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COMBATING SMARTPHONE ADDICTION THROUGH OTP-BASED NETWORK AUTHENTICATION AND A SOCIAL ACCOUNTABILITY FRAMEWORK

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A B S T R A C T

Smartphones have become an integral part of daily life, but excessive use has led to addiction, resulting in reduced productivity. Existing digital wellbeing solutions rely heavily on the user's self-control and fail to provide consistent results. This paper presents a digital wellbeing solution that addresses these limitations through two features: a focus mode unlocked only through a One-Time Password sent to a trusted contact, and a social accountability framework. Selected applications remain blocked until authentication is verified. A community dashboard displays focus streaks and peer progress to foster motivation. A 30-day study with 27 participants observed 24.7% reduction in average daily screen time along with a focus streak of 12 out of 15 days in the Intervention Phase. These findings provide objective evidence that combining external authentication with social accountability offers a more robust intervention against smartphone addiction than traditional self-regulated approaches.

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1. INTRODUCTION

Smartphone usage has increased significantly in recent years because of its convenience and portability. As many aspects of daily life have become digital, smartphones have become a necessity even for teenagers, which has led to an increase in digital addiction affecting their academic performance, mental health, and sleep patterns (Hsieh, 2025; Tabish, 2025). Modern apps are focused on engaging users for extended durations by introducing infinite scrolling and autoplay mechanisms. This results in addiction to smartphones and loss of self-control (Al-Mansoori et al., 2023; Anthes, 2016). In response to these concerns, operating systems and third-party developers have introduced various digital wellbeing tools (Al-Mansoori et al., 2023). While these tools offer limited efficacy, they still exhibit significant limitations such as frequent bypass of restrictions (Löchtefeld et al., 2013) and an absence of social accountability (Ko et al., 2015), highlighting the need for

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more robust methods. Most existing digital wellbeing solutions depend on the user's self-control and self-discipline (Al-Mansoori et al., 2023). Awareness-based tools provide feedback, notifications to users with the expectation that users will respond positively, but often, it is observed that the compulsive urges override self-regulation (Anthes, 2016; Molteni, 2022; Zheng et al., 2025).

Restrictive software-based tools attempt to impose stronger control through time-based limits, application blocking, or task-based lockouts (Kim, Park et al., 2019; Löchtefeld et al., 2013). While such approaches can help reduce usage, they exhibit two primary limitations. First, they can be readily circumvented; users can frequently override focus mode since they typically know the password (Löchtefeld et al., 2013). Second, if the restrictions are excessively restrictive, users may experience frustration, leading to the abandonment of the tool (Kim, Park, et al., 2019). Hardware-based solutions, such as physical phone lockboxes or cages, effectively mitigate impulsive smartphone usage (Kim, Park, et al., 2019), but these solutions are impractical, as users might require their phones in case of an emergency. These solutions lack flexibility, portability, and scalability for daily use. Another significant limitation of these solutions is their reliance on intrinsic self-regulation. They treat smartphone addiction as an isolated behavioural issue instead of integrating social influence, as research suggests that individuals are more likely to adhere to their intended goals when their actions are visible to others (Ko et al., 2015).

The analysis of existing digital wellbeing solutions reveals several critical research gaps. Software-based solutions are flexible, practical and scalable; however, a primary limitation is their dependence on the self-control of the user which causes users to deactivate the applications during impulsive episodes (Kim, Park, et al., 2019; Löchtefeld et al., 2013). Conversely, hardware-based solutions effectively mitigate poor self-regulation, but they lack large-scale practicality, as users must retain the autonomy to use their smartphones during legitimate tasks (Chen & Li, 2022).

Most existing solutions fail to address the fundamental problem, which is the inability of users to self-regulate during impulsive urges to use smartphones (Anthes, 2016; Löchtefeld et al., 2013). Existing solutions operate under the assumption that application users will follow the guidelines without succumbing to distractions; this is an unrealistic expectation, as this behaviour intrinsically defines addiction. They also overlook the role of social influence and accountability in modifying behaviour (Al-Mansoori et al., 2023; Ko et al., 2015).

Therefore, there is a critical need for a digital wellbeing solution that:

1) Mitigates impulsive behavior with an external barrier without requiring additional hardware,
2) Maintains usability and flexibility for daily smartphone use, and
3) Leverages social accountability to promote sustained behavioural change.

This work provides a novel bridge between ineffective software-based self-regulation and impractical hardware-based lockouts by utilizing network-enabled external authentication. The contributions of this work include:

- Designing and implementing a network-enabled digital wellbeing application. This system employs One-Time Password (OTP)-based external authentication required to unblock an app that is locked during a focus session. It eliminates dependence on the self-control of the user by introducing a trusted contact as a barrier to unlocking the app.
- Incorporating social accountability using a community dashboard, where the user's focus streaks, statistics, and peers' dashboards are updated in real time. This visibility motivates the user to complete tasks and remain committed to focus sessions.

The system is:

- Implemented on Android using Flutter for the user interface, native Android Application Programming Interface (API) for application control, and Firebase for authentication and data synchronization.
- Evaluated through a longitudinal field study involving 27 participants over a 30-day period. This objective evaluation measures behavioural data, including screen time reduction and focus session adherence, to validate the effectiveness of the system beyond user perception.

