LETO: A WORK-LIFE BALANCE SYSTEM DESIGNED FOR MOTHERS IN DUAL-EARNER FAMILIES

by

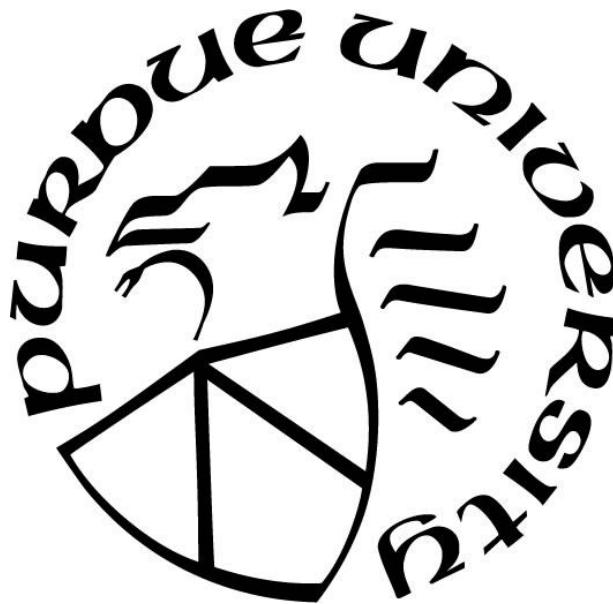**Yunran Ju**

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ABSTRACT

This project aims to build a system that helps users achieve a delicate work-life balance and decrease stress. Evidence shows that most dual-earner families currently live in multitasking contexts. The increase of multitasking behaviors and experiences among working mothers has led to negative emotions, stress, and work-family conflict. Studies have confirmed that balancing work and family is challenging for parents. After the COVID-19 pandemic, work-life balance became more challenging to achieve. Due to gender inequality, research shows that telecommuting mothers report feelings of depression and anxiety much more than fathers. The study highlights work-life conflict experiences with working mothers through qualitative and quantitative approaches involving specific numbers of interviews and online surveys. Based on research, I developed the system Leto, an application and product design to help mothers in dual-earner families build a better inner and outer system. Further, the design combines functions of the mother community, reminders, customized schedules, and a stress reliever. The design outcome was prototyped and assessed through a heuristic evaluation.

CHAPTER 1. INTRODUCTION

The number of working mothers is gradually increasing, and more mothers choose to work outside of the family. While the data shows that women's employment has had a positive impact on their physical health, the adverse effects of multiple roles cannot be ignored. These negative effects include, but are not limited to, multitasking behaviors and experiences, lack of personal time, and lack of social life. All of these unquestionably affect the physical and mental health of working mothers. It had been echoed by the increasingly common reports of women's negative emotions, stress, and work-life conflicts.

With the outbreak of the Coronavious epidemic and the telecommuting order, more family tasks were performed by women. Such a condition led to more work-life severe conflicts and caused more severe mental health problems, such as anxiety, loneliness, stress, etc. Many surveys targeted at telecommuting have verified this (Lyttelton, Zang & Musick, 2020).

This study analyzes the causes of stress among working mothers from multiple perspectives, investigates users' needs, and presents corresponding solutions according to users' needs. In the following chapters, I will introduce the entire developmental process of the project, including the literature review, peer product review, user study, design process, evaluation, and design refinement. Chapter 2 reviewed existing literature, including the history of working and mothers, mothers in dual-earner families, multitasking behaviors of working mothers, work-life balance, and the relationship of gender and work-life balance. In Chapter 3, to better understand the current market, I reviewed five types of peer products closely related to my research topic: scheduling products, applications that promote productivity, stress management services, a household duties assignment game, and a women-connecting application. In Chapter 4, I conducted several user interviews to understand user needs and current design problems. In Chapter 5, before going into the detailed design stage, I briefly introduced some design methodologies used in the later design process, such as affinity diagram, user persona, user journey map, and heuristic evaluation. Chapter 6 focused on the detailed user experience design process, from brainstorming, ideation, sketching, wireframing, and detailing the visual design features. Chapter 7 is about the usability evaluation of the interface design. I conducted a round

of heuristic evaluations with three expert UX evaluators, and two of them are potential users. After collecting the evaluation results, I provided a refined design and solved several significant issues based on their feedback. Chapter 9 summarized the project and described the prospect of the topic.

CHAPTER 2. LITERATURE REVIEW

From the matriarchal society to the patriarchal society, the mother has always played an irreplaceable role. Before designing to solve work-life balance problems beyond working mothers, I need to understand the gender issues at the societal and historical levels. This section focuses mainly on motherhood in modern society. The literature review covers three major perspectives: mothers in dual-earner families, focusing on their multitasking behavior and the work-life conflicts they face.

2.1 Mothers in Dual-Earner Families

2.1.1 Working and mothers

After the Second World War, the number of mothers who worked outside the family proliferated in western countries (Wilson, 2006). Changing concepts meant that women wanted a better material life with more material goods (Scarr, Phillips, & McCartney, 1989). The desire for a more comfortable family lifestyle encouraged women to seek work outside the family(Mitchell, 1988). In the United States, the statistics suggested that the number of working mothers documented has increased each year. In the 1990s, over half of the married women with children aged one or under, worked outside the family. (Offermann & Gowing, 1990). Based on a report released by The Department of Labor of the United States of America (U.S. Department of Labor, 2019), about 60 percent of mothers that participate in labor have children under age three. The percentage of working mothers with children under age six and those whose children are between six to seventeen are higher, at about 66 percent and 76 percent.

Mothers' choices to work outside the family provide more disposable income for their families and children and are common in today's society. But in the twentieth century, there were different social attitudes towards working mothers. Many observers judged working mothers as being selfish, unnatural, and even dangerous to their children and society (Wilson, 2006). A public opinion poll in 1965 showed that 80 percent of respondents believed that mothers with young children should always stay at home and take care of their children instead of going out to work (Dex, 1988). Dr. John Bowlby (Bowlby, Fry, Ainsworth, & World Health Organization,

1965) firmly believed that a mother gone daily would cause severe damage to the child, and the absence of the mother, even for a few hours of paid work, was not conducive to the healthy growth of the child (Bowlby, 1965). Mothers who work outside the home have even been blamed for the cause of family problems and juvenile delinquency.

These negative comments about working mothers in the 1950s and 1960s were ultimately overcome for two reasons. First, as societies became wealthier, the labor market showed a need for women workers. Second, the phenomenon of working women has changed the image of a good mother from one who stays at home to one who does extra work to benefit her family. Also, the motivation for achievement and the opportunity for adult sociability are both critical elements for working mothers.

2.1.2 Multitasking behaviors in working mothers

People often engage in doing more than one task at the same time (multitasking). The main characteristic of multitasking is that it requires people to pay attention to several things simultaneously (Laloyaux, Van der Linden, Levaux, Mourad, Pirri, Bertrand,& Larroi, 2014), including taking tasks in parallel or rotating between tasks. Another is that multitasking allows people to improve the efficiency and effectiveness of daily activities, especially when dealing with simple repetitive tasks (Judd, 2014). Multitasking would interrupt the main task and result in a distribution of attention, affecting the primary task performance (Judd, 2014). Evidence also shows that during task-switching, a human's brain has to respond to several stimuli at once, which leads to time lost as the brain determines which task to perform (Rosen, Carrier & Cheever, 2013).

Currently, most dual-earner families live in multitasking contexts (Wallis, 2006). It becomes a lifestyle and an unavoidable strategy for most American working families (Offer & Schneider, 2011). Within a limited daytime, role juggling between being a parent to being an employee and doing many things at once becomes the only way to get everything done (Williams, Suls, Alliger, Learner & Wan, 1991). Examples of a typical day include cooking dinner for the family while bathing the youngest child, talking about business on the phone while driving kids to school, and

dealing with chores while helping children with their homework. These all become the most common life scenes in dual-earner families.

Multiple role changing (multitasking) immediately had both negative and positive effects on task enjoyment and mood. For the negative part, during task-switch, the brain is forced to respond to several stimuli at once (Dux, Tombu, Harrison, Rogers, Tong & Marois, 2009), which leads to time lost as the brain determines which task to perform. Research has also confirmed that when people try to perform two or more related tasks simultaneously or alternating rapidly between them, errors go way up. The tasks take far longer—often double the time or more (Wallis, 2006). Compared with fathers, multitasking makes mothers feel more burdened and stressed when they have workloads (Offer & Schneider, 2011). This study showed that multitasking increases negative emotions, stress, and psychological distress (Rosen, et al, 2013). From a positive perspective, some kind of media multitasking behavior might lead to emotional gratifications instead of satisfying users' cognition needs, for example, listening to music while watching TV (Wang & Tcherney, 2012). Even though this emotional satisfaction has not been confirmed in the family multitasking environment, there is no doubt that these positive emotions help mothers get along with their children.

2.2 Work-Life Balance

Since the 1960s, after a large female population entered the workforce, research on women's work and life has gradually increased. New concepts like work-life balance or work-family balance emerged. Work-family preceded that of work-life balance and implied "the extent to which individuals are equally involved in—and equally satisfied with—their work role and family role" (Singh & Greenhaus, 2003). In the last two decades, the research direction of work-family issues gradually shifted from conflict to balance (Burke, 2004). To seek a balance of work-family relationship is not a simple matter (De Araujo, Tureta & De Araujo, 2015). Researchers also have to consider many uncertain factors, including gender, family status, personal effort, personality, time, job demands, education level, individual choice, and so on.

2.2.1   How much work? How much life?

Work-life balance has been defined as "the relationship between the institutional and cultural times and spaces of work and non-work in societies where income is predominantly generated and distributed through labor markets (Felstead, Jewson, Phizacklea & Walters, 2002)." It is generally understood as a state of equilibrium in which the demands of both a person's job and personal life are equal. (Lockwood, 2003). Work-life balance is an abstract concept with different theoretical definitions, measures, determinants, and it will lead to different interpretations and consequences. In modern society, almost everyone is seeking a stable work-life balance. They try to re-evaluate their lives and consider the meaning of work. Among men and women, mothers and fathers, employees and employers, it has become a daily topic of conversation. Research emphasizes that working adults need to learn to build networks of support at home, at work, and in the community to handle work-life balance (Friedman &Greenhaus, 2000). Research has shown that a good work-life balance increases an employee's life satisfaction, marital satisfaction, family performance, family satisfaction, parental satisfaction, and leisure satisfaction (Allen, Herst, Bruck & Sutton, 2000). Otherwise, a work-life conflict could increase psychological distress (Whiston & Cinamon, 2015), family-related stress, and the manifestation of illness symptoms (Allen et al., 2000).

2.2.2   Gender difference in work-life balance

Work-life balance is complicated, especially when gender difference is taken into consideration. Most research on gender and work-life balance had focused on quantitative studies, and few qualitative studies compared how women and men viewed work and life. Among those studies, according to different control variables, the research results are also different. Some studies found that women expressed more work-life conflict than men (Frankenhaeuser, Lundberg, Fredrikson, Melin, Tuomisto, Myrsten & Wallin, 1989). Almost all women admitted they have difficulty coordinating work and life skills while performing various roles (Emslie & Hunt, 2009).

Most importantly, when mothers coordinate the relationship between work and life, they often experience substantial demands from both work and family, making it hard for mothers to meet

both requirements. Thus, the separation of work and life has become particularly difficult for women. Research suggests that work-life balance is perceived as a personal issue to be dealt with using individual strategies and not as a structural problem (Emslie & Hunt, 2009). Also, with the development of society, the proportion of employed women is gradually increasing, and differences in the status of fathers and mothers in the family are also changing as time goes on. After the Coronavirus pandemic, many companies have followed the work-from-home order. Telecommuting has exacerbated inequality between mothers and fathers in dual-earner families (Lyttelton, Zang & Musick, 2020). Surveys showed that compared with fathers, mothers spend more time accompanying their children, do family chores, and even work. As a result, telecommuting mothers are more likely to experience negative emotions, such as depression, anxiety, and loneliness (Cummings, 2020).

CHAPTER 3. PEER PRODUCT REVIEW

Work-life balance is complicated and can be affected by gender, family status, personal effort, personality, time, job demands, education level, individual choice, and other factors. Based on different users, different strategies and tools can support the process and experience of work-life balance. For example, some users prefer using software that comes with a smartphone or computer system to help them stay organized and track their schedules. Others would choose to participate in workshops to learn strategies or tricks to balancing work and life. After surveying existing products on the market, I selected several resources and divided them into five categories related to work-life balance: 1) products with a scheduling purpose that help users stay organized; 2) products designed to improve users' efficiency and productivity; 3) products that help users manage stress; 4) game products that help husbands and wives divide household duties, and 5) last but not least, products that help women connect.

3.1 Scheduling Products

3.1.1 Calendar software on a computer or smartphone

In this part, I reviewed four commonly used calendar programs, including Google calendar (Google, 2006), Apple iCloud calendar (Apple, 2002), Microsoft's Outlook calendar (Outlook, 2009), and ClickUp (Clickup, 2017). Typically, the calendar program that comes with the computer system or smartphone system is the most widely used scheduling product. This kind of calendar usually has four main functions. First, it allows users to connect with multiple accounts, such as email accounts or other general accounts (Google account or iCloud account). This association enables users to present all their events in one calendar format. In this mode, users can view their work events and family events without switching between different software. Second, calendars can be color-coded for different users and different parts of life. In this way, users can get aware of their subsequent work, family, or personal events with a glance. Third, users can quickly set up their events and send calendar invitations to friends or coworkers. Lastly, when users add the event's location, the calendar will fill in the address and better understand when and where the event will happen.

3.1.2   Online scheduling websites and software

With online scheduling applications and websites, users can access more functions and a more personalized interface, such as Clickup(Clickup, 2017) and Monday (Monday, 2012). The available functions include a to-do list, project management, documents and notes, spreadsheets, emails and chats, events, reminders, goal tracking, and time tracking. For example, the project management function and spreadsheets function to allow users to share their schedule with others and co-edit with others. Thus, this type of software is better suited to teamwork within companies than on a personal calendar or schedule.

3.2 Applications that Promote Productivity

Some users choose applications that promote productivity to help them achieve productivity, consistent focus, and tracking time. Some productivity-promoting applications are Focus Booster (Focus Booster, 2009), Forest (Forest, 2014), and Habitica (Habitica, 2013). Focus Booster is one example. It is an application that helps users to stop procrastinating, focus consistently, and track time. It has three main functions: 1) offers users a to-do list and reminders and helps users stay focused on tasks. 2) the time tracking function helps users understand how they use their time and reviews users' output. 3) the dashboard function visualizes the progress of tasks. The charts also provide visual satisfaction for users if they are satisfied with their achievements. If not, the charts can be an incentive to help users improve productivity. Finally, the application keeps tracking the time users spend on work, life, fitness, and other activities. It also provides insights into how much time users dedicate to their goals to better balance activities.

3.3 Stress Management Services

To manage stress, different people use different strategies. Some people prefer physical exercise or working out, or doing meditation and yoga to relax. Others may seek out social support through communicating with friends or families. Spending time on hobbies or interests is another good way to manage stress. But besides these daily ways to relax and reduce the pressure, there are lots of workshops on stress management.

The Center for Stress and Anxiety Management (CSAM, 2008) offers a combination of stress management training and organizational change to prevent and reduce job stress on employees and workplace productivity. Stress management workshops often focus on teaching employees to understand what causes stress, how it affects their well-being, and what coping techniques are optimal, such as relaxation exercises or mindfulness practice, and also offer time management skills to better manage their time.

For different groups, other organizations offer similar workshops. The National Center for Faculty Development and Diversity (Faculty Diversity, 2010), for example, is targeted to tenured and tenure-track faculty and fellows. This workshop has several goals, including helping participants manage time to seek a balance between life and academia and to make plans to help them identify personal and professional goals.

3.4 Household Duties Assignment Game

A prevalent situation in many families is that wives still take on more responsibility for family chores, even though many have full-time jobs. To better solve the problem, Eve designed this "fair play" game (Rodsky, 2021). It is a card game system that is meant to help partners divide household tasks more fairly. By choosing cards that show finishing tasks and taking responsibilities, partners can learn to value their own time and honor the value of the other partner's time, resulting in a re-balance of each other's time.

Figure 1. Household Duties Assignment Game

3.5 Women Connecting App: Peanut

Social networking apps can also contribute to solving the tension in the work-life imbalance. For example, the Peanut application (Peanut, 2017) provides a social network for mothers in different life stages to connect with other women in similar situations. It has three main features: 1) The Peanut application provides a women-only community that allows women to join— women in different stages of their lives can find similar women and build connections. 2) Users can ask questions, share information, and find support from others. 3) Users can also join different communities and groups to make friends.
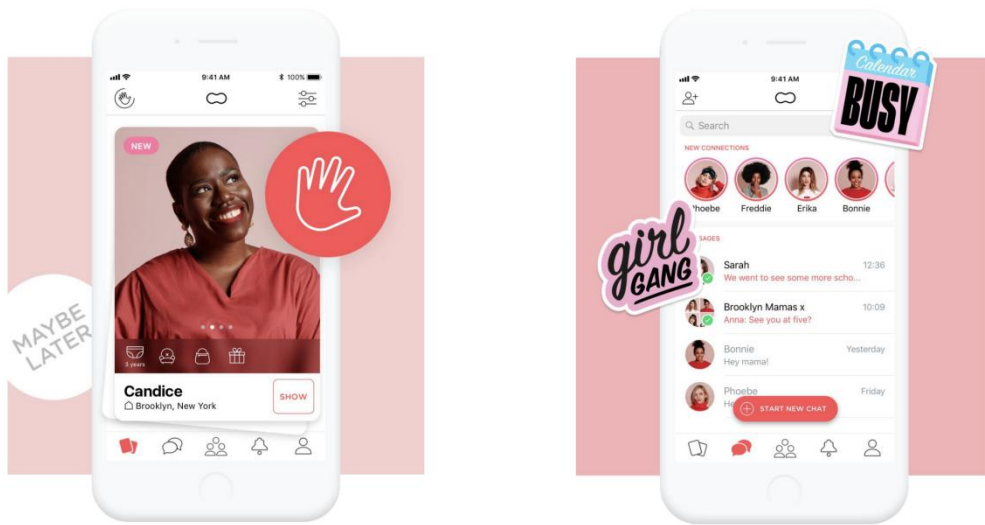
Figure 2. Peanut Application

As a mother dating community, it has some weaknesses (App Store Rating and Reviews, 2017). Users usually spend much time trying to find the right choice in a similar situation and share similar interests and lives nearby. Some users have also reported bullying occurring in the application. Some inexperienced mothers ganged up on one mother, and the innocent woman was kicked out immediately, even though she may have done nothing wrong. Also, there are many complaints about the filter function. It does not work most of the time. Users could not find people living in nearby neighborhoods even though they were already registered.

