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How is Your Mood Today? - A Taxonomy-based Analysis of Apps for Depression

Completed Research

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Abstract

Depression is a serious disease that affects partners, families, friends, and societies. Applications for depression therapy support assist users in daily life to cope with depression challenges. While the services provided can be advantageous, the benefits and apps provided in the market can be overwhelming and fragmented for its intended users. A rigorous classification and clustering of this important domain is still missing. We deduce insights examining a taxonomy and conducting a cluster analysis. We classify 55 applications into eleven dimensions and 46 corresponding characteristics. We identify six clusters of archetypical application configurations. Our procedure classifies this application domain and enables directions towards more tailored research for this eHealth and mHealth artefacts. (Potential) users and application developers can use our results and findings to improve their usage and development and select the most suitable application for their medical needs and interests.

Keywords

Depression, applications, taxonomy development, cluster analysis, archetypes.

Introduction

The future of healthcare services is more patient-centered, as today's user is active and well informed. Health insurances encourage the distribution and use of online services such as online treatment programs for widespread diseases, e.g., mild and moderate depression. This encouragement makes the characteristics and acceptance of online treatments an important field of research. Depression poses a major societal challenge due to the high costs of treatment and because depression burdens high costs on sufferers, their families, caregivers, and employers. In addition, accelerated through the COVID-19 pandemic, the prevalence of depressive symptoms in the U.S. was more than 3-fold higher than before the pandemic situation (Ettman et al. 2020). Generally, depression should be treated with psychopharmacological medication and/or psychotherapy (Butler et al. 2006). In contrast, only 50% of depression patients consult a physician or psychotherapist, and only one-third of these receive therapeutic interventions (e.g., Wittchen et al. 2002). A study by the Federal Chamber of Psychotherapists in Germany identified a significant gap in the supply of psychotherapy, indicating a waiting time until psychotherapy starts is around six months (Federal Chamber of Psychotherapists 2022a). The need for depression and accessible places of therapists became apparent (Federal Chamber of Psychotherapists 2022b). One of the possibilities to close this demand and supply gap for psychotherapy is electronic health (eHealth) applications („apps”). Some of these apps, such as internet-based cognitive-behavioral therapies (iCBT), are evidence-based treatment options for patients with depression. They can be considered as a convenient, widely available, and clinically effective form of psychotherapy for treating mild and moderate depression. iCBT has proven efficacy in treating depression, either self-guided or guided (Cuijpers et al. 2019). Therefore, the usage of iCBT is

helpful from a medical point of view. On the other hand, several other apps for depression exist on the app market showing distinct characteristics, i.e., functionalities, delivered to their intended users (e.g., Stawarz et al. 2018) without evidence base of their medical services.

While the market seems fragmented, we provide a rigorous structure of the field and classify apps for depression in empirically validated archetypes. As a result, we developed a taxonomy according to the methodology proposed by Nickerson et al. (2013) and additional suggestions by Kundisch et al. (2021). We utilize existing literature on the domain of interest and a sample of real-world apps as objects to classify. Based on the taxonomy, we conduct a cluster analysis to classify the real-world objects into groups (Kaufman and Rousseeuw 1990). To date, we did not find any study that investigates archetypes of apps for depression with a taxonomy-based approach. They can structure a field of interest comprehensively and transparently (Nickerson et al. 2013). We derive and interpret these apps to identify archetypical app configurations. From an academic point of view, taxonomies can be used as starting points for advancement to the higher-order predictive theories that allow researchers to better design and evaluate apps for depression and achieve a higher acceptance among users (Gregor 2006). Also, taxonomies can serve as a knowledge base for subsequent clustering. Clustering produces essential information about possible differences and similarities of objects that a taxonomy in its single form cannot deliver (Möller et al. 2021).

App developers and health app service providers can benefit from our taxonomy and derived archetypes. They can classify their apps, observe the competition, and use our insights to support app development, e.g., combining less frequent combinations of characteristics. Finally, users of depression apps can use the taxonomy and archetypes as decision support for selecting apps enhancing their personal medical needs. Also, people who have no experience with these medical apps on their devices, i.e., mobile phones, can grasp what is possible towards information technology-enabled medical services. Based on these motivations, we answer the following research questions (RQ):

RQ1: How applications for depression can be classified within a taxonomy?

