Exploring Barriers of Engagement and Influence of Gender on Attitude and Adoption

of DMHI Among Young Adults: A Mixed Method Study

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Abstract

Efforts to address mental health problems in young adults have led to the development of Digital Mental Health Interventions (DMHI). Despite their effectiveness, DMHI lack user engagement and adoption. A deeper understanding of the barriers, attitude, adoption and user specific characteristics, like gender, is necessary to identify their impact on low engagement. This study explored the barriers of engagement and gender differences in the attitude and adoption of DMHI. We employed a mixed methods cross-sectional design combining qualitative and quantitative methods; qualitative research used interviews ($N = 10$), quantitative research used an online survey ($N = 47$). Participants were between the ages 18 and 29, fluent in English, recruited through SONA, WhatsApp, Discord, Reddit, provided informed consent, and allowed for their data to be used in the study. Data was analysed using thematic and statistical analyses.

Thematic analysis unveiled nine themes comprising 19 subthemes. Key factors that impacted engagement and adherence were user personalisation, internal and external motivation, efficacy, time, and support features. No significant gender difference for attitude and adoption of DMHI was found. Both attitude ($M = 53.1$, $SD = 10.6$) and adoption ($M = 31.5$, $SD = 8.5$) were average in the sample (53.2% male, 46.8% female). A significant positive effect was found between attitude and adoption irrespective of gender. A disconnection between DMHI and users was the prominent barrier of engagement, causing beliefs of low efficacy and adherence. DMHI should follow a user-centred design approach to provide configurability for users. This considers the unique dynamic balance of each user, increasing engagement in DMHI. Nonetheless, various other key factors must be also considered to effectively foster engagement.

Keywords: DMHI, young adults, engagement, attitude, adoption, gender, assessment

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of DMHI Among Young Adults: A Mixed Method Study

The concept of a healthy state of mind and by extension mental illness has seen quite the range of opinions and perceptions throughout the decades by both the general public and health care providers alike. This much is clear according to Arboleda-Florez & Stuart (2012), who thoroughly explored the stigmatisation associated with mental illness throughout history. Despite lingering stigma identified by Arboleda-Florez & Stuart (2012), significant progress has been made in recognising, treating and fostering mental well-being. The vital role of mental health in achieving global humanitarian goals has gained recognition and received prioritised attention (World Health Organization, n.d.). This is evident due to international mental health concerns, with a reported 13% increase in unstable mental health conditions and drug abuse between 2007 and 2017 (World Health Organization, n.d.). This has positioned mental health as a public health concern (World Health Organization, 2014, as cited by Bucci et al., 2019) due to an estimated loss of US$ 1 trillion loss in untapped productivity (Mental Health Foundation, 2016, as cited by Bucci et al., 2019). Researchers actively pursued the development of accessible interventions to address this issue. This led to the development of countless new effective interventions. Coventry et al. (2020) conducted a meta-analysis of 116 studies, revealing the effectiveness of various psychological interventions in treating mental health concerns, particularly in individuals affected by severe trauma. Among the vast array of psychological interventions, digital interventions emerged as a particular field of interest.

Digital Mental Health Interventions (DMHI) have received a significant increase in popularity, with more than 10.000 digital applications created to promote mental well-being, as well as approximately 100 new DMHI being introduced each year (Roland et al., 2020). These include health assessments, prevention, support and treatment of various mental health

issues. The rise in DMHI popularity may have been partly caused by the COVID-19 pandemic. According to a study conducted by Sorkin et al. (2021), a significant increase in the use of DMHI was reported during the initial stages of the pandemic, with greater COVID case rates linked to an increased likelihood of using DMHI. The pandemic further highlighted the efficacy DMHI have in mental health care (Roland et al., 2020; Pretorius & Coyle, 2021).

In fact, the literature provides strong evidence supporting the effectiveness of DMHI in mental health care. Lattie et al. (2019) conducted a systematic literature review, demonstrating that a majority of DMHI tested were effective (42,5%) or partially effective (30,3%) in enhancing mental well-being in college students. They continue stating that a constant decrease in mental well-being is currently being reported among college students, and DMHI therefore enhance their mental health, ranging from depression, anxiety and overall well-being (Lattie et al., 2019). Another systematic literature search indicated that digital psychiatry was an effective alternative to non-digital psychiatry treatments, with reliability assessments and treatment results being comparable to those of face-to-face methods (Hubley et al., 2016). Powell et al. (2013) explored the effectiveness of web-based DMHI, and revealed significant improvement in depression and anxiety scores among intervention users compared to the control group. The researchers emphasised the cost-efficiency and potential for scaling up web-based DMHI to enhance mental well-being across the general population (Liverpool et al., 2020). The benefits of a large-scale DMHI implementation also extend beyond the general population; health care professionals are able to utilise these tools to deliver faster mental health care to a wider range of clients (LaMonica et al., 2021). Unfortunately, it seems unlikely that this will happen in the near future.

This is due to the underutilisation of DMHI by the majority of the general population, disrupting their progression (Balcombe & De Leo, 2022). A pilot study conducted by Apolinário-Hagen et al. (2017) revealed a negative attitude towards DMHI in the German

population, with low chances of participants using them in the future when facing mental health issues. Alkhaldi et al. (2016) report a similar statement to that of Balcombe & De Leo (2022), with a lack in user engagement obstructing its true potential. Extensive research studies have examined DMHI user engagement, revealing a variety of factors contributing to higher acceptability, like integrating DMHI with conventional therapy, and ensuring patient record safety (Almourad et al., 2021; Balcombe & De Leo, 2022; Bucci et al., 2019). However, these factors do not account for users' lack of prolonged engagement or abandonment of DMHI (Clough et al., 2022). A deeper examination of the core mechanisms, encompassing theories, and user attitudes of DMHI is necessary to identify potential internal issues. DMHI share several key internal factors that must be considered during development; engagement, usability, intent, acceptability, support and perceived attitude among others (LaMonica et al., 2021; Chang et al., 2012; Portz et al., 2019). It is crucial to consider these factors when developing DMHI to maintain prolonged engagement.

DMHI, like other interventions or products aiming for user engagement, rely on core psychological mechanisms and theories to encourage long-term voluntary interaction (Nahum-Shani et al., 2022). The Theory of Planned Behaviour (TPB) serves as a foundational framework in numerous current DMHI studies, particularly in the realm of mental well-being. Examples of this are studies conducted by Khatib et al. (2022), Adams et al. (2022) and Clough et al. (2022). TPB allows for the identification and change of attitude leading to the desired outcome (Ajzen, 1991). Clough et al. (2022) highlight the importance of prioritising this to study engagement in DMHI research. A negative attitude, expectation or lack of motivation may result in decrease in the intent to use DMHI (Hennemann et al., 2016, as cited by Apolinário-Hagen et al., 2017). Another theory frequently used is the Technology and Acceptance Model (TAM). This model is used to understand user adoption, acceptance and use of technologies (Davis et al., 1989, as cited by Portz et al., 2019). Understanding this

process could lead to an increase in adherence. Psychological theories are crucial in investigating the attitude and subsequent behaviour surrounding DMHI, and help to understand their underutilisation. Interestingly, this process may also be influenced by another factor.

Tailoring DMHI to specific user needs is crucial for sustained engagement. Almourad et al. (2021) identified a lack of personal control and customisation as reasons for user disengagement. Batterham & Calear (2017); Bolinski et al. (2018), as cited by Dederichs et al. (2021), also emphasise the importance of tailoring interventions to user factors. One such factor is gender. Gender differences have been found to play a role in mental health, with apparent differences in depression and anxiety between men and women (Astbury, 2006, as cited by Afifi, 2007) and require gender specific interventions (Afifi, 2007). Gender differences have also been observed in technology adoption. Men's decisions are influenced more by attitude, whilst women's decisions are influenced more by subjective norms and behavioural control (Venkatesh & Morris, 2000). Elburg et al. (2022) report similar findings with health applications, suggesting that perceived usefulness and attitude towards use are more strongly linked to intention for elderly men than women due to their adventurous nature and internet experience. These differences may also be generalisable to the rest of the population, specifically the younger population.

Young adults exhibit a substantial prevalence of mental health issues, such as mental strain, disruptive behaviour, and severe disorders (Auerbach et al., 2018, as cited by Apolinário-Hagen et al., 2021; Liverpool et al., 2020). Approximately 10-20% of children and young adults suffer from mental health issues, with the majority of problems appearing during adolescence (Nobre et al., 2021). On top of this, the desire of these young adults to seek professional help is rather low. Apolinário-Hagen et al. (2021) explain that barriers to take part in conventional face-to-face therapy remain a difficult problem to solve. These

barriers are formed due a to fear of stigmatisation, self-reliance and a feeling of burden (Apolinário-Hagen et al., 2021) that disrupt the possibility of treatment. Therefore, DMHI as self-help and promotional tools to mental health care could lead to positive changes in attitudes and perceptions about mental care, whilst also enhancing their own well-being (Apolinário-Hagen et al., 2021).

Goal of Research and Brief Overview

This research paper proposes the following research question: *"Which Factors Contribute to the Low Engagement of DMHI Among Young Adults, and is their Attitude and Adoption of DMHI Gender-Dependent?"*. To answer this, the study employed a mixed-method cross-sectional design study, utilising both qualitative and quantitative methods. Target group consisted of young adults between 18 and 29 years old. Interviews were used for the qualitative method, whilst an online questionnaire was used for the quantitative method. Following the literature, the TAM and TPB were used for the purposes of this research. Three hypotheses were formulated based on the literature that seeks to further substantiate the proposed research question:

H1

There will be a significant difference between male and female young adults on the adoption of DMHI; adoption for men will depend on attitude, whilst adoption for women will depend more on the subjective norm.

H1 was formulated based on the study findings proposed by Venkatesh & Morris (2000) and proposes a similar outcome with the adoption of DMHI's being dependant on attitude or the subjective norm based on the gender of the user.

H2

A higher positive attitude towards DMHI for male compared to female young adults is expected.

H2 was formulated based on the study findings by van Elburg et al. (2022), who found that positive attitudes for DMHI among elderly men were a stronger predictor for intention to use than elderly women.

H3

A lower adoption rate of DMHI for female compared to male young adults is expected.

H3 was also formulated based on the study findings by van Elburg et al. (2022), who reported that elderly men had a higher intention to use medical applications compared to elderly women.

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Study 1

Methods

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Design

The qualitative part, referred to as Study 1, consisted of interviews and served two functions: gather valuable insight on the barriers people face when using DMHI causing low engagement and using this insight to expand and improve upon the questionnaire. The quantitative, referred to as Study 2, consisted of an online survey and aimed to gather data on DMHI attitude and adoption differences between male and female young adults on a larger sample scale. Informed consent was obtained for both studies. We received ethical approval by the BMS ethics committee of the University of Twente to conduct this research (#230516). Study 1 followed the COREQ checklist (Tong et al., 2007). Study 2 followed the STROBE checklist (Vandenbroucke et al., 2007). See Appendices A1 and A2.

