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Conference Paper · January 2021

DOI: 10.1109/CCWC51732.2021.9375945

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SeVa: A Food Donation App for Smart Living

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***Abstract* – An important goal in our world today is to eliminate food waste by reutilizing available food sources within local communities: leftover food items in restaurants, stores and food distribution centers that may be approaching expiration; and any perishable items not used in entirety within their desired period. This is highly significant, particularly during crises such as the COVID-19 pandemic. This paper focuses on creating an interesting mobile application (app) called SeVa that provides a ubiquitous platform wherein users can visualize available food resources in their local area and consequently gain access to food, thereby tackling two major issues, i.e. hunger and food waste. This app is pertinent to the UN SDGs (United Nations Sustainable Development Goals) and fits the general realm of AI for Smart Living in Smart Cities. In addition to entailing IoT (Internet of Things) and ubiquitous computing, this work makes positive impacts on both healthcare and environment by reducing hunger and food waste respectively. We describe our SeVa app development using principles from AI, and especially HCI (Human Computer Interaction), along with its evaluation encompassing user surveys. We also list some open issues with the scope for future work.**

Keywords --- AI in Smart Cities; App Development; COVID-19; Food Waste Elimination; HCI; Healthcare; Hunger Alleviation; IoT; Smart Living; Ubiquitous Computing

I. INTRODUCTION

The year 2020 has been hit with challenging times due to the spread of COVID-19, i.e. the novel coronavirus infectious disease. In the midst of this global pandemic, the entire world population has been left to endure drastic consequences. With shortage of quantities in daily essentials such as disinfectant sprays, antiseptic wipes and hand sanitizers, along with lack of personal protective equipment (PPE) such as facemasks and respirators, another major issue has been food shortage! The immediate shutdown of public schools has impacted school children adversely since many of them depend on the free meals from schools daily. To overcome this problem, there have been food donation centers [1] distributing food as shown in Fig. 1. The COVID-19 pandemic has brought us into a new age operating businesses using a more AI-based virtual environment until daily operations resume as usual. Some businesses have taken this opportunity to enhance their AI-related platforms with new demographics. Several food vendors are learning from this newfound opportunity.

Given this background and challenges, we feel truly motivated to address the problem of food shortage affected by COVID-19. This is achieved via the development of a novel mobile application (app) called SeVa to help in food donation. The SeVa app is designed to act a middleman between the food supplier (vendor) and consumer. We create a knowledge base (KB) within the app for users to access, in order to communicate with each other. Both types of users (suppliers and consumers) can login and select the option that fits their profile to create an account. They can enter the information required to get the desired output. For example, if food suppliers intend to donate food through the SeVa app, they can enter the type of food they would donate, the quantity of the item(s), date of expiry, whether the items are perishable and so on. These are a few mandatory entries (for consumers to be aware of the food). There are parameters such as geographic and temporal ones to ensure freshness of the food upon delivery. Certain foods may have a short shelf life, thus we have distance and time constraints incorporated into the app, based on the addresses and times of availability. Principles from constraint satisfaction problems in AI are incorporated within the execution accordingly.

Fig. 1. Students getting food packets during COVID-19 school closures [1]

The app name *SeVa* is inspired by a Sanskrit word *"Seva"* which means "selfless service". This is an important practice in many South Asian cultures. It can be defined as "the act of compassion and care for others above oneself [2]." Fig. 2 depicts an example of selfless service related to food in places of worship, as surveyed by National Geographic [3]. While this has been practiced for ages, it is particularly apt today, since the COVID-19 crisis has affected many people due to food-related issues. We consider health and safety for all, placing the needs of others above our own, as embodied in this concept. Hence, we choose the name *SeVa* for our app.

There has been wastage of food since new regulations have been enforced on immediate shutdown of restaurants. Since customers have no longer been visiting the venues, plenty of food has probably been wasted. Some people have taken preemptive measures and turned it into an opportunity to serve essential workers. Many residents have bought gift cards from stores and restaurants to support local businesses. Our app is in the category of such efforts. While such food waste and hunger related issues are prominent during crises such as COVID-19, they are also significant otherwise. The United Nations (UN) has Sustainable Development Goals (SDGs) [4], among which some goals entail the following. *SDG1 - No Poverty, SDG2: Zero Hunger, SDG3: Good Health and Well Being, and SDG11: Sustainable Cities and Community.* Our SeVa app targets these goals.