3.6 Summary

In this part, I reviewed several peer products related to achieve work-life balance, including scheduling products, productivity promoting applications, stress management services, household duties assignment games, and women connecting applications. I learned that work-life balance is a relatively complex topic. Meanwhile, it can be achieved through different strategies and various measures, such as individual efforts and others' help. Also, I learned that several products and researches on women's work-life balance have emerged. However, little attention has been paid to working mothers. Therefore, a system to helping working mothers achieve work-life balance has unique potential.

CHAPTER 4. USER STUDY

This section discusses the entire process of user research, including collecting data, analyzing data, and finally identifying main insights. I aim to gather qualitative data from mothers in dual-earner families about their work-life balance experience to investigate mothers' main problems when handling the work-life conflict and the needs of work-life balance.

4.1 Methods of User Interview

To understand working mothers' daily routines, hear their opinions on work-life balance, find the main pain point for the group, and gain insight from potential users. I conducted several user interviews. Based on previous research, work-life balance was perceived as a personal issue to be dealt with using individual strategies instead of a structural problem. In this case, the interviews were semi-structured since this method is suitable for exploring the interviewee's opinion on specific issues (Louise Barriball & While, 1994). These semi-structured interviews started with a prepared interview guide including eight open-ended questions, and interviewees were encouraged to express and share their real-life experiences and thoughts (Richardson, 1965, Smith, 1991). After sharing, some follow-up questions could be asked to get more helpful insights.

Due to the Coronavirus pandemic, all the interviews were conducted via phone call or the online meeting platform Cisco. The interviews have been audio-recorded for later transcription and data analysis. Handwritten notes about the main points and keywords also have been taken during the interviews. During the following design process, some follow-up interviews were conducted to gather more specific opinions on the detailed design.

4.2 User Interview

Five working mothers were recruited in this user study as the participants. They have children from different age groups (see Figure 3). Among the mothers recruited, three have one child, one mother has two children, and another has three children. Also, two of the five mothers have children in college around their twenties, another two have children in primary around their tenth

year, and the last one has a child of two years old. These mothers have different occupations, including a middle school principal, professor, government worker, teacher, and insurance company clerk.

Beth. 60s
- 3 adult kids,
- been a working mom for 30 yrs

Wang. 50s
- 1 adult kid,
- been a working mom for over 20 yrs

Daina. 40s
- 2 kids, one kindergarten/one elementary school
- been a working mom for more than 10 yrs

Olivia. 30s
- 2 kids, 7 yrs and 5 yrs
- been a working mom for 6 yrs

Abby. 20s
- 1 kid, 2 yrs old
- been a working mom for 1 yr
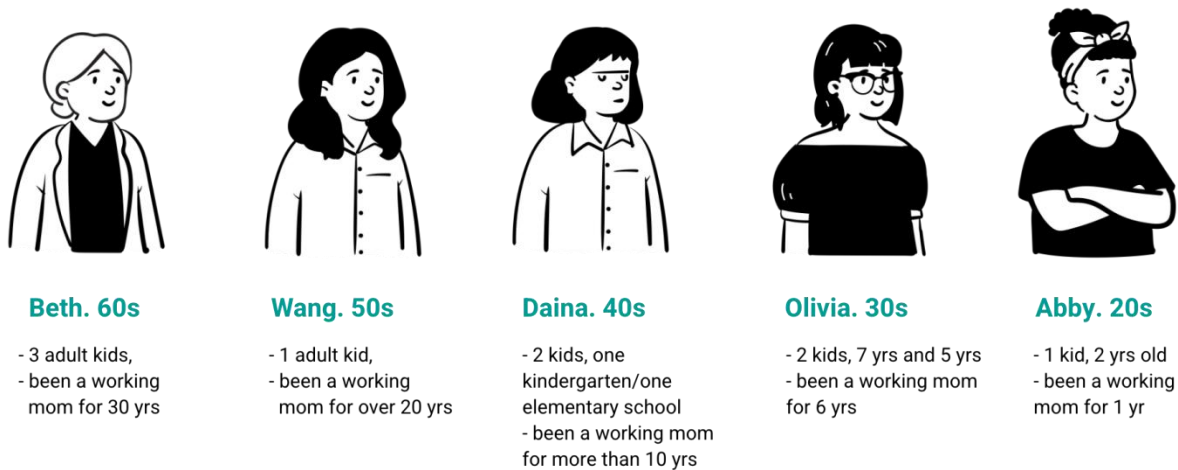
Figure 3. Profile Information of Interviewees

Here are the guiding questions for the semi-open interview :

1. Have you thought about work-life balance?

2. Do you assess your life and work are in balance? Why?

3. When did you usually think about work-life balance? Any example to illustrate the condition?

4. Have you tried to achieve the balance? In what ways?

5. What's the biggest frustration of work-life balance?

6. What difficulties have you met before? Any example?

7. Have you ever felt stressed? If you have, when and why does that happen?

8. How do you usually deal with stress?

9. Is there a particular stage in your child's growth that makes you feel more stressed?

10. Did you try looking for help? From who?

Interviewees have been encouraged to share some unforgettable experiences when they deal with work-life balance or work-life conflict. The interviews lasted about 20 to 30 minutes. The main goal of the interviews is to understand the overall experience of work-life balance from the perspectives of working mothers and to figure out the difficulties of achieving work-life balance.

4.3 Data Collection

After conducting interviews, I transcribed interview recordings and summarized notes. I organized the notes and transcriptions into five categories (Figure 4). The following are the main frustrations and problems mentioned by the five interviewees.

The first participant has three adult kids and has been a working mom for over 30 years. She said she was under tremendous pressure during her children's growth, mostly when her kids were in early childhood. As a young mom, the most frustrating part was that she had to quit the job that she loved to keep her standards and priority of being with her kids. Her husband did much to help her with everything, like cooking or cleaning, etc. All of the support also helped her balance. She also gained much help from other family members and some nannies. She mentioned that:

> *"I quit my loved career to have babies and didn't get back to it until the kids were in school. I also did all kinds of weird jobs to get money so I could be home with my kids.*
>
> *It's also important as a mom to renew or refill my cup. I need to have time to myself. That's really hard."*

The second participant only has one teenager. Same as the first interviewee, she also mentioned that priority is a significant choice. During a specific period, her family and child took more time and energy in her life. A successful tip she shared is to separate work and life as a working mom. She never took the job or negative emotions home. As a very traditional woman, she had mistakenly believed that women should take on more responsibilities when it comes to family and kids. Thus, she spends much more time on family and child compared to her husband. As her child grows up, she believes that the father's lack of role has negatively influenced the child's growth. She said:

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"Priority is the main thing, I always know that in those specific periods, my child and family come first. I always have preset goals for my child and my work, and if my child or myself can't accomplish this goal, I would feel frustrated."

The third participant has two children, one is an eleven-year-old boy, and another is a five-year-old girl. She said that work-life balance is always about priority and choice, different periods, different choices. The balance for her is dynamic, and the plan always needs to be adjusted at any time. She feels more stressed and frustrated when her children encounter some common problems that children encountered as they grow up that she cannot solve. She needed to talk with some experts or mature mothers to find solutions or read some parenting books to look for answers. Her expectations are:

"I hope there are some ways to talk about stress or worries with other mothers in similar situations. Sometimes I also struggle with balance. If I keep looking for a work-life balance, I will be more frustrated if I can't do it and barely anyone can do it. A pervasive psychological state is thinking about my children when I work and thinking about work with my children, making me feel guilty in both directions."

The next participant also has two children, a three-year-old and a five-year-old. As a younger generation and a young mom, she became used to living with pressure and can even do better under higher pressure. The only frustration she has so far is that she was trying to find a better way to have her husband more involved in her children's lives. Her husband is a surgeon and barely has some family time or even time for himself. She worried that this would be a negative influence on her children as they get older. She mentioned:

"I actually can use some help lots of times, either from my mom or other family members. To me, quitting my job is never an option. I love my job, although most of the time I would be under lots of pressure. I hope my husband can be involved more, but we haven't figured out how to achieve that goal yet."

The last participant is a young mom who has a two-year-old boy. After pregnancy, she quit her job and went back to work after being a stay-home mom for a year. She did not feel very stressed because her parents and parents-in-law helped her a lot. They took care of her baby during the daytime. She believed every moment that she spends with her child is precious, and that helped

her relieve stress. However, she complained that all of her life revolves around family and work, and she barely has personal time. She also mentioned:

"As a new mom, of course, I trust my parents and parents-in-law, but sometimes I worry that their methods of parenting are too old for the new generation. I want to hear some advice or experience from young generation moms, but the situation is that I don't have many mom friends. Most of my friends are not even married. I don't know who I can talk with."

1 spouse or family member's help

Husband's help, such as taking care of children, cleaning, or even providing emotional support, is crucial to help working mothers achieve balance.

2 personal times

Working mothers rarely have time to themselves, especially during workdays. Mothers who have younger children said that they can only get some relief after their children go to sleep. After a long day, even some short personal time can help moms relax and reduce stress.

3 schedule / plan

With a regular routine, moms usually don't need to spend extra time on making short-time schedules, they just need to set up weekly or monthly goals that can be adjusted.

4 job conditions

Being a working mom also means that sometimes they have to give up something in their career, either by quitting the job or giving up some opportunities. On the contrary, dads rarely experience such situations.

5 stress

The increase of multitasking behaviors and experiences among working mothers led to some negative emotions, stress, and work-family conflicts.

Figure 4. Five Important Categories Mentioned by Interviewees

4.4 Data Analysis Outcomes

After analyzing the interview data and organizing the findings, I found out that interviewees mentioned many problems and frustrations around two essential themes: mental issues and physical issues. Based on the health capital framework (Ohrnberger, Fichera, & Sutton, 2017), health capital includes two components, physical and mental health. Physical and mental health impact each other via four variables: social capital, lifestyle choices, socioeconomic status, and biological factors. After analyzing the interview data and organizing the findings, the researcher found five important insights into career, stress, husband or family's company, personal time, and planning. I adapted this framework and assigned data collected in the interviews into these four categories.

PHYSICAL HEALTH / MENTAL HEALTH

SOCIAL CAPITAL	LIFESTYLE CHOICES	SOCIOECONOMIC STATUS	BIOLOGICAL FACTORS
Social interactions	Physical activities	Income/Wage	**Stress**
Loneliness	Diet	**Job conditions**	Cognitive skills
Social isolation	Smoking/Drinking	Retirement	
Spouse or family member's help	**Personal times**		
	Schedule and plan		

Figure 5. Variables that Impact Physical and Mental Health

4.4.1   Social capital

Spouse or family member's help: Among the mothers interviewed, two indicated that they did not get enough help from their husbands, while the other three received a lot of support. Mothers who got help from husbands or family members all mentioned that others' support, understanding, and company had significantly helped them release stress. Husband's support, such as taking care of children, cleaning, or even emotional supporting, is crucial to helping

working mothers achieve balance. Also, during the growth of children, the father's role is beneficial to the health and overall development of the child. Important goals of the design are to encourage fathers to participate more in the child's growth, to be more supportive and understanding to mothers.

4.4.2   Lifestyle choices

Personal times: All the interviewed moms have mentioned the value of personal time. Even if the time is short, it is indispensable. The more frequent situation is that they rarely have time to themselves, especially during workdays. Mothers who have younger children said that they could only get relief after their children go to sleep. Mothers who work remotely from home are especially stressed because of the physical combination of home with family. They feel more stressed than usual, and their negative emotions also increased. They claimed that there is almost no personal time for mothers. Another insight I received from the interviews is that every mom has different ways to spend their personal time. It can be reading, exercising, meditation, shopping, going out with friends or families, or other activities. After a long day, even a short personal time can be precious, helping moms rest, relax, and relieve stress.

Schedule and plan: All mothers have different personalities. Still, those who are more organized are usually more efficient when dealing with a multitasking context, and they often make to-do lists of tasks to remind children and themselves. One mother claimed that she would organize all tasks into categories of most important and most urgent and then complete the tasks in this order. Compared with making a short schedule, some mothers prefer to keep plans in their mind. Also, with a routine, moms usually don't need to spend extra time making short-time schedules, and they would set up weekly or monthly goals and be adjusted any time.

4.4.3   Socioeconomic status

Job conditions: Most of the interviewed working mothers said they always have a clear priority, and most of the time, they focus more on family and children than on work. Being a working mom also means they sometimes must give up something in their career, either leaving the job or giving up some opportunities. For working mothers, a common scenario is that they sleep less or

lose personal time. They tend to get up earlier and fall asleep later than other family members. After completing a full day of high-intensity work, they still need to ensure that they have completed their family tasks. The following design should help mothers prioritize the goals they need to achieve.

4.4.4   Biological factors

Stress: According to different interviewees, their most stressful moments appeared in different life periods. Some moms felt more tired and stressed when their children were babies when they spent lots of time handling multifarious and numerous family affairs. During this period, it is also easier to have positive emotions when getting along with their children. Others claimed that the most challenging period was when their children were in high school and middle-high school, with pressure from schoolwork and competition among peers. Some moms said that they were usually under much mental stress during this period. It was much harder to deal with compared to the physical stress they faced when their children were young. Some of them said that they usually had some pre-set goals for their children and themselves, and when those goals were missed, they felt lost and frustrated.

4.5 Research Findings

After organizing the insights from the interviews and observations, all the problems or main points mentioned by interviewees fall into three categories (as Table 1). These three categories cover the main problems encountered by working mothers, which are also future design goals. The following table shows the categories and summarizes the details:

- Gain help: "I can use some help."
- Spouse's support: "His/her support means a lot."
- Female roles: "I'm not only a mom."

Table 1. Insights Gained from Interviews.

"I can use some help."	1) As a working mother, they can always use some help, whether from family, friends, or other mature mothers in their community
	2) This help can be physical help, such as an hour of babysitting when an emergency happens or after-school activities that children can attend, thus leaving working mothers some personal time.
	3) The system can also include mental support. There can be opportunities that allow moms to communicate with other mature ones or experienced ones to help them deal with problems or difficulties. It also can include helpful resources shared by others.
Spouse means a lot	1) After interviews and research, the data shows that husbands' or spouses' help and support can primarily help working mothers relieve stress.
	2) Husbands' or spouses' help includes physical and mental support. Physical help can be doing household chores, taking care of children, family activities, etc. Mental support can consist of having a stronger father-child relationship and being more understanding and supportive to moms.
	3) For some inexperienced fathers, encouraging them to do housework or build relationships with their children will help them become more confident fathers.
"I'm not only a mom."	1) Although every mom prioritizes family and work, it doesn't mean they need to rank themselves last. Lack of personal time is the main problem that is faced by working mothers. The design's ultimate goal is to help working mothers understand that being a mom is adding a role instead of being her whole character. Using a time banking system and reward mechanism encourages working mothers to manage their time better and gain more personal time.

CHAPTER 5. METHODOLOGY

5.1 Affinity Diagram

The affinity diagram, also known as KJ method (Kaminski & Blinowska, 1991), is a way to collect a large amount of data and arrange them into different categories based on their natural relationships. Designers and researchers often use this method in the brainstorming stage, where designers or researchers are still unsure about the specific solution. Typically there are five steps to create an affinity diagram. First, the researchers brainstorm and collect large numbers of different ideas and write them down on sticky notes. Then, they start to display ideas collected from the previous step—post sticky notes on the wall or other platforms. Next, they categorize ideas into groups. Through discussion, the researchers then group all similar or related ideas into the individual column. The researchers then create a header card for each group identifying the common theme or connection. Last, the researchers should review and polish the affinity diagram.

5.2 Persona

A persona (Harley, 2015) is a fictional character that represents an ideal type of user. This character should closely related to your system, product, or application design. As an interaction designer, the design process typically started with primary and secondary research. A persona is based on previous user research and incorporates users' profiles, needs, frustrations, experiences, expectations, goals, and scenarios describing how a persona would interact with the product. Creating a persona will help designers better understand and recognize problems from the users' point of view. Besides, during the design process, a persona should be the guidance and reference for designers to follow. It can help designers to achieve the design goals. In my project, one persona that represents the working mother community has been created. The explicit content is introduced in the following chapter.

5.3 User Journey Map

The user journey map (Richardson, 2010) is a visualization that describes the overall experience that users go through in a particular context. Several key components need to be shown on a user

journey map. It usually includes an actor (the persona who experiences the journey), a scenario with the map address, several journey phases, user actions and emotions, opportunities, and strategies gained from the map and guides designers to the next step. In this project, I separate the experience of a typical working day into three parts: before working, during working, and after work. The three-stage experience is illustrated on a map (Figure 11) with different scenarios and journey phases. The creation of a user journey map allows me to discover and focus on the user problems quickly and carry on the design of the next step.

5.4 Heuristic Evaluation

Heuristic evaluation (Nielsen & Molich, 1990) is an essential part of the designing process. Generally speaking, it is an evaluation method that helps designers and investigators discovering usability problems in the product's interface. Before evaluation, investigators should establish an appropriate list of heuristics (also known as usability principles) as references. A small set of evaluators should be recruited to evaluate and recognize problems based on selected heuristics. Typically, one evaluator does not find every single usability problem. The more evaluators involved, the more accurate the results will be. However, due to time limits and budget constraints, three to five evaluators are the best choice (Nielsen & Molich, 1990).

