Setting The Foundation for User-First Shared Space Reservation Systems: An Exploration and Analysis of User Experiences

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Reservable shared spaces are common rooms or areas that users occupy for set periods of time to carry out educational, recreational, and business activities. While these spaces are common within universities, offices, and other work environments, the reservation systems for these shared spaces remain relatively unstudied within HCI literature. To combat this, we present a user-first investigation interviewing and surveying users on their experiences with shared space reservation systems to learn more about how users use and reserve shared spaces. We then analyzed and synthesized our findings and key interview quotes in a Miro board to develop design considerations for developers around shared space systems. These design considerations fall under three core aspects of the systems: user interactions with a system, knowledge acquisition from a system, and aligning reservation system design with human behavior and cultural norms. With these design considerations, we hope to inspire developers to improve user experiences with shared space reservation systems and create more user-supportive shared space reservation systems within work environments.

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1 INTRODUCTION

Shared spaces are areas or rooms that can be temporarily reserved and occupied by users for set periods of time. These spaces are pervasive within public and private spaces, including areas such as campsites, park pavilions, and library rooms, as well as meeting rooms and conference rooms. Although previous HCI literature has studied shared spaces in the context of ubiquitous computing — analyzing and researching sensing and smart rooms — little work has been done to explore one of the main facets of shared spaces: shared space reservation systems. This leaves a gap within HCI research and suggests our current understanding of reservation systems may not be adequate for best serving users. As more and more companies and universities begin returning to campus, the need to understand shared space reservation systems becomes more and more important to help increase productivity and ensure users are utilizing these spaces to their maximum value. Furthermore, after experiencing and witnessing frustrations users experienced with current reservation systems, we were inspired to investigate these systems starting from the user.

Through our work, we seek to gain a deeper understanding of the reservation and utilization process of shared space reservation systems users engage in to help create more purposeful reservation systems. Our work aims to first develop a base understanding of why and how users engage with shared spaces and reservation systems to develop design considerations for these systems and encourage system designers to create informative and navigable systems that put the users' needs first. In specific, our work aims to answer the following research questions:

- Why do users make reservations for shared spaces?

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- What do users value in reservation systems?
- In what context do users make reservations?
- What problems exist within current shared space reservation systems?
- How can we design more purposeful reservation systems that put the user first and allow the user to utilize the system to explore all of their options in a comprehensive and understandable fashion?

To address these questions, we conducted semi-structured interviews with participants to establish a base understanding of users' experiences with reservation systems. To complement these interviews and our findings, we generated and conducted a crowd-sourced survey through Amazon Mechanical Turk to develop a deeper understanding of how users interact with shared space reservation systems. We then synthesized the findings from the semi-structured interviews with the survey findings to develop a set of recommendations for reservation systems developers. These recommendations serve to help developers create more accessible and user-friendly reservation systems and minimize the problems currently residing in shared space reservation systems.

At a high level, our design considerations address three core aspects of shared space systems. We introduce design considerations targeting user interaction with a system and how to improve workflow in reservation system interfaces. We also introduce design considerations for knowledge acquisition from a reservation system and discuss what knowledge of shared space users want and how to present this knowledge. Finally, we present design considerations to align reservation system design with human behavior and cultural norms.

2 RELATED WORKS

We now present some background information on previous works in three main areas related to our study: Scheduling and Reservations, Shared Spaces, and How Individuals Reserve and Use Rooms.

2.1 Scheduling and Reservations

Previous works have explored scheduling and collaboration in many ways, ranging from looking at how multiple users interact when scheduling activities to how we incorporate uncertainty into scheduling. As shared space scheduling tools innately serve multiple users, the activities and resulting use of these shared spaces do not only impact the immediate user and their reservation but also the schedules of others who also use these systems. Alarith Uhde et al. explore the multiple-person facet of scheduling, and Bradley D. Faust et al. performed a case study of room reservation within the Ball State University Library detailing that "scheduling and booking space is a problem facing many academic and public libraries." [5, 16]

Some of the main problems within the literature include difficulties around wasting energy, whether that be around searching for spaces that don't exist or wasting material energy use on spaces that aren't being utilized [9]. Jacob T. Biehl et al. and Magauwane R. Maepa et al. tackled and presented new solutions for saving energy searching for spaces by proposing new technologies that could help pinpoint user locations and highlight occupied rooms or seats [2, 8]. While these works highlight and show off the capabilities of these new technologies, HCI literature has yet to widely adopt the use of these technologies within shared space reservation systems. Furthermore, the overall idea of spatio-temporal scheduling and how digital reservations can implement considerations for physical spaces and travel time has only been explored in a couple of papers to date, which mainly focus on the navigation and scheduling for one user between multiple physical locations [3].

Supporting user preferences and constraints within a scheduling system is another large factor for building effective reservation systems, which multiple papers have attempted to tackle. Juho Kim et al. provided a look at the conferencing tool Cobi and how to build a scheduling tool that takes into account preferences, constraints, and affinity data to help users make changes to a conference schedule while retaining the ability to visualize those conflicts and preferences[6]. Ryan David Bowler et al. tackled the idea of incorporating uncertainty into schedules proposing the idea of "haziness" where users can provide more complex responses than just "yes, no, or maybe"[4]. The ability to provide these more complex responses was argued to be especially important when it came to privacy concerns, as users sometimes do not feel comfortable sharing their full schedule with other individuals. In addition to taking into account uncertainty, Jaime Teevan et al. argued for the ability to quickly and easily identify changes within a system to make sure users are aware of what changes happen within frequently visited sites[15]. These considerations and technologies all explore ideas behind scheduling and how we could build better schedules overall, but none of them focus specifically on shared spaces and rooms.