The development of SeVa occurs using principles from AI and in particular, Human Computer Interaction (HCI). For example, we use Fitt's Law which relates location time of an object in an app to the object's size and other parameters [5].

Other relevant concepts deployed herein include metaphors, affordance, stakeholders, ethnographic studies, wireframes, constraint satisfaction and commonsense knowledge, as elaborated later in this paper.

Based on this overview, we explain design, development and evaluation of our SeVa app, currently in its prototype phase with a possible release on the roadmap after a few enhancements. This work contributes to AI in Smart Living, via ubiquitous access on mobile devices for sustainability; and through incorporation of AI-related principles in the app design. It thus makes a positive impact on AI in Smart Cities.

Fig. 2. Food-related service in India (National Geographic) [3]

II. RELATED WORK

A. Food Insecurity Problems and Smart Living Solutions

Food insecurity is known as the "limited and uncertain availability of nutritionally adequate and safe foods" [6]. In the year 2018, 1 in 9 Americans were food insecure, i.e. 37 million Americans; 11 million of them were children. Some factors that cause food insecurity are lack of resources, often related to poverty. Though not all households below poverty line experience this, the intersection of other issues such as health concerns, high rents and high household expenses often cause food insecurity [7]. The "No Kid Hungry" mission [8] indicates that "more than 11 million children in the United States live in food insecure homes". While this site conveys pre-COVID-19 information, the estimates are that 18 million children could face hunger post-COVID-19. Many of us feel a moral need to address this crisis. We believe that our SeVa app can take a small step here towards developing an efficient system to help reduce hunger and food waste.

In the United States, food waste is projected as at least 40% of the food supply [9]. This amounts to approximately $161 billion worth of food (as of 2010). It brings attention to other wasted resources such as time, money and labor costs to produce and transport foods that are unfortunately wasted. In 2015, USDA (United States Department of Agriculture) alongside Environmental Protection Agency (EPA) joined forces with a goal to cut the US food waste by 50% by 2030. A useful step to recover and recycle wasted food is to donate excess food that is healthy and safe. Secondly, a proper product handling supply chain with storage, labelling and transportation to maintain freshness from production to consumption can be developed. Food no longer edible can be reprocessed into animal feed, compost, bioenergy etc. [9].

Existing applications are making an effort to eliminate food waste and contribute to Smart Living [10]. For example, *Feedie* is an application that turns a customer's photo into donations. When the user takes a picture of a dish from a participating restaurant, that restaurant makes a donation to a non-profit organization known as the "Lunchbox Fund". This application is available in the United States and South Africa. For every set of 500 restaurants that joins the program, 5000 South African children get free meals for a year. Hence, this encourages social media users to share their craving for food while contributing to a noble cause. *Flashfood*, found in the US and Canada, is an application to solve the problem of food worth around $5000 being discarded. It helps to sell foods approaching expiration dates at a discount, so that low costs can guarantee quick buys. Thus, the produce is not wasted and can get to the consumer quicker without the worry of overspending on items. *Food for All* is another application, catering to Boston and NYC areas, with the aim of food waste elimination in the restaurant industry. This app connects restaurants to users for getting discounted meals that they can buy for their own consumption or donate to the needy [10].

B. AI and Smart Living in the COVID-19 Crisis

In the light of the COVID-19 health crisis, there is a call for global AI investigators to conduct more research on the coronavirus. Some institutes with the help of AI are providing real-time data. Machine learning algorithms are being used to enhance studying the virus' patterns and spread. AI is also helping in survival prediction of severe COVID-19 patients and in finding possible medication to combat the virus [11].

Since there is urgency to obtain coronavirus data in real-time, AI scientists are deploying methods to aid medical professionals, e.g. through a research challenge resource of 138,000+ articles on COVID-19 and related viruses, with 69,000+ being full text [12]. The English-Corpora website has a dedicated section for obtaining data on COVID-19, called "The Coronavirus Corpus" having articles of 370 million words and growing, with dialects from 20 countries [13]. It ranges from January 2020 to date and entails economic, social and cultural impacts of COVID-19.

