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Mohamed Basel Almourad
Zayed University, mohamedbasel.almourad@zu.ac.ae

Amen Alrobai
King Abdulaziz University

Tiffany Skinner
Bournemouth University

Mohammed Hussain
Zayed University, mohammed.hussain@zu.ac.ae

Raian Ali
Hamad bin Khalifa University

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Mohamed Basel Almourad [a], Amen Alrobai [b], Tiffany Skinner [c], Mohammed Hussain [a], Raian Ali [d,*]

[a] College of Technological Innovation, Zayed University, Dubai, United Arab Emirates
[b] Department of Information Science, King Abdulaziz University, Jeddah, Saudi Arabia
[c] Faculty of Science and Technology, Bournemouth University, Bournemouth, UK
[d] College of Science and Engineering, Hamad Bin Khalifa University, Doha, Qatar

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ABSTRACT

There is a growing recognition of excessive, compulsive, and hasty use of technology as an emerging form of problematic behavior affecting individuals' emotional, social, and occupational wellbeing. Smartphone overuse, in particular, has been linked to negative effects on users' quality of life, such as anxiety, depression, sleep disturbance and loss in productivity. One strategy to help regulate digital usage and, potentially, increase digital wellbeing is to devise smartphone applications to collect data about usage and increase users' awareness of it and enable them to set limits and alert users accordingly. However, such applications have not been extensively evaluated from the users' perspective and whether they help the basic requirements for digital wellbeing. In this paper, we examine the quality of the emerging family of digital wellbeing smartphone applications from the users' perspective and based on persuasive design and established behavioral change theories. We performed a thematic analysis on the users' reviews on two popular applications, SPACE Break Phone Addiction and Google Digital Wellbeing (GDW). We report on the factors influencing user acceptance and rejection towards digital wellbeing applications and identify possible challenges and opportunities to improve their design and role in future releases.

1. Introduction

Due to the growing interest in self-health care management, the use of eHealth applications are becoming a major trend [1], and the market continues to grow rapidly. According to the [2], around 84 K companies released 325 K health applications and approximately, £5.4 billion has been invested in digital health start-ups.

eHealth applications show potential in enhancing various aspects of mental and social health, such as cognitive performance and communication skills [3]. Digital addiction can be defined as problematic use of digital technology, which is characterized by being excessive, compulsive, impulsive, hasty and associated with harm to the individuals and their social circle. Symptoms of digital addiction include loneliness, anxiety, and depression [4]. The software development industry collects data about users and generates knowledge to grab attention, prolong and intensify usage, which, in some cases, builds an addictive experience [5]. We note the same data can be used to build anti-addiction solutions and enhance digital wellbeing.

As technology can also be part of the solution, utilizing the same usage data, researchers started to look into the feasibility of developing digital wellbeing tools to positively change users' attitudes and behaviors towards the use of smartphones [6]. Digital wellbeing applications mainly focused on providing users with a better sense of actual time spent on digital devices through interactive statistics and dashboards. Examples of these efforts include SPACE Break Phone Addiction [7], GDW [8] NUGU [9], FamiLync [6], MyTime [10] and Lock n'LoL [11]. Additionally, Apple and Google both introduced a set of features and applications to help reduce distraction and enhance user digital wellbeing [12].

The design of successful digital wellbeing applications is expected to be based on established theories and to employ principles and models of behavior change which include, for example, the Theory of Planned Behavior [13] and the Technology Acceptance Model [14]. Theory of Planned Behavior (TPB) recognizes behavioral beliefs that serve as a link

* Corresponding author.
E-mail addresses: basel.almourad@zu.ac.ae (M.B. Almourad), aaaalrobai@kau.edu.sa (A. Alrobai), i7714591@bournemouth.ac.uk (T. Skinner), mohammed.hussain@zu.ac.ae (M. Hussain), raali2@hbku.edu.qa (R. Ali).

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between behavior and the expected outcome. The applications usually allow people to set limits and goals as expected outcomes and show them how they progress. The Technology Acceptance Model supports that if a user believes usefulness and ease of use are high, their attitude will be positive and hence a technology will be adopted [14]. The objective and automated measurement of digital time and time spent on applications form a new basis to apply behavior change theories, in particular, self-comparison and peer-comparison.

However, the vast majority of e-Health applications are developed commercially without the extensive involvement of health care professionals [15]. Some research showed that health care applications lack an underlying evidence base, scientific credibility and could pose a risk of over-reliance on applications and anxiety resulting from self-diagnosis [16]. For example, when relying on self-report in eHealth systems, measures and interventions can become subjective and erratic and this calls for systematic ways in building self-quantification systems rather than relying on designers' experience and creativity alone [17]. Unfortunately, digital wellbeing development inherits these properties which question the relevant impact of these particular applications [18]. Therefore, the eHealth market is subject to strict regulation to ensure posing no risk to users' safety [2].

In this paper, we carry out a qualitative study and analyze user reviews of two popular digital wellbeing applications aiming to elicit their acceptance and rejection factors of such applications. This study used 195 reviews on the SPACE Phone Life Balance application and 155 reviews on Google Digital Wellbeing (GDW). The reviews were provided by users who downloaded and used the applications and were meaningful by providing opinions about the app with an explanation. The reviews were linked, where possible, to the features and functionalities of the two selected applications to gather insights into how the design may affect user acceptance and rejection of such applications in enhancing digital wellbeing.

The remainder of the paper is organized as follows: In Section 2, we present background information on the digital wellbeing technology considering users' perspectives and the theoretical foundation of these applications. In Section 3, we explain our research method. In Section 4, we discuss our findings of user acceptance and rejection factors. In Section 5, we discuss the findings and provide recommendations on building this family of apps. In Section 6, we present related works, and in Section 7, we conclude the paper.

2. Literature review

2.1. Digital use and overuse

The advent of information technology offers a great opportunity to improve wellbeing and quality of life, such as enhancing independence [19], social connection [20] and supporting mental health, including stress and depression [21]. It also encourages a healthy lifestyle through increasing the degree of flexibility in working practices [22,23] encouraging healthy habits, such as physical activity [24] and nutritional diet [25]. However, among many positive technologies, harmful patterns of technology use can occur [26]. This includes losing the ability to focus attention [27], fear of missing out (FoMO) [28], and digital addiction [29]. Affective computing brings together human-computer interaction and psychology. Previous research has studied the relation between the duration of using different applications and mood [30]. found the increased duration of mobile phone use is associated with unfavourable psychological mood, in particular, a depressed mood. Decreasing mobile phone use may help maintain appropriate mental health in very long-duration users. A study measured the relationship between the time spent on email client application and mood and found the less time spent on the email that day, the more positive the affect balance [31]. This is supported by Ref. [32], who suggest a set of recommendations whereby reducing smartphone use can help to enhance wellbeing.

2.2. Digital use sensing

The literature indicates the correlation between digital overuse and stress [33–35]. Digital footprint data was proposed to predict stress levels based on smartphone application usage [36]. demonstrated this with the use of a subject-centric behavior model. The results achieved an average accuracy of 75% and precision of 85.7%, which can be used as an indicator of overall stress levels in work environments and, in turn, inform stress-reduction organizational policies, especially when considering interrelation between stress and productivity of workers.

Brdiczka et al. [37] used a different type of behavioral temporal pattern to investigate stress factors (productivity, autonomy, and workload) on routine tasks. Using this pattern detection algorithm, they analyze the number of repeated occurrences (temporal patterns) of application, document, and email events. The study suggested that these measures were able to indicate workplace stress factors. However, they could not show specific application-switch patterns that were often repeated when their participants were under a high stress level. These efforts show potential for using digital footprints data to sense the degree of digital addiction with the aid of other metrics, such as time on screen and frequencies and hence optimize digital wellbeing application processes.

2.3. Digital wellbeing technology

Recently, we started to see an emergence of technological means to help users regulate their digital usage, better their relationship with technology and combat such negative interactions to achieve digital wellbeing. Digital wellbeing advocates the design of artefacts meant to help individuals to find a balanced relationship with technology [38, 39]. The term "Positive technology" or "Positive computing" play the role of a "digital coaching" helping people to achieve goals and contribute to their self–enhancement of living and work-related behavior. The design of such technology requires knowledge of different disciplines such as psychology, design, and human-computer interaction. Ultimately, such solutions are meant to enhance wellbeing and shall be positioned as a priority requirement and a quality measure when designing digital media and technology [40,41].

The literature indicates barriers facing the adoption and integration of eCare platforms in their various domains and services such as information exchange, social involvement and lifestyle monitoring services. Obstacles include uncertainty about their benefit, a lack of legislation, a lack of sustainable financial models and the incompatible enterprise architecture of the healthcare provider [42,43]. Recently, however, the software development industry recognized the importance of promoting digital wellbeing as part of their corporate social responsibility and as a way to increase user loyalty and trust. Dominant companies in the industry of information technology, such as Apple and Google, have started building digital wellbeing into their devices and moved from simple screen time limits to unplugging strategies, time management, productivity, and parental control features. GDW initiative is aimed to be a new philosophy to software development practices [8]. The solution includes a collection of features, ideas, tools, and platforms for experiments and regulations to achieve digital wellbeing [44]. In addition to the solutions provided by Google, Android operating systems offer wellbeing applications available in Google Play Store to help limit and improve smartphone use, e.g. QualityTime and Forest [45]. It is still unclear how users perceive these applications and whether they lead to a sustainable enhancement on digital habits and behavior.

2.4. Behavioral change theories for digital wellbeing technology

In this paper, we focus on the acceptance and rejection factors of the emerging family of digital wellbeing applications. Our analysis of these factors links to established theories in the domain such as Self-Determination Theory (SDT) [46], Theory of Planned Behavior (TPB)

[13] and Technology Acceptance Model (TAM) [14] to conceptualize the perceived ease of use, perceived usefulness, autonomy, relatedness and subjective norms. Despite the importance of personality and other factors (e.g. mood), our data set will not allow us to explore these factors and their effect on the acceptance and rejection of digital wellbeing applications.

