P.O.M.A.T.O. - Personal Organizer for Managing Activities, Tasks, and Obligations.

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Introduction

In today's fast-paced world, individuals often struggle to balance the competing demands of work, personal life, and self-care. Therefore, time management techniques which can optimize productivity and maintain a healthy work-life balance are becoming more relevant than ever. Traditional time management techniques, such as the Pomodoro Technique [4], have provided some relief by breaking work into manageable intervals. Furthermore, it is also known as an useful technique to combat procrastination and to increase productivity [1].

The Pomodoro technique uses cycles to keep a person motivated during his work [4]. At the start, the person makes a list of activities where he also defines how many cycles of 25 minutes it takes to complete a task. When the list is completed, the person starts by working on the most important task for 25 minutes. If 25 minutes are done, the person takes a break between 3 and 5 minutes. If the activity is completed within 25 minutes (Also called one "Pomodoro"), then the person moves on to the next task. If the activity was unfinished, the person continued working on the initial task. At the end of four Pomodori, it is asked to take an extended break of approximately 15 to 20 minutes. Note: it is not allowed to do multiple tasks within one Pomodoro.

The person may choose to enhance the classic Pomodoro technique by incorporating the Dewin-Shewhart cycle, a continuous improvement cycle consisting of four steps: Plan, Do, Act, and Check (PDCA). This cycle offers a set of actions designed to facilitate improvement [5]. By doing this, the person also measures and reflects on working with the Pomodoro technique and thinks about how small adjustments and self-made goals can stimulate productivity.

While the Pomodoro Technique has gained popularity due to its simplicity and effectiveness, it assumes that all individuals share the same level of focus and productivity across the board. In reality, people's work patterns, attention spans, and energy levels vary significantly by time period and compared to others. Also, the preferred method of planning is diverse across people. For example, some favour planning at the start of the day, including activities to do for the rest of the day, while others choose to be "flexible" during the day and choose the activity to do at the moment. Moreover, the Pomodoro Technique's rigid structure is a good starting point for this project. During the project, its strong points and limitations will be investigated and reflected while extending the technique towards a more personal touch.

To address this challenge, a data-enabled design approach, as proposed by Kollenburg and Bogers, [8] is adopted. The project is centered around the Pomodoro technique and tries to empower users to discover a work schedule tailored specifically to their personal wants and needs, enhancing productivity and satisfaction. Throughout this research, two steps are used: *contextual steps* and *informed steps*. The first one is employed to gain insights into the domain of tailoring, personalizing, and improving the Pomodoro technique using sensor and qualitative data, which led to concept directions. The latter step is then implemented to build the prototypes, refining it, and converging the scope. Moreover, the eleven design principles [DP] - as seen in appendix B - presented by Funk and colleagues are consistently applied throughout the entire research process [3]). The data collected served as creative material to inspire and inform new design interventions and the research is characterized by a quick, iterative, and continuous approach that aims to remotely adapt prototypes while they are integrated into people's daily lives [3].

In addition, this innovative project harnesses the power of data analytics and machine learning to identify and recommend work schedules that are tailored to individual preferences and needs. By collecting user input, tracking performance, and analyzing patterns, the system can identify optimal work intervals, break duration, and task sequences that maximize productivity and satisfaction for each user. This data-enabled approach helps users' productivity by optimizing their work schedules and fosters a sense of empowerment and well-being as they take control of their time and energy. By embracing personalization, it is aimed to revolutionize time management by providing customized solutions that respect individual differences and acknowledge the diverse nature of human productivity.

First Iteration

In the first prototyping phase, the primary objective was gathering substantial sensory and empirical data. This enabled refining the research focus, creating prototypes, and exploring correlations between certain data elements. The decision to use these sensors and measurements was informed by the researchers' perceptions, experiences, and the findings in the literature. The different data streams

Figure 1: The first contextual iteration probe. Users can at any time input their (dis)agreement the the statements "I am feeling great" and "I am being productive". A sensor to detect phone usage, an LDR, and a temperature sensor were also included.

are a phone detector button, a light-dependent resistor (LDR), and two linear sliders. These were all implemented in a system where the data was gathered and sent to an always accessible database in real-time [DP5] [1]. The parts of the prototype are such attached that they can be reused later in the project [DP7] [2]

The phone detector button keeps track of how often and long the participant is using his phone by asking the participant to put his phone on the button while not using it. The button was implemented based on the findings of David et al. [2], which revealed a positive relationship between the frequency of mobile phone use, attention, and interference in daily life. Additionally, as stated by Mogas-Recalde and Palau [7]), lighting impacts cognition, as evidenced by its effects on academic achievement, attention rates, working speed, productivity, and accuracy. Consequently, an LDR sensor was employed in this study to explore the correlation between productivity and mood, as indicated by the sliders, with the light intensity in the current study environment. The participants indicated their mood based on the variable's productivity and focus by adjusting the two linear sliders. Ultimately, these efforts led to the creation of the initial prototype, illustrated in Image 1. In accordance with the course guidelines, this prototype is being deployed among fellow students enrolled in the same course. Participants are provided with brief instructions prior to deployment, and interviews are conducted with them during and after deployment, where there were asked about the gathered quantitative data to gather more in-depth data [DP1] [3] [DP3] [4] [DP4] [5].

