors with consumers and the needy to facilitate the donation and delivery of food (UNEP, 2021). Such initiatives as Feeding India or Robin Hood Army in developing countries, such as India use ICTs to a different extent, but many still use more basic ways of organizing volunteers or more basic ways of connecting with beneficiaries via social media. This online mediation reduces the role of human interaction, which boosts the sustainability and scalability of the food redistribution (Sanyal et al., 2021). As an example, food sharing between neighbors is done with the help of apps such as OLIO, and smart refrigerators with IoT devices will check the freshness of things and offer recipes, which will reduce waste at the household level directly (Colak, 2023). These online interventions promote the consumer interest by providing valuable information and resources, raising awareness, and promoting a behavioral change to minimize food waste (Adebisi et al., 2023). In addition, mobile applications such as Too Good to Go and Phenix allow obtaining real-time information about discounted foods that are nearing expiration of the food suppliers in the region, making it easier to optimize the redistribution process and reduce food waste (Hong et al., 2024). Similarly, FoodCloud and other cloud-based systems, enable focusing on the food suppliers in the region, connecting them with various charities to optimize the redistribution process and minimize the waste (Adebisi et al., 2023). The comparison of some digital solution available in developed countries is shown in table 1.

*Table 1: Comparison of Digital Solution Available in Developed Countries*

| Features | Too Good to Go | MealConnect | Olio | Food Rescue Hero |
|---|---|---|---|---|
| **Primary Purpose** | Connect surplus food donor to NGOs | Allow consumers to buy surplus at low cost | Enable locals to share food among neighbors | Allow voluntary food rescue and delivery |
| **Real-time Food Donation** | No | Yes | Yes | Yes |
| **Route Optimization** | No | Yes | No | Yes |
| **Volunteer Management System** | No | No | No | Yes |
| **GPs Tracking** | Yes | Yes | Yes | yes |

| User to User Interaction | Limited | Yes | Yes | Limited |
|---|---|---|---|---|
| Gamification | Yes (Eco-Impact & Reward Badges) | No | Yes (Social Sharing) | Yes (Volunteer Points) |
| In App Chat Option | No | No | Yes | No |
| Data Dashboard | No | Yes | No | Yes |
| Integration with NGOs | No | Yes | Limited | Yes |
| Mobile Accessibility | Yes | Yes | Yes | Yes |
| Community Engagement Focus | Yes | Limited | Yes | Yes |
| Consumer Focused | Yes | No | Yes | Yes |
| Free to Use | Yes | Yes | Yes | Yes |
| Key Limitation | Limited to Commercial Seller | Requires NGOs network for full operation | Depends on community participation | Needs strong volunteer and logistic setup |

Some of the important research questions identified are: What are the current challenges faced by food donors (both commercial and domestic) in donating surplus food in Pakistan? What logistical and operational issues arise when NGOs are collecting and distributing surplus food? How can a real-time mobile application solve coordination, scheduling, and food tracking problems in food donation? What features would make donors and riders more willing in using a digital donation platform? How can the platform facilitate food safety and transparency and donations and redistribution? What can a digital donation system do to minimize the amount of food wasted and hunger relief?

### 3. METHODOLOGY

The research is a mixed methods study that integrates the qualitative methodology and the quantitative methodology that will strive to answer the research questions in a holistic manner. This design is suitable in complicated social problems like food waste that needs a statistical perspective and a contextual perspective.

The qualitative research involves interviews to be conducted with the major stakeholders including the NGO managers, the food donors, and the logistic itinerants. User interview sample size is 30 users. Through these interviews one can unravel the hidden motives behind the working nature of the food donation processes, the hurdles of the processes and their working nature. Data collected will be analyzed through thematic analysis in order to identify recurring patterns and insights.

The quantitative research involves 2 surveys which collected data through Google form. One survey focused on donor and had total 50 participants. The participants of second survey were 10 NGOs such as Edhi Foundation, Food Saver, Rizq, Robin Hood Army, Hope Uplift Foundation, Muslim Hand, Saylani Welfare Trust, Global Alliance for Improved Nutrition, Ibn-e-Akram Welfare Foundation and Ehsaas as Pakistan has only 43 NGOs operating in the Hunger and Food Insecurity (Hunger, Food insecurity NGOs in Pakistan). The role of the surveys is to count the behavior, attitudes, and perceptions, regarding food waste and donation. and statistical analysis will be conducted to locate significant trends and correlations.



*Figure 3: Research Methodology Process Chart*

Jamovi version 2.7 was used to analyze the quantitative data of the NGO and Donor surveys(Jamovi, 2025). The data of NGOs survey was summarized using Descriptive Statistics, Frequency Tables, Histograms and Correlation Matric in order to identify the major patterns. The choice of these methods was due to understand the responses of the participants well without any complex statistical assumptions. For the donor survey data analysis, the Descriptive Statistics, Man-Whitney U and Reliability Analysis was performed. The qualitative data obtained after interviewing the NGOs and donors were based on thematic analysis, which was pursued after coding, categorization, and development of the themes, and identification of recurrent patterns concerning operational issues, communication gaps, expectations of platforms, as well as the feasibility of the proposed food redistribution system. Collectively, these quantitative and qualitative research gave a holistic view of what is currently being done and guided the design specifications of the developed digital platform.