Mobile health (mHealth) solutions for mental health have benefited from utilizing theories and models that explain users' behaviors and their motivation to change [16,21,47]. This would need to be the case for digital wellbeing applications which aim to enhance the socio-emotional status of their users. Self-Determination Theory (SDT) offers a framework for capturing the factors promoting human motivation. SDT defines the intrinsic and extrinsic sources of motivation and their role in fostering cognitive and social development [46]. Theory of Planned Behaviors (TPB) recognizes behavioral beliefs that serve as a link between behavior and expected outcome. It also emphasizes that the behavior is governed by attitudes, intent and actual behavior, which can be characterized by social norms and control [13]. The TPB identifies internal control as the perception of how the individual views their ability, skills and knowledge to perform a task. External control are the outside factors that determine personal behaviors. For example, time and peers' acceptance can develop a positive attitude. Hence, motivation of user digital wellbeing applications can relate to SDT and TPB factors such as the need for a sense of control over social media and notification usage and independence from peer pressure, without losing the ability to connect with others and relate to them online.

Technology Acceptance Model (TAM) is an information system theory that explains the influence factors of individuals' acceptance of technology-based solutions. This model is widely applied to understand user perception towards technology. TAM was adapted from the Theory of Reasoned Action (TRA) [48]. It explains perceived usefulness and the attitude to use a particular technology in terms of social influence and cognitive processes. With a positive attitude towards technology, individuals' chance to use it and change behavior is more likely to increase. Perceived ease of use is related to the judgement an individual makes about how much effort using the technology will involve. Perceived usefulness is an individual's evaluation of the benefits obtained from using the system processes. Further, TAM posits that perceived usefulness would be influenced by perceived ease of use as the easier it is to use the technology, the more useful it can be to the individual. Moreover, the external variables can influence the actual use of technology, such as system design characteristics. In the analysis of users' reviews of SPACE and GDW, we explored the perception of usefulness and ease of use by the users and how that linked to the features and functionalities of the applications.

2.5. Designing for digital wellbeing

The literature has recognized the importance of identifying the factors that drive users' acceptance of any new technology [49] and how to sustain users' engagement [50]. Self-regulation is systematic efforts to direct thoughts, feelings, and actions, toward the attainment of one's goals [51]. The user perspective is an inevitable dimension in digital wellbeing technology design especially with the conflict such solutions might create, e.g. the restrictions introduced that contradict with the desire to use technology or rely on it, more than a healthy level. Hence, negative effects such as the loss of autonomy and self-regulation over the use of technology encouraged us to research and identify conditions hindering individuals' development and competence. These conditions are variables, such as expectations of constant availability, escalation of commitment [18] and FoMO [28,52] which argue that research should avoid articulating the problem as a question of self-determination only which is likely to discount the responsibility of the design of digital wellbeing technology [52]. The design of technology can gather usage and online behavior data and make them available for digital wellbeing tools and solutions.

HCI researchers who investigated strategies for managing screen time with tools such as MyTime [10] and Lock n'LoL [11,53] found that most of these features follow a similar design pattern originally developed for tools to support self-management of physical activity, chronic conditions, and other life goals. However, the relationship between the time spent on devices, management, customization and wellbeing are hard to measure through screen time and need more attentiveness [53]. In addition to the usage time, digital wellbeing applications would need to take other informational resources into account, e.g. the digital literacy and social skills of users, the intention of use and context of use. Determining a user's situation leads to user modelling, where certain features of users can be exploited to customize and personalize applications. In turn, this would better personalize the intervention and increase user acceptance and retention.

However, other user's features like knowledge, skills, goals, interests and mood may be complex to track. Examples of users features which have been shown related to digital wellbeing but yet not utilized include *Time, Trust, Social skills, Health* [54].

Developers tend to view mental health apps as stand-alone products and overlook the complex context of use. Participatory design, particularly an informed participation approach, has the potential to improve the design of mental health apps [55]. Several studies were conducted to address this gap and involve users in the analysis and design of such applications [18,32,56]. Alrobai et al. [18] performed diary studies and semi-structured interviews on fourteen participants, where they installed four digital wellbeing applications on their smartphones and used them for two weeks. The authors interviewed the participants to analyze their experiences. The authors concluded that the use of these applications might result in negative side effects, such as a decrease in confidence and creating an alternative addictive experience, e.g. when checking to see how one digital usage compares to others. The authors recommended rigorous testing for such e-Health solutions for their adverse impact on both user experience and mental health.

Alrobai et al. [56] identified a lack of engineering principles in the design of online platforms dedicated to peer-support groups, in general, taking the area of digital addiction as a case study. The authors presented a reference model for developing interactive online platforms and a process model for providing rehabilitation strategies that take into consideration the nature of the support group.

Despite the effort to make the engineering process of digital wellbeing applications more theory-informed, there is still a paucity of research on how users view these applications as a whole, and their different functionalities and self-regulation facilities, in particular. There is also need to assess user expectations of such applications and their awareness of the limitations in these tools and the intended role as an auxiliary, rather than a primary, intervention.

3. Research method

The objective of this research is to assess digital wellbeing applications from users' perspective. To achieve this, two popular applications, SPACE and GDW, were selected and extensively investigated to collect evidence of their capabilities, design and potential use. The popularity was determined by the number of installs, the volume of users' reviews and to what extent they are feature-rich. SPACE is an application for self-regulating smartphone usage designed to provide users with control and achieve phone-life balance. It includes goals-setting and daily progress tracking features to maintain motivation. The GDW is an application to help users eliminate technology distraction, picture their digital habits and empower going off-the-grid. It tracks usage frequencies, notifications received, goals progress. Snapshots of the two applications are provided in Figs. 3 and 4 in the Appendices of this paper. We investigated the acceptance and rejection factors of SPACE and GDW by thematically analyzing reviews on them written by their end-users. The thematic analysis method is used to describe data set in rich detail via patterns identification and organization. Patterns in thematic analysis

moves beyond being quantification-dependent (i.e. counting explicit phrases) and focus on capturing important ideas relevant to the research questions [57]. The data collection and analysis followed three main stages:

3.1. Stage one: Data Extraction

The raw data about SPACE was extracted from their both Google Play and Apple Store sites while GDW data was collected from Google Play store and the application website. The total extract covers 350 reviews; 195 on SPACE and 155 on GDW. Samples of the reviews and the analysis are available in the supplementary material attached to this paper. Following the collection of data, the coding activity began with an initial meeting to list all qualitative data sources to be included and considering research questions.

3.2. Stage two: Data preparation

To minimized the issue of users' superficial reviews, data were examined to filter out the ones that were not insightful, e.g. just praising or criticizing the app without providing reasons. Based on these criteria, the reviews were cleaned and grouped based on the acceptance and rejection factors.

3.3. Stage three: Data analysis

In Ref. [58], the authors made a comparison between TAM and TPB. The results showed that despite them being derived from Theory or Reasoned Action (TRA) [48], TAM offers a small, yet significant, advantage in comparison to TPB as it is relatively simpler and adequate to use in a technology assessment context. In Ref. [59] the authors found that both the decomposed TPB and the TPB explain more fully technology acceptance than TAM. They also note the need to balance between the effort and the benefits, looking at the complexity of TPB in comparison to TAM and the amount of gain achieved. Given that our data, i.e. users review, did not have the demographics of the users, we were unable to link the factors to the subjective norms and environment dimension which distinguishes TPB from TAM. Hence, the theoretical underpinning for our analysis are based on the TAM. The *perception of usefulness* dimension is mainly present in the reviews of the functionality features, i.e. tools offered by the applications, while the *perception of ease of use* is primarily manifested through the reviews about the quality of implementation, i.e. user experience and transparency as well as the explicit mention of ease.

Thus, the study utilized TAM and applied thematic analysis method as it provides a systematic approach to analyzing reviews and generate initial codes in the form of discrete themes and sub-themes within the data and form the basic units of analysis. Then, we followed the 6-phases framework of thematic analysis as follows [57].

3.3.1. Data Familiarisation

Since users reviews were related to the two applications and their features, the coding team used each application for one week for contextual immersion purposes and understanding their features and different usage situations. This is to ensure that the application usage and contextual knowledge are apparent to the coders while reading the data. The coders noted the initial ideas and thoughts during the repeated reading activity. Once this phase has been completed, formal coding activity began.

3.3.2. Initial codes generation

Each member of the coding team, which consisted of two of the authors, read a set of reviews, coded interesting features, collected data relevant to these codes and organized them into meaningful groups which formed the basis of the potential themes.

3.3.3. Themes searching

As the coded data were expected to be broad, the coders applied interpretive analysis [57] as part of the thematic analysis to obtain a comprehensive view of the data. This helped to derive codes scope and organize them into main themes, subthemes and categories. A category is an idea that is directly expressed in the text giving more depth of understanding. The emerged categories brought the meaning of the themes to the attention of the research. Categories and sub-themes are all then related to the path in which the authors follow to reach the most abstract analysis. The same user's review can contain acceptance and rejection factors. We, hence, analyzed its various parts separately. We did not use the rating users gave on the app as often users tend to put a negative rating due to some technical errors that are later responded to and fixed by the development teams. Most technical errors are due to compatibility with the phone model and also found more often in SPACE reviews as GDW is fully supported by Android, the operating system developed by the same company, i.e. Google. Coders then used mind-maps as a visual representation to facilitate this activity and prepare initial version of the results. At this phase and subsequent ones, the reviews were re-visited to collect supportive extracts and discover new codes. All codes were subject to be collated, discarded or re-grouped into different subthemes.

3.3.4. Themes revision

In essence, dealing with different interpretations was an inevitable task since the coding development were data-driven rather than theory-powered. Hence, once the coders completed the independent thematic analysis, the other authors reviewed them and discussed major differences that existed until reaching consensus and creating a unified thematic map. To enhance the validity, the research team consulted the existing research on TAM and worked to identify relationships between themes and sub-themes.

