DESIGN AND EVALUATION OF A WEB APPLICATION TO PROMOTE SELF-ACTUALIZATION BEHAVIOUR TOWARDS GOAL-SETTING

by

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*I dedicate this thesis to my parents **Mr. and Mrs. Gourashettar**.*
I found peace and strength in your unconditional support.

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Abstract

Goal planning behaviours are common to the human experience. Multiple applications focus on goal-planning through extrinsic motivation and a reliance on self-motivation; however, self-motivation continues to be a challenge for users. How do we help users achieve their goals through the design of applications which target self-actualization? To address this question, we conduct a three-part study. In Study 1, we took a qualitative approach to understand the participants' goal accomplishment journey. In Study 2, we analyzed the current state-of-the-art by reviewing nine applications on the Google Play Store. Finally, in Study 3, we test features that allow breaking down goals into sub-goals, denoting the personal significance of each goal, and the availability of satisfactory or 'good-for-now' goal completion notation. Our results look to understand goal creation and completion alongside various design patterns to inspire behavioural change. Finally, we contribute design recommendations for successful goal actualization.

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Chapter 1

Introduction

Goal-setting is an aspect of human behaviour that plays a vital role, in personal and professional development. Researchers, in behaviour and psychology have extensively studied the intricacies of goal-setting shedding light on its motivational, cognitive and behavioural implications. Ordóñez et. al [69] explore the negative outcomes of goal-setting frameworks mainly in an organizational setting. Of all the negative outcomes discussed, we focus on the outcome wherein the goal-setting frameworks lead to a decrease in intrinsic motivation with a heavy reliance on external rewards thereby taking away from the satisfaction of completing the goal itself. Deci [32] suggests that the anticipation of external rewards can undermine intrinsic motivation. A meta-analysis by Deci et. al [33] further suggest that intrinsic motivation was found to be significantly reduced when individuals were given extrinsic rewards for activities they initially found intrinsically motivating. A majority of goal-setting apps utilise extrinsic motivation (e.g. rewards) to facilitate goal-setting journey. Hence, the focus on intrinsic motivation and self-actualization is lost. To address the above problem i.e., to support the goal-setting journey through self-actualisation, we formulated eight Research Questions (RQs) as follows:

- **RQ1**: *What strategies do users find effective in their goal journey?*

- **RQ2**: *What are the hindrances, distractions, and challenges that participants face?*

- **RQ3**: *How do we design effective mobile applications for goal accomplishment?*

- **RQ4**: *What strategies do users find effective in the already existing apps?*

- **RQ5**: *How effective is the app in decreasing procrastination levels?*

- **RQ6**: *How effective is the app in increasing self-efficacy levels?*

- **RQ7**: *How effective is the app in promoting motivational appeal?*

- **RQ8**: *How effective is the app in promoting positive usage experience?*

We designed three iterative studies to address the research questions. In the first study, we interviewed 16 participants to understand the needs and challenges in their endeavours towards their goal accomplishment journey. The qualitative data set gathered was analyzed using Interpretative Phenomenological Analysis (IPA) [84, 85]. We formulated seven themes that showcase the strategies and challenges faced by the participants in their goal-accomplishment journey.

In the second study, we analysed the goal-setting apps from Google Play Store and scraped respective user reviews to understand what is currently available to the users in the mobile app market. We performed sentiment analysis [44] on the extracted reviews to identify the features that the users liked and also their pain points. We formulated six themes that showcase user preferences and pain points.

In the third study, we designed and evaluated a web-app to promote self-actualization behaviour towards goal-setting. The aim of this study was to bridge the gap identified by study 1 and study 2. We designed four versions of the web-app to test features that allow breaking down goals into sub-goals, denoting the personal significance of each goal, and the availability of satisfactory or 'good-for-now' goal completion notation. The app focuses on fostering inner drive, in response to the nine reviewed goal-setting apps on Google Play Store that depend on extrinsic motivation. It encourages people to achieve personal fulfillment and significance in the pursuit of their goals. The study started with a pre-study survey followed by the app-usage period. After the app-usage, we administered a post-study survey. A total of 86 participants took part in the study followed by an one-on-one interview with 17 participants. The study was concluded with the inference that the app was successful in imparting an intention to change towards effective goal-setting.

1.1 Thesis Contribution

The thesis has two major contributions towards the field of Human-Computer Interaction (HCI) and the domain of goal-setting: Firstly, the *design* of a web-app to promote self-actualisation behaviour towards goal-setting. The design was preceded

by semi-structured interviews (to understand users' wants) and analysis of the apps present in the market (to understand what is being currently offered). The web-app, which was majorly focused on goal breakdown had four versions; each version to evaluate a design feature on top of the underlying basic version.

Secondly, the *evaluation* of the web-app by following mixed-methods strategies. The app was tested for self-efficacy, intention, motivational appeal, positive experience and procrastination behaviours. The semi-structured interviews offered qualitative insights towards the experience while using the app. Finally, we also provide design recommendations towards effective goal-setting strategies.

1.2   Thesis Overview

This thesis describes the iterative process followed during the design and evaluation of the goal-setting web-app in a series of seven chapters.

CHAPTER 1 Introduction: This chapter gives an overview of the thesis, the problem statement, the solution approach for the problem, and the contributions of the thesis work.

CHAPTER 2 Research Background: This chapter discusses the literature review related to goal-setting and explores the various studies conducted by other researchers from the HCI fraternity that form a good foundation for this work.

CHAPTER 3 Study 1 - Understanding the Goal-Setting Strategies and Challenges: This chapter discusses the qualitative study that was conducted to understand the strategies followed by people and various challenges they face during their goal-setting endeavours.

CHAPTER 4 Study 2 - Understanding the State-of-the-Art: This chapter explores the sentiment analysis of the user reviews extracted from the goal-setting apps in Google Play Store.

CHAPTER 5 Study 3 - Design and Evaluation of the Goal-Setting Web App: This chapter discusses the design and evaluation of the goal-setting web-app using a mixed-methods approach.

CHAPTER 6 Thesis Discussion: This chapter discusses the results from this iterative research, contributions to the HCI community and to the domain of goal-setting, and various design recommendations.

CHAPTER 7 Conclusion: This chapter discusses the limitations of this work and envisages future work.

Chapter 2

Research Background

Goal setting is a common practice in our current society. We set goals for our careers, our health, and our lives in general. Setting and taking progressive steps towards a goal is part of the shared human experience. People who are goal oriented generally aim to be achieving, dedicated, and productive [59]. To achieve this, people identify goals which they will pursue in a meaningful way as part of a larger goal[22, 81]. However, depending on how prepared an individual is to change behaviour, it is more or less easy to formulate concrete, easy-to-achieve and measurable goals [74]. Additional challenge arises from finding the motivation needed to do the activities, the energy to maintain commitment to a goal, and maintaining these efforts to stay on track [74, 77]. Several models and theories of motivation and behaviour change outline factors that influence motivation and readiness to change, e.g.,[17, 49, 58, 74, 77]. [36, 24]. Despite people's willingness to improve themselves, goal accomplishment journey continues to be a challenge for many [89].

Despite careful planning, often users fail to predict potential blockers, and other challenges; this effect is called the planning fallacy [55] and this leads to disruption of time estimates for goals. In recent times, phone addiction has proven to be a common distraction. Students frequently multitask with social media (SM) during self-study. Such Social Media Multitasking (SMM) has the potential either to support well-being by acting as a recovery activity or subvert it by acting as a procrastination activity [45]. To characterize SMM as a recovery activity or procrastination activity during self-study, a qualitative study was done by Hossain et al. [45] to explore their experiences of self-study and the role SM plays within them. The results suggest that both active and passive SM breaks can be well-being-promoting recovery activities and well-being-detracting procrastination activities. Thus, whether SM use is active, or passive does not by itself determine its impact upon well-being. Motivational and/or situational SM factors characterize instances of recovery and procrastination.

The transition from effective goal accomplishment strategies to habit formation is a vital aspect of achieving a sustainable behaviour change. Habit formation is a major component of lifestyle change. Vanschoren et al. [93] suggest that applications can support lifestyle change in two ways. First, the system can increase self-knowledge by presenting information that the user may not be fully aware of, for instance, by quantifying the strength of a current habit. Providing this knowledge is theorized to increase feelings of control to provide users with extra motivation to complete the change. Second, the systems can use the model for prediction of user behaviours, anticipation of changes ahead, and basing decisions of interventions on the model. The study discusses several challenges to this approach, including the need for accurate recognition of the target behaviour. Moreover, the work identifies challenges due to the lack of identification of higher-level cognitive processes such as goal setting, self-reflection, planning, and changes of intentions which are not yet modelled [93]. Efforts to model higher-level cognitive processes have been undertaken by several researchers including work by Consolvo et al. [25] who proposed eight strategies for designing technologies for lifestyle change and habit formation. The work theorizes that technologies should be abstract and reflective, unobtrusive, public, aesthetic, positive, controllable, trending/historical, and comprehensive.

This study focuses on designing and evaluating a web app to promote self-actualisation behaviour towards goal-setting. In this section, we review our theoretical foundation, we also review literature on goal-setting. We review state-of-the-art and analyse the corresponding strategies used.

2.1 Literature Review Process

We conducted a two-phase literature review: 1) Reviewing the literature about goal-setting and habit formation 2) Reviewing the existing state-of-the-art (applications) and user reviews. We explored the ACM Digital Library [1], Google Scholar [9] and Google Search Engine [8] to search for previous academic works in various journals and conference proceedings. We used the terms 'Goal setting', 'Habit formation towards goal setting' and 'Motivation strategies towards goal setting'. We excluded the papers that did not suit our research area. For the state-of-the-art, the selection criteria we followed was: editor's choice free (no cost to user) apps in the category of

goal-setting and productivity. We initially shortlisted 15 apps from Google Play Store [2]. We excluded other apps as they did not fit our criteria, because they dealt with more specific genres of goal-setting like step-counter, physical fitness, health tracking etc. Our scope of interest was the apps that implemented general or day-to-day goal-setting. Finally, nine apps were selected: Habitica [10], Superbetter [12], Do it now [4], Microsoft To Do [11], Any.do [3], TickTick [13], Forest [6], Glan [7], Dreamfora [5]. The remaining applications were chosen among the top free apps from Play Store.

2.2 Theories Related to Goal-Setting and Planning

Goal-setting theory as explained by Locke et al. [59] states that a goal should be specific, challenging and have appropriate feedback associated with it. Additionally, authors also discuss that the task characteristics such as complexity and familiarity of a task affect task performance. In agreement with the theory, a low-motivation and a high-motivation group were selected for two tests on the same task [23]. the low-motivation group was given specific goals to reach, and the high-motivation group was told to do its best on each trial of each test. The results suggested that specific goals can be used for people who bring a low degree of motivation to the task situation.

Self-determination theory distinguishes between intrinsic and extrinsic motivation within a self-regulation framework. It states different self-regulation behaviours deployed in a continuum with varying degrees of self-control. More self-regulated actions prove more adaptive than less self-determined ones [34, 35]. In general terms, these can be classified into three broader categories. Firstly, amotivation reflects the absence of motivation and perception of lack of control over events, including feelings of incompetence and purposelessness; it is usually positioned at the end of the motivational spectrum, denoting a maladaptive absence of self-determination. Secondly, Extrinsic Motivation (EM) is situated at a middle point in the spectrum, indicating an external goal being chased as the driving behavioural element. Lastly, Intrinsic Motivation (IM) is located at the most self-determined end of the continuum, where activities constitute goals themselves, and the driving factor becomes the individual's own will to act. The EM and IM dimensions are further subdivided to reflect differing respective external or internal goals driving the consequent behaviour. Regarding EM, it is divided into EM external regulation (EM-external), where behaviours are

carried out to avoid punishment or to obtain completely external rewards; EM introjected regulation (EM-introjected) implies behaviours aimed at avoiding anxiety and guilt; the last sub-dimension is EM identified regulation (EM-identified), in which the drive comes through the internal acceptance of the importance of achieving external goals (i.e., societal values on enrolling in higher education). As for IM, three sub-types are specified: IM to know (IM-know), where performing tasks is driven by the pleasure of gaining knowledge; IM towards achievement (IM-achievement), where behaviours are executed for internal achievement purposes such as overcoming one's limitations; IM toward stimulating experiences (IM-SE) refers to tasks performed for aesthetic or intellectual purposes [35, 87, 92]. In summary, the theory states that autonomous individuals (i.e., displaying higher levels of IM) are more likely to perform tasks diligently than less self-determined ones (i.e., exhibiting higher levels of EM and amotivation [34]). Sundar et al. [88] introduce 'Motivational Technologies' as a theoretical framework for designing preventive health apps.The paper discusses how the affordances of modern media interfaces could be used to enhance individuals' intrinsic motivation for preventive health, based on Self-Determination Theory (SDT). When a goal is set by an individual and is self-driven, then the behaviour is said to be autonomous. In contrast, controlled behaviour reflects forced adherence to certain goals set by other people (extrinsic factors). The key challenge therefore is to devise technologies for building self-determination among individuals without the need for repeated and expensive interventions [95]. SDT proposes that competence, autonomy, and relatedness are essential for one to be intrinsically motivated toward a goal [78]. Sundar et al.'s [88] theoretical model predicts that navigability (ability to explore the mediated environment), interactivity (ability to interact with others) and customization (ability to tailor the mediated environment) will influence intrinsic motivation.

Procrastination is at the center of several societal problems [16, 28]. From the environment to our health, we put off concerns and allow them to compound with time [82]. Procrastination is a known behaviour in academic environments too [90]. The study sought to analyze the impact of the self-determination spectrum of academic motivation on procrastination and the latter's impact on academic outcomes.

The results suggest that the interventions focusing on reducing amotivation, EM-introjected, and IM-know, and the fostering of IM-SE, IM-achievement, and EM-external may prove successful in reducing the negative academic impact of procrastination. Steel [86] proves that procrastination is more of an irrational delay rather than avoidance, arousal, and decisional. They conceptualize a new scale called the Pure Procrastination Scale (PPS) to improve the measurement base for procrastination. We incorporate PPS in our study to measure the users' baseline and post-intervention procrastination behaviours.

The Theory of Planned Behaviour (TPB) by Ajzen [17] suggests that when it comes to predicting someones behaviour their intention to perform an action plays a major role. This intention is influenced by three factors; attitude, subjective norms and perceived control. Attitude refers to how an individual evaluates a particular behaviour. Subjective norms involve the perception of social pressure or influence related to the behaviour. Perceived behavioural control reflects an individuals belief, in their ability to successfully carry out the behaviour (self efficacy). TPB is one the popular and successful theories employed by previous research [70] to measure the motivation as well as change in individuals' desired behaviour. With regards to our study, we incorporate the intention and self-efficacy elements of the theory as baseline measures and the post-intervention measures to assess a potential behaviour change towards goal-setting.

2.3 Design Strategies Used in the Apps

We present an analysis of the nine mobile apps and outline the features implemented in Figure 2.1. Figure 2.1 illustrates the features and underlying concepts present in the apps. Task management within the design of these reviewed applications emphasises consistency to follow one's set goals. Apps that use these features include TO-DO's, calendars and, task prioritization. Self-monitoring in the form of a progress tracker is implemented with features like historic goal progress. Focus mode in the form of Pomodoro timer is implemented in five apps and forced focus is implemented only in the app called Forest; the app restricts the user from using other apps during the defined work period. Virtual rewards in the form of digital coins or digital rewards is implemented in six apps. Similarly, Gamification as defined by Deterding et. al [38]

Features	Underlying concepts	Habitica	Do it now	Superbetter	Microsoft To Do	Forest	Any.do	TickTick	Dreamfora	Glan
Task management	Consistency	✓	✓	✓	✓	✓	✓	✓	✓	✓
Progress Tracker	Self-monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓
Focus	Forced focus	✗	✗	✗	✗	✓	✗	✗	✗	✗
	Focus mode e.g., Pomodoro timer	✗	✗	✗	✗	✓	✓	✓	✓	✓
Social		✓	✓	✓	✓	✓	✓	✓	✓	✗
Rewards	Virtual	✓	✓	✓	✗	✓	✗	✓	✓	✗
Penalty		✓	✓	✗	✗	✓	✗	✗	✗	✗
Competitive		✓	✓	✗	✗	✓	✗	✓	✗	✗
Gameful	Gamification	✓	✓	✓	✗	✓	✗	✓	✓	✗
Reminders		✓	✓	✓	✓	✓	✓	✓	✓	✓

Figure 2.1: Features and underlying concepts implemented in the nine apps

is also implemented in six apps.

Task or goal reminders are used in all nine apps. All the apps except Glan have a social component attached to them in the form of adding friends or sharing task progress with friends through the app. Being competitive with other app users or friends is also a paradigm used in a few apps. Rewards and gamification [38] are used in six apps, gamification is prominently used in Habitica and Do It Now in the form of user avatars, upgrades, digital coins etc. In Forest, gamification is used in the form of growing a virtual forest. Penalty as a paradigm is used in Habitica, Do It Now and, Forest as a consequence of gamification in the form of user avatar downgrades, loss in digital coins etc.

We observe features such as personalized and categorised task management that enable users to manage their tasks efficiently by enabling the creation of various categories (e.g., Personal, Work, Academia etc.). The apps also focus on the tasks of the present day and function as a to-do. The apps assist the users to concentrate on their tasks with various focus modes. Forest has an interesting outlook on the focus mode wherein the users are extrinsically motivated to concentrate on their tasks in return for the growth of their in-app forest. Pomodoro focus mode is a common focus timer observed across a few apps. Tracking daily goals and habits is another common feature observed across the apps. Dreamfora has a feature wherein the app provides a step-by-step daily guide to achieve a dream (habit), the user has options to choose from a set of pre-set dreams in the app. Ticktick has an important

prioritization feature called the Eisenhower matrix wherein the tasks are divided into four categories: Urgent and Important, Urgent and Not Important, Important and Not Urgent, and Not Urgent and Not Important. Features like a calendar and timely reminders are present in these apps to assist users to stay on track.

The insightful statistics of the goal progress is a feature that is common across the apps. The insights inform the users of their progress and assist them in keeping up their goal-accomplishment momentum. Habitica implements gamification [38] and rewards as the source of extrinsic motivation towards goal accomplishment. Superbetter also has similar gamification features, additionally, it focuses more on a character-driven story for better user retention. Users can upgrade their virtual avatars with skills and the skills can be enhanced by completing the tasks. Forest provides extrinsic motivation through virtual in-app trees and forests. As the users keep completing their tasks, the forest keeps growing. Reforestation is encouraged through the Forest app using a gamification strategy that seeks to motivate users to stay concentrated and keep away from distractions. By encouraging users to stay focused on their job, the app plants a virtual tree that grows, helping users become more productive. The virtual tree will perish if the user closes the app before the allotted period has passed. Users are rewarded with virtual money that may be used to plant actual trees in different places of the globe when they successfully complete an activity or attain a goal. The program helps users stay motivated and involved in their job while simultaneously encouraging social and environmental responsibility by rewarding users for their productivity and providing them with the chance to have a positive influence [6].

We explored two categories of apps that implement the social component. The first category of apps (Any.do, Microsoft to-do and Ticktick) have features like team collaboration and task assignments which are majorly used in a team setting. The second category of apps has functions around various social settings in a personal setting. Completing gamified quests with friends to accomplish some tasks in Habitica, Do it now and Superbetter, connecting with users with similar interests or dreams in Dreamfora and planting trees with friends and family in Forest are some of the features being implemented.

Following, we discuss the various paradigms and underlying theories as observed

in the nine apps and corresponding literature:

Task Management

All the explored apps implement task management by monitoring tasks through various stages from start to finish. All nine apps have a checklist structure with a deadline associated with every task. Fox [42] presents strategies for time management and how best to apply these strategies to our ever-changing and technology-laden lives. The driving factors to utilize our time and resources are goals and deadlines, prioritization and procrastination. The paper discusses philosophies and tools for setting priorities including the Eisenhower method, calendar, and, to-do lists. *Consistency* with actions is the key to improving Task Management. In Superbetter, tasks can be set based on difficulty. The app provides power-ups to the user on completing the tasks. Habitica and Forest also function on similar lines. Bellotti et al. [22] report on the results of studies of task management to support the design of a Task List Manager (TLM) called TaskVista. TaskVista is a lightweight resource for collecting and listing to-dos and conveniently launching tasks from the application. It is a comprehensive to-do list that easily handles a realistic number of active to-dos. Each to-do has the property of importance that determines its priority or position in the list when the list is sorted for importance. Bellotti et al. [22] found that relationships with other people are an important factor in task management and to-do list prioritization. Users may choose to sort tasks based on the individuals whom the task is associated with or completed for. For example, a parent might choose to prioritize their daily to-do list in accordance with their individual children's needs. Alternatively, the same to-do list can be sorted based on the urgency of an upcoming deadline.