Study 1

Participants

Ten participants took part in the interviews. Six were female and four were male (M_{age} = 21.3, SD_{age} = 1.86). Reported nationalities were: 7 from Germany, 2 from the Netherlands

and 1 from Kyrgyzstan. Reported education levels were: 1, High School, 8 Bachelor, 1 Master. Participants were recruited by means of convenience and snowball sampling via SONA, WhatsApp and Discord. A digital advertisement was made and distributed on these platforms (see Appendix B1).Inclusion criteria were being between 18 and 29 years of age, a proficient understanding of the English language and having had previous experience with a DMHI of any kind.

Materials

The interviews were conducted on Zoom and Microsoft Teams. An interview structure guideline was made with a set of 16 questions with probes included (see Appendix C), serving as a general guideline during interview conduction. Participants were asked to describe what DMHI application they used, the period of and reason for use, opinions on DMHI before and after first-hand experience, and reasons behind disengagement. An example question was *"What did you think about the use of DMHI to help or improve mental well-being, before your experience?"* with the prompt *"Were there any moments where you considered using them before your first experience?"*. The software Otter.ai and Descript were used for transcriptions. A shared Google Drive for the researchers was used to perform thematic analysis.

Procedure

A pilot test was conducted with the initial interview guide, resulting in minor adjustments to improve questions. Participants who expressed interest via WhatsApp and Discord were instructed to email the researchers to schedule an interview. SONA participants signed up and chose a timeslot. Interviews were conducted by the researchers (2 males, 1 female) who were undergraduate students without expert interview training. Participants with a personal relation to a researcher were interviewed by a different team member to avoid bias. Interviews took place online through Zoom or Microsoft Teams and were audio recorded.

Video camera's remained off. Probes were used during the interviews utilising the interview guide to gather more valuable insights. The interviews lasted 25 minutes on average. Audio files were securely stored and transcribed with software. Transcriptions were analysed collectively, identifying codes, themes and subthemes. Frequencies were counted to identify most commonly shared themes. Based on the relevant commonalities, 18 new questions focusing on barriers and disengagement were created and included in the Study 2 survey (see Appendix D).

Data Analysis

A shared Google Drive folder was created for researchers to collectively derive codes from the transcriptions. Each researcher individually examined the transcriptions and established codes inductively based on commonly shared opinions. The transcriptions were further analysed to count code frequencies and identify new relevant codes where deemed necessary through process of deliberation. After, a thematic analysis was conducted where themes and subthemes were established from codes through deliberation. Frequency of subthemes was counted per participant, and participant quotations were gathered for additional insight.

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Results

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Thematic Analysis

Thematic analysis identified patterns and barriers of engagement by analysing personal experiences with DMHI. The subthemes with the highest frequencies were Effective with a frequency of 46, Internal Motivation with a frequency of 45, Ineffective with a frequency of 27, Maximalistic with a frequency of 26 and Personalisation with a frequency of 24. The definitions of themes, subthemes and relevant quotations are described in the paragraph below Table 1. Quotations for the remaining subthemes can be found in Appendix E.

Table 1

Overview of Themes, Subthemes, their Frequencies and Percentages of Mentions

Theme	Subtheme	*n*	%
Features	Minimalistic	10	70
	Maximalistic	26	80
Time	Time Consuming	12	80
	Forced Use	21	80
Monetary Cost	DMHI Cost	19	70
	Cost of Healthcare	4	20
Personalisation		24	80
User Experience (UX)	Positive UX	14	70
	Negative UX	11	70
Effectiveness	Effective	46	100
	Ineffective	27	80
	Neutral	6	40
Motivation	Internal Motivation	45	90
	External Motivation	21	90
Reason to Use	Curiosity	14	80
	Other Motive	15	90
Variety	Diverse Content	9	40
	Repetitive Content	9	30

Note. The frequency of subthemes were counted per individual participant, after which the sum of the total count of subthemes and themes was calculated. The theme 'Personalisation' was found to not require a subtheme. The '%' column reflects the proportion of participants that expressed each individual subtheme in percentages.

Features

The theme *Features* referred to the useful qualities and functionalities that DMHI offered to users, covering ideal functionalities for effective engagement.

Minimalistic. The *Minimalistic* subtheme referred to participants who preferred a rather simplistic DMHI, not wanting too many features or complexities. Participants stated a need to not make the experience too overwhelming.

Maximalistic. The *Maximalistic* subtheme highlighted participants' preference for DMHI with multiple useful functionalities to enhance user experience. One example of this was a system that rewards progression through the application.

Time

  The theme *Time* referred to the time participants spent or prefer to spend on a DMHI.

Time Consuming. The *Time Consuming* subtheme encapsulated participants who found DMHI demanding too much time. Participants expressed a preference for shorter completion task completion times, wanting DMHI to not obstruct their daily schedules.

Forced Use. The *Forced Use* subtheme covered participants that felt forced to engage with DMHI due to its excessive effort requirements, resulting in a less enjoyable user experience. In the words of Participant 7:

> *"And, I think mainly it was because it felt like a chore more than anything you know, because you had to do all these things or, fill out all these questions and to me it started to feel like a chore. It didn't feel like actual help…" [Participant 7]*

Monetary

  The theme *Monetary* referred to monetary costs attached with DMHI, whether it was a subscription service, upfront cost or health care costs to access.

DMHI Cost. The *DMHI Cost* subtheme covered participants who were against paying for DMHI. A payment requirement was seen as a barrier, leading to a quick abandonment of DMHI.

Cost of Health Care. The *Cost of Health Care* subtheme covered participants' reasoning for using DMHI due to the high expenses associated with conventional mental health care. The cost-effectiveness and accessibility of DMHI was appealing to participants.

Personalisation

The theme *Personalisation* encompasses the level of individual tailoring in DMHI that participants demand for a personalised user experience, similar to that of conventional therapy. Participant 4 describes this best:

> *"...most of the times you talk to a psychiatrist or a therapist may the issues people come to those people with are very tailored to the actual person it's coming with and very tied to the background of the person and the life experiences that person has had."* [Participant 4]

User Experience (UX)

The theme *User Experience (UX)* referred to the design and structure of DMHI that either facilitated or hindered usability.

Positive UX. The *Positive UX* subtheme covered participants who found usability of DMHI satisfactory and emphasised the importance of clear, simplistic and an uncluttered structure in DMHI.

Negative UX. The *Negative UX* subtheme covered participants who encountered usability issues with DMHI due to a lack of coherent structure, confusing pathways, and too much clutter. This led to an unpleasant user experience.

Effectiveness

The theme *Effectiveness* referred to the efficacy of DMHI, or the potential efficacy of DMHI in specific situations.

Effective. The *Effective* subtheme covered participants who found DMHI to be effective during their personal experiences, or acknowledged its potential in other areas. Specifically, some viewed DMHI as an initial step into mental health care:

> *"I feel like, it's pushed me to get more therapy later, because that was what the app told me at the end of the day, and that they are not a qualified entity or something like that, then, you know, at the end of the day, I have to seek therapy, lets you tell me that and that was one of the contributing decisions towards me seeking more therapy. So I feel like it did have a small impact on my life, but that was about it." [Participant 2]*

Ineffective. The *Ineffective* subtheme covered participants who perceived DMHI to be ineffective and found no use in them. Participants considered conventional therapy to be superior.

Neutral. The *Neutral* subtheme covered participants who had no pre-determined opinions on DMHI, and were open to try them out.

Motivation

The theme *Motivation* referred to the incentive participants had or required to willingly engage with DMHI. This incentive was identified to either be internal or external.

Internal Motivation. The *Internal Motivation* subtheme covered participants who relied on intrinsic motivation to consistently engage with DMHI long-term. Participant 1 had an interesting case, where despite plenty of extrinsic incentives, still found engagement challenging:

> *"But I have issues with using like mental health apps for longer times in general, which is not really based on the structure of the app, but more about that it's just an app ... I'm just not motivated enough to just get me to actually use them."*
> *[Participant 1]*

External Motivation. The *External Motivation* subtheme covered participants who relied on external incentives provided by DMHI to maintain engagement, such as a user-centred experience, reminders and reward systems.

Reason to Use

The subtheme *Reason to Use* pertained to the initial reasons that led to participants using DMHI.

Used Out of Curiosity. The *Used out of Curiosity* subtheme covered participants who started using DMHI out of curiosity to assess whether it was suitable for their personal needs.

Used Out of Other Motive. The *Used Out of Other Motive* subtheme covered participants who started using DMHI for an circumstantial reasons, such as fulfilling study requirements.

Variety

The subtheme *Variety* represented the participants' desire for greater content diversity and versatility in DMHI, with limited repetitiveness.

Content is Diverse. The *Content is Diverse* subtheme highlighted the desire for a more diverse selection of available information in DMHI, including evidence-based articles, videos and interactive content to enhance engagement.

Repetitiveness. The *Repetitiveness* subtheme highlighted the desire for a reduction in task and question repetition in DMHI. Repetition led to feelings of frustration among participants, hindering engagement.

Study 2

Methods

Participants

Participants were recruited through survey distribution via SONA, WhatsApp, Discord and Reddit using convenience and snowball sampling. Inclusion criteria was being between 18 and 29 years of age and having a basic understanding of the English language.

No further inclusion criterion was necessary. Out of the 81 participants that filled in the survey, 34 were excluded, 21 of which were due to a technical error. A total of 47 participants were eligible for data analysis (M_{age} = 23.23, SD_{age} = 2.68, 53.2% male, 46.8% female, 42.6% German, 14.9% Dutch, 42.5% other). Demographic information includes highest level of education (48.9% high school, 40.4% Bachelor's, 8.5% Master's, 2.2% Doctoral) and current employment status (19.1% employed full-time, 12.8% employed part-time, 42.6% students, 21.3% students + employed part-time, 2.1% unemployed, 2.1% other).

Materials

The survey was developed and distributed online using Qualtrics (see Appendix F). An online advertisement was created for the survey (see Appendix B2). Questions measuring attitude and adoption measurement were created using the TAM and TPB framework. A 5-point Likert scale was used for response coding, ranging from 1 (strongly disagree) to 5 (strongly agree). The TAM measured adoption, with an item score range of 0 – 55. Scores below 18 were low, between 19 – 37 were moderate, and above 38 were high, each interpreting the adoption of DMHI in their lives (low indicates low adoption rate of DMHI). The scale found sufficient internal reliability (α = .89). The TPB measured attitude, with an item score range of 0 – 90. Scores below 30 were low, between 31 – 60 were moderate, and above 61 were high, each interpreting the attitude towards DMHI. Attitude found sufficient internal reliability (α = .87). TPB also measured subjective norm, with an item score range of 0 – 20. Scores below 7 were low, between 8 – 14 were moderate, and above 15 were high, each interpreting the subjective norm towards DMHI. Subjective norm found sufficient internal reliability (α = .72). Further analysis was conducted using statistical software.

Procedure

Participants accessed the Qualtrics survey using the anonymous link on the advertisement on WhatsApp, Discord and Reddit. SONA participants signed up for the study

and received access to the link. The survey took approximately 15 minutes to complete. The survey began with mental health related questions, followed by questions measuring attitude and adoption of DMHI accompanied with a detailed explanation of DMHI. Once finished, participants were greeted with a page thanking them for their participation and the survey was closed. SONA points were automatically credited upon completion using the automated credit feature. The responses were (reverse) coded in Qualtrics after which they were exported into RStudio for further analysis.

