

Co-design a Digital Learning Ecosystem for Children with Disabilities: An Agile Model

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Abstract. Traditional intervention models for children's rehabilitation services do not fully integrate technology and partakers such as parents, therapists, and managers. Due to children's particular needs and the new reality after COVID-19, it was identified as necessary to co-design an integrative model to improve these services. This research proposes a novel technological ecosystem model using a mixed approach of agile methodologies and design thinking tools by developing a digital learning ecosystem tailored to children with disabilities. The research ensures active involvement of users, fostering a user-centric design with three iterations that were carried on in practice with a Rehabilitation Center and a School for Special Needs in a case study underscoring the effectiveness with a measurement scale based on information success; in addition to health, education and service quality models that gave findings of how emphasize the potential of agile methodologies in future interventions for this vulnerable demographic population.

Keywords: *Co-design, Digital Learning Ecosystem, Children with disabilities, Family with Special Needs, Agile approach*

1 Introduction

Teachers and therapists belong to a group of users that deliver an essential service comprised of education and rehabilitation programs for a community of families with disabled children. Developmental disabilities or disorders in children are diagnoses that have a wide range of characteristics and aspects that impact the child and those in contact with them, requiring collaborative care, aftercare, and daycare rehabilitation [1]. Across the world, 240 million children live with disabilities, and most of them live in low and middle-income countries [2]. According to the Institute for Health Metrics and Evaluation from the World Health Organization, 1 in 3 people worldwide today is estimated to be living with a health condition that benefits from rehabilitation [3]. It means two out of 7 people in Mexico positioning Developmental Intellectual Disability and Cerebral Palsy as the leading conditions that require these services for special needs in children under five years. In the case of education services for children with

disabilities, their conditions represent diverse needs [4], which makes these services complex since they must be relevant and effective but also comprehensive. Besides, these services in a Latin American country undoubtedly require support in many areas such as financial, management, training, and staff increase.

The services of support in education and rehabilitation for early-age children with disabilities in Zacatecas, a center region of Mexico, face many challenges. The entire family where there is one or more children with disabilities often presents dares related to children's young age and skills deficits, financial and time problems to attend to them frequently, as well as limited knowledge to accompany them in the process, always leaving pending issues in the follow-up. Therefore, informed and understood interventions are complex to achieve. Even if there are successful testimonials regarding advances in children's development, the work needs a set of well-orchestrated resources, as well as easily accessible documentation.

Some projects and programs by the government began to add signs of digital modality, as was seen in the Mexican Study Plan 2022 that established the link between school/community/territory [5]. Nevertheless, although it speaks of education in general, it focuses on the care of healthy children and primary education, leaving aside the specific issue of initial-level students *with disabilities*. Furthermore, more recently, the New Mexican School (NEM by its Spanish acronym) was established. This institution prepares children, teenagers, and young people, promoting excellence and inclusive, multicultural, collaborative, and equitable learning throughout their training, adapted to all regions of the Mexican republic [6]. NEM has a platform with more than 23,500 educative digital resources aligned to study plans and textbooks that also have an initiative to provide special attention to vulnerable groups.

In health institutions, after the COVID-19 pandemic, Telehealth started as a crucial tool for exchanging medical information through electronic communication and Information and Communication Technologies (ICT), with which professional work network collaboration can be anywhere. This strategy, planned even for catastrophes, accidents, or any situation to strengthen medical attention, came together with innovations in technology advances, but it had a resounding failure due to difficulties of internet access. Although the country has health systems considered robust, in other cases, the structural and human resource weaknesses facilitate deviations from adequate care in rehabilitation (Frech López & Robles Saucedo, 2020).

1.1 Problematic definition

Challenges for educational and health professionals now set the problem of integrating new models to support children with diverse learning deficits or disabilities, asking how to jumble all the interested ones in the follow-up process of such a conditioned child.

When technology is not the unique answer, the linkage of people with task performance and a successful adoption of a new mode of work lead to co-designing, which in the learning process is a concept that stems from the term *Co-creation*, involving students in developing an educational product they will use for learning and practice [7]. As an approach, co-creation assists in a deeper understanding of knowledge, enhances motivation, and improves collaborative work and learning skills. Co-design is often confused with User-Centered Design (UCD), but it sees the 'user as a partner', unlike UCD, which thinks about the 'user as a subject', and now both

influence each other. In a collaborative approach known as co-design, designers' partner with non-designers to devise solutions. Serving as facilitators, designers steer participants through the design process [8]. The objective of co-design is to leverage the collective wisdom and perspectives of all involved in the design and development of products, services, or systems. Many works propose or implement co-design on systems, since ones related to software development, team management, and user experience. Some examples are collaborative product design, participatory urban planning, healthcare services co-design with patients or learning experiences.