The remainder of this paper is organized as follows. Section II reviews related work and existing digital wellbeing solutions. Section III describes the overall system architecture. Section IV discusses implementation, experimental evaluation, and results. Section V provides a discussion of the findings in the context of behavioural change and existing literature. Finally, Section VI concludes the paper.

2. RELATED WORK

Smartphone addiction tools currently range from basic trackers to intricate locking systems. This section reviews existing research and different types of solutions, highlighting why they often fail to provide a long-term solution. The widespread presence of mobile phones has resulted in a growing issue known as digital addiction. Smartphone addiction is defined as a condition in which control over device usage is reduced (Tabish, 2025). Since apps today are built specifically to maximize user engagement through features like infinite scrolling and constant notifications, relying solely on individual volition is often insufficient (Al-Mansoori et al., 2023).

A prominent concept in recent research is something called the self-control paradox. This occurs because most digital wellbeing apps simultaneously assign dual roles to the user: the jailer who makes the rules and the prisoner who must follow them. Since the user is the one who sets the lock in the first place, they also possess the power to turn it off the moment they experience an urge to check their phone (Löchtefeld et al., 2013). This makes most software-based locks fundamentally insecure because the power to break the rules remains with the individual experiencing the addiction.

The underlying premise of these tools is that instead of blocking access or employing coercion, the goal is to nudge users toward being more mindful. The theory is that if users are constantly reminded of their behaviour, such as viewing exactly how many hours they have spent on their screen, they will be motivated to stop independently. There are various methods by which these tools attempt to achieve this. For instance, the TIMER app integrates a clock right in the status bar so users can continuously monitor how long their current session has been. This is intended to address how users lose track of time when scrolling (Löchtefeld et al., 2013). In NudgeApp, small warnings and minor interface changes are introduced to discourage interaction with apps that rely on manipulative patterns such as infinite scrolling (Zheng et al., 2025). For younger users, motivational notifications related to health goals are delivered through the ATLAS app and similarly, Focus Beetle app encourages them to nurture a digital pet (Lee, 2021). Positive reinforcement is applied in gamified applications such as Forest, where focus is encouraged through the growth of a virtual tree (Anthes, 2016). In this case, loss aversion is applied by causing the tree to disappear when the app is exited (Anthes, 2016).

Recent evidence shows that digital self-control tools can help reduce unwanted technology use, but their effectiveness is highly contingent on how the intervention is designed and evaluated (Roffarello & De Russis, 2023). In research conducted on NudgeApp, no significant reduction in overall phone usage was observed, despite the presence of frequent nudges. Similar results were reported in the TIMER study, where time visibility alone was found to provide no substantive restriction when continued usage was desired. In the ATLAS app study, motivational notifications were frequently disregarded by adolescents, which resulted in low engagement levels (Lubans et al., 2014). Even in the Forest app, emotional attachment to the virtual tree exhibited minimal influence, as immediate urges were frequently prioritized over long term goals. These findings indicate that awareness focused interventions alone are insufficient to control compulsive smartphone behaviour (Anthes, 2016; Molteni, 2022) and user-centered analysis of digital wellbeing applications shows that many existing tools are not fully aligned with users' actual needs and expectations for behavior change support (Almourad et al., 2021).

Because limited efficacy has been observed with low-friction approaches, more restrictive interventions have been explored by researchers. In these methods, access to applications is restricted through digital or physical barriers. Required effort is deliberately increased to discourage impulsive access.

Table 1. Comparative Analysis of Proposed System vs. Existing Solutions

Comparators / Features	Session Security	External Authentication	Uninstall Restriction	Granular Control	Social Accountability	Automatic Timers	Portability	User Experience
Android / OS native tools	✕	✕	✓	✓	✕	✓	✓	✓
App Detox (Löchtefeld et al., 2013)	✕	✕	✕	✓	✕	✓	✓	✓
LocknType (Kim, Park, et al., 2019)	✕	✕	✕	✓	✕	✕	✓	✕
The Phone Cage (Chen & Li, 2022)	✓	✕	NA	✕	✕	✕	✕	✓
Proposed System (OTP + Social)	✓	✓	✕	✓	✓	✓	✓	✓

The assumption is that cravings are mitigated when additional steps are required before an application can be accessed. This approach is demonstrated in the LocknType app, where entry to applications is allowed only after a random string of up to thirty characters is typed. By this method, automatic behaviour is interrupted and conscious awareness is encouraged (Kim, Park, et al., 2019). Time-based restrictions have also been applied in tools such as the GoalKeeper app, where most phone functions are disabled after a daily limit is reached. In this case, continued access is prevented once the allowed time is exceeded (Kim,

Jung, et al., 2019). In some applications such as App Detox, usage limits are defined in advance by the user, including blocking selected apps during fixed hours (Löchtefeld et al., 2013). Furthermore, commitment-based interface design was explored, where users can intentionally switch into interfaces that reduce distraction while still preserving needed functionality (Lukoff et al., 2023). Despite stricter enforcement, several limitations have been observed in long-term use, as repeated interruptions can engender user frustration (Harbach et al., 2014). When such restrictions are sustained over extended periods, the application is often uninstalled, which remains a major weakness of software-based solutions. This issue has been linked to the self-control paradox, in which the authority to set restrictions and the ability to remove them are held by the same person (Löchtefeld et al., 2013). For this reason, support is generally preferred when it is sufficiently robust to guide behaviour change without becoming excessively restrictive or frustrating (Lyngs et al., 2022). It has also been reported that complete lockouts may create anxiety, especially when access to navigation or emergency communication is blocked. In such situations, the efficacy of the tool is compromised because critical tasks are also prevented. These findings suggest that an effective solution should be designed with a balance between firm restriction and necessary accessibility (Kim, Jung, et al., 2019).