RQ2: Which archetypes of applications for depression can be empirically deduced with this classification?

First, we provide the relevant background and related work. We explain our research design, our taxonomy development, i.e., our iterative process and the final taxonomy. We perform our cluster analysis and deduce specifics for each identified app archetype. We discuss our results and findings and provide implications and recommendations for academics and practitioners. We close with limitations, future research directions, and conclusions.

Applications in the Field of Depression and Related Work

Depression is denominated as the most common disorder in mental health (Kessler et al. 2005). Past research indicated that eHealth apps serve as a supporting component to deliver self-help interventions through the Internet, especially for mild and moderate depression symptoms (e.g., Ly et al. 2014). Possible information technology artifacts can be mobile and web apps used with the patients' smartphones, tablets, or desktop computers. Mobile apps can be generally defined as an „[information technology] software artifact that is specifically developed for mobile operating systems installed on handheld devices, such as smartphones [...]“ (Hoehle and Venkatesh 2015: 437). Web apps, in contrast, are „[...] software system[s] with business state, and that its front end is in large part delivered via a Web system.“ (Conallen 1999: 63). In the following, we will use the term apps as a synonym, meaning both mobile and web apps that deliver healthcare interventions treatment against depression to the user.

To identify past research on the topic of eHealth apps, we searched within several academic databases, e.g., AISeL, ScienceDirect and PubMed. We used the search terms like „depression apps“, „online therapy“ and „mental health apps“ for the search process within studies title, abstract, or keywords. We found that in the past years, several researchers investigated apps for depression in an (un-) structured manner. Related studies were primarily published in the last five years, showing an ongoing interest in this research domain. Shen et al. investigated in 2015 the App Markets of Android, iPhone, BlackBerry, Nokia, and Windows with qualitative content analysis. Their review of 243 apps reveals a need for standardized reporting in app stores to help users select the appropriate app. However, it is somewhat outdated for a vital topic like the app domain since the main app markets remain from Android and Apple. Another study comes from Huguet et

al. (2016). Their review of 117 apps in commercial markets and scientific literature criticized the non-existence of effectiveness studies of these apps. As a result, an evaluation of the utility of these information technology artifacts is somewhat questionable. The study of Stawarz et al. (2018) focuses on app functionalities and user reviews of cognitive-behavioral therapy apps for depression and other mental well-being apps. Their analysis reveals that app developers need to improve their solutions' according to evidence-based cognitive behavioral therapy elements. A study with a local focus on the German app market was published by Terhorst et al. (2018). Their qualitative review of 38 apps from Google and Apple's App Store examined a general lack of medical evidence for the usability of such apps. One year later, Marschall et al. (2019) investigated mobile mental health apps' medical effectiveness. Their investigation of app store descriptions identified that around 3.4 % of the analyzed apps had research to justify their medical efficacy. Another review of apps for depression came from Kerst et al. (2020). They conducted literature review of studies utilizing smartphone apps for depression and an additional qualitative study with professionals reveal that apps can be valuable tools for reducing depressive symptoms. In addition, professionals' attitudes to using these apps in practice were positive. Two other studies focused on apps for depression that we identified concentrated in dropout rates (Torus et al. 2020) and the usage of mobile mindfulness apps of young adults (Berg and Perich 2021). However, both studies did not investigate the app markets with an overall view on the functionalities and characteristics.

We found several articles that reviewed and structured apps for depression with or without a particular research focus, e.g., usability. Most of the studies used an underlying structured approach, e.g., the well-known PRISMA-scheme by Moher et al. (2005), and combined it with qualitative content analysis to derive the results. We did not find any study that uses a taxonomic approach towards a classification in the form of a taxonomy. More important, none of the identified related studies performed clustering techniques to identify archetypical app configurations.