These efforts resulted in valuable insights for the current deployment and improvements for subsequent deployments. The data was visualised and discussed with the participant [DP2: treat qualitative and quantitative data equally rigour], revealing new insights. First, a correlation between phone usage and productivity was found, aligning with the findings of the aforementioned literature. Furthermore, an interesting observation was made: participants often indicated high productivity when their mood was positive. However, there were instances where participants reported high productivity despite having a negative mood. These data points are further investigated during interviews, and participants explained that they pushed through the assignment due to upcoming deadlines, even when they were not feeling positive. Therefore it is concluded that productivity and mood variables are broadly influenced by numerous activity and environmental factors not included in the current deployment and could be further looked at. In addition, In contrast to the findings of Mogas-Recalde and Palau [7]), no influence of light intensity on the mood of the participant was found.

Further, a significant flaw of the current prototype was the lack of a reminder feature for participants to engage with it actively. Consequently, participants often forgot to provide data to the prototype while submerged in their activities. Additionally, the placement of the phone detection button on the prototype was too high, requiring participants to position their phones precisely for it to register, which resulted in sometimes the phone placed on

[1] stay in constant contact with the context we design for

[2] Use modular and reusable (smart systems, methodological building blocks

[3] design with stories and anecdotes rather than personas

[4] favor deep, contextual data over wide, big data

[5] visualise data in ways understandable and transparent for the participants

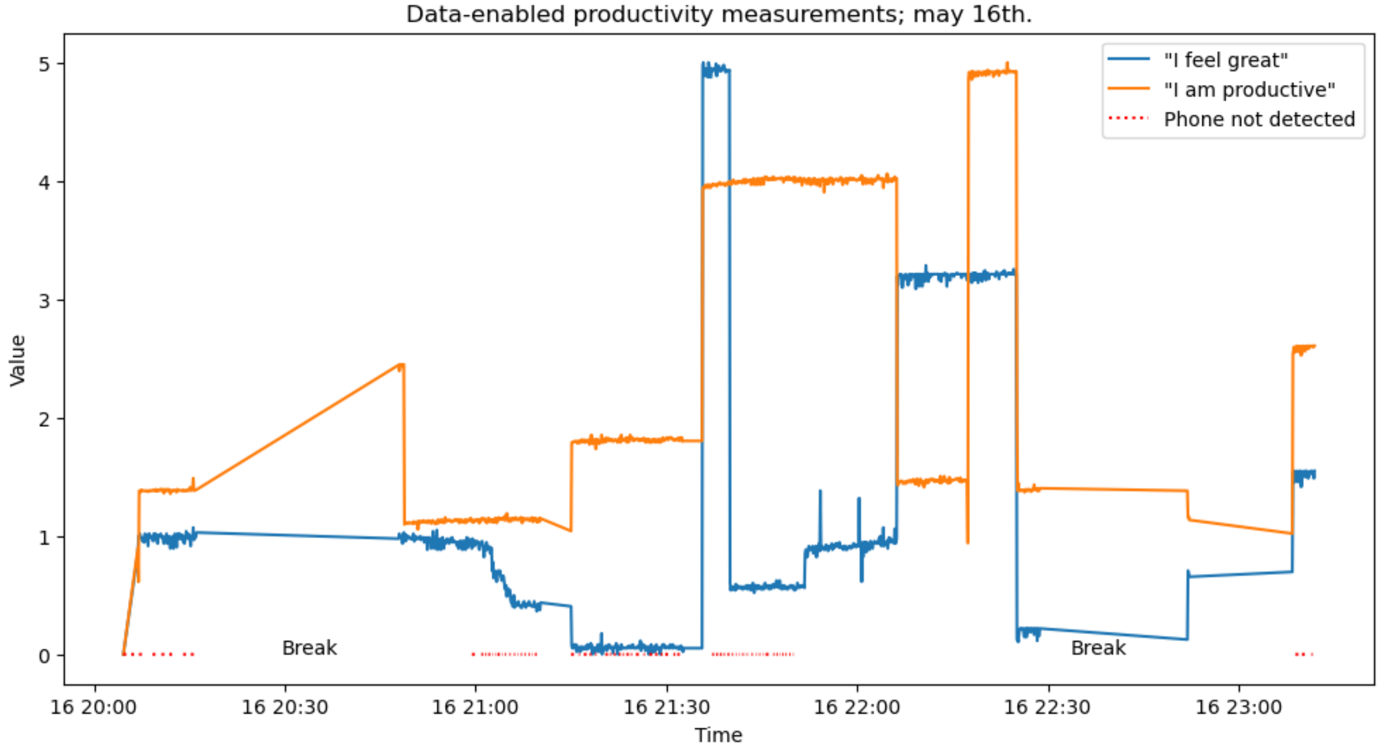

Figure 2: Line graph of the first contextual deployment. The participant was tasked with entering their dis(agreement) to the statements "I am feeling great" and "I am feeling productive". Absence of the participants phone is highlighted in red.

the button was not detected. Even when participants placed their phones on the button, it did not prevent distractions since they could access all distractions on their personal computers. Keeping better track of the (type of) distraction could be interesting.

In summary, further investigation is conducted to narrow down the scope and refine the goals related to these variables.

Second Iteration

After the first iteration, the complexity of which factors influence the mood was underestimated. Many factors, such as the complexity of the task, the cognitive load the tasks costs and the impact of how long a task costs on the motivation, were underexposed. In addition, it is considered that more insights into the preference for scheduling the day (or not) may lead to better personalization when automating the schedule. Additionally, it is seen that actively notifying the participant to insert data is needed to get a continuous stream of data. Therefore, this second deployment focuses on gathering more contextual data and participant preferences for planning their day. [DP5] [6]

Figure 3: The watch used during deployment 2.

[6]stay in constant contact with the design we design for