## 4. RESULTS AND ANALYSIS

The thematic analysis was used to analyze the qualitative data obtained from NGOs and donors The analysis was performed manually through reading the responses in the interviews, coding of similar ideas and categorizing them into theme, sub themes and insights/observation. These themes indicate the actual issues, needs, and expectations of the participants concerning the food donation and redistribution. The tables below provide the main themes that came out during the analysis.

*Table 2: Thematic Analysis of Food Donor User Group*

| Theme | Sub-Themes | Insights / Observations |
|---|---|---|
| **Motivation to Donate** | Altruism, Community Impact | Donors felt they had a social responsibility and that they wanted to save food waste. |
| **Barriers to Donation** | Time constraints, coordination issues | Contacting NGOs and lack of structured time for pick-up was a major issue. |
| **Communication Gaps** | No follow-up, unclear response time | Donors usually do not have an idea on when the food may be picked up in time or how it is treated. |
| **Need for Convenience** | Ease of scheduling, transparency | Many sought for a straight forward system through which they could key in donations and request for confirmations. |
| **Tech-Readiness** | Different level of digital literacy | Both commercial and domestic donor suggested simple and easy to use interface |

*Table 3: Thematic Analysis of NGOs User Group*

| Theme | Sub-Themes | Insights / Observations |
|---|---|---|
| **Tracking & Documentation** | Manual logs, inconsistent records | Most NGOs do not have an utmost way of keeping track of donations or deliveries. |
| **Partnership Building** | Need for trust & transparency | Sustainable, and repeated partnerships with the donors are difficult to maintain without tech support. |
| **Technology Acceptance** | Willingness to adopt if simple & scalable | The founders liked the idea of digitally-driven solutions to enhance transparency and impact reporting related to food. |
| **Coordination Workload** | Juggling calls, manual tracking | Operators are under much stress when operating manually under constraints of time. |
| **Communication Barriers** | Gaps between donors and riders | Miscommunications cause delays/confusions in pickup/delivery. |
| **Scheduling Issues** | No systemized task assignment | Resource allocation tools that are real time are required for coordinators. |
| **Need for Digital Tools** | Simple UI, instant notifications | Operators need mobile tools to support the elimination of reliance on calls and logs. |
| **Reporting & Logs** | Difficulty in maintaining records | Poor data tracking results in accountability and transparency. |
| **Route Optimization** | Time management, fuel consumption | Riders have problems with route planning causing wastes of time. |
| **Scheduling Constraints** | Late pickups, inconsistent delivery windows | They are never conscious of the appropriate time to collect food from various donors. |
| **Safety & Clarity** | Incomplete addresses, lack of coordination | Riders get frustrated when the addresses are confusing or donors are unresponsive. |

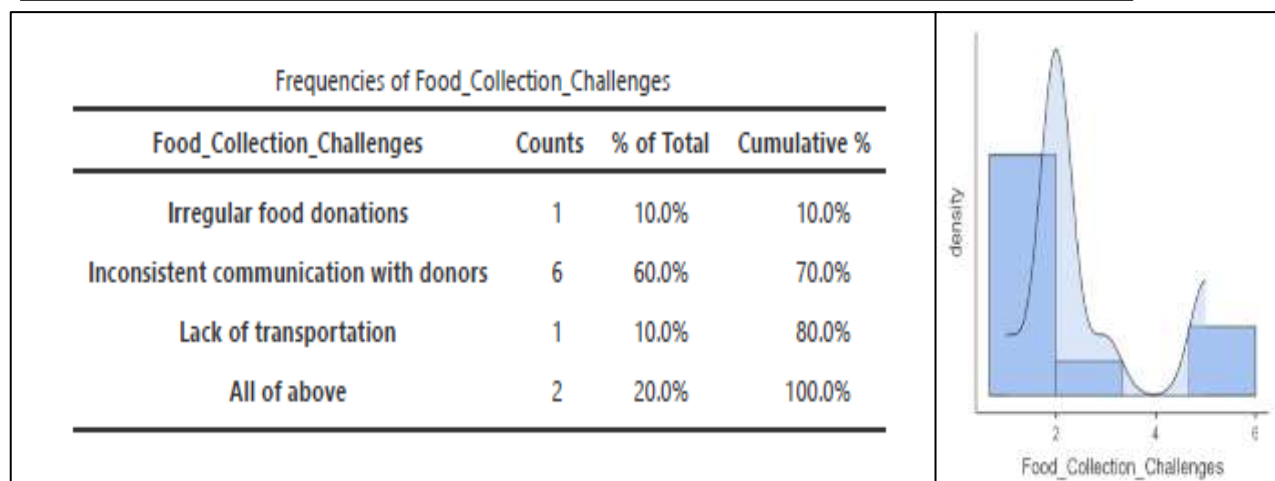| Real-Time Communication | Need for instant updates, tracking | They prefer live updates or push notifications so as not to have delays. |
|---|---|---|

### NGOs Data and Analysis

The descriptive statistics and frequency distributions were used to summarize the responses of the participants, whereas histograms gave a graphical image of the important variables. Correlation matrices were employed to establish some general trends in the datasets. The results were subject to interpretation because of sample sizes in a descriptive manner. The quantitative results are as shown in the following tables and figures.