Data Analysis

The data in Qualtrics was coded by creating categories for attitude, subjective norm and adoption. The code used for data cleansing and analysis in RStudio is presented in Appendix G. The reverse coded responses in Qualtrics had to also be reverse coded in RStudio to avoid miscalculation of Cronbach's Alpha values. Assumptions of normality indicated outliers for attitude (see Appendix H1), and subjective norm indicating skewed data (see Appendix H2). Due to the nature and importance of participant opinions in this study, outliers were retained. Parametric assumptions were also checked and did not indicate any violations. With the presence of outliers and skewed results in the data however, the following non-parametric tests were used for analysis: Generalised Linear Model (GLM) and the Wilcoxon Rank-sum Test. The GLM, fitted with a linear regression model, examined associations between adoption and attitude/subjective norm, and compared these for males and females. The Wilcoxon Rank-sum Test examined differences for attitude and adoption of DMHI between male and female young adults.

Results

Descriptive statistics were conducted on variables of interest. For each variable, the variance, median, IQR and Cronbach's Alpha was calculated (see Table 2). Furthermore, the

an interpretation was given to the scale range scores (low, moderate or high) as described earlier.

Table 2

General Descriptive Statistics on Variables of Interest

Variable	Variance	Median	IQR	Scale Range	Scale Score	Cronbach's Alpha
Attitude	112.1	55.0	12.0	0 - 90	Moderate	.87
Subjective Norm	10.7	11.0	5.0	0 - 20	Moderate	.72
Adoption	72.1	31.0	21.5	0 - 55	Moderate	.89

Note. A reliability coefficient of .70 or higher was considered to have good internal consistency.

The medians indicated a moderate score on the variables of interest, with the IQR indicating a wide range of variability. Moderate attitude, subjective norm and adoption of DMHI was indicated by respondents. The unequal range sum scales per variable may have been a contributing factor to variable variability.

H1: "*There will be a significant difference between young male and female adults on the adoption of DMHI; adoption for men will depend on attitude, whilst adoption for women will depend more on the subjective norm.*"

A GLM was conducted to investigate differences between male and female young adults in their attitude, subjective norm and how this correlates to their adoption of DMHI. The dependent variable was adoption, with independent variables gender (GD), attitude (AT) and subjective norm (SN) (see Table 3).

Table 3

Output of GLM Exploring Gender Differences in Attitude, Subjective Norm and Adoption

	Estimate	Std. Error	*t*-value	*p*-value
Intercept	-3.169	6.838	-.463	.646
GD (Female)	-2.550	18.692	-.136	.892
AT	.560	.139	4.026	< .001
SN	-.025	.503	-.051	.960
GD (Female) : AT	.105	.328	.318	.752
GD (Female) : SN	-.769	1.904	-.404	.689
AT : SN	.008	.010	.844	.404
GD (Female) : AT : SN	.009	.032	.285	.777

Note. A *p*-value of < 0.05 was used to indicate any significant effects.

The GLM analysis indicated a significant positive effect between attitude and adoption (*b* = .560, SE = .139, *p* < 0.001, 95% Cl [.282, .838]). All other findings were insignificant. Thus, the null hypothesis of H1 is accepted, indicating no significant gender differences in attitude, subjective norm and subsequent DMHI adoption.

H2: "*A higher positive attitude towards DMHI for male compared to female young adults is expected.*"

A Wilcoxon Rank-sum Test was conducted to compare the attitude towards DMHI between males (*N* = 25) and females (*N* = 22). No significant difference was found (*W* = 184.5, *p* = .055) for gender differences in DMHI attitude. Thus, the null hypothesis of H2 is accepted, indicating no significant difference in the attitude towards DMHI for male and female young adults.

H3: "*A lower adoption rate of DMHI for female compared to male young adults is expected.*"

A Wilcoxon Rank-sum Test was conducted to compare the adoption of DMHI between males ($N = 25$) and females ($N = 22$). No significant difference was found ($W = 190$, $p = .071$) for gender differences in DMHI adoption. Thus, the null hypothesis of H3 is accepted, indicating no significant difference in the adoption of DMHI for male and female young adults.

General Discussion

This study explored the engagement barriers and gender differences in the attitude and adoption of DMHI. Participants indicated a lack of factors such as personalisation, internal and external motivation, effectiveness, time, and support features as barriers that obstruct engagement and adherence with DMHI. No significant gender differences were found for DMHI adoption; attitude was found to be a significant predictor of adoption, subjective norm was not found to be a significant predictor of adoption. No significant gender differences were found in the attitude and adoption scores of DMHI.

The qualitative nature of Study 1 enabled participants to talk about the barriers they encountered during their experiences with DMHI, and how this affected their engagement. Barriers of engagement predominantly stemmed from a common overarching problem: a disconnection between DMHI and users' individual needs. Participants expressed frustration with the broad nature of DMHI, which hindered their ability to stay engaged. For instance, the inability to configure task completion time or daily use requirements made participants feel forced to engage with DMHI, which eventually led to low adherence. This was consistent with previous findings (Renfrew et al., 2021). Participants described a personalised user experience, accounting for individual user preferences, personalities, circumstances and goals as an important factor contributing to long-term engagement. In accordance with previous literature (Borghouts et al., 2021; Dederichs et al., 2021; Liverpool et al., 2020), DMHI should adhere to a User-centred Design Approach (UDA) offering configurability for a

personalised experience. A UDA emphasises collecting user specific and circumstantial information that help tailor the experience of DMHI to the individual. To strengthen the connection between user and DMHI, participants suggested increased human support and qualities, through in-app chatrooms or video conferences. This would serve as a source of credibility and human interaction, giving it a more personalised feel (Dederichs et al., 2021). Further findings suggested reward systems, evidence-based information and quality features tailored to the user as key factors that enhance engagement (Liverpool et al., 2020; Topooco et al., 2022). Prioritising a UDA is vital to not only avoid reduced engagement and adherence in DMHI, but also to avoid a perception of DMHI ineffectiveness.

Although frequency count of DMHI effectiveness was high, participants described their effectiveness in specific situations only. DMHI were effective in providing a first step into mental health care, providing accessibility and availability, consistent with previous findings (Dederichs et al., 2021). This suggests DMHI are effective in offering an approachable initial step towards accessing mental health care before seeking conventional therapy. However, participants considered DMHI ineffective when compared to conventional face-to-face therapy; they described the inability of DMHI to offer comparable treatment for (severe) diagnosis and symptoms. Furthermore, participants thought DMHI to be ineffective due to their inability to address individual needs through personalised human interaction, which links back to the importance of a UDA. Due to the absence of capabilities to address individual needs to the same extent of traditional therapy, DMHI were viewed as ineffective for mental health treatment, leading to low perception of DMHI, consistent with previous studies (Apolinàrio-Hagen et al., 2017; Clough et al., 2022). Although not directly comparable, a similar finding was true for our quantitative study; respondents showed moderate attitude and adoption of DMHI due to their ineffectiveness. Across our qualitative and quantitative analyses, this notion of DMHI ineffectiveness remained consistent. Due to a

comparison to conventional therapy, perception of DMHI efficacy is generally negative

(Apolinário-Hagen et al., 2017; Clough et al., 2022; Dederichs et al., 2021). Consequently,

the likelihood of engagement and adherence is reduced (Apolinário-Hagen et al., 2017;

Balcombe & De Leo, 2022; Borghouts et al., 2021).

Furthermore, our findings suggest that participants who expected DMHI to efficiently

treat symptoms on the capacity of conventional therapy were more likely to consider them

ineffective. These participants later expressed little desire to use DMHI again in the future.

This finding supports the proposition by Alkhaldi et al. (2016), emphasising the importance

of clear communication from developers regarding DMHI outcomes and expectancies to

avoid false expectations or misconceptions of the process that hinder engagement.

Another factor that hindered engagement was a lack of internal and external

motivation. Whilst a lack of external incentives, such as a personalised user experience and

reward systems described earlier impacted engagement, it was interestingly internal

incentives that impacted long-term engagement. Evidence of this is displayed by Participant

1; despite sufficient external motives from DMHI, she still found it difficult to motivate

herself to consistently engage with. A lack of internal motivation was also reported by

Renfrew et al. (2021) in their participants, which hindered engagement and long-term usage.

This suggests that whilst efforts to increase external incentives are important, it may not fully

address the challenge of sustained engagement with DMHI, even with the integration of a

UDA. Some young adults may struggle to find and maintain an internal consistent drive to

use DMHI, leading to low engagement and adherence regardless of the external incentives.

Still, it remains crucial to maximise the range of external motivation provided by DMHI to

compensate for a low internal incentive to use. This approach could potentially extend

engagement among these users.

The quantitative nature of Study 2 enabled us to explore attitude and adoption of DMHI differences in gender. Contrary to expectations, all three hypotheses were rejected, indicating that gender did not significantly impact attitude and adoption of DMHI. Consistent with previous findings, attitude was a significant predictor of DMHI adoption (Apolinário-Hagen et al., 2017; Clough et al., 2022; Dederichs et al., 2021). This was explained utilising the TPB, since attitude and behaviour are linked. Attitude scores were moderate irrespective of gender, and resulted in moderate DMHI adoption scores in both genders (Apolinário-Hagen et al., 2017; Clough et al., 2022; Dederichs et al., 2021). This was predominantly due to the ineffectiveness of DMHI, consistent with Study 1 as was aforementioned. However, our findings diverged from Venkatesh & Morris (2000) and Zhang et al. (2014) that emphasised gender differences in technology adoption. Specifically, they emphasised gender differences to emerge based on attitude, subjective norm and feelings of power towards technology acceptance. In contrast, van Elburg et al. (2022) found a stronger attitude of DMHI and intention to use for elderly men than women. They explain that this is due to the adventurous nature of men, and technology being predominantly male dominated. However, it is important to note that the present study had a different population sample and other differing variables compared to the previous studies. The current literature suggests a multitude of factors, like population, technology type and conditions among others that contribute to the inconsistent findings on gender differences. Further research is needed to reduce the uncertainty surrounding gender's influence on DMHI adoption.

Limitations and Strengths

This research saw some limitations. Firstly, participants were recruited using convenience and snowball sampling methods for Study 1 and 2, which may have caused a less accurate representation of the target audience. However, we utilised multiple platforms for recruitment to reduce this potential inaccuracy. Secondly, our research group had limited

proficiency in conducting interviews. We mitigated this by constructing an interview guide for a consistent structure and coherence. Participants were also not given the opportunity to review the transcripts due to time constraints. Next, we encountered a technical problem during Study 2, resulting in the loss of valuable respondent data collected up until that point. This led to a rather small sample size. To compensate for this, the survey distribution was expanded to other platforms besides SONA. Lastly, the survey scales we developed for the survey were not validated or checked for reliability using extensive statistical analyses. An effort was made to check the Cronbach's Alpha of the scales, which did indicate good internal consistency.

A strength of this study was the focus on young adults; an age group that has high prevalence of mental health issues and is in need of valuable insight of effective engagement strategies for DMHI. Next, the mixed methods approach combined qualitative and quantitative methods to gather valuable insights on the topic. Participants had unrestricted freedom to express their opinions, experiences and problems with DMHI. The Study 1 findings enhanced the survey used in Study 2 by incorporating new relevant and insightful questions.