After the evaluators are selected, investigators go through a brief introduction session for evaluators and acknowledge what will be covered during the evaluation process. Evaluators will provide a rough estimation of evaluation using a severity rating (0 to 4 rating scale) to describe identified issues. After finishing the assessment, I will summarize and analyze the feedback and problems to make the iterative design and fix the severe problems. Chapter 7 introduces the evaluation process.

CHAPTER 6. DESIGN PROCESS

6.1 Persona

To better focus on the target users, I build a persona representing the working mother community with young children, especially mothers who have children aged before middle-high school (normally before fourteen years old).

I created Sarah as my fictional character. Sarah is a full-time working mother, and she lives with her husband and two daughters in Ohio. She is a well-educated and independent woman, and she has tried to balance her work and family for years. Her husband, Brian, also has a full-time job. His career and work have taken most of his time, but he is still willing to support his family. Sarah has some frustrations: 1) she sometimes feels herself struggles with her children's education; she wants to talk with other moms or experts. 2) when it comes to an emergency and Sarah cannot be there with her child, she needs help from trustworthy people. 3) Sarah finds family and work take most of her energy. Her goals are: 1) when needed, get some help from people she can trust. 2) share experiences and communicate with other working mothers in similar circumstances. 3) encourage her husband to be more involved in child-raising and family chores. 4) look for a better schedule system to help her have more personal time and achieve a work-life balance.

Sarah Walls

Age 38 ys
Status Married working mom (Full-time career)
Family Live with her husband and 2 daughters (7 and 5) in Ohio
Educated Master's degree

" **It's not about balance,
it's always about choice and priority.**

Background
Sally is a 38 years old lecturer working for a university. She has been a working mom for eight years. She also tries to balancing her career and family. After her first daughter was born, her husband wasn't able to support to her and family because of the heavy workload. Since things are improving, he is being helpful for cleaning and taking care of the kids.

Goals
Get some help from trustworthy people.
Encourage husband to be more involved with child raising and family chores.
Achieve work-life balance and get some personal time.

Frustrations
Sarah sometimes struggled with her children's education and wants to talk with other moms or experts. When it comes to an emergency, and Sarah can't be here with her child, Sarah needs help from trustworthy people. Sarah finds family and work take away most of her energy and she needs have some personal time to refill her cup. Sarah spends much more time than her husband with family chores and children.

Figure 6. User Persona

6.2 User Experience Journey Map

The following user experience journey map visualizes a typical working day of a working mother. The user experience journey map can be branched into three main scenarios: 1) before work, 2) during work, 3) home from work. From the top column to the bottom column, there are four different parts: 1) detail phases, 2) users' actions and behaviors in different phases, 3) users' emotional feelings and experiences with the ups and downs on the green line showing the emotional changes of the actor. 4) insights and opportunities gained from the mapping.
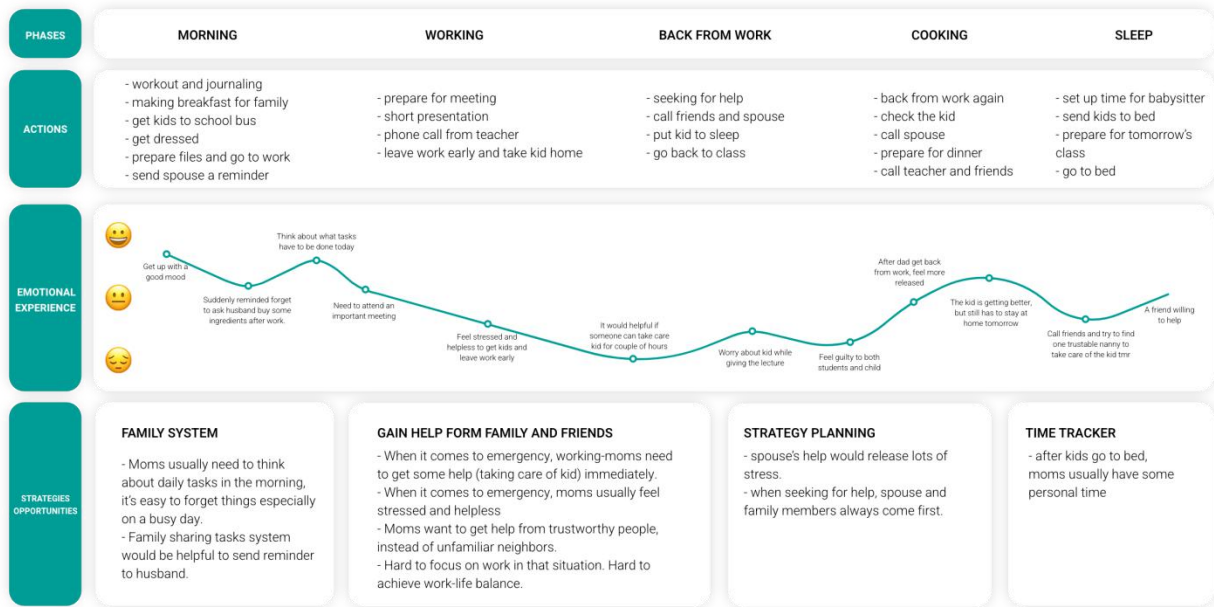
Figure 7. User Experience Journey Map

It is evident that the user Sarah experiences multiple emotional swings throughout the day in the user experience journey map above. Before users go to work, they need to go through the schedule for themselves and other family members, which is time-consuming, especially in the busy morning. During working, the most frustration a mother feels is when her child has some emergency at school, and she has to pick up the child. It can be very stressful if she cannot find someone to help in a short time. After work, Sarah still needs to deal with plenty of family tasks, such as preparing dinner for the family, spending time with her child, finishing up her work, and preparing for the next day's work.

By analyzing daily actions and emotional experience phases, the investigator finds some user pain points. For instance, before users go to work, they usually need to go through daily tasks. It is easy to forget things in the busy morning. Also, when dealing with time conflict issues, users need to check with family members and friends to find someone that can help. Since the major part of the daily time has been occupied by work and family chores, they can only get personal time before the children get up and after they go to bed.

After analyzing the user experience journey map, we found that some strategies and opportunities can be used to help develop future designs. For example, to solve morning problems, a family task-sharing system that allows family users to send reminders to each other might be helpful. A strategy planning platform can help users save time and achieve more personal goals. A trustworthy system will quickly offer users help, especially when it comes to emergencies.

6.3 Brainstorming

After reviewing previous researches and based on users' needs and problems, I started brainstorming to find the best solution. Brainstorming had been centered around the three design directions mentioned above: 1) provide more mental and physical help to working mothers. 2) encourage spouses to participant more in family affairs. 3) help working mothers to get more personal time.

6.3.1　Brainstorming round 1

In the first round of brainstorming, I tried to sketch and list possible solutions and ideas on sticky notes based on previous research.

1) **Family board game**
The idea of a family board game is to encourage spouses to become more involved in family activities and family chores. The main idea is to view children's growth as a journey. The tasks that parents need to complete during the children's different ages are presented in the form of board games, and these tasks are evenly distributed to the parents through the game.

2) **Time Banking system**
The idea of a family time banking system is meant to solve the problem that women still take on more responsibilities for family chores than their husbands in most families. Based on these, I used the bank saving idea as a starting point. By recording and visualizing the time spent on household chores in a week by both spouses, they can find out who spends more time in the family. Through the corresponding reward mechanism, the winning party can take on less

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housework in the next week. In contrast, the losing party will accept a particular consequence mechanism, such as buying a gift for the partner and being assigned more housework in the following week.

3) **Goals-saving idea**

Based on the problem of lacking personal time, the first idea I came up with was the goals-saving system. First, the idea is to encourage users to set up long-term and short-term goals for themselves. The goal can be very general, such as a personal travel reward, finishing a book within a given period, or even scheduling a date with a friend. After setting up the ultimate goal, users can start recording their time spent on work and family. When users reach a time point or finish several tasks in a day, the system will remind users that they have already spent plenty of time on work or family chores. They should either take some rest or save some time for themselves. Therefore, by encouraging users to accomplish these personal goals, they could achieve a better work-life balance.

6.3.2 Brainstorming round 2

After the first round of brainstorming, I presented ideas to my committee members for feedback. After discussion, we all agreed that the previous ideas lack details and may not be the fundamental solution. I decided to conduct a second round of brainstorming and combine three design directions and find a better and more detailed solution. Here are some ideas that I came up with during the second round of brainstorming.

1) Task sharing: Users can add tasks to the system and quickly share tasks with their spouses. By recoding tasks, users can easily track on time they spend on work and life.

2) Reward mechanism: After recording tasks, users and their spouses can find out who spends more time on family affairs or who finishes more family tasks. The lost party should accept the consequence. For example, he or she should take on more responsibilities next week, participate in more family affairs, organize some family activities, and so on.

3) Time report: By keeping track of daily tasks and schedules, provide users weekly, monthly, and annual reports. Meanwhile, through analyzing the data report, the system will push corresponding suggestions to users.

4) Family calendar and reminder: Users can import schedules from other calendars. By combining work schedules and personal schedules, they can quickly check time conflicts, share tasks with their spouses, and send reminders when they need help.

5) Emergency contact: Allow users to set up emergency contact lists. Users can quickly get the help they needed. Also, a supportive system allows users to check who is available and can offer help.

6) Mother community: Users can join or build a mother community with their friends or co-works who have children. They can share posts in the community when they have any questions or need suggestions. Meanwhile, other users can reply to these posts to communicate. Also, when users need help and family members are not around, they can also create posts to look for help from their community.

7) Activities: Users can arrange some offline activities with others in the same community. For instance, yard exchange is an excellent way to deal with children's clothes and toys and build a better relationship with the community.

8) Reward: In the mother's community, if someone has helped others multiple times, the system will send reminders to those who have received help and let them know that they should find some ways to repay.

As for the physical product, I also came up with several ideas:

1) Reminder: A reminder design that users can put on the table during work. It also connects with the system and sends reminders to the user via flashing LED lights.

2) Fidget cube design: A soft and squeezable fidget cube design that users can interact with when they want to release stress.

3) Wearable stress-tracker: An interactive stress-reliever that users can wear and monitor stress levels. By monitoring heart rate and other physical data, the device helps users relieve stress better.

During the second round of brainstorming, I realized that all of these ideas revolve around users' internal and external systems. The internal system means users themselves, and the external system includes their family members, friends, and others. Whether from internal or external systems, the ultimate goal of the theme is to help users. The definition of help here is very comprehensive. It includes both mental help and physical help. Mental help means helping users solve problems and reduce stress by providing suggestions or communicating with them. Physical help refers to sharing housework, taking care of children, and helping users solve practical problems.

Based on previous research and brainstorming, I organized the ideas and finalized three primary system functions and two physical product functions. As data sources, the product collects data through users' daily interactions and then transmits it to the system. The system is the output party. It estimates and evaluates the user's pressure level by analyzing the data. Also, the system sends corresponding notifications to the user according to the results. The notifications for the system include 1) personal planning and scheduling system, 2) family system that users can easily share tasks, 3) mother community that users can use for getting mental and physical help. The physical product includes 1) stress-reliever to help users relieve stress through the act of squeezing (Dumbleton, 2016), 2) collect squeezing data and transfer it to the system.

6.3 HTA Chart

Hierarchical task analysis (HTA) can be interpreted as a method to represent the system's hierarchy for further analysis (Stanton, 2006). The HTA chart method has been widely used in various contexts, especially interface design and user experience design (Annett, 2003). It helps designers understand tasks that users need to complete when achieving certain goals. When

designing a new system, designers are able to break these tasks into smaller ones. The HTA chart method also helps designers explore the interactions between users and the system.

I applied hierarchical task analysis to modify the tasks, subtasks, goals, sub-goals and optimize system interaction in my design process. This process also helps me clarify design ideas and find design bugs before entering the detailed design process. Encouraging users to complete sub-tasks, such as seeking help from the mother community, and analyzing and recording time spent on work and personal tasks will help attain the goal of achieving a work-life balance.

Figure 8 demonstrates the overall structure of how users can navigate the system. The detailed sub-tasks are shown in Figure 9, Figure 10, Figure 11, Figure 12, and Figure 13. This is the first generation of the structure of the application.
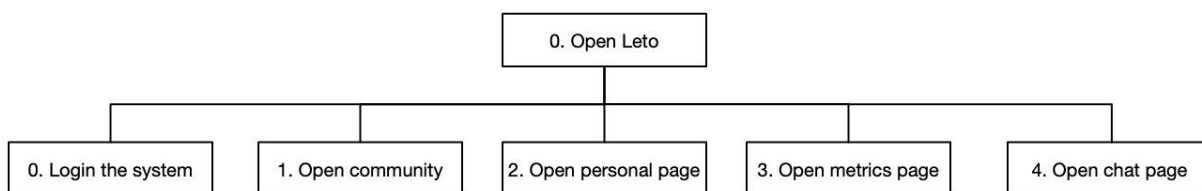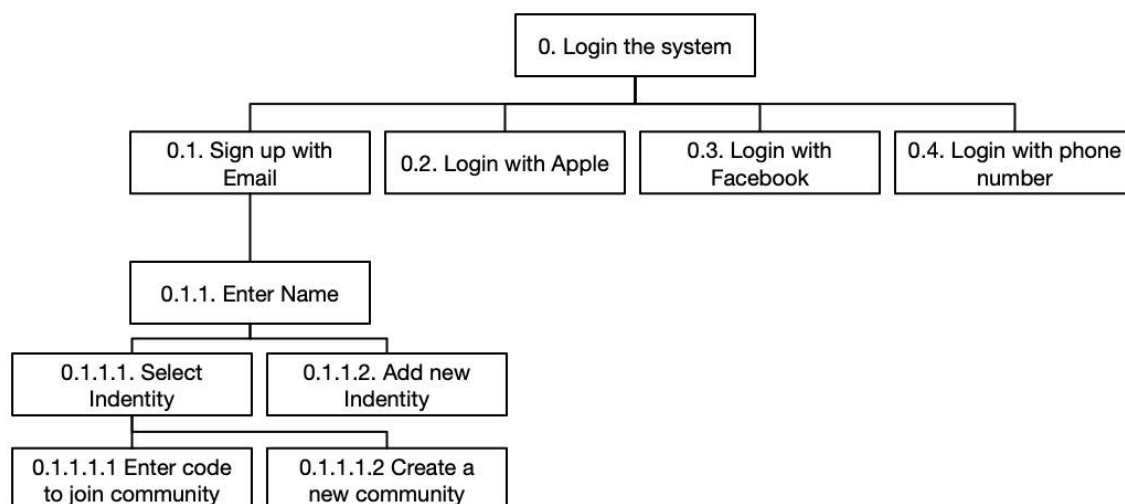