Based on the limitations identified in earlier tools, the need for a different approach has been recognized, as application-based interventions have shown promise, but their efficacy has diverged across features and implementations (Rahmillah et al., 2023). Some physical methods, such as phone cages, have been developed to lock devices for a fixed duration and are not easily bypassed. However, their routine adoption has been limited because they are impractical for daily routines (Chen & Li, 2022). Therefore, a hybrid approach is deemed more appropriate, in which the convenience of software is complemented by the dependability of physical restriction.

In recent studies, social accountability has been associated with heightened motivation than digital punishment alone (Ko et al., 2015). It has also been found that the relationship between daily activities and problematic smartphone use can be influenced by family and peer support, which supports the inclusion of socially based intervention methods (Koçak et al., 2025). Through OTP-based authentication, control is decentralized from the user. Impulsive behaviour is interrupted when access is made contingent upon a code received from an external source. In this way, the authority to unlock the system is positioned beyond the user's immediate control, and greater adherence to intended goals is facilitated.

A comparison is also presented in Table 1 between the existing solutions and the proposed solution based on:

- Session Security: This denotes the difficulty of terminating a focus session once it starts. Many applications, such as Android Digital Wellbeing exhibit vulnerability here as they allow users to bypass restrictions via system settings. Only the Phone Cage and proposed solution eliminate this immediate bypass mechanism for the user.
- External authentication: This entails a secondary device or an external agent deactivating the application restriction. Existing applications, such as App Detox and LocknType lack this functionality and the administrative control remains with the user. The proposed solution requires a designated third-party phone number to authorize decryption via an OTP.
- Uninstall Restriction: In instances of low self-regulation, users frequently circumvent restrictions by uninstalling the application. Native features integrated within Android and iOS circumvent uninstallation, whereas third-party software, including the proposed solution, remains susceptible.
- Granular Control: This refers to the user's capacity to selectively restrict specific applications. Software-based solutions provide this functionality but hardware-based such as The Phone Cage lack this capability as they enclose the entire device arbitrarily.
- Social Accountability: This leverages social dynamics to incentivize task completion. Existing solutions are predominantly individual-centric, whereas the proposed solution incorporates a community dashboard allowing peers to monitor progress, thereby fostering adherence.
- Automatic Timer: The session duration is predetermined by the user; upon expiration of the timer, restricted applications are automatically accessible.
- Portability: This evaluates the ease of transporting and accessing the solution across environments. This requirement is satisfied by software-based designs, representing a significant limitation for hardware alternatives.
- User experience: This encompasses usability and the efficacy of goal attainment. Certain applications generate frequent disruptions. The proposed solution restricts notifications to the completion of predetermined conditions or explicit user requests.

3. SYSTEM ARCHITECTURE

Although screen time features are integrated into smartphones, addictive usage patterns are still observed. These features rely primarily on individual volition, which is known to diminish during instances of impulsivity. Self-control is often challenged by addictive behaviour, which consequently leads to systematic failure. In many focus

applications, restrictions can be readily bypassed by terminating timers or modifying settings. As discussed earlier in the jailer and prisoner concept, restriction enforcement and restriction removal are administered by the same individual. As a more robust alternative, physical phone lockboxes have been introduced, as circumvention is rendered more difficult through hardware. However, daily utility is limited in such solutions. Routine portability is inconvenient, and access can be critically restricted during emergency situations. In most existing applications, the problem is conceptualized as an individual responsibility. Social support and peer accountability are largely absent, despite evidence demonstrating their effectiveness. Currently, a digital wellbeing system that is practical, enforceable, and straightforward to operate remains unavailable. The primary challenge is centred on the development of a solution that cannot be readily circumvented and yields measurable behavioural improvement instead of remaining dormant on the device.

This system has been developed to address this issue through specific objectives:

- Enhanced enforcement is ensured when focus restrictions cannot be readily bypassed during instances of impulsivity.
- External authentication is introduced whereby approval is required from a source inaccessible to the user, thereby reducing the likelihood of impulsive overrides.
- Usability and practicality are also prioritized so that efficacy can be sustained in daily use. Essential smartphone functions remain accessible, and no additional hardware is required.

The system is also defined by several additional features:

- Peer visibility and shared progress tracking are integrated with technical controls to support long-term focus.
- A scalable software-based architecture is implemented through existing mobile platforms and cloud services. Consequently, portability, scalability, and ease of deployment are attained.