*Table 4: Descriptive Statistics of NOGs Survey*

**Descriptives**

| | N | Missing | Mean | Median | SD | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| NGO_Working | 10 | 0 | 2.90 | 2.00 | 1.853 | 1 | 5 |
| Daily_Serving | 10 | 0 | 1.60 | 1.00 | 0.966 | 1 | 4 |
| Surplus_Food_Source | 10 | 0 | 3.10 | 3.50 | 1.524 | 1 | 5 |
| Surplus_Food_Collection | 10 | 0 | 2.10 | 2.00 | 0.876 | 1 | 3 |
| Surplus_Food_Collection_Time | 10 | 0 | 1.50 | 1.00 | 0.972 | 1 | 4 |
| Food_Collection_Challenges | 10 | 0 | 2.60 | 2.00 | 1.350 | 1 | 5 |
| Food_Distribution_Challenges | 10 | 0 | 2.70 | 2.50 | 1.252 | 1 | 4 |
| Food_Type | 10 | 0 | 2.60 | 3.00 | 1.430 | 1 | 4 |
| Food_Quantity | 10 | 0 | 1.40 | 1.00 | 0.699 | 1 | 3 |
| Digital_Platform_Interest | 10 | 0 | 1.20 | 1.00 | 0.632 | 1 | 3 |
| Platform_Feature | 10 | 0 | 3.80 | 4.00 | 0.632 | 2 | 4 |
| Wilingness | 10 | 0 | 1.40 | 1.00 | 0.843 | 1 | 3 |

The table 4 shows results of the descriptive statistics of the sample size of N=10 is mixed, but they give a significant level of consensus on the topic of digital intervention. The greatest mean measure was obtained on Platform_Feature (M = 3.80, SD = 0.632) which shows that the respondents highly supported the proposed feature set. On the other hand, the mean score was lowest on Digital_Platform_Interest (M = 1.20, SD = 0.632) and Willingness (M = 1.40, SD = 0.843), with the low standard deviations indicating a high degree of agreement that the organizations are very interested and willing to adopt a platform. Moreover, low means of Surplus_Food_Collection_Time (M = 1.50), Daily_Serving (M = 1.60), and the highest challenge means of Food_Distribution (M = 2.70) and Food_Collection (M = 2.60) show clearly that operations are performed on the daily basis, and the highest challenges are evidently logistics and coordination as the main pain points that the design solution should take into consideration.

*Table 4: Frequency Distribution of Variable Food Collection Challenges*

**Frequencies of Food_Collection_Challenges**

| Food_Collection_Challenges | Counts | % of Total | Cumulative % |
|---|---|---|---|
| Irregular food donations | 1 | 10.0% | 10.0% |
| Inconsistent communication with donors | 6 | 60.0% | 70.0% |
| Lack of transportation | 1 | 10.0% | 80.0% |
| All of above | 2 | 20.0% | 100.0% |

The frequency analysis of food collection related issues showed that Inconsistent communication with donors is the most significant pain point as it has been reported 60.0%. Inconsistent communication with donors (10.0%) and Lack of transportation (10.0%) were much less common. This information provides communication reliability as the most important area of intervention that the proposed design solution will address.

The table 6 shows the analysis of the sources of surplus food, it can be concluded that the major source is Factory Kitchen/Mess (30.0%), then Restaurants (20.0%), and Weddings/Events (20.0%). The smallest specific source (10.0%), is bakeries. This distribution indicates that the design solution would focus on engagement and integration tools based on high-volume commercial/institutional environments to maximize the food recovery effect, as well as allow the event-based and restaurant services significant contribution.