Future Research

The findings of this study suggest that a UDA is crucial for addressing the challenge of low user engagement, and should be implemented in DMHI development going forward. Tailoring user experience based on gender may not be necessary to consider during the design of DMHI. Future research should address the inconsistencies in the literature regarding gender differences in DMHI, and technology acceptance as a whole. Furthermore, future research should focus on the depth of personalisation, UDA development and how to balance this with user data security concerns, which does play a key role in engagement (Dederichs et al., 2021; LaMonica et al., 2021; Melcher et al., 2022). Future research should

also look to improve the public attitude of DMHI by using a longitudinal design, where participants learn the benefits of DMHI through educational workshops and apply them during their use over a specified duration.

Conclusion

This research found that an absence of factors that ensure a personalised user experience led to a disconnection between DMHI and users, which was the prominent barrier of engagement. Participants did not believe DMHI were effective when compared to conventional therapy due to a lack of a user-centred experience, resulting in moderate scores of attitude and adoption of DMHI. No gender differences were observed. However, DMHI were effective as an initial guidance into mental health care, and provided accessibility. DMHI should employ a UDA to account for the dynamic individuality of its users, enhancing engagement and adherence. Nonetheless, it is important to acknowledge other factors that also need to be considered to enhance engagement of DMHI effectively.

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Appendix A

Table A1

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	9
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	9
Occupation	3	What was their occupation at the time of the study?	9
Gender	4	Was the researcher male or female?	9
Experience and training	5	What experience or training did the researcher have?	9
Relationship with participants			

Relationship established	6	Was a relationship established prior to study commencement?	9
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	10
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	NA
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	10
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	9
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	9

Sample size	12	How many participants were in the study?	8
Non-participation	13	How many people refused to participate or dropped out? Reasons?	NA
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	9
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	NA
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	8 – 9
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	9 – 10
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	NA
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	9

Field notes	20	Were field notes made during and/or after the inter view or focus group?	NA
Duration	21	What was the duration of the inter views or focus group?	9
Data saturation	22	Was data saturation discussed?	NA
Transcripts returned	23	Were transcripts returned to participants for comment and/or	NA

Topic	Item No.	Guide Questions/Description	Reported on Page No.
		correction?	
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	10
Description of the coding tree	25	Did authors provide a description of the coding tree?	10
Derivation of themes	26	Were themes identified in advance or derived from the data?	10
Software	27	What software, if applicable, was used to manage the data?	10

Participant checking	28	Did participants provide feedback on the findings?	NA
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	11 – 15
Data and findings consistent	30	Was there consistency between the data presented and the findings?	19 – 23
Clarity of major themes	31	Were major themes clearly presented in the findings?	11 – 15
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	11 – 15

Table A2

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4 – 8
Objectives	3	State specific objectives, including any prespecified hypotheses	9 – 10
Methods			
Study design	4	Present key elements of study design early in the paper	9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	15 – 16

		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	17 – 18
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	18
Bias	9	Describe any efforts to address potential sources of bias	23
Study size	10	Explain how the study size was arrived at	15 – 16

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why		NA
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding		17
		(*b*) Describe any methods used to examine subgroups and interactions		17 – 18
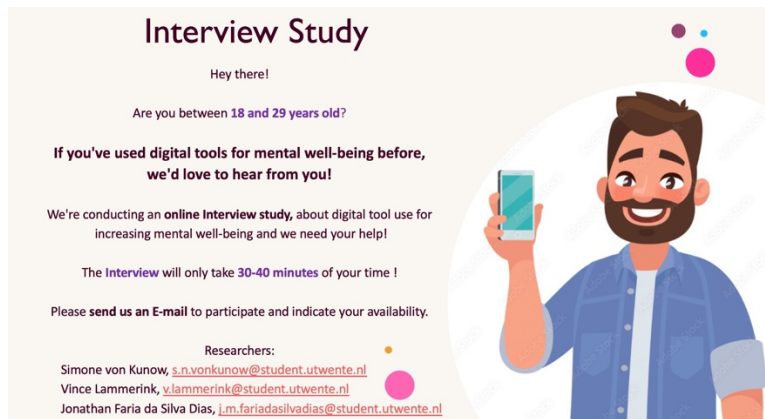
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy		NA
		(*e*) Describe any sensitivity analyses		NA
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		15 – 17
		(b) Give reasons for non-participation at each stage		15 – 17
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		15 – 16
		(b) Indicate number of participants with missing data for each variable of interest		NA
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		NA

		Case-control study—Report numbers in each exposure category, or summary measures of exposure		NA
		Cross-sectional study—Report numbers of outcome events or summary measures		19 - 24
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		NA
		(*b*) Report category boundaries when continuous variables were categorized		NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		NA

Appendix B

Figure 1

Digital Advertisement Graphic Created and Distributed on Platforms to Gather Participants

for Study 1

Figure 2

Digital Advertisement Graphic Created and Distributed on Platforms to Gather Participants

for Study 2

Appendix C

Interview Structure and Questions

Verbal Introduction to Participant

Hello, thank you for participating in our research study. My name is … , and I will be interviewing you today on the topic of digital mental health tools and interventions. This interview will last approximately 20-40 minutes, during which I will ask you some questions regarding your previous experience with digital tools and applications designed for improving mental well-being. With these questions, we aim to find out what the most important aspects are of using these digital tools, and what contributes to the lack of usage and engagement among the general population. This interview will be audio-recorded, no video-recording will be used and these recordings will be stored as data for two years as of today. I would like to ask you to please answer these questions as detailed as you can, as this gives us a clearer picture of the problem. You may take your time to answer a question, please do not feel rushed to give your answer, as there are no time restrictions. I would also like to remind you that you may withdraw from the study at any moment. Please do not hesitate to pause the interview and ask me anything should you have any concerns. Lastly, this study was approved by the ethics committee of the BMS of the University of Twente. Is all of this okay with you? Great! Then we can get started.

Interview Questions

1. Have you had any previous experience with a digital tool, application or intervention designed for mental health struggles, and could you tell me about this experience?
2. For what reason(s) did you decide to use this digital tool? *(prompt: and why did you choose this digital tool specifically?)*
3. What did you think about the use of a digital tool to help or improve mental well-being before your experience? *(prompt: were there any moments where you considered them before your first experience with them?)*
4. Did your initial thoughts and opinions of digital tools affect any intentions you may have had for using them? *(prompt: did it take some convincing for you to pick up the tool and use it due to any opinions you had of the tools?)*
5. What was it that you wanted to gain from using this digital tool? *(prompt: what benefits were you expecting?)*
6. How long were you intending on using the digital tool for? And how long did you actually end up using it?
7. During this period, how did you feel using the tool? *(for example; frustrated, excited, happy, forced etc)*
8. During this period, how focused and engaged were you with the contents of the tool? *(for example; determined, tired, uninspired, sluggish, slow, fast, skipping through it etc)*
9. Did the tool have a significant effect on your mental well-being? *(prompt: was it helpful in any way, if so how?)*

10. What were your reasons for dropping the use of the digital tool?

11. Did your thoughts and opinions on digital mental well-being tools change after this experience? If so, how?

12. After your experience, do you now believe that digital tools can be a viable alternative to traditional mental health care services? Please elaborate.

13. Would you try the digital tool for a second time? What would need to change with the tool in order for you to consider re-using it again?

14. As a user with experience, what do you now expect and demand from digital tools in order for you to continue engaging with them for a prolonged period of time?

15. Imagine a scenario in which all of your feedback was accepted and implemented in the tool. What would your thoughts on the effectiveness and impact on digital tools for mental well-being now be?

16. In your opinion, what things do digital tools designed for mental well-being need to prioritise in order to be effective and viable options for the general population? *(prompt: can be multiple things)* And can you rank these priorities based on importance?

That was the end of the interview. Thank you for your participation. Your SONA points will automatically be rewarded to you. Do you want to add anything, or have any questions? In any case, you have our contact information. Once again, thank you.

Appendix D

Table 1

Overview of Newly Constructed Survey Questions Based on Thematic Analysis Results

New Survey Questions
How much impact do you think the presence of advertisements in a mobile application impacts your likelihood to continue using it?
To what extent do you believe that people in your social circle support using digital tools to increase well-being?
In order to use a digital tool for a long period of time, I need to be motivated enough.
How effective do you think mobile applications that use 'streaks' (or other similar methods) would be for encouraging you to consistently use an app that helps you achieve a specific goal or task?
How important is it to you that the account creation process for a digital tool for mental health is quick and easy?
How important is it to you that a digital tool for mental health is engaging enough to hook you and keep you using it consistently?
In order to use a digital tool for a long period of time, the tool needs to keep me motivated.
A payment requirement would make me drop the use of the digital tool completely.
Please rate how significant of an obstacle each of the following factors is to you when using a digital tool for mental health. Please use the scale below to rate each factor from 1 to 5 (1. Payment/Subscriptions attached to a digital tool, 2. Minimal personalization, 3. Too many applications to choose from, 4. Little variety in tasks and/or questions, 5. No long-lasting results.
I will eventually lose interest in using a digital tool, even if I have no complaints about the tool.
I prefer not to rely on a digital tool for my mental well-being.
I expect digital tools for mental well-being to be a viable replacement for face-to-face therapy in the next five years.
How important is it to you to have access to all available content of a digital tool for mental health during a trial period before committing to a payment?

How strongly do you agree or disagree with the following statement: "The time pressure of having to complete daily questions and/or tasks in a digital tool within a limited time frame causes me stress".

How important is it for you to have direct contact with licensed medical health professionals within the digital tool?

How strongly do you agree or disagree with the following statement: "A poorly designed user interface would discourage me from using the digital tool for mental health"

How important is it to you that a digital tool for mental health provides a variety of different daily questions and/or tasks to keep you engaged with the tool over time?

In my opinion, the content of digital tools is too difficult for the general population to understand.

NOTE: A total of 18 new questions were added to the questionnaire based on the themes, subthemes and participant quotes.

