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SOFTWARE-BASED APPROACH FOR SUPPORTING APPLIED BEHAVIOR ANALYSIS THERAPY

ABORDAGEM BASEADA EM *SOFTWARE* PARA APOIAR A TERAPIA DE ANÁLISE DO COMPORTAMENTO APLICADA

ENFOQUE BASADO EN SOFTWARE PARA APOYAR LA TERAPIA DE ANÁLISIS DE CONDUCTA APLICADA

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ABSTRACT

Clinics that use Applied Behavior Analysis therapy for individuals with Autism Spectrum Disorder face organizational, communication, and data integrity challenges, as the manual management of individualized therapeutic programs becomes inefficient, error-prone, and difficult to scale as the number of patients and therapists increases. To address this problem, this paper presents a software-based approach implemented as a web application, MAPsi, that provides a customizable digital workflow for the systematic registration and management of patients, collaborators, programs, and evaluations. The evaluation of the proposed solution is theoretically grounded in the Technology Acceptance Model (TAM) to measure perceived usefulness and ease of use, and the System Usability Scale (SUS) to assess overall system usability. The evaluation showed high user acceptance, with the software receiving excellent TAM scores for perceived usefulness (4.86 out of 5) and perceived ease of use (4.53 out of 5), and a SUS score of 89.75 out of 100, corresponding to an "A+" usability rating. This study employs an applied research design combining software development with user-based evaluation.

KEYWORDS: *Autism Spectrum Disorder. Applied Behavior Analysis. Health Informatics. Usability Evaluation.*

RESUMO

Clínicas que utilizam terapia de Análise do Comportamento Aplicada para indivíduos com Transtorno do Espectro Autista enfrentam desafios organizacionais, de comunicação e de integridade de dados, uma vez que o gerenciamento manual de programas terapêuticos individualizados torna-se ineficiente, propenso a erros e de difícil escalabilidade à medida que o número de pacientes e terapeutas aumenta. Para abordar esse problema, este artigo apresenta uma abordagem baseada em software, implementada como um aplicativo web chamado MAPsi, que fornece um fluxo de trabalho digital personalizável para o registro e o gerenciamento sistemáticos de pacientes, colaboradores, programas e avaliações. A avaliação da solução proposta fundamenta-se no Technology Acceptance Model (TAM), para medir a utilidade e a facilidade de uso percebidas, e na System Usability Scale (SUS), para avaliar a usabilidade geral do sistema. A avaliação apresentou alta aceitação entre os usuários, com o software recebendo excelentes pontuações no TAM para utilidade percebida (4,86 de 5) e facilidade de uso percebida (4,53 de 5), além de pontuação SUS de 89,75 de 100, o que corresponde a uma classificação de usabilidade A+. Este estudo realiza uma pesquisa aplicada que combina o desenvolvimento de *software* com a avaliação baseada no usuário.

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PALAVRAS-CHAVE: Transtorno do Espectro Autista. Análise do Comportamento Aplicada. Informática em Saúde. Avaliação de Usabilidade.

RESUMEN
Las clínicas que utilizan terapia de Análisis Aplicado de Conducta para individuos con Trastorno del Espectro Autista enfrentan desafíos organizacionales, de comunicación e integridad de datos, ya que la gestión manual de programas terapéuticos individualizados se vuelve ineficiente, propensa a errores y difícil de escalar a medida que aumenta el número de pacientes y terapeutas. Para abordar este problema, este artículo presenta un enfoque basado en software implementado como aplicación web, MAPsi, que proporciona un flujo de trabajo digital personalizable para el registro y la gestión sistemática de pacientes, colaboradores, programas y evaluaciones. La evaluación de la solución propuesta está teóricamente fundamentada en el Technology Acceptance Model (TAM) para medir la utilidad percibida y la facilidad de uso percibida, y en la System Usability Scale (SUS) para evaluar la usabilidad general del sistema. La evaluación demostró una alta aceptación por parte de los usuarios, con el software recibiendo excelentes puntuaciones en TAM para utilidad percibida (4,86 de 5) y facilidad de uso percibida (4,53 de 5), y una puntuación SUS de 89,75 de 100, correspondiente a una clasificación de usabilidad A+. Este estudio emplea una investigación aplicada que combina el desarrollo de software con la evaluación centrada en el usuario.

PALABRAS CLAVE: *Trastorno del Espectro Autista. Análisis Aplicado de Conducta. Informática en Salud. Evaluación de Usabilidad.*

1. INTRODUCTION

According to Applied Behavior Analysis (ABA) (Cooper *et al.*, 2020), individuals with autism spectrum disorder (ASD) are recommended to participate in specialized therapies for the more appropriate development of their behavioral skills. According to Cooper *et al.* (2020), ABA focuses on understanding and improving human behavior. Sella (2018) stated that ABA has been internationally recognized as an applied science that has strongly corroborated the development of effective intervention methods for ASD, and that its effectiveness is evident even when compared to other forms of intervention.

For the proper application and execution of ABA, it is advisable to develop individualized skill programs using protocols that clearly specify the primary skills to target. The creation of these programs is the responsibility of a professional behavioral analyst (supervisor), who must correctly select the skills to target for the patient in question and define the program's duration. These programs are executed by specialized therapeutic assistants (collaborators).

Each skill in a program has evaluation metrics. The therapeutic assistant in charge must mark the patient's performance for each skill by using the corresponding metrics. At the end of the program, the scores are analyzed by a behavioral analyst, who must determine which skills to maintain, add, or remove.

In a clinic specializing in ABA, the number of patients and therapeutic assistants can gradually increase, making management more challenging and necessitating the creation of additional programs. In addition, creating programs can be exhausting, as skills must be analyzed within a protocol that typically comprises hundreds of elements.

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Additionally, once the program has been created, it must be adequately separated from the therapeutic assistant(s) with whom it is associated. These tasks, if carried out manually, can lead to errors or omissions, which, in turn, can cause serious problems in the patient's behavioral development, as they may be following demands different from those selected by the behavior analyst. Given this challenge, the following research questions are posed: How do clinical collaborators perceive the usefulness and ease of use of a software platform for managing ABA therapeutic programs? What is the overall system usability of the proposed web application when integrated into the workflow of an ABA clinic?

To answer these research questions, this work defines a software-based approach implemented as a web application called MAPsi. The central hypothesis of this study is that a specialized digital workflow can overcome the limitations of traditional management and achieve high user acceptance. Specifically, we hypothesize that:

- H1: The MAPsi platform provides high perceived usefulness and ease of use for clinical collaborators managing ABA interventions.
- H2: The platform achieves a high level of system usability (corresponding to at least an 'A' rating on the SUS scale) when evaluated by end-users.

Therefore, the objective of this work is to present the design and implementation of the MAPsi application and to empirically evaluate its acceptance and usability through a user-based study. The software was evaluated using questionnaires based on the Technology Acceptance Model (TAM) (Venkatesh, 2008) and the System Usability Scale (SUS) (Grier, 2013).