Nations worldwide are displaying quick responses to get rid of the COVID-19 pandemic. BMJ Learning [14] is a website where doctors, nurses, medical students and other essential healthcare workers can gain access to free course materials to best approach and tackle the pandemic. It lists an array of courses on introduction to COVID-19, primary care during a pandemic, critical care of COVID patients and control of infection with personal protective equipment, alongside other courses [14]. In China, the government in collaboration with Alipay has created an application to allow its residents to pinpoint the fact that they have been in close contact with people who have tested positive for COVID-19. It has gained nationwide popularity with usage in over 200 cities [15]. Aarogya Setu from India, an app available in 11 languages, is one of the fastest growing applications, with 50 million users in 13 days [16]. The function of this app is to notify users when they are in close contact with someone who has COVID-19. This is done by the use of GPS tracking and Bluetooth with a social graph to track users. Such apps also offer instructions on self-quarantine procedures and actions to be taken if the user gets infected by the virus [16]. These apps contribute to Smart Living by making a positive impact on healthcare, providing quick and easy information on devices such as smartphones, and aiming to achieve a better

quality of life. Issues on such developments, e.g. anonymized phone location tracking, contact tracing apps are addressed by Klonowska et al. [17], mainly from an EU (European Union) perspective. Their claims apply to a global context.

Our SeVa app is in line with such apps. Yet it is somewhat novel in the sense of providing quite a different functionality to assist food donation through ubiquitous interactive display of relevant knowledge on food for suppliers and consumers. *Based on our literature search, there is nothing identical to SeVa in other apps, to the best of our knowledge.* The SeVa app targets COVID-19 food relief, in addition to addressing UN SDGs on hunger, poverty and healthcare [4]. This app aids Smart Living via HCI-based ubiquitous access to useful knowledge that positively impacts healthcare and environment by helping to reduce hunger and food waste. Smart Living is an important characteristic of Smart Cities [18]. This work thus spans AI in Smart Cities, analogous to other research [19, 20]. It is supplementary to our own work on app development in related areas [21, 22, 23] and thus builds upon our experience therein.

III. App Development: Design and Implementation

A. Design of the SeVa App

Fig. 3. HCI-Based App Design Steps

We explain the design of our SeVa app that deploys several principles from HCI [24]. An overview of our design appears in Fig. 3. A good interaction design must incorporate targeted users' needs and concerns [25]. Thus, our app design entails the following steps.

1. ***Stakeholder Identification:*** In HCI, *stakeholders* are "people or organizations who will be affected by the system and who have a direct or indirect influence on the system requirements" [24]. For example, in a food donation context, these can be restaurant employees and food shelter workers. In our SeVa app, we specifically identify stakeholders as: NGO (non-governmental organization) managers, café owners, grocery store owners and other similar occupations with a good demographics of age and ethnicity. Most of these are from the NJ-NY area, easily accessible to us for visits.

2. ***Social Interaction for Interface Design:*** During the interface design, we conduct interviews of the stakeholders with regard to their suggestions, ideas and opinions based on the potential usability of the app, e.g. entry fields in the app interface from a food consumer versus food supplier angle. We use these fields in the app layout. It is fascinating to note the motivation of the stakeholders for our SeVa app, inspired by their own desire for selfless service! We also conduct ethnographic studies. *Ethnography* in HCI refers to "social organization of activities to understand work, particularly in the design of collaborative systems" [24]. This entails direct observation, comprehension of rules and procedures, and illustration with workflow diagrams. During our visits to stakeholder sites, we perform these tasks and collect relevant ethnographic data, e.g. amounts of leftover food in a café, significant attributes of food such as perishability. We incorporate these aspects while creating our app layouts.