Progress Tracker

In the goal accomplishment journey, a progress tracker refers to a real-time visual representation of task status. *Self-monitoring* is the principle behind the identified progress trackers. All nine apps implement a form of progress tracking to monitor user progress and visualize progress using bar charts, pie charts etc. The progress tracker provides historical data to the user about their task completion status to assist in monitoring one's actions and progress. Self-monitoring brings a sense of

accountability and motivates the user to proceed forward. Foulonneau et al. [41] propose Time Is LifeTime (TILT), a persuasive application that fights procrastination and helps people to decrease phone usage. TILT is guided by the works of [39, 40]. TILT aims at limiting smartphone dependency by implementing a self-monitoring persuasive design principle and adapts the persuasive message to the user and their environment dynamically to bring variety and relevance to the persuasion. A six-week trial illustrates the adaptation of the persuasive message limits persuasive efficiency attrition and strengthens the persuasive power from the beginning to the end of the trial.

Focus

Apps which attempt to help the user stay on task or focused generally implement two strategies: *Forced Focus* and *Pomodoro Timer*. Forced Focus is implemented in Forest. To prevent any distractions, the app blocks the launch of other apps during the focus period. For example, in Forest, users are blocked from accessing social media. Excessive phone and social media usage cause unfavourable social comparisons, or envy [31, 72].

Pomodoro is a technique in which timers can be set to construct variable work-break blocks based on user convenience. Pomodoro timers are present in Forest, Any.do, TickTick, Dreamfora and, Glan. Implementing Pomodoro Timers is a strategy that the designers of these applications have used to lower the cognitive load. Effective work-break patterns to reduce cognitive load. The negative feelings might lead to overwhelm; overwhelm causes a high Mental WorkLoad (MWL) [67]. MWL reflects the number of mental resources required to perform a set of concurrent tasks [29]. MWL is generally comprised of the demands of the task, the experience of responding to the task [79], and the resources available to meet the demands [99]. Midha et al. [67] describe how MWL can be increased until a point where task performance will suddenly drop, as when the demands of the task exceed the person's resources available, performance errors can happen. Midha et al. [67] performed a qualitative interview study with 19 participants and used an Interpretive Phenomenological Analysis (IPA) approach. The primary interview data for Midha et al.'s [67] study was collected using digitally recorded semi-structured interviews. Four themes

were identified from the transcripts. An important theme was the MWL Cycle, where a cycle was presented regarding the necessity to fluctuate between MWL levels (High MWL, Medium MWL, and Low MWL) in certain patterns to maintain a productive MWL.

Social

All identified apps, with the exception of Glan, have social contexts associated with them. These eight apps have implemented collaboration in various ways to enhance user productivity. In apps Habitica, Superbetter and, Forest, the social aspects are implemented through group challenges or group comparisons. Apps like Microsoft To Do and Any.do have a collaborative approach to the social aspect where tasks can be shared among a group (or team) of users. Similar to the apps, Tuition is an online community developed by Lu et al. [62] where users document, review and share their progress on their side projects. It is a web application based on persuasive technology which was built to help motivate people to reduce procrastination. Social Support is Tuition's main channel of persuasion. It includes social learning (seeing other people's progress), and normative influence (following users). The application is also designed for social facilitation, social comparison and competition by visualizing who is working. The last strategy implemented is recognition, enacted by asking users to follow a timeline.

Reminders

All nine apps implemented Reminders to assist users to stay on track. The majority of habit-formation apps rely on self-tracking and daily reminders; Wicaksono et al. [95] point out that these features lead to dependency on the app and the potential to form a habit is lost. Wicaksono et al. [95] examine supporting habit formation by using reinforced implementation intentions to allow the intended behaviour to eventually become habitual. Wicaksono et al.'s [95] functional prototype consisted of a smartphone application combined with Google Calendar's Goal feature and a physical reminder. The goals feature was used to set a time at which the participant would like to perform the activity. This feature automatically created a schedule for activities based on the frequency and time preference of each participant. It was

observed that implementation intentions help people to put intentions into action to achieve goals such as sufficient physical exercise.

Gameful

Deterding et al. [38] define the use of game design elements in non-game contexts as *Gamification.* It is used in Habitica, Do It Now, Superbetter, Forest, TickTick and Dreamfora. Gamification is prominently used in the form of user avatars, upgrades, digital coins etc. In Forest, gamification is used in the form of growing and maintaining a virtual forest while completing the tasks. Complementary to the gamified apps, Martín-García et al. [66] illustrate a mobile application called Fun task manager which integrates a gameful approach to productivity goals while motivating the user to finish their tasks. The application introduces a virtual element called Tasky which could be treated as a virtual pet and it feeds indirectly on points collected by a user upon completing tasks. The core idea is to make it hard for the users to deceive the system and at the same time use gamification to hold their attention on their tasks.

Rewards

Rewards are desirable features that can be used to increase the motivation of users [91]. Habitica, Do It Now, Superbetter, Forest, TickTick and, Dreamfora implemented *Virtual* rewards. The Virtual rewards are gamified in the form of digital coins, power-ups, praise or user avatar upgrades. Forest implemented virtual rewards by growing the in-app virtual forest. On similar lines, DillyDally is an application developed by [96]. It integrates social networks and task notifications to suppress procrastination via peers' intervention. The principle of this application relies on peer influence, authors believe DillyDally can increase users' intention to stay focused and finish tasks. This was a qualitative study wherein students were interviewed about their experiences with existing applications, and it was concluded that the sense of accomplishment when finishing the tasks decreases as time passes since the reward mechanism cannot maintain user adherence.

Penalty and Competitive

Habitica, Do It Now and, Forest adopted Penalty as one of the theories. Habitica and Do It Now implemented loss in digital coins and user avatar downgrades when users failed to complete tasks. Forest penalized users with a form of virtual forest deforestation. Habitica, Do It Now, Forest and, Tick Tick adopted the Competitive strategy towards goal accomplishment. The apps adopted social comparisons in the form of leaderboards. The Competitive strategy also used Gamification to an extent in Habitica, Do It Now and, Forest. Penalty in the form of financial loss is investigated by Valladares et al. [91] who developed a mobile bet-placing platform that can motivate a user to tackle procrastination with the prospects of potential financial loss or gain. The study mainly focuses on user motivation by leveraging financial loss or gain, community engagement and gamification. The system design to support this includes functions like a newsfeed, task management, a toolbox, and a leaderboard on the mobile platform. The study is done using a medium-fidelity prototype with assumptions such as the user would perceive the gain from the reward to be greater than the pleasure of procrastination. In the next section, we explore literature about analysing user reviews to draw relevant insights about a subject.

2.4 Analysing User Reviews

Luiz et. al [64] present a method that considers the app features mentioned in the user reviews and provides sentiment scores for each feature, allowing for a more in-depth assessment of users' perceptions. The authors created a feature extraction method to identify the characteristics highlighted in each review using a dataset of user reviews of mobile apps from the Google Play Store. Further, using the reviews' words as input, they trained a machine learning model to predict the sentiment rating for each characteristic. The work also demonstrated the value of their method for determining which app features users liked and disliked, which aids developers in allocating their development resources more effectively. Huang et. al [46] combine automated feature extraction with human annotation. The authors created a platform where crowd-sourcing employees may view candidate features for manual annotation and sentiment analysis. The process includes multiple phases. First, potential characteristics are

retrieved using automated methods such as dependency parsing and part-of-speech tagging. The features are then offered to crowd-sourced employees, who are tasked with selecting the most crucial aspects highlighted in each review and determining the sentiment scores for each feature. The combined sentiment ratings are then used to calculate the review's overall sentiment score. In a dataset of more than 4,000 evaluations of mobile applications, the authors ran trials to gauge the usefulness of the technique. The findings demonstrated that the crowd-sourcing method performed better in terms of accuracy than currently used automated feature-based sentiment analysis techniques, particularly for reviews containing different viewpoints or contradictory feelings. In order to identify design elements that contribute to positive behaviour change experiences, Pimenta et. al [73] outline a methodology for systematically reviewing and analyzing online user reviews of fitness and nutrition mobile applications. The process includes multiple phases: (i) a systematic review of applications for physical activity and healthier eating habits, coding Behaviour Change Techniques (BCTs); (ii) sentiment analysis performed on 20492 review sentences of these apps; and (iii) design implications regarding the implementation features for each BCT cluster, considering the highest-scored features in terms of sentiment analysis. The reviews from the fitness and nutrition apps from the Apple App Store and Google Play Store were classified as favourable, negative, or neutral using sentiment analysis. The most commonly reported design aspects and their effects on user satisfaction and behaviour change were determined. In order to discover recurring themes and trends in the user evaluations, a qualitative study was performed. On similar lines, an approach for assessing the privacy and security aspects of mobile payment applications using user-generated reviews is presented by Kishnani et. al [54]. In order to detect privacy and security issues highlighted by consumers, the authors gathered a dataset of user reviews of mobile payment applications from the Google Play Store and conducted a content analysis of the reviews. Using both automatic text mining methods and manual coding, the content analysis was completed. After extracting pertinent keywords and phrases from the reviews using natural language processing techniques, it was reported that consumers are most worried about the security of both the app and their own personal and financial information. In order to increase the privacy and security of their apps, the authors have outlined a number

of best practices for mobile payment app developers.

We leverage the technique of sentiment analysis of the user reviews in understanding the state-of-the-art from users' perspective.

2.5   ARCS Model

The ARCS model, which stands for Attention, Relevance, Confidence and Satisfaction is a recognized model that emphasizes four qualities that a system should possess to inspire motivation [52]. The ARCS model suggests that there are four qualities of systems that foster and maintain motivation, in individuals; capturing attention, being relevant to their needs, instilling confidence, and providing satisfaction [52]. Furthermore, it is an impactful overarching theory that incorporates influential motivational theories, like Self Efficacy theory, Expectancy Value theory Reinforcement theory, Social Learning theory and Cognitive Evaluation theory [51, 83, 53]. The ARCS motivation model is widely utilized in domains, including games [37, 98], health [18] and education [65, 30] to guide the design and evaluation of persuasive and behaviour change systems. Mulchandani et. al [68] applied the ARCS framework to examine how peoples' motivation to adopt Covid-19 measures changed after playing a customized game designed according to the Transtheoretical Model (TTM). Their results showed that the tailored version of the game was more effective compared to the non-tailored version. Inspired by the findings in various domains, on the usefulness of using the ARCS model, we also incorporated the ARCS survey scale to evaluate user motivation levels after using the goal-setting app. Table 2.1 outlines the description of each ARCS motivational construct [71].

Currently, not many apps exist in the market that focus on self-actualization behaviour in goal-setting, as seen from the reviewed apps and literature. The apps focus on extrinsic motivation strategies with little reliance on intrinsic motivation and self-actualization strategies. Hence, we designed an app through iterative design and conducted evaluation studies to assess if the app has the ability to increase users' self-actualization behaviour towards goal-setting. We also derived inspiration from the Goal-Setting Theory [60] and Self-Determination Theory [35] to align with users' goal-setting orientation. In the following section, as the first step, we discuss the qualitative study of understanding peoples' goal-setting strategies and challenges.

Construct	Definition
Attention	For a system to motivate users, it must arouse and sustain their attention.
Relevance	To motivate users, a system must reflect users' interests and goals. A system that is perceived as helpful and useful in terms of helping users accomplish their goals is more likely to motivate users. To be relevant, a system must be goal oriented, motive matching, and make use of familiar concepts.
Confidence	People do not like taking on a task with little or no probability of success. Although success is never guaranteed, and people like to be challenged, a challenge that is beyond a user's capability could demotivate them. Users' confidence levels are often correlated with their motivation and the amount of effort put forth towards achieving an objective.
Satisfaction	To motivate users and sustain their motivation, they must derive some satisfaction and reward for their effort.

Table 2.1: Description of the ARCS constructs [71]

Chapter 3

Study 1 - Understanding the Goal-Setting Strategies and Challenges

Literature suggests, heavy reliance on external rewards, takes away from the satisfaction of completing the goal itself [69]. Anticipation of external rewards can undermine intrinsic motivation [32] and a meta-analysis by Deci et. al [33] suggest that intrinsic motivation was found to be significantly reduced when individuals were given extrinsic rewards for activities they initially found intrinsically motivating. In complement with this, Tisocco [90] suggested fostering intrinsic motivation to reduce academic procrastination among the students. The aim of our first study is to investigate the goal-setting strategies that people use in their everyday life, factors that influence their goal-setting process and, challenges faced during the goal-setting process. This study aims to answer the following research questions:

- **RQ1**: What strategies do users find effective in their goal journey?

- **RQ2**: What are the hindrances, distractions, and challenges that participants face?

- **RQ3**: How do we design effective applications for goal accomplishment?

To answer our research questions, we conducted a qualitative study with 16 participants using a one-on-one semi-structured interview protocol (see supplementary work). In each interview, questions explored what goal-setting means to the participants, followed by their goal-planning and prioritization strategies. Our protocol probed the blockers or challenges that users face while working towards their goals and the motivational strategies that help them overcome hurdles. Our analysis followed Interpretative Phenomenological Analysis (IPA) paradigm using an affinity diagramming technique to identify specific themes from the interview transcriptions [85]. In IPA, each participant's data is considered in depth to enable an idiographic approach

before general claims about the data are made [85]. From our data analysis, we identified seven themes supported by participants' quotes presented in the results section. Our results examine the thoughtful breakdown of larger goals into smaller, progressive challenges. We attend to the work-break patterns that the participants follow to maintain balance and their emotional reactions towards goal outcomes. Users discuss how individual reflection and selective social sharing fuels additional efforts. Use of social media was limited; instead, participants chose to share with select people who have meaningful ties to their journey (i.e. parents, partners, and close friends). Selective social sharing helped participants with accountability and validation. Following the results, we discuss four Design Recommendations (DR), which aim to create a positive vision of the future to encourage the user to pursue their goals. Our recommendations contribute to improving the design of goal-oriented productivity applications by relating to the users' aspirations, positively framing their successes, breaking down goals into smaller challenges, and providing opportunities for work-life balance, and reflection.

3.1 Methodology

To answer the research questions, we employed a qualitative methodology to explore the goal-setting journey. The interview protocol includes questions about the goal-setting strategies used by participants (RQ1) and probed hindrances or challenges that participants face while working towards their goals (RQ2). We answer RQ3 with four design recommendations based on our results.

Data Collection Methods

The data collection methods included semi-structured interviews combined with participant observations by recording their audio and video responses. The interview questions were based on the investigation of the goal-setting strategies that people use in their everyday life, factors that influence their goal-setting process and, challenges faced during the goal-setting process. The study lasted for up to 75 minutes. The study assisted the researcher in understanding the goal accomplishment journey of the participants.

Participants

We conducted online one-to-one semi-structured interviews with 16 participants. The study population included university students and working professionals above the age of 18. Data was collected to the point of saturation; a strategy common to qualitative research stemming from grounded theory which indicates that the data sample is sufficient. Saturation is an exhaustive approach to data collection; researchers continue collection until the set of answers given presents no new directions in which to probe for additional information [21].

Protocol and Ethics

The study ethics was approved by the Research and Ethics Board at Dalhousie University (REB# 2022-6135). The interview was conducted online on Microsoft Teams. Each participant was remunerated with a $15 e-transfer to their email address in appreciation of their time. We collected the participants' responses through the interview with audio and video. Within the interview, participants were not asked to self-identify.

Data Analysis

We followed Interpretative Phenomenological Analysis (IPA) for the study. The analysis followed the method outlined by [85, 84]. IPA is a qualitative approach and the aim of IPA is to understand participants' lived experiences, exploring one's personal perceptions or accounts of an event [85, 84]. It is modelled on people as self-reflective beings who reflect on their experiences and try to interpret them [85]. In IPA, each participant's data is considered in depth to enable an idiographic approach before general claims about the data are made [85]. IPA was favoured over Thematic Analysis (TA) in this study because TA focuses on patterns across the dataset, and the voices of individual participants can get lost [63]. IPA does consider data patterns but is also concerned with individual experiences [85], which is what we are exploring in this study. The researcher familiarized themselves with the interview transcripts. Comments were then noted in relation to first impressions and interpretations of the participant's account. These notes were then translated into emergent codes. Once

all emergent codes had been created, connections between them were identified and emergent themes were grouped together to materialize as initial sub-themes. This was repeated for each participant, whilst using the themes from previous transcripts to orient the analysis. Respecting divergences as well as convergences in the data remained a priority throughout the analysis. After all transcripts had been analyzed, a final set of themes were identified across the full dataset. Final themes were subject to a review, where the implication of themes was presented and discussed. In the results section, each participant is referred to by a number, e.g., P15 refers to participant 15. A snapshot of the data analysis process is represented in the Figure 3.1. Column 1 represents the participants' quotes, column 2 represents the quotes categorised by codes and the last column represents the formulation of themes from the codes.

3.2 Results

In this section, we present the results obtained from the IPA performed on the qualitative semi-structured interview transcripts. Following, major themes were revealed by analyzing the participants' dataset as a whole. This process was followed to get an umbrella of seven major themes from our study. Afterwards, each identified theme developed was reviewed and presented with supporting quotes as evidence.

3.2.1 Goal-setting

Participants discussed the process of goal-setting gives them a sense of *purpose* and direction to move forward. They also felt that *social reflection* impacts their goal-setting process. Participants stated not having fixed goals makes them feel disorganized and unstructured.

> "...gives me an idea of how much I have done and how much is to be done. So without the goals, it would be just shooting in dark" - P2

The above quote demonstrates the importance of tracking the progress of goals including specific content. Goal-setting gives a sense of motive and organization.

> "It almost feels like taking care of myself because... when I don't have a lot going on. I tend to feel kind of disorganized..." - P15
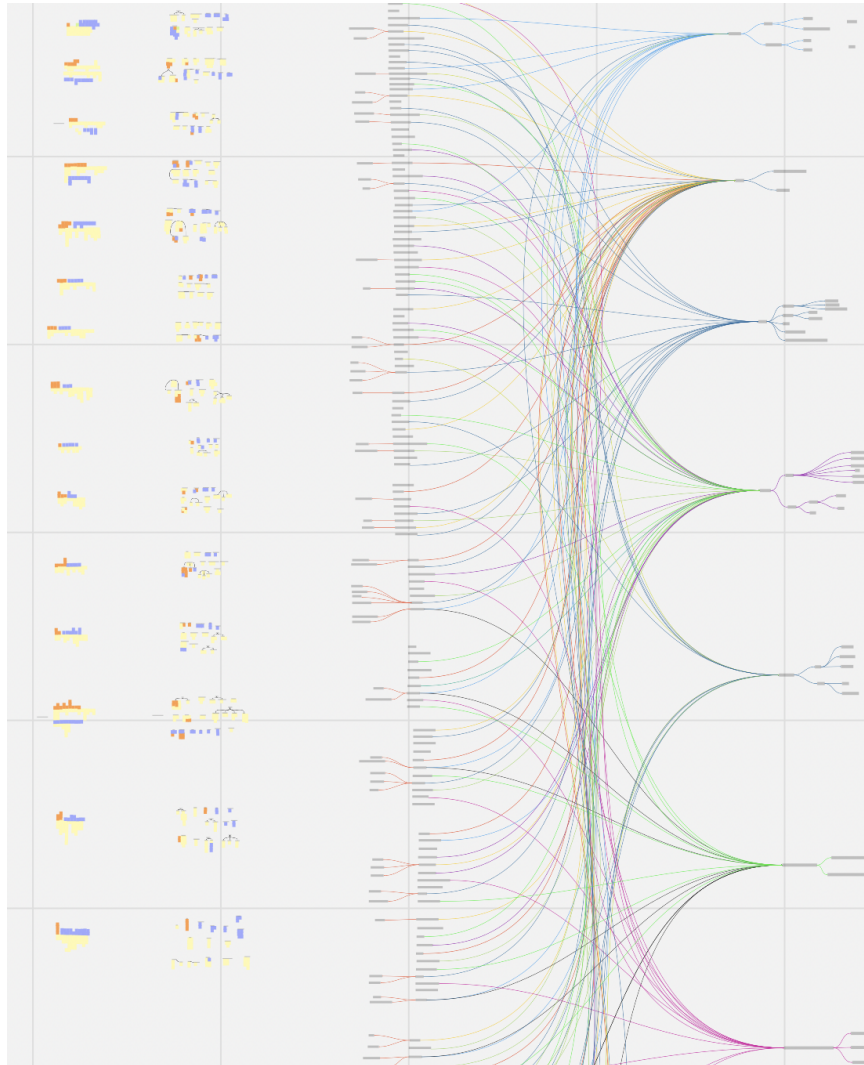
Figure 3.1: Snapshot of the Data Analysis Process on Miro Collaboration Platform [47]

P15 equated the importance of goal-setting to a sense of self-care that provides a structure to their daily life. Although goal-setting provides a purpose, participants felt that the process of goal-setting also causes overwhelm and fear of failure, especially when the goals are high stakes and long-term.

> "...having [goals] too big and then you're... overwhelmed...It could be a little bit of anxiety-inducing... look at the amount of things that I have to do. I don't know if I would be able to and that's kind of like a scary thought sometimes." - P11
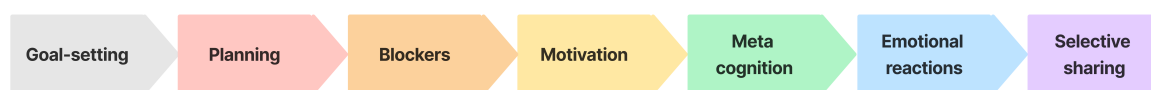
Figure 3.2: Summary diagram of the seven identified themes

Above, the participant expresses how thinking about long-term goals can be anxiety-inducing, just by considering the number of things to accomplish. Although goal-setting is an internal journey, it could also be influenced by social factors. *Social reflection* is a social process, that puts individual account, perception, inquiry, and judgment into dialogue with those of others [97].