3.3.5. Definition and names of themes

At this phase, a satisfactory thematic map was refined to ensure coherent and internally consistent relationships among themes. Then, we held group discussions focusing on whether to merge, divide themes and sub-themes, and assign appropriate names at the right level of granularity abstraction.

3.3.6. Producing the report

The *final stage* of the thematic analysis framework focused on providing cohesive, succinct, rational, and non-repetitive themes with sufficient data extracts to demonstrate the story of the data.

4. Findings: acceptance and rejection factors of digital wellbeing tools

In this section, we present a synthesis of acceptance factors (Section 4.1) and rejection factors (Section 4.2) towards both studied applications. In the supplementary material attached to this paper, we list the results that we obtained from analyzing the two applications together with supporting quotes from users' reviews. Some of the acceptance and rejection factors were found in only one of the two applications studied, while others were found in both. In Ref. [14], Davis suggests a scale to measure both perceived usefulness and perceived ease of use. The perceived usefulness is measured through the items of *Work More Quickly (WmQ)*, *Job Performance (JP)*, *Increased Productivity (IP)*, *Effectiveness (E)*, *Makes Job Easier (MjE)*, *and Useful in General (UiG)*. The perceived ease of use is measured through the items *Easy to Learn (EtL)*, *Controllable (C)*, *Clear & Understandable (C&U)*, *Flexible (F), Easy to Become Skillful (EtS)*, *Easy to Use in general (EiG)*. In Table 1 and Table 2, we list our discovered acceptance and rejection factors and how they map to TAM two dimensions of Perceived Ease of Use (PEU) and Perceived Usefulness (PU) and their items. When doing so, we assume the main goal for these applications is to enable users be conscious of

Table 1
Acceptance factors and their alignment to TAM and the two apps.

Main themes	Subthemes	Categories	Supported dimensions	Supported items	Application
Functionality	Usage awareness	Reminding	PU	MjE, E	SPACE & GDW
		Usage tracking	PU	UiG, JP	SPACE & GDW
		Notifications	PU	MjE, JP	SPACE
		Progress tracking	PU	UiG, E	SPACE & GDW
		Charts & visualization	PEU	C&U	SPACE
		Constant feedback	PU	MjE, JP	SPACE
		Sensory stimulus reduction	PU	E	SPACE & GDW
	Control	Goal setting	PU	IP	SPACE
		Power of choice	PU	E, JP	SPACE
		Positive reinforcement	PU	UiG, JP	SPACE
	Motivation	Battery efficiency	PU	UiG, E	GDW
		Healthy lifestyle	PU	E	GDW
		Time management	PU	IP	GDW
User experience	Behavioral Change	Limiting unconscious and passive usage	PU	E	SPACE & GDW
		Unlocking frequency	PU	E, JP	SPACE
		Deleting applications	PU	E, WmE	SPACE
		Planning	PU	UiG, MjE	SPACE & GDW
		Screen time reduction	PU	E	SPACE & GDW
	Language	Friendliness	PEU	EiG	SPACE
		Non-intrusive	PEU	C, F	SPACE
	Usability	Easy to use	PEU	EiG	SPACE & GDW
		Appealing layout	PEU	C&U	SPACE & GDW
		Personalization	PU	WmQ	SPACE
			PEU	EiG	
		Disabling applications	PU	WmQ, MjE	GDW
		Customization	PEU	C	GDW

Table 2
Rejection factors and their alignment to TAM and the two apps.

Main themes	Subthemes	Categories	Affected dimensions	Affected items	Application
Functionality	Control	Lack of Functional Customization	PEU	F	SPACE & GDW
		Autonomy Disruption	PU	WmQ	SPACE & GDW
			PEU	C	
		Primitive Reporting Capabilities	PU	MjE	GDW
			PEU	C&U	
	Unreliability	Perceived Inconsistency	PU	MjE, E	SPACE
		Lack of Fault-tolerance	PEU	F	GDW
		Task Flow Disruption	PEU	C	SPACE & GDW
		Inaccuracy	PU	E	SPACE & GDW
	Performance	Interference with other functionalities	PEU	C	SPACE & GDW
		Discrepancies between expectation and actual use	PU	E	GDW
Usefulness	Desensitization	Repetitive Reminders	PU	E	SPACE
		Lack of Personalization	PU	WmQ	SPACE
			PEU	F	
	Behavioral Change	Practical Acceptability	PU	UiG	GDW
		Outcomes Imperceptibility	PU	E, UiG	GDW
Transparency	Trustworthiness	Privilege Escalation	PEU	C	GDW
		Unauthorized Access	PEU	C	SPACE
	User consent	N/A	PEU	C	GDW

their own usage and also enable them to have a sense of control over it.

4.1. Digital wellbeing tools: user acceptance factors

Fig. 1 shows a summary of the user acceptance factors of the two analyzed applications. We grouped the acceptance factors into main themes, sub-themes, and categories.

4.1.1. Functionality - usage awareness

Providing users with means to increase awareness of behavioral patterns, e.g. usage measurement, is likely to influence technology adoption. Enhancing users' awareness of actual usage, performance, and potential risks can be seen as a proximal variable and major determinant to distal outcomes, e.g. adopting digital wellbeing to change behaviors. The overall impression of the wide range of functionalities provided by SPACE and GDW applications was positive. The SPACE application provided reminders *"… prompts I set to remind myself if I have been on for* 15 min", usage tracking, "*It tracks the usage time perfectly and pushes you to decrease that gradually*", notifications, "*I like that it tells me to get off of my phone and how long I've been on it*", progress tracking, "*The best part is you can track your progress over the time*". Also, chart and visualization of actual usage can help to increase Perceived Ease of Use and consequently increase the intention to use digital wellbeing tools. A user commented on SPACE as being "*Very helpful to visualize how much time I really spend on my phone … helped me reduce the time I spend on it!*". Additionally, the prominent home screen widget gives constant feedback of unlocks and usage time which improves perceived ease of use. However, the difference in age and personality might have an influence on users' acceptance of some functionalities. For example, peer comparison may appeal and profiling may appeal less to different users and even appear as a distraction from the main functionality [18].

Self-awareness has been identified as a key element of effectiveness. Increasing awareness enables the likelihood of behavior change [60]. The research on self-regulation concluded six components to increase systems effectiveness; goal-setting, self-monitoring, feedback, self-reward, self-instruction, and social support [61,62]. Similar to the

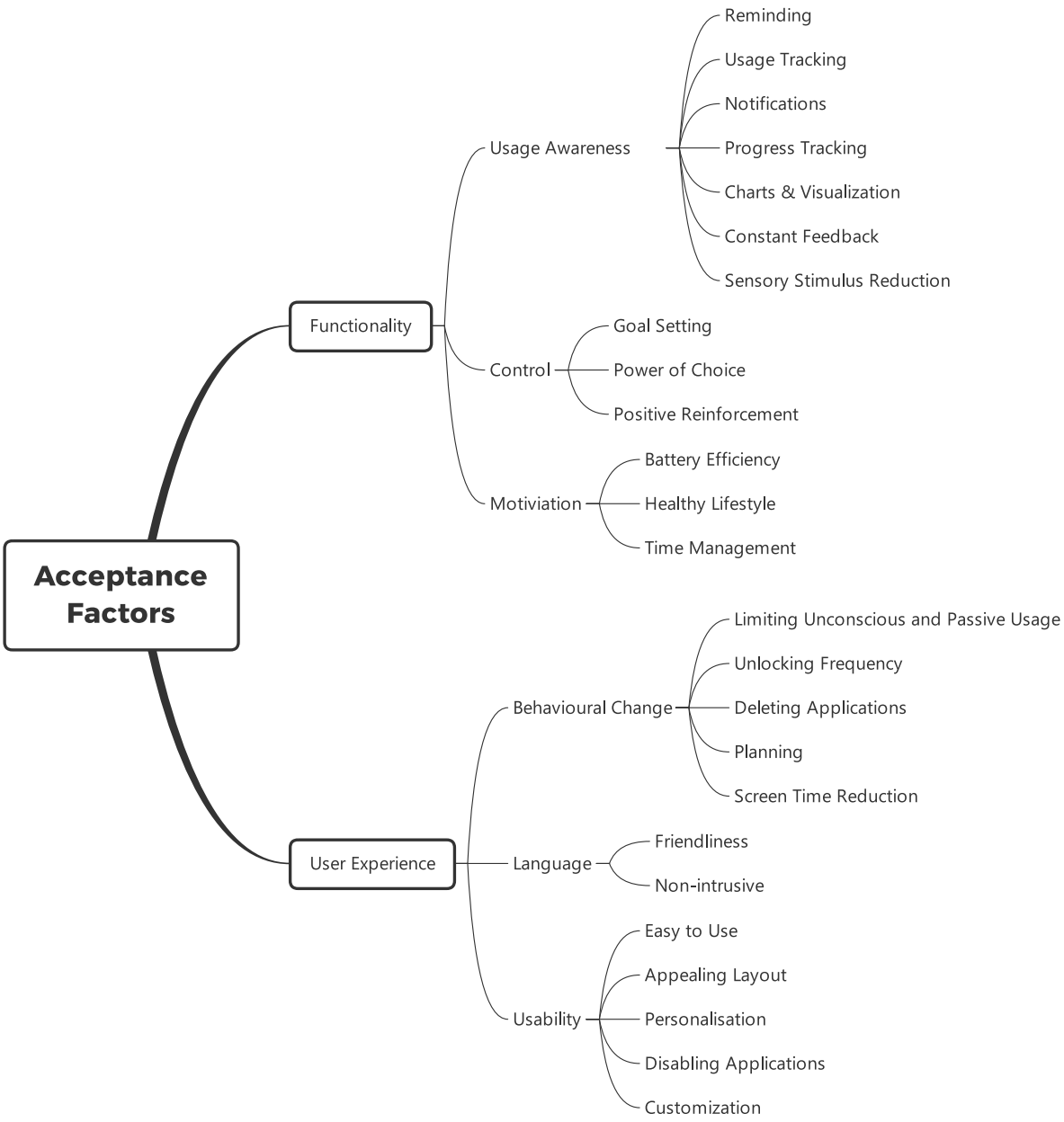

Fig. 1. Users' acceptance factors of the reviewed digital wellbeing tools.