Table 1

Participant Quotations per Subtheme

Subtheme	Participant Quotation
Minimalistic	" I think that the apps that I don't tend to use are the ones that are very complicated or have too many features too many buttons to push, where I have to make a lot of decisions" [Participant 2]
Maximalistic	"And maybe also getting some sort of reward like I don't know, growing some plants or whatever. If you just can get something out of it." [Participant 9]
Time Consuming	"…don't want to spend more than like, maybe 20 minutes out of my day on it, to go through something." [Participant 4]
Forced Use	"And, I think mainly it was because it felt like a chore more than anything you know, because you had to do all these things or, fill out all these questions and to me it started to feel like a chore. It didn't feel like actual help…" [Participant 7]
DMHI Cost	"There was a lot of paid stuff out there. So you also want to avoid kind of the apps that you have to pay, I don't know, 10 euros a month." [Participant 3]
Cost of Health Care	"… because one of the biggest problems of therapy is that it's unaffordable, and not and unavailable for a lot of people. And that was probably one of the reasons internet therapy, and like app therapy was becoming popular in the first place." [Participant 2]
Personalisation	"…most of the times you talk to a psychiatrist or a therapist may the issues people come to those people with are very tailored to the actual person it's coming with and very tied to the background of the person and the life experiences that person has had." [Participant 4]
Positive UX	"I think it should be a very clear structure." [Participant 1]
Negative UX	" I think the only real note I really had about it was the lack of interface…" [Participant 4]
Effective	"I feel like, it's pushed me to get more therapy later, because that was what the app told me at the end of the day, and that they are not a qualified entity or something like that, then, you know, at the end of the day, I have to seek therapy, lets you tell me that and that was one of the contributing

	decisions towards me seeking more therapy. So I feel like it did have a small impact on my life, but that was about it." [Participant 2]
Ineffective	"…but I don't think they could ever completely replace someone in face to face meetings with the people like that." [Participant 4]
Neutral	"Um, well, I was definitely open to the experience, I wasn't completely sure how helpful it would be." [Participant 9]
Internal Motivation	"But I have issues with using like mental health apps for longer times in general, which is not really based on the structure of the app, but more about that it's just an app … I'm just not motivated enough to just get me to actually use them." [Participant 1]
External Motivation	"I think for that it should be engaging somehow. For example that you can see a transformation in your behavior, that you can set and achieve goals, or collect points, level up etc." [Participant 8]
Curiosity	"I was I was purely just trying to test it yes, I was. I didn't have a mental health crisis going on or anything like that. I was very curious about how far I could go with the app." [Participant 2]
Used Out of Other Motive	"Not really, it was more so because of the credits for the Sona thing. Not because it was specifically chosen that one." [Participant 10]
Diverse Content	"That's something I was surprised about, even after discovering a lot of parts of the app. It just kept the pumping out more content." [Participant 2]
Repetitive Content	"I mean, like all it was, was just filling out the same questions every day." [Participant 10]

Dear participant,

Thank you for your willingness to participate in this study. With this study, we aim to investigate the use of digital tools to increase mental health and explore factors related to user acceptance, engagement, and willingness to use such tools.
Through the collection and analysis of data from participants who have used digital tools for mental health, the study aspires to gain insights into the perceived usefulness and ease of use of these tools and how they may influence users' motivation to engage with them.
The ultimate goal is to inform the development and implementation of more effective digital tools to increase mental health that can improve the well-being of individuals.

The participant will be asked several multiple-choice and Likert-scale questions regarding their mental well-being and the use of digital tool to increase well-being and their personal opinions, attitude, and perception regarding such tools.
The specific questionnaires the participant will be introduced to are the Beck's Depression Inventory, GAD-7 Anxiety, the Perceived Stress Scale (PSS), the Warwick–Edinburgh Mental Well-being Scale (WEMWBS). In addition, Likert scale questions based on the Technology Acceptance Model (TAM) and Theory of Planned Behavior regarding perceived usefulness & perceived ease of use, attitude & behavioral Intention, and lastly willingness and engagement, will be part of the survey.

The survey will take approximately 15-25 minutes to complete.

Note that this survey is anonymous. The data provided by you cannot be used to identify who you are. Furthermore, you can also withdraw at any time in this study, without being forced to give an explanation. When you feel uncomfortable about your data, you can always contact us via email. Afterward, we will delete your data. Moreover, participating in this study is completely voluntary.
This Bachelor's thesis is part of our psychology program at the University of Twente. We are supervised by assigned supervisors who are Alejandro Dominguez Rodriguez and Gerko Schaap. Moreover, this study was reviewed and approved by the BMS Ethics Committee.

In case of any questions or concerns, feel free to contact us via email:

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Demographical Survey questions

Demographics What is your age?

_____

- -

Demographics What is your gender?

○ Male (1)

○ Female (2)

○ Non-binary / third gender (3)

○ Prefer not to say (4)

Demographics What is your nationality?

○ German (1)

○ Dutch (2)

○ Other (please specify) (3)

_____

- -

Demographics What is your highest level of education?

○ High school (1)

○ Bachelor's degree (2)

○ Master's degree (3)

○ Doctoral degree (4)

Demographics What is your current employment status?

☐ Employed full-time (1)

☐ Employed part-time (2)

☐ Student (3)

☐ Unemployed (4)

☐ Retired (5)

☐ Other (6) _____

Q12 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I do not feel sad. (1)

○ I feel sad (2)

○ I am sad all the time and I can't snap out of it. (3)

○ I am so sad and unhappy that I can't stand it. (4)

Q13 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I am not particularly discouraged about the future. (1)

○ I feel discouraged about the future. (2)

○ I feel I have nothing to look forward to. (3)

○ I feel the future is hopeless and that things cannot improve (4)

Q14 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I do not feel like a failure. (1)

○ I feel I have failed more than the average person. (2)

○ As I look back on my life, all I can see is a lot of failures. (3)

○ I feel I am a complete failure as a person. (4)

Q15 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I get as much satisfaction out of things as I used to (1)

○ I don't enjoy things the way I used to. (2)

○ I don't get real satisfaction out of anything anymore. (3)

○ I am dissatisfied or bored with everything. (4)

Q16 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't feel particularly guilty (1)

○ I feel guilty a good part of the time. (2)

○ I feel quite guilty most of the time. (3)

○ I feel guilty all of the time. (4)

Q17 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't feel I am being punished. (1)

○ I feel I may be punished. (2)

○ I expect to be punished. (3)

○ I feel I am being punished. (4)

Q18 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't feel disappointed in myself. (1)

○ I am disappointed in myself. (2)

○ I am disgusted with myself. (3)

○ I hate myself. (4)

Q19 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't feel I am any worse than anybody else. (1)

○ I am critical of myself for my weaknesses or mistakes. (2)

○ I blame myself all the time for my faults. (3)

○ I blame myself for everything bad that happens (4)

Q20 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't have any thoughts of killing myself. (1)

○ I have thoughts of killing myself, but I would not carry them out.   (2)

○ I would like to kill myself. (3)

○ I would kill myself if I had the chance. (4)

Q21 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't cry any more than usual. (1)

○ I cry more now than I used to. (2)

○ I cry all the time now. (3)

○ I used to be able to cry, but now I can't cry even though I want to. (4)

Q22 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

   ◯ I am no more irritated by things than I ever was. (1)

   ◯ I am slightly more irritated now than usual. (2)

   ◯ I am quite annoyed or irritated a good deal of the time. (3)

   ◯ I feel irritated all the time. (4)

Q23 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

   ◯ I have not lost interest in other people. (1)

   ◯ I am less interested in other people than I used to be. (2)

   ◯ I have lost most of my interest in other people. (3)

   ◯ I have lost all of my interest in other people. (4)

Page Break

Q24 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

   ◯ I make decisions about as well as I ever could. (1)

   ◯ I put off making decisions more than I used to. (2)

   ◯ I have greater difficulty in making decisions more than I used to. (3)

   ◯ I can't make decisions at all anymore. (4)

Q25 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't feel that I look any worse than I used to. (1)

○ I am worried that I am looking old or unattractive. (2)

○ I feel there are permanent changes in my appearance that make me look unattractive (3)

○ I believe that I look ugly. (4)

Q26 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I can work about as well as before. (1)

○ It takes an extra effort to get started at doing something. (2)

○ I have to push myself very hard to do anything. (3)

○ I can't do any work at all. (4)

Q27 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I can sleep as well as usual. (1)

○ I don't sleep as well as I used to. (2)

○ I wake up 1-2 hours earlier than usual and find it hard to get back to sleep. (3)

○ I wake up several hours earlier than I used to and cannot get back to sleep. (4)

Q28 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I don't get more tired than usual. (1)

○ I get tired more easily than I used to. (2)

○ I get tired from doing almost anything.   (3)

○ I am too tired to do anything. (4)

Q29 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ My appetite is no worse than usual. (1)

○ My appetite is not as good as it used to be.   (2)

○ My appetite is much worse now. (3)

○ I have no appetite at all anymore. (4)

Q30 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I haven't lost much weight, if any, lately.   (1)

○ I have lost more than five pounds. (2)

○ I have lost more than ten pounds. (3)

○ I have lost more than fifteen pounds. (4)

Q31 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I am no more worried about my health than usual. (1)

○ I am worried about physical problems like aches, pains, upset stomach, or (2)

○ constipation. (3)

○ I am very worried about physical problems and it's hard to think of much else. (4)

○ I am so worried about my physical problems that I cannot think of anything else. (5)

- -

Q32 Please indicate how you are feeling at the present moment, and choose an answer that portrays your feelings best.

○ I have not noticed any recent change in my interest in sex. (1)

○ I am less interested in sex than I used to be. (2)

○ I have almost no interest in sex. (3)

○ I have lost interest in sex completely. (4)

GAD-7 Anxiety Over the last two weeks, how often have you been bothered by the following problems?

	Not at all (1)	Several days (2)	More than half the days (3)	Nearly every day (4)
1. Feeling nervous, anxious, or on edge (1)	○	○	○	○
2. Not being able to stop or control worrying (2)	○	○	○	○
3. Worrying too much about different things (3)	○	○	○	○
4. Trouble relaxing (4)	○	○	○	○
5. Being so restless that it is hard to sit still (5)	○	○	○	○
6. Becoming easily annoyed or irritable (6)	○	○	○	○
7. Feeling afraid, as if something awful might happen (7)	○	○	○	○

Q34 l. In the last month, how often have you been upset because of something that happened unexpectedly?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q35 2. In the last month, how often have you felt that you were unable to control the important things in your life?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q36 3. In the last month, how often have you felt nervous and stressed?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q37 4. In the last month, how often have you felt confident about your ability to handle your personal problems?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q38 5. In the last month, how often have you felt that things were going your way?

○ 1. Never (1)

○ 2. Almost never (2)

○ 3. Sometimes (3)

○ 4. Fairly often (4)

○ 5. Very often (5)

- -

Q39 6. In the last month, how often have you found that you could not cope with all the things that you had to do?

○ 1. Never (1)

○ 2. Almost never (2)

○ 3. Sometimes (3)

○ 4. Fairly often (4)

○ 5. Very often (5)

- -

Q40 7. In the last month, how often have you been able to control irritations in your life?