The remainder of this paper is organized as follows. Section 2 presents the theoretical framework. Section 3 details the methodological procedures adopted in this study. Section 4 reports the proposed approach, design decisions, software description, and the results of the software evaluation and discussion. Finally, Section 5 provides the concluding remarks and outlines potential directions for future work.

2. THEORETICAL FRAMEWORK

According to Cooper *et al.* (2020), ABA is a science focused on understanding and improving human behavior. Sella (2018) states that ABA has been internationally recognized as an applied science that has strongly contributed to the development of effective intervention methods for ASD, and its effectiveness is evident even when compared to other forms of intervention. This therapy operates by systematically applying learning principles to modify and improve socially significant behaviors.

The process begins with an individualized assessment to identify the patient's behavioral excesses or deficits, which are used to design tailored skill-acquisition and behavior programs (Cooper *et al.*, 2020). During intervention sessions, skills such as communication, socialization, and daily living tasks are broken down into small and manageable steps.

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Therapeutic assistants implement these steps using positive reinforcement and systematic prompting to encourage desired behaviors while gradually fading support as the individual gains independence. Continuous data collection and analysis are important components of the process, ensuring that the supervising behavior analyst can objectively monitor progress and make data-driven decisions to optimize the intervention (Cooper *et al.*, 2020).

SUS

The System Usability Scale (SUS), developed by Brooke (1996) and validated for software evaluation contexts by Grier (2013), is a widely adopted instrument for assessing the perceived usability of systems. It comprises 10 items rated on a 5-point Likert scale, yielding a single usability score ranging from 0 to 100. Scores above 71 are considered above average, and the scale has been extensively benchmarked across diverse software domains, including healthcare applications, making it suitable for comparative analysis in clinical software evaluation. According to Lewis & Sauro (2018), the obtained value can be applied to the scale to determine the grade or tier to which the system will be allocated, such as in percentiles or letter grades, as described in Table 1.

Table 1. SUS Score to Grade and Percentile Mapping

Grade	SUS Score Range	Percentile Range
A	84.1 – 100.0	96 – 100
A	80.8 – 84.0	90 – 95
A	78.9 – 80.7	85 – 89
B	77.2 – 78.8	80 – 84
B	74.1 – 77.1	70 – 79
B	72.6 – 74.0	65 – 69
C	71.1 – 72.5	60 – 64
C	65.0 – 71.0	41 – 59
C	62.7 – 64.9	35 – 40
D	51.7 – 62.6	15 – 34
F	0.0 – 51.6	0 – 14

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TAM

The Technology Acceptance Model (TAM), originally proposed by Davis (1989) and later extended by Venkatesh (2008), posits that user acceptance of technology is primarily determined by two constructs: Perceived Usefulness (PU), defined as the degree to which a person believes that using a particular system would enhance their job performance, and Perceived Ease of Use (PEOU), defined as the degree to which a person believes that using a system would be free of effort. TAM has been widely applied in health informatics to evaluate the adoption of clinical information systems, providing a robust theoretical foundation for understanding technology acceptance in therapeutic contexts.

Related Works

There are some platforms and applications available on the market designed to support professionals working with ABA interventions. WayAba and ODAPP were identified. Both platforms offer similar functionality, focusing on creating and recording patient programs and evaluations, and providing staff with access to programs featuring real-time, up-to-date data, among other features. However, the MAPsi is the only platform that allows users to register new protocols and skills according to their preferences, making it the most flexible solution.

A literature search was also conducted on Google Scholar using the following search string: “Applied Behavior Analysis or Autism Spectrum Disorder and (software or applications)”. We sought studies that describe software applications that employ the principles of Applied Behavior Analysis (ABA) to support the development of individuals with Autism Spectrum Disorder (ASD). However, these works are not focused on supporting specialized clinics or therapy settings; many address systems designed for direct use by individuals with autism, with a focus on accessibility, as described below.

Artoni (2013) presents an application for mobile devices that collects information from ABA sessions, providing supervisors with quick access to the data, including graphical visualizations. Differently, Artoni (2018) introduces a playful system that combines technology use with ABA therapy through customizable tasks featuring graphical elements and a simple user interface. Similarly, Cartagenes (2016) describes accessibility-oriented educational software designed to stimulate attention, concentration, and memory in children with ASD. In this study, the authors present several electronic games developed based on ABA principles, including tasks such as matching names to images and completing missing parts of figures. These studies underscore the importance of integrating technology into ABA interventions, highlighting the significant benefits these tools offer for skill development and more effective, personalized care.

However, unlike the identified works, this study focuses on managing activities and staff in clinics that conduct such interventions, emphasizing the management of individualized programs using selected skills. Furthermore, the software presented in this paper was designed for professionals in the field, rather than for individuals with ASD.

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3. METHODOLOGY

First, the activities performed in a clinic that fosters the development of individuals with autism were observed. During this observation phase, the main procedures were examined, along with the challenges and difficulties encountered in the clinic's daily activities. Interviews were conducted with the responsible analysts to obtain a deeper understanding of the operational and therapeutic processes. These analyses revealed issues in the organization and monitoring of individualized programs, as well as in communication and coordination among team members.

The observation phase was conducted over a period of four weeks in a specialized neuropsychology clinic located in Brazil, which provides ABA therapy services for individuals with ASD. A total of six semi-structured interviews were carried out with three behavioral analysts and three therapeutic collaborators, each lasting approximately 45 minutes.

The interview protocol addressed topics including daily workflow, challenges in program management, data integrity concerns, and requirements for a digital solution. Inclusion criteria for the evaluation phase comprised: (1) a minimum of six months of professional experience in ABA therapy; (2) active involvement in patient program management or execution; and (3) voluntary participation with informed consent.

Ethical considerations were addressed through anonymization of all participant data and institutional authorization for the observation and evaluation activities. The TAM questionnaire employed a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), and the SUS instrument followed the standard scoring procedure as recommended by Brooke (1996).

By combining direct observation with interviews, a comprehensive understanding of the clinic's workflow was obtained, and opportunities to enhance efficiency, accuracy, and overall intervention management through technological solutions were identified. Next, an approach was defined that can be implemented by software. This approach aims to contribute to ongoing activities and address potential problems in current clinical practices.

Based on this approach, a software development project was initiated, and its requirements were refined in collaboration with field professionals to address real-world issues. Additionally, a competitor analysis with software in the sector was conducted to identify existing solutions and refine requirements.

The project was planned and constructed in accordance with the Manifesto for Agile Software Development (Beck *et al.*, 2001), aiming to deliver software incrementally, with each increment adding value and functionality. The main idea is to develop complete software within a short timeframe, allowing the client to periodically access the project's progress and evaluate the elaborated requirements, thereby enabling the proposal of new functionalities.

Figure 1 presents the set of identified requirements, their corresponding user stories (Cohn, 2004), and the associated importance and difficulty levels. This organization provides a clear view of

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how each functionality contributes to the system's overall goals, supporting informed decision-making during the development process.

