

# Backend Concept of the eSano eHealth Platform for Internet- and Mobile-based Interventions\*

Abdul Rahman Idrees<sup>1,2</sup>, Robin Kraft<sup>1,2</sup>, Rüdiger Pryss<sup>3</sup>, Manfred Reichert<sup>2</sup>, Tran Nguyen<sup>1</sup>,  
Lena Stenzel<sup>1</sup> and Harald Baumeister<sup>1</sup>

<sup>1</sup>Department of Clinical Psychology and Psychotherapy, Ulm University, Germany

<sup>2</sup>Institute of Databases and Information Systems, Ulm University, Germany

<sup>3</sup>Institute of Clinical Epidemiology and Biometry, University of Würzburg, Germany

**Abstract**—Mental disorders represent an ongoing challenge to global health and can affect anyone at any age from any region in the world. The response of healthcare providers to mental health disorders still lags behind that of other diseases and a significant number of people who are affected by mental health disorders do not receive adequate treatment. The widespread usage of Internet-connected devices provides new opportunities to deliver treatment to more people using innovative approaches. The groundwork is being laid for the adoption of Internet- and mobile-based interventions, providing mental and behavioral health support to more people and narrowing the treatment gap. This paper discusses the main technical details of the backend API of the eSano eHealth platform as an example for a complex and comprehensive IT-framework for large-scale and flexible Internet- and mobile-based interventions. An overview of eSano is provided and the platform is compared with other technical solutions in the field. In addition, the components of eSano are described and further technical insights are elaborated in more detail. To this end, the work at hand demonstrates the main requirements of the backend API powering eSano, its concepts and the overall developed solution. It will as such inform researchers and practitioners about state-of-the-art backend API development in the eHealth context.

**Index Terms**—eHealth-Platforms, eSano, Internet-Interventions, Mental-Disorders, Behavior-Change

## I. INTRODUCTION

Recent studies show that mental and behavioral disorders are very common. Mental disorders represent 13% [1] of the global burden of diseases. In a report published in 2010 [2], it was found that mental and behavioral disorders increased by 37.6% over the course of two decades from 1990 to 2010. The report indicates that mental and behavioral disorders are the main contributors to disability worldwide, with depressive disorders representing 40.5% of this statistic. More recently, according to [3], it was found that one in three elderly people in Europe had experienced a mental disorder in the previous year and one in four still lives with one. Looking at other regions, 46% of the population of the United States — approximately 150 million people — experience a mental health disorder in their lifetime [4].

This research was partially funded by PSYCHOnlineTHERAPY and CHIMPS-NET funded by the Innovation Committee of the Joint Federal Committee (Gemeinsamer Bundesausschuss, gBA, no: 01NVF18036 and 01NVF18003) as well as ProTransition funded by the Ministry of Social Affairs and Integration, Baden-Württemberg.

These numbers are likely to be low estimates, due to the fact that some disorders were omitted from the survey [4]. 70% of people with mental illness are not currently receiving treatment [4]. These figures indicate that there is a significant treatment gap. Additionally, this gap is even more noticeable among ethnic minority groups [4]. Mental health treatment gaps are a global issue. However, statistics vary among regions and are illness-specific. In Europe, for example, the treatment gap for late-life depression amounts to 79% [5]. In developing countries, between 76% and 85% of people who struggle with mental disorders did not receive treatment in the previous year [6].

Novel approaches should be considered when trying to overcome this issue. Recent developments have suggested that Internet interventions may be a promising method of delivering treatment to people who would otherwise fall into the treatment gap [7]. Findings from [8] show that guided interventions may yield similar outcomes when compared to face-to-face therapy for several mental disorders. [8] indicates that guided interventions are also effective in treatment of depression and anxiety disorders. Baumeister et al. [9] suggest that the eCoaching in Internet interventions by staff with lower qualification standards than experienced clinicians might provide similar effects, however, without implementation effects and potential adverse event prevention being well studied in this context. Anyway, these aspects would mean that such interventions could be provided to a wider number of people. [10] also suggests that Internet- and mobile-based interventions (IMIs) can reach potentially more and — even more importantly — other people than traditional treatments. Furthermore, it could reduce costs and increase effectiveness when introduced alongside traditional treatment activities [10]. A prerequisite of such IMI represents the IT-framework necessary to run the interventions not only in controlled environments such as randomized controlled trials (RCTs) but also in routine care.