In this paper, a network-enabled digital wellbeing system is proposed to enforce focus sessions using an OTP-based external authentication method. Based on the defined objectives, control over session termination is transferred away from the user. To disable an active focus session, an OTP is required from an external contact, which impedes impulsive disengagement. The system is designed to incorporate both technical enforcement and social accountability. Focus streaks and progress metrics are shared with peers to foster accountability. By integrating external control with social motivation, both the technical and behavioral dimensions of smartphone addiction are addressed. An Android-based software implementation is used to maintain usability while providing more robust control relative to existing digital wellbeing applications.

A network-centric client-server architecture is employed in the proposed system. External authentication is used for focus enforcement, while usability and scalability are prioritized. The architecture comprises two primary components: the mobile client application and the cloud backend services, as illustrated in Figure 1.

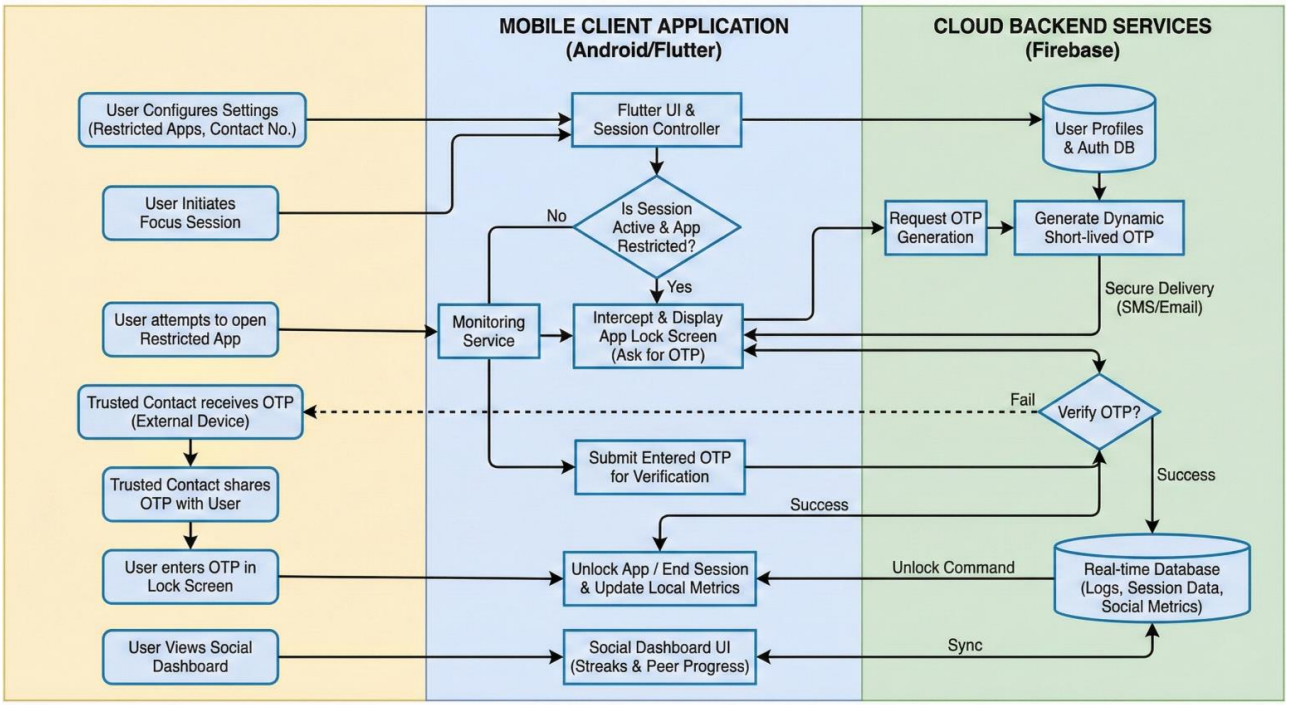


Figure 1. System architecture of the proposed OTP-based digital wellbeing framework.

3.1 Mobile Client Application

The mobile client application is developed using a cross-platform user interface framework and is supported by a session controller. Focus timers and restriction rules are managed by this controller. Foreground application monitoring and app blocking are handled through native Android services. An external barrier in the form of a trusted contact is placed so that the user is unable to disable the focus session independently. Android is selected as the target platform for the mobile client application. By using this combined approach, an intuitive user interface is achieved, and real-time monitoring of usage is supported while distracting applications are restricted, as illustrated in Figure 1.

Focus sessions are initiated and managed by the client application. Access to selected applications is blocked, and usage statistics are tracked during the session. Progress metrics are displayed to the user. Application-level restrictions are enforced, and usage behaviour is observed in real time through native Android APIs. Application access is limited according to predefined focus protocols. Application and session parameters are configured prior to activation.

Android's native services then enable application blocking by monitoring foreground activity, thereby restricting access to specified applications during focus sessions. When the user launches a restricted application, the system intercepts it and displays the application lock screen. To access the application, the user is required to enter a one-time password (OTP). Focus mode is not disabled immediately, as authentication is required before termination. A focus session is terminated only after successful external authentication, through which enforcement control is maintained and bypass attempts are significantly reduced.