The second design keeps track (throughout the day) of how the participant plans out the day while reducing the cognitive load of the participant while participating in the study. The formerly used sliders are now redesigned into smartwatch-ESM, and the other sensors are neglected. Changing the continuous slider to a more convenient 7-point Likert scale [6] assumes that the participants' answers will become clear. While using the sliders of the previous deployment, one relies on spatial awareness and the participant to be aware of his change of motivation and mental state. An active focus on answering the questions is required in the new deployment. It is assumed that by actively needing to insert the questions, the participant takes more time to reflect on his current situation. Also, the phone button is removed as it is considered that more factors than just the phone influence the number of distractions, making it too complicated to research within this project. As described above, the LDR sensor was removed, and no correlation was found with light intensity. Further, the smartwatch is worn constantly by the participant throughout the deployment, resulting In the participant being able to answer questions at all times while minimizing cognitive load/disruption of their activity. In addition, the new design enables faster development for future developments of gathering objective sensor and subjective data from the wearable and self-report data. The questions asked to the participant can be found in appendix A. [DP8] [7]

[7]use technology consciously and be transparent and critical about applied practices

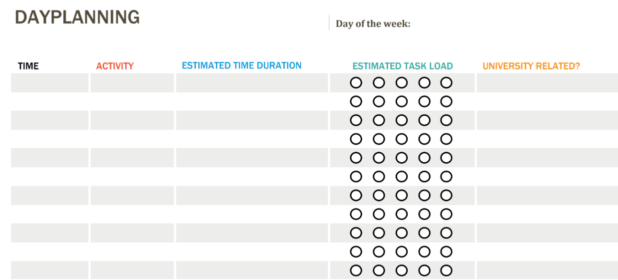

Figure 4: The planner used during iteration 2.

The new system's second part consists of filling in two forms. In the beginning, the participant is asked to fill in the planning of his days and further define the planned activities. These specifications include which activity is executed, at which time it is completed, the estimated cognitive load of the task, the estimated time duration, and if the activity is university related. At the end of the deployment, the participant is asked to fill in a new form where he compares the initial planning with what was done that day and additional questions are asked to get more in-depth information, notice correlations and information about their personal preferences [DP1] [8] [DP2] [9][DP3][10].

The second deployment came with enriched feedback from the participants and the watch. First, it is seen in the day planning and interviews that the routine of every participant differs quite firmly. The three participants do vary in making and executing their planning. One participant likes making a very detailed plan where even the timing of the tasks (and breaks) are defined and executed. Another participant writes down (roughly) the tasks to be done for that day and starts working on them, not following the planning that well. And the last participant stands between the two approaches. In addition, one participant starts their day by doing small "easy" tasks to feel accomplished. The other prefers doing the more significant, complex tasks, as they mention, to use more energy at the start of the day. However, all participants agreed on their willingness to start the day by planning to improve their working experience. Secondly, while answering questions about which considerations the participant makes while doing the planning, three major themes repeatedly came back in the answers. 1. Cognitive load, 2. The duration of the task, 3. The urgency of the task. The participants do not consider these components to be equally important. It is repeatedly answered that the urgency of the task and duration is believed to take a more prominent role while planning than the cognitive load of the task. Thirdly, it is seen that all participants value the flexibility to be very important when making and following their planning. It is mentioned that some activities are just challenging to estimate how long it takes and that when an activity takes longer/shorten than planned, it is essential that the planning is changed along with the changes.