Methodology Approach Towards a Taxonomy of Applications for Depression

Taxonomies play an essential role in information systems research, e.g., structuring and organizing a domain of interest. Generally, a taxonomy is suitable for building up in-depth knowledge about the objects (Glass and Vessey 1995; Nickerson et al. 2013). Nickerson et al. (2013: 1) mentioned, „a fundamental problem in many disciplines is the classification of objects of interest into taxonomies.“ Consequently, by proposing a taxonomy to understand the dimensions and characteristics of apps for depression and their interrelated connections in archetypes, we analyze the domain in a structured manner. To date, it has become the „most prominent and widely used approach in the field“ (Schöbel et al. 2020: 647). Therefore, by proposing a taxonomy to understand the dimensions and characteristics of apps for depression and their archetypes, we analyze the domain in a structured and well-accepted manner. Usually, the taxonomy development process begins with determining the meta characteristics and ending conditions. This is followed by either a Conceptual-to-Empirical (C2E) or an Empirical-to-Conceptual (E2C) approach to develop the taxonomy further. While this process is iterative, the current taxonomy is checked against the ending conditions. As a result, the development process ends or continues with a new C2E- or E2C-approach. In the following, we describe our adapted research design for each step of the taxonomy development and our dataset.

Definition of Meta-Characteristic. The meta-characteristic is defined as the most inclusive characteristic. As a result, it serves as a basis for all dimensions and characteristics that follow (Nickerson et al. 2013). To be valid, the meta-characteristic must reflect the expected users and purpose of the taxonomy (Nickerson et al. 2013). We decided that the perspective of the activities of its intended users of the apps for depression makes the most sense for our meta-characteristic. The taxonomy aims to determine and present the dimensions and characteristics of app usage for depression. From this perspective, we can identify potential pitfalls in descriptions of what the app intends to deliver and derive meaningful recommendations from it. As a result, we define the meta-characteristic for this taxonomy *as health services provided through apps in the area of treatment or support for depression from the perspective of its health consumers*. As suggested by Kundisch et al. (2021), we constantly compare the meta-characteristic with the included objects in our taxonomic process.

Definition of Ending Conditions. Nickerson et al. (2013) provide two defining factors of a taxonomy: mutual exclusivity and collective exhaustiveness. In addition, seven objective and five subjective ending

conditions must be met to terminate the taxonomy development procedure. We aim at meeting six objective and all five ending conditions in our final taxonomy. We excluded the objective ending condition „every combination of characteristics is unique“ since we identified that this condition would not be met according to the characteristics of our objects. We will discuss this issue in the discussion section later. In our online appendix [here](#) (Table A), we that show which defining factors and subjective and objective ending conditions were met at the end of each iteration of our taxonomy development can be found here.

1st Iteration - Conceptual-to-Empirical. The objects we classify are apps for depression that were found through a search of the German App Stores of Apple and Android, the Digital Health Applications Directory (DiGA) provided by the German Federal Institute for Drugs and Medical Devices (BfArM) (German Federal Institute for Drugs and Medical Devices 2022). and the HealthOn database (HealthOn 2022). DiGa and HealthOn also provide an overview of relevant apps for depression in the market. We used the term „depression“ for the search process within these databases. Apps that were included in the taxonomy must (1) be available in the German Apple or Android App Store or be part of the DiGa or HealthOn directory, (2) descriptions of the apps must be available in at least either German or English and (3) have at least the term „depression“ stated in the title or description. Some apps that came up during the search process that did not focus on depression were excluded from the taxonomy, e.g., the app Mindshine: Mental Health Coach. As a result, these apps did not meet our meta-characteristic. Where descriptions did not provide enough information to classify the app for the taxonomy, we downloaded and tested the apps to identify important specifications. We chose to include apps from the DiGa and HealthOn databases because several apps for depression, e.g., Deprexis or Moodgym, were not listed within the common app stores. As a result, we wanted to obtain a more diverse view of the apps available on the market. Figure 1 shows the dimensions progression within our development process. It shows the introduction of new dimensions, dimensions that were split up, and established dimensions through the iterative process.