SPACE application, tracking usage time was the predominant method to increase users' awareness in GDW application. Users accepted the application due to the functionalities provided to calculate the time spent on the mobile device, i.e. Perceived Usefulness "*this is a great way of seeing how much you use your phone*". This is in addition to the Gray-scale mode, which acts as a sensory stimulus reduction via preventing visual overstimulation to serve as a nudging reminder to reduce usage, "*I love the greyscale feature! It helps me to be less addicted to my phone and use it more for functionality*".

The analyzed reviews of both applications show that improving self-awareness seems an important acceptance factor in digital wellbeing technology. This is in line with the research that associates perceived risk with technology acceptance [63]. In other words, self-awareness reduces the discrepancies between users' perception of their usage and actual performance. The existence of such discrepancies entails financial, psychological, physical, or social loss. Hence, wellbeing technology should work on reducing that gap to increase the attitude of users towards using this new technology, according to TAM [64].

4.1.2. Functionality – control

It was considered essential to empower users with skills, knowledge, and most importantly, a sense of control via goal setting "*I set a goal to reduce time … now understand what usage I don't need to cut and what I want to cut down on*", and giving them the power of choice "*… gives me the choice regarding what to do about it and when*", and applying Nudge theory, which is a positive reinforcement technique, only when needed "*Nice nudging toward the phone-usage behavior you aspire to decrease phone usage*". These strategies relate two basic human needs; autonomy and competence according to the self-determination theory [46]. These factors play a role in increasing Perceived Usefulness (PU) construct according to the TAM. PU can be defined as the extent to which task performance will be improved due to the use of specific technology [64].

4.1.3. Functionality – motivation

Finally, both applications provided functionalities to increase motivation mainly through showing the benefits obtained in terms of battery efficiency "*saves me from overusing my phone hence saving my battery life*",

healthy lifestyle, "*this application brought me back to my sense and helped me to sleep more*" and time management, "*An effective self-management and discipline tool!*". When users perceived the usefulness of the application, they are more likely to rely on that application to change their behavior. This can be associated with effort expectancy introduced by the Unified Theory of Acceptance and Use of Technology (UTAUT) model [65], which is an extension to the TAM model. Effort expectancy refers to the degree to which a user believes that technology helps to improve performance [66].

4.1.4. User experience – behavioral change

Providing objective data and measures to inform users about their behavioral change performance seems to be an important acceptance factor in digital wellbeing tools. According to the reviews, the SPACE application helped users to regulate their usage in a more quantifiable form. For example, some users reported that their scrolling frequency, after the use of SPACE, has dropped significantly, which helped to limit unconscious and passive usage "*think about my habits and intentions and I seriously haven't scrolled aimlessly for almost two weeks!*". Others reported reducing smartphone unlocking frequency "*in the first day SPACE helped me unlock my phone less. It's already working*" and deleting applications "*Decided to delete some social media applications after realising how much time I spent on my phone*". Some users highlighted the positive role of the planning aspect on decreasing time spent on-screen time, "*Really helped me plan and reduce my mobile usage to bare minimum …*". GDW application has also helped users to regulate their usage in terms of their screen time, "*I am able to immediately reduce my screen time down to about 3.5 to 4 h a day*".

4.1.5. User experience – language

Another aspect that seems important in self-regulation systems is the use of language in terms of feedback format, timing, and method of delivery. The comments on the SPACE application showed that users accepted the language of the application due to having humor which reflect friendliness, "*I like the humorous reminders*", and non-intrusive, "*feels friendly, not judgy, so I enjoy opening it every day … It isn't annoying or pushy, but it is persistent*". In digital wellbeing technology research, there is a growing interest in studying the role of careful implementation of feedback in enhancing the attitude towards adopting this technology [67].

4.1.6. User experience - usability

The reviews on both applications showed that usability can also play an important role to increase application adoption. Comments on the SPACE application described the interface as being easy to use, "*It is simple, easy to use application … helping me cut down on my mobile usage tremendously*", and having an appealing layout, "*Great UX on onboarding and data display is cool … The UI is clean and nice … beautiful layout and useful information*". It had, also, an element of personalization, "*Very helpful and kind and I like how much I can personalize it … Also feels personal with the little rewards galaxy items you get every day*". This is also applied to GDW. A user commented: "*I love how I can set timers to disable applications*". The UX factor has also manifested itself in users' perception towards the customization of notification setting, "*it gives you a notification a few minutes before it closes the applications that you have set in a time limit*". The quality of optimizing usability aspects contributes to giving the user a sense of control on the application still without compromising the goals of the application of aiding limit-setting and adherence to these limits.

4.2. Digital wellbeing tools: user rejection factors

It has been argued that technology rejection is a distinct phenomenon from technology adoption [68]. This means that understanding acceptance does not automatically mean knowing why rejection happens. While there is an overlap between the factors of both, technology adoption may employ an understanding of technology 'nonuse', but it could fail to reveal the causes behind deliberate rejection [69]. Hence, this section will look at individual rejection factors that could hinder sociotechnical transitions towards digital wellbeing technology. The analysis of the reviews on both applications indicated that any negative impact on Perceived Usefulness seems to be determinant for rejecting digital wellbeing technology. Fig. 2 summarizes the rejection factors that emerged from our analyzed users' feedback. The rejection factors have been grouped into themes, subthemes, and categories in Fig. 2.

4.2.1. Functionality – control

Our reviewed digital wellbeing applications enable users to make selections according to their priorities and needs in order to entice usage. The lack of functionality customization can lead to technology rejection. For example, GDW was described as being inflexible, "*change the application-timer reset to your own preference … instead of midnight*" as it seems the user day and lifestyle follow a different pattern. Fostering user control and enabling self-tailoring of the mediated environment through explicit users' inputs might be a potential approach to achieve perceived control.

Customization may include '*what*' and '*when*' data is being logged (i.e. activity- and time-based). For instance, users highlighted that GDW was very restrictive, "*I couldn't implement certain application limits depending on the day of the week*". The SPACE application exhibits similar issues where users believed that the application would be "*more useful if I had more control over what activity was being logged*". Hence, logging the activity may entail what content is being consumed (i.e. content-based). The lack of customizability to allow users altering their experience as they see appropriate can lead to technology rejection. Therefore, customization can be extended to enrich users experience by considering the actual task being performed. This may incorporate situational factors, such as software functionalities users interacted with, and content consumed, enhanced with spatiotemporal analysis and social context (i.e. contextual-based logging).

Disrupting users' autonomy may also discourage engagement with digital wellbeing tools. The literature on ubiquitous computing pointed out the need for studying the trade-offs between control (e.g. via customization) and autonomy [70]. Limiting users' interventions with the operating conditions of the application may support user and application autonomy which is one of the objectives of assistive technologies. However, this may increase anxiety and discomfort since users have less control [71]. On the contrary, maximizing user control will eventually decrease autonomy and increase cognitive load. Achieving the right balance is a design and personalization challenge.

Similar issues have been highlighted in the SPACE application. For example, some users do not want the application to calculate time usage that is associated with work-related duties, *"would be super to be able to disable it from tracking calls …*", and others want to have the option to disable applications at particular times (i.e. opt them out of monitoring) "*block certain applications at specific times of the day or week*", "*if you could set times of the day … I really want to stay off it during work times, but I care how much I use it at home*".

These findings are in line with that suggested in Ref. [69] where flexibility is a fundamental operational aspect of any technology. This requires further research to explore the operational Definition of flexibility from the perspective of digital wellbeing users to account for the balance between autonomy and control.

Users also highlighted that GDW and SPACE provided less control over reporting functionalities. For instance, GDW was criticized for providing primitive reporting capabilities and less control over how to manage usage reports, "*a weekly/monthly report of my average screen time, application usage time, unlocks, and notifications*", where no functionalities to export these data "*Please add an option to export my data …*".