> "...As a person... I got emotional and I have set-up some goals. Now you have to... Grow up and you have to show [friends and relatives]...I am fortunate enough like those emotional goals I have set-up. Put me in a right track...But with age I think when you will find right people besides you and when you start discussing actually... It can help you in when we have setting emotional decisions or emotional goals." - P7

P7 describes how social reflection has emotionally affected their goal-setting decisions in the earlier days of their life. They explain that age can play a factor in looking at social reflection in a different way and the burden of social factors can be controlled or better understood by discussing with the right people.

Purpose and *social reflection* have both positive and negative consequences associated with them but essentially contribute to goal-setting. After the initial step of goal-setting, participants describe the strategies for effective planning and prioritization of their goals.

3.2.2 Planning

The participants discussed the process of planning their personal and work-related goals. *Breaking down larger goals into sub-goals* and *prioritization* were identified as the major strategies from the interview data.

> "So being able to split things up and allow myself some breaks helps me retain that focus... and I make sure to kind of set almost like checkpoints for myself to reach to make things a little bit less intimidating..." - P15

The above quote demonstrates that splitting long-term goals into short-term goals and setting checkpoints for every goal helps in increased focus towards the goal while also making the bigger goal seem less intimidating. Splitting up goals and working on them consistently with appropriate breaks helps in lowering the cognitive load, says P15. Decomposing long-term is essential for effective prioritization. Participants discussed prioritizing short-term goals based on the urgency or deadline of the respective goals.

> "...it's very difficult to achieve long term..after one year I wanna do this after two years. I wanna do this. But that's a gradual process. So I generally used to plan my short-term goals...like if the deadline is coming near... I tend to work towards my goal more efficiently." - P5

P5 describes how effective *prioritization* and setting deadlines for short-term goals creates a sense of positive urgency and pressure which in turn makes the goal achievement journey more efficient.

Effective planning and prioritization give a good start to the goal accomplishment journey but, participants discuss various blockers they face when they begin working on their goals.

3.2.3 Blockers

Participants described various challenges or hindrances that they faced while working towards their goals. Environment, friends, phone, and social media came across as major sources of *distraction* for a majority of the participants. Participants also explained how their *behaviour*, *health* and *factors that are out of control* act as hindrances in their goal accomplishment journey.

> "...The number one factor is social media and... playing games or any form of entertainment which I believe, or at least now I have understood that they should have their own specific time." - P2

P2 explains how social media and games act as major sources of distraction. Since social media is a never-ending journey, there should be a specific time allotted to it so that it does not come in the way of the goal achievement journey.

Being in a productive mental space, in complement to the physical and emotional considerations, is very important to gain focus and flow at work.

> "...one of the most important things I think that affect my ability was... mental health...I found that if I am not motivated to do something or if I'm not feeling well, [It]... greatly increases my chances of procrastinating...physical health too is another factor that affects my ability" - P15

In the above quote, P15 describes how both physical and mental health has affected their ability to meet their goals. Expressions of this sentiment echos that of the full dataset demonstrating the interplay between social, physical, emotional, and mental health considerations all play into the formation of space to combat distractions allowing the focus to be placed on personally relevant activities. Despite all the efforts to reduce blockers, there remain factors that are out of control (e.g. financial limitations, societal changes, and similar). The COVID-19 pandemic was an example of one such external factor that affected individuals. In the following quote, P14 illustrates one instance of a shared pervasive circumstance:

> "...external like COVID and it flashed on and other stuff like I cannot really control it. So it's like slow down my progress a little bit..." - P14

The interplay of both controlled and uncontrollable circumstances can create blockers within the goal-accomplishment journey. Although blockers discussed can create challenges for individuals; participants discussed several motivation strategies to adapt and overcome.

3.2.4 Motivation

Participants expressed *Intrinsic* factors that motivated them to begin their journey. Intrinsic motivation is defined as the doing of an activity for its inherent satisfaction rather than for its consequences [77]; intrinsic motivation can inspire the creation and adherence to disciplined routines.

> "I just [try] to be as consistent as possible... So basically following the routine... even if you are like way behind as well so little by little eventually will get close to your goal" - P8

P8 describes that working towards the goals consistently and sticking to a routine has helped them get closer to their goals irrespective of the circumstances. Once a pattern is established adherence is the focal challenge; however, creating the pattern at the beginning of one's journey precedes disciplined adherence.

> "...it's easier to start really slow, like you can just do something really small... Like in the beginning you need to put just a little bit effort, so I think it's easier to maintain it that way... when you have a momentum it's easier to increase." - P14

P14 explains that even though the goal might seem overwhelming in the beginning, taking initiative and effort to start working on the goal helps in a big way. They further describe that this process gradually builds momentum that could be used for the next steps. Once the goal pursuit is in progress, participants talk about gaining motivation from the achievement of past goals to move forward.

> "...if I've done something successfully in the past, that's just going to motivate me for what I'm doing in or what I'm going to do, the future..."
> - P6

P6 summarizes that viewing their past progress and their achievements motivates them toward their current goals. Tracking the progress or self-monitoring gives a sense of systematic progression towards the goal and this acts as a source of motivation. Although, an individual is motivated to work, sometimes, they might face challenges or blockers as discussed in the previous section; when this happens, participants talked about compensating for the less work accomplished on a given day.

> "...strategy could be the guilt, guilt factor. You know, I would say that's my primary factor because you feel like, oh, I have not done anything. So I would say the next day I would do double the amount of work to compensate for the previous day." - P16

P16 expresses that the guilt of not working as planned on a given day motivates them to work more the next day. The added pressure acts as a motivation to get the work done on time.

Along with the intrinsic factors, participants also spoke about the external factors that motivate them. External factors as motivation cues is the definition of *extrinsic motivation* [77]. Below, P10 talks about how financial gain acts as a source of motivation. Even if there is an aversion towards work, the motivation for monetary gain overtakes the dislike towards work.

> "...money is a very big motivation...I hate going to work, but when the paycheck comes. You know. Yeah, pretty self explanatory" - P10

> "...when the goal is completed, you have a badge that says that you accomplished your goal successfully or you've been able to finish this set of goal that you had prepared" - P12

In the above quote, P12 explains that virtual rewards act as a source of motivation for them. It gives them a sense of achievement while also adding to the fun factor. Straddling the definitions of intrinsic and extrinsic rewards is praise from peers. Feeling validated motivates efforts taken towards a goal. In the following quote, P5 summarizes that praise from their peers or someone in authority makes them feel satisfied towards their work which in turn increases their motivation.

> "...my team is very nice... they try to be very... normal towards me they just praise me every time... I'm still in the phase of learning I'm a student so they appreciate me every time..." - P5

Holding high motivation and working towards goals would lead to a high cognitive load. Participants talk about various strategies that lower their cognitive load in their goal pursuit.

3.2.5   Meta Cognition

Participants spoke about their thought processes and work-break patterns. They described the *active* and *passive* experiences that help them maintain a lower cognitive load. Active experiences include features of mobile or web applications that are accessible and easy to use; passive experiences include away-from-the-app experiences that help in maintaining healthy work-break routines. Easy to use and well-laid-out apps appealed more. The apps should display precise data on the goal progress with easy accessibility, says P4 below.

"Some sort of like calendar... something that's a little bit more like easy on the eyes. Like you can actually see like your goal like right there... whatever like steps are left... I guess just like more laid out..." - P4

"organizing the type of tasks too. So like being able to differentiate for whether this task is for work or for school or if it's a personal thing that'll definitely help." - P15

Logical classification of all the goals into different categories adds a layer of structure in the goal accomplishment journey. It also helps in easier access and better tracking of the goals, says P15. At the same time, the apps should be intuitive and easy to use. Apart from the app features, participants discussed the work-break patterns that help them rejuvenate and get back to work with increased productivity. We have categorized these quotes under *passive* metacognition.

"I love Nature... I just wear my headphones, listen to music, so that was pleasant. So that itself motivated me so that time, I guess one of my goals were to kind of go for regular walks or learn guitar and things like that. So this again forms as part of my hobby..." - P6

P6 talks about how they utilized their break rituals to consciously work towards their goal of learning guitar and that process worked as a source of motivation for them. Participants also talked about looking at their work from a different perspective to make their work seem more interesting.

"For me, something that is quite fun for when I need to get something done or like accomplish a goal is to kind of make it into a game... Either it's just like I win and I'm like, Oh my God, that's awesome. I won even though I didn't win anything..." - P4

Introducing a fun factor in the goal accomplishment journey and treating a goal as a game increases motivation and also gives an added sense of accomplishment as described by P4.

It is evident from the quotes that the reduction of cognitive efforts accompanied by healthy work-break patterns helps in the goal accomplishment journey. Although

adopting these processes is helpful in goal pursuit, the outcome of the goals might be positive or negative. Participants talk about their emotional reactions towards their goal outcomes.

3.2.6 Emotional Reactions Towards Goals

Participants conveyed that they attached emotional perspectives to their goals. Their feelings varied from *positive* to *negative* based on the outcome of the goals.

> "I think I feel very satisfied. You know, I feel that I feel good...So I think it's just constant motivation and like a very good feeling knowing that I am accomplishing what I wanna do." - P13

P13 describes that accomplishment of a goal boosts their self-confidence and provides motivation to keep moving forward. On the contrary, not being able to accomplish a goal, especially a high-stake goal induces a *negative* feeling.

> "I would say it's sometimes takes a mental toll on me...when I can't achieve it... it's kind of like a little voice. It keeps telling, OK you didn't do this... It's gonna [keep] adding like more pressure to that" - P9

P9 summarizes their feelings when they fail to achieve the goals that they worked hard towards. They say that the failure adds unpleasant pressure on them.

In summary, participants attach emotions to their goals and the outcomes affect them. Participants mentioned that selective social sharing helps them both to celebrate success and to reduce the burden of failure by adding a layer of accountability and authority.

3.2.7 Selective Sharing of Goals

Participants agreed that sharing the progress of their goals with their *peers who have an understanding of the goals* or with *close friends and family* benefits them. They believed that social sharing helped them whenever they required any external *help or resources.*

> "...if there is anyone like with guiding me throughout so that it becomes easy for me...So my short-term strategy is like to work with any of the

person you know who is more knowledgeable than me or just to be a buddy with me... who can just guide me throughout the process..." - P5

P5 describes that sharing their goals with relevant people helps them. Time wastage can be avoided and the goal accomplishment journey becomes relatively easier with guidance. The added sense of authority also increases accountability. Along with this, *Sharing with peers who have an understanding of the goals* gives a sense of validation for the work done.

"...specifically with gym, when you're going with somebody, even if you don't feel like going that particular day. They kind of forced you into it. I mean, that's another check mark right there cause you get went to the gym even when you were feeling at that there." - P10

P10 describes that having an accountability partner has benefited them. Sharing common goals with peers helps in achieving the goals more easily because of mutual understanding and trust. *Family and close friends* are an integral part of one's life, as expressed by P6:

"if it's someone who's special to you, like, who takes part in your day-to-day activities and things like that they celebrate with you. That's another thing that I can imagine of." - P6

The above quote demonstrates that sharing goals with family or close friends brings a sense of fulfilment.

We observed the views of participants towards the goal-pursuit process. Each participant's quote highlighted an important aspect of the respective theme. Figure 3.2 depicts the summary of the discussed themes as we move forward towards our DRs.

3.3   Discussion

As the literature suggests, extrinsic motivators have low adherence and their effects eventually decrease with time [95, 96]. As our results suggest, people are well aware of their end goals. However, effective learning is required to break down goals minutely while constantly reminding the users what is at stake for each goal; thereby focusing

on self-actualization. Based on our analyzed data, we recommend four system design features that might benefit people in their goal-accomplishment journey. Accessibility and an intuitive user experience (UX) are the backbone of our DRs [80, 25]. We recommend a focus on intrinsic motivation strategies over extrinsic motivation strategies for long-term sustenance and habit formation.

We took into account these strategies to propose our DRs below:
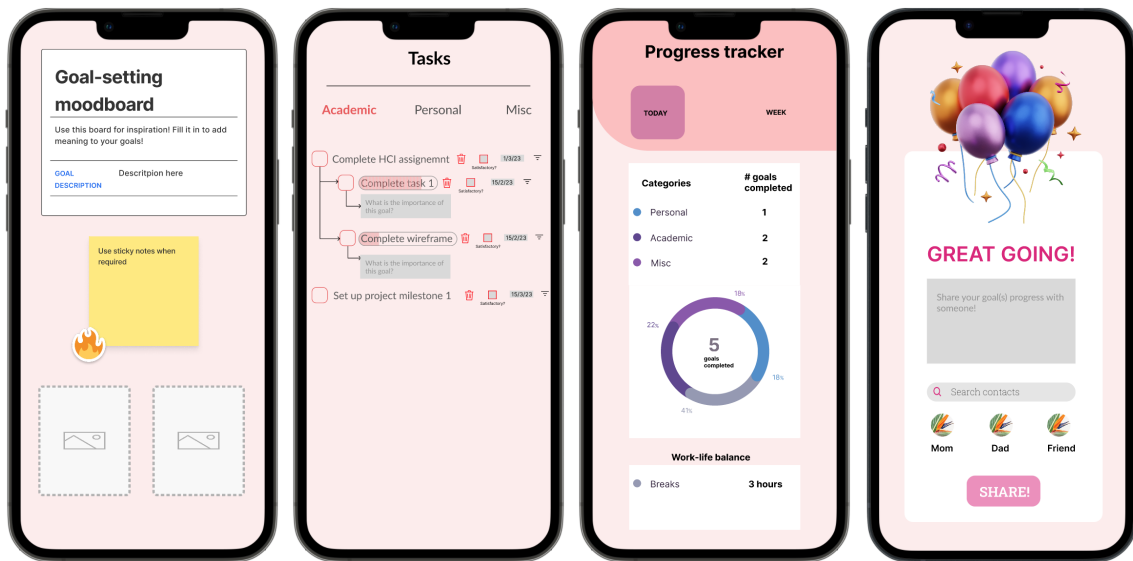
Figure 3.3: Depiction of the DRs (a: Moodboard, b: Tasks to-do, c: Progress tracker, d: Selective social sharing)

Figure 3.3 illustrates our four Design Recommendations (DRs). Each screen represents a prototype for each of our DRs i.e., Long-Term Vision using 'Mood Boards', Breakdown Long-term Goals using 'To-Do's', Balance Progress with 'Progress Tracker' and, Seeing Your Desired Self through Positive Reflection through 'Selective Social Sharing'. The prototypes are developed on Figma [15].

3.3.1 DR 1: Long-Term Vision using 'Mood Boards'

From the results: Goal-setting, Planning, and Motivation, we justify designing applications that take into account users' long-term vision. We observed that the process of goal-setting gives a sense of purpose and direction driving the move forward. Breaking down goals and prioritizing effectively are the key strategies that facilitate planning. Our results regarding motivation indicate that being disciplined and sticking to a

well-defined routine helps facilitate progression and achievement. Being consistent enforces intrinsic motivation and self-realization of the goals. Even if a goal is perceived as intimidating, a small step towards the goal boosts self-confidence and helps in building momentum. One important factor that helps in being consistent is the ability to look at the bigger picture (long-term goals) and plan accordingly. A mood board (or inspiration board) is a combination of images, colours, and words that represent goals as represented in Figure 3.3a. A mood board should be personalizable and include representations of the users' inspirations. The tool serves as a reminder of their intrinsic motivations and evokes meaning. Users can look at their mood boards regularly to stay inspired and stay focused on their goals.

3.3.2 DR 2: Breakdown Long-Term Goals using 'To-Do's'

Evidence from our results in planning, meta-cognition, and emotional reactions towards goals points towards assisting users in the decomposition of long-term goals into manageable short-term activities; effective deadline-based prioritization was achieved through decomposition. From our results in meta-cognition, participants talked about app engagement and expressed sentiments in line with accessibility, so as to maintain a low cognitive load. Evidence from our results in emotional reactions towards goals, we observed that accomplishment of goals induced positive feelings whereas failure induced negative feelings. If a goal seems very intimidating, participants are often overwhelmed and procrastinate because of fear of failure and poor social reflection. In this case, breaking down the goal into sub-goals and trying to build momentum by achieving the sub-goals is a helpful strategy. Decomposing large goals into smaller tasks also creates a sense of urgency and motivates consistent incremental achievement based on dispersed deadlines. As such, our DR is to create a to-do checklist where the user can compose long-term goals and further divide those goals into a list of short-term activities with individual deadlines. From Lindgren et al.'s [56] work, it was observed that not all the people have same values associated with an activity. The value directions with respect to activity were measured by the people's levels of satisfaction, confidence, preparedness and, importance associated with a particular activity. Based on this finding, we recommend creating a section for each goal which prompts the users to enter what is at stake for the corresponding goal as depicted in

Figure 3.3b. This creates a sense of accountability and discipline. Traditional goal setting assumes a binary outcome for goal evaluation. This binary judgment does not consider a user's effort, which may demotivate the user. Jung et al.'s [50] work explore the possibility of mitigating this negative impact on the goal evaluation criterion, by introducing a 'margin'. A margin represents a range near the goal where the user's outcome will be regarded as 'good enough' even if the user fails to reach it. We recommend on implementing this idea in the application by introducing a margin of error for each goal. The margin would support goal achievement by reducing negative emotions while anchoring the users to strive toward their goal even if the evaluation becomes relaxed.

3.3.3 DR 3: Balance Progress with 'Progress Tracker'

From the results: Motivation, Blockers, and Metacognition, we see the justification for designing applications that prioritize balance. Participants expressed that reflection or 'looking back' at their progress provides momentum or a drive to move forward. When discussing blockers, it becomes clear that thought is needed to construct an environment that considers physical, emotional, social, and external factors to reduce distractions that can be harmful to the goal journey. Striking balance in space is complemented by the balance in routine, as discussed in Metacognition. Creating balance through awareness of one's cognitive load is important to the individual attempting to reduce barriers that detract from focusing on their journey. Tracking goals not only gives a picture of the overall progress of the goals but also boosts motivation, heightens positive emotions, and sustains user productivity. During the execution of the goals, taking appropriate breaks to avoid burnout is healthy behaviour. Breaks are very essential to maintain a lower cognitive load as we found from the results. Participants talked about taking naps, taking a walk, and spending time with friends and family helped them rejuvenate. To have a healthy balance, we recommend on designing a daily goal progress tracker for self-monitoring [39, 40, 41] as represented in Figure 3.3c. For further personalization, weekly or bi-weekly email reports could be sent out to the users to highlight their goal progress status [43, 19]. The email templates could be made entertaining for better appeal and the email subject could

be personalized to create curiosity among the users [94]. Moreover, the results indicate that the design of the application should consider the cognitive load of the user by focusing on ease of use thereby reducing overhead from engagement with the application [29, 67].

3.3.4 DR 4: Seeing Your Desired Self through Positive Reflection through 'Selective Social Sharing'

Within our results, under the themes of Emotional reactions towards goals and Selective sharing of goals, we find justification for including positive reflection narratives as a DR. Deriving from our results in emotional reactions towards goals, we observed that participants felt positive or negative emotions based on the outcome of their goals. From our results in selective sharing of goals, participants reveal that social sharing helps increase the satisfaction of success or reduce the burden of failure by adding a layer of accountability and authority. The accomplishment of a goal boosts self-confidence and provides satisfaction [88, 78]. The level of satisfaction is directly proportional to the priority of the goal. Users are social, so sharing their achievements or progress gives them a sense of validation. Participants expressed, sharing their goal progress with family or peers induced a sense of fulfillment and accountability. The caveat is sharing on social media widely did not have the same positive impact as selectively sharing. Hence, we propose a design wherein users can have a choice of templates which could be populated with their goal progress and can be shared with their contacts as illustrated in Figure 3.3d.

In this study, we explored the strategies and challenges the participants face in their goal accomplishment journey. In simple terms, the study contributed in understanding the lived experiences and pain points in their goal-setting behaviours. In the next study, we look at understanding user perceptions towards the design features of the nine goal-setting apps through sentiment analysis.

Chapter 4

Study 2 - Understanding the State-of-the-Art

Following the insights about the goal-setting strategies and challenges from study 1, in this chapter, we explore and analyse the user reviews from the nine mobile apps explored in the literature to understand the positive and negative aspects of their goal-setting features. We scrape the user reviews from the nine apps, we filter the reviews that are relevant to the seven themes (Goal-setting, Planning, Blockers, Motivation, Meta cognition, Emotional reactions towards goals, Selective sharing of goals) formulated from study 1. We then perform sentiment analysis on the filtered reviews and formulate six themes. This study aims to answer the following research question:

- **RQ4**: What strategies do users find effective in the already existing apps?