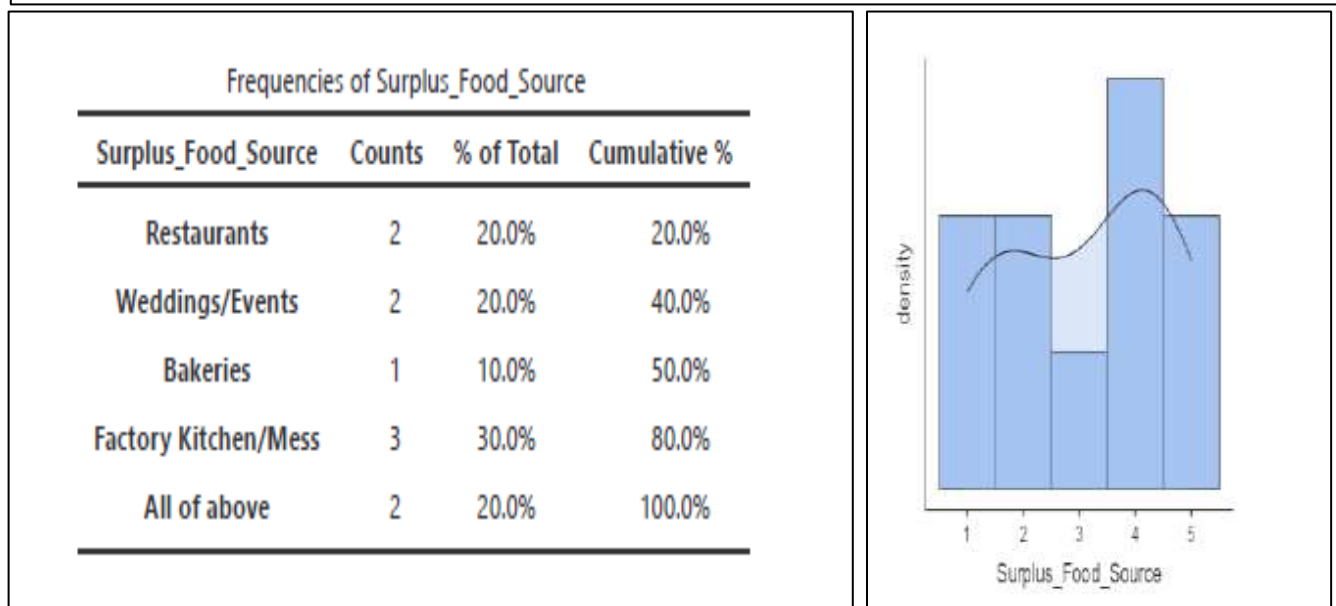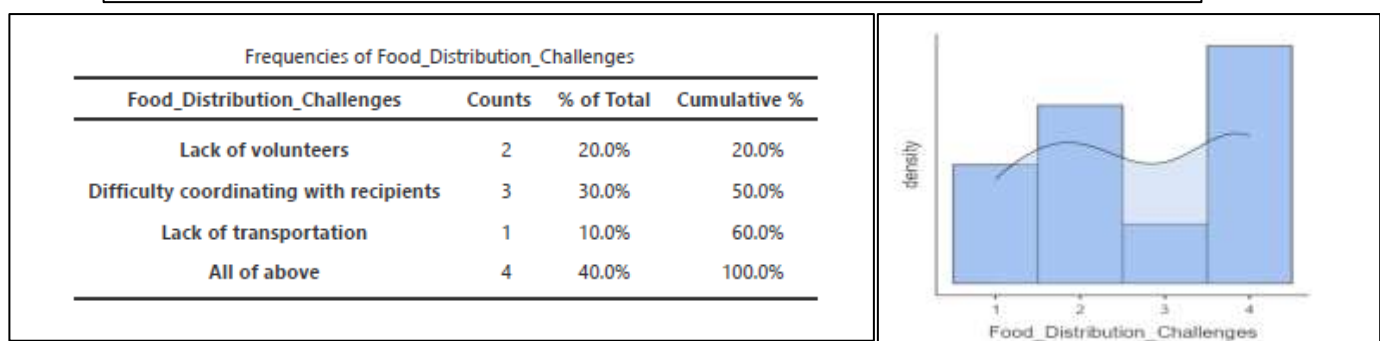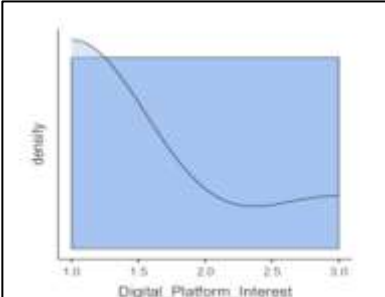**Table 6: Frequency Distribution of Variable Surplus Food Source**

Frequencies of Surplus_Food_Source

| Surplus_Food_Source | Counts | % of Total | Cumulative % |
|---|---|---|---|
| Restaurants | 2 | 20.0% | 20.0% |
| Weddings/Events | 2 | 20.0% | 40.0% |
| Bakeries | 1 | 10.0% | 50.0% |
| Factory Kitchen/Mess | 3 | 30.0% | 80.0% |
| All of above | 2 | 20.0% | 100.0% |



**Table 7: Frequency Distribution of Variable Food Distribution Challenges**

Frequencies of Food_Distribution_Challenges

| Food_Distribution_Challenges | Counts | % of Total | Cumulative % |
|---|---|---|---|
| Lack of volunteers | 2 | 20.0% | 20.0% |
| Difficulty coordinating with recipients | 3 | 30.0% | 50.0% |
| Lack of transportation | 1 | 10.0% | 60.0% |
| All of above | 4 | 40.0% | 100.0% |



The table 7 shows multi-faceted nature of the food distribution stage is represented by 40.0% of the respondents reporting All of above as their choice (Lack of volunteers, Difficulty coordinating with recipients, and Lack of transportation). The cited specific challenge that has been stated most often is Difficulty coordinating with recipients (30.0%), then lack of volunteers (20.0%). This complexity also calls a design solution, which can combine scheduling, volunteer management, and communication with the recipients into one and a unified platform to simplify logistics.