In conclusion, personalization and flexibility should lead in the design when further developing Pomodoro with the three activity themes in mind.

Intervention design: Deployment 1

Based upon the contextual deployments, POMATO was redesigned in a few significant ways. Firstly, we chose to more strictly define the target audience to people who are not conscientious. This slight change of focus made the concept more geared towards making people better at planning over time. These users highlighted a need for

[8] Design with stories and anecdotes rather than personas
[9] treat qualitative and quantitative data with equal rigor
[10] favour deep, contextual data over wide, big data

Figure 5: The Intervention Design. The POMATO probe downloads all the daily planning and displays a task for the users to do. Users have the ability the set the length of their work block, and can skip recommended tasks when wanted.

flexibility [DP1] [11] [DP5] [12] . As a result, we designed this iteration to be suggestive in its planning, instead of absolute. Users get the freedom to deviate from the plan. But, by ordering tasks in a prioritized way, users are still subconsciously nudged towards the more important tasks. The importance of a task is calculated through a formula that considers the duration, urgency, and difficulty of the task. All of these values are mapped to a range of 1-100, with duration's mapping being dependent upon the participant's preference to start the day with shorter of longer tasks. It was important to make sure that deviation from the algorithmically generated daily planning requires a fitting amount of effort. It should be easy, but not too easy, to change tasks. Shaking the prototype was chosen as the means to skip to a new task, as this was hypothesized to be easy enough to do, but slightly tedious to keep doing.

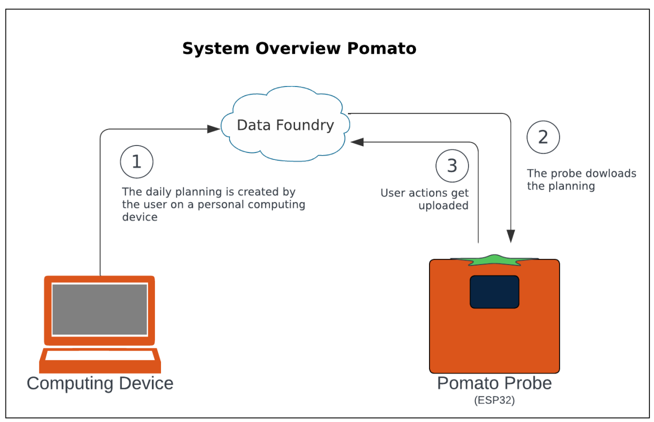

Figure 6: Overview of the system. Users enter their planning on a web site. This planning is subsequently downloaded by the probe. User interactions are uploaded back to Data Foundry for future analysis.

Figure 7 shows a participant's daily planning [DP4] [13]. At the start of the session, they uploaded the tasks that they needed to perform that day, along with their perceived urgency, difficulty, and duration. After submission of these tasks, POMATO would order them. Users can either accept the task or dismiss it by shaking the probe. The skipping of a suggested task is highlighted in orange in figure 7. If accepted, participants were prompted to set their desired work duration for that task, ranging anywhere between 15 and 50 minutes. These values were chosen as to allow for more freedom, while still stimulating hourly breaks. Tasks completions are shown in green. We see that the 'Continue paper' task was skipped over two times. While important, the participant suggested that this activity was too cognitively challenging immediately after the task of 'Reflection DED'. A more sophisticated algorithm could take this into account better. We will shortly summarize some suggestions for improvement within the next chapter. Participants noted that they did like the visual reminder of their commitment to a certain task for 15-50 minutes. An ordinary timer (e.g., kitchen timer) does not show the task, and thus does not serve as a visual cue to their commitment.

The participant claimed to like the flexibility that the new design provided. They did however mention that the planning did not allow for random events happening during the day. Currently, there is no way to add a new task after initially setting them. Entering the tasks in the morning together with their difficulty, urgency, and

[11] design with stories and anecdotes rather than personas
[12] Stay in constant contact with the context we design for
[13] visualise data in ways understandable and transparent for the participants