3.2 Cloud Backend Services

A cloud-based backend is used for this application to manage functionalities including authentication, OTP generation, and real-time synchronization. To disable a focus session, an OTP is generated by the backend and sent to a trusted contact. Control is therefore shifted outside the user device. The entire system is operated through software, and no additional hardware is required. A network-based enforcement layer is introduced through this approach. Secure OTP delivery and real-time data synchronization are facilitated by the backend, as illustrated in Figure 1.

Essential user data, such as user profiles, focus sessions and logs, are maintained within secure storage to ensure seamless retrieval across all devices and sessions. Real-time synchronization is implemented for consistency between the application and the backend. State machines are implemented to preserve state integrity in the event of a network failure or an application relaunch.

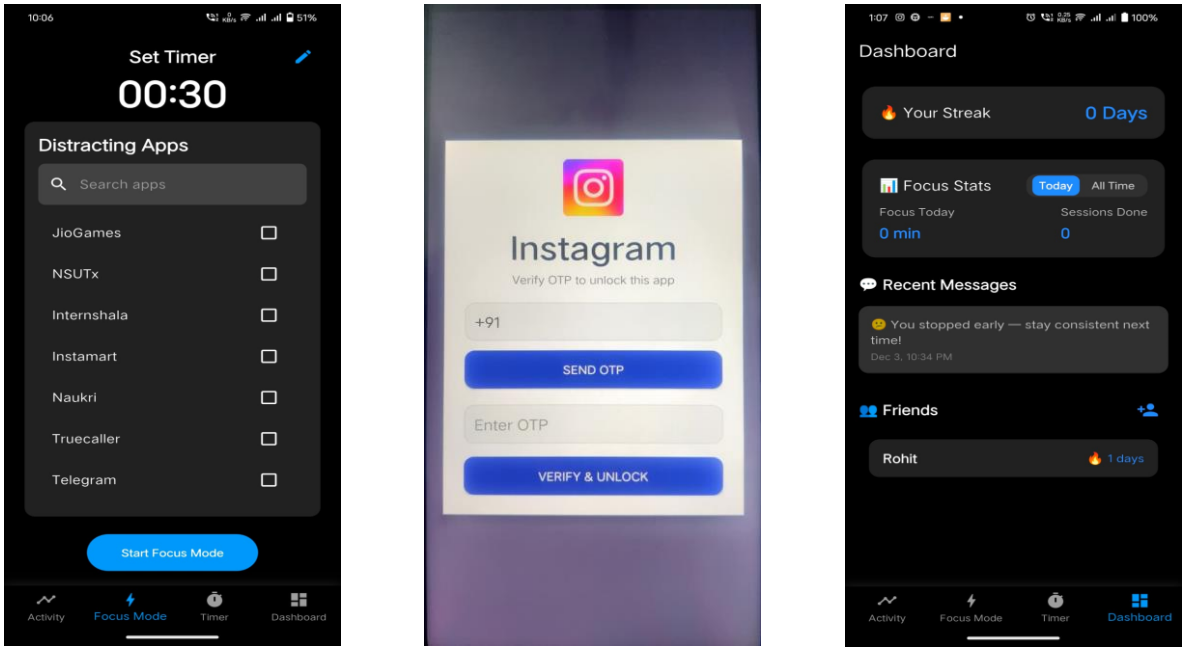
To add another layer of enforcement, an OTP verification mechanism is introduced. A user cannot remove application restrictions by prematurely ending a focus session. Upon a termination attempt, the application requests authentication, forwarding the request to backend services which generate an OTP and send it to the designated contact number. Only after entering the correct OTP is the user permitted to terminate the focus session, which ensures that a user cannot impulsively bypass the enforcement layer.

4. IMPLEMENTATION AND RESULTS

The user interface of the proposed solution is developed using Flutter, through which an interactive and responsive design is achieved. The user initiates a focus session via the mobile app, restricting access to distracting applications, which are selected by the user along with the session duration, as shown in Figure 2(a). When the user attempts to access the restricted application during the active focus session, an application lock overlay appears over the application, which requires an OTP for access, as shown in Figure 2(b). The OTP generation, external authentication, and real-time dashboard data synchronization are managed by Firebase.

Social accountability is integrated with technical enforcement through a dashboard feature within the application. Focus streaks, session statistics, and progress data can be shared with peers through this interface, as shown in Figure 2(c). Progress updates are facilitated via real-time backend updates. This visibility of progress and peer support fosters positive behavioural change among users. A primary feature of the system design is the robust security and privacy. Short duration OTPs, secure communication channels and secure storage prevent the misuse of services. For participation in any of the features with a social accountability aspect, prior user consent is required. Configuration options are also provided to regulate the visibility of the progress data to align with user preferences.

To comprehensively evaluate the proposed system, a mixed-methods approach consisting of three phases was employed. First, prior to system design, a survey was conducted to understand user opinions on existing limitations and their acceptance of stricter enforcement. Second, a post-development survey accompanied by a demonstration video assessed user understanding, ease of use, and perceived effectiveness. Finally, to validate the subjective survey feedback with objective behavioural data, a 30-day longitudinal field study was conducted to measure the system's empirical impact on screen time reduction.