3. ***Conceptual Design Construction:*** This process typically involves outlining *wireframes* i.e. initial mockup designs to serve as blueprints for further work [25]. Thus, we make wireframes for the SeVa app based on our own creative ideas, various features suggested by stakeholders and data from our ethnographic studies. For example, our wireframe has fields "storage method" for the food supplier and "allergy / dietary restrictions" for food consumers based on our ethnographic studies since these are critical issues, especially in the United States. The wireframe has a simple outline with entry fields.

4. ***Design Evaluation by Stakeholders:*** This process in HCI leverages feedback from stakeholders on wireframes created in conceptual design. Typically app designs are subject to refinement based on assessment by stakeholders [25]. In our SeVa app design evaluation, we offer simple questionnaires to our stakeholders and have direct discussions with them to get their feedback on the wireframes. The final design of the app is revised using feedback given by the stakeholders while exploring the mockup design. An example of such feedback is the inclusion of icons. In HCI terms, these are addressed via the concept of a *metaphor* that can be defined as "a way of visualizing an operation, e.g. an icon of a shopping cart into which we place items we wish to purchase on an online shopping site" [24]. Likewise, we include a metaphor for the operation of SeVa (selfless service) on the welcome screen of the app and also add descriptive icons with the food supplier and consumer buttons for quick and easy comprehension. These are some outcomes of stakeholder feedback.

5. **Final App Design:** In HCI, the final app design is usually iterative [24]. It can proceed with just one iteration of design evaluation in a smaller context. In larger systems it can entail multiple iterations until stakeholders are satisfied (analogous to the spiral model of software development as opposed to the waterfall model). Given that our SeVa app is in its prototype phase, and also given that we target a small region and clientele for food donation catering mostly to stakeholders in NJ-NY, the final app design occurs in one iteration. This is also due to the fact that our stakeholders are very cooperative, giving satisfactory evaluations the first time.

The app design adheres to the HCI concept of *affordance*, i.e. "an attribute of an object that allows people to know how to use it" [24]. In other words, this implies making its function obvious through its appearance, e.g. "a cup handle affords holding" [24], since by looking at a cup it is obvious that we should use its handle for holding it. In AI terms, such aspects constitute commonsense knowledge (CSK) i.e. a simple, intuitive understanding of basic day-to-day concepts. We inadvertently deploy the AI paradigm of CSK in our app design by implementing the HCI principle of affordance. Therefore, we design the app screens in such a manner as to

make it obvious to people how to use the respective functions. Note that metaphors significantly help to enable affordance in the SeVa app design.

Another important HCI concept, namely, Fitt's Law [5] is used herewith. This states the following.

$T = k \log_2 (D/S + 1.0)$ where
T = time to move the pointer to an object
D=distance between the pointer and the object
S=size of the object
k is a constant of approximately 200ms/bit

This means that the time to locate an object is inversely proportional to the object's size and directly proportional to its distance from the starting point. Hence, by incorporating Fitt's Law, the various objects in our app (data entry fields, icons, buttons etc.) are designed such that: they are large enough for the user to spot, thus requiring less time to search; and close enough to the opening screen, thereby not requiring too much navigation.

This final design that takes into account Fitt's Law, affordance and other concepts, based on all the prior steps of the design process, is then used to implement the SeVa app.

B. App Implementation on Android Platform

The implementation of the SeVa app is conducted using the Android Platform [26]. The reasons for choosing Android are: (1) Android Studio provides various notable features that are highly creative and easy to use; and (2) we aim to release this app on the Android marketplace via Google (where releases are quite feasible for individual developers). Notable features of the Android Studio [26] are stated here.

Android Studio entails a fast and a rich emulator
It has a very flexible Gradle-based build system
It gives a unified environment for app development
It provides templates for code generation and easily integrates with GitHub
It offers extensive testing tools and frameworks
It has lint tools to catch performance, usability, version compatibility, and also other problems
It supports C++ and NDK (Native Development Kit)
It leverages built-in support for Google Cloud that facilitates integration of Google Cloud Messaging and the App Engine