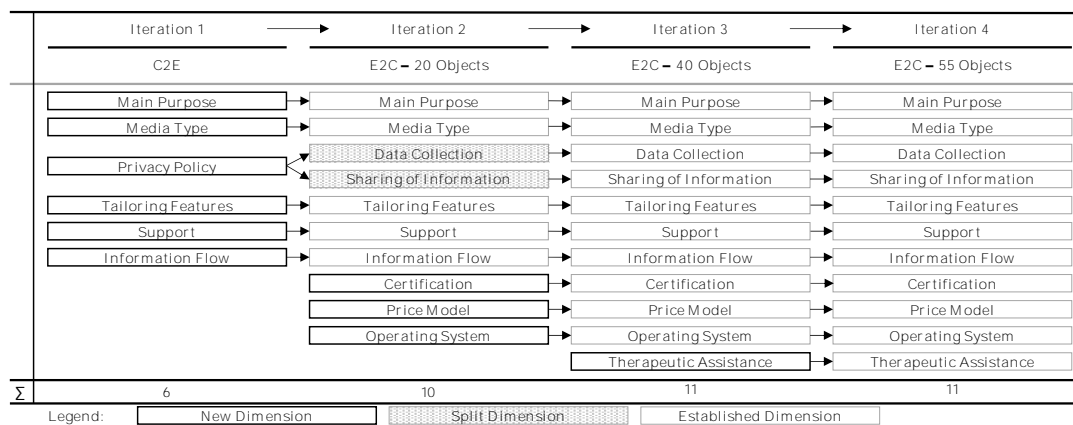


Figure 1. Dimensions Progression

In the first iteration, the C2E-approach was used. Based mainly on existing literature on eHealth apps, we created a preliminary taxonomy consisting of six dimensions. In regards to the Shen et al. (2015) classification of mental health apps, we chose *Main Purpose* as our first dimension with the characteristic „Psychoeducation“, meaning that the app provides educational material on the subject of depression. „Medical Assessment“, „Symptom Management“, „Supportive Resources“, „Therapeutic Treatment“ and „Multiple Purposes“ constitute the remaining characteristics of the *Main Purpose* dimension. A list of definitions for the characteristics of all dimensions is provided on our online appendix [here](#). To portray the transparency aspect of data processing, we constructed the dimension *Privacy Policy* with the characteristics being „Yes“ and „No“ to capture the availability of a privacy policy (Huguet et al. 2016). The next dimension, *Media Type* („Audio Only“, „Text Only“, „Pictures Only“, „Video Only“, „Visual“, „Multimedia“) was adopted from the content analysis of the depression marketplace of Shen et al. (2015). Concerning the personalization of apps, we chose the dimension *Tailoring Features* („Interface Customization“, „Treatment-oriented Customization“, „App-driven Tailoring“, „Mood-Driven Tailoring“, „Customization of Push Notifications“, „Multiple“). The dimension mentioned as well as the dimension *Support* („Information on External Support“, „Direct Personal Support“, „Integrated Safety Plan“, „None“) originated from the Systematic Search and Analysis of Engagement and Tailoring Features for Mobile Apps for Anxiety of Balakas et al. (2021). The last dimension of our preliminary taxonomy *Information Flow*

(„Informational“; „Reporting“; „Interactive“) is taken from the taxonomy of mobile applications of Nickerson et al. (2013). We continued the development process since this preliminary taxonomy did not meet the ending conditions.

2nd Iteration - Empirical-to-Conceptual. For the second iteration, we used the E2C-approach by choosing a random sample of 20 apps and classifying them into our preliminary taxonomy. We discovered new features of the apps that we implemented as new dimensions and from which we derived modifications to existing dimensions. We found that all viewed objects in this iteration delivered access to a privacy policy. Hence, we split the dimension into two new dimensions *Data Collection* („Yes“; „No“) and *Sharing of Information* („App Provider Only“; „App Provider and Service Providers“; „Other Third-Party Providers“). We also established three new dimensions. The first one *Certification* („Yes“; „No“) allows the classification of apps that are authorized as medical products. As our second new dimension, we chose the *Price Model* with its characteristics „Free“, „Freemium (Subscription)“, „Freemium (One-time-payment)“, „Premium (One-time-payment)“ and „On Prescription“. Defining the dimension *Operating System* („Mobile“; „Web“; „Both“) concludes the third iteration. Since only having looked at a small number of objects and not meeting the defining factors and ending conditions of a taxonomy, further development was necessary.