2.2 Shared Spaces

Some attention has been focused on scheduling and reserving shared spaces within other works but not on the reservation systems themselves. Peter G. Scupelli et al. focus on how hospitals and busy areas that see a lot of traffic can be scheduled and represented physically and virtually for users to engage with and understand schedules as a whole[14]. They discuss ideas behind conveying information on scheduling busy shared public spaces that are constantly changing and being updated, while also bringing up questions on how to make rapidly changing schedules easily available to users within public spaces. Nadine von Frankenberg also focuses on exploring conflict resolutions within shared spaces, and how groups of users can work together with a system to resolve conflicts[17]. This is especially important within shared spaces as many users often need spaces during peak "busy" hours resulting in conflicts that need to somehow be resolved. These systems, however, can be challenging to use, and Sandjar Kozubaev et al. explore how many shared spaces can be used by anyone within the public, making it essential for librarians and other administrators to be experts in using these digital systems [7]. Sandjar Kozubaev et al. heavily push for these systems to prioritize the user, putting forth the idea that we need to fully understand how individuals reserve and use rooms if we want to build systems that put the user first, especially since these shared spaces can be extremely important to some of the most vulnerable members of communities.

2.3 How Individuals Reserve and Use Rooms

While speculating about how users themselves use shared space scheduling systems may provide some insights, digging deeper into what factors influence users and how they actually utilize shared spaces is essential for building effective shared space reservation systems. Joshua C. Manzano et al. found that time, day, human relations, proximity, course priority, and workload can heavily influence scheduling preferences for students on a college campus [10]. Sleep was also found to be an important variable of interest when studying college students and their study techniques by Gloria Mark et al. [12]. College students were also found to have a high positive correlation between stress and multitasking which may provide an avenue where study rooms and other common shared spaces can provide a safe haven for students to focus on one task and eliminate stress from their lives [11].

User preferences were also explored within various papers with Shameem Ahmed et al. highlighting how visualizations can give deeper insights to autistic users for personal informatics [1]. This finding raises a question as to whether or not visualizations can be important and helpful for all users within other aspects of life, such as shared space

reservation systems. Preferences and scheduling are also highly personal, with individuals sometimes employing certain tactics and behaviors for their own benefit. James Zou et al. found that users sometimes push for more convenient times within group polling systems to try and reach a consensus faster, while others will behave more selfishly [18]. Similarly, Katharina Reinecke et al. found that cultural differences in how users structure their days changed how they viewed scheduling systems, with some users maximizing their personal benefit while others accidentally spread misinformation to try and benefit the entire group [13]. To gain an even deeper insight into how users interact with shared spaces and reservation systems, we felt it was necessary to carry out our own study, which started from users and explored their perspective.

3 METHODS

3.1 Methodology Motivation

In order to explore users' perspectives and how/why they reserve shared spaces, we first engaged in an interview study which could help us gain responses to many open-ended questions. Since personal experiences and details about the various reasons for reserving a space can be very personal, we decided semi-structured interviews were well suited for explaining users' perspectives due to their flexibility in follow-up questions and conversations. They also provided us with the ability to dig deeper into motivations, contexts, and thought processes which were critical for answering our research questions and finding out more about the "why" and "how" questions we had surrounding reservation systems.

To gain a more comprehensive picture of users and how they use shared space reservation systems, we extended our study to a questionnaire study to try and understand why individuals reserve rooms, what individuals value in shared spaces, and what problems users have faced when using shared space reservation systems. The questionnaire study took advantage of the ability to gain quick answers to simple questions, allowing us to establish a baseline for user experiences with shared space reservation systems. Using this data collection methodology allowed us to complement our findings from our interviews to see if the responses we gathered there were more broadly applicable to user experiences.

We then conducted a thematic analysis of the interview results after they had all been transcribed. Due to the limited time to conduct the analysis, we performed the analysis on key quotes from the interviews rather than qualitatively coded results. Thematic analysis was done independently by each of the three researchers, and then each of the results was reviewed by the team. We discussed which thematic analysis felt the most accurate and meaningful to draw from. We then suggested edits to refine it and ideated design considerations, as described in the discussion.

3.2 Participants

Interview participants (N = 6) were recruited using convenience sampling, with each of the three student researchers recruiting 2 participants. For the crowd-sourced questionnaire study, participants were recruited on Prolific, with the only screening requirement being fluency in English. Four participants (N = 4) were recruited for the pilot study, and sixteen participants (N = 16) were recruited for the final survey.

3.3 Method Specifics

Three researchers trained in classical HCI methods conducted 2 semi-structured interviews each. Interviews were 30 minutes to 1 hour long. 4 interviews were conducted remotely via Zoom, and 2 interviews were conducted in person. The research team conducted a total of 6 interviews with 6 different participants. Interviews were audio recorded and

transcribed via Otter.ai. Each interview had an additional member of the research team sit in and observe the interview, taking notes. After each interview was conducted, the research team met to discuss and synthesize key findings from the interviews.