(a) Focus Mode (b) App Lock (c) Dashboard

Figure 2. Screenshots of the proposed system: (a) Focus Mode, (b) App Lock, and (c) Dashboard

4.1 Pre-Design Survey Results: User Insights and Problem Validation

An initial pre-design survey was conducted with a sample size of 83 participants belonging to the 18 to 24 age group to gather insights regarding user perspectives on smartphone addiction and its impact. Among these respondents, 66% agreed to getting distracted during work or study. Furthermore, 86% of participants expressed a desire to reduce their screen time, as shown in Figure 3.

71% of respondents had stopped using existing solutions because they were able to bypass during moment of weakness and hence did not help them in curing the addiction. These responses highlighted the shortcomings of solutions based mainly on awareness and self-regulation. Strong support for stricter control methods was also observed in the survey results. As shown in Figure 4, a focus application that was difficult to bypass was preferred by 78.2% of respondents, while 71.4% believed that intentional delays or barriers during lock bypass would reduce impulsive actions. Based on these findings, the use of external OTP based authentication was selected for the proposed system design.

4.2 Post-Design Survey Results: Application Acceptance and Perceived Effectiveness

After implementation, a second survey was conducted with the same cohort of 83 participants (aged 18 to 24) to evaluate user acceptance and the perceived effectiveness of the application. High approval was observed among respondents, and improved screen time control compared to existing solutions was expected by 89.6% of participants, as shown in Figure 5. The OTP-based unlocking mechanism was positively received, with approval reported by 89% of users. Stricter control enforced through external authentication was perceived as acceptable and useful rather than restrictive. Satisfaction with the user interface and visual design was reported by 89.3% of respondents, indicating that usability was not compromised by stronger enforcement. The social accountability framework was considered effective, as 86.2% of participants felt motivated by viewing peer progress during focus sessions.

The following sections detail the experimental field study conducted to provide quantitative evidence.

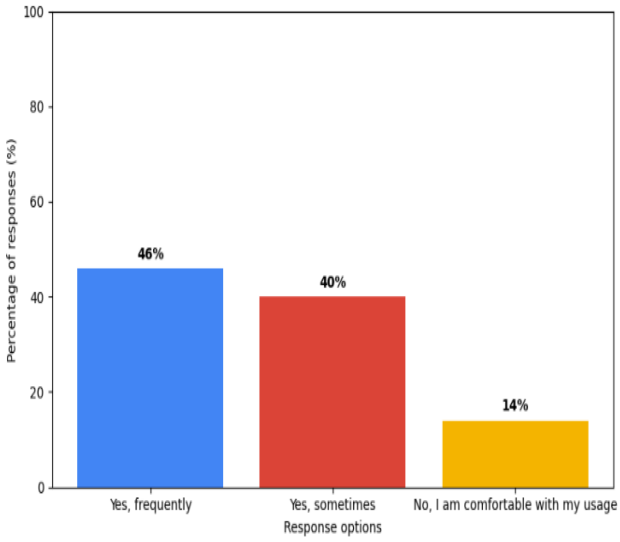


Figure 3. Have you ever wished you could reduce the amount of time you spend on your phone?

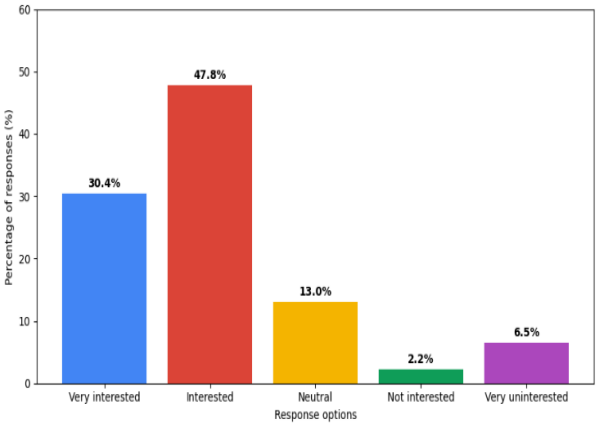


Figure 4. How interested would you be in a focus app that was truly difficult to bypass?

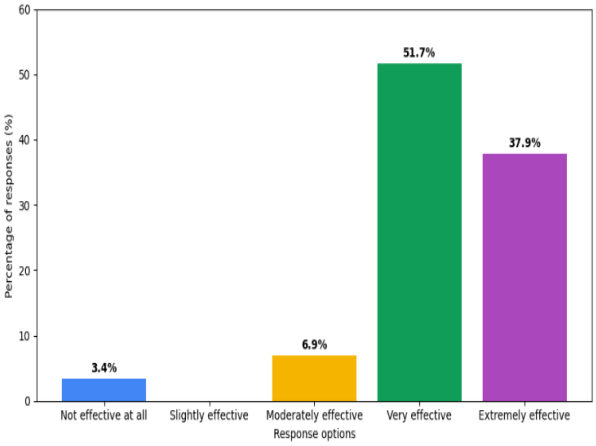


Figure 5. How effective do you think this app would be in helping you reduce screen time compared to standard "Digital Wellbeing" tools?

4.3 Experimental Setup

To objectively assess the efficacy of both the proposed OTP-based network authentication system and the social accountability framework, a longitudinal field study was conducted with 27 participants from an urban demographic aged 18 to 24, spanning a total duration of 30 days.