Figure 1. Requirements and user stories with their importance and difficulty

Requirement	User Story	Importance (0–100)	Difficulty (0–5)
Registration/Editing of Patients	As a clinic staff member, I want to register and edit patient information to maintain up-to-date records for each individual under treatment.	100	2
Registration/Editing of Protocols and Skills	As a supervisor, I want to create and edit protocols and skill sets to define structured learning and intervention plans to each patient's needs.	90	3
Registration/Editing of Programs	As a therapist, I want to register and modify therapeutic programs so that I can organize sessions and track the progress of each intervention plan.	90	4
Registration/Editing of Staff Members	As an administrator, I want to register and edit staff member profiles so that I can manage access permissions and responsibilities within the system.	80	2
Registration/Editing of Supervisors	As an administrator, I want to register and edit supervisor information so that I can assign them to specific programs and ensure appropriate oversight.	80	2
Access to Programs	As a therapist or supervisor, I want to access the list of available programs so that I can review and implement the appropriate intervention plans for each patient.	80	3
Program Evaluation	As a supervisor, I want to evaluate the effectiveness of programs based on patient performance data so I can adjust and improve intervention strategies.	70	5
Authentication	As a system user, I want to authenticate using secure login credentials so that I can access the data and features relevant to my role.	60	4

After defining the backlog, a non-functional prototype of the application was created, namely a sketch of the software screens, to serve as a basis for the future implementation of the interface. At this stage, the locations of the buttons and text boxes, along with other graphical elements that contribute to the user experience, were determined. The Figma[3] tool was used to elaborate on the non-functional software prototype.

Based on this product backlog (Sedano *et al.*, 2019) and the prototype, the software was developed in iterative sprints (Das Chagas Júnior *et al.*, 2023), during which requirements were prioritized and selected accordingly. At the end of each sprint, the implemented requirements were expected to be functional, tested, and properly integrated into the system, allowing stakeholders to evaluate the progress and provide feedback for subsequent development cycles.

Finally, the software was evaluated using the System Usability Scale (SUS) and the Technology Acceptance Model (TAM). Despite their similar evaluations of software, they complement each other by examining different attributes: perceived usefulness and ease of use in TAM, and effectiveness and efficiency in SUS.

[3] Available in: https://www.figma.com/

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4. RESULTS AND DISCUSSION

Approach

The proposed approach addresses the organizational and communication challenges commonly encountered in Applied Behavior Analysis (ABA) clinics by establishing a structured yet flexible digital workflow for managing therapeutic interventions. Its central principle is to systematize the registration, organization, and evaluation of individualized programs while allowing full customization according to clinical criteria and therapeutic methodologies.

Unlike existing solutions that rely on predefined skill sets and protocols, this approach enables professionals to create and modify both elements directly within the system. This flexibility ensures that intervention plans can evolve in response to each patient's unique developmental goals, promoting more personalized and adaptive therapy management. The workflow is structured into four interrelated processes:

- Registration of patients and collaborators: Personal data from patients and clinic staff are recorded in a shared database that underpins program management and access control.
- Registration of protocols and skills: Therapists and supervisors define protocols and associate them with one or more skills, creating modular learning components that can be reused across different patients and programs.
- Registration of programs: Programs are created by linking a specific patient to one or more collaborators and selecting relevant skills or protocols. This organization provides clear visibility into who is responsible for each intervention and which competencies are being targeted.
- Program evaluation: Collaborators can record assessments, grades, and qualitative observations for each skill, facilitating data-driven supervision and continuous program refinement.

Together, these processes create an integrated cycle of data entry, planning, execution, and evaluation that enhances both the efficiency and transparency of clinical operations. By combining structured data management with customizable content creation, the approach supports evidence-based decision-making and fosters better coordination among multidisciplinary teams.

Design Decisions

The previously described approach is implemented in software that follows the design decisions outlined below.

- Platform - Considering that the platform should be accessible at any time by supervisors and collaborators of the clinic and that it can be used during a therapeutic session (for recording assessments or to check the description of a skill, for example), the software must be sufficiently flexible and versatile to be available on both mobile devices and computers. Therefore, it was decided to develop the software as a web application.

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- Programming Language - Java was used to develop the back-end due to its well-suited structure for object-oriented programming and its extensive standard library, which provides a range of data structures and methods to facilitate practical, secure code development. TypeScript was chosen for the front-end because it is currently one of the most popular languages for front-end development, according to the Stack Overflow Developer Survey 2023. The primary characteristic of this language is static typing, defined by the types of variables, function parameters, and return types.
- Frameworks - The back-end was developed using the Spring Boot framework. This framework streamlines API development by enabling the execution of web endpoints via Java methods. Spring Boot was selected as the framework because it is among the most suitable for back-end development in Java, primarily due to its simplified development environment and numerous easy-to-use features and libraries, which enable everything from dependency injection to application security, including password encryption. The Next.js framework was used to develop the application's front end. It facilitates front-end development by providing features for creating dynamic, interactive interfaces and for communicating with the back-end, along with other benefits such as dynamic page routing and integration with popular technologies.
- Architecture - For the Web development of this project, it was necessary to have a back-end service responsible for data registration, structuring, and security, and another front-end service responsible for direct user interaction through interfaces and data input and output. Therefore, the software has an architecture comprising three subsystems that communicate with one another: front-end, back-end, and database, as shown in Figure 2.

The front-end requests the back-end to access, modify, create, or remove data. These requests may or may not include the body containing the requested data (e.g., a patient's name). The back-end receives requests, processes data, communicates with the database, and returns the responses to the front-end. The main front-end elements are described below.

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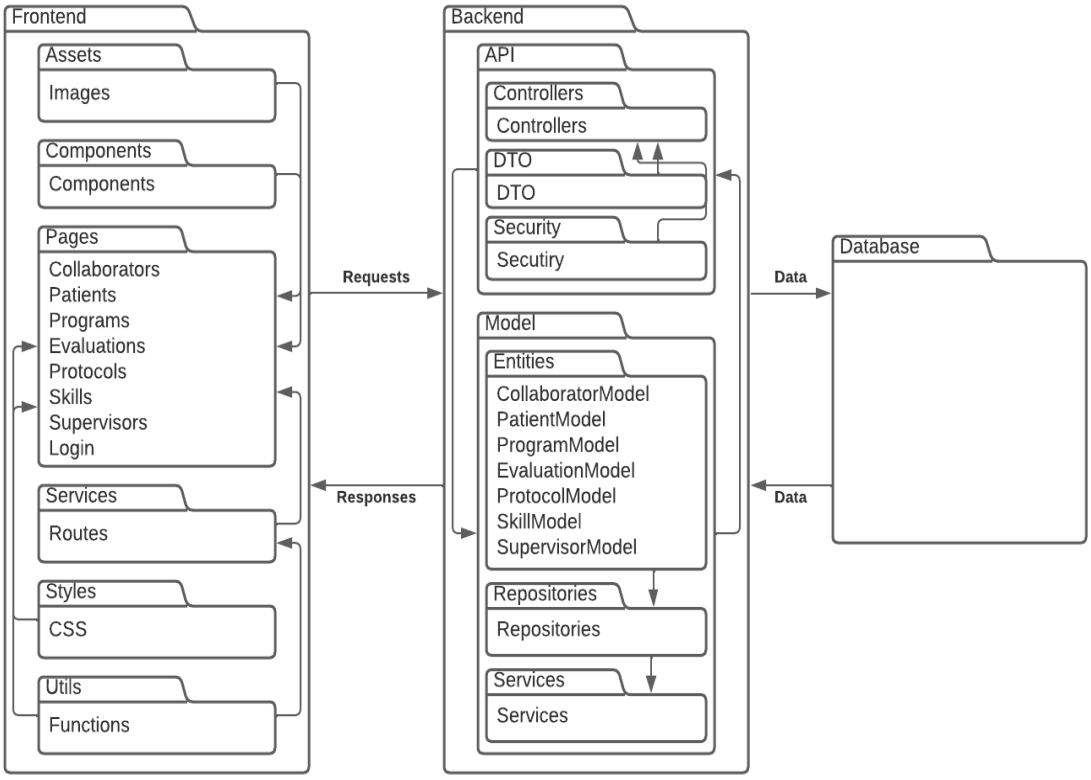
Figure 2. Package architecture and communication of the front-end and back-end of the developed software