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**Table 8: Frequency Distribution of Variable Digital Platform Interest**

| Frequencies of Digital_Platform_Interest | | | |
|---|---|---|---|
| Digital_Platform_Interest | Counts | % of Total | Cumulative % |
| Yes | 9 | 90.0% | 90.0% |
| Maybe | 1 | 10.0% | 100.0% |



The table 8 shows level of interest in the digital solution is overwhelmingly positive with 90.0% of the respondents saying "*Yes*" to the development of a digital platform to manage such processes. Responses to the question of whether they are interested in the digital platform for food donation were 10.0% corroborating the response of maybe, and zero percent saying no. This high recommendation proves the need and acceptance by users to a centralized digital tool, and the additional investment and development of the proposed solution is justified.

The correlation analysis has given a good statistical justification of the proposed digital platform and its main feature set. The final rationale behind the app lies in the fact that the positive correlation between Digital Platform Interest and User Willingness ($r = 0.667$) is a highly significant one, which means that the app will allow to transform the

**Table 9: Correlation Matrix of NGOs Survey Dataset**

| Correlation Matrix | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Daily_Serving | Surplus_Food_Source | Surplus_Food_Collection | Food_Collection_Challenges | Food_Distribution_Challenges | Food_Quantity | Surplus_Food_Collection_Time | Willingness | NGO_Working | Digital_Platform_Interest | Platform_Feature | Food_Type |
| Daily_Serving | — | | | | | | | | | | | |
| Surplus_Food_Source | 0.298 | — | | | | | | | | | | |
| Surplus_Food_Collection | -0.202 | -0.528 | — | | | | | | | | | |
| Food_Collection_Challenges | 0.443 | -0.158 | -0.178 | — | | | | | | | | |
| Food_Distribution_Challenges | -0.011 | -0.289 | 0.401 | 0.011 | — | | | | | | | |
| Food_Quantity | -0.167 | 0.195 | -0.155 | -0.610 | -0.271 | — | | | | | | |
| Surplus_Food_Collection_Time | -0.167 | 0.195 | 0.095 | -0.343 | -0.130 | 0.625 | — | | | | | |
| Willingness | 0.050 | -0.222 | 0.553 | 0.148 | 0.320 | 0.161 | 0.645 | — | | | | |
| NGO_Working | 0.650 | 0.469 | -0.459 | 0.182 | -0.387 | 0.250 | 0.250 | -0.046 | — | | | |
| Digital_Platform_Interest | -0.266 | -0.474 | 0.369 | -0.131 | 0.365 | 0.438 | 0.438 | 0.667 | -0.438 | — | | |
| Platform_Feature | 0.266 | 0.474 | -0.369 | 0.131 | -0.365 | -0.438 | -0.438 | -0.667 | 0.438 | -1.000 | — | |
| Food_Type | -0.480 | -0.040 | 0.392 | -0.594 | 0.000 | 0.217 | -0.217 | -0.280 | -0.392 | 0.000 | 0.000 | — |

current user intent into increased participation. Moreover, there was a significant negative relationship between Food Collection Challenges and Food Quantity ($r = -0.610$); since the primary challenge is the lack of consistency in communication (60.0% of the responses), such an outcome predetermines the primary role of the app in ensuring the volume of food through the main means of the real-time system of communication and notification. Lastly, the positive correlation between Willingness and clear Scheduling ($r = 0.645$) and the approach to focusing on NGO features ($r = 0.650$) underpins the need in logistics features.

**Food Donor Data and Analysis**
Analysis of donor survey data was performed with the help of descriptive statistics to determine the base practices, then the Independent Samples T-Test (Mann-Whitney U) was applied to compare the non-parametric groups, and Reliability Analysis was done to prove the internal consistency of scales applied. The quantitative results are as shown in the following tables and figures.