Figure 8. HTA Chart: Overall Structure
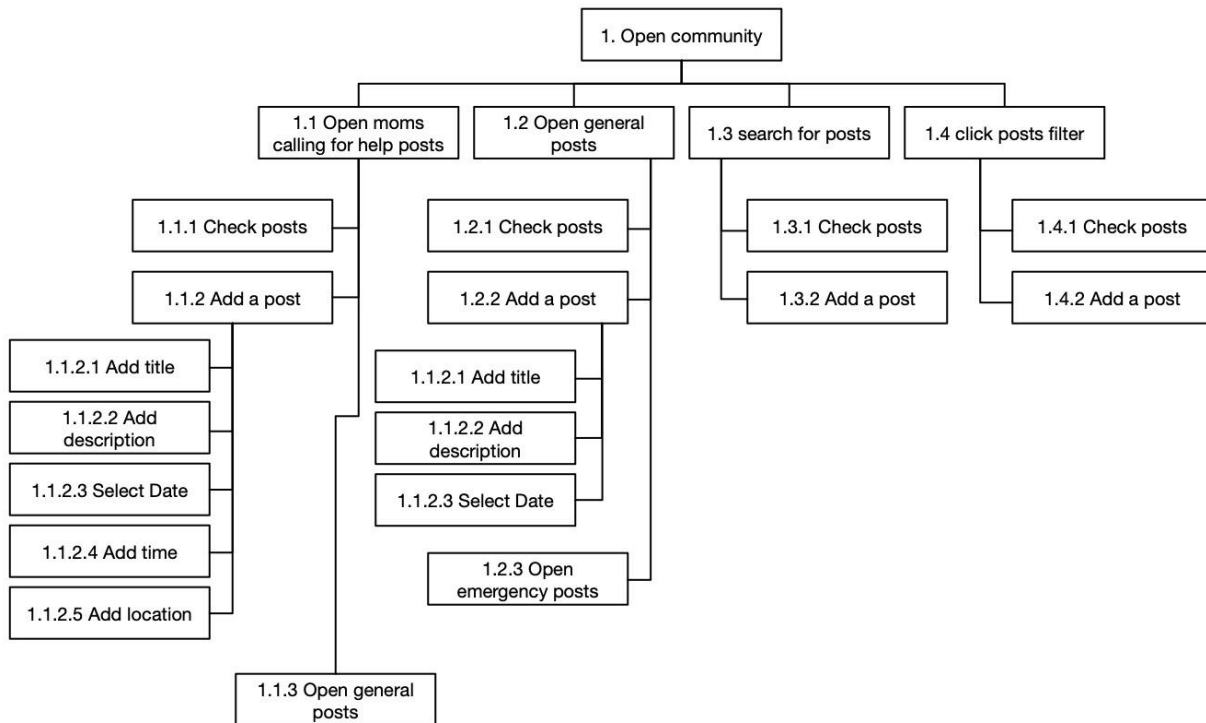

Figure 9. HTA Chart: Log In

Figure 10. HTA Chart: Mother Community
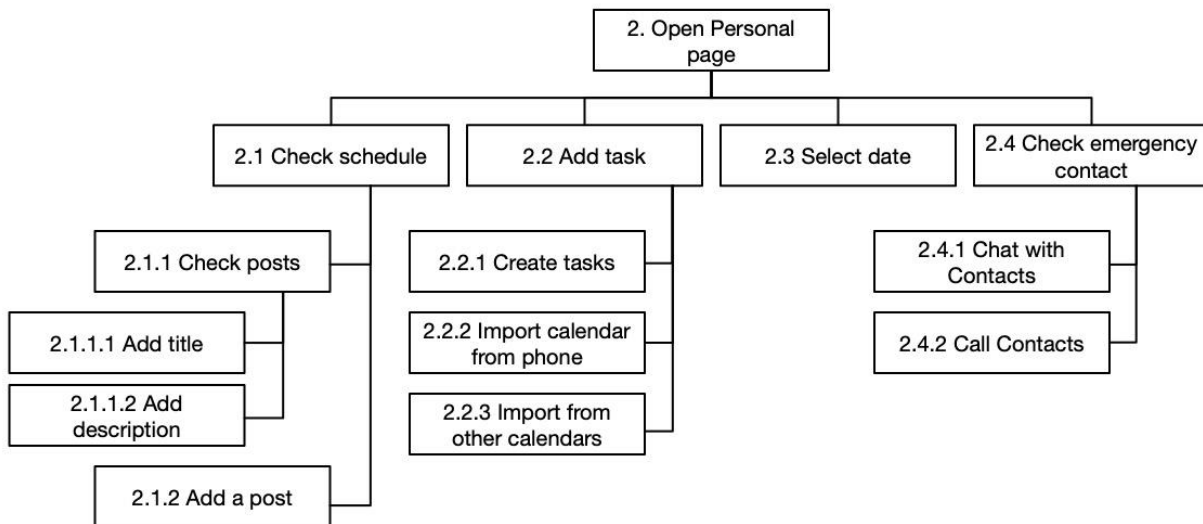
Figure 11. HTA Chart: Personal Page
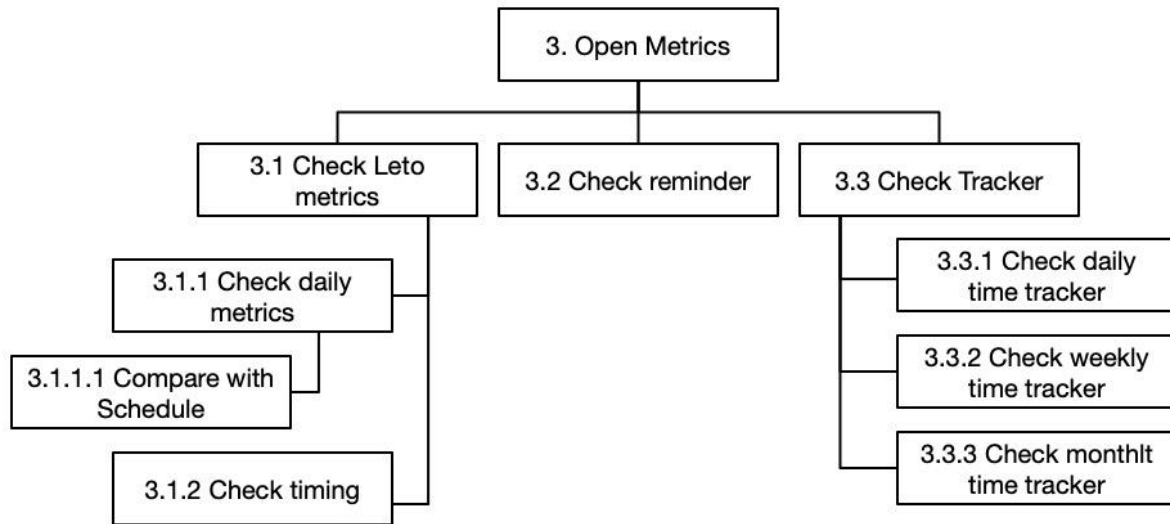
Figure 12. HTA Chart: Metrics Page
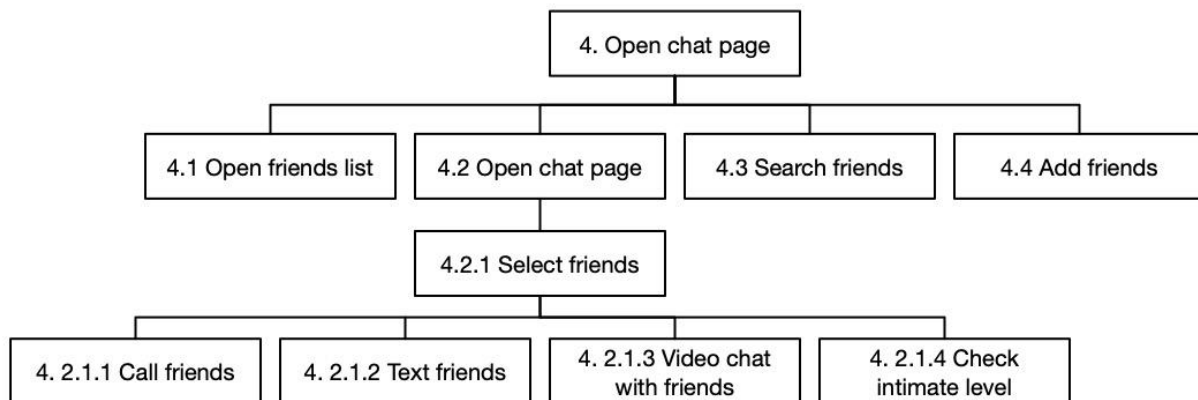
Figure 13. HTA Chart: Chatting Page

6.4 Ideation and Sketches

After setting up the HTA chart, I started sketching user interface pages and the detailed design of the products. During the ideation phase, I applied the concept of a Japanese Zen garden to my design. A Zen garden is a miniature stylized landscape made with carefully composed arrangements of rocks, water features, moss, pruned trees, and bushes. The garden uses gravel or

sand that is raked to represent ripples in water. The ripples will show a meandering path that looks like rising and falling water waves. (as Figure 14)

Figure 14. Japanese Zen Garden

I tried to apply some visual elements to my design with abstract elements like ripples, waves, and rocks, such as curves, encircling, and smooth lines. At the beginning of the user interface design, I applied the embraced idea and encircled element to the personal page (as Figure 15) to express the concept that users are being loved, surrounded, cared and helped by using these elements. As for the physical product design, I planned to use the rock and ripple elements to keep the consistency of the application and product (as Figure 16).
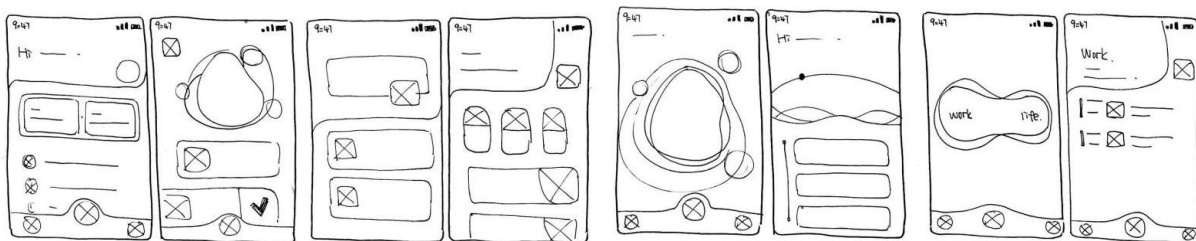

Figure 15. User Interface Sketches

Figure 16. Idea Sketches: Stress Relief Products

6.5 Wireframing

Wireframes can be understood as simplified representations of a system, an application, or a website. Wireframes often consist of elements such as lines and text. However, they do not include color, graphics, or other visual design elements. The page structure, layout, page function, and user flow should be presented during the wireframing process in the form of a two-dimensional skeleton outline. During the design process, wireframes help designers visualize design ideas and test the design's effectiveness.

Based on the information hierarchy and sketches, I started to plan page structures and more complex functions, such as where to place buttons and the content layout. There are five main pages included in the system: login and register page, mother community page, personal page, and metrics page. The login and register page allow users to enter personal information, authenticate their identity, and join a community or create a new one. The mother community page is where users can ask or offer help and suggestions. While on the personal page, users can check personal and spouse schedules. They can also easily send reminders and share tasks with each other. Last but not least, the metrics page is connected with the stress-reliever product. Users can analyze personal stress levels by looking at the data and comparing it with personal schedules.

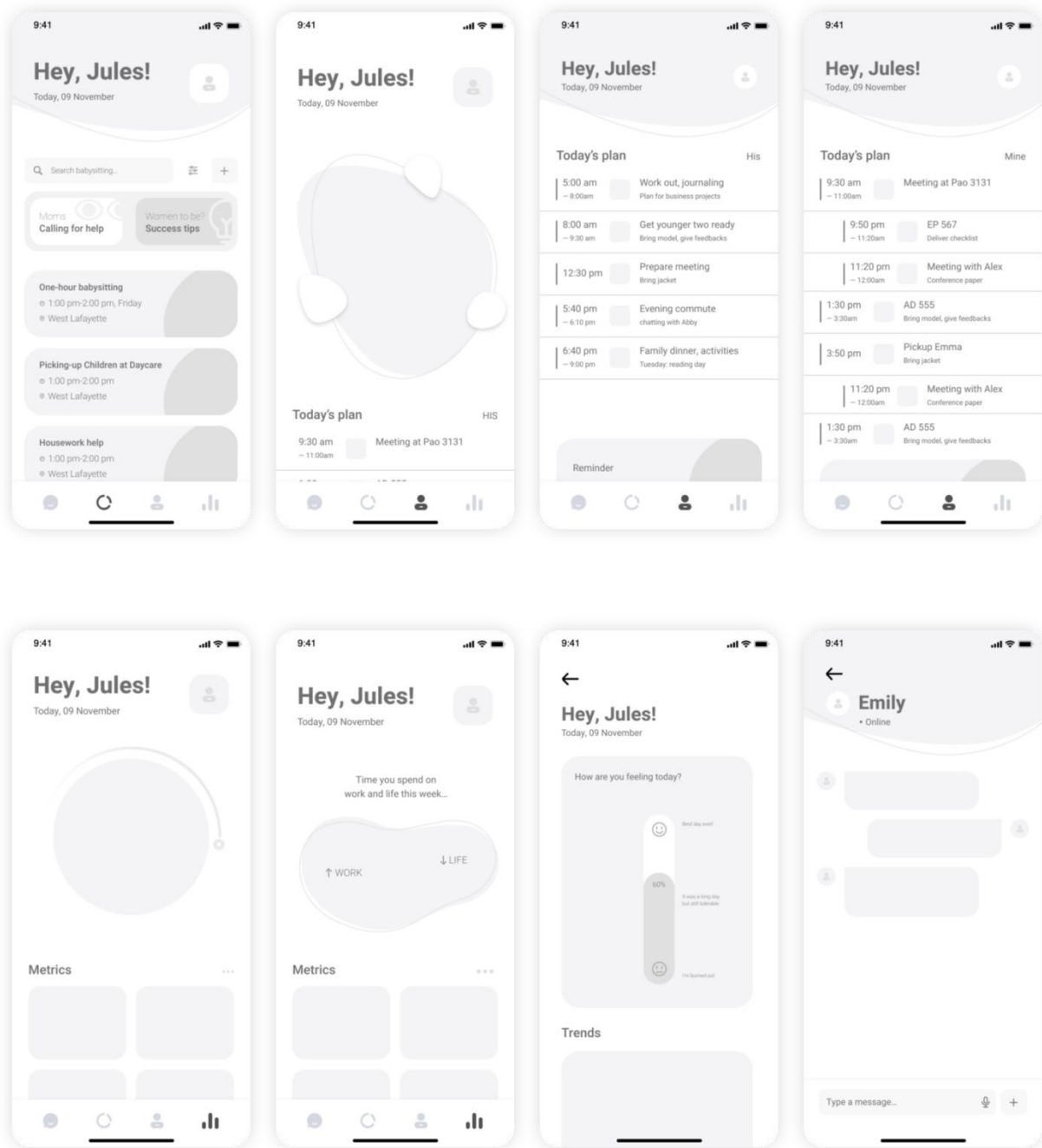The figures below show the first version of some wireframes.

Figure 17. First Version of Wireframes

After presenting these wireframes to my committee members, we discussed some details on the personal schedule page, planning page, and chatting. For the personal schedule page, we all agreed that the current design is similar to other competing products and does not reflect the

working mother group's characteristics. Also, the visual contrast between the personal schedule and partner schedule is not very obvious. For the metrics page, it does not show the connection of the product. The presentation of the data is not apparent and still lacks details. As for the chatting page, we considered that users are typically seeking help in emergencies. However, it might take a while to type. We decided to add a predetermined dialogue package. Users would be able to select from the package instead of typing by themselves.