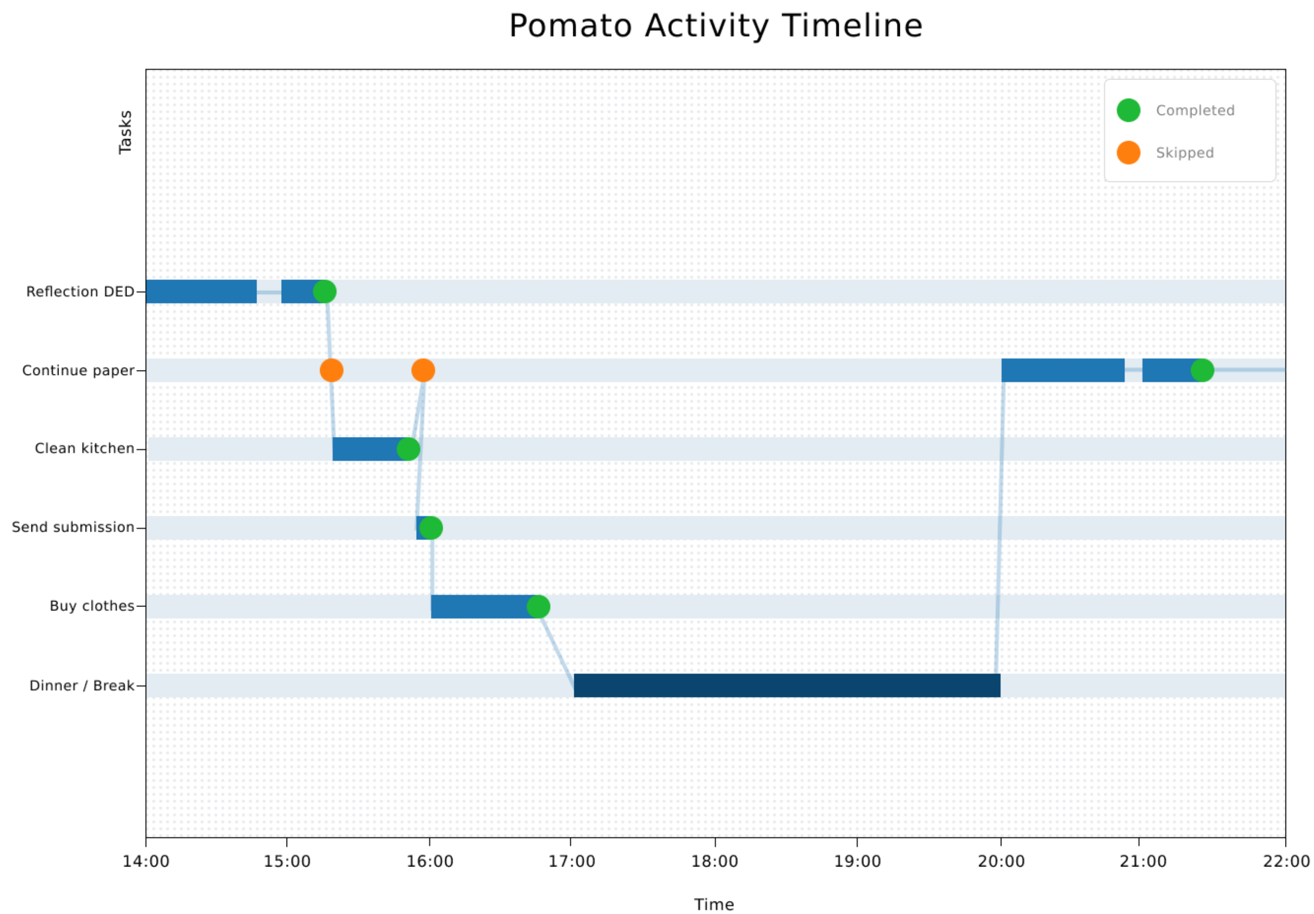

Figure 7: Overview of the tasks performed over time during a deployment of POMATO.

duration was found to be quite tedious. Further steps need to be taken to make this process easier. Calendar integration and semantic analysis of the task descriptions could lead to a more streamlined user experience. A smart system would take these additional data points into account, to alleviate some of the burden on the user. One example would be automatically rating the urgency based upon the deadline in the calendar.

Intervention design: Deployment 2

Based upon the first design intervention, a few adjustments should be made to POMATO. First, entering the tasks in the morning with their difficulty, urgency, and duration was found quite tedious. Therefore, an application is added to the deployment which has direct connectivity to the system to reduce this burden. By using a simple layout, the user now fills in the activities with their characteristics more easily. In addition, more flexibility is implemented. By making the system adaptive and reactive, random events or other sudden changes in activities are automatically considered in the planning. At last, the sophisticated algorithm considers the participant's behaviour by looking at past behaviour. For example, if the participant skips all tasks before a particular task is displayed, then this task will be displayed as the first activity next time. On the other hand, when a task is always skipped to be one of the last tasks to be executed, the system takes this behaviour into account by next time automatically moving it to the end. In addition, the three variables coupled with urgency, cognitive load and time duration of the task are slightly changed every time a new day planning is done. This results in a variety of day planning. Based on the number of times an activity is skipped and the feedback from the participant after the participation, the variables are fine-tuned to minimize the number of activities skipped and therefore streamline the user experience. Nevertheless, due to participant scheduling issues, testing this new setup was impossible. Therefore, unfortunately, no results can be displayed.