3rd Iteration - Empirical-to-Conceptual. Within the third iteration, the E2C-approach was used again. Through classifying another set of 20 objects, we were able to derive an additional three characteristics to the *Price Model* dimension („Freemium (Hybrid)“; „Premium (One-time-payment, Refundable)“; „Premium (Subscription, Refundable)“). We also modified the dimension *Data Collection* by splitting the characteristic „Yes“ into two more refined characteristics being „Yes, Only Usage Data“ and „Yes, Usage and Personal Data“. Furthermore, we decided to remove the characteristics „Pictures Only“ and „Video Only“ from the *Media Type* dimension since there was no object to be classified within these characteristics. Additionally, we developed *Therapeutic Assistance* as a new dimension with the characteristics „Independent“, „Therapist Contact Possible“ and „Compulsory Assistance“. Having modified and added new dimensions to the taxonomy, we violated several objective and subjective ending conditions. Therefore, we continued the taxonomy development process.

4th Iteration - Empirical-to-Conceptual. During the classification of the last 15 objects, there was no need to add or modify any dimensions or characteristics, leading to the termination of the taxonomy development process after the fourth iteration. Since no new dimension or characteristic arose, we identified that we included and investigated a representative sample of objects. Table 2 presents the final taxonomy consisting of eleven dimensions and 46 characteristics with the number of occurrences stated for each characteristic. All 55 apps in the definitive taxonomy and a list of apps in each cluster can be found in our online appendix [here](#).

Dimension	Characteristics								
Main Purpose	Psychoeducation (13)		Medical Assessment (7)		Symptom Management (4)		Supportive Resources (2)	Therapeutic Treatment (7)	Multiple Purposes (22)
Media Type	Audio only (1)		Text only (11)			Visual (7)		Multimedia (36)	
Data Collection	Yes, Only Usage Data (13)			Yes, Usage and Personal Data (36)			None (6)		
Sharing of Information	App Provider Only (19)			App Provider and Service Providers (25)			Other Third-Party Providers (11)		
Tailoring Features	Interface Customization (7)	Treatment-oriented Customization (2)	App-driven Tailoring (1)	Mood-driven Tailoring (4)	Customization of Push Notifications (12)		Multiple (16)	None (13)	
Support	Information on External Support (18)			Direct Personal Support (8)		Integrated Safety Plan (4)		None (25)	
Information Flow	Informational (4)			Reporting (4)			Interactive (47)		
Certification	Yes (9)				No (46)				
Price Model	Free (23)	Freemium (Subscription) (16)	Freemium (One-time-Payment) (2)	Freemium (Hybrid) (3)	Premium (One-time-Payment) (2)	Premium (One-time-Payment, Refundable) (5)	Premium (Subscription, Refundable) (2)	On Prescription (2)	
Operating System	Mobile (37)			Web (6)			Both (12)		
Therapeutic Assistance	Independent (41)			Therapist Contact Possible (6)			Compulsory Assistance (8)		

Table 1. Final Taxonomy (with number of occurrences for each characteristic), n=55 Apps

Cluster Analysis and Archetypes of Applications for Depression

To address RQ2, we conducted a cluster analysis, based on our taxonomy derived, to empirically identify typical patterns (archetypes) of apps for depression. Archetypes are useful to complement the knowledge

about a given domain about the differentiation of the objects. Therefore, we expand the information provided that the taxonomy alone cannot deliver (Möller et al. 2021). We identified clusters with cluster analysis. Generally, a cluster analysis aims to find groups of classified objects that minimize differences and maximize differences between groups (Kaufman and Rousseeuw 1990). We chose the k-means clustering technique to partition a data set into k groups or clusters. The k-means clustering thereby minimizes the variance within each cluster [total within-cluster sum of square (WSS)], moving the objects iteratively to the nearest clusters' centroid (Punj and Stewart 1983). To determine the ideal number of clusters, we used the „Silhouette“ method that calculates the average silhouette width and the „Elbow“ method that minimizes the WSS for k clusters. Applying both techniques to our dataset resulted in a recommended number of six clusters. Based on these findings, we performed the cluster analysis with six clusters using R Studio. The results are shown in Table 2, with the clusters' numeration being in ascending order based on the number of apps per cluster and each characteristic's percentage share within each cluster and corresponding shading ranging from 0% (light) to 100 % (dark). For example, 75% of apps in the first cluster offer no support to the user, whereas 25% provide an integrated safety plan.