With the findings from our interviews, we created a survey questionnaire and conducted a crowd-sourced survey on Prolific to better understand why, how, and when people reserve shared spaces. Four pilot participants were first recruited to establish our survey and discover any possible faults in our survey. Following the pilot, the survey was revised and conducted with 17 participants. The survey was composed of 14 total questions, which consisted of multiple choice questions with a fill-in other option, Likert scale questions, and short-response questions. Questions addressed topics such as the frequency in which shared spaces were reserved, how shared spaces were reserved, how the space was found, as well as if the space they reserved failed to meet their expectations.

Respondents completed the survey with a median time of 2:44 minutes and were compensated $1.00 USD each for completing the survey. According to Prolific, our hourly wage ended up being around $21.96 USD per hour (for a median time of 2:44), a higher amount than average because we determined that people deserve a living wage. Demographic data was collected from the participants as part of Prolific's available data.

201 key quotes were obtained from interview transcripts processed through Otter.ai and were analyzed by each team member separately using a Miro board. The results of the analysis were then discussed. Following the discussion, a short thematic analysis was done to create design suggestions for shared space reservation systems based on the information and themes we discovered during our analyses and discussion.

4 INTERVIEW RESULTS

Our thematic analysis of the interviews yielded seven themes across 201 interview quotes. These themes are (1) current reservation systems lead to wasted time and fail to support users who are stressed, (2) systems lack or obfuscate important information about spaces, (3) users consider a wide range of factors when reserving a room, (4) rooms have nuanced features which add or detract from their value, (5) people use shared spaces for individual and group productivity, (6) shared spaces come with shared problems, and (7) it is difficult for users to know what information will be readily available. Five of our interview participants were users of reservation systems, and one was an employee of a library at a local university who helped patrons reserve spaces.

4.1 Current reservation systems lead to wasted time and fail to support users who are stressed

The current state of many of the reservation systems our participants encountered was confusing or dysfunctional. This was because systems had confusing, difficult to navigate interfaces, tedious policies, or technical issues. Participant P2 described their experience using a system that was, in effect, a "giant list" of days and rooms. During our interview with P2, they opted to show us the reservation system that they used to reserve group meetings. This system opened to a page listing all rooms regardless of availability for a week at a time. This meant that they had to scroll through the entire list for an entire week in order to find an appropriate reservation.

Interface designs, such as the one seen in figure 1, led to problems that were challenging for users to overcome on their own, especially when they were in a stressed state. Participant P1, who worked at a university library and helped students navigate these systems as part of their job, said,

> "Usually when people come to the desk, they're needing help immediately because they've gotten to that point that they can't figure it out on their own, or there's a time crunch. And so usually, you can

kind of tell what's going on with the student. And so giving them a sheet of paper and telling them to go figure it out isn't very helpful. And they probably won't figure it out. And we'll just be frustrated."

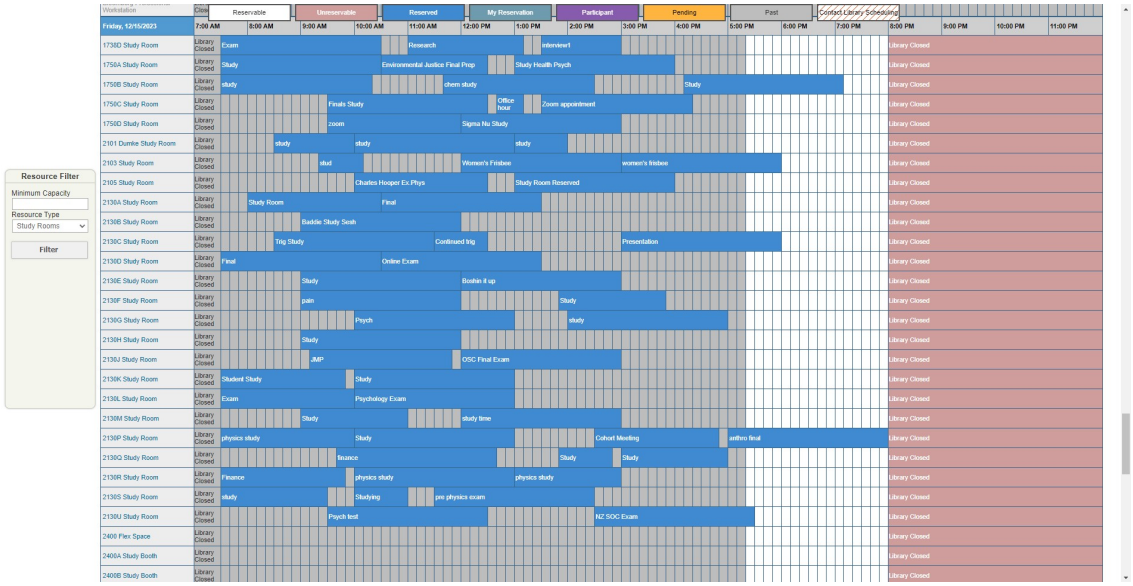

Fig. 1. A screenshot of the reservation system used by the University of Utah's Marriott Library. Note how far down the page the user has to scroll to be able to view availability for Friday.

Participants also reported that systems had policies that created tedious workflows. P6, for instance, reported that despite having already reserved a room at their place of work, when front desk staff would put meetings on their schedule, it was not tied to the room they had reserved for that purpose, "so we have to go in later and assign a room." There were also issues for those who had regular or longer meetings. P2 described difficulty with reserving spaces at their university library for long enough periods of time. They would meet with a team every week for six hours but explained that "the library only lets you reserve for three hours at a time. So one team member has to go and reserve the first three hours, and then someone else has to go in and reserve the second half of it." They were also only able to book these meetings, at most, two weeks in advance.