- The [Components] subpackage is an interface element or component replicated on one or more screens, such as buttons or text boxes.
- The [Pages] subpackage contains the implementations of the pages to be displayed, as well as the structure in which they are organized.
- The [Services] subpackage contains code responsible for direct communication with the back-end API.

Additionally, the main architectural elements of the back-end subsystem are described below.

- The [API] subpackage includes the following packages: [Controllers], composed of elements responsible for receiving and handling front-end requests; [DTO], also known as data transfer objects, composed of elements that determine the structure of the entities that will be shared with the front-end or database; [Security], composed of elements responsible for the security of the application, such as password encryption.
- The [Model] subpackage includes the following packages: [Entities], composed of elements that represent the project's model entities, with their attributes and relationships; [Repositories], composed of elements called repositories that allow the isolation of the data access layer and provide an interface for the services layer; [Services], composed of elements called services that

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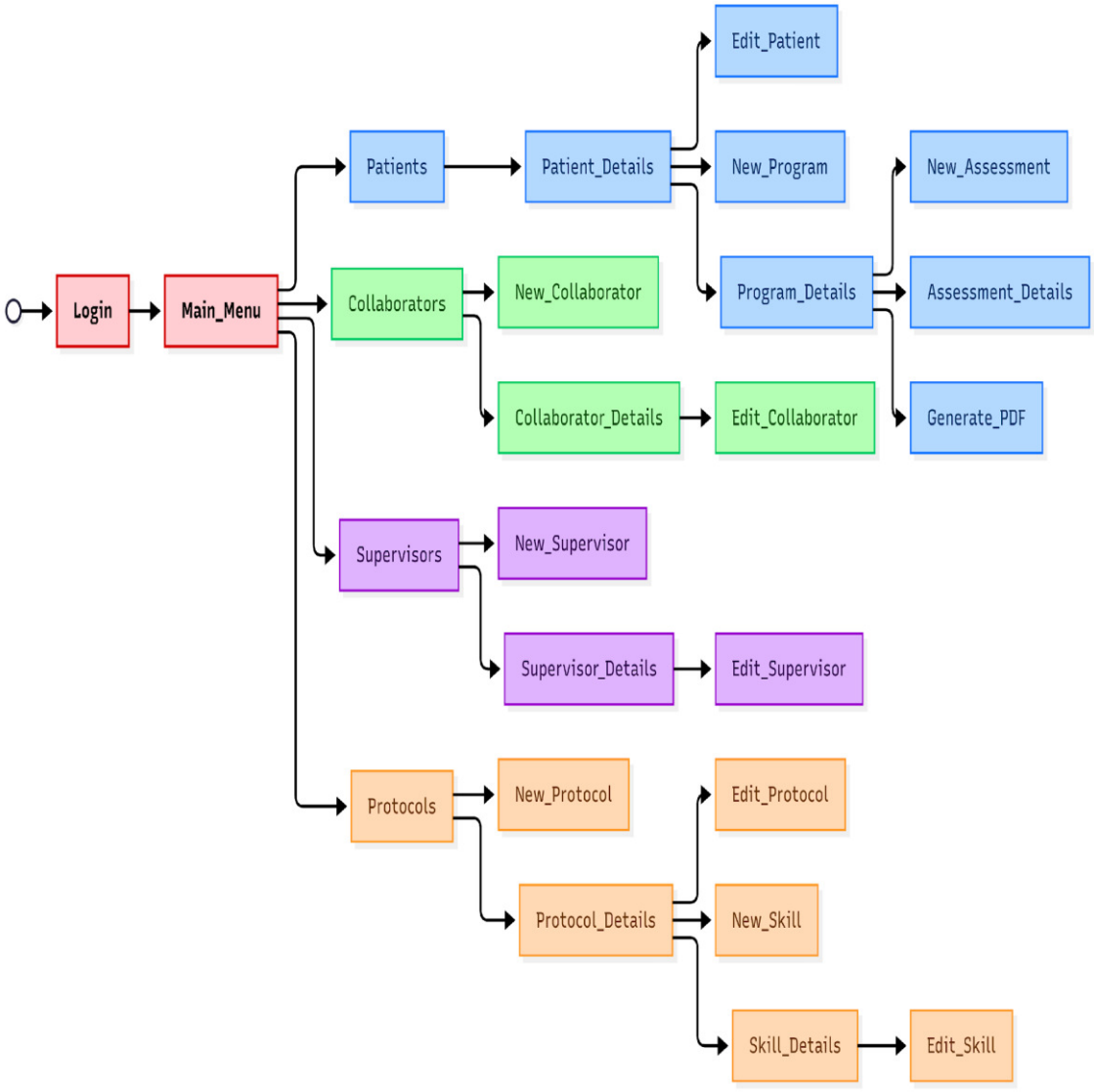
encapsulate business logic; for example, the removal of a protocol culminates in the removal of all its skills.

The Software

The overall structure of the MAPsi software for supervisor users is illustrated in the screen flow diagram presented in Figure 3. This diagram provides a high-level overview of navigation across modules and interfaces, including login, main menu, patient management, collaborator management, supervisor management, and protocol management.