○ 1. Never (1)

○ 2. Almost never (2)

○ 3. Sometimes (3)

○ 4. Fairly often (4)

○ 5. Very often (5)

Q41 8. In the last month, how often have you felt that you were on top of things?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q42 9. In the last month, how often have you been angered because of things that happened that were outside of your control?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Q43 10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

○ 1. Never   (1)

○ 2. Almost never   (2)

○ 3. Sometimes (3)

○ 4. Fairly often   (4)

○ 5. Very often (5)

Appendix G

```
library(CTT)

library(mirt)

library(broom)

library(ShinyItemAnalysis)

library(dplyr)

install.packages("dplyr")

data <- read.csv("Survey Data New.csv", sep = ",")

library(car)

install.packages("ShinyItemAnalysis")

library(ShinyItemAnalysis)

startShinyItemAnalysis()

library(ggpubr)

install.packages("ggpubr")

install.packages("ggpubr", lib = "/Users/jonathan/Library/R/4.0/library")


data_numeric5<- read.csv("Survey Data Final.csv", sep = ",")


### Renaming Variables

DATA_NEW <- data_numeric %>%

  rename(Age = Demographics, Gender = Demographics.1, Nationality = Demographics.2, Education = Demographics.3,

Employment_Status = Demographics.4, Interview_Questions = SC6, Attitude = SC7, Subjective_Norm = SC8,

Perceived_Ease = SC9, Perceived_Usefulness = SC10, Adoption = SC11, Perception = SC12)


### Omit all participants who did not finish the survey

DATA_NEW = DATA_NEW %>% filter(Finished == 1) ### 10 participants were omitted


### Select Relevant Variables Only

DATA_NEW = DATA_NEW %>% select(Finished, Age:Nationality, Education, Employment_Status, Q12:Q44_14,

Q45:Q98, Interview_Questions:Perception)


### Code Testing

test3 = DATA_NEW %>% mutate(na_if(DATA_NEW, ""))
```

```
test4 = na.omit(test3)
```

Omit participants who did not fill in the updated interview questions + skipped questions

```
DATA_NEW = DATA_NEW <- DATA_NEW %>%
  mutate_all(~na_if(.x, ""))
DATA_NEW = na.omit(DATA_NEW) ### 23 participants were omitted
```

Test Coding

```
test4 = test4 %>% filter(Age <= 29)
```

omitting participants outside the desired age range (18-29)

```
DATA_NEW = DATA_NEW %>% filter(Age <= 29) ### 2 participants were omitted
```

Make Gender, Nationality and Education a Categorical Variable ### Not necessary

```
test4 = test4 %>% mutate(Gender_New = recode(Gender, '1' = "Male", '2' = "Female", '4' = "Other"))
```

Descriptive Statistics about Participants

```
test4 = test4 %>% numeric = as.numeric(Age)
age_numeric <- as.numeric(test4$Age)
test4 %>% summary(test4)

test5 <- test4 %>%
  mutate(Age = as.numeric(Age))
summary(test5)
```

Age

```
DATA_NEW = DATA_NEW %>% mutate(Age = as.numeric(Age))
summary(DATA_NEW) ### Mean Age = 23.27, Median Age = 23.00, SD Age = 2.66
sd(DATA_NEW$Age)
```

Gender

```
gender_count <- table(DATA_NEW$Gender) ### 25 Males (53.2%), 22 Females (46.8%)
gender_count["1"] / sum(gender_count) * 100
gender_count["2"] / sum(gender_count) * 100
```

```
gender_count["4"] / sum(gender_count) * 100
```

Removing 1 'Other' Participant -> 1 participant omitted (47 now in total)

```
DATA_NEW = subset(DATA_NEW, DATA_NEW$Gender != 4)
```

Nationality

```
nationality_count <- table(DATA_NEW$Nationality) ### 20 German (42.6%), 7 Dutch (14.9%), 20 Other (42.6%)
nationality_count["1"] / sum(nationality_count) * 100
nationality_count["2"] / sum(nationality_count) * 100
nationality_count["3"] / sum(nationality_count) * 100
```

Education

```
education_count <- table(DATA_NEW$Education) ### 24 High School (48.9%), 19 Bachelor's (40.4%), 4 Master's (8.5%),
1 Doctoral (2.1%)
education_count["1"] / sum(education_count) * 100
education_count["2"] / sum(education_count) * 100
education_count["3"] / sum(education_count) * 100
education_count["4"] / sum(education_count) * 100
```

Employment

```
employment_count <- table(DATA_NEW$Employment_Status) ### 9 Employed Full-Time (19.1%), 7 Employed Part-
Time (12.8%), 20 Students (42.6%), 10 Employed Part-Time + Students (21.3%), 1 Unemployed (2.1%), 1 Other (2.1%)
employment_count["1"] / sum(employment_count) * 100
employment_count["2"] / sum(employment_count) * 100
employment_count["2,3"] / sum(employment_count) * 100
employment_count["3"] / sum(employment_count) * 100
employment_count["4"] / sum(employment_count) * 100
employment_count["6"] / sum(employment_count) * 100
```

Descriptive Statistics about Variables of Interest

Attitude

```
DATA_NEW <- DATA_NEW %>%
  mutate(Attitude = as.numeric(Attitude)) ### Mean Attitude = 53.1, Var = 112.1, SD = 10.6
summary(DATA_NEW)
```

```
var(DATA_NEW$Attitude)


z_scores <- (DATA_NEW$Attitude - mean(DATA_NEW$Attitude)) / sd(DATA_NEW$Attitude)

print(z_scores) ### all z-scores lie between -3 and 3


boxplot(DATA_NEW$Attitude) ### boxplot shows 2 outliers (both with values 28)

boxplot.stats(DATA_NEW$Attitude)$out

out <- boxplot.stats(DATA_NEW$Attitude)$out

out_ind <- which(DATA_NEW$Attitude %in% c(out))

out_ind ### rows 1 and 12


boxplot(DATA_NEW$Attitude,

    ylab = "Respondent Data",

    main = "Attitude Level")

mtext(paste("Outliers: ", paste(out, collapse = ", "))) ### printing out the boxplot for thesis


sd(DATA_NEW$Attitude)


### Reverse Coding Item Values in Data Set as was done in Qualtrics

### Attitude

### Reverse Coding Q59_3

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == '5'] <- "five"

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == '4'] <- "four"

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == '2'] <- "two"

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == '1'] <- "one"


DATA_NEW$Q59_3[DATA_NEW$Q59_3 == "five"] <- 1

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == "four"] <- 2

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == "two"] <- 4

DATA_NEW$Q59_3[DATA_NEW$Q59_3 == "one"] <- 5


### Reverse Coding Q67

DATA_NEW$Q67[DATA_NEW$Q67 == '5'] <- "five"

DATA_NEW$Q67[DATA_NEW$Q67 == '4'] <- "four"
```

```
DATA_NEW$Q67[DATA_NEW$Q67 == '2'] <- "two"

DATA_NEW$Q67[DATA_NEW$Q67 == '1'] <- "one"


DATA_NEW$Q67[DATA_NEW$Q67 == "five"] <- 1

DATA_NEW$Q67[DATA_NEW$Q67 == "four"] <- 2

DATA_NEW$Q67[DATA_NEW$Q67 == "two"] <- 4

DATA_NEW$Q67[DATA_NEW$Q67 == "one"] <- 5
```

Reverse Coding Q68

```
DATA_NEW$Q68[DATA_NEW$Q68 == '5'] <- "five"

DATA_NEW$Q68[DATA_NEW$Q68 == '4'] <- "four"

DATA_NEW$Q68[DATA_NEW$Q68 == '2'] <- "two"

DATA_NEW$Q68[DATA_NEW$Q68 == '1'] <- "one"


DATA_NEW$Q68[DATA_NEW$Q68 == "five"] <- 1

DATA_NEW$Q68[DATA_NEW$Q68 == "four"] <- 2

DATA_NEW$Q68[DATA_NEW$Q68 == "two"] <- 4

DATA_NEW$Q68[DATA_NEW$Q68 == "one"] <- 5
```

Reverse Coding Q88

```
DATA_NEW$Q88[DATA_NEW$Q88 == '5'] <- "five"

DATA_NEW$Q88[DATA_NEW$Q88 == '4'] <- "four"

DATA_NEW$Q88[DATA_NEW$Q88 == '2'] <- "two"

DATA_NEW$Q88[DATA_NEW$Q88 == '1'] <- "one"


DATA_NEW$Q88[DATA_NEW$Q88 == "five"] <- 1

DATA_NEW$Q88[DATA_NEW$Q88 == "four"] <- 2

DATA_NEW$Q88[DATA_NEW$Q88 == "two"] <- 4

DATA_NEW$Q88[DATA_NEW$Q88 == "one"] <- 5
```

Subjective Norm
Reverse Coding Q62

```
DATA_NEW$Q62[DATA_NEW$Q62 == '5'] <- "five"

DATA_NEW$Q62[DATA_NEW$Q62 == '4'] <- "four"
```

```
DATA_NEW$Q62[DATA_NEW$Q62 == '2'] <- "two"

DATA_NEW$Q62[DATA_NEW$Q62 == '1'] <- "one"


DATA_NEW$Q62[DATA_NEW$Q62 == "five"] <- 1

DATA_NEW$Q62[DATA_NEW$Q62 == "four"] <- 2

DATA_NEW$Q62[DATA_NEW$Q62 == "two"] <- 4

DATA_NEW$Q62[DATA_NEW$Q62 == "one"] <- 5
```

Reverse Coding QX..4

```
DATA_NEW$X..4[DATA_NEW$X..4 == '5'] <- "five"

DATA_NEW$X..4[DATA_NEW$X..4 == '4'] <- "four"

DATA_NEW$X..4[DATA_NEW$X..4 == '2'] <- "two"

DATA_NEW$X..4[DATA_NEW$X..4 == '1'] <- "one"


DATA_NEW$X..4[DATA_NEW$X..4 == "five"] <- 1

DATA_NEW$X..4[DATA_NEW$X..4 == "four"] <- 2

DATA_NEW$X..4[DATA_NEW$X..4 == "two"] <- 4

DATA_NEW$X..4[DATA_NEW$X..4 == "one"] <- 5
```

Reverse Coding QX..5

```
DATA_NEW$X..5[DATA_NEW$X..5 == '5'] <- "five"

DATA_NEW$X..5[DATA_NEW$X..5 == '4'] <- "four"

DATA_NEW$X..5[DATA_NEW$X..5 == '2'] <- "two"

DATA_NEW$X..5[DATA_NEW$X..5 == '1'] <- "one"


DATA_NEW$X..5[DATA_NEW$X..5 == "five"] <- 1

DATA_NEW$X..5[DATA_NEW$X..5 == "four"] <- 2

DATA_NEW$X..5[DATA_NEW$X..5 == "two"] <- 4

DATA_NEW$X..5[DATA_NEW$X..5 == "one"] <- 5
```

Reverse Coding Q65

```
DATA_NEW$Q65[DATA_NEW$Q65 == '5'] <- "five"

DATA_NEW$Q65[DATA_NEW$Q65 == '4'] <- "four"

DATA_NEW$Q65[DATA_NEW$Q65 == '2'] <- "two"
```

```
DATA_NEW$Q65[DATA_NEW$Q65 == '1'] <- "one"


DATA_NEW$Q65[DATA_NEW$Q65 == "five"] <- 1

DATA_NEW$Q65[DATA_NEW$Q65 == "four"] <- 2

DATA_NEW$Q65[DATA_NEW$Q65 == "two"] <- 4

DATA_NEW$Q65[DATA_NEW$Q65 == "one"] <- 5
```

Perceived Usefulness
Reverse Coding Q97

```
DATA_NEW$Q97[DATA_NEW$Q97 == '5'] <- "five"

DATA_NEW$Q97[DATA_NEW$Q97 == '4'] <- "four"

DATA_NEW$Q97[DATA_NEW$Q97 == '2'] <- "two"

DATA_NEW$Q97[DATA_NEW$Q97 == '1'] <- "one"


DATA_NEW$Q97[DATA_NEW$Q97 == "five"] <- 1

DATA_NEW$Q97[DATA_NEW$Q97 == "four"] <- 2

DATA_NEW$Q97[DATA_NEW$Q97 == "two"] <- 4

DATA_NEW$Q97[DATA_NEW$Q97 == "one"] <- 5
```

Adoption
Reverse Coding Q60

```
DATA_NEW$Q60[DATA_NEW$Q60 == '5'] <- "five"

DATA_NEW$Q60[DATA_NEW$Q60 == '4'] <- "four"

DATA_NEW$Q60[DATA_NEW$Q60 == '2'] <- "two"

DATA_NEW$Q60[DATA_NEW$Q60 == '1'] <- "one"


DATA_NEW$Q60[DATA_NEW$Q60 == "five"] <- 1

DATA_NEW$Q60[DATA_NEW$Q60 == "four"] <- 2

DATA_NEW$Q60[DATA_NEW$Q60 == "two"] <- 4

DATA_NEW$Q60[DATA_NEW$Q60 == "one"] <- 5
```