*Table 10: Descriptive Statistics of Food Donor Survey*

| Descriptives | | | | | | | |
|---|---|---|---|---|---|---|---|
| | N | Missing | Mean | Median | SD | Minimum | Maximum |
| Donor Type | 50 | 0 | 1.40 | 1.00 | 0.495 | 1 | 2 |
| Edible Food Waste | 50 | 0 | 2.90 | 3.00 | 1.832 | 1 | 6 |
| Food Wastage Type | 50 | 0 | 1.80 | 2.00 | 0.756 | 1 | 3 |
| Current Practice | 50 | 0 | 2.40 | 2.00 | 1.125 | 1 | 4 |
| NGOs Collaboration | 50 | 0 | 1.90 | 2.00 | 0.303 | 1 | 2 |
| Digital Platform Consideration | 50 | 0 | 1.10 | 1.00 | 0.303 | 1 | 2 |
| Platform Feature | 50 | 0 | 2.60 | 2.50 | 1.578 | 1 | 5 |
| Food Donation Concerns | 50 | 0 | 3.10 | 3.00 | 1.233 | 1 | 5 |
| Digital Platform Usage | 50 | 0 | 1.50 | 1.00 | 0.814 | 1 | 3 |

Descriptive statistics have been specified in the table 10, to summarize the most important features of the donor survey data (N=50). This analysis was able to come up with important baseline measures based on the Median in order to have an accurate central tendency of the non-normally distributed data. The major results revealed low rate of engagement with existing networks, since the median score of NGOs Collaboration was low (Median= 2.00, SD =0.30), and this proves the fragmented nature of the current management practices. Most importantly, the Digital Platform Consideration median (Median= 1.00) is very low, which is one of the most important evidence that donors do not currently use digital platforms to donate, which in its turn allows establishing the clear gap in the market and the urgency to implement the offered solution. Although the median of Donation Concerns on Food (Median = 3.00) is moderate, which verifies the fact that a donor has an adequate amount of motivation to engage in an efficient solution.

*Table 11: Comparative Analysis of Commercial and Domestic Food Donors*

| Independent Samples T-Test | | Statistic | p |
|---|---|---|---|
| Edible Food Waste | Mann-Whitney U | 0 | <.001 |
| Food Wastage Type | Mann-Whitney U | 0 | <.001 |
| Current Practice | Mann-Whitney U | 150 | 0.001 |
| NGOs Collaboration | Mann-Whitney U | 250 | 0.059 |
| Digital Platform Consideration | Mann-Whitney U | 250 | 0.059 |
| Platform Feature | Mann-Whitney U | 188 | 0.021 |
| Food Donation Concerns | Mann-Whitney U | 250 | 0.302 |
| Digital Platform Usage | Mann-Whitney U | 288 | 0.768 |

Note. $H_a \; \mu_{Commercial} \neq \mu_{Domestic}$

The comparative analysis (table 11) was based on the Mann-Whitney U Test which is the right non-parametric test of the two independent donor segments when the data is non-normally distributed. The test showed statistically significant differences in the main metrics of operation, which prove the significant difference in Edible Food Waste ($p < 0.001$) and Digital Platform Consideration ($p > 0.001$), which can be empirically justified by the need to have a segmented platform and the high willingness in the target market. Importantly, a common high level of motivation was also validated by the test as there was no difference in importance of Food Donation Concerns ($p = 0.302$), which proves that it is the digital platform that works to address logistical friction and not moral intent.

Table 12: Reliability Analysis of food donor survey dataset

**Scale Reliability Statistics**

| | Cronbach's α |
|---|---|
| scale | 0.672 |

[3]

**Item Reliability Statistics**

| | If item dropped Cronbach's α |
|---|---|
| Edible Food Waste* | 0.459 |
| Food Wastage Type* | 0.625 |
| Current Practice | 0.615 |
| NGOs Collaboration | 0.671 |
| Digital Platform Consideration* | 0.666 |
| Platform Feature | 0.702 |
| Food Donation Concerns | 0.690 |
| Digital Platform Usage | 0.669 |
| Donor Type | 0.616 |

* reverse scaled item

The further analysis involved a critical analysis of the internal consistency of the survey tool, and statistical correlations of the significant variables. Reliability Analysis (Cronbach's alpha) (table 12) was firstly conducted to make sure that the scales were sound and in a consistent manner where they were intended to measure the desired concepts. At the same time, the Pearson Correlation heatmap (figure 4) was created to also support the internal correlation between the items and to measure the linear correlation between the crucial constructs. This correlation analysis showed a high-positive relationship between the Current Practice donors and their Digital Platform Consideration. The consistency of the variables helps to increase the reliability of the instrument and makes it possible to rely on the strong correlation as the high level of digital preparedness of the target audience is proved empirically and preconditions the high credibility of the platform's feasibility.
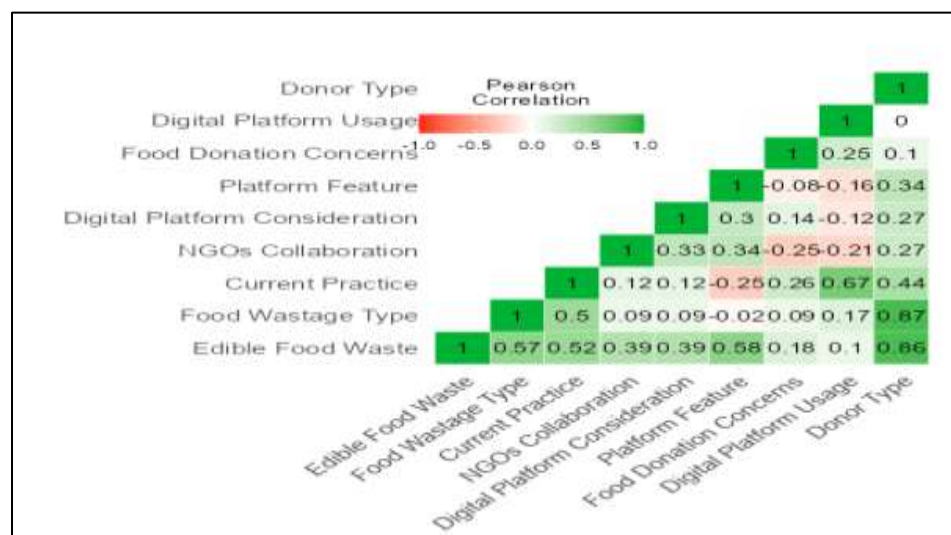