The SeVa App implementation is portrayed in Fig. 4 which depicts its overall workflow. App layout and functionalities are coded using Android on the frontend and Java on the backend. These include login screens, user profile creation for suppliers and consumers, data entry for food items by suppliers, search functions for consumers, time and distance constraints for delivery etc. Note that suitable aspects of constraint satisfaction problems (CSP) in AI are deployed here in order to implement the constraints applicable to time and distance in order to help provide a seamless food delivery by connecting the appropriate suppliers with consumers, e.g. if a consumer is searching only within a 5 mile radius for available food items, then those suppliers with food item entries beyond that radius should not be shown to the given consumer. Similar constraints apply to the time of the search. At this point we have only implemented basic CSP concepts, i.e. we execute a simple backtracking search that avoids any constraint violation. We do not provide heuristics to search for satisfying all constraints with minimal complexity (such as most constraining variable, least constrained variable etc.) since the app design is fairly simple as of now and the suppliers and consumers are not anticipated to be very high in number. In other words, this constitutes "small data". We thus use SQLite [27] for persistence-capable storage of data inserted by users (suppliers and consumers) and for the knowledge extracted from that data. This forms the knowledge base (KB) of the app. SQLite is used here because it is freeware and open source. Since the SeVa prototype app has "small data" of the order of MB, SQLite is good for storage and retrieval needs. Also, our SeVa app is motivated by *selfless service*, devoid of external funding, thus it is feasible to use freeware: SQLite and Android Studio. The process for input-output execution in the SeVa app is shown in Algorithm 1 (for one instance of data entry and search).

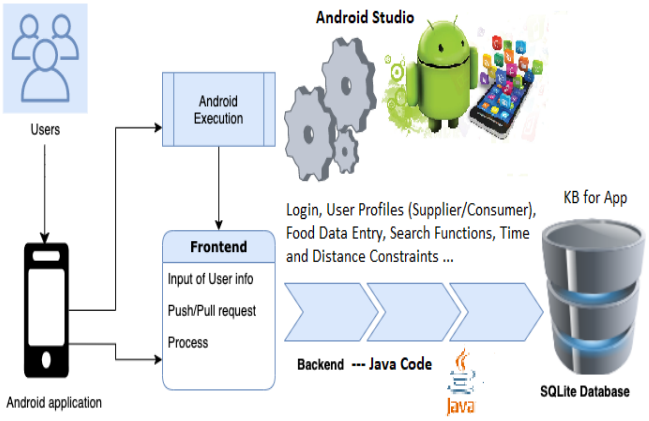

Fig. 4. Illustration of App Implementation

Algorithm 1: Input-Output Execution in the SeVa App

Input: Food data entry by supplier *S*
Output: Food data display to consumer *C*
D: Data on food, *i:* index for data, *f:* field in data, t: time, *d:* distance
Accept login (username, password) for S via Android frontend
Check login via Java backend
If *S.login* == invalid
    Report (Invalid username or password)
Else Begin Data Entry / shown for one instance only */*
    S enters *D[i]* via Android Frontend
    For all fields *D[i].f* ϵ *D[i]*
        Check constraints using CSP via Java Backend
        If constraint.violation == True
            Report (Error)
    Else add *D[i]* to SQLite *KB* via Java backend
End Data Entry
Accept login (username, password) for C via Android frontend
Check login via Java backend
If *C.login* == invalid
    Report (Invalid username or password)
Else Begin Data Search / shown for one instance only */*
    C searches *D for (t: t1 … tn, d: d1 … dm)* via Android frontend
    Apply constraints *(t, d)* using CSP via Java backend
    Execute query on *D* for *(t, d)* from SQLite *KB* via Java backend
    If *D[i] for (t, d)* exists
        Display *(D[i])* via Android frontend
    Else Display (No food items available)
End Data Search

IV. Evaluation And Discussion

A. Experimental Evaluation with Surveys

We conduct simple informal user surveys to test the effectiveness of the SeVa app. These surveys are provided to various users in order to assess the app in an objective as well

as subjective manner. The objective survey questions are stated here as follows.

Q1. Which state do you reside in?
Q2. What is your profession?
Q3. How useful do you find the SeVa App in general?
Q4. Do you feel the app is specifically helpful during and after COVID-19?
Q5. How good do you find the overall layout of the SeVa app?