4.1 Methodology

The aim of this study is to understand the perceptions of the users towards features of the nine selected apps. We employed Natural Language Processing (NLP) techniques to extract user reviews from the apps. We filtered the reviews based on the final themes from study 1. Through sentiment analysis we categorised the reviews into positive and negative. We employed Thematic Analysis (TA) [63] on the reviews and derived a set of themes to answer RQ4.

Data Collection

We extracted the user reviews of the nine apps from the Google Play Store. The apps are: **Any.do, Dreamfora, Glan, Ticktick, Microsoft to-do, Habitica, Forest, Do it now** and **Superbetter**. We extracted the reviews present in English, from September 2022 to February 2023. The query was restricted to reviews from Canada.

However, the reviews related to app-specific technical issues are out of scope of this study.

Protocol and Ethics

The study did not require an approval from the Research and Ethics Board as there were no human participants involved and all data was in the public domain.

Data Analysis

For each of the nine apps, we retrieved the reviews from the Google Play Store. All the extracted reviews were imported into NVivo software [61]. We created a text search query with the keywords from the themes of Study 1: Goal, Plan, Motivate, Emotion, Block, Cognition, Social and Share. We used the keywords Social and Share separately because, filtering the reviews only with the keyword Share fetched the reviews that talked about app sharing rather than the share feature within the app. Hence, we incorporated the keyword Social to fetch the reviews that talked about the share feature within the app from an angle of social media. We applied the query to the imported reviews. The query results were the reviews that contained one or more keywords. The filtered reviews were then imported into Microsoft Excel [27] spreadsheets for sentiment analysis; one spreadsheet per app. We used SiEBERT - English-Language Sentiment Classification for the sentiment analysis of the filtered reviews [44]. The model ("SiEBERT", a prefix for "Sentiment in English") is a fine-tuned checkpoint of RoBERTa-large [57]. It enables reliable binary sentiment analysis for various types of English-language text (Positive and negative). We used the Google Colab platform [75] to run the model. We uploaded nine spreadsheets onto Google Colab. The model was run individually for each spreadsheet and the result was captured in an additional spreadsheet with a column indicating the user review to be either *positive* or *negative*. We imported the final dataset into Tableau [48] and Microsoft Excel to draw insights from the data and represent the findings through visualisations. We then analysed the user reviews per app and clustered similar reviews together in an iterative manner. While analyzing the reviews, we found patterns which indicated the reasons why users generally liked or disliked a particular app. Following, we performed a thematic analysis [63] of the cumulative

Apps	#Extracted reviews	#Filtered reviews	#Positive reviews	#Negative reviews
Any.do	1127	58	26	32
Microsoft to-do	3050	177	149	28
Forest	3593	80	71	9
Habitica	350	44	36	8
Superbetter	22	4	3	1
Do it now	117	20	18	2
TickTick	1464	48	44	4
Dreamfora	44	6	5	1
Glan	115	8	8	0

Table 4.1: Table signifying the number of extracted reviews, filtered reviews, positive and negative reviews per app

filtered reviews. We employed affinity diagramming to identify specific themes.

4.2   Results

In this section, we discuss the insights obtained from sentiment analysis of the user reviews and the insights from thematic analysis of the user reviews.

4.2.1   Insights From Sentiment Analysis of the User Reviews

The apps' metadata is summarised in the Table 4.1. The column #Extracted reviews signify the total number of reviews extracted from the app. The column #Filtered reviews signify the total number of filtered reviews after applying the keywords text query. The number of positive and negative reviews are mentioned in the last two columns respectively. It is evident that Microsoft to-do and Forest received the most feedback from the users among the listed apps with 177 and 80 filtered user reviews respectively. Dreamfora, Glan and Superbetter are the least-used apps with six, eight, and three filtered user reviews respectively.

Although Glan has eight filtered reviews, they are all classified positive according to our sentiment analysis model. All the apps expect Any.do have positive reviews in the majority. Any.do has 55.17% negative user reviews as illustrated in Figure 4.1. The Figure 4.1 represent the ratio of positive and negative reviews out of 100%.

Magnified versions of all the apps are illustrated below from Figure 4.2 to Figure
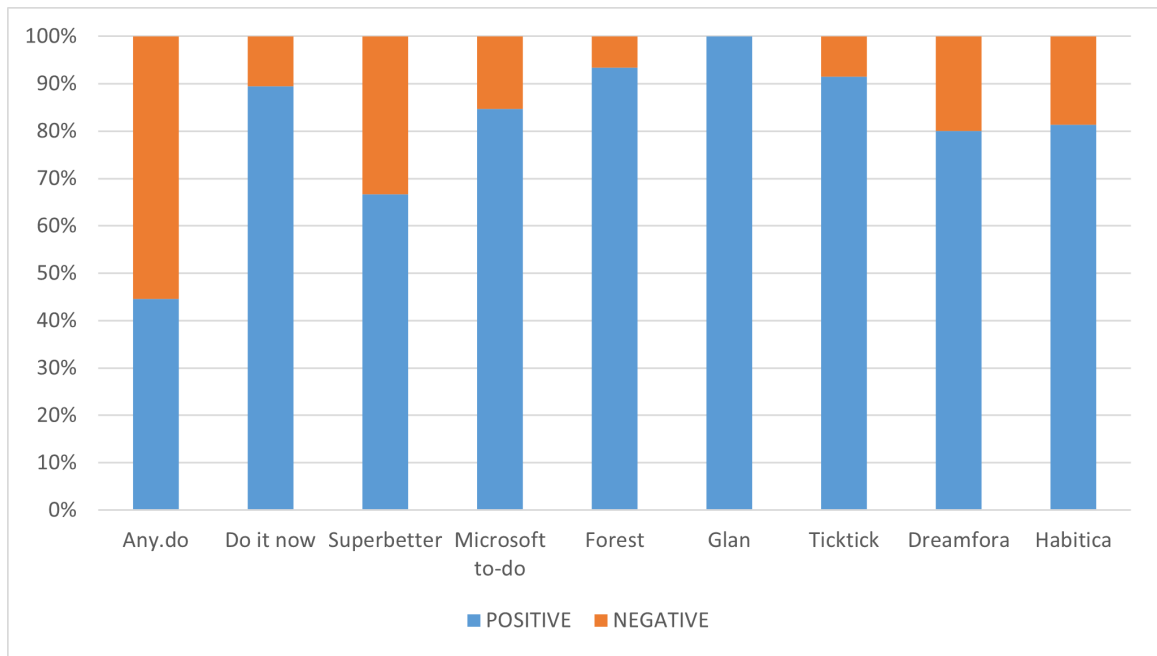
Figure 4.1: Ratio of positive and negative reviews per app

4.10 below. From Figure 4.2 it is evident from our results that *Plan* is the most
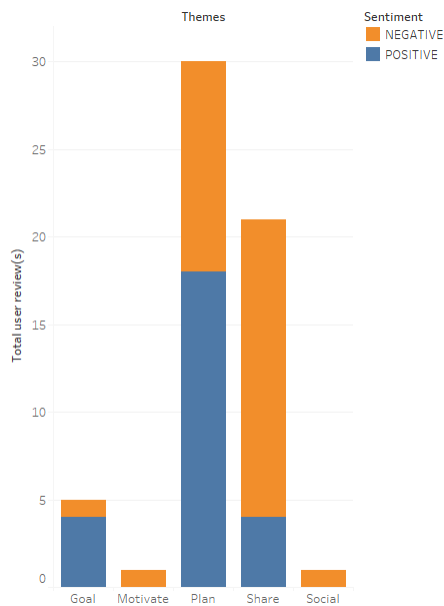
Figure 4.2: Total number of positive and negative reviews per theme in Any.do

discussed review keyword with 18 positive and 12 negative reviews signifying that Any.do is mainly reviewed for planning tasks. The users summarized the effectiveness of the planning feature of Any.do

> "...something where reminders are consistent and obtrusive enough not
> to ignore, a visual widget of the tasks for the day and something that
> not only reminds you to plan and walks you through it - but also LINKS
> EVERYTHING..."

In contrast, a few users did not find the 'My Day' feature for planning to be very effective

> "Amazing app, but I wish there was a way to plan the day the night before
> instead of for the same day." "Very practical and useful application, please
> add timing and editing option to my day plan configuration including the
> ability to choose the time of the task manually"

Further, *Share* is the next highlight of the app with four positive and 17 negative reviews. The negative reviews in Any.do are concentrated around the feature of sharing in the app, which was deprecated. The users expressed their concerns regarding the share feature

> "Worked great for me in the past but now I am no longer able to share
> tasks. I had not shared tasks in a while so I do not know when this broke.
> The Share option from the support page does not show up in the desktop
> app or the android app. I can still see the sharing that I had previously
> setup for other lists but I can no longer share with new people."

The keyword *Goal* has four positive reviews and one negative review. Keywords *Motivate* and *Social* are the least discussed with one negative review each.

Although, Dreamfora has considerably less number of user reviews as shown in Figure 4.3, *Goal* is the most discussed keyword among all the user reviews with four positive and one negative review. The users stated their views on the pre-set goals feature.

> "Another good-looking app, which does what it does well. Unfortunately,
> I want to add quantifiable targets (like OKRs), rather than Boolean
> (checkbox) targets. If you want to focus on habits and steps towards
> an end goal, it does that pretty well..."
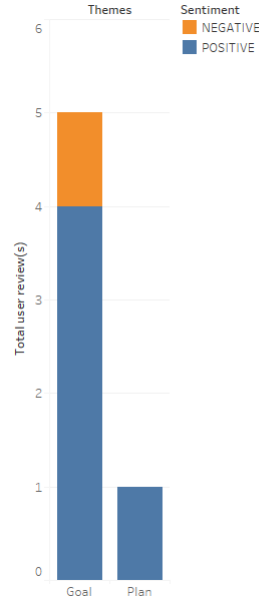
Figure 4.3: Total number of positive and negative reviews per theme in Dreamfora

> "it's a great app, but it lacks that you can't design your own goals and habits."

The above review states, even though Dreamfora is useful for habit formation with pre-set goals, the same feature might render inflexible to some users. The keyword *Plan* has 1 positive review.

Motivate is the most discussed keyword in the reviews of Habitica as depicted in Figure 4.4. It corresponds to 27 positive and two negative reviews. The gamification factor [38] in Habitica is the major contributor towards reviews with *Motivate* as the keyword. The users summarized their experiences with the motivation factor of the app with various features.

> "...I highly recommend it to any folk that can't focus without exciting motivation or something to look forward to. Many options (habit tracker, daily tasks, a long-term to-do list) and helpful tools (optional notifications, due date, able to view completed to-dos, and MORE) all alongside a simple to understand layout. Perfect, with a cherry on top!"

> "download this app If you're looking for the GAMING aspect of it, it's not super. But if you're looking for a task, habit, to-do list tracker with
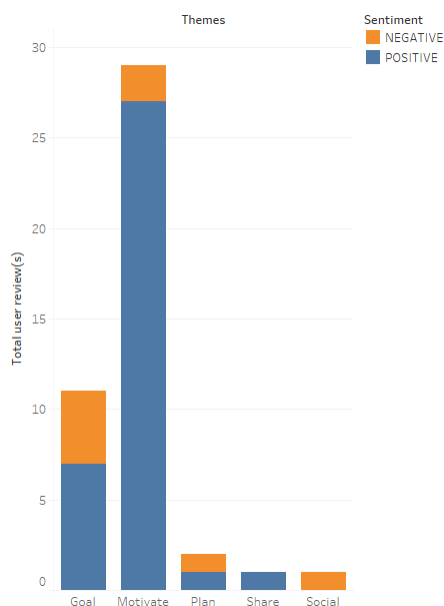
Figure 4.4: Total number of positive and negative reviews per theme in Habitica

> really good motivation tools and barely any ads, this is the best app ever.
> There's so many useful functions and yet it stays simple, casual, and easy
> to use + appealing to the eyes. You can make your own rewards and buy
> it for coins you earn by completing your tasks which is one of my favorite
> features. Best habit motivation on the app store rn."

The reviews summarize how Habitica incorporates extrinsic motivation in the form of gamification towards the goal-setting journey. *Motivate* is followed by *Goal* with seven positive and four negative reviews. *Plan, Social* and *Share* are the least discussed keywords.

Superbetter has the least number of user reviews among all the considered apps as represented in the Figure 4.5. The keyword *Goal* is negatively reviewed with one review. *Emotion, Share* and *Social* are the positively reviewed with one review each. The users expressed their thoughts as to how Superbetter has proved beneficial to them in a short time.

> "I love all the positive challenges! This opens up a whole new world for
> you mentally, emotionally, physically, and socially! There are no negatives
> that I can see. I would be curious to see if the challenges that people can
> add, could then be shared with everyone so they can pick and choose other
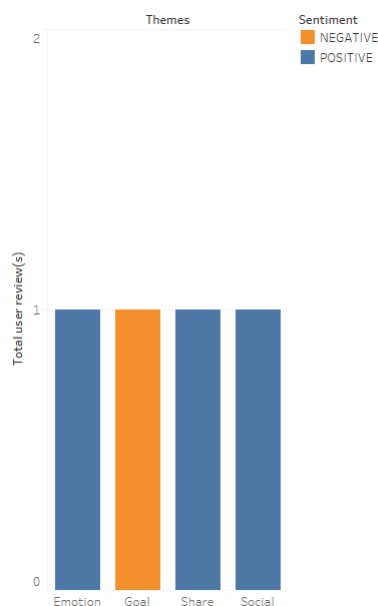
Figure 4.5: Total number of positive and negative reviews per theme in Superbetter

> peoples' ideas that might work for them. I would love to see what others
> have chosen and add them to my collection if I felt they were beneficial
> to me...?"

The above user also expressed learning from other people on the app might be an
useful feature.

The keyword *Plan* in Ticktick is reviewed the highest with 22 positive reviews and
no negative reviews as represented in the Figure 4.6. The positive reviews are because
of a range of features on the app that support efficient planning like Eisenhower
matrix, habit builder, pomodoro timer and priority-driven to-do.

> "...Contains dozens of features like promo, focus, To do, planner, habit
> tracker, statistics, monthly report etc. These are all free and even more
> amazing features can be accessed by upgrading to premium..."

The users also state the importance of reminders in complement to their goal-planning
journey.

> "It's doing things right. The ability to plan out your day in time blocks
> alongside all of my calendar events is amazing. The reminders are actually
> useful too, and hard to miss, while at the same time giving amazing
> flexibility as to how long you snooze it for when needed."
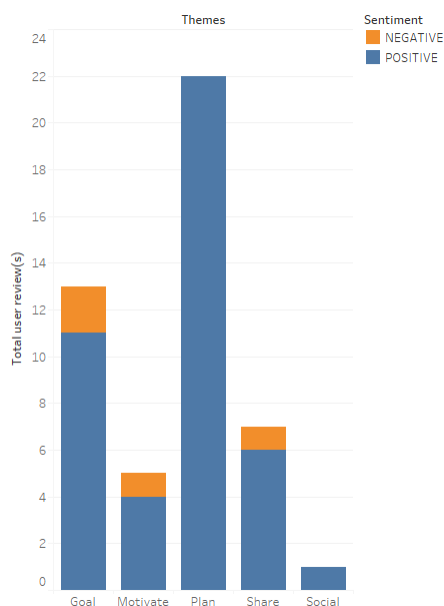
Figure 4.6: Total number of positive and negative reviews per theme in TickTick

The keyword *Goal* has 11 positive and two negative reviews. Users summarize the different functionalities that the app supports

> "...I personally love the Eisenhower method. It's also fun and you can choose different backgrounds and colours to make life a little more fun as you strive to accomplish tasks and goals. I have tried many lists and I always come back to this one."

The above user states the different options supported by Ticktick and that Eisenhower Matrix encourages them to accomplish their goals. The keyword *Social* has one positive review. *Motivate* has four positive and one negative review. *Share* is discussed moderately with six positive and one negative review.

Glan has fewer reviews compared to other apps as shown in the Figure 4.7. The keywords *Block* and *Plan* have one positive review each. The keywords *Motivate* and *Goal* have three positive reviews respectively. The users summarized the app to be sufficient with all the basic features included. They also express dissatisfaction about the non-customizable goal time.

> "The idea is great, and up to this moment the execution too. Though, there are a few features missing. I think there should be a customizable
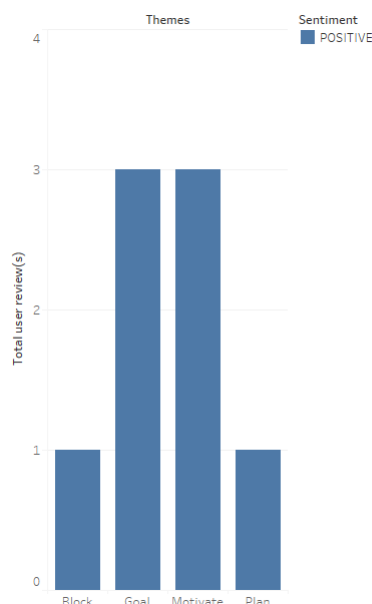
Figure 4.7: Total number of positive and negative reviews per theme in Glan

goal time, because 3 hours is too much for what I want to do during the day. A widget wouldn't do bad too."

Goal and *Motivate* are the most discussed keywords in Do it now as depicted in the Figure 4.8. *Goal* has nine positive and one negative review. *Motivate* has seven positive and one negative review. Majorly, the gamification and reward features in the app have contributed to these reviews. The app has one positive review each for *Plan* and *Social.*

"I really like the character levelling concept. Being able to customise what and how you level up, you can really tailor it to suite your goals and habits"

Customizability within the app was appreciated by the users, but the users also found the app to have a high learning curve

"Used for years. helps a ditz like me stay on top of things that I need to do and work towards short term to long term goals. Down side I found was steep learning curve to get the most out of this app but one of the best."
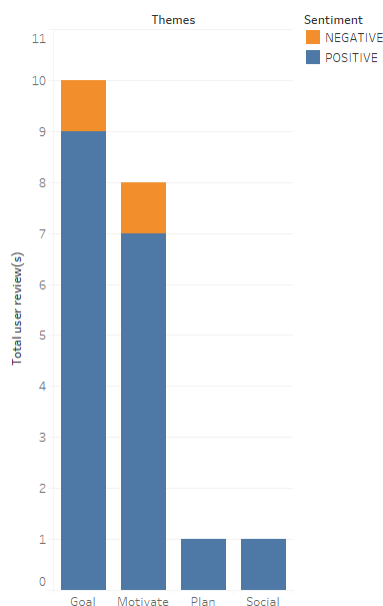
Figure 4.8: Total number of positive and negative reviews per theme in Do it now

From Figure 4.9 it is evident that *Motivate* and *Goal* are the keywords with the most reviews in Forest. The concept of growing a virtual forest as a reward for accomplishing tasks is the feature that stood out in the reviews. Forest has 31 positive reviews with the keyword *Motivate*. *Goal* is the next highlight with 22 positive and one negative review. The users state the ability of the app to make them stay focused on their goals.

> "I highly recommend this app for people who struggle staying focused on tasks such as studying!! It helps you get things done like a little game : The more you get things done , the more trees you will have in your forest! Once you start the timer , your tree will grow! Stopping the app will cause your tree to die so it gives you more motivation to keep going till the end of the timer..."

As summarised, the virtual forest acts as an extrinsic motivator towards goal accomplishment. Contrarily, a review also stated a limitation of the app.

> "I love this app in many ways - but I was so disappointed to learn that it only let you plant a maximum of three real-life trees. The whole reason why this app worked well for me was that it feels purposeful to participating in reforestation, which keeps me sticking to my digital detox goals.
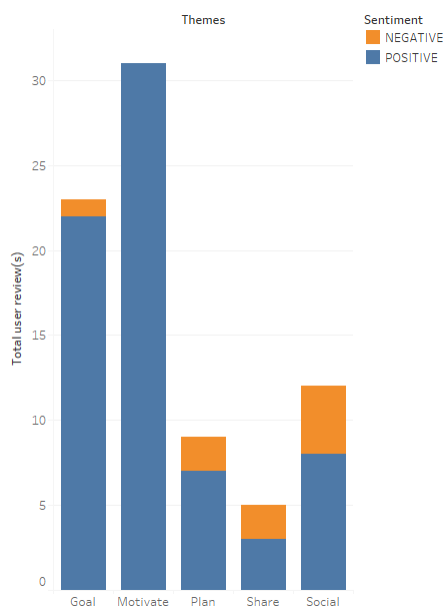
Figure 4.9: Total number of positive and negative reviews per theme in Forest

> Without that motivation, the motivation to stay off my phone is so much
> lower and the app lost its main value for me. I'd be happy to pay more/see
> ads in order to plant more real-life trees!"

Plan and *Social* are placed similarly. *Plan* has seven positive reviews and two negative
reviews. *Social* has eight positive and four negative reviews. The keyword *Share* has
the least number of reviews with three positive and two negative reviews.

Plan and *Share* are the keywords with the most reviews in Microsoft to-do as
represented in Figure 4.10. There are 70 positive and 13 negative reviews for *Plan.*
70 positive and 14 negative reviews have *Share* as the keyword. The reviews with *Plan*
and *Share* signify that Microsoft to-do is mostly used professionally as a collaborative
task management tool. Many users summarised the effective planning abilities of the
app.