Willingness/Engagement
Reverse Coding Q61

```
DATA_NEW$Q61[DATA_NEW$Q61 == '5'] <- "five"
```

```
DATA_NEW$Q61[DATA_NEW$Q61 == '4'] <- "four"

DATA_NEW$Q61[DATA_NEW$Q61 == '2'] <- "two"

DATA_NEW$Q61[DATA_NEW$Q61 == '1'] <- "one"


DATA_NEW$Q61[DATA_NEW$Q61 == "five"] <- 1

DATA_NEW$Q61[DATA_NEW$Q61 == "four"] <- 2

DATA_NEW$Q61[DATA_NEW$Q61 == "two"] <- 4

DATA_NEW$Q61[DATA_NEW$Q61 == "one"] <- 5
```

Reverse Coding X..3

```
DATA_NEW$X..3[DATA_NEW$X..3 == '5'] <- "five"

DATA_NEW$X..3[DATA_NEW$X..3 == '4'] <- "four"

DATA_NEW$X..3[DATA_NEW$X..3 == '2'] <- "two"

DATA_NEW$X..3[DATA_NEW$X..3 == '1'] <- "one"


DATA_NEW$X..3[DATA_NEW$X..3 == "five"] <- 1

DATA_NEW$X..3[DATA_NEW$X..3 == "four"] <- 2

DATA_NEW$X..3[DATA_NEW$X..3 == "two"] <- 4

DATA_NEW$X..3[DATA_NEW$X..3 == "one"] <- 5
```