4.2.2. Functionality – unreliability

The unreliability was a major reason for annoyance and frustration

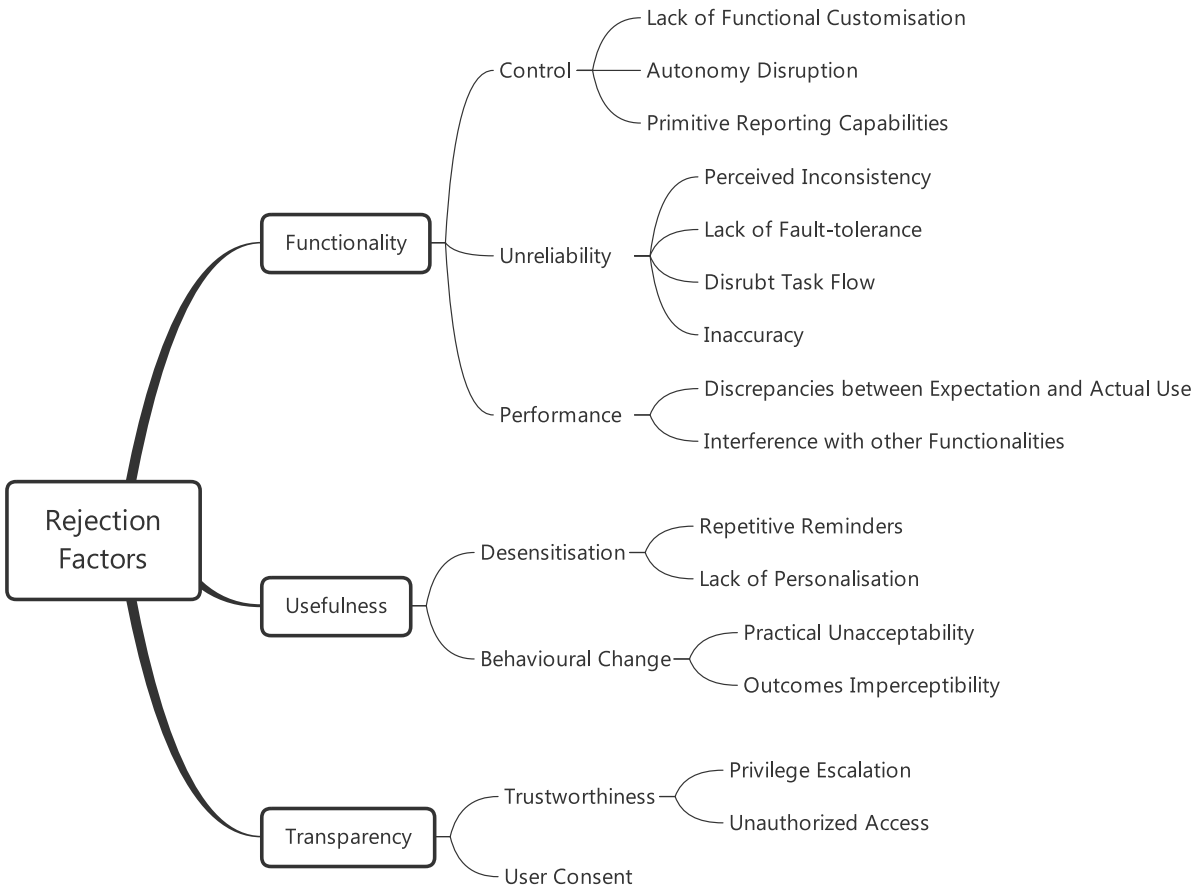

Fig. 2. Users' rejection factors of the reviewed digital wellbeing tools.

among users in both applications. This can be attributed to the set of permissions that can be granted to smartphone applications with regard to accessing data, sending notifications and changing settings, e.g. colour schemes and the like. Some errors can be related to the smartphone model and compatibility issues beyond the control of the developers of the applications. Users' perceived consistency with their past experience, values, needs and even existing technologies can have an impact on technology acceptance.

For example, on the SPACE application, many users found the pause mode less predictable. Pause mode is when the user chooses to pause the SPACE application from monitoring usage, "*often when I pause to use my phone for work it somehow unpauses and registers time anyway … unpauses itself*", and often applications that were whitelisted were being calculated by the time tracker, "*even with 'pause' and with my workout application in the whitelist, I went over my daily allowance while working out*". Whitelisted applications are the applications that the user choose to exclude from being monitored, and this means their usage is not calculated as a usage time e.g. accessing the calendar, clock, to-do list, etc. Also, the notification blocker was inconsistent, and this was in "*annoying and dangerous is when I am driving and using Google Maps to navigate, and this application pops up*". Notification blocker or Mute is a feature that allows the user to disable specific apps from notifying them with updates (e.g. Twitter notification). Ideally, these three functionalities are seamlessly cooperated to support users' utilization of their mobiles and minimize disrupting their tasks flow to encourage technology adoption.

Moreover, progress incentive mistakes seem to be of high importance to the users, "*I cannot view past data on the application … this happened multiple times …*", "*This application lacks daily progress tracking. It would be helpful to see when I use my phone throughout the day, so I would know when to minimize usage*".

The SPACE application was, also, rejected by some users because of the inaccuracy of the time tracker, "*doesn't count the time, which makes it almost useless*" and the unlock frequency "*The number of times it suggested I had unlocked my phone was incorrect two days running so I removed the application*".

We can observe that due to the recentness of such applications, a range of technical factors is yet to be considered, mainly towards better integration of their permissions and functionalities with those offered by the operating systems and phone manufacturers. Ideally, any application would require a high degree of dependability to account for reliability issues. Unfortunately, not all errors are preventable. Assistive technologies are prone to these issues as they operate based on inputs coming from other sources (e.g. sensors, operating systems and even other applications) and, in some cases, are supposed to take control of other aspects of the smartphone. For example, a user highlighted that GDW was "*catastrophic for first generations of Pixel phones as it causes the System UI to crash when answering phone calls*". Therefore, fault-tolerance (reactive) and fault-intolerance (proactive via prior elimination of the causes) are complementary approaches to account for such problems via execution handling to increase the reliability of digital wellbeing applications.

4.2.3. Performance – performance expectancy

Expectation can be seen as a central premise in human sense-making shaped by prior experience or assumptions to perform an action, such as the case of the notification blocker highlighted in the previous section. In GDW, some functionalities fail to perform as expected, for example, disabling applications, "*wind down, it still alerts me for calls from WhatsApp, Skype etc.*". There was also interference with the main device features "*this application keeps locking up my phone calls*", such as the timer, "*my main problem is that the timer doesn't come back to zero at*

midnight". Discrepancies between actual use and expectation stem from an implicit service promise made by developers can lead to technology rejection. Hence, to increase perceived usefulness, trustworthiness in executing required functions under all situations must be treated as a first-class quality attribute.

4.2.4. Usefulness – desensitization

Desensitization is the diminishing of emotional responsiveness to a stimulus after repeated exposure to it. The desensitization to the repetitive reminders also played a role in rejecting the SPACE application, "*convincing the user to put down the phone as it always repeats the same set of reasonings … There's not enough variety in the pop-ups so after a few days dismissing them becomes automatic*". The users want the messages to be more personalized "*The notification to spend less time on the phone … can it be more personalized*".

4.2.5. Usefulness – behavioral change

The GDW application was rejected by some users, as they feel such applications have little impact on their behavior change, and they are skeptical about the change that the application is trying to achieve. This is in terms of the practical acceptance of some users, "*I'm very skeptical of the idea that using my phone excessively harms my wellbeing*" and the outcomes imperceptibility (i.e. the degree to which the results of the technology usage are visible to users, e.g. usage reduction) *"has little or no impact on one digital habit*". The UTAUT model [65] looked at the attribution of technology acceptance to the notion of Task-Technology Fit (TTF). TTF can affect performance expectancy and the initial trust, which in turn impact technology adoption. The 'task' in this context refers to the measures taken by users to regulate usage with the aid of a particular technology. We observe that a successful digital wellbeing technology need fulfils user's expectation of the usefulness and fitness of this technology to help users achieve their goals. Poor management of this cognitive notion can lead to technology rejection.

Also, Nielsen [72] attributed technology adoption to social acceptability (i.e. subjective norms), which include a wide range of factors may emerge from new assistive technologies. These factors include, for example, ethical implications, social tensions, and astigmatism. The concern of behavior change, made by some users, corresponds to Ref. [73] findings. In their study, a wide range of lifestyle behavior applications were selected for their impact on health: which included smoking, alcohol use, physical activity, nutrition, and mental wellbeing. The wide variety of apps included in this study and the limited number of behavior change techniques found that many applications suggest an opportunity for improvement in app design that will promote sustained and significant lifestyle behavior change and therefore, better health.

4.2.6. Transparency – trustworthiness

Trustworthiness can also play a role in the adoption and rejection of digital wellbeing applications. For example, the automatic installation which reflects undesirable privilege escalation can lead to technology rejection. The issues appear in GDW and not in SPACE as GDW comes with an Android operating system and people perceive they are forced to have it. One user commented, "*This app comes preinstalled on my Pixel 3 XL, the main reason why I purchased this phone was the ability to uninstall any unwanted app that doesn't affect the overall phone performance or function*". The same user felt that such digital wellness care was imposed on them and they were left without a choice, "*The Wellbeing app is a great idea but I don't much care for it. I deleted the updates, cache, data, and try uninstalling it. But it just there taking space afterwards. If I am not careful, "update all apps" on the Play Store will also update Digital Wellbeing. Annoying. Extremely annoying*". It seems that users wanted both the freedom of choice and transparency why they should have the service as well as why updates are made to it. Such transparency is typically associated with the perception of trust and trustworthiness of the service.

In digital mediums, data generated, transmitted, and collected become potential for surveillance. In fact, other rejection factors, e.g. the failure to *whitelisting* applications, which aid users to opt-out a particular application from being accessed and monitored, may trigger some trust concerns and raise the question about the intention behind unauthorized access to applications data. Users may view data captured through digital wellbeing applications as not merely a set of characters, but actually seen in the context of usage where intentions and goals can be, to a certain extent, made explicit.

4.2.7. Transparency – user consent

Users' behaviors can be influenced by their trust in the source of the application in digital wellbeing technology. This was in terms of who owns that data (i.e. data ownership) "*It is quite probably intrusive as hell and never informed about the data collected*".

5. Discussion

The results show that the functionalities embedded in the two digital wellbeing applications mainly focused on promoting awareness of digital usage. The interpretation of the users' comments suggests that enhancing self-awareness to be more mindful of self-responses can enable positive behavioral change providing that technology takes into consideration the factors highlighted in the results section.

Users reported increased awareness and behavior change through the functions of reflection for self-awareness, reinforcements by self-tracking, cues to action, e.g. reminders, motivation and skills effects, and behavioral activation states. This has been supported in other health domains such as the study conducted in Ref. [74] to assess the effectiveness of smartphone group intervention applications enhanced by self-monitoring capabilities to support people living with HIV. It also became evident that users found gamification elements, e.g. the feedback and goals, useful both as motivation and awareness technique. Education is still lacking in both apps and gamification can be used in that to make it more engaging [75,76].

The functionalities in the reviewed applications provided users with a sense of control over the usage. The Theory of Planned Behaviour [13] described that having perceived behavioral control as well as a positive attitude towards behavior change can lead to positive behavior intention. For example, the SPACE application had a goal-setting feature to enable users to compare current performance against their goals. This, in turn, helps to reduce discrepancies and increases self-efficacy (perceived capabilities for learning or performing actions at given levels) within the particular behavior and ensure sustained motivation as suggested by Ref. [51]. Both SPACE and GDW utilized the nudge theory by providing choices and notification updates as reminders, which are fully controlled by users. A nudge can be defined as a positive reinforcement approach that focuses on the altering of an individual's context to ensure that cognitive processes are triggered to favor the targeted outcome [77]. Typically, 'nudges' motivate people to consciously consider the options when making decisions and therefore persuasive interventions are not included in the process of this technique. Consequently, the validation of the nudging technique is the element of choice is preserved, as opposed to regulatory demands.