This paper provides a technical overview of the eHealth platform *eSano* [11] as an example of a comprehensive and complex IT-framework for delivering Internet- and mobile-based interventions. More specifically, the requirements, design and implementation for the backend that powers the eSano platform are described. Furthermore, it is explained how the platform enables the use of therapeutically unguided

or guided interventions that can be used both as standalone intervention or in a blended care scenario.

The remainder of this paper is organized as follows: Section II gives an overview of related work including similar platforms and compares these platforms to eSano. Section III shows the concept of the eSano eHealth platform, the overview of its structure, and how it operates. Section IV discusses the main requirements of the platform and the concepts used to implement the overall platform solution. Section V provides more detailed descriptions of the underlying implementations of the backend. Section VI discusses the current uses of eSano and its shortcomings. Finally, section VII provides an outlook for future plans and a conclusion for the paper.

## II. RELATED WORKS

Delivering health treatment over the Internet continues to gain the attention of researchers [12]. Several research-initiated platforms and applications already exist that aim to improve the quality of life for their users and treat mental disorders. Iterapi is a multilanguage Internet-based platform developed by the Department of Behavioral Sciences and Learning at Linköping University in Sweden. The goal of the app is to help users cope with their mental and behavioral symptoms [13]. The platform is flexible and allows treatment courses to be developed for a wide range of psychological and health challenges [13]. Treatment components include worksheets, text, audio and video communications, a discussion forum and a questionnaire module. Moodbuster is another platform that leverages the Internet to deliver psychological treatments<sup>1</sup>. It was developed by Vrije Universiteit Amsterdam. Currently, the platform offers six online modules that use cognitive behavioral therapy treatment to treat depression. Its content includes text and videos. Users of the platform are also offered exercises and home-works<sup>1</sup> [14]. As part of the Australian government mission to promote eHealth, they developed an eHealth platform named Mindspot. It has been made available to adult Australian citizens who are suffering from symptoms of anxiety and depression [15]. Mindspot offers online assessments, information about local mental health support and Internet-delivered cognitive behaviour therapy (ICBT) guided by therapists [15]. Furthermore, several commercial platforms are also readily available. Minddistrict is a web-based eHealth platform designed to contribute to the prevention of mental illness and provide after-care<sup>2</sup> [16]. The platform offers a Content Management System (CMS) to enable health care providers to create and customize interventions based on their specific needs. They can also monitor patient progress via the dashboard. Other features include video sessions, social support, plan design and patient questionnaires<sup>2</sup>. SilverCloud<sup>3</sup> and online-therapy<sup>4</sup> are

<sup>1</sup><https://www.moodbuster.science/>

<sup>2</sup><https://www.minddistrict.com/>

<sup>3</sup><https://www.silvercloudhealth.com/>

<sup>4</sup><https://www.online-therapy.com/>

two examples of commercially available platforms, without much information available about their internal components.