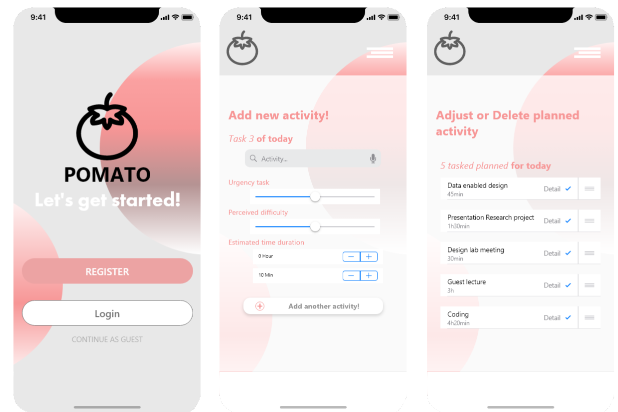

Figure 8: Conceptual mock-ups of the planning interface.

Discussion

There were several limitations identified throughout the design iterations of POMATO. In the first phase, participants often forgot to actively engage with the system due to the lack of a reminder feature. Additionally, the phone detector button was inconveniently placed causing missed phone detection's. These factors may have caused data collection gaps, hindering data analysis and interpretation. Additionally, the data collection gap disrupted continuous tracking of participants' activities and their impacts on various variables. This may have made it difficult to establish correlations between factors and identify meaningful insights or trends.

In addition, during the first two phases, data was gathered on mood and productivity, which are generic terms with a wide range of variables affecting them. This variability could have potentially decreased the accuracy and effectiveness of the collected data.

Another limitation was the reliance on participant feedback and self-report data, which may be subject to biases or inaccuracies. While efforts were made to gather contextual and deep data, there is still a possibility of incomplete or subjective information affecting the accuracy of the insights gained. Additionally, the generalizability of the findings may be limited by the specific target audience chosen which may not represent the broader population.

The small sample size of participants also imposed limitations on the generalizability and robustness of the findings. With such a limited sample, the study may not adequately capture the diversity and variability of the target population, making it challenging to draw broad conclusions or make reliable predictions about the broader user base. The insights and patterns observed within this small sample may not accurately represent the behavior, preferences, or experiences of the larger population.

Lastly, due to technical limitations, the correlation between light intensity and mood could not be observed in the study, suggesting the need for further investigation and more advanced sensing capabilities. Similarly, the *Intervention Design: Deployment 2* could not be tested and validated with users which remains as future work for researchers to conduct.

These limitations highlight areas for improvement and call for further research and development to address these issues and enhance the overall functionality and usability of POMATO.

Conclusion

In conclusion, the data-enabled design process [8] of POMATO provided valuable insights and feedback which were used in multiple deployments, resulting in significant refinements of the prototypes. In the first phase, the focus was on gathering substantial sensory and empirical data. Analysis of the data showed highlighted a need for more user-specific data.

In the second deployment, the aim was to gather more contextual data and participant preferences to better understand the factors that influence mood and to get a better overview in their daily scheduling. By utilizing smartwatch-ESM, the study aimed to reduce cognitive load and improve data collection. Three major themes emerged from the deployment regarding planning considerations: cognitive load, task duration, and task urgency, where the last two are being considered most significant. Additionally, all participants emphasized the importance of flexibility in adapting their plans based on changes in task duration or unforeseen circumstances.

In the phase hereafter, the objective was to improve their planning skills over time by focusing on making the concept more suggestive rather than absolute. The redesign introduces increased personal customizability, enabling users to personalize both the Pomodoro interval and the ordering of suggested activities. The visual reminder of commitment during the designated time slot was appreciated by participants. User highlighted that the planning process lacked the ability to account for random events during the day and that there was no option to add additional tasks once the planning was set. Furthermore, entering tasks along with their difficulty, urgency, and duration in the morning was found tedious.

In the final phase, the refinements were aimed at addressing the limitations and feedback from users regarding the previous phase. The first adjustment focused on reducing the tediousness of entering tasks in the morning by introducing a dedicated application with direct connectivity to the system. This simplified layout enabled users to fill in activity details more easily, which enhanced the user experience. In addition, more flexibility was added which made it more adaptive and reactive to random events or sudden changes in activities.

Lastly, a few alterations were proposed for future explorations.