The UX factors have played an important role in influencing how users interact with their smartphones. In the SPACE application, for instance, the visualization helped users to get insights, priorities actions, and change their behavior. Rennie et al. [78] supports this and found increased and stronger intention to change behavior when an informational health message was combined with visualization in a first-person perspective, of engagement of a health act. The beneficial effect of visualization, and the first-person perspective, on intentions was enhanced by increased perceived self-efficacy and action planning. The SPACE application provides visual engagements to help individuals achieve their goals when combined with helpful reminders. Although some people may develop an intention to change health behavior, real action might not be taken. This inconsistency has been labelled the

"intention-behavior gap". To mediate behavior and intentions, detailed action plans and perceived self-efficacy with the task to hand can increase behavior change [79]. This is supported by Ref. [80] who found forming an' if-then' plan improved target detection and led to reductions in cigarette smoking as it promoted planning and to foster effective goal settings.

In both applications, users stated they liked the simple design and its ease of use. The simplicity of the design is important for the users' experience as [81] explained that effective persuasive technologies can enhance ability and motivation if the use of technology were made simple and intuitive. This is in line with the TAM [14] where the external variables of a technology (i.e. system design characteristics) feed into whether the individual perceives the technology as useful and easy to use or not. If this is positive, it is more likely that the attitude to use digital wellbeing application is positive and thus leading to positive behavioral intention and active use of the information technology.

Major rejection factors in both applications were the limited control given to users over the functionality and overlooking different motivations levels of when, where and how much smartphones devices are used. Negatively impacting perceived usefulness according to the TAM [14] can have a profound influence on the attitude towards rejection of wellbeing technology and whether the user will intend to use it in the correct manner or not. Therefore, identifying personalization and control mechanisms over what is even displayed on the application can serve as important mediating variables to achieve digital wellbeing.

The unreliability of some of the functionalities led to a significant negative impact on the users' attitude towards the analyzed applications and their perceived ease of use and usefulness which is also supported by Ref. [14]. The SPACE application was rejected by some users based on desensitization to the reminders. This led to perceiving the reminder functionality as an intrusive and non-effective nudging mechanism and negatively influenced their acceptance. The emotional responsiveness to a negative, aversive or positive stimulus after repeated exposure to it, i.e. reminders in our case, has diminished. Having no new messages and lacking personalization can lead to losing interest and failing to change the behavior and attitude towards the application.

Imposing the digital wellbeing tools on users was an important rejection factor and led to reactance. For example, the automatic installation of GDW and data collected was a cause of rejection both for limiting the freedom of choice, which led to the uncertainty of the purpose for which data were being collected from them. Burgess [82] states that it is integral to preserve the customer's choice and provide the customer with options without unsatisfactory demand. This power of having a choice helps a positive attitude towards an application and shall increase the intention of use. A compromise between giving users a choice and keeping the interventions effective through these applications is a challenge to address. We also note here that advanced stages of problematic behaviors require a more substantial intervention, such as motivational interviewing, cognitive behavior therapy [34] and, hence, more advanced version of mobile and digital health to facilitate them. The use of digital wellbeing applications in their current forms may lead to reactance, i.e. when users react negatively to the intervention when their freedom of choice is compromised [83]. For example, some users perceived GDW negatively when it was automatically installed with their phones. Similarly, they rejected reminders and weekly reports when they had no control over them.

It is worth noting that the two applications share core functionalities, e.g. limit setting, focusing by muting notification, time and frequency awareness, periodic reports and bedtime mode. Still, there are differences in the way these features are implemented. For example, the limit setting in GDW allows timing at both the app and screen levels while it is only at the phone level in the case of SPACE. They also have some differences in the set of features they implement, e.g. the ability to exclude apps from being counted in screentime in SPACE. This is supposed to allow users to exclude time they spend on apps like Maps and other utilities. One fundamental difference between the two applications relates to the fact that DGW is installed by default as part of Android default apps. Being native to the operating system made it technically more robust. The comments about technical errors were found in SPACE more while those related to freedom of choice were primarily found in DGW. These differences made it difficult to make a comparison between the two applications in terms of overall acceptance and rejection as users reviews are typically tied to the features the applications offer. User rating could have been used to asses the overall acceptance and rejection of each of the apps. However, as GDW is offered by Android, while SPACE is an independent app, we chose not to take the rating as a primary measure as we noted most the negative rating in he case of SPACE came from the technical errors where compatibility with Android and phone model are the underlying issues.

We recognise the possible role of personal and social context in the acceptance and rejection factors. For example, demographics may play a role in whether the peer-comparison feature would be accepted or rejected by some users. Culture can also be a factor to decide whether users would like the application to take control and be autonomous in suggesting targets and enforcing limits [84]. Our data did not include the demographics of users as users profiles are protected by the review platform. Our future work will consider studying such differences, possibly through surveying the users, collecting their demographics and measuring the relevance and importance of each of our findings to them.

6. Conclusion

Digital wellbeing applications are a type of assistive technology that utilizes usage data to promote awareness, empower users and increase efficiency. In this paper, we provide a review of the design of this emerging technology and present acceptance and rejection factors deduced from users' feedback on a sample of two popular applications. We analyzed the reviews through the lenses of behavioral change theories and models. The paper also sheds light on the needs to understand users' perspectives towards the design requirements and identifies opportunities and challenges. We report on different drivers for users' adoption inferred from their feedback. These factors help to understand the users' experience and attitude towards this type of technology.

The findings showed that acceptance of wellbeing applications is positively influenced by the implementations of usage awareness functionalities, such as reminders, usage tracker, notifications, progress tracker and visual representations. To provide an enhanced user experience, these features need to be designed carefully taking into consideration an adequate application of nudging theory, the use of non-intrusive language, enabling users to have control over the behaviors of the applications, supporting autonomy, and offering tangible outcomes in a form of visualized statistics supported by simplified user interface design.

While these applications have become an integral part of some users' everyday lives regardless of design flaws, others' responses vary from concerns about their intention, intrusiveness which has led and complete rejection due to questioning the principle of benevolence, especially when they come pre-installed with the phone. The reviews indicated that limiting perceived control can be a determinant for user's rejection which can be illustrated in the absence of customization and personalization. Other issues stem from the imbalance between offering controlled user experience and user autonomy. Examples of controlling user experience include customizing the interfaces, re-structuring complex interactions to a step-by-step process. It also includes designing the interface components to be explorable and encouraging users to try things and making consequences of errors less severe. Autonomy, on the other hand, is about supporting self-governing operation conditions to minimize users' intervention, which is an important principle in the design of assistive technology. Thus, the results indicate that offering the optimal amount of both and achieving that balance are challenges to address.

A wide spectrum of issues are rooted in unreliability, performance,

and transparency for further determinants of user rejection. These issues include, for example, erroneous tracking aggravated by the lack of fault-tolerance, perceived inconsistency, discrepancies between expectation and actual use, and data ownership implications. It should be noted that the unreliability issues which appeared resulted from the restrictions iOS and Android impose. As such, we conclude that software designs are not yet digital-wellbeing-native. Also, in digital wellbeing applications, the element of choice must be preserved. This may increase the positive attitude towards the application and increase the intention to reduce the time spent on the device. Failing to influence the behavior or at least trigger it may be the cause of these applications to be questioned by users. For example, the lack of consideration for the desensitization effect and the inability to provide relevant reporting capabilities and outcomes seem to have led to rejection. As conclusion, it appears when designing this family of applications, it is integral to look into different conflicts in preferences in their user set and treat these applications as a behavioral intervention rather than utility software. Inter-disciplinarity in the team of development and testing shall be a primary requirement to cater to the various user experience and functionality requirements as well as to decrease user conflict and create resolution and effectiveness within well-being applications.

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Declaration of competing interest

The authors declare no conflict of interest.