Figure 3. MAPsi software screen flow diagram



Users with the collaborator role have a more limited workflow. Collaborators can only access the patients to which they are linked, view the programs associated with those patients, record new

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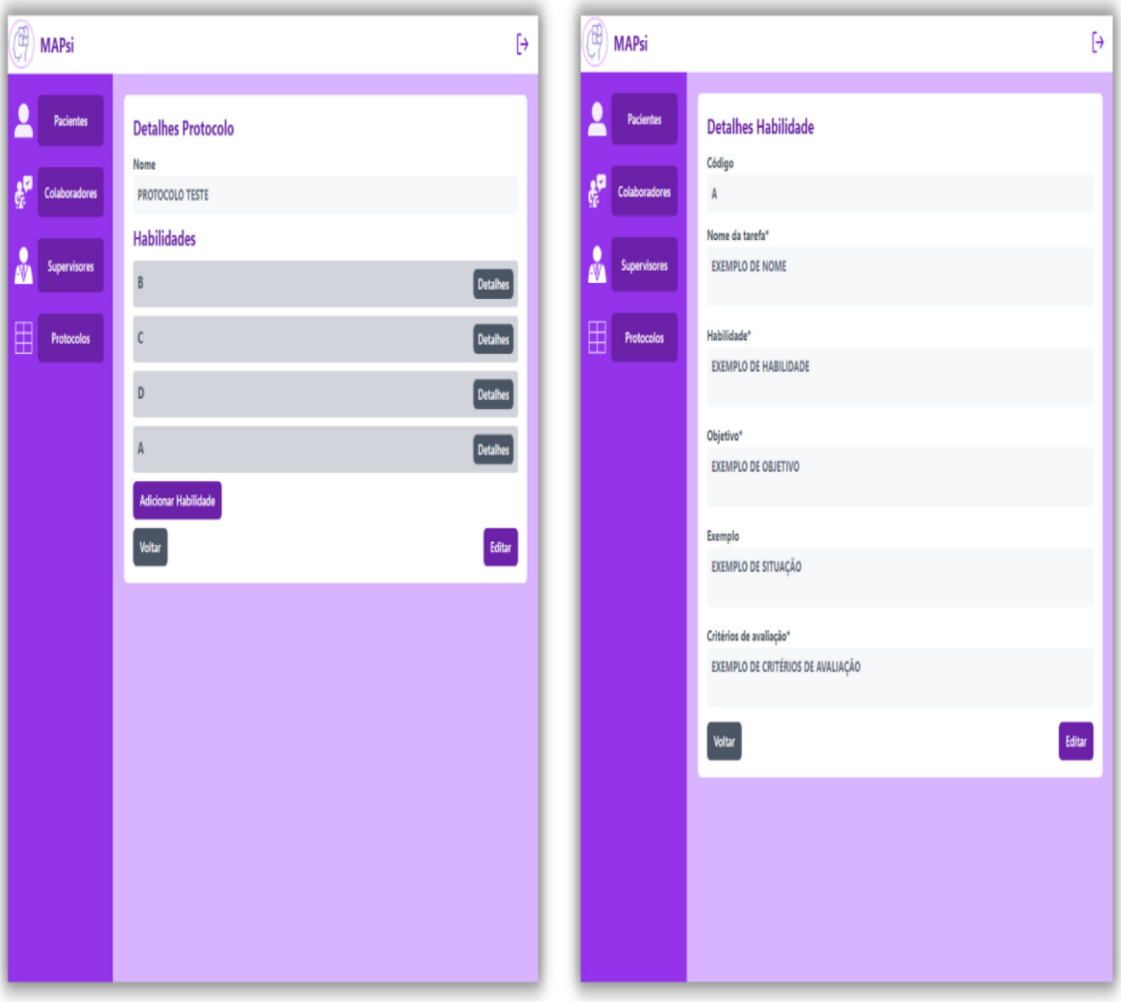
assessments, and edit their own profile data. This distinction ensures that access and permissions are properly managed according to the user's role within the system.

The application's primary functionality is to record programs and patient assessments, assisting with the organization and execution of ABA therapy-related activities. It also allows listing, registering, and removing patients from the database. For patient registration, the software requests the full names, dates of birth, and other relevant information of the two guardians. Only a supervisor can add, modify, or remove patients from the application.

The software allows protocols to be registered with a name and a set of skills, as shown in Figure 4 (left). The details of each skill are presented in Figure 4 (right). Only a supervisor can add, modify, or remove protocols and skills from an application.

Figure 4. Interface for protocol details (left) and interface for skill details (right), respectively



The software allows for registration and modification of programs related to a patient. As shown on the left side of Figure 5, the programs contain all the patients' data, the supervisor's name, the

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name(s) of the collaborator(s) responsible for that patient, the date on which the program was created, the duration of the program (in months), the codes of the selected skills, and the description of each selected skill. Only a supervisor can add, modify, or remove programs. The patient detail interface is shown on the right side of Figure 5 and contains their data and the linked programs.

The software enables collaborators or supervisors to record the results for each skill the patient performs, assigning values according to the skill evaluation criteria. The assessments include a list of the program's skills, grades, and descriptions for each skill. The assessment details interface is presented on the left side of Figure 6, with the assessment date, a list of skills from the corresponding program, and spaces to record notes and observations for each skill. The program details interface is shown on the right side of Figure 6, which contains information about the program, its skills, and registered assessments.

Figure 5. Interface for creating a program (left) and interface for listing programs (right) in a patient's profile, respectively