Among these, Q3-Q5 use a Likert scale [24] for evaluation, popular in HCI. We offer the survey to over 50 participants and obtain 48 respondents. In response to Q1, we find that surveys are taken by people from 9 different states in the US, i.e. AZ, CA, MA, NC, NJ, NY, TX, VA and WA, implying that there is an interest in the app across wide residential demographics. For Q2, responses include occupations of: AI scientist, attorney, chef, computer engineer, CS professor, environmental engineer, food store owner, healthcare worker, IT professional, management professor, NGO volunteer, fashion industry employee, quality control manager, research scientist etc. We encounter over 10 different occupations here, indicating that this app arouses interests spanning a broad range of occupational demographics. Results of survey questions 3 to 5 are summarized in Figs. 5 to 7. It is quite fascinating to observe that people are so motivated to fill the surveys, and that they convey positive responses to all these questions, proving they are happy with the SeVa app.

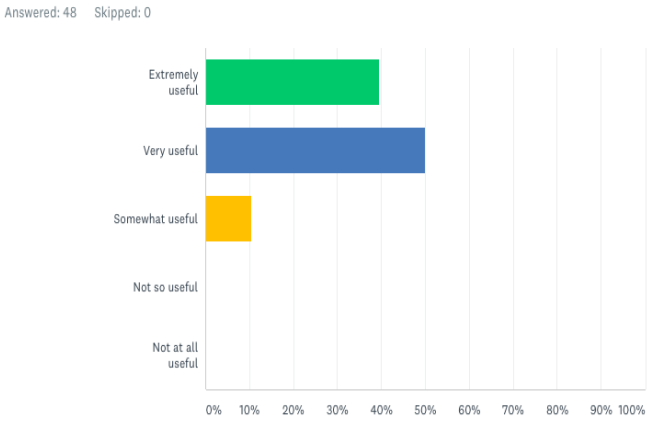

Fig. 5. Responses to Q3 based on the usefulness of the SeVa app

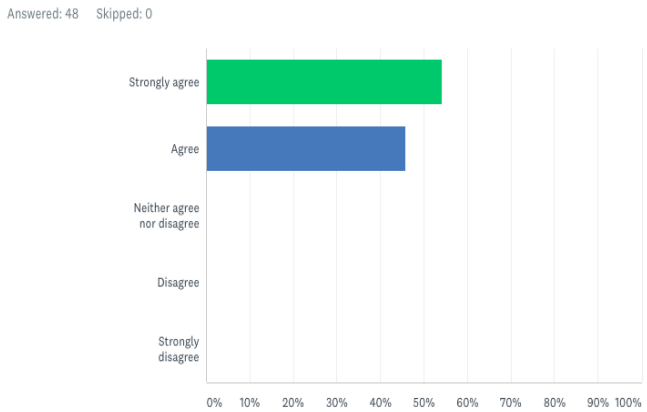

Fig. 6. Responses to Q4 based on helpfulness during and after COVID-19

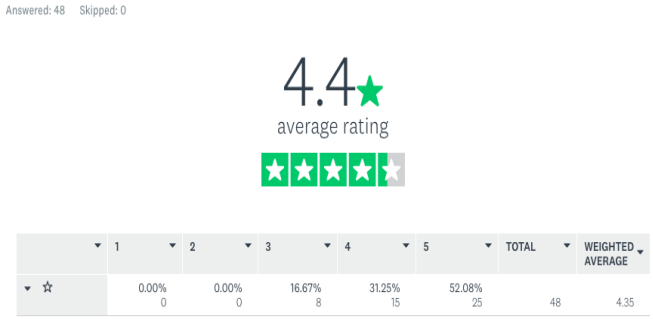

Fig. 7. Responses to Q5 based on the overall layout of the app

We also ask users to give verbal comments in the surveys in order to enable a subjective evaluation of the SeVa app. These comments are summarized herewith.