After receiving the feedback, I started to design the second round of wireframes. The detailed wireframes are shown below.
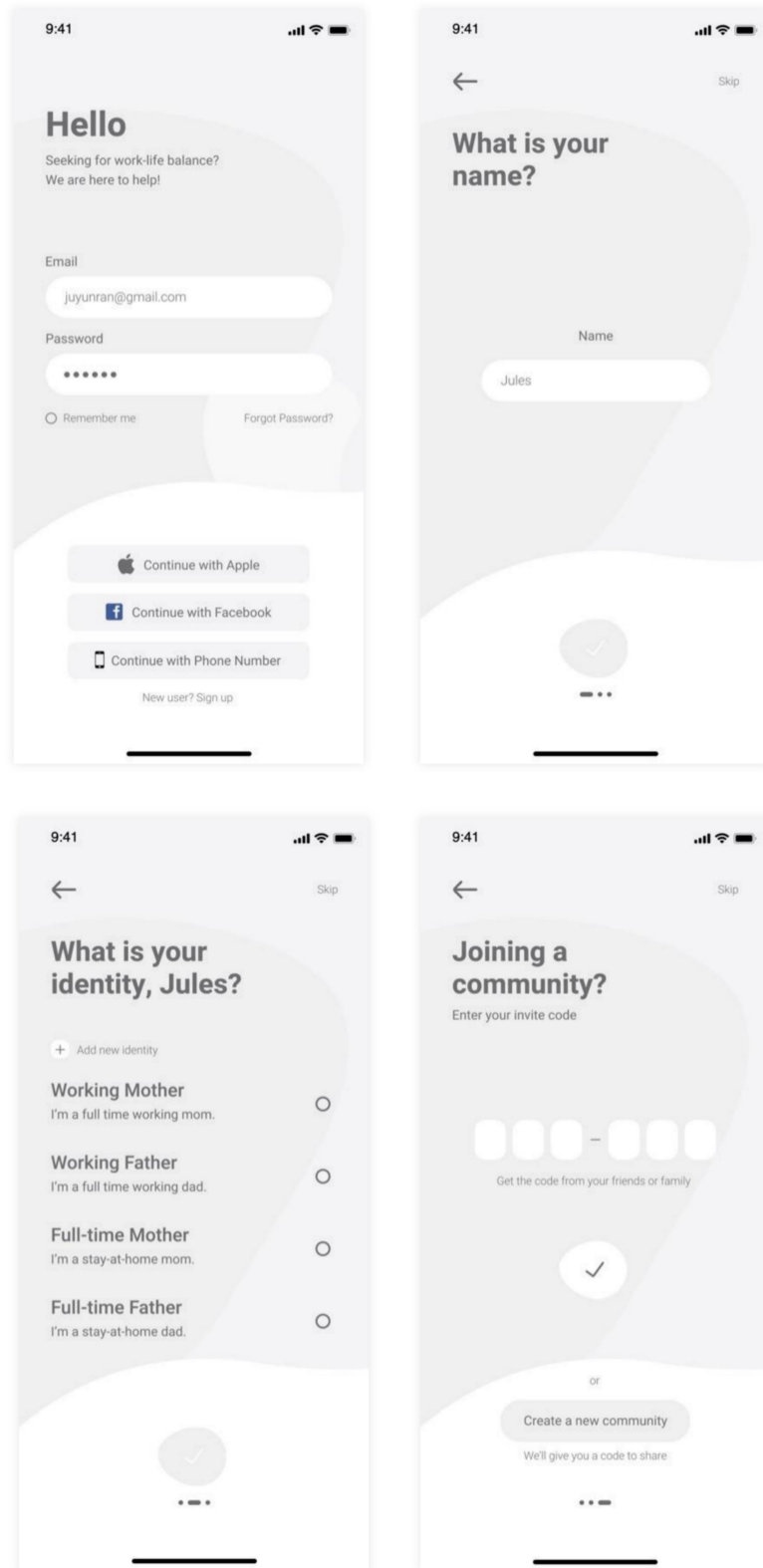
Figure 18. Wireframe: Sign Up Page
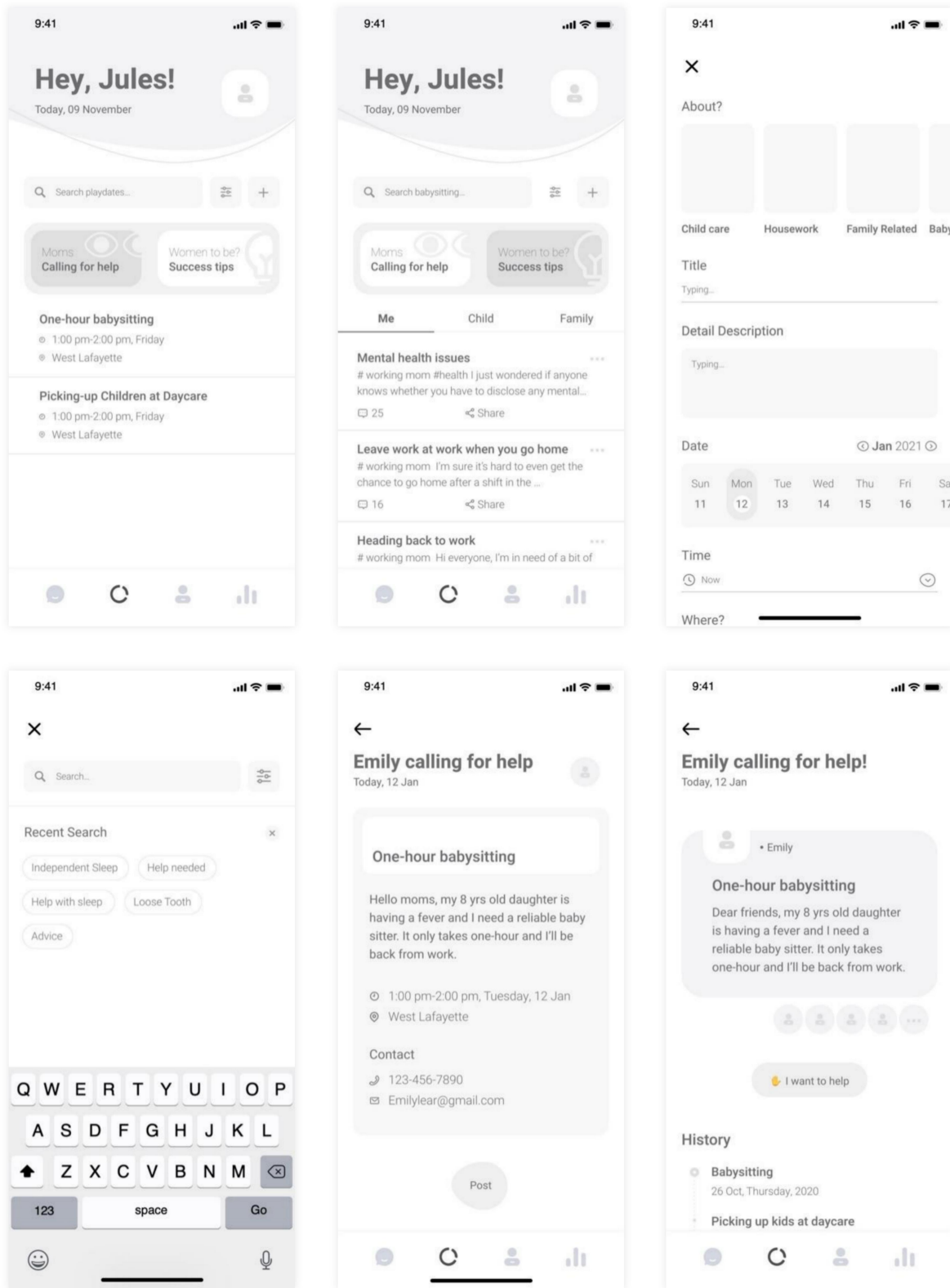
Figure 19. Wireframe: Mother Community Page
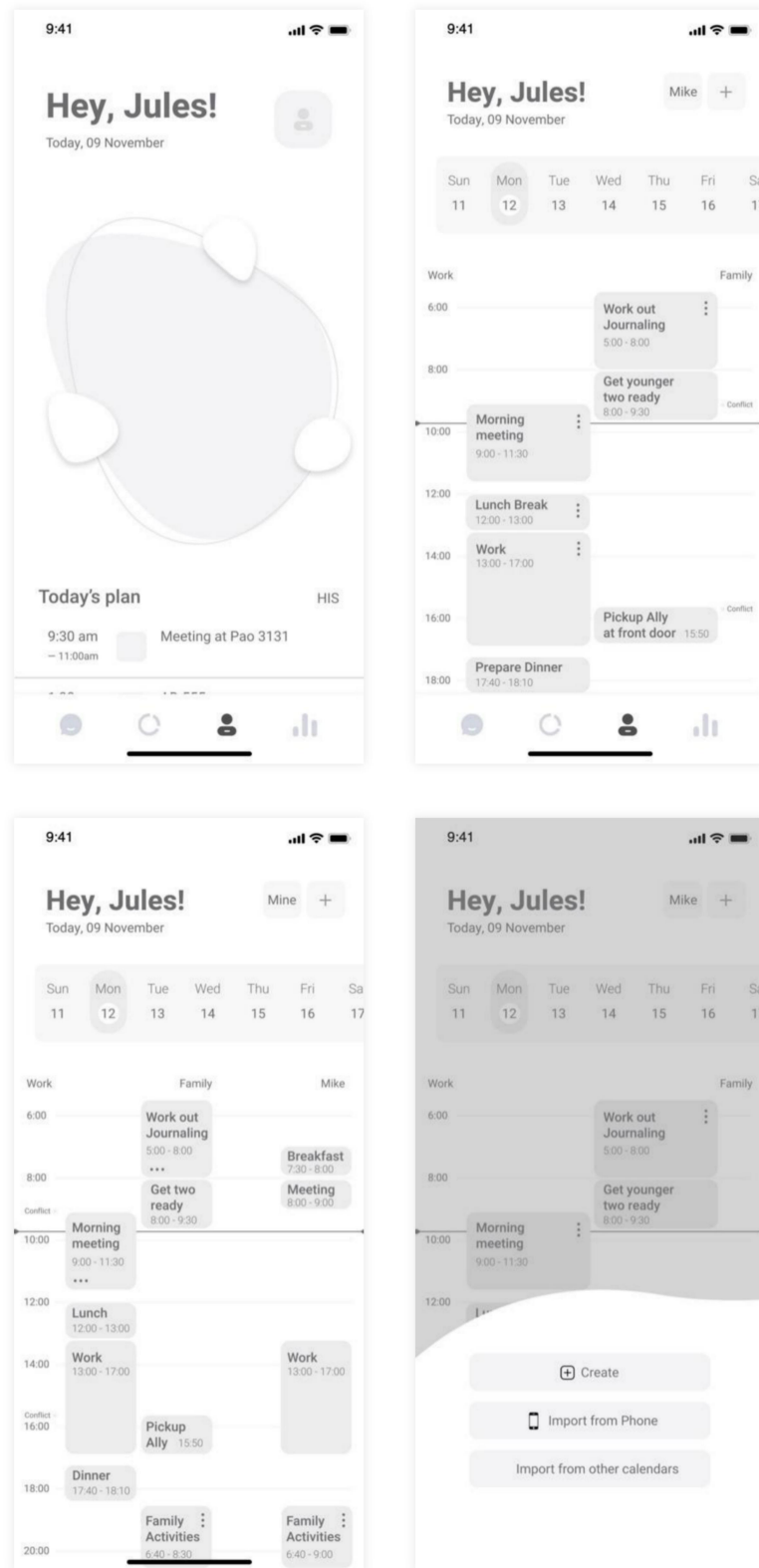
Figure 20. Wireframe: Personal Page
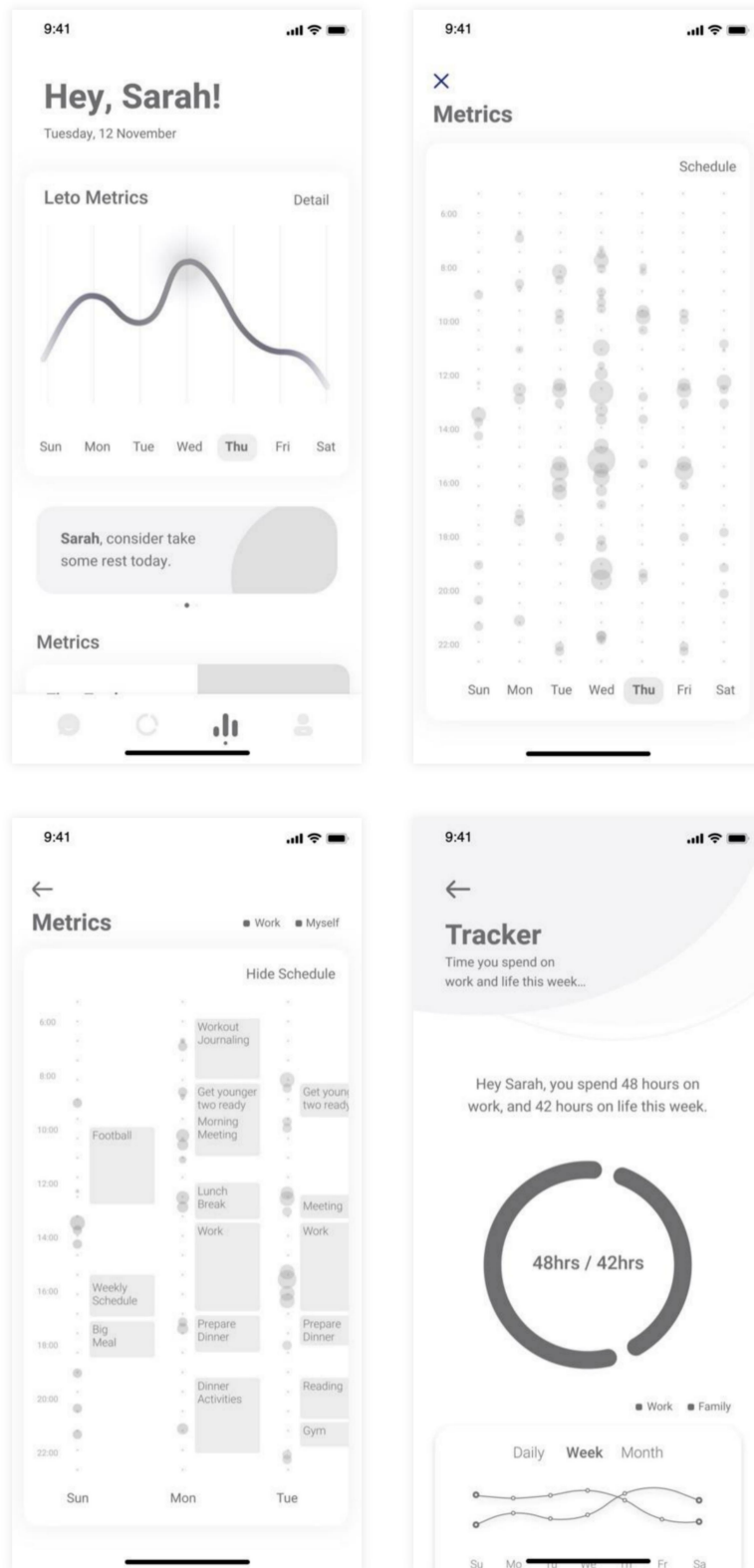
Figure 21. Wireframe: Metrics Page
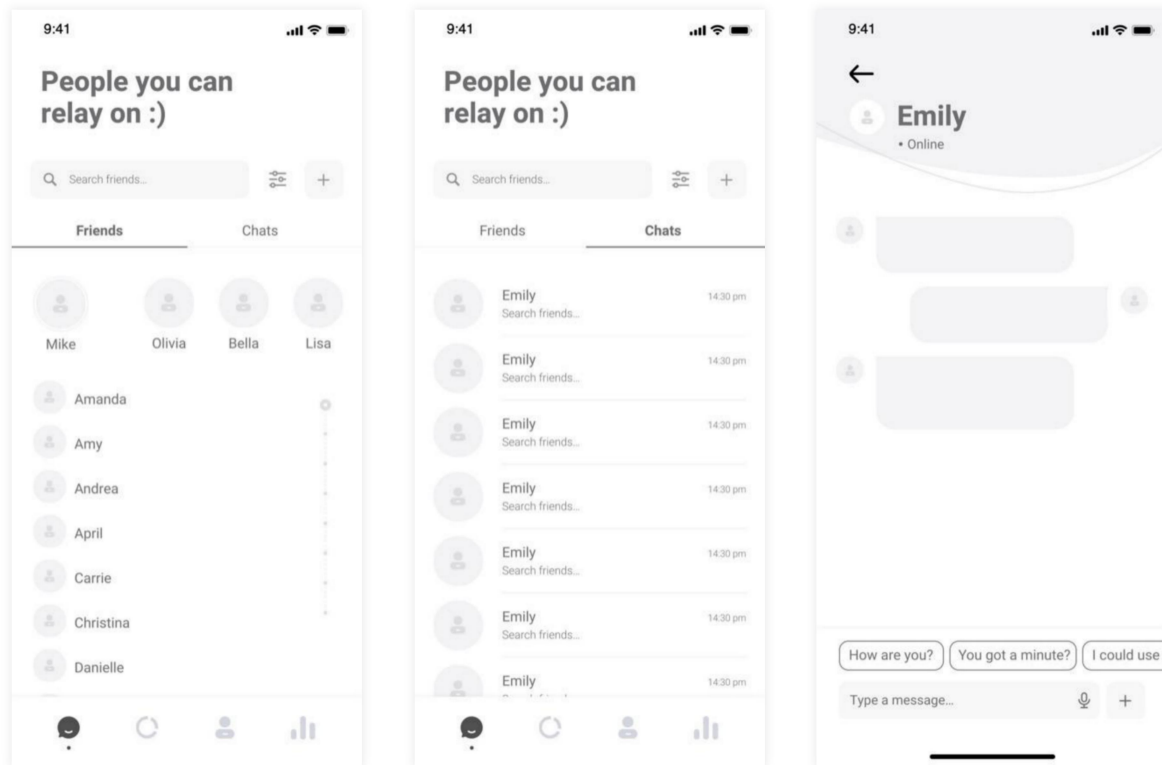
Figure 22. Wireframe: Chatting Page

6.5 Visual Design

After defining the main function and layout, I started developing the visual part of the design. The visual design mainly focuses on the aesthetic part of the system. Designers should focus on visual elements such as lines, shapes, color palette, texture, and typography in this stage. An excellent graphic design helps understand the system's content and function and allows users to complete tasks and improve efficiency.

In the visual design process, I started with the color palette design. I chose light pink with low brightness and low saturation as the primary color. From the perspective of psychology, bright pink evokes the feeling of calmness and love (Braam, 2020). It also complements the design subject. For the second color, I selected a high contrast with an experimental purple. It is applied for highlighting and will be used on some buttons, titles, and tabs. (see Figure 23)
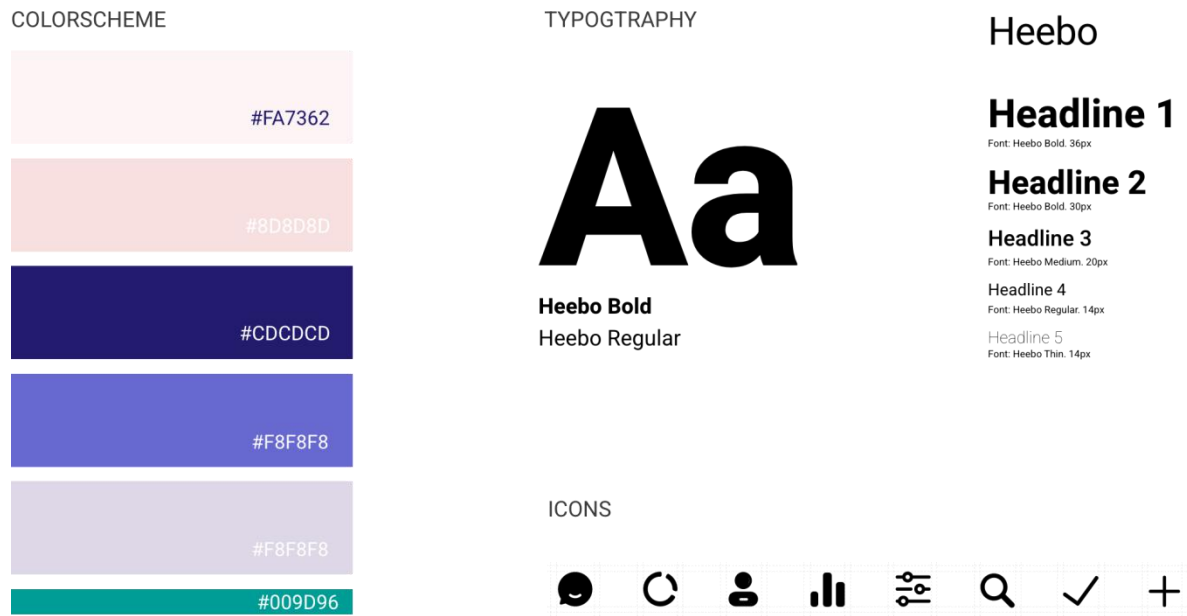
Figure 23. Visual Design Elements

The logo is another essential part of the design. I adopted the name of the Greek Goddess of motherhood, Leto, as my product name. I used the ripple elements of the Zen garden and adopted a simple concentric circle design (see Figure 24). Also, to follow the minimalist design principle and keep the whole product design consistent, I adopted a monochrome design.

Figure 24. Logo Design

During the visual design process, I also focused on the interface elements design. The interface elements design revolves around three components, input components, information components, and navigational components. All of these elements help users move around a product. Input elements include checkboxes, dropdown lists, buttons, toggles, text fields, password fields, date

pickers, and confirmation dialogues. Information components share information with users and include tooltips, icons, progress bar, notifications, message boxes, and modal windows (pop-up windows). Navigation components help users navigate the system and have search fields, tags, and icons. The details of interface elements will be introduced in the next part.

6.6 Detailed Features

6.6.1   Landing page

The main idea of the application is to encourage users to gather familiar people together and build a trustable community. In the register and log-in process, first-time users can choose to create a new community or use the invite code to join an existing community. The invite code can only be obtained from other users. Also, every new user needs to get approval from the community founder to ensure reliability. To provide users' closeness and familiarity, a community contains a limited number of users. However, users can join multiple communities at the same time. This is useful if a user has two kids in different age groups.