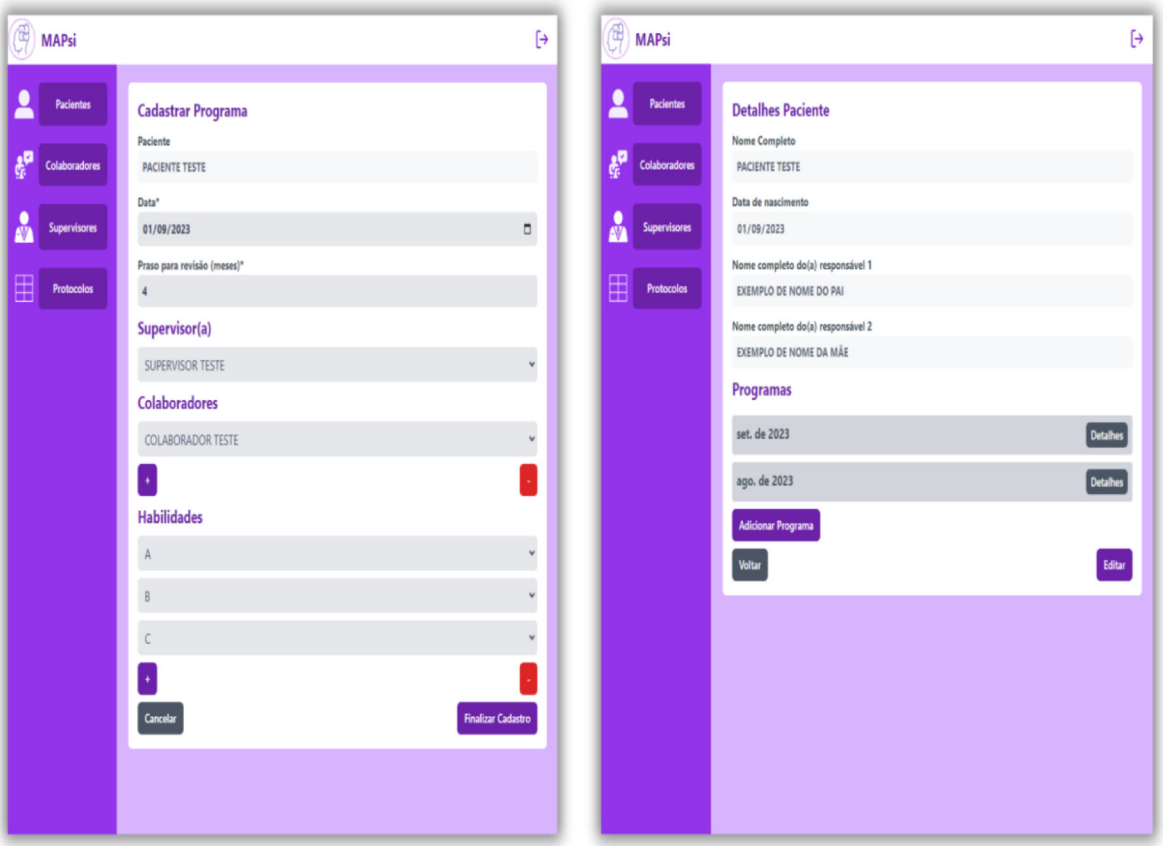

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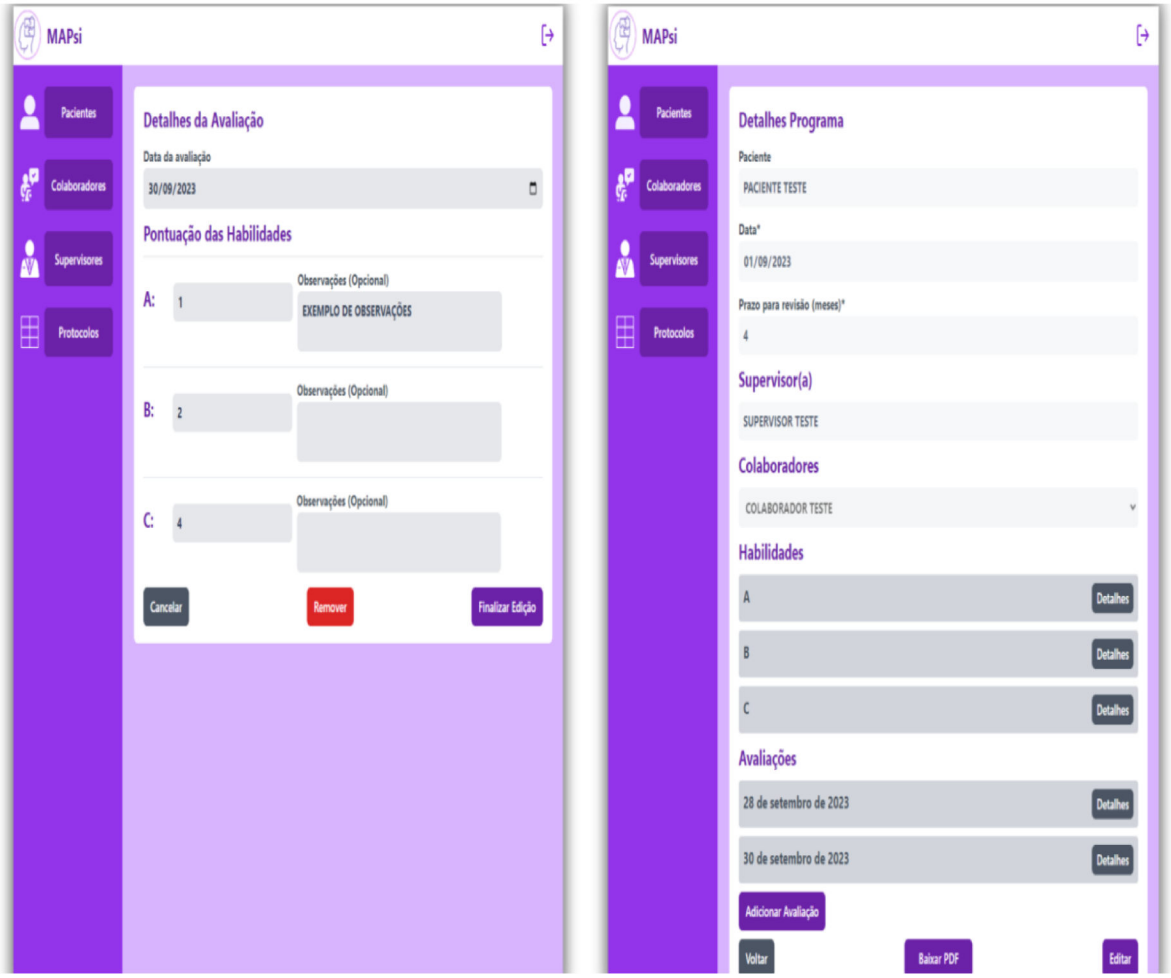
Figure 6. Interface for creating an assessment (left) and interface for listing assessments (right) in the details of a program, respectively



The interfaces for collaborators and supervisors were similar and required the same data for registration. Thus, the software enables them to register their full names, email addresses, and passwords. The software has the following business rule: only one supervisor can add, modify, or remove supervisors from the application. Additionally, a supervisor can register collaborators, provide their full name, email, and password, or remove an existing collaborator. Modifying a collaborator's data can be performed by either the collaborator or their supervisor. The software requires authentication via a login screen that accepts the email and password of a registered supervisor or collaborator.

Collaborators have access to the programs they are linked to, allowing them to view all their content. They can also record new assessments and download the program as a PDF. The downloaded program presents the details and descriptions of all registered skills. Figure 7 shows the PDF generated.

Finally, the MAPsi software features responsive graphical elements that adapt to a wide range of screen sizes. Furthermore, each interface has a dedicated mobile layout that incorporates graphical adjustments to facilitate interaction on touch-sensitive screens.