Appendix A. Screenshots of the analyzed digital wellbeing applications

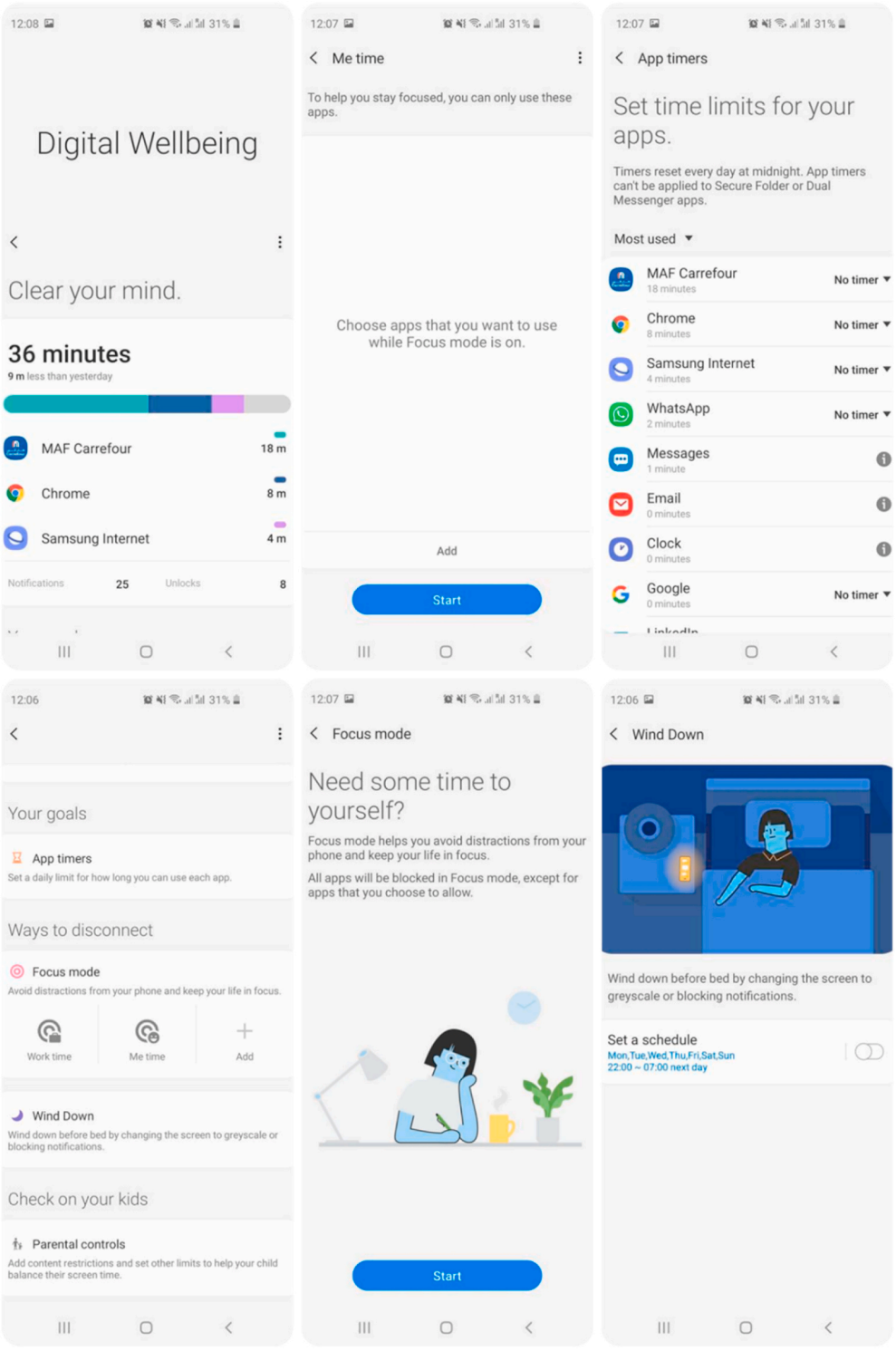

Fig. 3. Sample of GDW application user interfaces at the time of doing this research

Fig. 4. Sample of SPACE application user interfaces at the time of doing this research

Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.techsoc.2021.101778.

References

[1] P. Olla, C. Shimskey, mHealth taxonomy: a literature survey of mobile health applications, Health Technol. 4 (4) (2015) 299–308.
[2] Research2Guidance, mHealth Economics 2017 Report: Status and Trends in Digital Health, R2G. research2guidance, 2017.
[3] A. Brown, S. O'Connor, Mobile health applications for people with dementia: a systematic review and synthesis of qualitative studies, Inf. Health Soc. Care 45 (4) (2020) 343–359, https://doi.org/10.1080/17538157.2020.1728536.
[4] E. Peper, R. Harvey, Digital addiction: increased loneliness, anxiety, and depression, NeuroRegulation 5 (1) (2018) 3–8.
[5] P. Berthon, L. Pitt, C. Campbell, Addictive de-vices: a public policy analysis of sources and solutions to digital addiction, J. Publ. Pol. Market. 38 (4) (2019) 451–468.
[6] M. Ko, S. Choi, S. Yang, J. Lee, U. Lee, FamiLync, in: Facilitating Participatory Parental Mediation of Adolescents' Smartphone Use Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '15, Osaka, Japan, 2015. http://dl.acm.org/citation.cfm?doid=2750858.2804283.
[7] SPACE: Break phone addiction, stay focused - by Mobifolio (https://findyourphonelifebalance.com/).
[8] Google Digital Wellbeing by Google (https://wellbeing.google/for-everyone/).
[9] M. Ko, S. Yang, J. Lee, C. Heizmann, J. Jeong, U. Lee, D. Shin, K. Yatani, J. Song, K.-M. Chung, NUGU: a group-based intervention app for improving self-regulation of limiting smartphone use, Comput. Support. Coop. Work 15 (2015).
[10] A. Hiniker, S. Hong, T. Kohno, J.A. Kientz, MyTime, in: Designing and Evaluating an Intervention for Smartphone Non-use Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose California USA, 2016. https://dl.acm.org/doi/10.1145/2858036.2858403.
[11] M. Ko, S. Choi, K. Yatani, U. Lee, Lock n' LoL, in: Group-based Limiting Assistance App to Mitigate Smartphone Distractions in Group Activities Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose California USA, 2016. https://dl.acm.org/doi/10.1145/2858036.2858568.
[12] S.P. Perez, Apple Unveils a New Set of 'digital Wellness' Features for Better Managing Screen Time, TechCrunch, 2018. https://social.techcrunch.com/2018/