Figure 4: Pearson Correlation Heatmap

A comparison of the consideration of adopting a digital platform by NGOs and donors is shown in Figure 5. Both user group show the positive response such as 90% of NGOs and 88% of donors by choosing "Yes". However, a significantly smaller percentage of them expressed uncertainty, with 10 % of NGOs and 12 % of donors by choosing maybe. In general, the figure indicates that there is a high degree of willingness by both NGOs and donors to adopt a digital solution, which implies that the level of acceptance and feasibility of implementing a digital platform to regulate food donation processes are high.
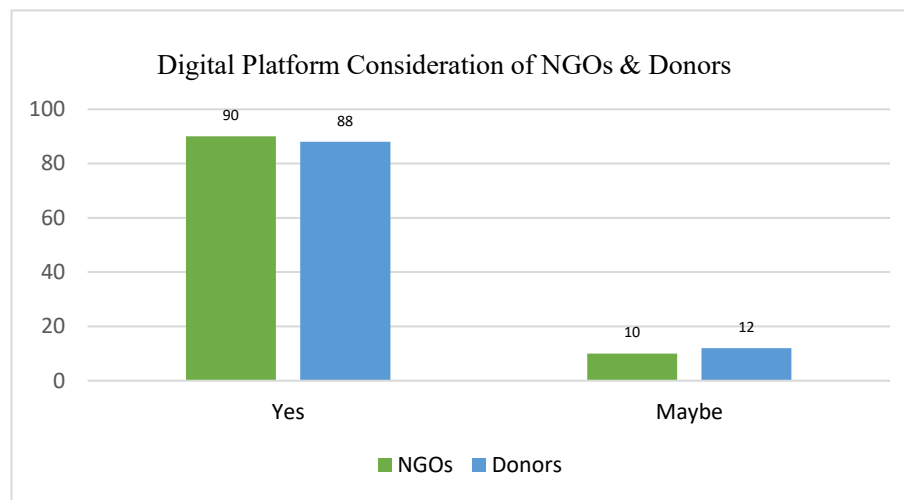
*Figure 4: Comparison of NGOs and Donor on the Digital Platform Consideration*

## 5. DISCUSSION AND IMPLEMENTATION

After thorough examination of the thematic analysis and survey analysis along with several sessions of brainstorming, the ultimate solution proposed ***Dast-e-Barkat*** was created. This was aimed at the development of an integrated, credible, and accessible system that would help to overcome the current communication and coordination gap between the donors, NGOs and the delivery riders. The information obtained during the research showed that a significant proportion of problems includes irregular food collections, ineffective communication, limited cooperation between donors and NGOs, and the lack of a systemic digital channel to coordinate excess food. Dast-e-Barkat directly addresses these problems. Dast-e-Barkat is a digital food redistribution ecosystem to be used in the current food donation environment in Pakistan. The platform will consist of a mobile application where donors can make donations, a dashboard where NGOs can access the donation process, and an integrated rider interface, which will provide a comprehensive experience in making the donation process simplified, more transparent, and build trust among the stakeholders. On the one hand, donors can effortlessly report excess food with a few taps, whereas on the other hand, NGOs can effectively handle their demands and allocate riders and check their deliveries in real-time. Some of the problems that are solved through the system include food wastage, miscommunication, late pickups, accountability. Through the integration of clear flow of information and actual updates, Dast-e-Barkat makes sure that the right food gets to the right time and place. The user experience and design process are made based on the principles of UX concerned with clarity, ease of use, and accessibility, and the solution is flexible to suit various types of donors, including restaurants and catering services to households and event halls. Dast-e-Barkat makes everyone stronger through the incorporation of organized digital processes and effective communication channels that eventually help the NGOs to feed underserved populations more effectively.

• The app allows quick food donation entry, which requires the donor to confirm the food type, the amount of food, pick up time and pick up location. The streamlined reporting system eliminates timidity and ease of making donations. This comes right out of the survey results that show that the donors are ready to donate but they are lacking a proper system on how to do that.