> "Quite an efficient app. It allows me to plan and schedule my work on
> my laptop as well as my phone and syncs without a problem which is a
> huge help for a person like me who forgets easily."

But, some users disliked the 'My Day' feature for its lack of flexibility.

> "Promising app if they would listen to users suggestions. No way to plan
> MY DAY for the next day at the end of my work day, the evening or
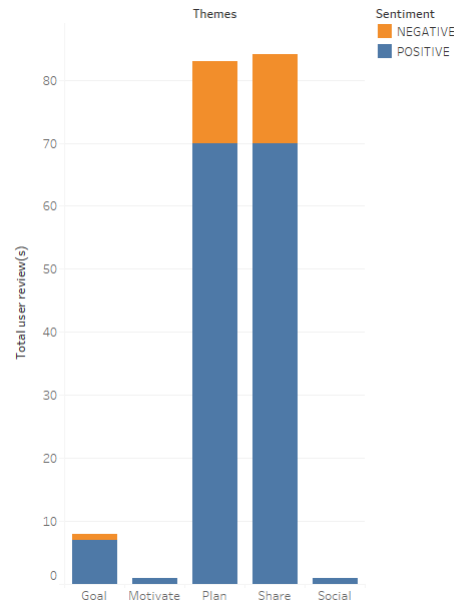
Figure 4.10: Total number of positive and negative reviews per theme in Microsoft to-do

night before. Why am I forced to do it on the same day. I know and learn at the end of my day what I need to do the next day. I only make additions to the MY DAY in the morning the next day, but most of the planning for my next day happens at the end of the day before. This is how I understand many people do it."

The keyword *Goal* is used in seven positive and one negative review. *Motivate* and *Social* have one positive review each.
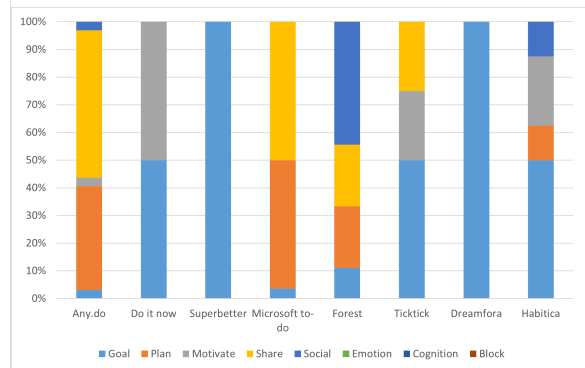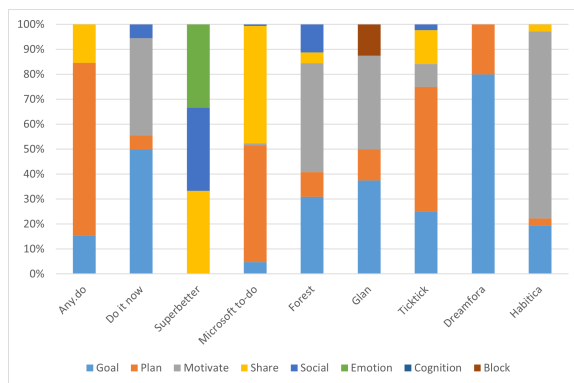
Figure 4.11: Frequency of occurrence of keywords in the positive reviews

Figure 4.12: Frequency of occurrence of keywords in the negative reviews

In summary, the frequency of occurrence of themes (keywords) in the user reviews of every app is represented in Fig 4.11 and Fig 4.12.

The word cloud visualisations for the frequency of occurrence of themes (keywords) in the negative reviews of the apps are depicted in the Figure 4.13 and 4.14. The visualisation for Glan is not represented as there are no negative reviews present with the selected keywords.

Figure 4.13: Word Cloud Visualisations (a: Habitica, b: TickTick, c: Forest, d: Microsoft To Do)

Figure 4.14: Word Cloud Visualisations (a: Superbetter, b: Do It Now, c: Any.do, d: Dreamfora)

The word cloud visualisations for the frequency of occurrence of themes (keywords) in the positive reviews of the apps are depicted in the Figure 4.15, 4.16 and 4.17 respectively.

Figure 4.15: Word Cloud Visualisations (a: Any.do, b: Do It Now, c: Superbetter)

In the following section, we explore the themes obtained from the analysis of the dataset of positive and negative user reviews.

Figure 4.16: Word Cloud Visualisations (a: Microsoft To Do, b: Forest, c: Glan)

Figure 4.17: Word Cloud Visualisations (a: TickTick, b: Dreamfora, c: Habitica)

4.2.2 Insights From Thematic Analysis of the User Reviews

In the current study, we explored the design features of the selected nine apps by analysing the respective positive and negative reviews. We clustered the design features related to each keyword. In doing so, we formulated six new themes. *Effective planning and goal-setting, Intervention tools, Assist in building consistency, Simple and clear task organisation, Social sharing* and *App-specific technical issues*. App-specific technical issues are out of scope and hence not discussed in the current study. As depicted in 4.20, each theme is formulated by clustering a set of design features implemented in the apps obtained from analysing the dataset of user reviews.
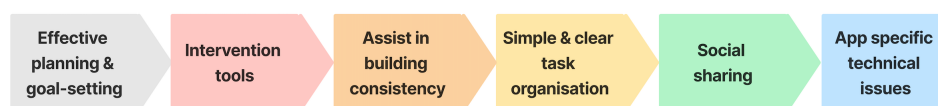
Figure 4.18: Themes formulated from the dataset of user reviews

In study 1, we interviewed 16 participants to understand their requirements and strategies throughout their goal-accomplishment journey. We analysed the interview data with Interpretative Phenomenological Analysis (IPA) and formulated seven themes about the requirements and strategies of the participants throughout their goal-accomplishment journey. The seven themes are *Goal-setting, Planning, Blockers, Motivation, Meta-cognition, Emotional reactions towards goals and Selective sharing*

of goals. Following, we relate our previous work in study 1 to demonstrate the relationship between user needs, identified in study 1, and available interventions in the market identified in study 2. Through this triangulation of these thematic results and qualified sentiments - we begin to understand the effect of design on user satisfaction and goal completion.

Figure 4.19 highlights the relation between the set of themes from study 1(represented in column 1), the set of themes from study 2(represented in column 2) and the apps that have the respective themes implemented (represented in column 3). In brief, the themes from column 1 highlight the requirements and strategies of the users during their goal-accomplishment journey. The themes from column 2 answer the respective user requirements with the design features that currently exist in the apps.
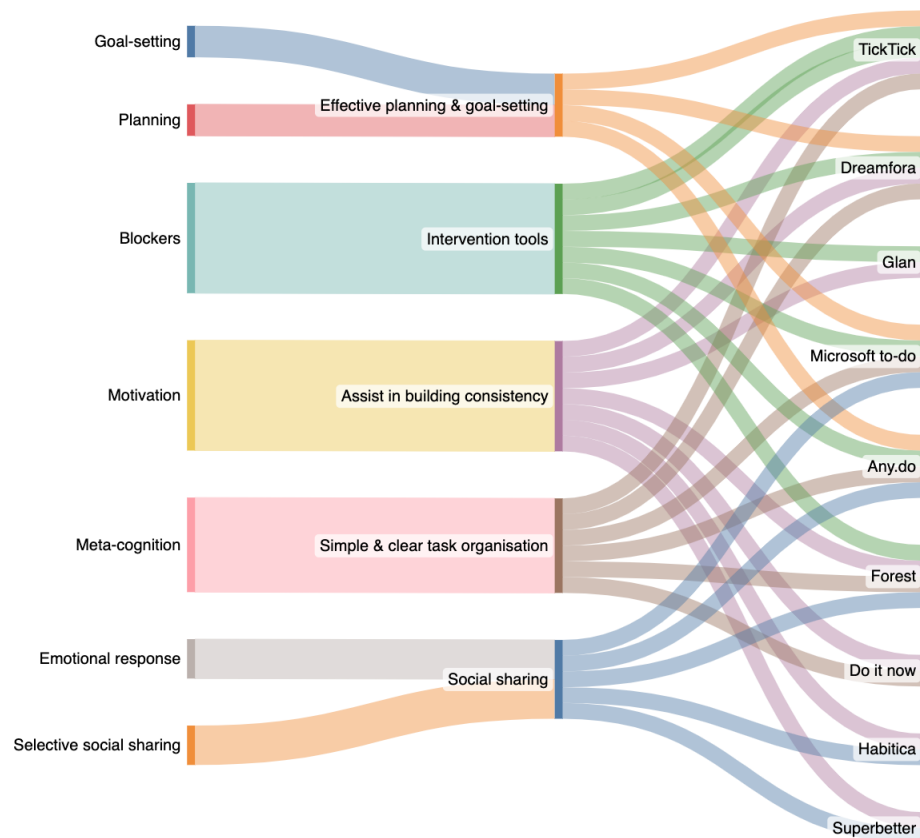
Figure 4.19: Sankey diagram indicating the themes and the corresponding apps

We elaborate on the themes in the following section through the affinity diagram, Figure 4.20. The blue notes in the Figure 4.20 represent the themes from study 1, the
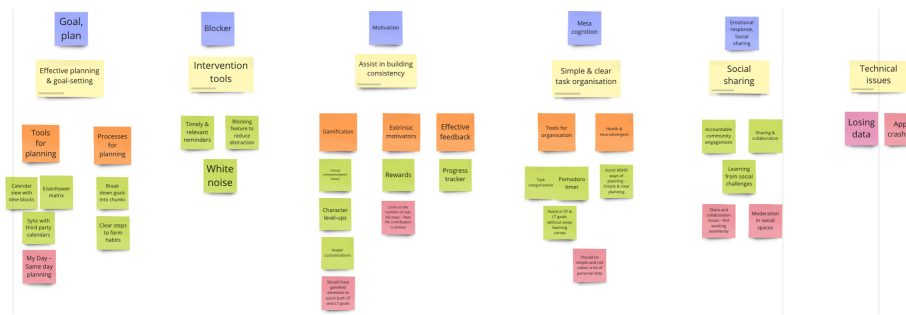
Figure 4.20: Affinity diagram representing the six themes and sets of design features under each theme

yellow notes signify the themes from study 2, the orange notes signify the categories under each theme, the green and pink notes represent the design features appreciated by the users and disliked by users respectively.

Effective planning and Goal-Setting

The theme signifies the positive and negative aspects of the tools that the users preferred for effective planning and goal-setting. The theme also encompasses the processes that assisted the users in visualising their goals clearly. The theme encompasses two categories:

Tools for planning: The tools that the users expressed positively about include: *Calendar with time blocks* to represent the priority and deadlines of the upcoming goals. The time blocks on a calendar represent a clear visualisation of the goals within a selected time-frame as implemented in Microsoft to-do, Any.do and TickTick. *Eisenhower matrix* categorises the goals into urgent and important, not urgent but important, urgent and unimportant, and not urgent or not important as implemented in TickTick. *Synchronisation with third-party calendars* assist the users to synchronise all their goals across the third-party environments (e.g., Microsoft calendar, Apple calendar, Google calendar etc.) into a single platform. Some of the tools that the users expressed negatively about are *My Day - Same day planning* implemented in Microsoft to-do and Any.do, this feature was not appreciated as the users did not have the flexibility to plan their goals a day prior. Most users preferred planning their goals in advance.

Processes for planning: The planning methods that the users appreciated are

breaking down goals into sub-goals; set timelines for the individual sub-goals and prioritise accordingly as observed in Any.do. *Clear steps to form habits* was another feature that the users expressed positively about, wherein the apps that provided daily steps towards forming a habit were appreciated in Dreamfora.

Intervention Tools

This theme encapsulates the various intervention tools that encourage users in their goal-accomplishment journey. *Timely and relevant reminders* about the goals were appreciated as the timely notifications and reminders brought a sense of accountability to the users as observed in Microsoft to-do, Any.do, Dreamfora and TickTick. *Blocking feature to reduce distraction* in Forest; this feature blocks the selected apps from distracting users during their work period, access to the selected apps is blocked until the users override. *White noise* is indicated to bring in a sense of calmness and momentum during the work period as implemented in Glan.

Assist in Building Consistency

This theme represents the tools that assist users to stay on track while working towards their goals. The theme explores three categories that assist in building consistency.

Gamification: Gamification [38] is used to attract users in building consistent behaviours through *Virtual companions* that bring a sense of accountability and a feeling of affection towards the virtual companion. The virtual companion is nurtured by completing the goals. The virtual companion in Forest is in the form of virtual trees and forests. *Character level-ups* and *Avatar customisations* induce aspirations within the users. Habitica and Do it now allow users to create a new character or avatar. Character level-ups and avatar customisations are done when the users complete the associated goals. Some users of Habitica expressed negatively that the app was no more challenging after witnessing all the gamified elements and completing all the challenges. They also summarised that the *app does not focus on long-term user retention*.

Extrinsic motivators: Many extrinsic motivators are used in the apps for better user retention. The most popular of them all is the *Rewards*. Digital incentives that

users may earn or unlock within the apps are virtual rewards. The benefits include virtual currency, badges, levels and character level-ups as seen in Habitica, Forest and Do it now. Users expressed that the rewards gave them a sense of achievement and advancement towards their goals. Users of Forest also care about the impact they have on the environment as the users can choose to have real trees planted in designated areas as a tangible representation of their productivity and environmental impact. A few users expressed negatively that the *app has a limit on the number of real-life trees it allows per user.*

Effective feedback: Assessing the feedback on the completed tasks is an important motivator. It acts as a catalyst to keep moving forward and maintain momentum. *Progress tracker* is used to assist users in retrospectively looking at their past accomplishments and gaining momentum.

Simple and Clear Task Organisation

Simple and clear task organisation is essential for a smooth user experience. It involves presenting tasks in a logical and intuitive manner, allowing users to easily navigate and accomplish their goals.

Tools for organisation: In order to provide user-friendly interfaces and enable effective navigation, *task categorisation* is crucial in apps. Microsoft to-do and Any.do thoughtfully classify goals into useful categories. The *Pomodoro timer* is a time-management method that divides work into "Pomodoros," or periods of work that last 25 minutes or less, and is followed by brief breaks. It encourages a disciplined approach to work, which helps with attention, productivity, and time management as observed in Forest, TickTick and Dreamfora. Users also expressed that the task organisation *should assist both in short-term and long-term goals.* The apps should be simple enough to *not have a steep learning curve* as seen in Do it now.

Health The users expressed that with features like smart lists and tags for task organization, priority levels and due dates for task prioritization, and integration with calendars to visualize tasks the TickTick app supports neurodivergent methods of goal-setting and planning. These elements improve productivity and task completion by assisting people with neurodivergent in breaking down goals, successfully managing time and staying organized.

Social Sharing

By incorporating social networking components within the main functionalities of the apps, social sharing in the apps often encourages collaboration, communication, and effective workflows. Within the social sharing framework, *Accountable community engagement* was appreciated by the users. The community interaction brought a sense of accountability towards the goal accomplishment journey. Community engagement was implemented with features like community chat, leaderboards, community posts etc in Habitica and Forest. The users also expressed positively about *Sharing and collaboration* wherein task lists (e.g., grocery lists) were shared in a personal setting; collaboration and delegation of tasks were appreciated in a professional setting as observed in Microsoft to-do and Any.do. *Learning from social challenges* was viewed positively with features like community quests and challenges as designed in Superbetter and Habitica. The users encountered issues with *Share and collaboration feature not working seamlessly.* In a few instances, it was reported that version upgrades broke the functionality of share and collaboration or charged premium for already free functionalities. While social spaces were appreciated by the users, an effective *Moderation in social spaces* was requested by the users. Moderation is important in community spaces to maintain relevancy of the space.

4.3 Discussion

From the results, we observed that the users preferred apps that promote simple and clear task organisation. During the planning of goals, the apps should support effective planning and goal-setting. During the execution of goals, the apps should assist in achieving and maintaining focus with relevant intervention tools. The apps should assist in building consistency towards goal execution. Users also appreciated apps that promote social collaboration both in personal or professional settings. The user reviews summarised that the effect of extrinsic motivation factors in the apps is diminished after the completion of all related challenges, thereby reducing long-term user retention. Our research indicates, the concept of self-actualisation is missing in the apps. Being consistent while working towards a goal is the foundation to function effectively. Hence, we aim to propose design features that promote consistency among

the app users, thereby promoting self-actualisation among the users.

Design Features

To propose the design features, we divide the themes from study 1 and study 2 into three groups: Initiation phase, Execution phase and Completion phase.

- The initiation phase encompasses **effective planning and goal-setting**. We leverage findings from Study 1 that indicate the need for support of **goal-setting** and **planning** as represented in the Figure 4.19. After considering the features under **effective planning and goal-setting**, we propose, designing and developing the feature of breaking down goals into sub-goals. Study 2, then explored the presence of these needs (determined in study 1) to understand availability within the current state-of-the-art. Study 2 reveals that the features needed to support the breakdown of goals are implemented in apps like Any.do; however, these on-the-market apps do not actively focus on the process of goal breakdown. Hence for the initiation phase, we choose the recommendation of *breaking goals into sub-goals* from study 1. Each sub-goal will have the treatment of a full goal such as deadline date and completion progress.

- The execution phase encompasses **intervention tools**, **assist in building consistency** and **simple and clear task organisation**. These themes answer the needs of themes **blockers**, **motivation** and **meta-cognition** respectively from study 1 as represented in the Figure 4.19. After assessing the features under all the three themes, we narrow in on the *implementation of goal completion bar, progress tracker* and *denoting the personal significance of each goal (importance box)* from the recommendations of study 1. The goal completion bar and progress tracker act as a visualisation tool that provide a clear overview of the user's advancement towards the goals. The importance box will encourage users in having a vision and accountability factor for each goal.

- The completion phase encompasses **social sharing**. This theme answers the needs of themes **emotional reactions towards goals** and **selective social sharing** from study 1 as represented in the Figure 4.19. After considering the

features under **emotional reactions towards goals**, we narrow in on implementing the concept of *satisfactory or 'good-for-now' goal completion notation* to control the potential negative emotional reactions associated with incomplete goals.

For each of the three phases, we chose design features from our proposed recommendations (section 3.3) from study 1. We leveraged the insights from study 1 and study 2 to finalise the features for the goal-setting web app as discussed above. We did not consider all the recommendations from study 1. To begin with, we concentrate on the basic goal-setting features i.e., Figures 3.3b and 3.3c. In the next chapter, we discuss the design and evaluation of the goal-setting web app through a mixed-methods approach.

Chapter 5

Study 3 - Design and Evaluation of the Goal-Setting Web App

Following the insights from study 1 and study 2, we design a goal-setting web app with the following features: breaking down goals into sub-goals, denoting the personal significance of each goal, the availability of satisfactory or 'good-for-now' goal completion notation and measuring the goal progress. The scope of this research is to understand user self-actualization behaviour towards goal-setting through the breakdown of goals, which is an initial step in the goal-setting journey. Hence, we did not focus on the design of mood board and social sharing in this research. We design four versions of the app, each version to test a separate feature. The study design consists of a pre-study (baseline) survey, app usage for 10 days, post-study survey and optional interview. Through the evaluation of the all the app versions, we have answered the following research questions:

- **RQ5**: *How effective is the app in decreasing procrastination levels?*

- **RQ6**: *How effective is the app in increasing self-efficacy levels?*

- **RQ7**: *How effective is the app in promoting motivational appeal?*

- **RQ8**: *How effective is the app in promoting positive usage experience?*

5.1 Methodology

To answer our research questions, we designed four versions of a web app to promote self-actualization behaviour towards goal-setting. This section covers the app design, study design, data collection, and data analysis techniques used in the research.

5.1.1 App design

We designed the web app to promote effective goal management through a self-actualization. The app empowers users to achieve their goals through intrinsic motivation and self-actualization. It provides a unique approach to goal management by breaking down larger goals into smaller, more manageable sub-goals. The key concept used in the app is, focus on intrinsic motivation and self-actualization: The app focuses on fostering inner drive, in contrast to the reviewed productivity apps that depend on extrinsic motivation (e.g., rewards). Our app encourages people to achieve personal fulfillment and significance in the pursuit of their goals through the use of importance box, satisfactory checkbox and goal progress tracker. The main features of the app are:

1. Goal Breakdown: Users can input their main goals into the app and they can break these goals down into smaller, achievable sub-goals. This helps users avoid feeling overwhelmed and provides a clear path forward.

2. Goal Tracking: Each goal and sub-goal can be assigned specific deadlines. Users can mark off completed goals or sub-goals, track their progress, and celebrate their achievements along the way. The approaching deadline for a goal or sub-goal is indicated by a dynamic growing bar within the title of the goal.

3. Goal Updating: Each goal and sub-goal can be edited for the goal title and completion date. The checkbox on the left indicates if the respective goal is complete. The satisfactory checkbox on the right indicates if the goal progress is satisfactory, but not 100% complete.