Ethical Statement and Informed Consent: The study protocol was conducted in accordance with the institutional ethical review guidelines of Netaji Subhas University of Technology (NSUT). Prior to data collection, formal informed consent was obtained from all 83 survey respondents and 27 longitudinal study participants. All individuals were fully briefed on the behavioral metrics being monitored, and participants were assured that their data would remain entirely confidential, anonymized, and used exclusively for academic research purposes.

The evaluation was executed in two distinct 15-day phases:

1) Baseline Phase: For the first 15 days, participants' daily screen time was recorded using native operating system metrics without our digital wellbeing application installed. This established a baseline for regular usage patterns.
2) Intervention Phase: For the subsequent 15 days, participants installed the proposed application on their smartphones, where they configured two trusted peers' phone numbers for OTP authentication and utilized our focus mode feature along with the social dashboard.

Data Collection and Verification: Daily behavioural metrics, which included total screen time, focus session duration, session completion rates, and streaks, were captured. To ensure data integrity, participants submitted daily screenshots of the application's social dashboard to the team. This verified data was then manually transcribed into a centralized spreadsheet for quantitative analysis and behavioural mapping.

4.4 Quantitative Results

The experimental data demonstrated a substantial shift in user behavior following the introduction of the proposed application. To assess the efficacy of the intervention, a paired-samples $\boldsymbol{t}$-test was conducted to compare the metrics between the baseline and intervention phases.

During the baseline phase, the average daily screen time across the sample size ($\boldsymbol{N}$ = 27) was 348.46 minutes. During the 15-day intervention phase, the average daily screen time decreased to 265.23 minutes. This represents an average absolute reduction of 83.23 minutes per user per day, equating to a 24.7% overall reduction in screen time. Figure 6 presents a participant-wise comparison of baseline and intervention screen time.

To mathematically validate that this reduction was statistically significant and not due to random variance, the paired $\boldsymbol{t}$-test was calculated using the difference in screen time for each participant. The variables and formulas used in this analysis are defined as follows:

- $\boldsymbol{N}$ (Sample Size): The total number of participants in the study ($\boldsymbol{N = 27}$).
- $\boldsymbol{D_i}$ (Individual Difference): The reduction in screen time for a single participant, calculated as Baseline Screen Time minus Intervention Screen Time.
- $\bar{\boldsymbol{D}}$ (Mean Difference): The average of all individual differences across the participant group.

$$\bar{D} = \frac{\Sigma D_i}{N} = 83.23\ minutes \quad (1)$$

- $\boldsymbol{s_d}$ (Standard Deviation of Differences): The measure of dispersion or variance in the screen time reduction among the participants. The calculated standard deviation for this dataset was $\boldsymbol{s_d = 25.76}$.

- $\boldsymbol{SE_d}$ (Standard Error of the Difference): This estimates the variability of the mean difference. It is calculated by dividing the standard deviation of differences by the square root of the sample size:

$$\boldsymbol{SE_d = \frac{s_d}{\sqrt{N}} = \frac{25.76}{\sqrt{27}} \approx 4.96} \quad (2)$$

The $\boldsymbol{t}$-statistic represents the ratio of the mean difference to its standard error, indicating the magnitude of the intervention's effect relative to the variation in the data. The formula and calculation are:

$$\boldsymbol{t = \frac{\bar{D}}{SE_d} = \frac{83.23}{4.96} = 16.78} \quad (3)$$

To determine the statistical significance, the Probability ($\boldsymbol{p}$-value) was derived by comparing the computed $\boldsymbol{t}$-statistic against the $\boldsymbol{t}$-distribution critical values. This requires calculating the Degrees of Freedom ($\boldsymbol{df}$), which represents the number of independent values that can vary in the analysis:

$$\boldsymbol{df = N - 1 = 26} \quad (4)$$

Evaluating the $\boldsymbol{t}$-statistic at $\boldsymbol{df = 26}$ yields a highly significant statistical outcome ($\boldsymbol{t(26) = 16.78}$, $\boldsymbol{p < 0.001}$). This standard notation confirms that there is less than a 0.1% probability that the observed reduction in screen time occurred by random variance, robustly validating the empirical effectiveness of the proposed system.

Beyond total screen time, transcribed metrics revealed strong adherence to the focus constraints. The average daily focus session lasted 71.40 minutes. Out of the 405 total daily focus sessions initiated during the study, only 32 sessions (7.90%) were broken early, suggesting that the "Trusted Contact" authentication acts as a successful deterrent against impulsive usage. Furthermore, participants maintained an average social streak of 12 days out of the 15-day trial period, highlighting consistent daily engagement with the accountability framework.