Cronbach's Alpha for Attitude

```
DATA_NEW$Q45 <- as.numeric(as.character(DATA_NEW$Q45))

DATA_NEW$Q49 <- as.numeric(as.character(DATA_NEW$Q49))

DATA_NEW$X..2 <- as.numeric(as.character(DATA_NEW$X..2))

DATA_NEW$Q56 <- as.numeric(as.character(DATA_NEW$Q56))

DATA_NEW$Q81 <- as.numeric(as.character(DATA_NEW$Q81))

DATA_NEW$Q58 <- as.numeric(as.character(DATA_NEW$Q58))

DATA_NEW$Q59_1 <- as.numeric(as.character(DATA_NEW$Q59_1))

DATA_NEW$Q59_2 <- as.numeric(as.character(DATA_NEW$Q59_2))

DATA_NEW$Q59_3 <- as.numeric(as.character(DATA_NEW$Q59_3))

DATA_NEW$Q67 <- as.numeric(as.character(DATA_NEW$Q67))

DATA_NEW$Q68 <- as.numeric(as.character(DATA_NEW$Q68))

DATA_NEW$Q69 <- as.numeric(as.character(DATA_NEW$Q69))

DATA_NEW$Q75 <- as.numeric(as.character(DATA_NEW$Q75))
```

```
DATA_NEW$Q86 <- as.numeric(as.character(DATA_NEW$Q86))

DATA_NEW$Q88 <- as.numeric(as.character(DATA_NEW$Q88))

DATA_NEW$Q90 <- as.numeric(as.character(DATA_NEW$Q90))

DATA_NEW$Q96 <- as.numeric(as.character(DATA_NEW$Q96))

DATA_NEW$Q101 <- as.numeric(as.character(DATA_NEW$Q101))


DATA_NEW$Attitude = as.numeric(as.character(DATA_NEW$Attitude))

test3 = data.frame(Attitude = DATA_NEW$Attitude)

alpha(test3)


test2 <- data.frame(Q45 = DATA_NEW$Q45, Q49 = DATA_NEW$Q49, QX..2 = DATA_NEW$X..2, Q56 =

DATA_NEW$Q56, Q81 = DATA_NEW$Q81,

        Q58 = DATA_NEW$Q58, Q59_1 = DATA_NEW$Q59_1, Q59_2 = DATA_NEW$Q59_2, Q59_3 =

DATA_NEW$Q59_3,

        Q67 = DATA_NEW$Q67, Q68 = DATA_NEW$Q68, Q69 = DATA_NEW$Q69, Q75 = DATA_NEW$Q75,

Q86 = DATA_NEW$Q86,

        Q88 = DATA_NEW$Q88, Q90 = DATA_NEW$Q90, Q96 = DATA_NEW$Q96, Q101 = DATA_NEW$Q101)

alpha(test2)


### Subjective Norm
DATA_NEW <- DATA_NEW %>%

  mutate(Subjective_Norm = as.numeric(Subjective_Norm)) ### Mean Subjective = 11.2, Var = 10.7, SD = 3.3

summary(DATA_NEW)


z_scores <- (DATA_NEW$Subjective_Norm - mean(DATA_NEW$Subjective_Norm)) /

sd(DATA_NEW$Subjective_Norm)

print(z_scores) ### all z-scores lie between -3 and 3


boxplot(DATA_NEW$Subjective_Norm) ### No outliers present

var(DATA_NEW$Subjective_Norm)

sd(DATA_NEW$Subjective_Norm)


hist(DATA_NEW$Subjective_Norm)

hist(DATA_NEW$Attitude)
```

```
hist(DATA_NEW$Perceived_Usefulness)


### Cronbach's Alpha for Attitude: 0.76

DATA_NEW$Q62 <- as.numeric(as.character(DATA_NEW$Q62))

DATA_NEW$X..4 <- as.numeric(as.character(DATA_NEW$X..4))

DATA_NEW$Q65 <- as.numeric(as.character(DATA_NEW$Q65))

DATA_NEW$X..5 <- as.numeric(as.character(DATA_NEW$X..5))


test4 <- data.frame(Q62 = DATA_NEW$Q62, X..4 = DATA_NEW$X..4, Q65 = DATA_NEW$Q65, X..5 =

DATA_NEW$X..5)

alpha(test4)

### Perceived Ease of Use

DATA_NEW <- DATA_NEW %>%

  mutate(Perceived_Ease = as.numeric(Perceived_Ease)) ### Mean Ease = 21.1, Var = 10.5, SD = 3.2

summary(DATA_NEW)


z_scores <- (DATA_NEW$Perceived_Ease - mean(DATA_NEW$Perceived_Ease)) / sd(DATA_NEW$Perceived_Ease)

print(z_scores) ### all z-scores lie between -3 and 3


boxplot(DATA_NEW$Perceived_Ease) ### No outliers present

var(DATA_NEW$Perceived_Ease)

sd(DATA_NEW$Perceived_Ease)


### Cronbach's Alpha

DATA_NEW$Q50 <- as.numeric(as.character(DATA_NEW$Q50))

DATA_NEW$Q52 <- as.numeric(as.character(DATA_NEW$Q52))

DATA_NEW$Q68 <- as.numeric(as.character(DATA_NEW$Q68))

DATA_NEW$Q73 <- as.numeric(as.character(DATA_NEW$Q73))

DATA_NEW$Q88 <- as.numeric(as.character(DATA_NEW$Q88))

DATA_NEW$Q98 <- as.numeric(as.character(DATA_NEW$Q98))


test5 <- data.frame(Q50 = DATA_NEW$Q50, Q52 = DATA_NEW$Q52, Q68 = DATA_NEW$Q68, Q73 =

DATA_NEW$Q73, Q88 = DATA_NEW$Q88, Q98 = DATA_NEW$Q98)

alpha(test5)
```

```
test7 <- data.frame(Q50 = DATA_NEW$Q50, Q52 = DATA_NEW$Q52, Q68 = DATA_NEW$Q68, Q73 =

DATA_NEW$Q73, Q88 = DATA_NEW$Q88, Q98 = DATA_NEW$Q98,

          Q45 = DATA_NEW$Q45, Q49 = DATA_NEW$Q49, Q59_3 = DATA_NEW$Q59_3, Q59_4 =

DATA_NEW$Q59_4, Q59_5 = DATA_NEW$Q59_5, Q74 = DATA_NEW$Q74, Q75 = DATA_NEW$Q75, Q97 =

DATA_NEW$Q97)

alpha(test7)


data.frame(Q45 = DATA_NEW$Q45, Q49 = DATA_NEW$Q49, Q59_3 = DATA_NEW$Q59_3, Q59_4 =

DATA_NEW$Q59_4, Q59_5 = DATA_NEW$Q59_5, Q74 = DATA_NEW$Q74, Q75 = DATA_NEW$Q75, Q97 =

DATA_NEW$Q97)

alpha(test6)


### Perceived Usefulness

DATA_NEW <- DATA_NEW %>%

  mutate(Perceived_Usefulness = as.numeric(Perceived_Usefulness)) ### Mean Usefulness = 23.4, Var = 23.9, SD = 4.9

summary(DATA_NEW)


z_scores <- (DATA_NEW$Perceived_Usefulness - mean(DATA_NEW$Perceived_Usefulness)) /

sd(DATA_NEW$Perceived_Usefulness)

print(z_scores) ### 1 value is just 3.0


boxplot(DATA_NEW$Perceived_Usefulness) ### 1 outlier present

boxplot(DATA_NEW$Perceived_Usefulness) ### boxplot shows 2 outliers (both with values 28)

boxplot.stats(DATA_NEW$Perceived_Usefulness)$out

out <- boxplot.stats(DATA_NEW$Perceived_Usefulness)$out

out_ind <- which(DATA_NEW$Perceived_Usefulness %in% c(out))

out_ind ### rows 47


boxplot(DATA_NEW$Perceived_Usefulness,

    ylab = "Respondent Data",

    main = "Level of Perceived Usefulness")

mtext(paste("Outliers: ", paste(out, collapse = ", "))) ### printing out the boxplot for thesis
```

```
var(DATA_NEW$Perceived_Usefulness)

sd(DATA_NEW$Perceived_Usefulness)


### Cronbach's Alpha

DATA_NEW$Q45 <- as.numeric(as.character(DATA_NEW$Q45))

DATA_NEW$Q49 <- as.numeric(as.character(DATA_NEW$Q49))

DATA_NEW$Q59_3 <- as.numeric(as.character(DATA_NEW$Q59_3))

DATA_NEW$Q59_4 <- as.numeric(as.character(DATA_NEW$Q59_4))

DATA_NEW$Q59_5 <- as.numeric(as.character(DATA_NEW$Q59_5))

DATA_NEW$Q74 <- as.numeric(as.character(DATA_NEW$Q74))

DATA_NEW$Q75 <- as.numeric(as.character(DATA_NEW$Q75))

DATA_NEW$Q97 <- as.numeric(as.character(DATA_NEW$Q97))


test6 <- data.frame(Q45 = DATA_NEW$Q45, Q49 = DATA_NEW$Q49, Q59_3 = DATA_NEW$Q59_3, Q59_4 =

DATA_NEW$Q59_4, Q59_5 = DATA_NEW$Q59_5, Q74 = DATA_NEW$Q74, Q75 = DATA_NEW$Q75, Q97 =

DATA_NEW$Q97)

alpha(test6)


### Adoption

DATA_NEW <- DATA_NEW %>%

  mutate(Adoption = as.numeric(Adoption)) ### Mean Adoption = 31.5, Var = 72.1, SD = 8.5

summary(DATA_NEW)


z_scores <- (DATA_NEW$Adoption - mean(DATA_NEW$Adoption)) / sd(DATA_NEW$Adoption)

print(z_scores) ### all values lie within -3 and 3


boxplot(DATA_NEW$Adoption) # no outliers present

var(DATA_NEW$Adoption)

sd(DATA_NEW$Adoption)


### Cronbach's Alpha

DATA_NEW$Q56 <- as.numeric(as.character(DATA_NEW$Q56))

DATA_NEW$Q81 <- as.numeric(as.character(DATA_NEW$Q81))

DATA_NEW$Q58 <- as.numeric(as.character(DATA_NEW$Q58))
```

```
DATA_NEW$Q59_1 <- as.numeric(as.character(DATA_NEW$Q59_1))

DATA_NEW$Q59_2 <- as.numeric(as.character(DATA_NEW$Q59_2))

DATA_NEW$Q60 <- as.numeric(as.character(DATA_NEW$Q60))

DATA_NEW$Q67 <- as.numeric(as.character(DATA_NEW$Q67))

DATA_NEW$Q69 <- as.numeric(as.character(DATA_NEW$Q69))

DATA_NEW$Q74 <- as.numeric(as.character(DATA_NEW$Q74))

DATA_NEW$Q88 <- as.numeric(as.character(DATA_NEW$Q88))

DATA_NEW$Q90 <- as.numeric(as.character(DATA_NEW$Q90))


test7 <- data.frame(Q56 = DATA_NEW$Q56, Q81 = DATA_NEW$Q81, Q58 = DATA_NEW$Q58, Q59_1 =

DATA_NEW$Q59_1,

        Q59_2 = DATA_NEW$Q59_2, Q60 = DATA_NEW$Q60, Q67 = DATA_NEW$Q67, Q69 =

DATA_NEW$Q69,

        Q74 = DATA_NEW$Q74, Q88 = DATA_NEW$Q88, Q90 = DATA_NEW$Q90)

alpha(test7)


### Perception

DATA_NEW <- DATA_NEW %>%

  mutate(Perception = as.numeric(Perception)) ### Mean Perception = 44.8, Var = 52.9, SD = 7.3

summary(DATA_NEW)


z_scores <- (DATA_NEW$Perception - mean(DATA_NEW$Perception)) / sd(DATA_NEW$Perception)

print(z_scores) ### 1 outlier z-score of 3.2


boxplot(DATA_NEW$Perception, ylab = "Respondent Data", main = "Level of Perception") ### 2 outliers present

boxplot.stats(DATA_NEW$Perception)$out ### outliers at 28 and 68

out <- boxplot.stats(DATA_NEW$Perception)$out

out_ind <- which(DATA_NEW$Perception %in% c(out))

out_ind ### rows 12 and 47

var(DATA_NEW$Perception)

sd(DATA_NEW$Perception)


test8 <- data.frame(Q45 = DATA_NEW$Q45, Q49 = DATA_NEW$Q49, Q59_3 = DATA_NEW$Q59_3, Q59_4 =

DATA_NEW$Q59_4, Q59_5 = DATA_NEW$Q59_5, Q74 = DATA_NEW$Q74, Q75 = DATA_NEW$Q75, Q97 =
```

```
DATA_NEW$Q97, Q50 = DATA_NEW$Q50, Q52 = DATA_NEW$Q52, Q68 = DATA_NEW$Q68, Q73 =

DATA_NEW$Q73, Q88 = DATA_NEW$Q88, Q98 = DATA_NEW$Q98)

alpha(test8)


### Statistical Analysis: Multiple Regression Analysis (Hypothesis 1) (SCRAPPED - NOT DOING THIS ANYMORE)

myregression <- lm(DATA_NEW$Adoption ~ data_numeric_new$Gender + DATA_NEW$Attitude +

DATA_NEW$Subjective_Norm + DATA_NEW$Gender*DATA_NEW$Attitude +

DATA_NEW$Gender*DATA_NEW$Subjective_Norm, data = DATA_NEW)

summary(myregression)


### Determining which dummy variable corresponds to which gender

DATA_NEW$Gender <- as.factor(DATA_NEW$Gender)

levels(DATA_NEW$Gender)

contrasts(DATA_NEW$Gender) ### Reference category is Gender1 (Male), Gender2 = Female


### ANOVA Analysis (Hypothesis 2) (SCRAPPED - NOT DOING THIS ANYMORE)

### Checking for Normality first

hist(DATA_NEW$Attitude) ### More or less normally distributed

shapiro.test(DATA_NEW$Attitude) ### Says it is normally distributed


hist(DATA_NEW$Perception) ### Normal Distribution

hist(DATA_NEW$Subjective_Norm, xlab = "Subjective Norm", main = "Histogram of Subjective Norm") ### Normal

Distribution

hist(DATA_NEW$Adoption)

DATA_NEW %>%

  ggplot(aes(x = Adoption, y = Subjective_Norm)) +

  geom_point()



plot(x = fitted(myregression), y = residuals(myregression), xlab = "Fitted values", ylab = "Residuals")

ggplot(data = data.frame(fitted = fitted(myregression), residuals = residuals(myregression)), aes(x = fitted, y = residuals)) +

  geom_jitter(width = 0.2, height = 0) +

  labs(x = "Fitted values", y = "Residuals")
```

```
plot(x = 1:length(resid(myregression)), y = residuals(myregression), xlab = "Observation Order", ylab = "Residuals")

cor_matrix <- cor(test5[c("Gender", "Attitude", "Subjective_Norm")])

print(cor_matrix)


test5 = test5 %>%

  mutate(Gender = as.numeric(Gender))

summary(test5)
```

```
### Using non-parametric test (GLM) to answer Hypothesis 1 (ACTUAL ANALYSIS - NON-PARAMETRIC)

data_test <- data.frame(DATA_NEW$Gender, DATA_NEW$Adoption, DATA_NEW$Attitude,

DATA_NEW$Perceived_Ease)


# fit a GLM with linear regression

model <- glm(DATA_NEW$Adoption ~ data_numeric_new$Gender + DATA_NEW$Attitude, data = data_test)

summary(model)


model2 <- glm(DATA_NEW$Adoption ~

DATA_NEW$Gender*DATA_NEW$Attitude*DATA_NEW$Subjective_Norm*DATA_NEW$Perceived_Ease, data =

DATA_NEW)

summary(model2)


### Using non-parametric test (Mann-Whitney U Test) to answer Hypothesis 2

data_female = subset(DATA_NEW, Gender == "2")

data_male = subset(DATA_NEW, Gender == "1")


data_male %>% summary() ### Mean Attitude for Males = 50.1, Mean Perception for Males = 43.4

data_female %>% summary() ### Mean Attitude for Females = 56.0, Mean Perception for Females = 46.3


# Perform Wilcoxon rank sum test for attitude and perception separately for each gender

attitude_test <- wilcox.test(data_female$Attitude, data_male$Attitude)

perception_test <- wilcox.test(data_female$Perception, data_male$Perception)
```

```
# Print the results

cat("Attitude test p-value:", attitude_test$p.value, "\n")

cat("Perception test p-value:", perception_test$p.value, "\n")




### Convert '1' and '2' to 'Male' and 'Female'

DATA_NEW$Gender = factor(DATA_NEW$Gender, levels = c(1, 2), labels = c("Male", "Female"))



### BOXPLOT FOR LEVEL OF ATTITUDE BETWEEN MALES AND FEMALES

boxplot(Attitude ~ Gender, data = DATA_NEW,

    col = c("lightblue", "pink"),

    xlab = "Gender", ylab = "Attitude")



### BOXPLOT FOR LEVEL OF PERCEPTION BETWEEN MALES AND FEMALES

boxplot(Perception ~ Gender, data = DATA_NEW,

    col = c("lightblue", "pink"),

    xlab = "Gender", ylab = "Perception")



### Hypothesis 3

adoption_test = wilcox.test(data_female$Adoption, data_male$Adoption)

cat("Adoption test p-value:", adoption_test$p.value, "\n")



boxplot(Adoption ~ Gender, data = DATA_NEW,

    col = c("lightblue", "pink"),

    xlab = "Gender", ylab = "Adoption")



df <- data.frame(DATA_NEW$Adoption, DATA_NEW$Gender)

wilcox.test(DATA_NEW$Adoption ~ DATA_NEW$Gender, data = df)



lol <- data.frame(DATA_NEW$Gender, DATA_NEW$Attitude)



# conduct Wilcoxon rank-sum test

wilcox.test(DATA_NEW$Attitude ~ DATA_NEW$Gender, data = lol)
```

```
### Visualizing Means of Attitude between males and females

mean_attitude <- tapply(DATA_NEW$Attitude, DATA_NEW$Gender, mean)


barplot(mean_attitude, beside = TRUE, col = c("blue", "red"),

    main = "Mean Attitude by Gender", xlab = "Gender", ylab = "Mean Attitude")


barplot(mean_attitude, beside = TRUE, col = c("blue", "red"),

    main = "Mean Attitude by Gender", xlab = "Gender", ylab = "Mean Attitude",

    ylim = c(0, max(mean_attitude) + 10))  # Adjust the ylim range as per your needs


### Visualizing Means of Adoption between males and females

mean_adoption <- tapply(DATA_NEW$Adoption, DATA_NEW$Gender, mean)


barplot(mean_adoption, beside = TRUE, col = c("blue", "red"),

    main = "Mean Adoption by Gender", xlab = "Gender", ylab = "Mean Adoption",

    ylim = c(0, max(mean_adoption) + 10))  # Adjust the ylim range as per your needs


str(DATA_NEW)

class(DATA_NEW)

names(DATA_NEW)  # should print the names of your variables


summary(DATA_NEW)

ls()

# Create a box plot to visualize the differences in attitude by gender


### Create Separate Variable Combining the 'Barriers'

data_numeric4 %>% mutate()



write.csv(DATA_NEW, "C:\\Users\\Jonathan\\Desktop\\Data_Final.csv", row.names=FALSE)


male_model <- glm(DATA_NEW$Adoption ~ DATA_NEW$Attitude, data = DATA_NEW, subset =

(DATA_NEW$Gender == "Female"))
```

Appendix H

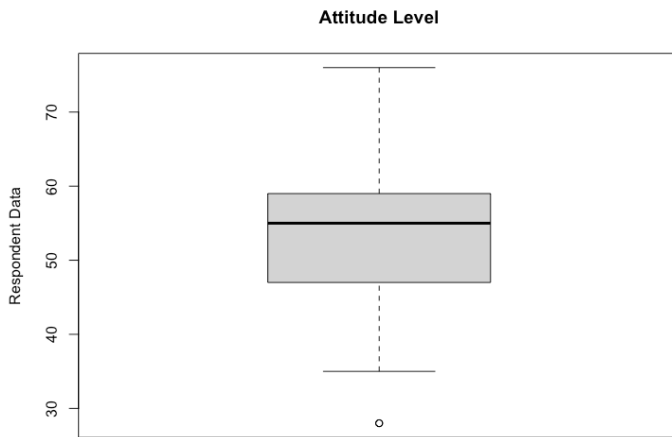**Figure 1**

Boxplots Visualising Outliers for Attitude

Figure 2

Histogram Visualising Skewed Data of Subjective Norm