1. It looks really useful and important! I think this can be really good as a Proof of Concept to identify what the end-users will like to see in such an app.
2. I think the app is an amazing idea! I absolutely love it! :) My only comment is that when the app is launched, it should definitely be advertised! Sounds like a fantastic idea. I do know that a lot of restaurants throw out their food at the end of the day, so if they have this app, there will potentially be less food waste.
3. I think the app is great! Some ideas for improvements would be to add a location filter and group the suppliers based on the type of food they provide. For example, groceries, fast food, etc. Other than that, the idea is great and the app looks user-friendly!
4. The app will come in very handy this COVID season and beyond. I will just suggest that for entry into the app there can be some more of dropdown than users typing, as naïve users are more prone to making errors. Secondly, hints can be given for each field, e.g. date of expiry (mm/dd/yyyy). Great work!
5. This is a very good idea especially considering our current situation. Maybe add a bar code scanner function to further improve the user experience…
6. I feel this is a great concept and the prototype serves its purpose really very well. Release it soon!
7. I think that the "SeVa" app is conceptually a great idea, especially now during the times of COVID-19. Providing food to those in need is important and having an easily accessible, user-friendly app to do so is great :) In all, I think that as the app continues to grow throughout its development cycle, it will truly be useful in providing food to individuals, even past the effects of COVID.
8. I liked how simple the app was… I feel that it could help out many people. Great thought and work!
9. The app is a very good database submission and retrieval because it can be helpful for anything requiring book-keeping. I guess for the app to be better usable, a more interactive search functionality is needed. What is the exact use case in mind? There are two options: one is that an NGO uses it which makes it a standard software. Another is like an Uber for food donation. Nice work!
10. I think this easy access mobile app is a great common platform for both donors and the needy in this present COVID situation.

B. Discussion on App Evaluation

The objective and subjective evaluation of the prototype SeVa app convey a very good reception on the whole. It is clear that survey participants find this app useful, and feel that it is particularly helpful during COVID-19 pandemic and its aftermath. The verbal comments from the surveys are very encouraging since they reflect a positive initial response and the eagerness to see the eventual release of app. It is good that some participants also offer ideas for enhancement.

Based on these ideas and our own studies, some scope for further development potentially includes the following.

- Add enhanced graphics using metaphors from HCI, e.g. users should be able to point and click on pictures for commonly used food items instead of typing the names of the items
- Use more dropdown and autocorrect menu options to enable easier entry for various fields in the app
- Identify potential use cases and advertise the app in order to enhance its visibility
- Incorporate barcode scanners for easier access to food items wherever applicable

Such points would be beneficial in future work to increase the appeal of an updated version of the SeVa app. This would be good for its potential release.

Our roadmap entails the possible release of the SeVa app on the Android marketplace via Google, after enhancements and some work on publicity. We would highlight its positive impacts on the post-COVID phase and its overall contribution to UN SDGs as well as Smart Living for Smart Cities. While this is on our future roadmap, the prototype SeVa app at present is available on GitHub for download. Its link can be provided to some interested users upon request.

The work in this paper makes direct impacts on ubiquitous computing, app development and IoT along with broader impacts on Smart Cities and environmental management in line with other such research [28, 29, 30, 31, 32]. It entails aspects of AI, focusing specifically on HCI principles.

V. Conclusions and Future Work

This paper focuses on the design, implementation and evaluation of a simple prototype app called SeVa to assist food donation. The following are the highlights of our work.

- Proposing the SeVa food donation app in line with other useful apps such as FlashFood, Feedie and Food for All.
- Addressing the issues of hunger as well as food waste, thereby targeting the UN SDGs related to poverty, hunger, health etc.
- Impacting AI in Smart Living for Smart Cities via ubiquitous access on mobile devices to knowledge about food, essential for health and sustainability.
- Deploying concepts from AI and in particular HCI in the app design, accordingly implementing the app on the Android platform, and getting 48 user surveys with wide demographics and very good reception.

Future work entails the potential release of the SeVa app on the Android marketplace after a few enhancements based on the reception of the prototype. We anticipate that our work in this paper would be quite useful to app developers, NGO employees, HCI and IoT researchers, as well as professionals from AI in Smart Cities.

Acknowledgments

Dr. Aparna Varde's research is funded by Montclair State University. She is also funded by a grant from NSF MRI: Acquisition of a High-Performance GPU Cluster for Research and Education. Award Number 2018575.

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