Cluster 1 – Mobile Symptom Management and Self-Monitoring. The first cluster includes apps for independent mood tracking and monitoring symptoms and feelings. All apps are solely to observe one's symptoms and emotions over time. For example, the app Moodistory provides a colored visualization. The user only provides information that can indicate their current mood via emojis or diary entries. The majority of apps offer no support. Only one app offers the option to create a safety plan that can be retrieved when in need of help. All apps provide possibilities for individualization, e.g., changing the color scheme or customizing emojis that indicate the current mood.

Cluster 2 – Refundable Online Therapy. Apps in our second cluster provide a platform for online therapy via video call. All apps are web-based, with some apps also providing their service via mobile apps. This online supporting treatment is either subscription-based or accessible via one-time payment, both of which can be reimbursed by health insurance. Using the apps involves a compulsory therapist accompaniment during therapy sessions. Apart from that, only one app offers personal support in a crisis situation, e.g., Minddoc, whereas the remaining apps provide information on external support. Hosting the therapy sessions requires the app provider to use tools for video calling offered by third-party service providers and thus share user data with them.

Cluster 3 – Certified Internet-based Cognitive Behavioral Therapy Apps. The apps in this cluster are certified interventions providing structured psychotherapy mainly with methods from cognitive behavioral therapy offering extensive support for their users, e.g., personal support in case of an emergency and the possibility if not an obligation of therapist assistance. All apps are premium/one-time payment products whose costs are refundable by health insurance for most apps, e.g., the app Selfapy is part of the DiGA directory, meaning their course is accessible on prescription. Most apps fulfill high data security standards, i.e., keeping collected data with the app provider and not sharing it with other service providers.

Cluster 4 – Free Psychoeducational Apps with a High Claim on Data Protection. Cluster 4 includes primarily free apps that offer mainly psychoeducational services and, in some cases, additional services like depression tests or mood tracking features. Most apps only collect usage data, if not data at all. The data collected is not shared with any other third party for most apps, from which a high claim on data security can be deduced. All apps use more than one media type and incorporate a highly interactive yet independent app usage.

Cluster 5 – Self Screening with Additional Text-based Informative Resources. Most of the apps included in this cluster provide a medical assessment feature (e.g., Depressionstest+) to evaluate the severeness of depression. At the same time, some of the apps also offer additional psychoeducational information (e.g., Dealing with Depression). Due to the apps primarily providing depression tests, they are mainly text-based and offer little to no support in case of crisis. As a result, the users receive a first indication based on the self-screening without further supervision, e.g., therapists.

Cluster 6 – Multipurpose Individualized Self Help. Our biggest cluster contains apps that primarily serve multiple purposes combining different services and various media types, e.g., the Remente app offers its users the to track their moods and set goals while also providing tips on self-help in video form. Nearly every app provides an opportunity to customize it, primarily offering the possibility to set a reminder to use the app regularly. Almost all apps in this cluster provide a freemium subscription-based price model

meaning that only a fraction of the features can be accessed in the free version. Purchasing the full version gives access to more functionalities, e.g., graphical visualization of mood changes, more courses, and informative resources to choose from.