06/04/apple-unveils-a-new-set-of-digital-wellness-features-for-better-managing-screen-time/.
[13] I. Ajzen, The theory of planned behavior, Organ. Behav. Hum. Decis. Process. 50 (2) (1991) 179–211.
[14] F.D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technology, MIS Q. 13 (3) (1989), 319.
[15] K.J. Heffernan, S. Chang, S.T. Maclean, E.T. Callegari, S.M. Garland, N.J. Reavley, G.A. Varigos, J.D. Wark, Guidelines and recommendations for developing interactive eHealth apps for complex messaging in health promotion, JMIR mHealth and uHealth 4 (1) (2016), e14.
[16] S. Leigh, S. Flatt, App-based psychological interventions: friend or foe?: Table, Evid. Base Ment. Health 18 (4) (2015) 97–99.
[17] M. Almalki, K. Gray, F.M. Sanchez, The use of self-quantification systems for personal health information: big data management activities and prospects, Health Inf. Sci. Syst. 3 (2015), https://doi.org/10.1186/2047-2501-3-S1-S1.
[18] A. Alrobai, J. McAlaney, H. Dogan, K. Phalp, R. Ali, Exploring the requirements and design of persuasive intervention technology to combat digital addiction, in: C. Bogdan, J. Gulliksen, S. Sauer, P. Forbrig, M. Winckler, C. Johnson, P. Palanque, R. Bernhaupt, F. Kis (Eds.), Human-Centered and Error-Resilient Systems Development, vol. 9856, Springer International Publishing, 2016, pp. 130–150.
[19] W.A. Rogers, T.L. Mitzner, Envisioning the future for older adults: autonomy, health, well-being, and social connectedness with technology support, Futures 87 (2017) 133–139.
[20] M.E. Morris, B. Adair, E. Ozanne, W. Kurowski, K.J. Miller, A.J. Pearce, N. Santamaria, M. Long, C. Ventura, C.M. Said, Smart technologies to enhance social connectedness in older people who live at home: smart technology and social connectedness, Australas. J. Ageing 33 (3) (2014) 142–152.
[21] T. Donker, K. Petrie, J. Proudfoot, J. Clarke, M.-R. Birch, H. Christensen, Smartphones for smarter delivery of mental health programs: a systematic review, J. Med. Internet Res. 15 (11) (2013), e247.
[22] A. Bullock, R. Dimond, K. Webb, J. Lovatt, W. Hardyman, M. Stacey, How a mobile app supports the learning and practice of newly qualified doctors in the UK: an intervention study, BMC Med. Educ. 15 (1) (2015) 71.
[23] M.P. Gupta, G.P. Sahu, S. Gauri, Assessing impact of mobile communications on organizations: a flexibility analysis, Global J. Flex. Syst. Manag. 6 (3/4) (2005) 11–23.
[24] A. Middelweerd, J.S. Mollee, C.N. van der Wal, J. Brug, S.J. te Velde, Apps to promote physical activity among adults: a review and content analysis, Int. J. Behav. Nutr. Phys. Activ. 11 (1) (2014) 97.
[25] K.N. DiFilippo, W.-H. Huang, J.E. Andrade, K.M. Chapman-Novakofski, The use of mobile apps to improve nutrition outcomes: a systematic literature review, J. Telemed. Telecare 21 (5) (2015) 243–253.
[26] L. Widyanto, M. Griffiths, Internet addiction, in: Psychology and the Internet, Elsevier, 2007, pp. 141–163.
[27] N.G. Carr, in: pbk Norton (Ed.), The shallows: what the Internet is doing to our brains, W.W. Norton, 2011.
[28] A.K. Przybylski, K. Murayama, C.R. DeHaan, V. Gladwell, Motivational, emotional, and behavioral correlates of fear of missing out, Comput. Hum. Behav. 29 (4) (2013) 1841–1848.
[29] A. Alrobai, K. Phalp, R. Ali, Digital addiction: a requirements engineering perspective, in: C. Salinesi, I. van de Weerd (Eds.), Requirements Engineering: Foundation for Software Quality, vol. 8396, Springer International Publishing, 2014, pp. 112–118.
[30] K. Ikeda, K. Nakamura, Association between mobile phone use and depressed mood in Japanese adolescents: a cross-sectional study, Environ. Health Prev. Med. 19 (3) (2014) 187–193, https://doi.org/10.1007/s12199-013-0373-3.
[31] G. Mark, M. Czerwinski, S. Iqbal, P. Johns, Workplace Indicators of Mood: Behavioral and Cognitive Correlates of Mood Among Information Workers, vol. 16, DH, 2016.
[32] É. Duke, C. Montag, Smartphone addiction and beyond: initial insights on an emerging research topic and its relationship to internet addiction, in: C. Montag, M. Reuter (Eds.), Internet Addiction, Springer International Publishing, 2017, pp. 359–372.
[33] S. Thomée, A. Härenstam, M. Hagberg, Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults - a prospective cohort study, BMC Publ. Health 11 (1) (2011) 66, https://doi.org/10.1186/1471-2458-11-66.
[34] K.S. Young, C.N.d. Abreu, Internet addiction, in: K.S. Young, C.N.d. Abreu (Eds.), A Handbook and Guide to Evaluation and Treatment, John Wiley & Sons, 2011.
[35] S.-I. Chiu, The relationship between life stress and smartphone addiction on taiwanese university student: a mediation model of learning self-Efficacy and social self-Efficacy, Comput. Hum. Behav. 34 (2014) 49–57, https://doi.org/10.1016/j.chb.2014.01.024.
[36] R. Ferdous, V. Osmani, O. Mayora, Smartphone app usage as a predictor of perceived stress levels at workplace, in: 9th International Conference on Pervasive Computing Technologies for Healthcare, 2015.
[37] O. Brdiczka, N.M. Su, B. Begole, Using temporal patterns (t-patterns) to derive stress factors of routine tasks, CHI EA 9 (2009).
[38] C. Burr, M. Taddeo, L. Floridi, The ethics of digital well-being: a thematic review, Sci. Eng. Ethic. 26 (2020) 2313–2343, https://doi.org/10.1007/s11948-020-00175-8.
[39] M.D. Alhassan, I. Osman Adam, The Effects of Digital Inclusion and ICT Access on the Quality of Life: A Global Perspective, Technology in Society, 2021, p. 64.
[40] R. Ali, Digital Motivation, Digital Addiction and Responsibility Requirements 1st International Workshop on Affective Computing for Requirements Engineering (AffectRE), 2018.
[41] S. Diefenbach, The potential and challenges of digital well-being interventions: positive technology research and design in light of the bitter-sweet ambivalence of change, Front. Psychol. 9 (2018), 331.
[42] O.A. Adenuga, R.M. Kekwaletswe, A. Coleman, eHealth integration and interoperability issues: towards a solution through enterprise architecture, Health Inf. Sci. Syst. 3 (1) (2015) 1, https://doi.org/10.1186/s13755-015-0009-7.
[43] F. Vannieuwenborg, T. Van der Auwermeulen, J. Van Ooteghem, A. Jacobs, S. Verbugge, D. Colle, Bringing eCare platforms to the market, Inf. Health Soc. Care 42 (3) (2017) 207–231, https://doi.org/10.1080/17538157.2016.1200052.
[44] Google, Digital Wellbeing Experiments | Experiments with Google, 2020.
[45] 2019/05/02/ A. Monge Roffarello, L. De Russis, The race towards digital wellbeing: issues and opportunities, CHI 19 (2019).
[46] E.L. Deci, R.M. Ryan, Self-determination theory, in: Handbook of Theories of Social Psychology, vol. 1, SAGE Publications Ltd, 2012, pp. 416–437.
[47] M. Fiordelli, N. Diviani, P.J. Schulz, Mapping mHealth research: a decade of evolution, J. Med. Internet Res. 15 (5) (2013), e95.
[48] I. Ajzen, M. Fishbein, in: Pbk (Ed.), Understanding attitudes and predicting social behavior, Prentice-Hall, 1980.
[49] H. Taherdoost, A review of technology acceptance and adoption models and theories, Procedia Manuf. 22 (2018) 960–967.
[50] A. Caraban, E. Karapanos, D. Gonçalves, P. Campos, 23 ways to nudge: a review of technology-mediated nudging in human-computer interaction, in: The 2019 CHI Conference, 2019.
[51] D.H. Schunk, Self-Regulation through Goal Setting. ERIC/CASS Digest [Information Analyses—ERIC Information Analysis Products (IAPs) (071); Information Analyses—ERIC Digests (Selected) in Full Text (073);], 2001.
[52] M.E. Cecchinato, J. Rooksby, A. Hiniker, S. Munson, K. Lukoff, L. Ciolfi, A. Thieme, D. Harrison, Designing for Digital Wellbeing: A Research; Practice Agenda, vol. 19, CHI EA, 2019.
[53] M.E. Cecchinato, J. Rooksby, A. Hiniker, S. Munson, K. Lukoff, L. Ciolfi, A. Thieme, D. Harrison (Eds.), Designing for Digital Wellbeing: A Research & Practice Agenda Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, Glasgow Scotland Uk, 2019. https://dl.acm.org/doi/10.1145/3290607.3298998.
[54] M. Schmidmaier, A Perspective On Digital Wellbeing. Designing for Digital Wellbeing, 2018. https://digitalwellbeingworkshop.wordpress.com/position-papers/.
[55] B. Aryana, L. Brewster, J.A. Nocera, Design for mobile mental health: an exploratory review, Health Technol. 9 (4) (2019) 401–424.
[56] A. Alrobai, A. Algashami, H. Dogan, T. Corner, K. Phalp, R. Ali, COPE.er method: combating digital addiction via online peer support groups, Int. J. Environ. Res. Publ. Health 16 (7) (2019), 1162.
[57] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2) (2006) 77–101.
[58] G.S. Hubona, P.H. Cheney, System effectiveness of knowledge-based technology: the relationship of user performance and attitudinal measures, in: Proceedings of the 27th Annual Hawaii International Conference on System Sciences (HICSS-27), 1994, pp. 532–541.
[59] S. Taylor, P.A. Todd, Understanding information technology usage: a test of competing models, Inf. Syst. Res. 6 (2) (1995) 145–176.
[60] G.J. Hollands, T.M. Marteau, P.C. Fletcher, Non-conscious processes in changing health-related behaviour: a conceptual analysis and framework, Health Psychol. Rev. 10 (4) (2016) 381–394.
[61] A. Bandura, Social foundations of thought and action: a social cognitive theory, Prentice-Hall, 1986.
[62] D.H. Schunk, B.J. Zimmerman, Modeling and self-efficacy influences on children's development of self-regulation, in: J. Juvonen, K.R. Wentzel (Eds.), Social Motivation: Understanding Children's School Adjustment, Cambridge University Press, 1996, pp. 154–180.
[63] I. Im, Y. Kim, H.-J. Han, The effects of perceived risk and technology type on users' acceptance of technologies, Inf. Manag. 45 (1) (2008) 1–9, https://doi.org/10.1016/j.im.2007.03.005.
[64] F.D. Davis, User acceptance of information technology: system characteristics, user perceptions and behavioral impacts, Int. J. Man Mach. Stud. 38 (3) (1993) 475–487.
[65] V. Venkatesh, J. Thong, X. Xu, Unified theory of acceptance and use of technology: a synthesis and the road ahead, J. Assoc. Inf. Syst. Online 17 (5) (2016), https://doi.org/10.17705/1jais.00428.
[66] E.L. Slade, M. Williams, Y. Dwivedi, An extension of the UTAUT 2 in a healthcare context, in: UK Academy for Information Systems Conference Proceedings 2013, 2013.
[67] R. Ali, N. Jiang, K. Phalp, S. Muir, J. McAlaney, The emerging requirement for digital addiction labels, in: S.A. Fricker, K. Schneider (Eds.), Requirements Engineering: Foundation for Software Quality, vol. 9013, Springer International Publishing, 2015, pp. 198–213.
[68] H. Gatignon, T.S. Robertson, Technology diffusion: an empirical test of competitive effects, J. Market. 53 (1) (1989) 35–49.
[69] S. Rama Murthy, M. Mani, Discerning rejection of technology, SAGE Open 3 (2) (2013), 215824401348524.
[70] B. Hardian, J. Indulska, K. Henricksen, Balancing autonomy and user control in context-aware systems - a survey, in: Fourth Annual IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOMW'06), 2006.
[71] J.G. M.v. d. Heijden, Ubiquitous computing, user control, and user performance: conceptual model and preliminary experimental design, in: Research Symposium on Emerging Electronic Markets, 2003.
[72] J. Nielsen, in: Nachdr (Ed.), Usability Engineering, Kaufmann, 2010.

[73] F.H. McKay, A. Wright, J. Shill, H. Stephens, M. Uccellini, Using health and well-being apps for behavior change: a systematic search and rating of apps, JMIR mHealth and uHealth 7 (7) (2019), e11926, https://doi.org/10.2196/11926.
[74] D. Swendeman, N. Ramanathan, L. Baetscher, M. Medich, A. Scheffler, W. S. Comulada, D. Estrin, Smartphone self-monitoring to support self-management among people living with HIV: perceived benefits and theory of change from a mixed-methods randomized pilot study, JAIDS J. Acquir. Immune Defic. Syndr. 69 (2015) S80–S91.
[75] C. Dichev, D. Dicheva, G. Angelova, G. Agre, From gamification to gameful design and gameful experience in learning, Cybern. Inf. Technol. 14 (4) (2015) 80–100.
[76] C.-L. Hsu, M.-C. Chen, Advocating recycling and encouraging environmentally friendly habits through gamification: An empirical investigation, Technology in Society, 2021, p. 66.
[77] R.H. Thaler, C.R. Sunstein, Nudge, in: Rev, expanded (Eds.), Improving Decisions about Health, Wealth, and Happiness, Penguin Books, 2009.
[78] L. Rennie, A.K. Uskul, C. Adams, K. Appleton, Visualisation for increasing health intentions: enhanced effects following a health message and when using a first-person perspective, Psychol. Health 29 (2) (2014) 237–252.
[79] F.F. Sniehotta, U. Scholz, R. Schwarzer, Bridging the intention–behaviour gap: planning, self-efficacy, and action control in the adoption and maintenance of physical exercise, Psychol. Health 20 (2) (2005) 143–160.
[80] T.L. Webb, P. Sheeran, A. Luszczynska, Planning to break unwanted habits: habit strength moderates implementation intention effects on behaviour change, Br. J. Soc. Psychol. 48 (3) (2009) 507–523.
[81] B. Fogg (Ed.), A Behavior Model for Persuasive Design Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09, Claremont, California, 2009. http://portal.acm.org/citation.cfm?doid=1541948.1541999.
[82] A. Burgess, 'Nudging' healthy lifestyles: the UK experiments with the behavioural alternative to regulation and the market, Eur. J. Risk Regul. 3 (1) (2012) 3–16.
[83] A. Alrobai, J. McAlaney, K. Phalp, R. Ali, Exploring the risk factors of interactive E-health interventions for digital addiction, Int. J. Sociotechnol. Knowl. Dev. (IJSKD) 8 (2) (2016) 1–15.
[84] J. McAlaney, M. Aldhayan, M.B. Almourad, S. Cham, R. Ali, On the need for cultural sensitivity in digital wellbeing tools and messages: a UK-China comparison, in: World Conference on Information Systems and Technologies, Springer, Cham, 2020, April, pp. 723–733.