Table I shows a comparison between the features of each of the platforms mentioned above. It can be seen that eSano already provides most of the features available on the other platforms. Furthermore, eSano enables researchers to develop new interventions for mental disorders, as well as chronic somatic diseases and health behaviour risk factors, without being bound by commercial requirements or boundaries of existing projects [11]. In addition, the flexible platform allows the development, integration and investigation of new, innovative eHealth approaches without the need to make any changes or updates to the source code, thanks to the accessibility of the CMS. Additionally, eSano allows text communication between intervention supervisors and participants and it provides a journal feature which enables participants to keep a regular journal of their activities. It also comes with multilanguage support which means that interventions can be provided in different languages. Since eSano is a research-based platform, there is a lot of room for research and experimentation with new concepts. For example, social support elements are already implemented and could be integrated into eSano interventions with the intention of increasing user motivation and engagement with the participants' app. Gamification is also another concept that has been integrated into eSano. Both of these two features will be evaluated and tested soon. Moreover, new features for eSano will be added (see Section VI for more details).

## III. CONCEPT

The eSano platform provides tools to enable researchers and clinicians to develop a wide range of behavioral and/or mental health IMI in a variety of possible implementation scenarios and to provide these interventions to users (patients, people with prevention and health promotion demands, health care professionals, researchers etc.). As mentioned by [11], the platform is comprised of three parts that are connected together through one central backend. The three parts are: a CMS, an eCoach platform, and the participant application. The CMS and the eCoach platform are both web applications that can be accessed via any web browser, such as Google's Chrome or the Microsoft's Edge. The participant application is a cross-platform app that runs as a web app and also on Android and iOS platforms. The platform is empowered by one backend that enables communications to run smoothly between the three parts of the platform. Furthermore, the backend relies on one central database to store the data of the platform. The participant app is used to provide users access to their intervention courses. Users of the participant app are not required to have knowledge of the rest of the platform and all their interactions happen exclusively through this app. The CMS is where clinicians and researchers develop their interventions — possibly across the whole spectrum of mental- and behavioral health interventions — which are then made available through the platform. Finally, the eCoach platform is where eCoaches

TABLE I  
PLATFORM COMPARISON

Feature/Platform	eSano	Iterapi	Moodbuster	Mindspot	Minddistrict	SilverCloud	online-therapy
Evidence-based	Yes	Yes	Yes	Yes	Yes	Yes	No
Course design	Flexible	Flexible	Flexible	Not flexible	Flexible	N/A	N/A
Multi-language	Yes	Yes	Yes	No	Yes	No	No
Video sessions	No	Yes	No	No	Yes	No	Yes
Text communication	Yes	Yes	No	N/A	Yes	Yes	Yes
Journals	Yes	Yes	No	No	Yes	No	Yes
Commercial	No	No	Yes	No	Yes	Yes	Yes
Platform	Web/mobile	Web	N/A	Web/mobile	Web/mobile	Web/mobile	Web/mobile
Availability	Globally	Globally	Globally	Australia	Globally	Globally	Globally

manage the treatment courses of their participants. Through the eCoach platform, guidance can be offered to users. eCoaches, in turn, can then monitor the progress of each of their users and provide them with feedback and support.

Communication between the three applications of the platform and the backend is compatible with the REpresentational State Transfer (REST) architectural style. The principles of the REST architectural style were firstly introduced by Roy Fielding in his work "Architectural Styles and the Design of Network-based Software Architectures" [17]. REST architecture principles serve as standards to help systems communicate with each other in a stateless manner [17]. Such communications are performed by using RESTful APIs (application programming interfaces), which are interfaces for the services. These APIs hide the complexity of the underlying functionalities from the clients; for eSano, for the CMS, the eCoach platform and the participant application. This enables the clients to perform the various required functionalities by simply communicating with the backend via the APIs.

#### IV. REQUIREMENTS

It was essential for the eSano backend to be flexible and scalable in order to have a prototype that is even ready for its practical use and to enable continuation/scaling of the development of the eSano platform. One even more challenging aspect of eSano's development was to provide researchers and clinicians with the ability to develop new interventions themselves and publish them for users without the need for any adjustments or changes to the source code. To the lack of space, in Table II, only the major functional requirements of the eSano platform are presented in terms of their API endpoints. These requirements are discussed in more detail within this section.