Participants also reported technical issues when using reservation systems. These issues included information not showing up in the system despite being input, features such as view changes not working, different form factors or browsers not being supported, and even reservations being erased. For instance, P1 reported that "they function differently on different web browsers or different devices. So if I'm having trouble, I'm like, Okay, well, now I have to switch to a different device." Yet, P6 reported experiencing an issue that created a significant amount of work for them throughout the week leading up to their reservation and described significant behavior changes to cope with the issue. "there's a different type of scheduling that happens with specific types of appointments over the phone where people sign up online. And then when they sign up online, it like erases our room reservation even though we had a room reservation at that time." As a result, they felt it was necessary to check if their reservation still existed multiple times leading up to the reservation, beginning up to a week in advance.

4.2 Systems lack or obfuscate important information about spaces

Information such as where or what a space was, room availability, and how to find a space was not always clear to participants. Participants described systems that did not adequately describe spaces, potentially providing no description whatsoever. At times, information was as little as a time and a room number. However, this information was at times difficult to obtain, such as one system described by P3 where "there's no way to see the reservation unless you go to the actual room." While some systems provided users with diagrams or maps, others failed to provide participants with adequate information to find the space they had reserved. As a result, some participants described wandering around until they found the space. Yet, P1 reported that the information about a space may not be accurate upon arrival, "like I booked, like picnic tables or things like that, where the trash can or the bathrooms weren't close by. Or it said that there was a trashcan there, and it wasn't there." This led to participants having feelings about reservation systems similar to P3, that "booking can be kind of a frustrating experience."

4.3 Users consider a wide range of factors when reserving a room

Participants considered factors ranging from when the room is available, including if they will be working alone or with others, pictures or diagrams of a space, uncertainty in how long they will need the space, if there is a feeling of scarcity about space availability, and if they have any prior knowledge about the space. At the forefront of participants' minds when reserving a space was what spaces were available and when. Some participants would pull up a map of the area so they knew exactly where the space they were considering reserving was alongside the time–though for some, this required the use of a secondary system. There was also consideration for how many people would be in a space. Participants didn't want to take a larger space than necessary. As described by P3, they would "[optimize] for the amount of people in the meeting and the size of the room." To aid in this decision-making, participants appreciated when visuals were provided to support their understanding of a space. The use of visuals was reported as useful both as pictures or diagrams of the space itself, and as a way to convey space availability. In addition to these kinds of aids, participants reported that prior experience with a space helped them to know if it would be appropriate for their needs.

Scarcity of both space availability and especially time was an important consideration among participants. Some participants described feeling worried that they wouldn't be able to find a space if they didn't reserve it well ahead of time. Four of our participants had experiences of there not being enough spaces available to reserve and potentially feeling pressure to reserve well ahead of time. For instance, P2 described a time when "we forgot to reserve that space for a [meeting]. By the time you remember, there are no spaces available." Time uncertainty was described as an important consideration by all of our participants. Participants described adding time to both the beginning and end of when they were certain they would need it. As described by P1, "Sometimes things go longer than I planned. Sometimes I like, I like to get places a bit early before things are set so I can set up and do things."

4.4 Rooms have nuanced features which add or detract from their value

The features participants required were diverse and nuanced. This is demonstrated by P6, who is a therapist, describing their needs, which included

> "Because of confidentiality reasons… I would hope for a space with walls that are thick enough that you can hear other people or it's insulated well enough [from sound]... has dimmable lighting and has appropriate furniture for therapy. So comfortable seating for two individuals."

This is a very different level of needs from those reported by P5, who runs board meetings for a nonprofit. They said,

> "Sometimes there's someone finishing up a zoom call off in the… farmstand portion of the [building]. You, if it's totally silent, you could hear, you know, you could hear some brief, some faint mumbles through the wall, but certainly not enough to be distracting. There's no air conditioning in the space. So in the summer, we often have the front and back doors open."

Four participants described a desire for features that supported social aspects or collaboration, such as the seating capacity of a space, Zoom integration, whiteboards, and large tables. Internet access was an important consideration for participants who had others joining them remotely, or for looking up information during a meeting. Participants also looked for features such as the type of writing surface that was available, such as a standing desk or a whiteboard.

A more surprising finding was how common environmental factors such as lighting, noise, and visual isolation came up in interviews. Yet participants reported that the reservation systems they used did not tend to include this kind of information. This turned it into a bit of a guessing game where participants like P2 relied on assumptions, "I was looking for something that was in a quieter space. Okay. So I just assumed the first floor is quieter than the second and third. So I planned for the first floor."

4.5 People use shared spaces for individual and group productivity

Participants were motivated to reserve spaces because they were more productive in these spaces. Reserved spaces were found to be a productivity benefit to both individuals and groups. P4 said that when "studying at home, I often find myself getting distracted." This motivation is increased for participants who are feeling stressed, as described by P3, "I would choose to reserve when I felt the desire to or the pressure to be more focused and be more productive."