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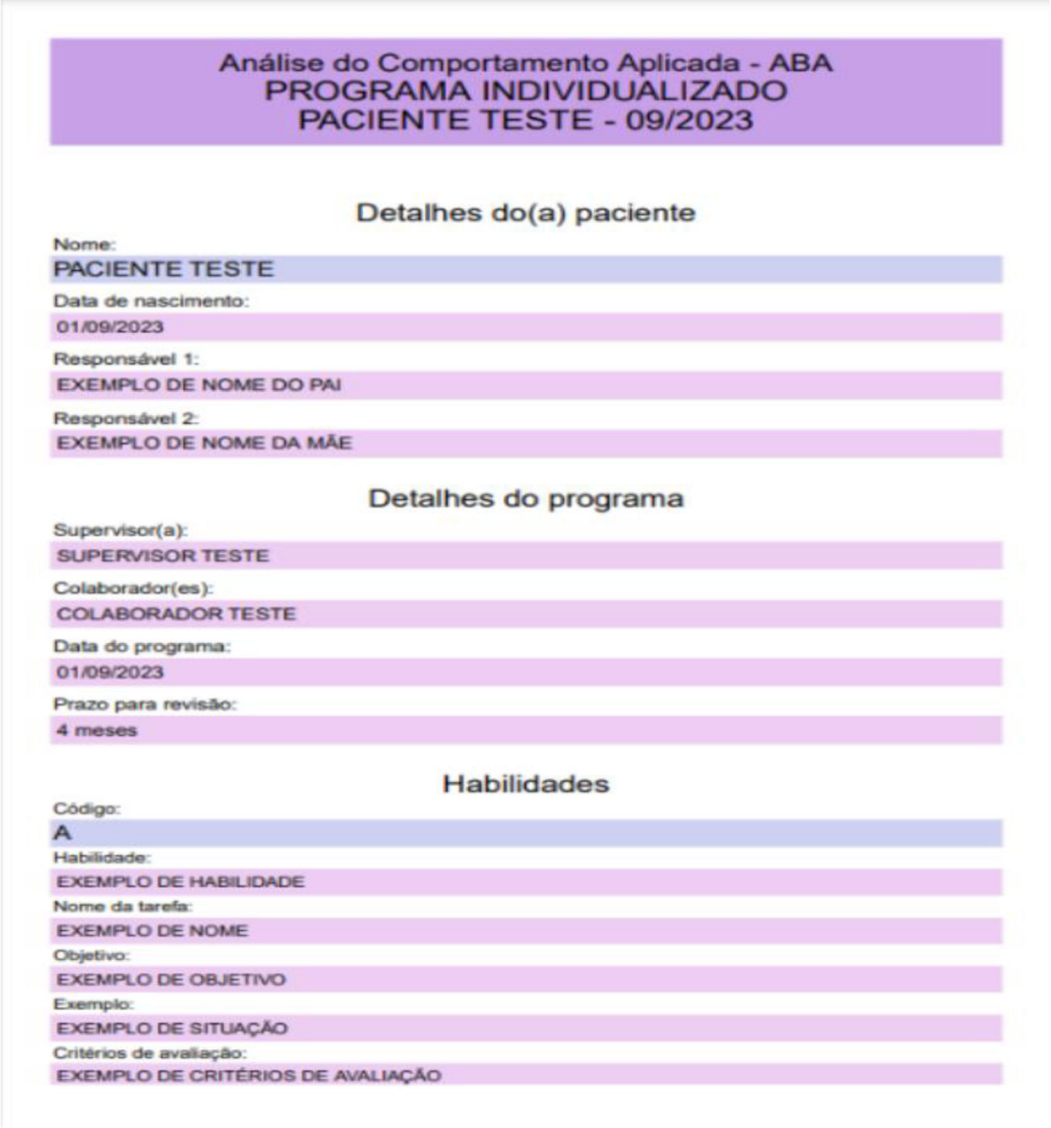
Figure 7. PDF generated by the software.



Análise do Comportamento Aplicada - ABA
PROGRAMA INDIVIDUALIZADO
PACIENTE TESTE - 09/2023

Detalhes do(a) paciente

Nome:
PACIENTE TESTE
Data de nascimento:
01/09/2023
Responsável 1:
EXEMPLO DE NOME DO PAI
Responsável 2:
EXEMPLO DE NOME DA MÃE

Detalhes do programa

Supervisor(a):
SUPERVISOR TESTE
Colaborador(es):
COLABORADOR TESTE
Data do programa:
01/09/2023
Prazo para revisão:
4 meses

Habilidades

Código:
A
Habilidade:
EXEMPLO DE HABILIDADE
Nome da tarefa:
EXEMPLO DE NOME
Objetivo:
EXEMPLO DE OBJETIVO
Exemplo:
EXEMPLO DE SITUAÇÃO
Critérios de avaliação:
EXEMPLO DE CRITÉRIOS DE AVALIAÇÃO

Evaluation and Discussion

Ten supervisors and ten collaborators from a specialized neuropsychology clinic in ABA were interviewed to conduct the software evaluation. The following script was performed to standardize the evaluations. The developer presented the software and its features for 5 minutes; the user used the software for 10 minutes (with some guidance to test various features); and the user completed the form with questions from the TAM and SUS methods.

Figure 8 shows the results for the TAM questions on perceived usefulness (A) and perceived ease of use (B) for each functionality, using a five-point Likert scale (Jamieson, 2004). When analyzing the left side of chart (A) in Figure 8 for perceived usefulness, all responses fell within the "agree" and "strongly agree" ranges, indicating an excellent result for the software's perceived usefulness. Furthermore, the overall application received 100% "strongly agree" responses, highlighting

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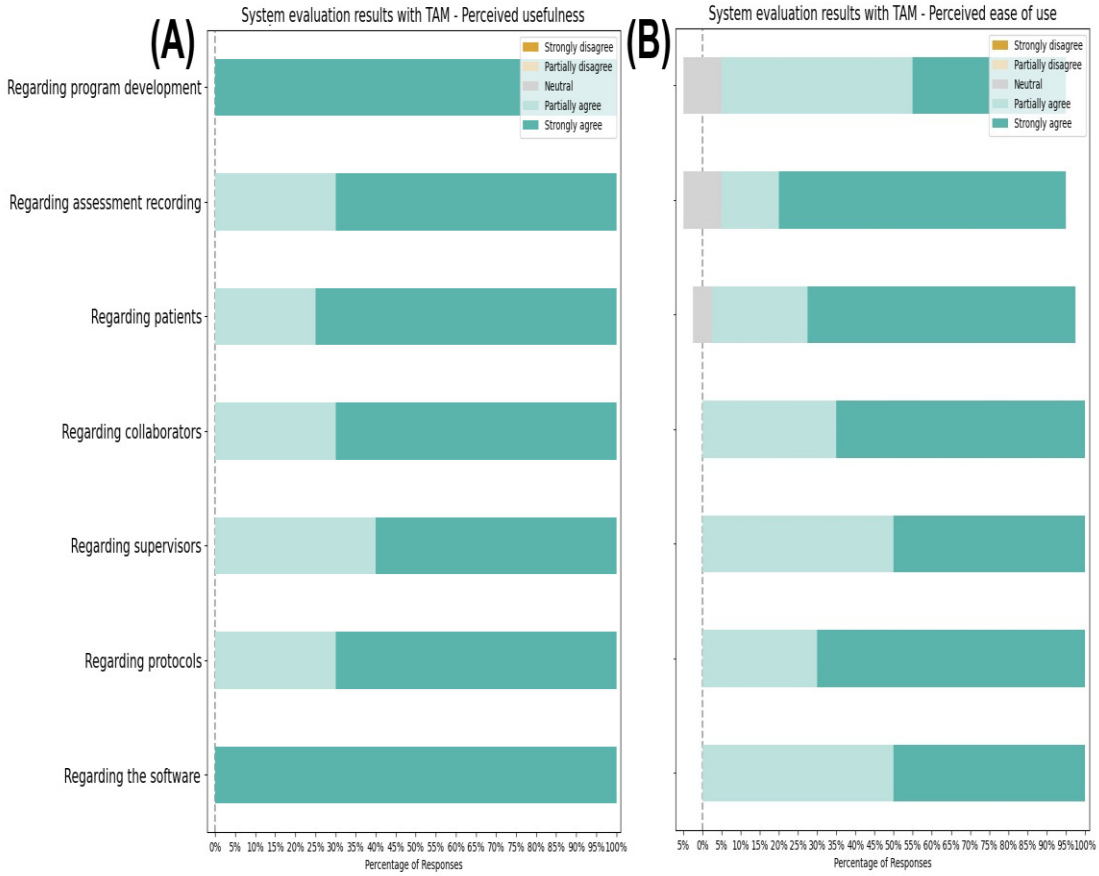
the importance of its functionalities to these users. Observing the right side of the chart (B) in Figure 8, which refers to perceived ease of use, it can be seen that the majority of responses had positive values, with none below "neutral", supporting the idea that the software is easy to use and learn from the users' perspective.