An authorization mechanism is used to control what data each user is allowed to access. APIs are organized into groups and an authorization middleware is used to control which users are allowed to access which APIs. Furthermore, inside each API, another protection layer filters the coming requests based on what permissions the user has on the requested resources (Req. 1). Adding new users to the platform is done via the admins or the eCoaches. An invitation is sent to people who are interested in participating in a certain intervention via an email with more details on

TABLE II  
MAJOR REQUIREMENTS OF ESANO IN TERMS OF API ENDPOINTS

ID	Requirements	APIs
1	authentication and authorization mechanisms	POST auth/login
2	Users Accounts Managements	POST admin/auth/assign/register POST ech/auth/register POST admin/auth/reactivate POST admin/users/{ID} DELETE ech/users/nonverified
3	Interventions Development	POST editor/interventions PATCH /editor/interventions/{ID} POST editor/interventions/{ID}/questionnaires POST questionnaires/{ID}/elements
4	Intervention Configuration	POST ech/interventions/instances PATCH ech/interventions/instances/{ID} PATCH ech/interventions/instances/unlock
5	Monitoring	GET e/members/{ID}/interventions/instances GET ech/interventions/instances/{ID}/activities PATCH ech/interventions/instances/{ID}/state PATCH ech/interventions/instances/{ID}/feedback PATCH ech/interventions/instances/unlock
6	User-eCoach Communication	POST e/messages/threads GET ech/interventions/instances/{ID}/threads GET ech/messages/folders/inbox GET messages/threads/{ID} POST /messages/threads
7	Reminders	POST ech/users/{ID}/email GET ech/users/{ID}/unread/feedback

how to activate their accounts and how to further proceed (Req. 2). The platform enables clinicians and researchers to create new interventions inside the platform. Interventions are created inside groups and each intervention can contain a different number of lessons, while each lesson contains a different number of elements of different types. Intervention developers can add lessons to interventions and adjust the contents of the lessons. The content can contain text, audio, images, videos or a combination of these, with different styling options (Req. 3). Furthermore, conditional elements are also available, which can only be used conditionally, based on certain answers provided by the users throughout the intervention course [11]. eCoaches also have the option to adapt an intervention to the specific needs of each user (before and during the treatment) (Req. 4). User supervision



TABLE III  
INTERVENTION INSTANCE STATE TRANSITIONS

T#	Current State	Available Lesson	Finished Lessons	Feedback Required	Feedback Provided	Feedback Read	To
T1	configuration	+1	-	False	null	null	active
T2	configuration	0	-	False	null	null	awaiting_next_lesson
T3	active	0	All	False	null	null	completed
T4	active	0	-	True	False	False	feedback_required
T5	feedback_required	0	-	False	True	False	feedback_provided
T6	feedback_provided	+1	-	-	-	-	active
T7	feedback_provided	0	-	-	-	-	awaiting_next_lesson
T8	awaiting_next_lesson	+1	-	-	-	-	active
T9	active	0	-	-	-	-	awaiting_next_lesson
T12	paused	0	-	-	-	-	awaiting_next_lesson
T13	paused	+1	-	-	-	-	active
T16	paused	0	-	True	-	-	feedback_required
T22	paused	0	-	False	True	-	feedback_provided
T23	feedback_provided	0	All	-	True	True	completed

TABLE IV  
STATES OF AN INTERVENTION INSTANCE

ID	State	Description
S0	configuration	The intervention instance is being configured and participants cannot start the treatment yet
S1	active	The intervention instance is available
S2	awaiting_next_lesson	No lessons are available for the participant
S3	feedback_required	The eCoach supervising the participant is invited to provide a feedback
S4	feedback_provided	The eCoach supervising the participant has provided a feedback and the participant is invited to read it
S5	paused	The eCoach supervising the patient has paused the instance. Temporary, the participant cannot access any lesson
S6	canceled	The intervention instance is canceled by the eCoach
S7	completed	The patient has finished all the available lessons

follows:

- Current state of the intervention instance.
- Number of available lessons.
- Number of finished lessons.
- Whether an eCoach's feedback is required.
- Whether feedback was provided or not.
- Whether feedback was read or not.