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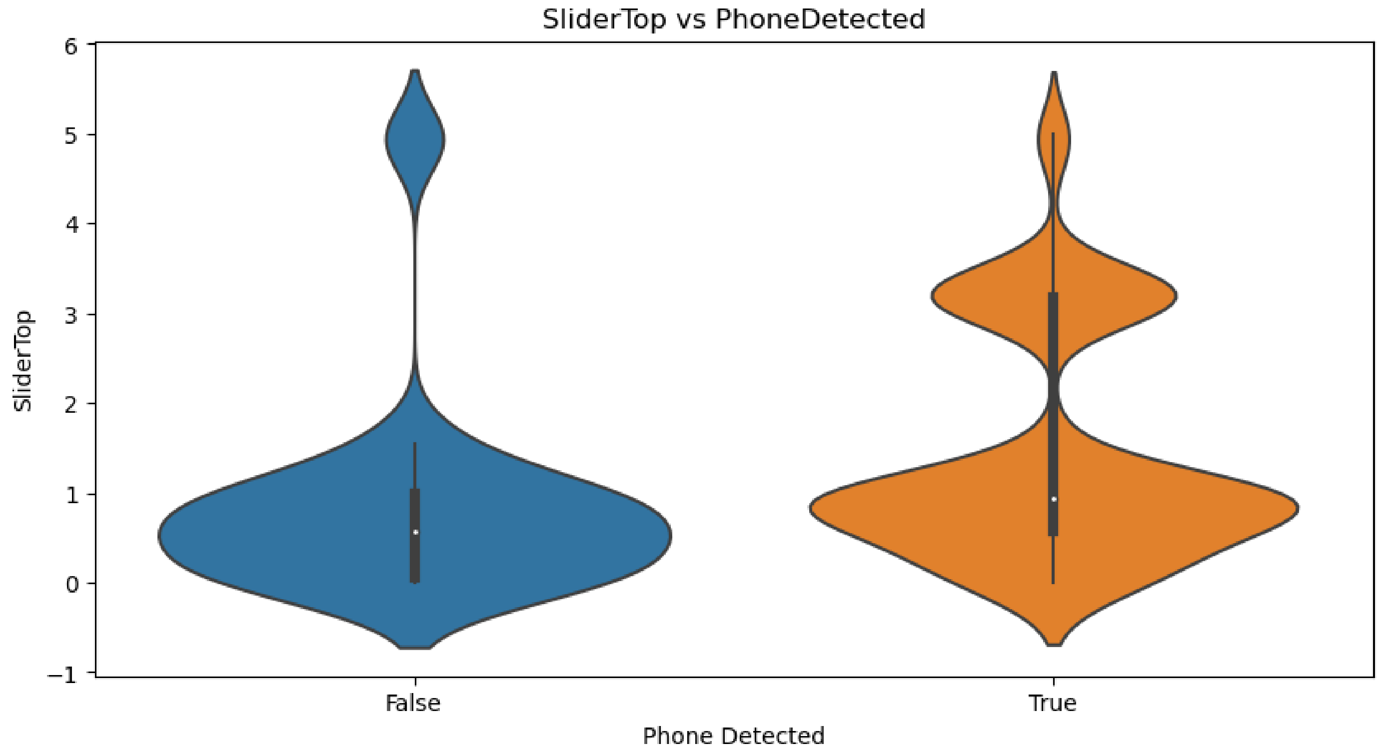
Appendix

Appendix A: Interview questions for qualitative analysis.