Although the system is designed for the working mother community, other identities such as working fathers, full-time mothers, and full-time fathers are encouraged to join the community. Compared with working mothers, stay-at-home mothers or fathers may have more disposable personal time. In specific time slots, they may have more freedom to offer help. (see Figure 25)
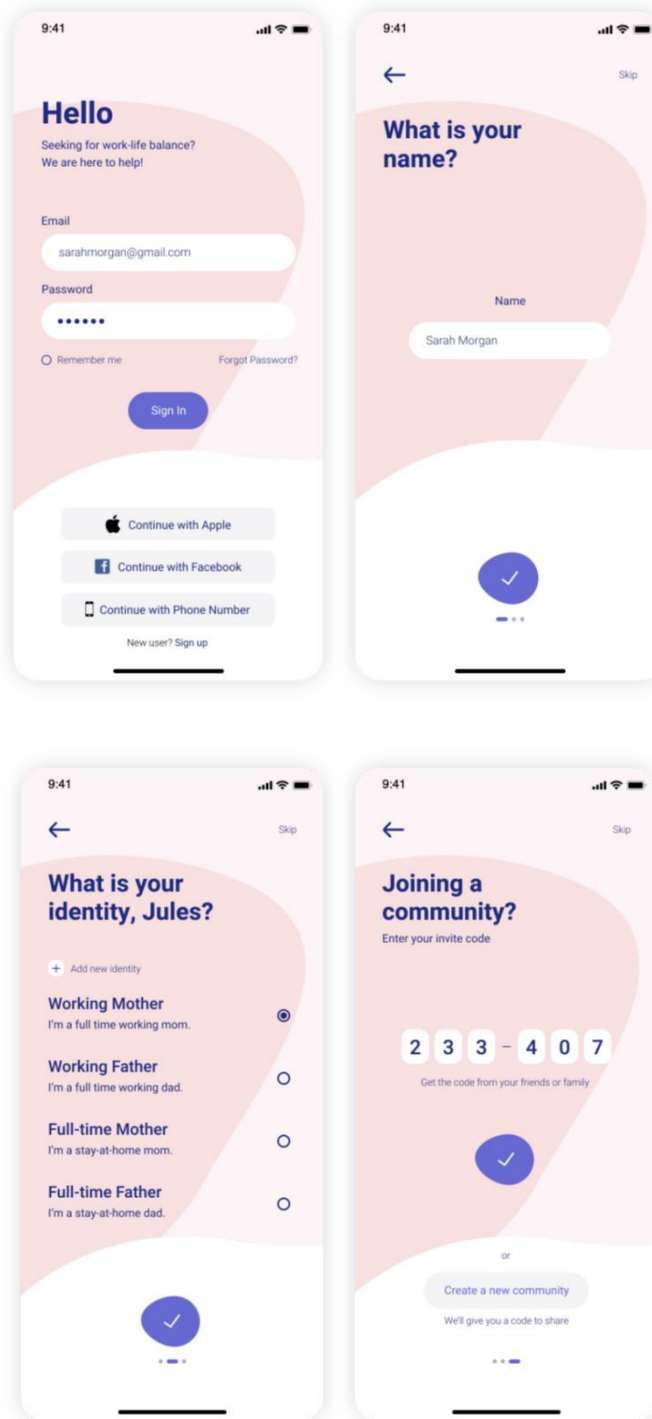
Figure 25. Prototype: Register and Log-In

6.6.2   Mother community

Moms calling for help!: In the community, users can share posts when they need some help, especially when it comes to an emergency and their spouses or family members are not available. Sometimes, moms need friends' help, such as to pick up a child or take care of a baby, but they also feel embarrassed asking others to help, and they want to find a suitable way to pay them back. If mothers can offer to pay each other back, they may be more willing to ask. When sharing posts, users need to enter detailed information such as title, a detailed description, time, and location.
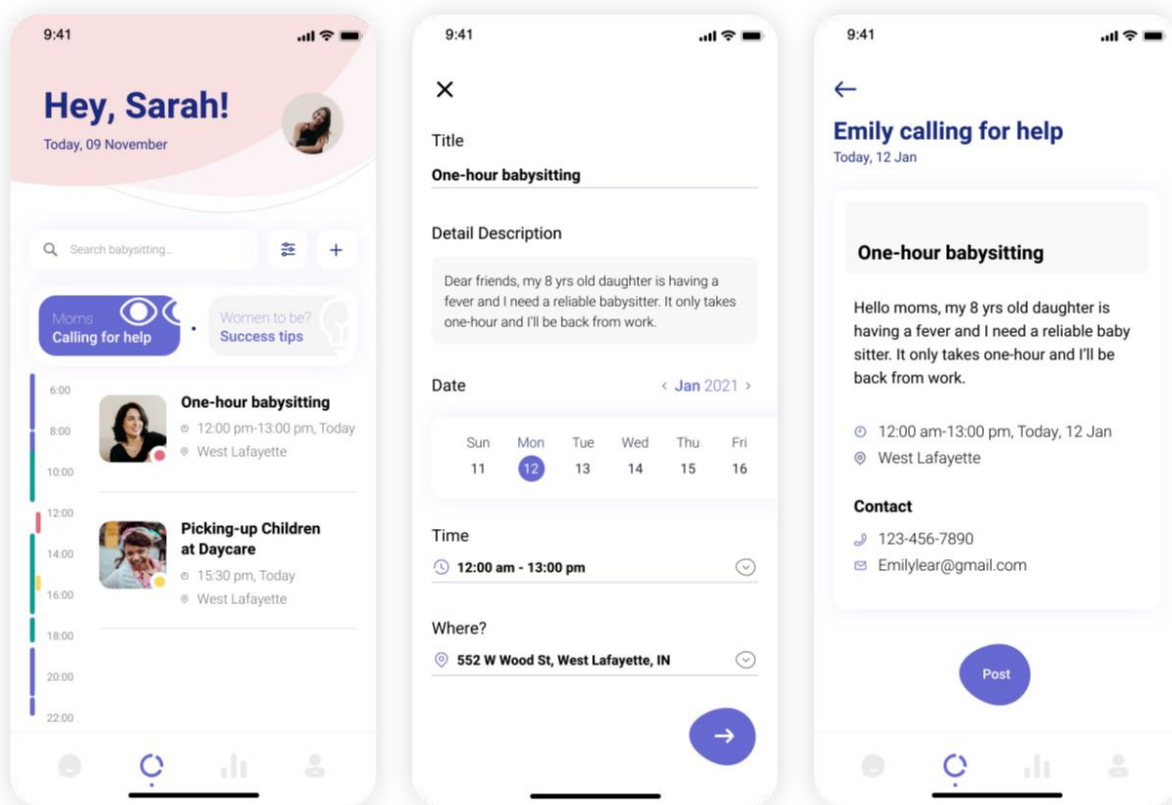
Figure 26. Prototype: Moms Calling for Help-Add a Post

On the main page, the green and purple slots match personal schedules (details on the personal schedule will be introduced in the following few paragraphs). In contrast, the empty slots

indicate that users are not scheduled for this period. When calling for help, different users will be shown in different colors. Through color coding, users can easily compare need-helped-time-period with personal schedules and decide whether they can offer support or not. (see Figure 27) If users want to offer help to someone, they can check detailed needs and call for confirmation. On the detail page, alongside the information, users can also check the helping history.
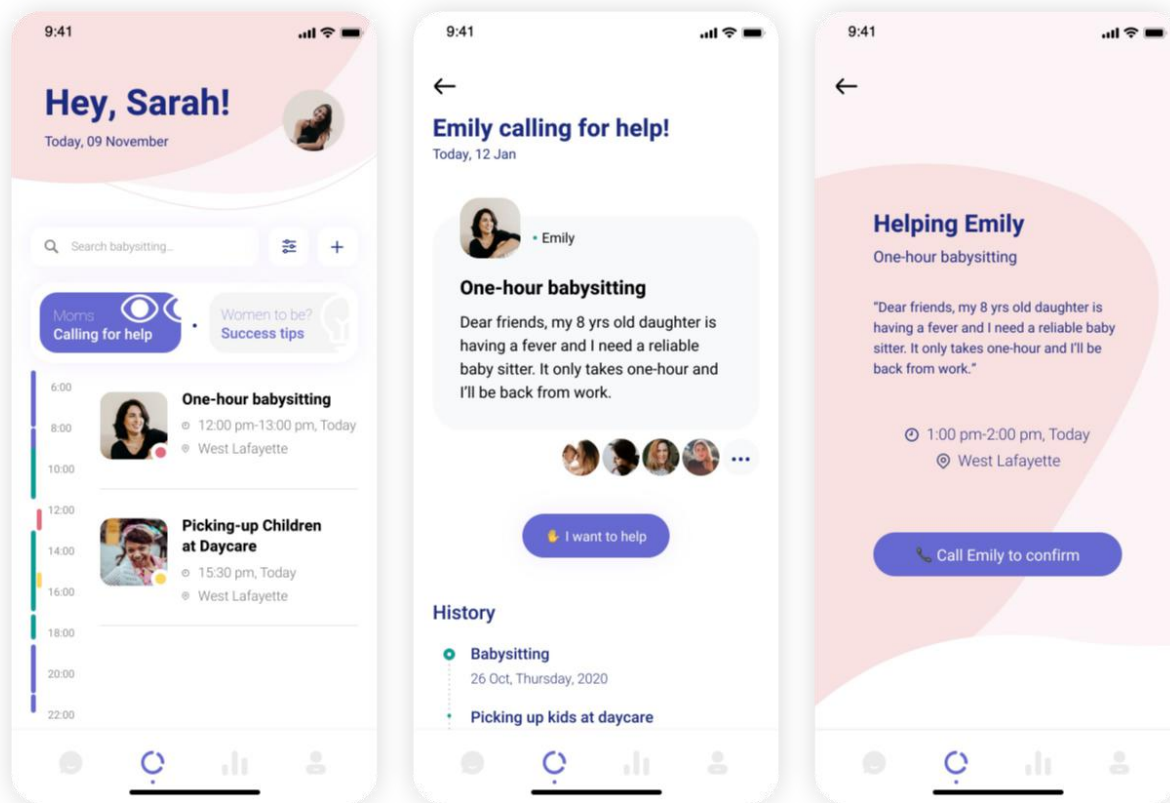
Figure 27. Prototype: Moms Calling for Help-Offer Helps

Women to be? Success tips: This is a place where users can share resources, tips, and advice. It can be anything related to themselves, childcare, housework, health, work, and family. Users can also post questions, concerns, or suggestions to each other. By using the search and filter function, users can filter and read interesting topics. Users can also reply, save, and share others'

posts. Building a mother platform encourages users to interact and communicate with each other and helps users express emotions and relieve stress. (see Figure 28)
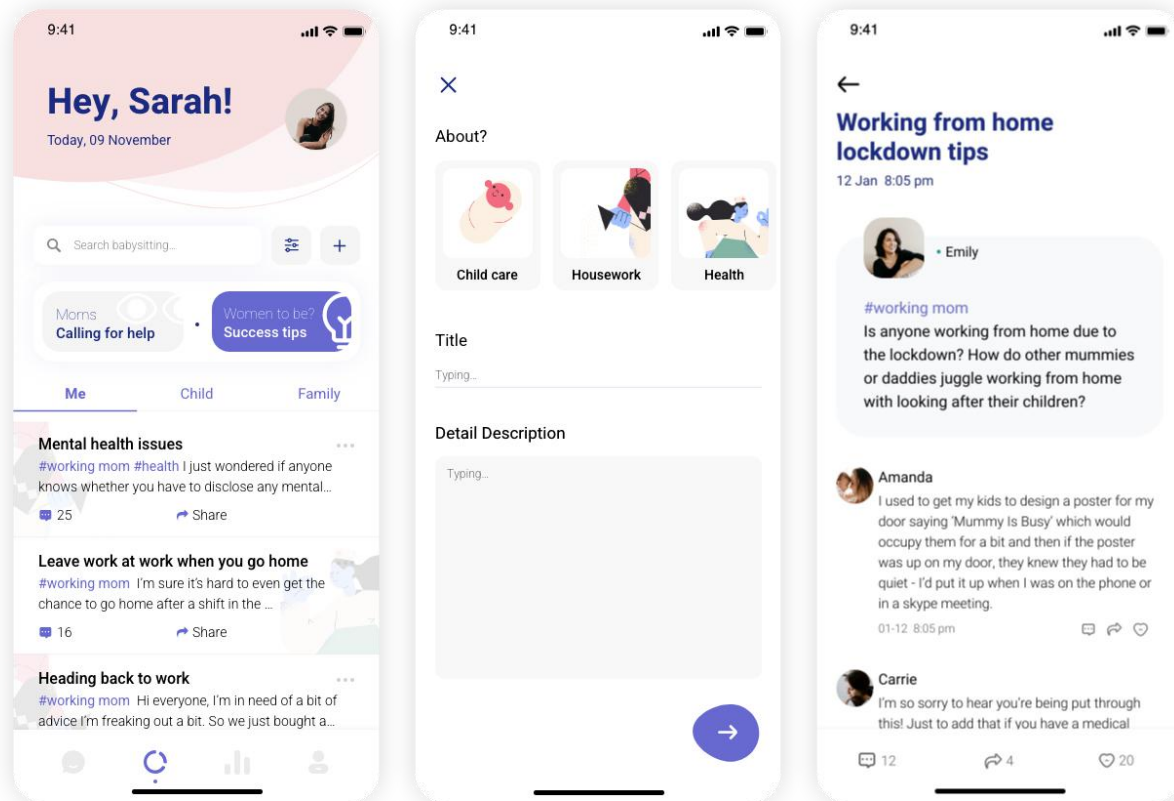
Figure 28. Prototype: Women to Be? Successful

6.6.3   Personal schedule

On the top of the personal page, the rock shape and surrounding form mimic the Zen garden design—the user's picture is located in the center circle and surrounded by intimate friends. Through such a sense of form, the goal is to let users know that they are always being helped, loved, and surrounded.

Users can scroll down and check personal and spouse schedules. By importing schedules from other calendars, users can quickly check personal and spouse schedules. On this page, the working events and personal events are divided into two columns with different colors. Over time, completed events will be grayed out. When there is a time conflict between work events

and personal events, a red line across two columns will appear to remind users that there is a time conflict and that they will need to take action.

With a simple click, users can quickly view their spouses' calendars. With a glance, they will know if their spouses are free or not when they need help. Whenever needed, users can share tasks with their spouses and send reminders to them. (see Figure 29)
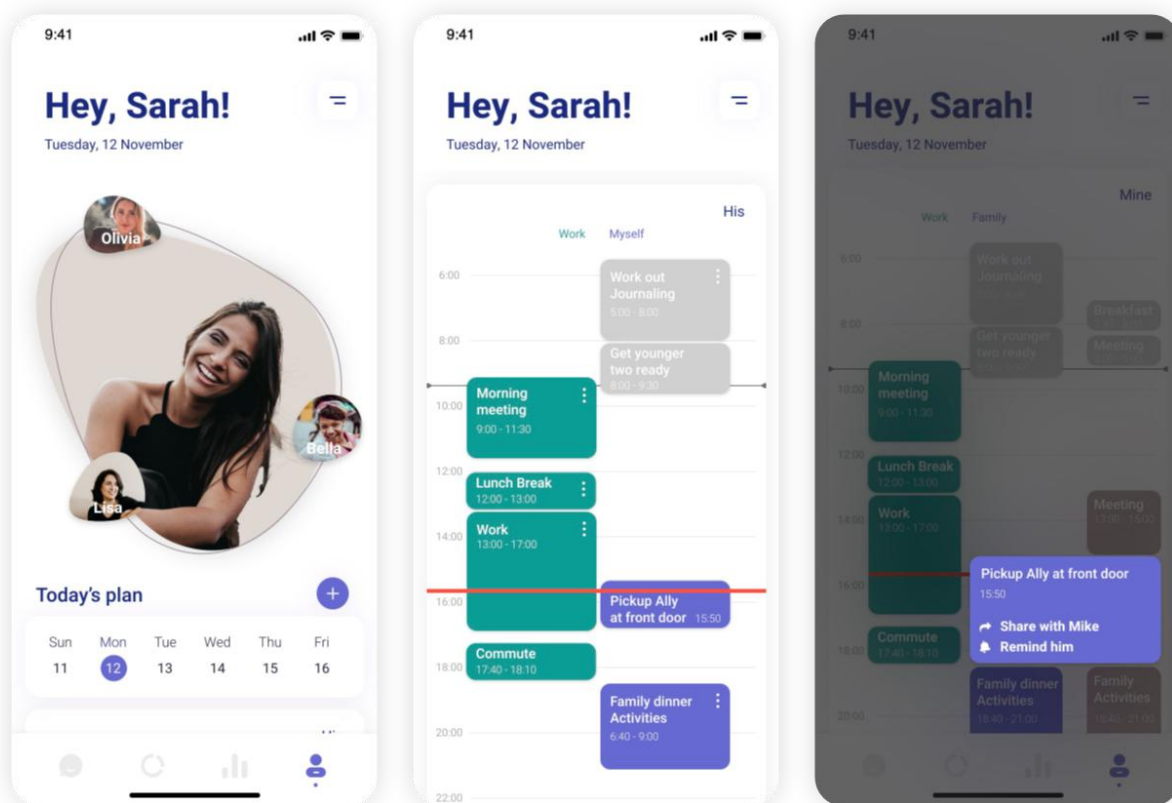
Figure 29. Prototype: Schedule and Plan

6.6.4 People you can rely on

The list of "people you can rely on" shows users their spouses and friends in the community. Friends will be ranked in alphabetic order. The most intimate friends and those users who have the most frequent interactions will be shown on the top. The goal of this design is to help users set up their priorities. When users need help, they can quickly locate these closest and trustworthy friends and ask for help, even before adding posts in the mother community. The

pre-set messages help users kick off the conversation quickly and conveniently to save time when dealing with an emergency on the chat page. The heart shape under the name represents the intimacy level between users. When users collect three hearts, the system will send a push notification and remind users to repay.
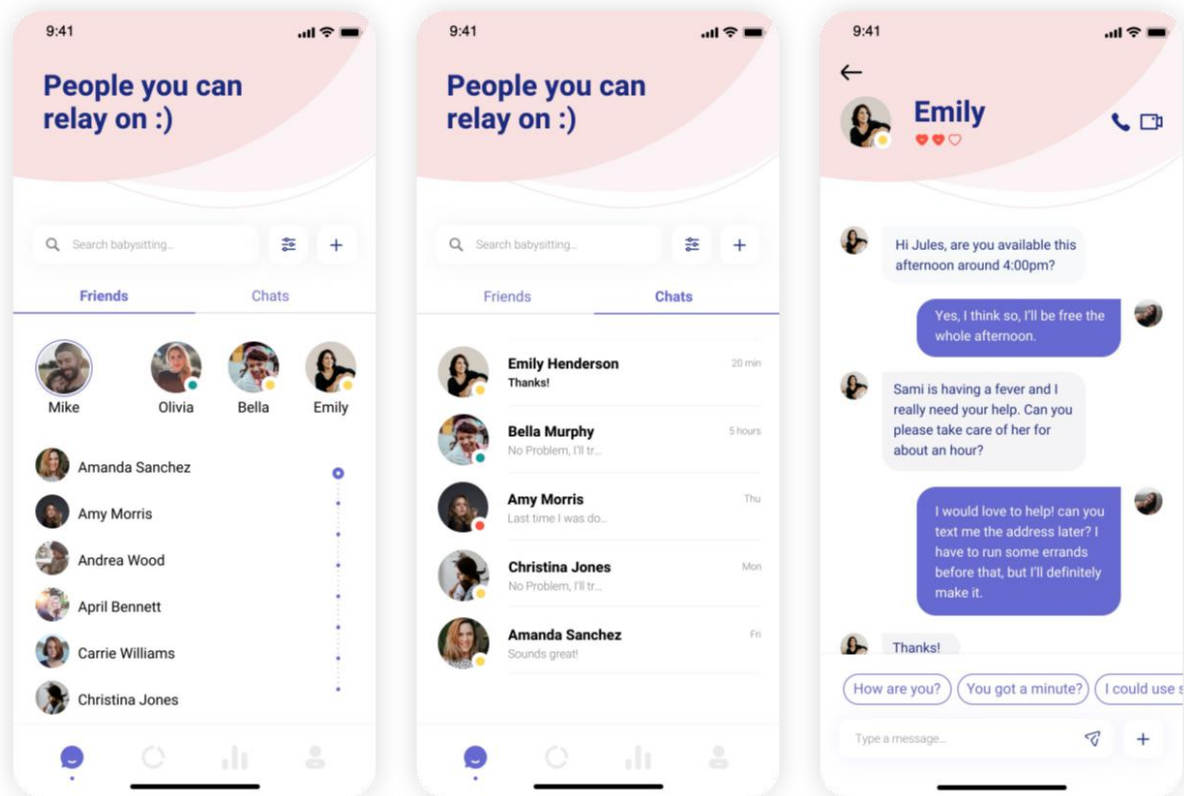
Figure 30. Prototype: People You Can Rely On

6.6.5   LETO: fidget keychain (input)

The LETO fidget key chain is a stress reliever and data collector. The product is composed of two parts. The upper part is the fidget key chain, and the lower part is the Bluetooth rechargeable base. The key chain will be carried by users in their daily life, while the base will be kept at home. The base is also a wireless charger and powered by changeable batteries. When users put the key chain back on the base, it will charge the key chain. There is a button on the back of the base. With a long press, it will connect to the LETO application and start to transfer the data.