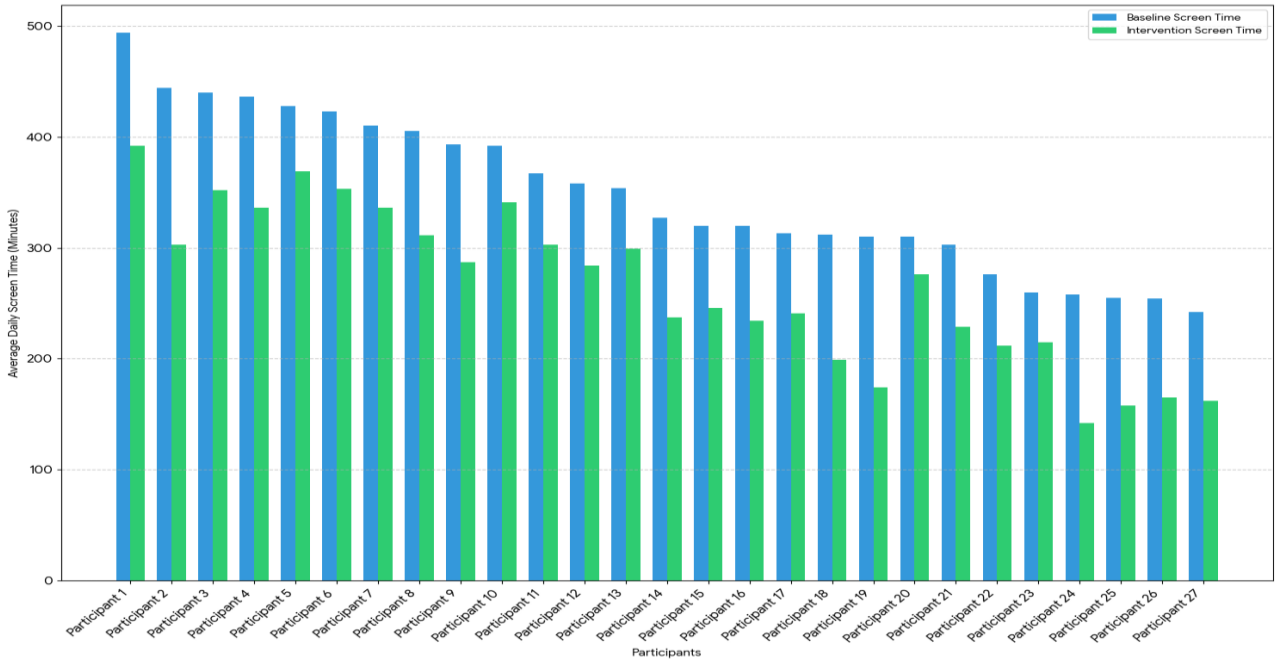


Figure 6. Participant-wise comparison of average daily screen time during Baseline and Intervention Phases

5. DISCUSSION

The quantitative results validate the hypothesis that external authentication and social accountability provide a more robust barrier against smartphone addiction than self-regulated software solutions.

A major limitation of existing digital wellbeing tools is the "self-control paradox," whereby users readily circumvent restrictions during instances of impulsivity. The exceptionally low early-termination rate (7.90%) observed in the intervention phase provides concrete behavioural evidence that the OTP mechanism successfully mitigates this vulnerability. By requiring an external trusted contact to authorize session termination, the application introduces sufficient behavioural friction to deter impulsive unlocking, ultimately resulting in a statistically significant 24.7% reduction in daily screen time.

Existing standalone applications frequently exhibit high abandonment rates. However, participants in this study sustained an average streak of 12 out of 15 days. This high retention and adherence rate can be attributed to the community dashboard. Visibility of peer progress and focus statistics shifted the digital wellbeing paradigm from an isolated individual struggle to a collaborative social endeavour.

While standard OS-native tools primarily serve as passive trackers resulting in the high baseline usage of 348.46 minutes per day, the proposed intervention actively interrupted compulsive usage patterns. Unlike hardware-based phone cages, which achieve strict lockouts at the expense of practicality (Chen & Li, 2022), the proposed software-based OTP method achieved significant behavioural changes without completely restricting user access to emergency device functions, establishing an optimal balance between security and everyday usability.

6. CONCLUSION

Smartphone overuse has emerged as a significant public health and productivity concern for which existing interventions have proven largely inadequate. The main reason for this insufficiency is the dependence of these solutions on the user's self-regulation. This limitation is addressed in the proposed system through the introduction of OTP-based external authentication. The solution developed has OTP-based network authentication, where the user must retrieve the OTP from a trusted contact to disable the focus session. This was done intentionally, as it makes impulsive circumvention much more difficult than in existing solutions. The usage statistics and app timer also allow users to self-regulate within defined parameters. The absence of social accountability mechanisms in existing solutions is further addressed through the integration of a community dashboard, which exposes focus statistics, streaks, and peer progress data to provide external motivational reinforcement.

While initial surveys indicated that users found the OTP-based authentication and community dashboard highly favourable, the true effectiveness of the system was validated beyond subjective perception through a 30-day longitudinal field study. Objective metrics from 27 participants demonstrated a statistically significant 24.7% reduction in daily screen time, dropping from a baseline average of 348.46 minutes to 265.23 minutes. Furthermore, the system successfully countered impulsive bypass attempts, evidenced by a low 7.9% session early-termination rate. The integration of the social accountability framework also yielded high user engagement, with participants maintaining an average focus streak of 12 out of 15 days during the intervention phase. Ultimately, this project demonstrates that digital wellbeing tools can be fundamentally improved by reallocating the mechanism of self-regulation from the user's immediate willpower and relying instead on external authentication and peer accountability. By combining rigorous focus constraints with social visibility, the proposed solution comprehensively addresses the limitations of existing digital wellbeing applications.

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