Dimension	Characteristic	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
		4 Apps	5 Apps	6 Apps	9 Apps	15 Apps	16 Apps
Main Purpose	Psychoeducation	0%	0%	50%	44%	27%	13%
	Medical Assessment	0%	0%	0%	0%	40%	6%
	Symptom Management	100%	0%	0%	0%	0%	0%
	Supportive Resources	0%	0%	0%	0%	7%	6%
	Therapeutic Treatment	0%	100%	0%	0%	7%	6%
	Multiple Purposes	0%	0%	50%	56%	20%	69%
Media Type	Audio Only	0%	0%	0%	0%	7%	0%
	Text Only	0%	0%	0%	0%	73%	0%
	Visual	0%	0%	0%	0%	13%	6%
	Multimedia	100%	100%	100%	100%	0%	94%
Data Collection	Yes, Only Usage Data	25%	0%	17%	78%	27%	0%
	Yes, Usage and Personal Data	25%	100%	83%	11%	53%	100%
	None	50%	0%	0%	11%	20%	0%
Sharing of Information	App Provider Only	100%	0%	83%	78%	13%	6%
	App Provider and Service Providers	0%	80%	0%	22%	73%	50%
	Other Third-Party Providers	0%	20%	17%	0%	13%	44%
Tailoring Features	Interface Customization	0%	0%	0%	11%	40%	0%
	Treatment-oriented Customization	0%	0%	17%	0%	7%	0%
	App-driven Tailoring	0%	0%	0%	0%	0%	6%
	Mood-driven Tailoring	25%	0%	33%	0%	7%	0%
	Customization of Push Notifications	0%	20%	0%	33%	7%	44%
	Multiple	75%	0%	33%	22%	13%	44%
Support	Information on External Support	0%	80%	50%	44%	20%	25%
	Direct Personal Support	0%	20%	50%	11%	0%	19%
	Integrated Safety Plan	25%	0%	0%	22%	0%	6%
	None	75%	0%	0%	22%	80%	50%
Information Flow	Informational	0%	0%	0%	0%	20%	6%
	Reporting	100%	0%	0%	0%	0%	0%
	Interactive	0%	100%	100%	100%	80%	94%
Certification	Yes	0%	0%	100%	11%	0%	13%
	No	100%	100%	0%	89%	100%	87%
Price Model	Free	50%	0%	0%	89%	80%	6%
	Freemium (Subscription)	25%	0%	0%	11%	7%	81%
	Freemium (One-time-Payment)	0%	0%	17%	0%	7%	0%
	Freemium (Hybrid)	0%	0%	0%	0%	7%	13%
	Premium (One-time-Payment)	25%	0%	0%	0%	0%	0%
	Premium (One-time-Payment, Refundable)	0%	40%	0%	0%	0%	0%
	Premium (Subscription, Refundable)	0%	0%	33%	0%	0%	0%
On Prescription	0%	60%	50%	0%	0%	0%	
Operating System	Mobile	75%	0%	0%	67%	93%	88%
	Web	0%	40%	33%	22%	0%	0%
	Both	25%	60%	67%	11%	7%	13%
Therapeutic Assistance	Independent	100%	0%	17%	89%	100%	81%
	Therapist Contact Possible	0%	0%	50%	0%	0%	19%
	Compulsory Assistance	0%	100%	33%	11%	0%	0%

Table 2. Results of the Cluster Analysis

Results, Discussion, Implications, and Recommendations

Regarding our clustering results, it is noticeable that there is a high number of occurrences for characteristics that apply when more than one other characteristic in the respective dimension is given, e.g., „Multiple“ in the *Tailoring Features* dimension. This is because the characteristic „Customization of Push Notifications“ is mainly provided. Therefore, any other tailoring feature that apps might have automatically leads to classification within the „Multiple“ characteristic. The same applies to the *Main Purpose* dimension. This made the development process somewhat difficult but was necessary because otherwise, the defining factor of mutual exclusiveness and the subjective ending conditions covering conciseness and robustness would have been violated. For the same reason, we also decided to exclude the objective ending condition „every combination of characteristics is unique“ because we found it challenging to be met with many apps falling into the „Multiple“ characteristic.

Cluster 4 to 6 provide an overlap regarding their characteristics and dimensions. For example, Clusters 4 and 6 include apps that use multimedia as their major media type and mainly offer multiple services to be used independently. In the dimensions *Certification*, *Therapeutic Assistance*, and *Information Flow*, the numbers of occurrences of the characteristics are also very much alike. However, they show a significant difference in the two dimensions *Price Model* and *Sharing of Information*. This indicates that even apps that seem similar can differ in specific ways. Therefore, choosing a suitable app as a consumer is dependent on an individual decision according to the users' preference. Here, we argue that the taxonomy should be considered as a supplemental information source by interested users to see more detailed differences between the dimensions and characteristics that the clustering cannot provide. This would help to choose the right app for own purposes.