4.6 Shared spaces come with shared problems

Two participants described issues with rooms being clean and having everything that is expected when they arrive at their reserved space. For instance, P3 said, "if the room is in like a poor condition. Dirty or like missing some things you'd expect, like, say you book a room for four people, but there's only like two chairs, or there's a lot of like trash leftover all over the room, stuff like that can up or down the quality of it." P5 described similar issues, but they also said there were social norms that helped abate this issue. Yet, P5 nonetheless tried to arrive at the space early to clean it if necessary.

We also found that it was an issue for three participants that they would find people using the space they had reserved when they arrived. This led to awkward social interactions where the participant had to ask the other party to leave. Describing this problem, P1 said, "it's kind of hard when you don't have like very clear signage or designation."

4.7 It is difficult for users to know what information will be readily available

We found that reservation systems used by our users did not always convey information appropriately nor make it easy for reservation staff to work with. Sometimes, the reservation systems revealed personal information that the participants would rather be kept hidden, such as their name and contact information. The reservation system that P2 used required them to input their name, email, and phone number in order to reserve a space. Then, it would reveal this information to any other user of the system who hovered over the reservation, which P2 said they "don't want the entire university to know."

For reservation system employees, however, it can be important to know this information. P1 described circumstances where they or their colleagues would need to be in contact with law enforcement because events that reservation

users were holding would result in protests. In circumstances such as this, they need information so that "if there's any question on how they booked it, we can say there was no special treatment." Additionally, P1 reported that there were security issues that arose with reservations

> "Because sometimes students will be joking when they're booking stuff, right? It's midterms. They're stressed out. And when they're booking it, it'll ask what's the use, and people will put like, 'kill myself.' And we have to contact them, and we have to contact the, like, the university, and it's like, a big whole thing."

It was also unclear to some participants if their reservation had been successful. Sometimes participants thought that a reservation had been made, but then users had an experience such as P3 where they would "show up at the library and be like, where's my room?" Furthermore, P6 had issues where the reservation system they had would sometimes erase a reservation, as described in section 4.1, but there was no notification given to them that the reservation had been canceled. Instead, they said that they "only knew because of retrospectively finding out that there wasn't the room reserved anymore."

5 QUESTIONNAIRE RESULTS

Below are the results from our Prolific Questionnaire. We found that the frequency of reserving spaces varies. Reserving spaces over the phone remains common, with 87.5% of reservations made the month of or sooner. Leisure and personal activities constitute half of the shared space activities, and 81.25% of these spaces are reserved for multiple people. Respondents express confidence in shared space amenities, although the sources of their confidence vary. Finding a shared space relies on maps, directions beforehand, logical room structure, or past experience.

5.1 The frequency with which people reserve spaces varies

Our survey showed that 25% of respondents rarely reserve shared spaces, 25% of respondents reserve a space once a year, 31.25% of respondents reserve a space every month, and 12.5% of respondents reserve weekly. This seems to suggest that shared space reservations aren't as common as we thought but vary from person to person.

5.2 87.5% of reservations are made the month of or sooner

We found that most respondents reserved their space within the month they needed it, with 12.5% reserving the space right when they needed it. This indicates that most reservations are typically made a month before or less. From our findings from the interviews, we saw that pressures leading to reserving spaces beforehand are due to scarcity or competition for shared space. Furthermore, we found that 62.5% of all reservations are made with less than a week's notice, indicating that users are making and using their reservations in quick succession. The full distribution of responses can be seen in figure 2.

5.3 Leisure and personal activities made up half the activities done in a shared space

The results from our survey showed that 50% of respondents reserved shared spaces for personal activities, while the remaining participants reserved shared spaces for work or school-related activities. Our interviews were counter to this as interview participants mostly talked about using shared spaces for work or school and rarely brought up reserving spaces for personal activities.

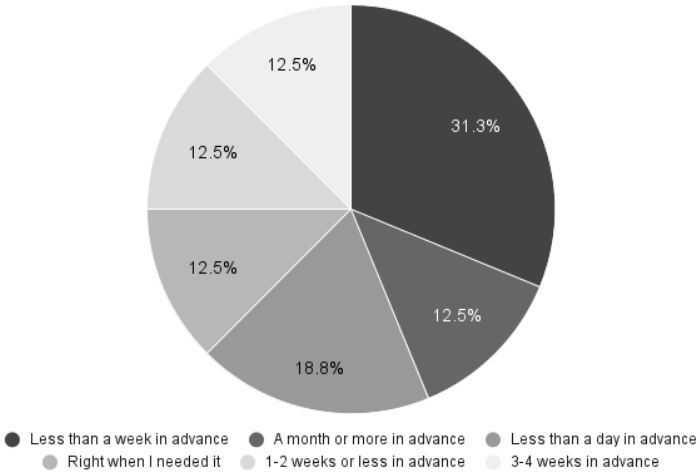

Fig. 2. How survey respondents answered the question, "How long before needing the space did you make the reservation?"

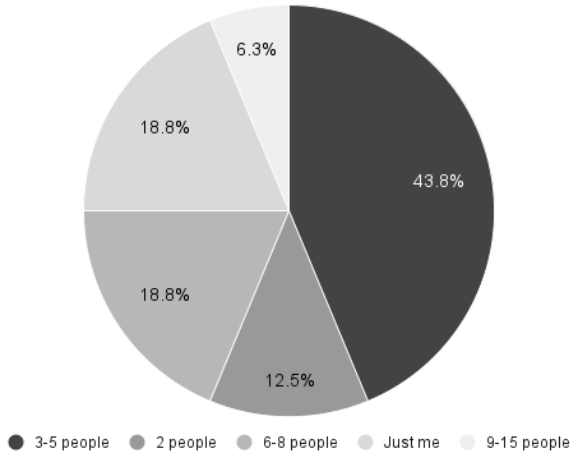

Fig. 3. How survey respondents answered the question, "How many people did you reserve the space for?"