4. Satisfactory Checkbox: The checkbox is present for every goal and sub-goal. This checkbox is different from the completion checkbox. The satisfactory checkbox is used to assist the user in identifying that a particular goal or sub-goal is not 100% complete but the progress is satisfactory for now and can be attended to at a later date. On click of the checkbox, the progress bar turns green but the progress remains unchanged.

5. Goal Importance Box: Each goal has a corresponding 'importance box'. This is a text input box that prompts the user to enter the impact of a particular goal

in their lives. The importance box reminds the user of the reason they planned to pursue the goal.

6. Progress Tracker: The app offers a dedicated progress tracker screen that visually represents the user's advancement through their goals and sub-goals. The users are provided with the number of goals and sub-goals completed and also the number of main goals remaining. This provides a sense of accomplishment and encourages users to continue moving forward.

The application has two screens. The first screen is a to-do for goals and sub-goals (Goals screen). The second screen is a goal progress tracker (Progress Tracker screen). The progress tracker screen is common across all the four versions as represented the Figure 5.5. Each version also has a tutorial that popped up upon hover on the tool-tip as displayed in the Figure 5.6. We designed four versions of the app with variations as explained below:

- Version 1: This version has the following features - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker, Satisfactory Checkbox and Goal Importance Box as represented in the Figure 5.1.

- Version 2: This version has the following features - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker and Satisfactory Checkbox as represented in the Figure 5.2.

- Version 3 - This version has the following features - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker and Goal Importance Box as represented in the Figure 5.3.

- Version 4 (Basic version) - This version has the following features - Goal Breakdown, Goal Tracking, Goal Updating, and Progress Tracker as represented in the Figure 5.4.

5.1.2 App Implementation

The app was developed using the React framework in JavaScript (JS). We chose React as our aim was to make the app available over multiple digital environments.
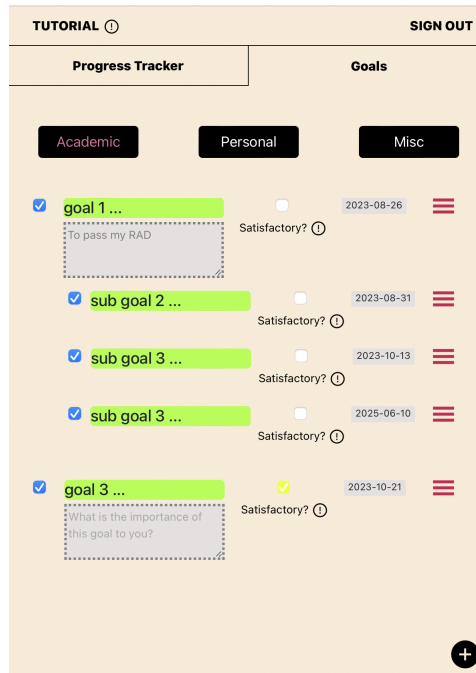
Figure 5.1: Version 1 - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker, Satisfactory Checkbox and Goal Importance Box
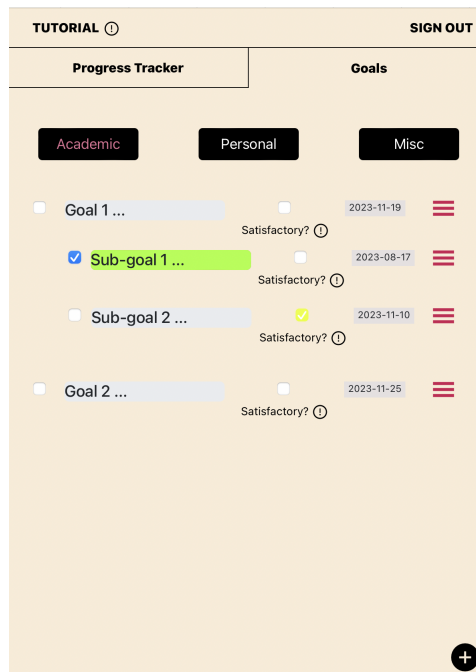
Figure 5.2: Version 2 - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker and Satisfactory Checkbox
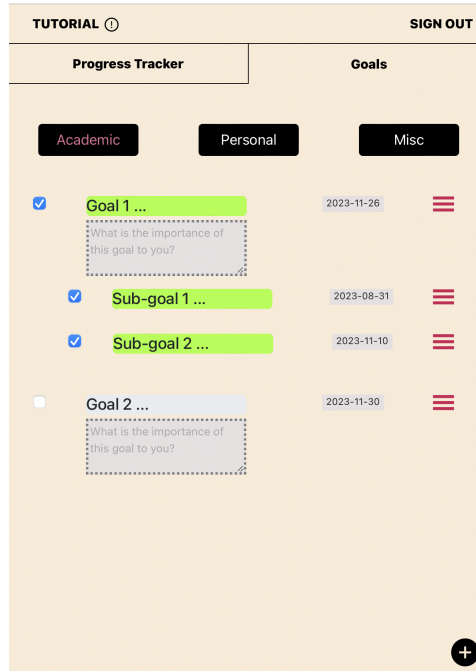
Figure 5.3: Version 3 - Goal Breakdown, Goal Tracking, Goal Updating, Progress Tracker and Goal Importance Box
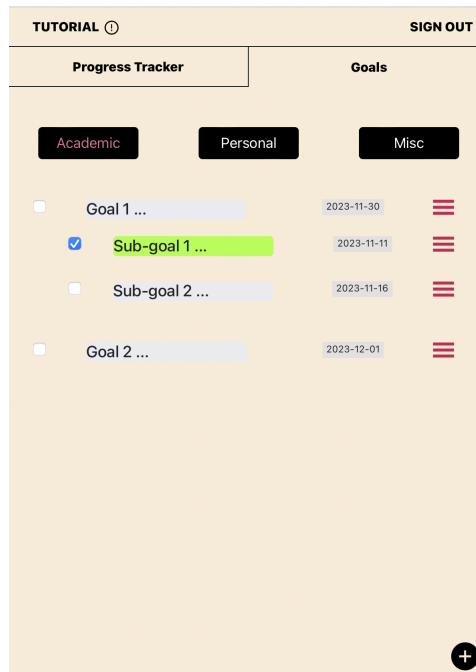
Figure 5.4: Version 4 - Goal Breakdown, Goal Tracking, Goal Updating, and Progress Tracker
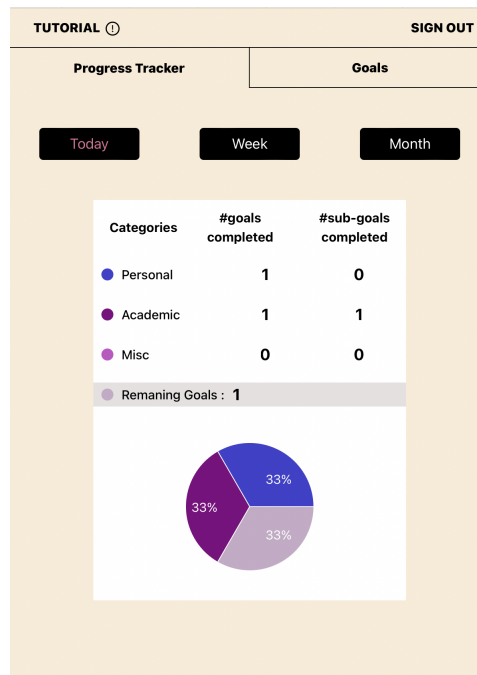
Figure 5.5: Progress tracker screen common across all the four verions
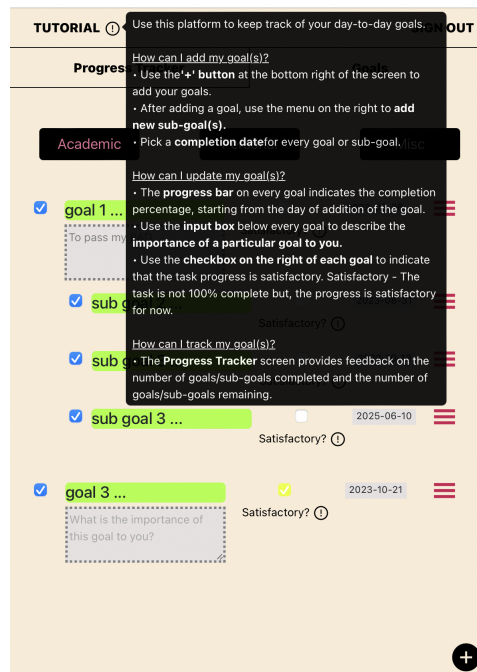
Figure 5.6: Tutorial pop-up in version 1

We followed an iterative approach to app development while incorporating feedback.

Version 1 of the app was developed first. When version 1 was finalised, we implemented the other three versions. Further, we used Amazon Web Services (AWS) [20] for deploying all the versions of the apps.

5.1.3 Study Design

The study was divided into multiple stages as depicted in figure 5.7:
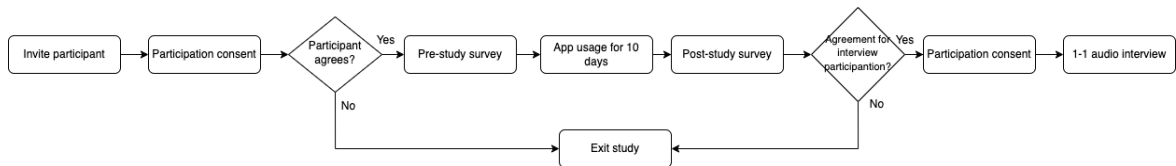
Figure 5.7: S3 flow diagram

We conducted a pre-study survey to collect participant demographics, identify their baseline procrastination levels, and identify their self-efficacy and intention for behaviour change. We used the Pure Procrastination Scale (PPS) [86] to measure the baseline procrastination levels. We also adapted the self-efficacy and intention questionnaire from Theory of Planned Behaviour (TPB) [17]. We assigned participants to each version based on their sign-up order for the study i.e., we followed a rolling-assignment based on the sign-up order of the participants. The rolling-assignment was random to avoid any participant bias in the study. For e.g., P1 was assigned to version 1, P2 was assigned to version 2, P3 was assigned to version 3, P4 was assigned to version 4, P5 was assigned to version 1 and so on.

After assigning the participants to the different app versions, we sent them the link to the app and asked them to use the app regularly for a period of 10 days. We tracked the login counts of the participants. We logged the number of goals and sub-goals completed, and the number of goals remaining. We also logged the event history (satisfactory checkbox, completion checkbox, goal updates and importance box updates).

We conducted a post-study survey to identify the impact of the app. With the questionnaires, we measured the procrastination levels through PPS [86], we measured the self-efficacy and intention levels from Theory of Planned Behaviour (TPB) [17], we measured the Intrinsic Motivation levels of the app through IMI [76], we also measured the Attention, Relevance, Confidence, Satisfaction (ARCS) [52].

We used the online survey as a data collection tool for our study. Both our surveys were designed and hosted on Opinio, and all the data collected was stored on our organization's online server.

To gather more insights and feedback about the app, we conducted online one-on-one interviews with 17 participants selected from the participants of the whole study. At the end of the post-survey, participants were asked for their consent to participate in the interview.

5.1.4   Protocol and Ethics

The study ethics was approved by the Research and Ethics Board at Dalhousie University (REB# 2023-6615). The pre-study and post-study were hosted on Opinio servers. Each participant was remunerated with $5 for the pre-study survey. The remuneration for the app usage over a period of 10 days and the post-study survey together was $10. The optional interview was conducted online on Microsoft Teams. Each participant was remunerated with a $10 e-transfer to their email address at the beginning of the session in appreciation of their time. We collected the participants' responses through the interview with audio. Within the interview, participants were not asked to self-identify.

5.1.5   Data Collection

The process of data collection started with a pre-study survey. The participants were recruited from advertising through the university's email list. We also used word-of-mouth and snowball sampling techniques. In the pre-study survey hosted on Opinio, there were three sections in the survey questionnaire. The first section contained demographic-related questions such as participants' age group, gender, educational qualifications and employment status. In the second section, we employed PPS [86] to capture the baseline procrastination levels of the participants. The last section had questions to capture the baseline self-efficacy and intention for behaviour change using TPB [17]. The post-study survey of our study included four sections. The first section had questions to measure the ARCS parameters consisting of 12 items measured on a 5-point Likert scale ranging from "1 – Strongly Disagree" to "5 – Strongly Agree." [52]. The second section had questions to measure the intrinsic motivation

and positive experience of the participants during their app usage. The questionnaire was adapted from the Intrinsic Motivation Inventory (IMI) [76]. The section had questions about Interest or Enjoyment, Effort or Importance, Pressure or Tension, Value or Usefulness, Perceived Competence and Perceived Choice. The questions had a 7-point Likert scale ranging from "1 – Not at all true" to "7 – Very true". The third section had questions to measure the procrastination levels of the participants after their app usage period through the PPS questionnaire. This section had a total of 12 questions measured on a 5-point Likert scale ranging from "1 – Strongly Disagree" to "5 – Strongly Agree.". The last section had questions to capture the self-efficacy and intention for behaviour change of the participants after the app usage period. The questions were derived from TPB. There were a total of five questions measured on a 5-point Likert scale ranging from "1 – Strongly Disagree" to "5 – Strongly Agree.". Finally, we conducted online one-on-one interviews with 17 participants who used the app and completed the survey. Each interview lasted for about 30 minutes. We audio-recorded all of the interviews with the participants' permission. This semi-structured interview provided us with insightful qualitative feedback from the participants about their experiences with the app, its impact on their goal-setting behaviour, what they liked/disliked about the app, and their suggestions for any improvements in the app.

5.1.6 Demographics Data

In the pre-study survey we registered the responses from 204 participants. Of these 204 participants, 101 of them used the app for the study period and 92 of them filled the post-study survey. We included the final 86 responses in our analysis, having removed incomplete responses from the surveys. Our participants were adults (18 years or above) and proficient in English. This is in accordance with our Ethics approval.

The summary of the participants' demographic data is represented in the Table 5.1

5.1.7 Data Analysis

We used a mixed-methods approach for the data analysis. For quantitative data analysis, we used IBM SPSS [26] and Microsoft Excel [27]. For qualitative data

		Count	Percentage (%)
Gender	Prefer not to say	1	1.2%
	Female	25	29.1%
	Male	59	68.6%
	Non-binary	1	1.2%
Age	18-24	60	69.8%
	25-34	23	26.7%
	35-44	3	3.5%
	45-54	0	0.0%
Qualification	Bachelor's Degree	49	57.0%
	High School	20	23.3%
	Master's Degree	16	18.6%
	Ph.D or higher	0	0.0%
	Prefer not to say	1	1.2%
Employment	Employed Full-Time	9	10.5%
	Employed Part-Time	24	27.9%
	Prefer not to say	7	8.1%
	Retired	0	0.0%
	Seeking opportunities	46	53.5%

Table 5.1: Table representing the demographics data

analysis, we used the Miro collaboration platform [47].

To answer RQ5, we first conducted a Repeated-Measures (RM) Analysis of Variance (ANOVA) with time (pre-test, post-test) as within-participant factors and the app version as between-participant factor on PPS. Next, we conducted an Analysis of Co-Variance (ANCOVA) with the baseline (pre-test) procrastination as a co-variate.

To answer RQ6, we first conducted an RM-Anova with time (pre-test, post-test) as within-participant factors and the app version as between-participant factor on the self-efficacy scale from TPB (self-efficacy). Next, we conducted an ANCOVA with the baseline (pre-test) self-efficacy as a co-variate. We then conducted a one-way ANOVA to measure a difference in means of the in-app metrics (i.e., login count, number of goals completed, number of sub-goals completed) with the four versions of that app as the between-participant factor.

To answer RQ7, we first conducted an RM-Anova with time (pre-test, post-test) as within-participant factors and the app version as between-participant factor on the intention scale from TPB (intention). Next, we conducted an ANCOVA with the baseline (pre-test) intention as a co-variate. We then conducted a one-way ANOVA

Scale	Cronbach's alpha (α)
Pure Procrastination Scale (PPS)	.902
Theory of Planned Behaviour (TPB) - Self-efficacy	.510
Theory of Planned Behaviour (TPB) - Intention	.550
ARCS	.866
IMI	.858

Table 5.2: Table representing the Cronbach's alpha values for all the questionnaires

to measure a difference in means of the motivational appeal (measured through the ARCS scale) across the four versions respectively.

To answer RQ8, we conducted a one-way ANOVA to measure a difference in means of the positive experience measured through the IMI scale across the four versions respectively.

To analyze the qualitative interview data, we first familiarized ourselves with the interview transcripts. We then classified the interview data according to the four app versions. Comments were then noted in relation to first impressions and interpretations of the interview data. These notes were then translated into emergent codes. Once all emergent codes had been created, connections between them were identified and the codes were grouped together to materialize as themes.

5.2 Results

In this chapter, we present the results from the mixed-methods evaluation of the web app. In the following subsections, we present our findings pertaining to procrastination, self-efficacy and intention levels before and after using the app. Next, we also present the differences in the app-usage metrics across the four versions. Further, we discuss the outcome of the motivational appeal of the app across the four versions. Finally, we discuss the qualitative results of the semi-structured interviews.

We calculated Cronbach's alpha (α) [14] to check the reliability of the responses. The reliability analysis with Cronbach's alpha values is represented in the Table 5.2.

To measure a change in procrastination, self-efficiacy and intention we ran Repeated Measures Analysis of Variance (RM-ANOVA) with time as a pre and post factor and version as a within-participant factor. To further strengthen the statistical observations, we incorporated Analysis of Co-Variance (ANCOVA) procrastination,

self-efficiacy and intention with the pre-study survey responses as baseline co-variates and version as a within-participant factor. We then ran One-way ANOVAs on login count, number of goals completed, number of sub-goals completed, ARCS questionnaire responses and IMI questionnaire responses. We further dissected the entire dataset into seven categories as represented in Tables 5.3 and 5.4: Login count, Goals completed, Sub-goals completed, Gender, Age, Qualification and Employment. The categories were further divided into sub-categories. The sub-categories and the corresponding range of counts are represented in the Table 5.3. For e.g., 0 to 2 were categorised as a low login count, 3 to 6 were categorised as a medium login count as so on.

Categories	Sub-categories	Range of counts
Login count	Low	0 to 2
	Medium	3 to 6
	High	7 to 10
	Low	0 to 8
	Medium	9 to 17
Goals completed	High	18 to 27
	Low	0 to 7
	Medium	8 to 15
Sub-goals completed	High	16 to 24

Table 5.3: Table representing the in-app metrics and corresponding ranges

We ran the above suite of tests for the overall dataset of n = 86 participants. We also ran the suite of tests for the above seven categories separately to magnify the overall findings i.e, we ran the tests for Login count - low, Login count - medium, Login count - high and so on. Therefore, along with the master dataset, we had a 25 separate datasets, each for a sub-category represented in Tables 5.3 and 5.4.

5.2.1 Effects of the App on Procrastination Levels

After validating the data for the assumptions of ANOVA, we conducted an RM-ANOVA with time (pre-test, post-test) as within -participant factors and the app version as between -participant factor on PPS [86]. The results show no significant main effect of time on procrastination levels overall. There is no significant difference between the pre-test and post-test; procrastination levels measured immediately

Categories	Sub-categories
Gender	Male
	Female
	Non-binary
Age	18-24
	25-34
	35-44
	45-54
	55 and above
	High school
	Bachelors degree
	Masters degree
	Ph.D or higher
Qualification	
	Seeking opportunities
	Employed part-time
	Employed full-time
Employment	Retired

Table 5.4: Table representing the demographic data

following the app usage showed no significant decrement than that taken before the app usage. However, for version 3 of the app there was a sharp decrement in the procrastination level after using the app but, the change was not significant. Next, we conducted an ANCOVA with the baseline (pre-test) procrastination as a co-variate. The co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 80) = 44.58, p < 0.001, \eta^2 = 0.35$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. Finally, we conducted the same tests - RM-ANOVA and ANCOVA for the seven categories described in Table 5.3 and Table 5.4.

Login Count

For login count - low, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 50) = 30.39, p < 0.001, \eta^2 = 0.37$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significant results for RM-ANOVA.

For login count - medium, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 22) = 8.76, p = 0.007, \eta^2 = 0.28$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

We did not perform the tests for login count - high as the number of participants in this category was low (n = 3).

Goals Completed

For goals completed - low, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 67) = 32.01, p < 0.001, \eta^2 = 0.32$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

For goals completed - medium, we did not observe significance in RM-ANOVA and ANCOVA.

We did not perform the tests for goals completed - high as the number of participants in this category was low (n = 2).

Sub-Goals Completed

For subgoals completed - low, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 73) = 48.15, p < 0.001, \eta^2 = 0.39$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

We did not perform the tests for sub-goals completed - medium (n=4) and sub-goals completed - high (n = 3) as the number of participants in these categories was low.

Gender

For gender - male, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 54) = 35.65, p < 0.001, \eta^2 = $

0.39. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

For gender - female, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 19) = 7.73, p = 0.012, \eta^2 = 0.28$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. For gender - female, the results of RM-ANOVA show significant main effect of time on procrastination levels overall. However, there is a violation of equality of variance, hence we report the Greenhouse-Geisser correction for the significant difference between the pre-test and post-test $F(1, 20) = 5.873, p = 0.025, \eta^2 = 0.22$. Procrastination levels measured immediately following the app usage showed a significant decrement than that taken before the app usage. However, there was no significance observed for the between-participant factor (version).