Figure 31. Prototype: LETO Fidget Product

As for the key chain, there is a pressure sensor inside that can measure and record pressure. At the same time, the outside is made of closed-cell polyurethane foam rubber. The soft feel is very user-friendly and comfortable to the touch.

Figure 32. Prototype: LETO Fidget Key Chain

6.6.6 Metrics (output)

The metrics page connects with the LETO key chain. After collecting the user's daily interactive data and transferring it to the application, users can easily check their daily and weekly data to analyze their stress levels. Figure 33 below shows the weekly data of squeezing the Fidget. By observing the curve line, users can identify which day of the week they interact most frequently with the key chain. Users can also click the detail button to check specific times during the day. On the second page, there is a data visualization that shows the detail of the squeezing data. The vertical axis represents the day, and the horizontal axis represents a week. The size of the circle represents how many times the user has squeezed the key chain.
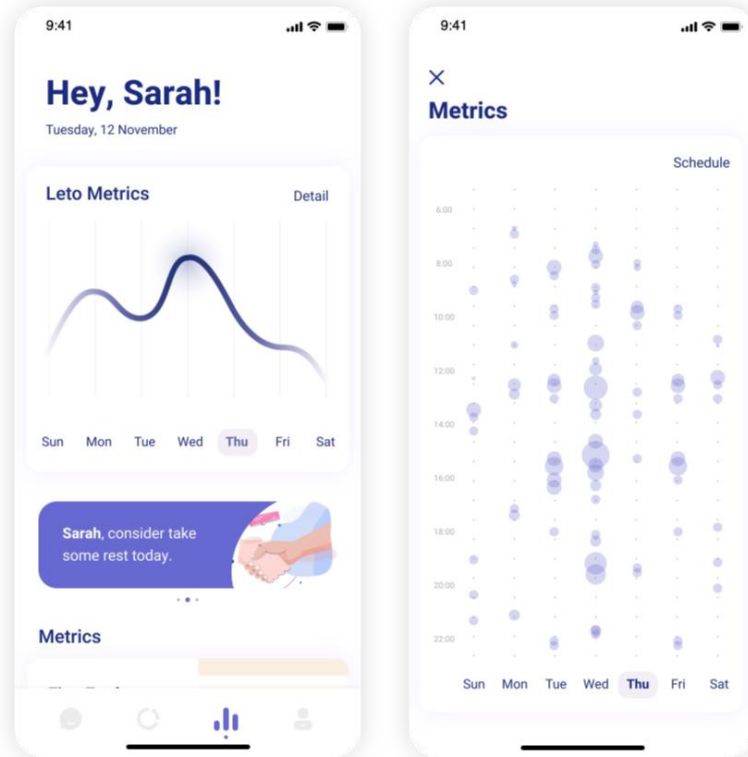
Figure 33. Prototype: LETO Metrics Part 1

Users can also match the data with their schedule to trace back to the specific timing by clicking the schedule button (see Figure 34). Data shows that the act of squeezing can help people ease concerns and release stress (Dumbleton, 2016). As a result, many people decide to use stress balls to relieve stress. People sometimes play with the stress ball unconsciously. Therefore, to

ensure the accuracy of the data, users can compare the schedule with their squeezing data. For example, suppose users think they are interacting with the LETO ball several times during a specific period. Still, after comparing it with the schedule, they find out that they are only playing with the LETO during the free timeslot. In that case, they can understand their patterns more accurately.

Based on the calendar, the metrics page will record users' weekly time—how much they spend on work and life. The app will send a reminder and pop-up window to remind users to relax or get some rest. By banking personal and spouse's time, the reward mechanism would remind users to reward themselves or their spouse.
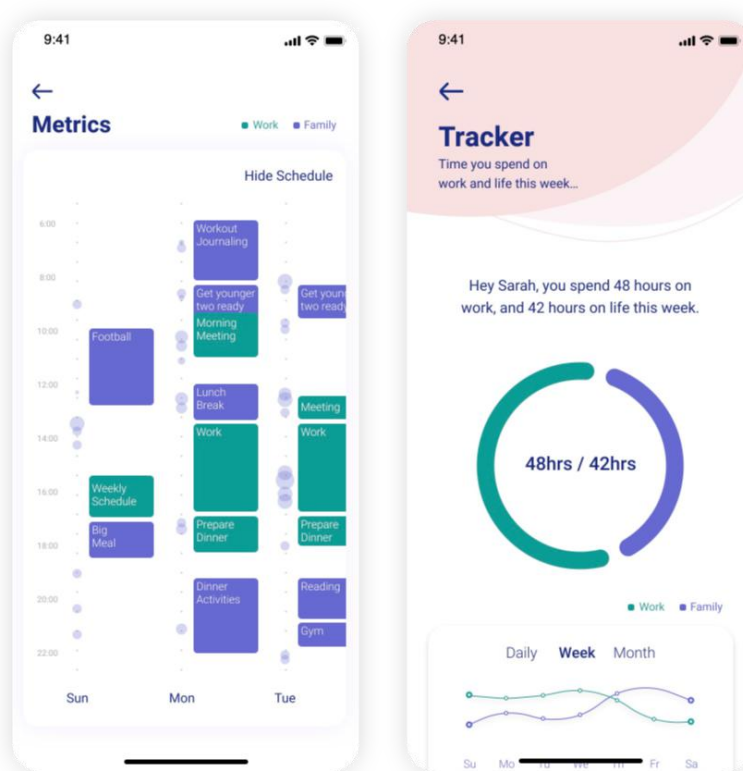
Figure 34. Prototype: LETO Metrics Part 2

CHAPTER 7. EVALUATION

7.1 Heuristic Evaluation

After finishing the detailed design to test the system's usability and possible user interface problems, I conducted a round of heuristic evaluation studies. Usually, the evaluators will be experts who are familiar with interaction design and heuristic evaluation. Based on the feedback gathered from several evaluators, designers will be able to take the suggestions and thus improve the design.

Depending on a variety of design goals, researchers will choose different heuristics to evaluate. I adapted several heuristics based on Jakob Nielsen's ten usability heuristics for user interface design (Nielsen & Molich, 1990) and Donald Norman's design principles for human-computer interfaces (Norman,1983). I divided them into four categories with fourteen sub-categories: A-aesthetic, B-consistency, C-usability, D-others. Table 2 shows the heuristics I selected with detailed problem descriptions. Furthermore, I applied Nielsen's severity rating scale for the evaluators to rate usability problems:

0= No usability problem at all.

1= Cosmetic problem. Fix it only if the designer has extra time.

2= Minor problem. Not very urgent to fix.

3= Major problem. It will affect the usability of the system if not be fixed.

4= Catastrophe problem. The system should not be released unless the problem is fixed.

Table 2. Heuristic Evaluation

Heuristic	Sub-heuristic	Problem Description
A: Aesthetics	A1: Attractiveness	Do you think Leto (including product and UI) has a unique and appealing appearance (color, material, shape, texture)? Do you think Leto has an attractive design?
	A2: Minimalist Design	Do you think Leto (including product and UI) follows the minimalist design rule? Does it have any irrelevant information?
B: Consistency	B1: Consistency and Standards	Do you think that in Leto (UI), users don't need to wonder whether different words, situations, or actions mean the same thing?
	B2: Linguistic Clarity	Do you think the Leto (both product and UI) will communicate as efficiently as possible?
C: Usability	C1: Affordance	Do you think you can understand how to find someone to help and finish tasks based on the info provided in the slides (UI)?
	C2: Visibility of System Status	Does the interface or product always keep users informed about the results of their actions and the interface's status through appropriate feedback within a reasonable time?
	C3: User Control and Freedom	Does Leto (UI) offer users space where backward steps are possible, including undoing and redoing previous actions?
	C4: Flexibility and Efficiency of Use	Users should be able to customize or tailor the interface to suit their needs so that frequent actions can be achieved through more convenient means.
	C5: Ease of Use	The system should be easy for the user to accomplish tasks even when they encounter the design for the first time. Do you think Leto(UI) is easy to interact with?
	C6: Feedback	Does Leto (UI) provide effective feedback for users? Such as finished one task?
	C7: Practicality	Do you think by using the Leto (UI), working mothers would be able to ask for help when they need it and then better achieve work-life balance?
	C8: Learnability	Does the Leto (UI) provide additional assistance as needed or requested?
	C9: Error Prevention	In case of operation error, does this design provide a corresponding message to help users recognize, diagnose and recover (UI)?
D: Others		Additional comments (you are encouraged to provide further comments which may not have been covered by the heuristics above)

7.2 Recruit Evaluator

I recruited three evaluators to help me evaluate the system. Two of them are experts with more than three years of experience in the interaction design field and had conducted heuristic evaluations before. Another evaluator is not an expert in user interface design and does not have lots of design experience. However, she is a well-educated Ph.D. candidate and has some basic knowledge of interaction design. This evaluator is also a target user that belongs to the working mother community. The detailed information of evaluators is shown in Table 3.

Table 3. Evaluators Information

Evaluator	Identity	Duration
E1 Female	Ph.D. candidate major in Education at Purdue University A working mother with two kids	50 minutes
E2 Female	Third-year graduate student Interaction Design at Purdue University	60 minutes
E3 Female	Ph.D. candidate major in User Experience at Purdue University A working mother with one kid	60 minutes

7.3 Evaluation Process and Feedbacks

All of the evaluations were contacted online through Zoom meetings due to the Coronavirus pandemic. Evaluation forms, interactive prototypes, and introduction slides were sent to evaluators before the assessment. In the beginning, I shared my screen and spent 15 to 20 minutes with each evaluator to introduce design goals and key features. Then, I spent another 5 to 10 minutes going through the evaluation form and heuristics. After the introduction, evaluators went through interactive prototypes and started evaluating the system by themselves. According to heuristic statements and problem descriptions, evaluators provided corresponding severity ratings and gave feedback and suggestions. Table 4 shows the evaluation rating provided by three evaluators, and Table 5 shows the detailed comments.

Table 4. Evaluation Rates

Heuristic	Sub-heuristic	Evaluation Rating			Total Severity Ratings	Mean Severity Ratings
		E1	E2	E3		
A: Aesthetics	A1: Attractiveness	0	1	1	2	0.67
	A2: Minimalist design	0	0	1	1	0.67
B: Consistency	B1: Consistency and standards	0	1	2	3	1
	B2: Linguistic clarity	0	1	2	3	1
C: Usability	C1: Affordance	0	1	1	2	0.67
	C2: Visibility of system status	2	2	3	7	2.33
	C3: User control and freedom	0	0	1	1	0.67
	C4: Flexibility and Efficiency of Use	0	0	1	1	0.67
	C5: Ease of use	0	0	2	2	0.67
	C6: Feedback	1	1	4	5	1.67
	C7: Practicality	0	1	3	4	1.33
	C8: Learnability	0	0	2	2	0.67
	C9: Error prevention	0	0	4	4	1.33
D: Others		1	1	0	2	0.67

Table 5. Heuristic Evaluation Feedback

Heuristic	Sub-heuristic	Comments
A: Aesthetics	A1: Attractiveness	1) Conflict on schedule is a little weird. 2) Leto app has a good color scheme (pink-purple). The soft survey forms in the app and the warm-toned color scheme make sense. 3) There are many minor inconsistencies in materiality and issues when it comes to icons and compositions. For example, some buttons and text entries have a shaded effect, but others don't. Some linework is thick while others are thin, etc. 4) The white outline icons on the "Calling for Help" and "Success Tips" buttons are vastly different from the pictures used for the theme buttons: child care, housework, etc.
	A2: Minimalist design	1) The UI of the app and the keychain definitely adhere to a minimalist design aesthetic. 2) However, the interactions and graphs upon loading should animate, at a minimum. The drawings or background bubbles could animate at maximum.
B: Consistency	B1: Consistency and standards	1) Task creation page wording could be more consistent. 2) The red-yellow-green dot indicating the current activity level for the user is differently sized and presented across the app. 3) The current iPhone calendar uses a thin red line to mark the current time in the calendar, so using a red thick line is too close to the current status (vs. alerting a conflict). Also, the gray and red line markers in the calendar are not consistent: the gray line sits under the event bubbles, while the red line sits atop of them. 4) Another consistency issue is the saturation of the shade behind a selection: for example, "Today's Plan" has a fully saturated highlight, but the day selection on the "Metrics" page is opaque, while there is no shade at all for the current day on the metrics page when the calendar is pulled in or for the "week" selection on the tracker page. 5) Some icons are not consistent—for example, the phone icon and video icon.

Table 5 Continued

	B2: Linguistic clarity	1) A linguistic issue is how time is represented: Many are only used to AM/PM times versus military or the rest of the world 24h clock in the US. It may be essential to allow users to choose how they wish that time is represented in the app. 2) If the "Metrics" page needs to say "Hide Schedule," then it must need "Show Schedule" as the default instead of just "Schedule." 3) Some verbal terminology and visual consistency are the main roadblocks for communicative clarity. For example, I think that Full-Time Other" is best referred to as a "role," not an "identity." 4) I think that there is an error in the button: "Women to Be? Success Tips" - I assume it should read "Mothers to Be?" instead? Would this read "Fathers to Be?" if the user identifies as a male upon sign-up? 5) "Women to Be" is super unclear; success tips could be another word. 6) Your partner shouldn't be under the "Friends" list on the chat page
C: Usability	C1: Affordance	1) the style of two tabs on the community page looks like an entry to a new page. 2) Since this is a mock-up, much of the interaction statuses are not yet designed and thorough. However, these will be very important for error prevention and for conveying user and system status. For example, the "next" buttons should be grayed out until the user has input the necessary info (e.g., when posting a call for help). 3) Since people often forget their keys, the keychain holder is a great idea to create a specific location for keys in the house. However, the keychain should emit a glowing light or other animating reminders so that people would not forget to take their keys.
	C2: Visibility of system status	1) After I shared my schedule with my husband, it would disappear from my task list, right? Can I take it back if I shared it by mistake? 2) Do you really need to have the confirmation page "Call Emily to confirm"? The system should show if the request has been seen by anybody. If so, then who has volunteered, send a confirmation request to the person who was selected to help, and show visually that the person has confirmed. 3) Since the app grays out the inactive page icons and colors the active page icon purple, there is no need for the little dot under the icon.

Table 5 Continued

	C3: User control and freedom	1) User has full control in the app, over their communities, over what advice they seek, over what they reach out for help for, etc. 2) However, the user has no control over the keychain. The user is supposed to use the keychain whenever desired for stress release purposes. However, the keychain is always tracking their data, and the user has no control over it (e.g., to opt-out, delete or not collect it). 3) The app could automate even more and reduce the requirement for users to call others to confirm the help availability. I did not see it in the app right now, but can users control their settings when they are shown to be available and when not?
	C4: Flexibility and efficiency of use	1) The app seems to have some essential flexibilities built into it. For instance, one can join or create a community. 2) The keychain data can be shown side by side to the schedule or alone. This is good for a detailed view of what specific events correlate with the highest levels of stress-balling. 3) The week's bubble chart of keychain fidgeting could color code the bubbles based on if they were done during leisure or work time.
	C5: Ease of use	1) Confirmation requirements could be eliminated by further automating the help-seeking and confirmation processes. 2) The app could better match help seekers and providers by matching people based on availabilities and live time feedback.
	C6: Feedback	1) I am wondering what will happen when several people respond to my "call for help"? 2) When a task is created, it could give a pop-up to confirm. 3) The keychain does not seem to give any feedback about its status: e.g., when its battery is low or fully charged and ready to be picked up from its charger. This could be vital feedback to avoid data loss. 4) If the app provides sufficient confirmation about posts being posted, help requests being confirmed for sure, if someone is trustworthy, if the keychain needs charging or not, etc.