5.4 81.25% of shared space reservations are for multiple people

As seen in figure 3, our survey found that shared spaces were mostly reserved for group activities, though a small portion (n=3) was reserved for individual activities. Personal activities such as camping, parties, and recreation make up 50% of participants' reasons for reserving a room. These activities often involve multiple people, such as work meetings. While these results are not surprising, they indicate a need for systems to communicate how spaces can and can not support multiple people.

5.5 Respondents were confident in the amenities a shared space provided, but how they gained confidence varied

We saw that 68.75% of respondents were confident that a shared space had the provided amenities, while 31.25% were not. This question included a follow-up that had the respondents explain why they were confident. While almost every participant who felt confident stated that they did research beforehand, the way they went about this research varied. Some participants stated that they looked at pictures of the space before reserving. One participant, in particular, stated that they checked Discord and Reddit to confirm that the space had what they needed. Three respondents said they checked the website in which the shared space was listed for details, and one respondent said that they talked over the phone to confirm the amenities provided. The findings from this question show that attributes of shared space are presented and accessible through different channels, such as social media, websites where the space is listed, and over the phone.

5.6 Finding a shared space relies on maps and directions beforehand, logical room structure, or past experience.

Most participants stated that they had no issue finding their shared space, with 50% of participants answering with the lowest difficulty possible. The majority of participants stated that they were able to find their space because they were given directions beforehand, while some participants (n=3) stated that they had already visited the space before. Other attributes that made reserved spaces easy to find were signposts that indicated where users needed to go, as well as logical room number ordering. One respondent even stated that they were unable to find their space easily because it was "Not laid out in a logical numbering system" suggesting logical numbering systems for buildings play a key role in helping users find their reservations.

6 DISCUSSION

To answer our **RQ5 - How can we design more purposeful reservation systems that put the user first and allow the user to utilize the system to explore all of their options in a comprehensive and understandable fashion?**, this section presents design considerations that aim to improve three core aspects of reservation systems:

- **User Interaction with a System**
- **Knowledge Acquisition from a System**
- **Aligning Reservation System Design with Human Behavior and Cultural Norms**

6.1 Design considerations for improving user interaction with a system.

From our findings, we see that systems add unnecessary workflow to users, that they often come with time-wasting bugs and oddities, and in some cases, require outside help to navigate. Below we present design considerations for improving user interaction with a system.

6.1.1 Support "looking up". Look-up is a term commonly used in data visualization. It is an action a user does when the target and location are known. In the context of this paper, a "look-up" is when a user knows what space they want to reserve. From our findings, participants often knew what space they wanted to reserve and when they wanted to reserve it. Despite this, 50% of our participants (n=3) said navigating to their desired space required excessive scrolling or navigating through several pages. Participants bemoaned that navigating to a known space was needlessly difficult. Reservation systems often incorporate features that help with browsing, such as scrolling and pagination, but neglect

supporting "looking up." To alleviate this, we suggest adding at least one additional navigation mechanism that supports "looking up," such as a search bar or space IDs that allow instant snapping to the reservation mechanism for that space.

6.1.2 Present users with different channels to use a reservation system. Users value when they can interact with a reservation system in a variety of ways, and are frustrated when they can't. Appropriate channels include mobile devices, other humans, and tablets/kiosks located at the reservation space. In our interview with an employee at a library, P1 stated that many patrons would go to them asking for help reserving a room. P1 was unable to reserve a room for them and had to walk them through the online reservation system with them. While having users learn a reservation system reduces employee downtime, it comes to the immediate detriment of the user. In some cases, requiring a person to navigate and reserve a room on their own is inappropriate, given their circumstance. In the case of P1, they stated that stressed students cramming for finals would often come to them for help to reserve rooms. In such cases, cognitive resources for the user are low, and stress is high. Allowing an employee to make a reservation for the user is more beneficial, compared to the potential stress added to the user. Likewise from our prolific survey, we found that many people still make reservations over the phone talking to a person, emphasizing a preference for the flexibility that human assistance provides.

Users found value in at-location reservation providers like QR codes and tablets. In the case of the tablets, two participants liked that they had a tablet located outside of a room that allowed them to make reservations. At-location mechanisms such as QR codes and tablets provide value to users by simplifying the reservation process. Designated devices such as tablets eliminate the need for personal device use and QR codes bypass would be digital navigation of a space.

6.2 Knowledge acquisition from a system

Users want to acquire knowledge of shared spaces to assess whether or not they can support the tasks they want to do. What users want to know varies depending on the task. Two design consideration make up this section: appropriately conveying space availability and displaying the information about a space users cares about.

6.2.1 Convey availability so that it is easy to access and understand. Uncertainty of availability presented challenges to several of our participants. One participant lamented how there was no way to see reservations unless they went to the actual room. Additionally, another participant stated that study rooms that appear empty may be reserved, and for them to know, they have to access the system, and navigate to the room to find out. To prevent these breakdowns, we offer the design consideration of making availability accessible. In the cases above, making availability accessible could be a tablet attached to the front of the room displaying availability status and integration with an online system that one can access remotely can squash any uncertainty on availability.