We did not perform the tests for gender - non-binary as the number of participants in this category was low (n = 1).

Age

For age - 18 to 24, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 54) = 19.62, p < 0.001, \eta^2 = 0.26$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

For age - 25 to 34, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 18) = 10.24, p = 0.005, \eta^2 = 0.36$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

We did not perform the tests for age - 35 to 44 as the number of participants in this category was low (n = 3). There were no participants present in the age group above 45.

Qualification

For qualification - highschool, the results of RM-ANOVA show significant main effect of time on procrastination levels overall. There is a significant difference between the pre-test and post-test $F(1, 16) = 6.502, p = 0.021, \eta^2 = 0.28$. Procrastination levels measured immediately following the app usage showed a significant decrement than that taken before the app usage. However, there was no significance observed for the between -participant factor (version). For qualification - highschool, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 15) = 4.77, p = 0.045, \eta^2 = 0.24$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels.

For qualification - bachelors, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 43) = 24.09, p < 0.001, \eta^2 = 0.35$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

For qualification - masters, we did not observe significant results in both RM-ANOVA and ANCOVA.

There were no participants present with a qualification of Ph.D and above.

Employment

For employment - seeking opportunities, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 40) = 16.85, p < 0.001, \eta^2 = 0.29$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significance results for RM-ANOVA.

For employment - part time, the co-variate pre-test procrastination was significantly related to the the participants' post-test procrastination $F(1, 19) = 8.73, p = 0.008, \eta^2 = 0.31$. However, there was no significant effect of versions on post-test procrastination levels after controlling the effect of pre-test procrastination levels. We did not get significant results for RM-ANOVA.

For employment - full-time, we did not get significant results for RM-ANOVA.

For equality of variance was violated for ANCOVA.

5.2.2 Effects of the App on Self-Efficacy Levels

After validating the data for the assumptions of ANOVA, we conducted an RM Anova with time (pre-test, post-test) as within -participant factors and the app version as between -participant factor on the self-efficacy scale from TPB [17]. The results show no significant main effect of time on the self-efficacy levels overall. There is no significant difference between the pre-test and post-test; self-efficacy levels measured immediately following the app usage showed no significant increment than that taken before the app usage. However, for version 4 of the app there was a sharp increment in the self-efficacy level after using the app but, the change was not significant. We then validated the data for the assumptions of ANCOVA. We conducted an ANCOVA with the baseline (pre-test) self-efficacy as a co-variate. The co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 80) = 11.53, p = 0.001, \eta^2 = 0.12$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels.

We then conducted a one-way ANOVA to measure a difference in means of the in-app metrics (login count, number of goals completed, number of sub-goals completed) with the four versions of that app as the between-participant factor. The results of the one-Way ANOVA show there are no statistically significant differences between login count, number of goals completed and number of sub-goals completed across the four versions of the app.

Finally, we conducted the above suite of tests i.e., RM-ANOVA, ANCOVA and one-way ANOVA for the seven categories described in Table 5.3 and Table 5.4.

Login Count

For login counts - low and medium, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA. We did not perform the tests for login count - high as the number of participants in this category was low (n = 3).

Goals Completed

For goals completed - low, the results of RM-ANOVA show significant main effect of time on self-efficacy levels overall. There is a significant difference between the pre-test and post-test $F(1, 68) = 4.50, p = 0.038, \eta^2 = 0.06$. Self-efficacy levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between-participant factor (version).

For goals completed - low, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 67) = 5.46, p = 0.022, \eta^2 = 0.07$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels.

For goals completed - low, we did not observe significant results for one-way ANOVA. For goals completed - medium, we did not observe significance for RM-ANOVA, ANCOVA and one-way ANOVA. We did not perform the tests for goals completed - high as the number of participants in this category was low (n = 2).

Sub-Goals Completed

For subgoals completed - low, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 73) = 10.40, p = 0.002, \eta^2 = 0.12$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA and one-way ANOVA.

We did not perform the tests for sub-goals completed - medium (n=4) and sub-goals completed - high (n = 3) as the number of participants in these categories was low.

Gender

For gender - male, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 54) = 4.64, p = 0.036, \eta^2 = 0.79$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance

results for RM-ANOVA and one-way ANOVA.

For gender - female, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 19) = 5.84, p = 0.026, \eta^2 = 0.23$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA and one-way ANOVA.

We did not perform the tests for gender - non-binary as the number of participants in this category was low (n = 1).

Age

For age - 18 to 24, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 54) = 5.06, p = 0.029, \eta^2 = 0.08$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA and one-way ANOVA.

For age - 25 to 34, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 18) = 4.55, p = 0.047, \eta^2 = 0.20$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA and one-way ANOVA.

We did not perform the tests for age - 35 to 44 as the number of participants in this category was low (n = 3). There were no participants present in the age group above 45.

Qualification

For qualification - highschool, we did not observe significance for RM-ANOVA, ANCOVA and one-way ANOVA.

For qualification - bachelors, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 43) = 4.30, p = 0.044, \eta^2 = 0.09$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA and one-way ANOVA.

For qualification - masters, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA.

There were no participants present with a qualification of Ph.D and above.

Employment

For employment - seeking opportunities, the co-variate pre-test self-efficacy was significantly related to the the participants' post-test self-efficacy levels $F(1, 40) = 5.12, p = 0.029, \eta^2 = 0.11$. However, there was no significant effect of versions on post-test self-efficacy levels after controlling the effect of pre-test self-efficacy levels. We did not get significance results for RM-ANOVA. For One-way ANOVA, the equality of variance was violated but, we did get a significance $F(3, 45) = 3.490, p = 0.024$. However, from the Games-Howell Post-Hoc test (equality of variance not assumed), we did not find significant differences between groups.

For employment - part-time and employment - full-time, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA.

5.2.3   Effects of the App on Motivational Appeal

After validating the data for the assumptions of ANOVA, we conducted an RM-ANOVA with time (pre-test, post-test) as within -participant factors and the app version as between -participant factor on the intention scale from TPB [17]. The results show a significant main effect of time on the intention levels overall. There is a significant difference between the pre-test and post-test; intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage $F(1, 81) = 4.48, p = 0.037, \eta^2 = 0.05$. However, there was no significance observed for the between -participant factor (version). We then validated the data for the assumptions of ANCOVA. We conducted an ANCOVA with the baseline (pre-test) intention as a co-variate. There is no significant difference between the four versions with baseline intention as a co-variate. To understand the motivational appeal of the app, we employed the Attention, Relevance, Confidence, Satisfaction (ARCS) scale [52]. ARCS consists of four categories: Attention, Relevance, Confidence and Satisfaction. All the values were measured on a 5-point Likert scale ranging from "1-Strongly Disagree" to "5-Strongly Agree". We then conducted

a one-way ANOVA to measure a difference in means of the ARCS questionnaire responses with the four versions of the app as the between-participant factor. The results of the One-Way ANOVA show there are no statistically significant differences between Attention, Relevance, Confidence and Satisfaction across the four versions of the app. Finally, we conducted the above suite of tests i.e., RM-ANOVA, ANCOVA and one-way ANOVA for the seven categories described in Table 5.3 and Table 5.4.

Login Count

For login counts - low and medium, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA. We did not perform the tests for login count - high as the number of participants in this category was low (n = 3).

Goals Completed

For goals completed - low, the results of RM-ANOVA show significant main effect of time on intention levels overall. There is a significant difference between the pre-test and post-test $F(1, 68) = 4.55, p = 0.036, \eta^2 = 0.06$. Intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between-participant factor (version). We did not observe significant results for ANCOVA and one-way ANOVA.

For goals completed - medium, we did not observe significance for RM-ANOVA, ANCOVA and one-way ANOVA. We did not perform the tests for goals completed - high as the number of participants in this category was low (n = 2).

Sub-Goals Completed

For subgoals completed - low, the results of RM-ANOVA show significant main effect of time on intention levels overall. There is a significant difference between the pre-test and post-test $F(1, 74) = 4.78, p = 0.032, \eta^2 = 0.06$. Intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between-participant factor (version). We did not observe significant results for ANCOVA and one-way ANOVA.

We did not perform the tests for sub-goals completed - medium (n = 4) and sub-goals completed - high (n = 3) as the number of participants in these categories was low.

Gender

For gender - male, the results of RM-ANOVA show significant main effect of time on intention levels overall. There is a significant difference between the pre-test and post-test $F(1, 55) = 4.25, p = 0.044, \eta^2 = 0.07$. Intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between -participant factor (version). For gender - male, the co-variate pre-test intention was significantly related to the the participants' post-test intention levels $F(1, 54) = 8.60, p = 0.005, \eta^2 = 0.13$. However, there was no significant effect of versions on post-test intention levels after controlling the effect of pre-test intention levels. We did not observe significant results for one-way ANOVA.

For gender - female, we did not observe significant results for RM-ANOVA, AN-COVA and one-way ANOVA.

We did not perform the tests for gender - non-binary as the number of participants in this category was low (n = 1).

Age

For age - 18 to 24, we did not get significant results for RM-ANOVA, ANCOVA and one-way ANOVA.

For age - 25 to 34, the results of RM-ANOVA show significant main effect of time on intention levels overall. There is a significant difference between the pre-test and post-test $F(3, 19) = 3.881, p = 0.025, \eta^2 = 0.38$. Intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between -participant factor (version). We did not get significant results for ANCOVA and one-way ANOVA.

We did not perform the tests for age - 35 to 44 as the number of participants in this category was low (n = 3). There were no participants present in the age group

above 45.

Qualification

For qualification-highschool, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA.

For qualification - bachelors, the results of RM-ANOVA show significant main effect of time on intention levels overall. There is a significant difference between the pre-test and post-test $F(1, 44) = 6.39, p = 0.015, \eta^2 = 0.12$. Intention levels measured immediately following the app usage showed a significant increment than that taken before the app usage. However, there was no significance observed for the between -participant factor (version). We did not observe significant results for ANCOVA and one-way ANOVA.

For qualification - masters, the co-variate pre-test intention was significantly related to the the participants' post-test intention levels $F(1, 11) = 5.30, p = 0.042, \eta^2 = 0.32$. However, there was no significant effect of versions on post-test intention levels after controlling the effect of pre-test intention levels. We did not observe significant results for RM-ANOVA and one-way ANOVA.

There were no participants present with a qualification of Ph.D and above.

Employment

For employment - seeking opportunities, the co-variate pre-test intention was significantly related to the the participants' post-test intention levels $F(1, 40) = 4.31, p = 0.044, \eta^2 = 0.09$. However, there was no significant effect of versions on post-test intention levels after controlling the effect of pre-test intention levels. We did not observe significant results for RM-ANOVA and one-way ANOVA.

For employment - part-time, we did not observe significant results for RM-ANOVA, ANCOVA and one-way ANOVA.

For employment - fulltime, the co-variate pre-test intention was not significantly related to the the participants' post-test intention levels. However, there was a significant effect of versions on post-test intention levels after controlling the effect of pre-test intention levels $F(3, 4) = 8.28, p = 0.034, \eta^2 = 0.86$. We did not observe significant results for RM-ANOVA and one-way ANOVA.

5.2.4   Effects of the App on Positive Experience

To measure the positive experience of the app, we employed the Intrinsic Motivation Inventory (IMI) scale [76]. IMI consists of six categories: Interest/Enjoyment, Effort/Importance, Pressure/Tension, Value/Usefulness, Perceived Competence and Perceived Choice. For the analysis, we excluded the responses of the Perceived Choice category. All the values were measured on a 7-point Likert scale ranging from "1-Not at all true" to "7-Very true". We then conducted a one-way ANOVA to measure a difference in means of all the IMI categories with the four versions of the app as the between-participant factor. The results of the One-Way ANOVA show there are no statistically significant differences between the overall IMI categories across the four versions of the app. Finally, we conducted the above suite of tests i.e., one-way ANOVA for the seven categories described in Table 5.3 and Table 5.4. There were no significant differences between the four versions.

We did not observe significance for any of the seven categories i.e., login count, goals completed, sub-goals completed, gender, age, qualification and employment.

5.2.5   Qualitative results

We interviewed a total of 17 participants across the four versions after the post-study survey to learn more about their app usage experience during the study period. The interview was one-on-one and was audio recorded with the participant's consent. To analyze the qualitative data, first we transcribed all the interviews. We analyzed the interview quotes by clustering similar quotes together in an iterative manner. After that, we performed thematic analysis on the interview quotes. We employed affinity diagramming to identify specific themes. We achieved convergence after 17 participants where we found a pattern. Six main themes were identified from the thematic analysis with associated sub-themes. The six main themes were – Completion progress, Breakdown of goals, Satisfactory check, Importance box, Prioritisation through goal categorisation and Potential features.

Completion Progress

Participants summarised that the dynamic progress bar associated with every goal served as a source of constant realisation of time ticking. The progress bar acted as a psychological *assessment for goal progress.*

> "...bar underneath which showed me the progress...I'm like psychologically enforced, like ohh I have this much time left. That was a really useful indication" - P16 - V3

Similarly, the goal completion feedback on the progress tracker screen provided a constant source of motivation and a sense of accomplishment to keep the moving forward.

> "I think the biggest thing that happened was seeing the progress tracker...I'm seeing those goals completed that kind of motivated me more because like I mentioned in the previous in the previous answer that I used to use a paper and pen technique to just get my goals done and get my work done"
> - P3 - V4

Breakdown of Goals

Breakdown of goals was the most discussed theme. Breakdown of goals into sub-goals was a common feature across all versions of the app. Larger goals tend to create a feeling of overwhelm which eventually leads to procrastination. Participants summarized the breakdown of goals into sub-goals *reduces their feeling of overwhelm* which gradually helps them *overcome procrastination behaviours.*

> "I thought about the processes, so otherwise I would have kept that as one whole thing and just thinking about that one whole task I would have...kind of been scared to do that or started but to see that...Down into the the sub goals, it was kind of a like I had the courage to start it"
> - P5 - V1

> "Usually when I set my goals, I-I wouldn't say I get overwhelmed by like how big the goal is, but I do sometimes get lazy to like start on it because I'm like, well, this is like such a big goal" - P12 - V1

> "it was an interesting [app]. I really liked it so like I do procrastinate a lot...so I believe like having the goal and the sub-goal in the app was really useful" - P10 - V2

When a bigger goal is broken down into chunks of sub-goals, it leads to *better control or flexibility over the goal* in terms of completion deadlines. This flexibility in-turn leads to *better prioritisation of the sub-goals.*

> "...So in this [app] I got to like it was a good addition of making sub task...I can, like, make a new sub-task and clear it out when it's completed."

> "Like no, that I have to complete this topic by this day instead of just like a big timeline like the end of the month, I have to complete everything...So I think that's a better process of creating goals." - P1 - V2

Participants state since the sub-goals are *easy to manage*, their *focus is increased* so as to concentrate on one sub-goal at a time instead of focusing on the bigger goals as a whole.

> "Like no, that I have to complete this topic by this day instead of just like a big timeline like the end of the month, I have to complete everything...So I think that's a better process of creating goals." - P1 - V2

> "So I learned how to focus on one thing at a time and more accurately, how can I, you know, finish it in time" - P3 - V2

Participants outlined that the completion of the sub-goals gives them a sort of *'dopamine boost'* which participants use to describe the momentum that they feel serves them in maintaining *discipline and consistency.*

> "if I don't divide the task, it's very big and I I tend to procrastinate...But when I divide it into sub tasks I it's kind of like a dopamine boost" - P10 - V4

> "the app like sort of forced me to break it down into sub goals, which I then set due dates on...So then I was able to accomplish more because I was like, OK, I don't need to focus on the whole thing, but today I need to do this" - P12 - V1

Satisfactory Check

Participants had a diverse view on the satisfactory checkbox. Some participants mentioned the checkbox did not seem useful since, they have a binary outlook towards a goal i.e., they view a goal to be either 100% complete or 0% and nothing in-between. A few participants indicated that they did not initially think of using the satisfactory checkbox since, there was no specific outcome associated with it.

> "I mean if it is not 100, I wouldn't consider it...To be a complete in a certain extent at all." - P5 - V1

While some participants stated that they used the checkbox to *de-prioritise a goal while also controlling overwhelming feelings*. They explained, even though a goal might not be fully complete but, it could be de-prioritised for now; this induced a sense of accomplishment while also bringing down overwhelm.

> "One thing I would say is I tend to I was a bit overwhelmed with main goals added so some of them [I] couldn't complete...I wasn't able to conclude first it was a lot of it needed more time, but I think I was able to do enough just to have enough knowledge on the topic that if I want I can move ahead, but I would just for the day it was due if I had done enough I would check the satisfactory, but I would only complete move on to the next thing the next day." - P13 - V2

Participants also used the checkbox as a *delay indicator*. They used the checkbox to indicate that a goal is completed but it is past its deadline date.

> "I use it because I was unable to complete it and it was due...It will satisfactory to you, but because I did it, but not on the due date" - P3 - V2

A few participants also used the checkbox to *identify repeating goals* i.e., if there is a daily repeating goal, it is not complete until the goal end date but, the progress is satisfactory every day.

> "It's because it my goal wasn't just to, like, wake up early one day and then be like done with it. It was to wake up early for every single day for

a week, so I'm like sort of making progress on it by making up early the first few days, which is why I used to satisfactory box." - P12 - V1

Importance Box

The importance box served the participants in different ways. Participants noted the description in the importance box so, the next time they logged in into the app, they could see see the notes associated with a goal which acted as an *emotional trigger* in their goal accomplishment journey.

> "So it like helps me to connect emotionally...So I like I I wrote about the things like why it is important...So every time I see that it reminds me like why I need to do the goal." - P7 - V1

Participants also summarised that they added a layer of personalization to their goals by noting down *personal reminders* in the importance box.

> "the importance box served as a reminder for myself because my my going back to the waking up early every single day it has...And then I'm like, this is important because whenever I wake up late, I feel a lot more, a lot lazier than I do" - P12 - V1

A few participants also used the importance box to note the *goal description*, while some participants used the importance box to tag a particular priority (high priority, low priority etc.) to their goals.

> "So the importance box was useful just to write all the description and why this goal is necessary so that I won't forget some of the important points for those particular goals" - P1 - V1

Participants also mentioned noting down critical points regarding a goal in the importance box was equivalent to *journaling*, while also having the important points of the goal in place.

> "I just postpone it several times and I added a note that this time you need to complete it...It was like like journaling for myself." - P21 - V1

The same participant also mentioned about having a summary of all their journaled notes for future reference.

Prioritisation Through Goal Categorisation

Participants mentioned that the goal categorisation assisted them in organising their goals which in-turn helped them in effective prioritisation.

> "I think one of the biggest learnings that I had using the app was that the I was able to sort out my goals in the sense that...I had some study related goals and I had some personal goals...So just classifying them into the way I wanted that kind of no, I mean that was one sort of a learning"
> - P3 - V4

The segregation of goals enhanced their learning towards effective prioritisation.

Potential Features

Finally, participants also expressed about the features they would like to see in the app. The major one was *reminders and notifications* about an upcoming deadline; reminders in the form of push-notifications or email notifications. The reminders would assist them to check-in into the app while also tracking their progress.

> "there can be one thing like if the goal sub goal is not being reached right, I can keep one alarm kind of thing or like any mail like every day at 7:00 PM so that it can mail me and remind like ohh today you have these three goals to be done..." - P1 - V1

Participants also suggested the implementation of a *calendar view* to have a high level view of their long-term and short-term goals.

> "although there was a a like a completion date sort of a thing, but there wasn't really sort of a a calendar like basically if I have something in December to do and there is a lot of things in the next few...months or something" - P3 - V4

Some participants also expressed interest in having *custom categories* instead of only academic, personal and miscellaneous. Custom categories in the form of personalised tags would help them achieve a higher degree of personalization.

"I'll just you know you create a reminder or create a task and they're like
if it had a option for tagging, you know in which you can add your own
tags and then the system would recognize it" - P15 - V1

Having *pre-set goal templates* as a quick way to add goals and sub-goals was a also a
feature participants talked about.

"...we can have a set of templates or for the goals for academics or for this
personal you have anyway have already characterized these things" - P6
- V4

Participants suggested having a cumulative *summary of the notes from all the impor-*
tant boxes.

"Summary of important notes if that could be there" - P21 - V1

The participant further mentioned that the summary of the notes would assist them
as a reminder of the things completed as part of their previous goals.

In the next section, we discuss the implication of the results.

5.3   Discussion

We designed and evaluated four features in our app across all the versions: breakdown
of goals into sub-goals, satisfactory checkbox, importance box and progress tracker.
From the results, we gained insights on the changes of participants' procrastination
levels, self-efficacy levels and intention levels before and after using the app. We also
measured the overall motivational appeal and positive experience of the app.

The results demonstrated, there was a decrement in the procrastination levels of
the participants after using the app but it was not significant as seen in the results.
Similarly, there were no significant positive effects on participants' self-efficacy after
using the app. However, there was a significant increase in the intention levels of the
participants after using the app ($p = 0.037$) but, there was no significance observed
between versions.