Regarding the aspect of data protection, it is noticeable that there are three clusters (i.e., Clusters 1, 3, and 4) with a high claim on this topic. This can be derived from the high number of occurrences of the characteristic „App Provider Only“ in the *Sharing of Information* dimension. Considering that privacy and security of user data have a high impact on the decision of whether to use the app as a consumer or to recommend the app as a therapist (e.g., Schueller et al. 2016), developers should orientate themselves on the apps included in the named clusters if they plan to offer apps for depression with a high claim on data protection.

Concerning the price model of the different apps, we see that there are four clusters (i.e., Clusters 1, 4, 5, and 6) that have numerous amounts of varying price models (e.g., Free, Freemium (Subscription), Freemium (One-time-payment)). It is evident that the premium price model (e.g., Premium (Subscription, Refundable), (On Prescription) is only, with the exemption of one app in Cluster 1, associated with certified apps (e.g., Novego) or those that offer actual online therapy (e.g., Mentavio). From that, it can be derived that providing a premium product to the user requires the app to be certified as a medical product.

The final taxonomy and the presented clusters provide relevant dimensions, characteristics, patterns, and differences to structure the field of apps for depression. Therefore, our study can serve as a systematic discussion platform among academics and practitioners about the status quo of the eHealth domain, especially for depression. The expandable nature of our taxonomy allows researchers and practitioners to modify, merge, add and delete characteristics and dimensions according to the most current state of the art in the app market.

The taxonomy provided in our study can serve as a meaningful knowledge foundation for high-order theory building (Gregor 2006), e.g., a tailored acceptance theory especially designed in the case of apps for depression. A survey of acceptance and usage of eHealth apps with diverse stakeholders, e.g., medical students and patients showed that around 15.0% of the 80 students and 41.2% of the 85 patients knew at least one eHealth app, few had already tried one (1 student, 22 patients) (Mayer et al. 2019). Regarding evidence-based iCBT solutions, acceptance and moderating factors such as social influence or gender have been crucial for using such services (e.g., Baumeister et al. 2014). From an academic perspective, our study can be a starting point for future research towards a better understanding of acceptance and critical success factors to improve acceptance and usage of apps for depression.

Besides providing a rigorous classification that can be a starting point for further research directions, (mobile) app developers can benefit from our insights when comparing with competitors. Furthermore, we provide support to advance their apps with new services. (Potential new) users of apps for depression can use our taxonomy and archetypes to support selecting an appropriate app that optimizes their personal needs and interests, e.g., regarding high claims on data protection or specific price models. However, supplemental visualizations, e.g., a decision tree, that is based on the information provided in this study can enhance the usefulness of the results and leave room for further discussions.

Limitations, Future Research Directions, and Conclusion

The study's limitations can guide future research on the field of apps for depression. Firstly, we classified a sample of 55 apps to develop our taxonomy. We stopped the development process since we felt that the sample was representative according to the predefined ending condition. However, with the usage of databases located in Germany (DiGa and HealthOn), still, future research can evaluate the applicability of our taxonomy with new objects, especially with apps from other geographical regions. This would determine the stability of the proposed taxonomy in more detail (Kundisch et al. 2021). We did not evaluate the

taxonomy and archetypes by third parties. Therefore, conducting interviews with, e.g., app developers or psychotherapists can be advantageous towards an evaluation of its usefulness. Another avenue for future research is measuring the success of the investigated apps, e.g., with the success model proposed by DeLone and McLean (2004). In our iterations, it became apparent that download numbers, review counts, and ratings differ between the apps within the archetypes if they were listed within Google's Play Store or Apple's App Store. This point was also identified by Meyer and Okubuyejo in 2019 in their Emergent Research Forum paper for the Android market. Success measurements enable meaningful design principles, e.g., with guidance from Gregor et al. (2020), for more successful app designs.

Apps for depression can lead to meaningful improvements in health behavior for patients and users but also for families and society. To shed light on this (mobile) health app domain, we developed a taxonomy and classified 55 apps for depression (RQ1). We were able to identify eleven dimensions and 46 corresponding characteristics. We examined six distinct archetypes of these apps based on cluster analysis (RQ2). Our research investigated the field in a structured manner and can ignite a more nuanced discussion among academics and professionals.

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