Availability can also be displayed poorly, as found in one of our interviews, availability can be hard to parse if it is displayed as "just numbers on a graph" P3. We also advise that availability is appropriately visualized and easy to parse. Displaying availability in plain text format, such as "9:00 am to 11:00 am," while correct, requires additional cognitive effort to parse when appearing in a list. Such plain text format should also be accompanied by some form of visualization.

6.2.2 Display appropriate knowledge. From our findings, amenities, even seemingly mundane ones like the upholstery of furniture, are important to users and dictate if they will reserve a space. Likewise, the space around the space is also important. Things like proximity to noise, access to natural light, and a sense of privacy were commonly brought up

by participants in our interviews. To know what to convey what amenities a room has, it is important to understand what tasks a user will do in a space. Display only information and amenities of a space that affects the productivity of a certain task. If the space can support various tasks such as group work, recreation, or personal study, then allow users to select a task they will do and display relevant information pertinent to the task they selected. While pictures do convey many amenities of a space, they fail to convey experiential or sensory ones such as privacy, noise level, and sometimes access to natural light, all things participants found value in.

6.3 Design considerations to align system design with human behavior and cultural norms.

Designing and implementing a reservation system that carefully encourages positive social interaction is key. Shared spaces and their reservations are impacted by social behavior. The scarcity of a space impacts users to reserve time they normally would not. Similarly, the uncertainty of time needed to complete a task in a space also leads users to reserve more time than needed, and shared space is wasted as a result. Additionally, some individuals face uncomfortable conflict when others occupy a space in the time they reserve.

6.3.1 Implement features that facilitate peaceful handoffs of shared space. Individuals who encounter others in their shared space face the uncomfortable decision of telling people to leave their space, waiting until they leave, or forfeiting the space to them. Moreover, shared spaces can be left in poor states. Individuals may not clean up after themselves, leaving it for the next person to use the space to deal with, as mentioned in our interviews. A reservation system can facilitate peaceful handoffs by integrating technology into the space in such a way that it notifies users when their time in the space is up. Furthermore, displaying who currently has the space reserved legitimizes a user's right to a space. Cameras that take a picture before and after somebody has used a space can also be used to enforce cleaning and hygienic standards that are necessary in shared spaces. While entitled individuals who circumvent rules and social norms exist, integration of tech into a space, for the most part, can ensure peaceful handoffs between well-adjusted members of society and coerce those who are on the more entitled side to do their part in facilitating a peaceful handoff.

6.3.2 Implement equitable reservation policies. Participants in our interview stated that they often reserved more time for a space than what was needed, in fear that they were losing out if they did not do so. Where appropriate implementing equitable reservation policies such as time allowed to reserve per week, and giving priority to groups of people in greater need. Implementing equitable reservation policies can alleviate the fear of missing out, people feel toward the reservation of shared spaces.

6.3.3 Allow users to forfeit their space to prevent waste. Often users book more time than they need. We found that users typically err on the side of caution when it comes to reserving shared spaces. In many current reservation systems, users are unable to relinquish their remaining shared time back to the public, essentially wasting it. We found from our participants that people are cognizant of the fact that they are using a shared resource and often try to reserve spaces in a community-conscious manner. Allowing users to relinquish reservations allows users to practice thoughtfulness and potentially reduce demand for shared spaces.

7 LIMITATIONS

Within our study, there are several limitations. Firstly, our survey pool and interview pool highly differ in demographics and are not consistent with one another in terms of recruitment. Convenience sampling is not diverse in population and could have heavily skewed our results, resulting in some discrepancies between common trends in our interviews

compared to our questionnaires. This is compounded by the fact that all of our interview participants were from North America, while none of our survey participants were from North America. The cultural differences and differences in the environment could have heavily shifted the responses we obtained and could lead to conclusions that may not have been appropriate for all cultures involved. Furthermore, the amount of people recruited for both the survey and questionnaire is quite small, with a total of less than 30 overall participants in our study. This indicates that our study could have quite easily generalized results to a larger overarching system without having a solid basis to do so in terms of participant count and population diversity.

Our team also consists of only students within HCI research. While student researchers are still researchers, our work is not at the same level as experts within the field, and multiple mistakes were made during interviews which could have led to biased and slanted responses. While we hope that our work is still suitable, it cannot be understated that we are mere students training to be researchers within the field and aren't fully experienced yet.

8 CONCLUSION

The main contribution of this paper is the in-depth findings on reservation systems and the design considerations we produced in light of these findings. Some of our key findings reveal that shared space reservation systems lack support for stressed users. These systems also often obfuscate important information about shared spaces. Finally, shared space reservation systems raise privacy concerns and do a poor job of conveying that reservations are confirmed. From our findings, we present design considerations that tackle three core aspects of reservation systems, user interaction with a system, knowledge acquisition from a system, and the alignment of reservation system design with human behavior and cultural norms.