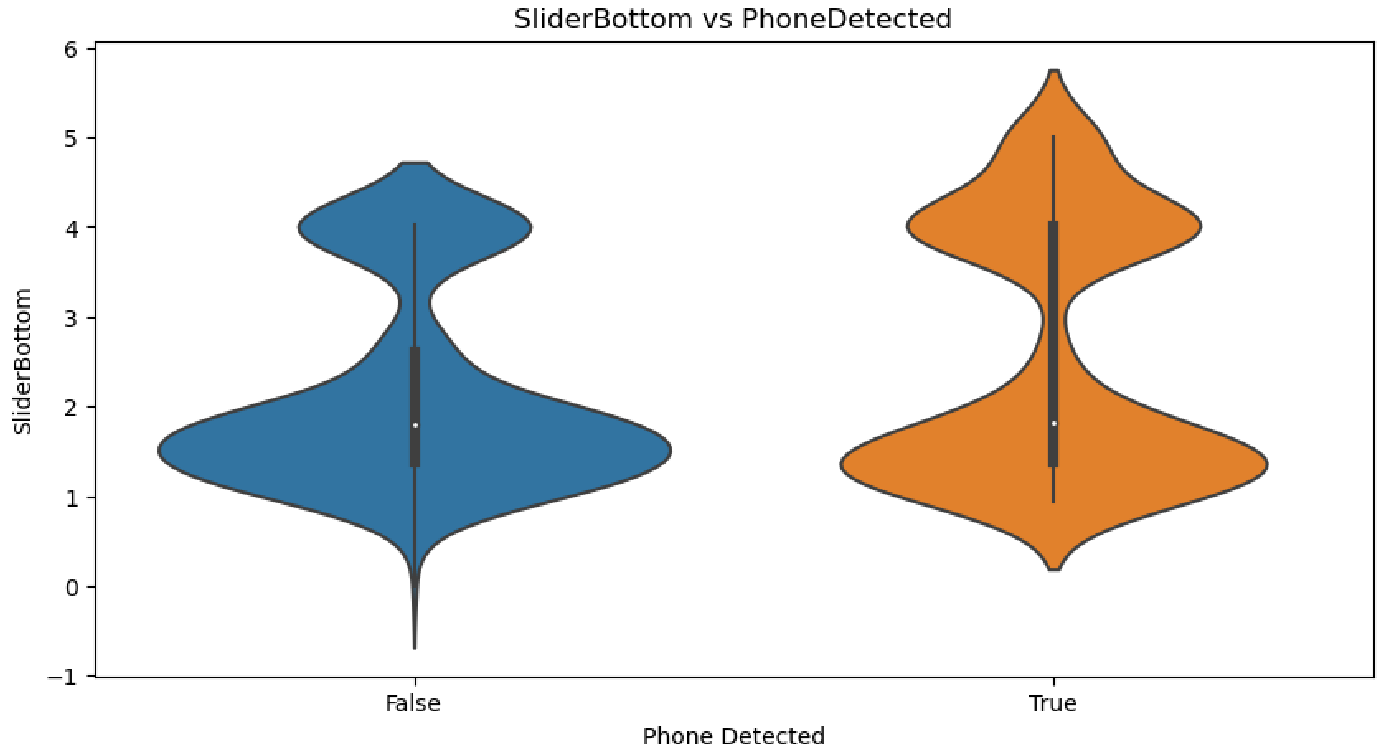
- What is your gender?
- What is your age?
- Which faculty?
- How would you describe the purpose of the prototype and the objectives assigned to you? Was everything clear?
- Did you come across any aspects of the prototype that you found unsettling or bothersome?
- Can you describe how you incorporate planning into your work or daily routine, and how it helps you achieve your goals or objectives?
- Did you have the feeling that you were studying differently due to your participation in this research?
- Can you explain your approach to planning your day? Do you follow any specific techniques or use particular tools?
- When it comes to planning your day, do you perceive it as a stressful task or find it to have a cognitive load? How do you personally experience the process of planning your day and managing your tasks?
- If your day plan were to be automated and optimized specifically for you, do you believe it would be highly beneficial? How do you envision the impact of such a personalized and optimized day plan on your productivity and overall well-being?
- Do you prefer to strictly adhere to your plans or do you allow for flexibility and adjustments along the way?
- When it comes to estimating the time required for tasks and prioritizing your activities, how would you describe your level of accuracy? Do you find it challenging to estimate time accurately and prioritize effectively, or do you have strategies that help you in these aspects?
- When you engage in the process of planning, do you differentiate between various tasks and their different aspects? For example, when working on a group project, do you adjust your planning based on specific tasks like writing a report, prototyping, or attending meetings? Similarly, when faced with a task such as writing a report, do you make a distinction between activities like conducting literature searches, actually writing the report, revising or editing it, and restructuring its content? How do you approach this level of granularity in your planning process?
- What is your preference: tackling the easiest task first or prioritizing the completion of difficult tasks? And why?
- When you have a 30-minute gap in your schedule, do you prefer filling it with simpler tasks like answering emails, or engaging in more complex tasks that may have required a significant amount of time later, so already start working on it?
- How do you typically decide when to begin your day's activities? Is it based on specific tasks or goals you've set, or do you have other factors that influence the start of your day?

- How do you determine when your day comes to an end? Is it based on completing everything you planned, or do other factors play a role in deciding when to wrap up your day's activities?
- When it comes to planning your day, what are some contextual factors that have a significant impact on how you construct your plans? How do these factors influence your decision-making process and the structure of your day?
- What do you do when things take longer than expected? Also, when it takes shorter than expected?
- While analyzing the data, I noticed the presence of [Null] values in some instances where you have provided responses to other data points. Could you please share your insights on this observation?

Appendix B: Overview of the eleven design principles by Funk et al. Presented in the course Data-enabled Design and adapted from the work of Kollenburg and Bogers.[8]



Appendix C: Violin plot of the phone detection related to the position of the "I feel Great" slider (sliderTop). t-statistic: 7.227376694061019, p-value: 9.37071432953425e-13



Appendix D: Violin plot of the phone detection related to the position of the "I am productive" slider (sliderBottom). t-statistic: 5.029777253352336, p-value: 5.758582714831854e-07