Figure 8. Chart of the evaluation results with TAM



In Figure 9, the SUS evaluation model is used to present averages for each question, and the scores are adjusted to a scale of 0 to 4. It is essential to note that the even-numbered questions (2nd, 4th, 6th, 8th, and 10th) counterbalance the corresponding odd-numbered questions. Therefore, the adjustment for these questions accounts for this inversion. After the conversion, the scores were summed to obtain the final result. The total score of 89.75 is excellent, ranking highest among the sectors in Figure 9. Thus, according to the evaluation system, the application demonstrated high usability.

It is important to acknowledge that the high scores obtained in both TAM and SUS evaluations should be interpreted with caution. The sample size of participants from a single clinical institution limits the generalizability of the findings. The short evaluation period also does not allow assessment of long-term usability patterns or potential learning-curve effects that may influence perceived ease of use over time. Furthermore, the even-numbered SUS items, which require reverse scoring, showed slightly lower

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average scores than the odd-numbered items, suggesting that certain aspects of system efficiency and learning curve may pose more challenges than initially perceived. These limitations are discussed in greater detail in Subsection “Threats to the validity and limitations**”**.

The exceptional TAM and SUS results stem from a human-centered, iterative, and context-aware development approach that aligned technological design with real user needs. This idea is explored in the following paragraphs.

Figure 9. SUS Evaluation Results

Question	Scores	Adj. to metrics
I think I would like to use this system frequently.	5.0	4.0
I found this system unnecessarily complex.	1.2	3.8
I found the system easy to use.	4.6	3.6
I think I would need the support of a technician to use this system.	2.1	2.9
I think the various functions of this system were well integrated.	4.8	3.8
I think there is too much inconsistency in this system.	1.2	3.8
I imagine that most people would lean to use this system very quickly.	4.6	3.6
I found the system too complicated to use.	1.2	3.8
I felt very confident using the system.	4.6	3.6
I needed to learn many things before i could use this system.	2.0	3.0
Total	**89.75**	
Relative Percentile	**96% - 100%**	
Score	**A+**	

First, the approach followed in this study was grounded in direct observation and active collaboration with professionals from the clinical environment where the software would be applied. This close interaction enabled the identification of genuine operational needs, ensuring that the developed functionalities directly addressed real-world problems rather than hypothetical requirements. Consequently, users perceived the system as useful and relevant to their daily activities, positively influencing the Perceived Usefulness construct of TAM.

Second, the development process followed Agile principles, emphasizing iterative refinement, continuous feedback, and the early delivery of functional prototypes. This iterative cycle enabled progressive usability validation, resulting in interfaces that were not only efficient but also intuitive. Such design practices substantially enhanced Perceived Ease of Use, as measured by TAM, as reflected in the strong SUS scores.

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Finally, the system's ability to register protocols and skills based on clinical criteria was a key differentiator compared with existing solutions. This flexibility not only increased its perceived usefulness but also fostered a sense of ownership and satisfaction among users, who could adapt the tool to their specific therapeutic contexts.

Threats to the validity and limitations

A potential threat to the external validity of this study is that the software was evaluated within a single organization, which may limit the generalizability of the findings. This threat was mitigated by administering questionnaires to as many collaborators as possible. Nevertheless, it is considered essential to replicate this evaluation in other companies that utilize ABA therapies.

The benefits of using the system over an extended period were not empirically measured. Consequently, quantitative evidence supporting the claim that the system reduces the likelihood of errors in the integrity of the generated data is not yet available. However, given that the procedures previously adopted in the participating clinics relied heavily on manual record keeping, it is reasonable to infer that the automation introduced by the developed system inherently minimizes human error and enhances data consistency.

Additionally, the current version of the system does not support interoperability with electronic health records, a critical requirement for clinical information systems in real-world deployment scenarios. Data security and privacy protection mechanisms, although implemented through password encryption and role-based access control, have not been formally evaluated against healthcare data protection standards. Future work should also consider the scalability of the system across multiple clinical units and the integration of analytical dashboards for therapeutic performance indicators, as these features were identified by users as valuable extensions during the evaluation phase.[4]

5. CONCLUDING REMARKS

This study presented an approach to overcome the limitations of manual management, data integrity challenges, and inefficiencies in ABA therapy clinics. To realize this approach, the web application MAPsi was developed with a responsive interface designed to optimize clinical workflows across both desktop and mobile devices.

Through a user-based evaluation, this work successfully answered the proposed research questions and validated the hypotheses. Regarding RQ1 "*How do clinical collaborators perceive the usefulness and ease of use of a software platform for managing ABA therapeutic programs?*" and H1 "*The MAPsi platform provides high perceived usefulness and ease of use for clinical collaborators*

[4] Ethical Statement: This study involved the participation of healthcare professionals in software evaluation activities. All participants provided voluntary informed consent, and personal data were anonymized in accordance with institutional guidelines. No clinical patient data were collected or processed during the evaluation phase. The authors declare no conflict of interest related to this research

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managing ABA interventions.", evaluation via the TAM showed that clinical collaborators perceived the platform as highly useful and easy to use. All responses regarding perceived usefulness fell within the "agree" and "strongly agree" ranges, and for perceived ease of use, most responses were positive, with none below "neutral".

Furthermore, using the SUS to address RQ2 "*What is the overall system usability of the proposed web application when integrated into the workflow of an ABA clinic?*" and H2 "*The platform achieves a high level of system usability (corresponding to at least an 'A' rating on the SUS scale) when evaluated by end-users.*", we found that the system achieved an outstanding score of 89.75, surpassing the target "A" rating threshold and confirming excellent perceived usability.

The findings suggest that the MAPsi platform successfully addresses the challenges faced by clinics that work with ABA interventions. By digitizing the registration and management of patients, collaborators, and evaluations, this approach has the potential to enhance data reliability, reduce tracking errors in program management, and streamline therapeutic coordination in ABA clinics.

Despite the various features it offers, this software can be improved. Some examples of improvements include interfaces for recording therapies performed and the availability of rooms or schedules with marked times. Additionally, the possibility of generating graphs from the assessment results can be highlighted to provide a clearer visual and analytical understanding of the patient's situation.

Finally, future longitudinal studies are recommended to assess the practical advantages of using the system and to collect objective metrics of accuracy, reliability, and long-term performance in real clinical contexts.

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