REFERENCES

[1] Shameem Ahmed, Md Monsur Hossain, Cody Pragner, Mitch Kimball, Ashima Shrivastava, Joseph Gildner, Sean McCulloch, and Moushumi Sharmin. 2022. Constrained Life in a Multifarious Environment - A Closer Look at the Lives of Autistic College Students. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–17. https://doi.org/10.1145/3491102.3517788

[2] Jacob T. Biehl, Matthew Cooper, Gerry Filby, and Sven Kratz. 2014. LoCo: a ready-to-deploy framework for efficient room localization using Wi-Fi. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. ACM, Seattle Washington, 183–187. https://doi.org/10.1145/2632048.2636083

[3] Vicky Bilbily, Elaine Huynh, Karan Singh, and Fanny Chevalier. 2021. Space, Time, and Choice: A Unified Approach to Flexible Personal Scheduling. In *The 34th Annual ACM Symposium on User Interface Software and Technology*. ACM, Virtual Event USA, 484–497. https://doi.org/10.1145/3472749.3474764

[4] Ryan David Bowler, Benjamin Bach, and Larissa Pschetz. 2022. Exploring Uncertainty in Digital Scheduling, and The Wider Implications of Unrepresented Temporalities in HCI. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–12. https://doi.org/10.1145/3491102.3502107

[5] Bradley D. Faust, Arthur W. Hafner, and Robert L. Seaton. 2010. OpenRoom: Making Room Reservation Easy for Students and Faculty. *The Code4Lib Journal* 10 (June 2010). https://journal.code4lib.org/articles/2941?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+c4lj+(The+Code4Lib+Journal)

[6] Juho Kim, Haoqi Zhang, Paul André, Lydia B. Chilton, Wendy Mackay, Michel Beaudouin-Lafon, Robert C. Miller, and Steven P. Dow. 2013. Cobi: a community-informed conference scheduling tool. In *Proceedings of the 26th annual ACM symposium on User interface software and technology*. ACM, St. Andrews Scotland, United Kingdom, 173–182. https://doi.org/10.1145/2501988.2502034

[7] Sandjar Kozubaev and Carl DiSalvo. 2021. Cracking Public Space Open: Design for Public Librarians. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–14. https://doi.org/10.1145/3411764.3445730

[8] Magauwane R. Maepa and Michael N. Moeti. 2021. IoT-Based Smart Library Seat Occupancy and Reservation System using RFID and FSR Technologies for South African Universities of Technology. In *Proceedings of the International Conference on Artificial Intelligence and its Applications*. ACM, Virtual Event Mauritius, 1–8. https://doi.org/10.1145/3487923.3487933

[9] Abhinandan Majumdar, Zhiru Zhang, and David H. Albonesi. 2016. Characterizing the Benefits and Limitations of Smart Building Meeting Room Scheduling. In *2016 ACM/IEEE 7th International Conference on Cyber-Physical Systems (ICCPS)*. IEEE, Vienna, Austria, 1–10. https://doi.org/10.1109/ICCPS.2016.7479070

[10] Joshua C. Manzano, Adrienne Francesca O. Soliven, Antonio Miguel B. Llamas, Shenn Margareth V. Tinsay, Briane Paul V. Samson, and Rafael A. Cabredo. 2021. Using Boolean Satisfiability Solvers to Help Reduce Cognitive Load and Improve Decision Making when Creating Common Academic Schedules. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–13. https://doi.org/10.1145/3411764.3445681

[11] Gloria Mark, Yiran Wang, and Melissa Niiya. 2014. Stress and multitasking in everyday college life: an empirical study of online activity. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Toronto Ontario Canada, 41–50. https://doi.org/10.1145/2556288.2557361

[12] Gloria Mark, Yiran Department Of Informatics Wang, Melissa Niiya, and Stephanie Reich. 2016. Sleep Debt in Student Life: Online Attention Focus, Facebook, and Mood. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, San Jose California USA, 5517–5528. https://doi.org/10.1145/2858036.2858437

[13] Katharina Reinecke, Minh Khoa Nguyen, Abraham Bernstein, Michael Näf, and Krzysztof Z. Gajos. 2013. Doodle around the world: online scheduling behavior reflects cultural differences in time perception and group decision-making. In *Proceedings of the 2013 conference on Computer supported cooperative work*. ACM, San Antonio Texas USA, 45–54. https://doi.org/10.1145/2441776.2441784

[14] Peter G. Scupelli, Yan Xiao, Susan R. Fussell, Sara Kiesler, and Mark D. Gross. 2010. Supporting coordination in surgical suites: physical aspects of common information spaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Atlanta Georgia USA, 1777–1786. https://doi.org/10.1145/1753326.1753593

[15] Jaime Teevan, Susan T. Dumais, Daniel J. Liebling, and Richard L. Hughes. 2009. Changing how people view changes on the web. In *Proceedings of the 22nd annual ACM symposium on User interface software and technology*. ACM, Victoria BC Canada, 237–246. https://doi.org/10.1145/1622176.1622221

[16] Alarith Uhde, Nadine Schlicker, Dieter P. Wallach, and Marc Hassenzahl. 2020. Fairness and Decision-making in Collaborative Shift Scheduling Systems. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM, Honolulu HI USA, 1–13. https://doi.org/10.1145/3313831.3376656

[17] Nadine Von Frankenberg. 2021. Towards Resolving Thermal Comfort Conflicts in Shared Spaces. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–5. https://doi.org/10.1145/3411763.3451512

[18] James Zou, Reshef Meir, and David Parkes. 2015. Strategic Voting Behavior in Doodle Polls. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work Social Computing*. ACM, Vancouver BC Canada, 464–472. https://doi.org/10.1145/2675133.2675273