Table 5 Continued

	C7: Practicality	1) I think several important aspects are missing for this to work well in a variety of contexts. A lot of the time, babysitting help needs may be urgent. In these situations, distance is critical. Other times, mothers may need help understanding their child, but child issues are very much based on the child's age. Hence, sub-grouping or labeling potential helpers (especially on parenting tips) with their child's ages. 2) As years go by and the children age and new issues emerge, parents often start forgetting the old problems. Could the app uses AI to remind mothers to take a break and offer them tips on what to do based on their reported interests during the initial onboarding? For example, a book lover can be reminded to read a book, or it can advertise a recent best-selling novel. 3) Is there any science-based benefit from tracking one's stress-balling activity? Presumably, the user will fidget much more during their free time or when on the go, rather than at work, even though work may be the primary contributor to stress. At work, people are often behind the computer with their hands busy. 4) I wonder about tracking the stress ball use—I am unconvinced of its value. On the contrary, I think that automatically tracking the work and family life hours could be eye-opening. However, some goal setting or AI-based assistant would be helpful to achieve the desired balance and then preserve it.
	C8: Learnability	Are tooltips available in the app? If not, they should be. For example, it is not apparent to me what the heart icons under a user mean. I am especially unsure about the minus marks or horizontal lines inside the hearts. Another element I am confused about is the big bubble for the first person in the ranked list of "People you can rely on"—why is there a big bubble for the first person in the ranked list? If this does not have a meaning, then it might be a good idea to create a visual marker or a few to indicate things. For example, availability for the time that you have entered for your help request, or a marker for a person whom the user has received a lot of help from in the past so that they can remember not to ask the same person too many times, or to remember to return the favor to them.
	C9: Error prevention	The main thing is making confirmation of help crystal clear by automating it in a clear and error-free way, but without requiring busy moms to take additional steps. Uploading a help request needs a cancel option. The keychain needs charge-level feedback to avoid data loss.

Table 5 Continued

		2) I am wondering if all the relatives could be included in the design, especially the grandparents, because they are the main support system of the mother.
		3) Also, I guess it will be better to have the information of who the inviter is. It might make the connection more trustworthy.
D: Others		4) Community code is not the safest solution; we could consider having a community owner verification.
		5) The keychain is also minimal in its look but does not convey fun as much. For instance, would it stretch and press through my fingers when I squeeze it in my hand? Does it have interesting material inside it that would respond to my different levels of touch and squeeze *, e.g., memory foam)?

Based on the evaluators' feedback, I noticed that some major issues become evident in two heuristics: visibility of system status and feedback. I summarized several comments in the following categories.

C2-Visibility of system status:

1) On the detailed "Moms Calling for Help" page, when users click on the detail description page, the system shows who, if anyone, has volunteered. Also, it sends a confirmation request to the person who volunteered and indicates visually that the person has confirmed.

2) On the "Personal" page, after users have shared tasks with their spouses, this task should either disappear on the personal schedule or be greyed out.

C6-Feedback:

1) After users created tasks on the "Mother community" page, the system offers a pop-up window to confirm and give users feedback.

2) On the "Metrics" page, other than data analysis, the system does not provide feedback regarding the keychain status, for example, when the keychain battery is low, fully charged, or ready to pick up from the base. It could be vital feedback to avoid data loss.

Other minor problems are:

B1-Consistency and standards: Some buttons and icon design is lacking consistency. For example, the telephone icon on "Call Emily to Confirm" does not have enough contrast. The red line indicates that time conflict breaks UI design standards. The current iPhone calendar uses a thin red line to mark the current time in the calendar, so using a thick red line is too close to the current status (vs. alerting a conflict).

B2-Linguistic Clarity: On the Chatting page, the spouse's profile picture should not show under the friends' list. Also, some verbal usage is not consistent and lacks communicative clarity. On the Task-Creating page, the words "Time" and "Where" can be changed to "Time" and "Location" or "When" and "Where." On the onboarding page, the word "identity" is not accurate, and the roles list seems essential and not representative of the incredible variety that exists.

C7-Practicability: Although one of the design goals is to encourage users to join different groups based on their children's age, it is not well represented in the current design. Sub-grouping or labeling potential users with different child's age groups are necessary. Helping users achieve personal goals should also be considered by reminding users to take a break and offering them tips on what to do based on interests.

D-Others: To ensure the trustworthiness of the mother community, when a new member joins the community, besides the invite code, another confirmation from the community founder adds another security check to the community's safety.

7.4 Design Refinement

As can be seen from Table 4, most of the mean severity ratings are under one. It means that the overall system has reached the design goal and met the users' needs. However, there is some weakness such as feedback and visibility that can still be improved. Due to the limitations of heuristic evaluation, some problems identified by evaluators can be false alarms. Therefore, in the design refinement phase, I only focused on the most severe issues and finished the design iteration.

7.4.1 Landing page refinement

During the registration and log-in process, I changed the word "identity" to "role" and combined mother and father identities. Also, to create a variety of the role, I added part-time mother and father roles. Although the original design idea is to help working mothers save more time and achieve personal goals, the design concept is not well represented in the first design generation. Therefore, by encouraging users to set up, create and write down a personal goal, I added a goal-achieving page. The system will remind users to take breaks and offer them tips on what to do based on their reported interests during the onboarding page. To better ensure the community's security, after new users enter the invite code, they will still need approval from the community founder (see Figure 35).
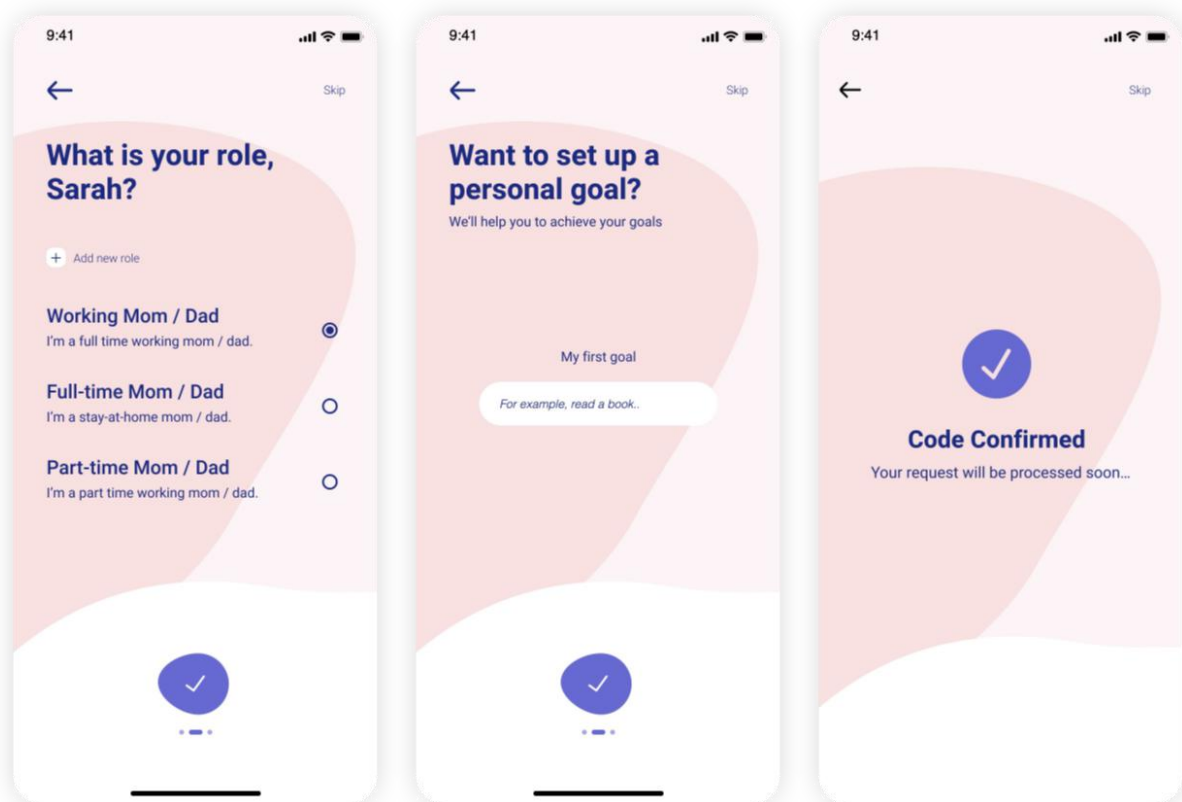

Figure 35. Refined: LETO Landing Page

7.4.2   Mother community refinement

After users share a post, other than the conclusion page, I also added a confirmation page to provide users' feedback. During the design refinement, I changed the detailed design of the "Calling for Help" page. Before, it was not obvious who had checked the post. After design iteration, the system will show if the request has been seen and who has volunteered. It will send a confirmation request to the person selected to help and show visually that the person has confirmed. (see Figure 36)
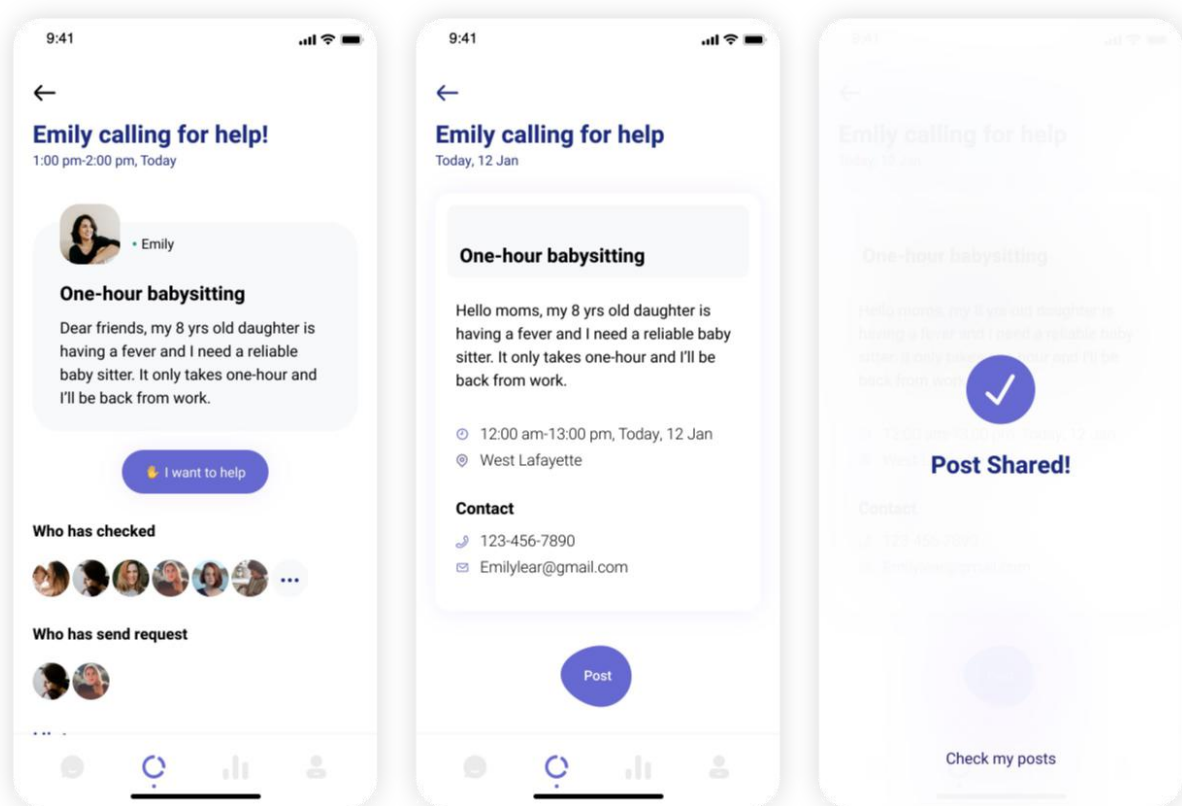

Figure 36. Refined: Post-Sharing Page

7.4.3   Personal schedule refinement

For the personal schedule page, Figure 37 shows the refined design. Evaluators mentioned that the current iPhone calendar uses a thin red line to mark the present time, so using a thick red line

is too close to the current status. Thus, I changed the thick red line used to indicate time conflicts to an alert icon. To ensure linguistic clarity, I changed the word "Work" and "Myself" that represent different calendar columns to "About Mine" and "About Myself."
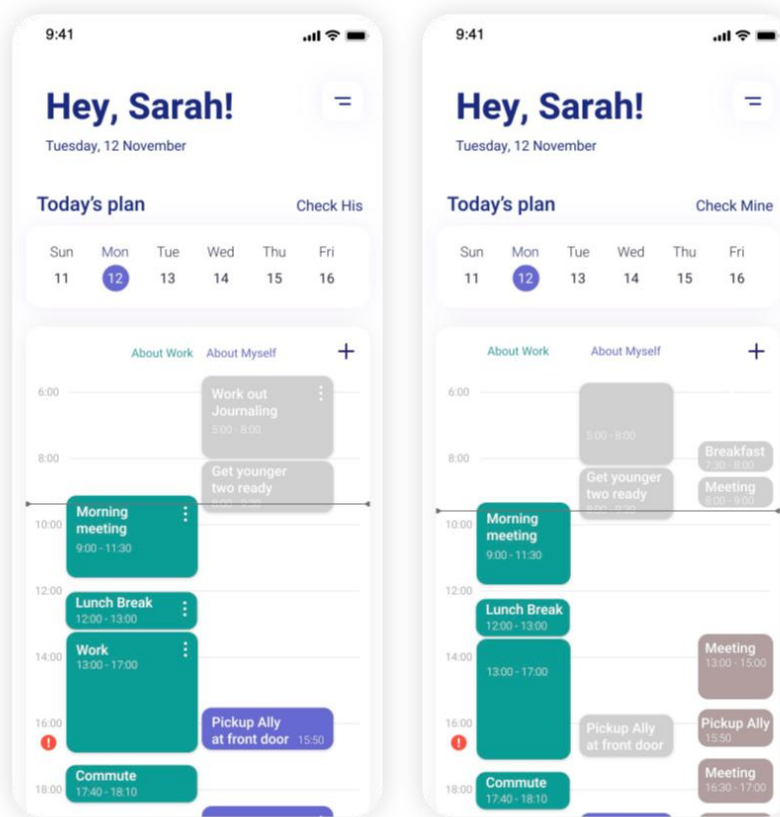

Figure 37. Refined: Personal Schedule Page

7.4.4   Metrics Page refinement

As for the metrics page, besides data analysis, the system will also provide feedback regarding the keychain status. It will indicate the keychain battery level, also reminding users to charge it or if the keychain is ready to pick up from the base. (see Figure 38)
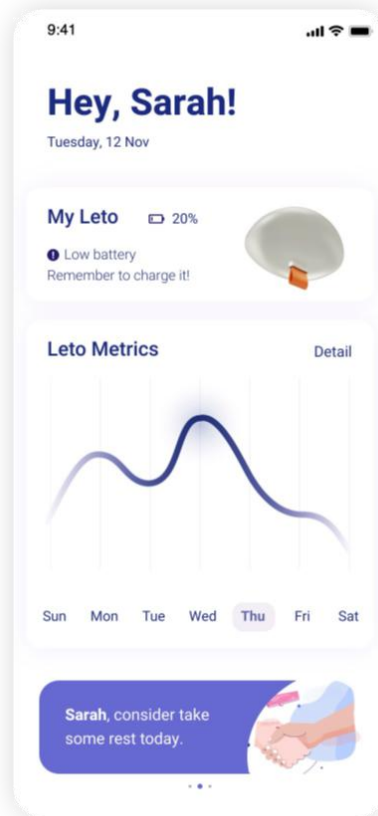
Figure 38. Refined: Metrics Page

7.5 Summary

The refinement mainly focused on four parts, the onboarding page, mother community>post sharing page, personal scheduling page, and metrics page. Two major issues, visibility of system issues and feedback issues identified in the evaluation, have been solved. Also, I refined some minor issues such as consistency and standard, linguistic clarity, and practical problems. Overall, after the heuristic evaluation and design refinement, the usability of the system has been improved. In the future, I will continue focusing on design iteration and updating the system.

CHAPTER 8. CONCLUSION

My research aims to help working mothers achieve work-life balance both internally and externally. The inner aspect refers to the users themselves, by encouraging users to create a better schedule system and tracking their stress level to help them better analyze personal data and provide suggestions accordingly. The external aspect includes their spouses and other users. Bringing in other people and building up a mother community, and promoting users to help each other can reduce stress and achieve personal goals.

The system presents four components that intend to solve problems that I identified in the research. First, the mother community provides two functions, a platform that allows users looking for emergency help and a forum where users can exchange information and give each other suggestions. When family members are not around, users can quickly look for emergency help from trustworthy people with a simple post in the mother community. Second, a personal and family schedule system helps a user divide personal tasks and work tasks, thus easily tracking time conflicts and sharing tasks with her spouse. Third, a stress reliever keychain that users can carry around and manipulate in their hands to relieve stress. By recording and transferring the squeezing data, the system also helps users track stress levels, give suggestions, and send reminders accordingly. Last but not least, the data analysis system enables users to track their squeezing data. By comparing detailed squeezing data with weekly schedules, users can accurately locate the specific time points, thus further analyzing the pressure source and taking corresponding measures.

In modern society, more and more mothers choose to work outside the family. It means that they take on different social roles in addition to the role of mother. The superposition of roles puts working mothers under tremendous pressure. Since mothers do not belong to vulnerable groups, they are often ignored by society. Simultaneously, many working mothers claim that they have a pre-set priority. They spend most of their time in their children's growth, education, and family life and rank themselves last. It also leads to personal neglect. This project intends to help working mothers establish a unique role by collaborating with the individual, family, and community to provide help for working mothers mentally and physically.

Due to time limitations, even though some minor issues have not been solved at this stage, the design has received several positive comments from other designers and evaluators. While helping working mothers achieve work-life balance, it is still at an early stage in development. Apart from iterating the current design and enhancing the user experience, I realized a new door has opened: a tremendous amount of need to support working mom is there for all the designers and the society to address.

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