For example, in transition number three (T3), the state moves from *active* (S1) to *completed* (S7). This only occurs when there are no more available lessons for the participant, the participant has already finished all the lessons, and feedback is not required by the eCoach. This can be seen in Fig. 2, in the transitions T0, T1, and T3. Additionally, Table III does not show transitions from any state to either *paused* (S5) or *canceled* (S6) (T10, T11, T14, T15, T17, T18, T19, T20 and T21). This is because these transitions are triggered manually by an eCoach and do not get calculated

automatically.

## VI. LIMITATIONS AND CURRENT PRACTICAL USE

Although eSano has already fulfilled many of the initial functional and non-functional requirements, there is still room for improvements. Interoperability and scalability are two challenges that still await solutions. eSano is not yet able to communicate with other health systems to via Fast Healthcare Interoperability Resources (FHIR) standard. Scalability is another challenge facing eSano. Since the app has a central database, this could potentially lead to a dropdown in performance when the data exceeds a certain limit. One solution would be to employ microservices and organize the data over several smaller databases. eSano also still relies on eCoaches to send reminders to their users manually if, for example, the user did not go through a lesson that was made available after a certain amount of time has passed. Automatic reminders should be implemented to detect such cases and send reminders to users who have activated the reminders option in their profile. Other limitations include the lack of a mechanism to collect more data on the users via smart sensing. Such data can provide an understanding of the user experience and deliver better behavioral health treatments [20] [21]. Furthermore, the introduction of just-in-time adaptive interventions (JITAI) to eSano is still in its early stages and more research is needed before such interventions can be made available for users. However, eSano is already being used to improve the well-being of its users. An example of such use is the development of PSYCHOnlineTherapie (POT) [22] for the (accompanying) treatment of depressive disorders and anxiety disorders. The online modules of POT are based on cognitive behavioral therapy. The intervention contains lessons for depression, different anxiety disorders and other transdiagnostic modules (e.g., on loneliness, perfectionism, gratitude, sleep, physical activity). iCHIMPS is another IMI developed and delivered via eSano. This IMI aims to support adolescent children of parents struggling with mental health

disorders. A cluster-randomized controlled trial (cRCT) is already planned to evaluate the clinical effectiveness as well as cost-effectiveness of iCHIMPS against that of traditional treatment models [23]. Currently, there are already over 500 active users on the platform who have worked on more than 2800 unique answer sheets.

## VII. SUMMARY & OUTLOOK

This paper has discussed one possible solution to the global mental health treatment gap, in the form of an online mental health treatment tool. More specifically, it described the development of the backend powering eSano, which is an eHealth platform for Internet- and mobile-based interventions that could be utilized as a remote and easily accessible treatment tool for mental health disorders worldwide. The general workflow and concepts of the platform were presented. In addition, the key functional requirements of eSano were discussed, as well as the technical approaches, main interfaces and underlying features that were implemented in the backend to fulfill these requirements. Most importantly, the data model behind the platform and the concept of intervention instances were presented in more detail. Finally, technical and conceptual limitations of the platform were discussed and it was described how eSano is currently used in practice.

For future versions of eSano, some of the limitations (see Section VI) of the platform are planned to be addressed. These include the addition of new features, such as interfaces to external eHealth systems (e.g., via FHIR), personalization options and automatic reminders, as well as the integration of new scientific developments such as just-in-time adaptive interventions, smart sensing, and persuasiveness. Furthermore, the platform should be optimized in terms of scalability and privacy. Finally, when it comes to mental disorder interventions, user engagement is often an important factor. Therefore, as eSano continues to be developed, it is intended to focus on approaches that engage users and to create a convenient, easy-to-use, and trusted platform for patients, clinicians, and researchers.

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