• The built-in scheduling system that will enable the donors to choose their favorite pickup time, and NGOs will be able to see the requests in real time and provide a rider with an assignment. This attribute is responding to the NGO criticism that there is no consistency in the time of food collection and the necessity of adequate coordination.

• Through the interface, riders are given pickup assignments, and maps and verification screens. The arrival of the riders can be observed by the donors, which will mitigate uncertainty and enhance accountability-which is a significant issue raised by donors during the survey.

• All the donation requests, types of food, locations and status of riders are provided to the NGOs in a clear view. This organized dashboard addresses the NGOs issues regarding manual coordination, disjointed communication, and pickups.

• Real-time messages ensure that donors, NGOs, and riders stay informed about each part of the process request processed, rider on way, collected food, and delivery done. This feature directly satisfies the requirement by NGOS to have real-time coordination.

• Each successful donation grants donor's points and badges, monthly highlights, and recognition. This helps a regular attendance and make the process of donation more fulfilling. It also fits the research wisdom that most of the donors get motivated once they feel that their contribution is being recognized. The same approach is used for the rider the factor multiplication system is used on each ride to help them financially and as they complete more assignments the factor will increase

• The system accommodates all the types of donors: domestic users, restaurants, catering, bakery owners and event organizers with slightly modified interfaces to suit each type. This was a necessary flexibility, given that various kinds of donors mentioned different pain points during the interview.

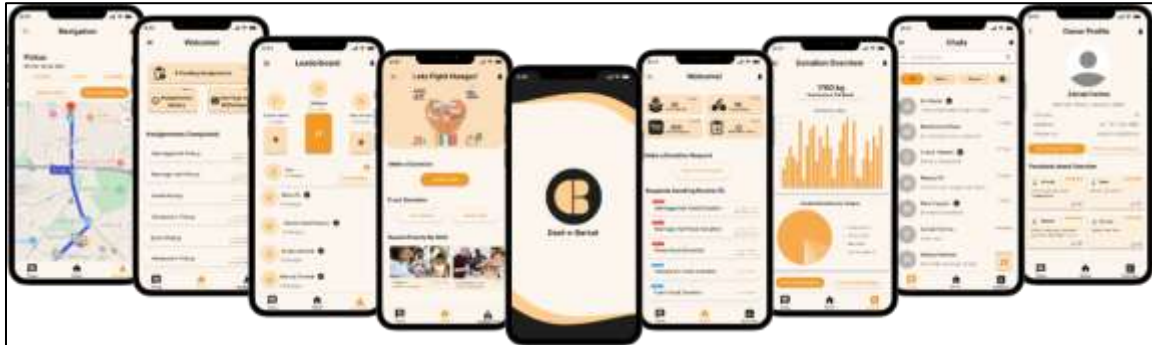The mockups and the user flow of Dast-e-Barkat is shown below:



*Figure 5: Mockups of Dast-e-Barkat*

## 6. CONCLUSION

The study has effectively worked on the critical issue of food insecurity and surplus food waste in Pakistan by establishing and asserting a user-based structure of the digital platform, Dast-e-Barkat. Results of the mixed-method analysis, which combined the in-depth interviews with the quantitative survey of donors, empirically validated the systemic operational problems, such as disconnected communication, lack of donor-NGO interaction and, crucially, the lack of reliable digital management tools. The Dast-e-Barkat platform, as the main contribution, is planned on the basis of these verified insights, which provides segmented and user-friendly workflows prioritizing transparency, accountability, and safety to unify the donation and distribution lifecycle. The whole study shows that this platform has a high potential of making a big difference in improving the efficiency of operations, minimizing edible food waste, and strategically empowering the food redistribution system in Pakistan by enhancing the technological solution with real-life user demands.

As Dast-e-Barkat moves beyond the theoretical construct towards a usable system a number of future considerations can inform its progress, scaling and overall effects. To begin with, the merging of AI-based capabilities, including intelligent food-NGO matching algorithms and predictive analytics might allow the company to increase the effectiveness of its operations, by predicting trends in donations and locations with greater demand. Also, it can be beneficial to add IoT tools such as temperature or freshness sensors to enhance food safety tracking when storing and transporting the item. To enhance additional transparency and accountability, the tracking of donation tracing end-to-end may be considered using blockchain. Geographic expansion beyond bigger cities will demand solutions to adapt to the situation, which could be offline mode, USSD/SMS access, or simplified low-data interfaces to cover areas with internet access issues. Legitimacy can be improved by institutional partnerships with government agencies, municipal authorities and CSR partners and legitimacy and reach can be widened and long-term financial sustainability supported. It will also be necessary to provide structured training programs to NGOs, donors and riders so that they can be adopted effectively and their operations remain similar. Last but not least, the ongoing user testing, evidence-based assessment, and redesign reviews should take the center-stage in the evolution of the platform to allow Dast-e-Barkat to keep in touch with user requirements and contextual issues in the food redistribution environment of Pakistan.

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**Annexure A: App Working and Design System**