The trend observed in the results proves that our app intervention did have a
positive impact on the intention of participants i.e., the app was successful in impart-
ing an intention to change towards effective goal-setting through its design features.

From the qualitative results, it is evident that the features of the app supported the participants in achieving consistency [P13], overcome the feeling of overwhelm while starting a goal [P12], focus on one thing at a time [P9], overcome procrastination [P10] etc. Although, participants stated how each feature supported them behaviourally and technically, the quantitative results about procrastination and self-efficacy were not significant. Hence, we infer that the through the app intervention, we were able to create a positive impact on the intention levels but not observe considerable behaviour changes in participants. Goal-setting is a long process and even though we conducted a longitudinal study for 10 days, a longer longitudinal study would prove beneficial in assessing a change in goal-setting behaviours. Additionally, participants would have considerable time to develop a habit of checking-in into the app regularly if the study were to be conducted e.g., for a period of over an entire term (for students).

Chapter 6

Thesis Discussion

The aim of the overall research was to design a tool that could promote self-actualisation behaviour towards general goal-setting. In doing so, we derived insights from popular theories including SDT [35] and GST [60] to support the research. On the spectrum of motivation, from amotivation to extrinsic motivation [34], we focused on self-actualisation through intrinsic motivation. Here in the thesis discussion chapter, we summarize our research findings by discussing the implication of the results of the three studies. In the first study, we interviewed participants to understand their strategies and challenges that they face during their goal-accomplishment journey. This study acted as a foundation to answer RQ1, RQ2 and RQ3.

- To answer **RQ1**: *What strategies do users find effective in their goal journey?*

    From the results of study 1, the major strategies that the participants followed on a regular basis were: Being consistent in the long-term, breaking down goals into sub-goals, prioritization, self-monitoring, taking appropriate breaks, gaining momentum from the satisfaction of accomplishment, selective sharing of goal progress, and rewards. Participants used tools like to-do, timers and calendars to block time for their goals. Apps that align with presented strategies were discussed to understand active and past use.

- To answer **RQ2**: *What are the hindrances, distractions, and challenges that participants face?*

    From the results of study 1, participants highly valued the work environment and paid attention to multiple facets. Not being in the right environment physically and socially also acted as a hindrance. Participants expressed being with peers who are not goal-oriented was a challenge and considered social media to be one of the major distractions. Mentally, being overwhelmed or intimidated

by an upcoming goal confounded actions taken to create productive physical and social environments.

- To answer **RQ3**: *How do we design effective mobile applications for goal accomplishment?*

  From the results of study 1, in accordance with our findings for RQ1 and RQ2, we recommend four system design features as summarised in study 1. They are: Long-Term Vision using 'Mood Boards', Breakdown Long-term Goals using 'To-Do's', Balance Progress with 'Progress Tracker', Seeing Your Desired Self through Positive Reflection through 'Selective Social Sharing' Accessibility and an intuitive user experience (UX) are the backbone of our DRs [80, 25]. We recommend a focus on intrinsic motivation strategies over extrinsic motivation strategies for long-term sustenance and habit formation.

Following an iterative study approach, in the second study, we built on the findings of the first study. We explored the goal-setting app user-review sentiments on Google Play Store to understand the the perception of users towards the app features. This study answered our RQ4.

- To answer **RQ4**: *What strategies do users find effective in the already existing apps?*

  From the results of study 2, we observed that the users preferred apps that promote simple and clear task organisation. During the planning phase, the apps should support them with effective planning and goal-setting. During the execution phase, the apps should assist them to achieve and maintain focus with relevant intervention tools. The apps should assist them in building consistency towards goal execution. Users also appreciated apps that promote social collaboration both in personal or professional settings.

Finally, in the third study, we designed four versions of a goal-setting web app. The breakdown of goals into sub-goals was the primary feature common across all the versions. In each version, we measured user interaction events (login count, goals and sub-goals completed), effect on their procrastination levels, self-efficacy levels and intention levels. We also measured the motivational appeal and the app experience

overall. To complement the measurements, we interviewed the participants post study to gather more insights. The findings from this study answered our RQ5, RQ6, RQ7 and RQ8.

- To answer **RQ5**: *How effective is the app in decreasing procrastination levels?*

  From the results of study 3, we observed, the overall procrastination levels of the participants decreased after using the app across all the versions but, the decrement was not significant. However, for the demographic group of participants who have completed highschool, we did observe a significant decrease in the procrastination levels after using the app. The participants also expressed that the breakdown of goals supported them in overcoming procrastination.

- To answer **RQ6**: *How effective is the app in increasing self-efficacy levels?*

  From the results of study 3, we noticed that the app did not have a positive effect on the self-efficacy levels of participants. However, for the group of participants who completed less than eight goals, there was a significant increase in their self-efficacy levels.

- To answer **RQ7**: *How effective is the app in promoting motivational appeal?*

  From the results of study 3, it can be observed that the app had a significant positive effect on the intention levels across all the four versions. We also observed significance among the magnified categories: goals completed - low, sub-goals completed - low, gender - male and qualification - bachelors. We did not observe significance through the ARCS responses.

- To answer **RQ8**: *How effective is the app in promoting positive usage experience?*

  From the results of study 3, it can be observed that the app had no significant positive effect over the positive usage experience measured through IMI responses [76].

We designed the entire research under the umbrella of goal-setting so as 1) to understand the needs and challenges of the users. 2) to understand what is currently available to the users in the mobile app market. 3) to design and evaluate the ways by

which we can bridge that gap. In the following paragraphs, we triangulate the findings of the three studies and also discuss the implication of our results for designers and researchers.

At first, we explored the entire goal-accomplishment journey of the participants to understand their strategies and challenges during the process. At the end of the study, we formulated seven themes that represent the participants' strategies and challenges: Goal-setting, Planning, Motivation, Blockers, Meta-cognition, Emotional reactions towards goals and Selective social sharing. Secondly, we analysed the user reviews of the nine apps on Google Play Store. After classifying the reviews as positive and negative by performing sentiment analysis on the reviews, we formulated the six themes based on the design features mentioned in the reviews to complement the themes from study 1 as depicted in the Fig 4.18 and Fig 4.19. In other words, each theme from study 2 answered the needs of the corresponding themes from study 1. The six themes are: Effective planning and goal-setting, Intervention tools, Assist in building consistency, Simple and clear task organisation, Social sharing and App-specific technical issues. Finally, designed a goal-setting web app with features like: breaking down goals into sub-goals, denoting the personal significance of each goal, the availability of satisfactory or 'good-for-now' goal completion notation and measuring the goal progress. As mentioned in the results, we did not observe significance change in the procrastination and self-efficacy levels before and after using the app. However, we did observe a significant change in the intention levels towards effective goal-setting. The qualitative interview data provided better insights on how every feature impacted the participants. Breakdown of goals into sub-goals enabled the participants to focus on one piece of a goal at a time [P12]. Better focus in turn helped them in curb procrastination [P10] and achieve consistency [P13]. The completion of every sub-goal also served as an added 'dopamine boost' to have the momentum to keep moving forward [P10]. The satisfactory check was designed to indicate good-for-now and de-prioritise a goal. Few participants did use the satisfactory check for its intended behaviour but, we also observed that it was used when a goal could not be completed within the deadline (to indicate a delay) [P3]. Users also used the satisfactory check as a tool to differentiate completion of a one-time goal and a daily recurring goal. Importance box was designed to note the importance of a particular

goal. We observed that users did note down the importance of goals that served them as personal reminders [P12] and emotional triggers [P7] for goal completion. However, users also used the importance box to note down goal description [P5]. Users also used it as a combination of personal reminders and goal description which they stated felt like journaling [P21]. Lastly, the completion bar associated with every goal served as an assessment tool [P1]. The progress tracker motivated users to keep moving forward [P3].

6.1   Design Recommendations

From the work presented, we discuss the implications of the studies conducted as part of this research. We also discuss the cumulative design recommendations that we arrived at during the course of the studies.

1. *Breaking down goals into sub-goals* proved to be a major factor for the users across all the three studies. Breaking down goals into smaller tasks assisted users in overcoming long-term goal-related overwhelm. Goal breakdown helps the users in maintaining consistency while focusing on a single task at a time.

2. *Goal completion progress* is another important factor in the goal-accomplishment journey. The completion progress can be looked at from two angles. On a macro level, the completion progress, in the form of progress tracker helps in maintaining momentum by realising the number of goals already completed over a given period of time. On a micro level, the completion progress of an ongoing goal with a visualisation of the percentage of a goal completed induces a sense of urgency to work on the goal.

3. *Social sharing* is the next important factor that we witnessed during the studies. This was observed in two settings. In a personal setting, involving a social group or an individual in the goal-accomplishment journey served as an accountability tool to help users stay on track. Users also appreciated being able to share personal goal achievements with their loved ones. In a professional setting, collaboration with other users on common goals served as an important feature to complete goals.

4. The importance box in the app was used was used for various reasons as discussed in the previous sections. Participants mentioned using the importance box as a *personalised tool to take notes* associated with every individual goal. They expressed interest in having a summary of all the personal notes for future references.

5. Participants preferred planning long-term goals or at-least having a high level view of their upcoming and past goals. Hence , they preferred having a *calendar view* with their goals in place. Tools like *Eisenhower matrix* was preferred wherein the goals could be prioritised according to their importance and urgency.

6. Users stated having *pre-set goal templates* or widgets for quick addition of goals is an useful tool. This not only saves time but also makes goal addition not seem like a chore.

7. Goal categorisation through *personalised tags* i.e., having users create their custom tags proves better than having fixed goal categories (e.g., academic goals, personal goals etc.).

8. Majority of the users stated having appropriate and timely *reminders* about an upcoming goal not only helps them with checking-in into the app but, having personalised reminders helps them shift their focus to the goal.

Chapter 7

Conclusion

In this chapter, we summarize the thesis contributions, limitations and potential directions for future work.

7.1 Contributions

Through this research work, we have demonstrated that the app was successful in creating a positive impact on the intentions of the participants towards effective goal-setting. However, to observe positive behaviour changes towards goal-setting, a longitudinal study with a longer duration will be necessary. Throughout the work, we have provided design recommendations. The recommendations can be used by the designers to model goal-setting apps. The researchers of motivation can derive insights about goal-setting through self-actualization and build on the current work.

7.2 Limitations and Future Work

One of the limitation of the research is that the procrastination, self-efficacy, intention levels, ARCS and IMI questionnaires are self-reported. We specified in the consent form for the participants to be completely honest but, there is no way to measure if there was any bias involved. One factor can also be the length of the survey questionnaire that might cause fatigue to the participants. To avoid this, a longer longitudinal study of around three months will be beneficial. The longitudinal study can be designed to have multiple data collection checkpoints every month with fewer set of questionnaires spaced evenly.

The next limitation could be that, while using the app, the participants might have marked their goals or sub-goals complete without actually completing them towards the end of their study period. To avoid this, reminders or email notifications can be incorporated to remind users of their upcoming goals.

We reviewed nine apps from Google Play Store. The spectrum of analysis can be broadened by increasing the number of apps on multiple platforms like App Store, desktop apps and web apps. Additional exploration of apps designed for particular goals (e.g., weight loss, exercise, finance) may broaden the findings due to their inclusion.

Further, we developed a web app for our evaluation due to multi-platform accessibility and convenience. However, a few participants mentioned that it would be more convenient to have a mobile app instead. A future app version can be developed and deployed for Android and iOS for better accessibility.

Selective social sharing is a feature that can be implemented in the app. The results of study 1 suggested, selective social sharing helps participants in increasing their accountability. In study 3, we focused on the design of initial phase of goal-setting journey which is the break down of goals. Hence, social sharing was out of scope for the study. Adding a social component to the app not only broadens the existing design features but also opens path for social research among the app participants.

The future work can involve evaluating the goal-setting strategies for different personality types. Our research involved evaluation of general goal-setting strategies. With respect to participant groups, future studies can be designed to explore goal-setting behaviour among neurodivergent group of participants.

Future work can also involve heuristic evaluation of the goal-setting app with experts in the field. The analysis would not only provide better insights about the goal-setting behaviour but also help the researchers and designers improve the app usage experience.

We observed from our results that there was no significant reduction in procrastination levels and no significant increase in self-efficacy levels of the participants. However, there was a significant increase in the intention levels. Hence, a longer longitudinal study of around three months will address this shortcoming as well. Multiple data collection checkpoints every month would assist in observing the behaviour changes incrementally. Finally, study 3 recruitment was done in phases, as such, the assignment of the participants to groups was not 'true' randomization because of the rolling recruitment period. Future studies, may take a longitudinal approach and

synchronized start times (e.g., the beginning of a semester) to test the application as a driver for behavioural change.

7.3 Conclusion

The thesis is an important contribution to the field of HCI and to the domain of goal-setting. The research was composed of three iterations: The first study aimed to understand the strategies and challenges that participants face in their goal-setting journey. The second study aimed to analyse the goal-setting apps present on Google Play Store to understand if the all the needs of the users are being met. The third study involved the design and evaluation of a goal-setting web app with four versions. Each version to evaluate a feature built on top of the the underlying basic version. Although, we did not find significant differences between the versions, we found that, the app was able to bring a positive effect on users' intention levels towards goal-setting over time. Through the app intervention, we were able to "scratch the surface" but not observe considerable behaviour changes in participants i.e., the results indicated positive intention levels towards effective goal-setting behaviour changes. However, a longer longitudinal study would prove beneficial in assessing significant changes in the goal-setting behaviours.

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Appendix A

Permission to Use

In presenting this thesis in partial fulfilment of the requirements for master's in computer science degree from the Dalhousie University, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the Dalhousie University in any scholarly use which may be made of any material in my thesis. Requests for permission to copy or to make other use of the material in this thesis in whole or part should be addressed to:

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Appendix B

Study 1 - Research Ethics Board Approval

Social Sciences & Humanities Research Ethics Board

Letter of Approval

July 11, 2022

Raviprasanna Gourashettar

Computer Science\Computer Science

Dear Raviprasanna,

REB #:   2022-6135

Project Title: Interview on understanding the goal-setting process and time management strategies that people use in everyday life

Effective Date: July 11, 2022

Expiry Date: July 11, 2023

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans.* This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Megan Bailey, Chair

Appendix C

Study 1 - Interview questions

1. Tell me about goal setting process.
2. Tell me about your long-term and short-term goals
   a. Does the progress on your short-term goals affect your long-term goals?
   b. Are your long-term goals an extension of your short-term goals?
3. How do you reserve time for your goals?
   a. Do you have any methods/strategies to reserve time for your goals?
   b. Do you use to-do lists/apps/fridge post-it notes?
4. What are the strategies that you use to accomplish your goals?
   a. Goals could be personal, or work-related.
   b. Could you tell me about your new year goals and how you planned them?
5. How do you feel when you set goals?
6. How do you feel when you accomplish your set goals?
7. What are the external factors that affect your ability to meet your goals?
8. Prompt – There is a concept called social motivation wherein you decide to share your task completion progress with your peers whom you choose. Your peers would be able to monitor your progress. All this would be done through a smartphone app. Would social motivation help you in any way to accomplish your goals? If yes, what kind of contributions do you expect from your peers?
9. People generally face some challenges/hindrances/distractions when it is time to start working on their planned goals. Do you have any such experiences?
   a. What were your thoughts/feelings at that point in time?
   b. People sometimes tend to put off their planned tasks due to various reasons. Do you have any such experiences? How does it make you feel?
10. Often goal setting is an emotional journey. Are you someone who attaches emotional reasons to your goals? Could you please walk me through the process? - Callback to 5.

11. Suppose we build a mobile app for efficient time management. What features would you like to see in the app?

12. Do you use any specific tools to plan your goals? (apps) - If 3 is not answered

Appendix D

Study 3 - Research Ethics Board Approval

Social Sciences & Humanities Research Ethics Board Letter of Approval

May 29, 2023

Raviprasanna Gourashettar

Computer Science\Computer Science

Dear Raviprasanna,

REB #:   2023-6615

Project Title: Design and Evaluation of a Mobile Application to Promote
Self-actualization Behaviour towards Goal-setting

Effective Date: May 29, 2023

Expiry Date: May 29, 2024

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans.* This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Megan Bailey

Chair, Social Sciences and Humanities Research Ethics Board

Dalhousie University

Appendix E

Study 3 - Pre-study survey questions

Section 1: Demographics questions

Section 2: Pure Procrastination Scale (PPS) questionnaire

1. I delay making decision until it's too late.
2. Even after I make a decision, I delay acting upon it.
3. I waste a lot of time on trivial matters before getting to the final decisions
4. In preparation for some deadlines, I often waste time by doing other things.
5. Even jobs that require little else except sitting down and doing them. I find that they seldom get done for days.
6. I often find myself performing tasks that I had intended to do days before
7. I am continually saying "I'll do it tomorrow."
8. I generally delay before starting on work I have to do
9. I find myself running out of time.
10. I don't get things done on time
11. I am not very good at meeting deadlines
12. Putting things off till the last minute has cost me money in the past.

Section 3: Theory of Planned Behaviour (TPB) questionnaire

1. I find it difficult to effectively break down my large goals into smaller chunks.
2. I find it difficult to remain calm when I encounter a large task to be completed
3. I believe I have the knowledge and ability to break down my large goals into smaller chunks.
4. I intend to not get overwhelmed when I encounter a large task to be completed.
5. I intend to take "1 step at a time incrementally" while working towards my goals.

Appendix F

Study 3 - Post-study survey questions

Section 1: Participant email

Section 2: Attention, Relevance, Confidence, Satisfaction (ARCS) questionnaire

1. This app captures and holds my attention.
2. This app has some contents that stimulate my curiosity
3. This app is relevant to me.
4. I can relate with the contents of this app.
5. The contents of this app make sense to me.
6. The contents of this app are useful to me.
7. It was easy to understand and use this system.
8. This app would help me in breaking down my goals.
9. This app built my confidence in my ability to break down my goals efficiently
10. I really enjoyed using this app.
11. It was a pleasure to use an app like this.
12. This app would help me accomplish my behaviour goal (improved ability to break down my goals efficiently)

Section 3: Intrinsic Motivation Inventory (IMI) questionnaire

1. I enjoyed using this app very much.
2. This app was fun to use
3. I thought this was a boring app
4. This app did not hold my attention at all
5. I would describe this app as very interesting
6. I thought this app was quite enjoyable.

7. While I was using this app, I was thinking about how much I enjoyed it.

8. I put a lot of effort into this app.

9. I didn't try very hard to do well in this app.

10. I tried very hard to use this app

11. I didn't put much energy into this app

12. I did not feel nervous at all while using this app

13. I felt very tense while using this app

14. I was very relaxed while using this app

15. I was anxious while using this app

16. I felt pressured while using this app

17. I believe this app could be of some value to me

18. I think that this app is useful for improving my ability to efficiently break down my goals

19. I think this is important to do because it can help me work more efficiently towards my goals

20. I would be willing to do this again because it has some value to me

21. I think using this app could help me to change my current outlook towards large goals

22. I believe using this app could be beneficial to me

23. I think this is an important app

24. I think I am pretty good at this app

25. After using this app for a while, I felt pretty competent

26. I am satisfied with my performance at this app

27. This was an app that I couldn't use very well

28. I believe I had some choice about using this app

29. I felt like it was not my own choice to use this app

30. I didn't really have a choice about using this app

31. I felt like I had to use this app

32. I used this app because I had no choice

33. I used this app because I wanted to

34. I used this app because I had to

Section 4: Pure Procrastination Scale (PPS) questionnaire

1. I delay making decision until it's too late.

2. Even after I make a decision, I delay acting upon it.

3. I waste a lot of time on trivial matters before getting to the final decisions

4. In preparation for some deadlines, I often waste time by doing other things.

5. Even jobs that require little else except sitting down and doing them. I find that they seldom get done for days.

6. I often find myself performing tasks that I had intended to do days before

7. I am continually saying "I'll do it tomorrow."

8. I generally delay before starting on work I have to do

9. I find myself running out of time.

10. I don't get things done on time

11. I am not very good at meeting deadlines

12. Putting things off till the last minute has cost me money in the past.

Section 5: Theory of Planned Behaviour (TPB) questionnaire

1. I find it difficult to effectively break down my large goals into smaller chunks.

2. I find it difficult to remain calm when I encounter a large task to be completed

3. I believe I have the knowledge and ability to break down my large goals into smaller chunks.

4. I intend to not get overwhelmed when I encounter a large task to be completed.

5. I intend to take "1 step at a time incrementally" while working towards my goals.

Appendix G

Study 3 - Interview questions

1. What was your experience with the app? Did you learn by using the app?

2. Did the app have any impact on your goal-setting process? If yes, how?

3. Please walk me through one of your goals that you completed using the app.

4. People tend to get overwhelmed when they encounter a huge goal to be completed and this might lead to procrastination. The solution to this is to effectively break down the goal into smaller chunks and undertake them one step at a time. Did the app help you in practicing this goal breakdown process?

5. What are your views on the satisfactory checkbox? Did it help you in any way?

6. What are your views on the importance box? Did it help you in any way?

7. Do you have any suggestions/features for improvement of the app?