One way to co-create systems by integrating people and technology components is through a Digital Learning Ecosystem (DLE). Although many terms refer to a DLE, depending on the background and organization frameworks, a DLE is the interaction created between biotic and abiotic factors affected by social, cultural, and economic environments [9]. It includes the learning process with additional modalities such as e-learning or mobile learning through methods and resources to enhance learners' competencies.

Nevertheless, the service providers in this context also need a guide to make the DLE's implementation effective due to its systematic nature. Practitioners attending scholars or patients need to know how to use agile methods to drive innovation, digital transformation, and management activities in general [10] Agile methodologies emerged as a response to continuous challenges, emphasizing iterative development, constant feedback, and cross-functional team collaboration [11]; they transcended their software development industry as its initial domain to become a vital component of project management across various sectors.

After this brief introduction, the article is formed by following sections: section 2) Related Work; 3) Method 4) A Digital Learning Ecosystem co-design; 5) a Case Study with three iterations; 6) Results 7) Discussion, that include Limitations and Future work; and the 8) Conclusion which talks about theoretical, social and for practitioners implications.

2 Related Work

Since the body of knowledge is robust, some related studies are mentioned for their relationship with educative and health services for children that face serious illnesses and special needs with solutions that integrate technological resources. The first work of Sanders [12] talks about three levels of engagement for co-design in healthcare. The initial level involves one-time events, such as hands-on workshops, to initiate participatory design for innovation. The second level comprises a series of participatory events over time, addressing various stages of the design process. Finally, the highest level entails a co-design culture characterized by ongoing relationships, where co-designing becomes the default mode of engagement for all involved. This progression highlights the evolution towards a deeply collaborative approach in healthcare design and development.

A second work is one of the P4C models that delivered integrated rehabilitation services for children with special needs. It also has a research program that evaluates the development and implementation in 40 schools in Ontario, Canada [13]. This

service model is innovative, collaborative, and evidence-informed, using a needs-based and tiered approach.

The PULSE study addresses the lack of research supporting treatment for postural tachycardia syndrome (PoTS) by co-creating a feasibility trial protocol and rehabilitation intervention. Utilizing the 'three Co's framework', involving co-definition, co-design, and co-refinement, the intervention was developed with input from patient and public involvement members, experts, and intervention practitioners. The resulting intervention comprises online support sessions, tailored functional movement activities, and recumbent bikes for home use. This collaborative approach acknowledges the expertise of individuals living with PoTS and aims to meet the diverse needs of stakeholders, providing a template for future international research in this area [14].

There are also guidelines as the one from UNESCO that integrates digital skills and literacy to learn [15] by the establishment of digital entry points for people limited in these competencies through a virtuous cycle that accelerates learning and development to strengthen communities and livelihoods more focused for digital solutions providers as the main target audience, who are also users and stakeholders of this system.

Another study for building Inclusive Toys (IT) with Participatory Design [16] is a collaborative model that looks for a multidisciplinary work of different actors in the process. It anticipates the participation of other actors in the IT creation/adaptation process, among which detached health professionals (doctors, physiotherapists, therapists, nurses), the very child (patient), parents, caretakers, engineers, 3D device designers and programmers; and finally, the Half Double and Scrum [17], is a project management approach based on actual human behavior, unpredictability and complexity focused on three core elements: Impact, Flow and Leadership.

These models' examples cover different layers, such as the design of rehabilitation products, such as applications, devices, or serious games. However, there is a high need also to address the role of professionals in planning, organizing, and monitoring work projects around their services.

3 Method

The study employed a mixed approach, beginning with the documentary review of related technology adoption studies in child learning and rehabilitation contexts. Participant observation with key informants constituted a transversal study, utilizing structured and non-structured interviews, surveys, and Personas as user research tools for comprehensive data collection. The applications of survey were internally in the institution of the case study where there were around fifteen respondents. The primary survey predominantly featured Likert-type scaling with a correlational-causal scope. To get the consent of participants, it was necessary to have the authorization of some managers, and then a second survey based on an extension of the E-learning Success model [18] carried out on paper and online format depending on location and authorized permissions.

4 Digital Learning Ecosystem Co-design

Due to the significant problems that need to be solved, a digital learning ecosystem seems appropriate for development in education and rehabilitation services for children. Digital ecosystems are interlinked, and interdependent actors are distinguished by co-specialization and complementary skills, resources, and capabilities [19], including many co-creators where technology becomes instead of only a support, an orchestrator of relationships that evolve [20]. A co-design approach helped achieve this goal, yet different actors are involved in the service delivery backstage. The importance of co-design in these contexts lies in every family with disabled children who require special attention for specific needs and a deeper understanding of their diagnosis as well as their progress.

Observing six Infancy Rehabilitation Centers and two Special Education Pre-Schools served to know their activities and work dynamics; then, a diagnostic survey was carried out to analyze the current organizational ecosystem from dimensions such as adaptability, reliability, response time, user satisfaction, enjoyable experience, and overall success. Also, other details were identified through data obtained by interviews application to these organization's professionals. With this information, an initial set of digital tools was selected, including team management tools, virtual reunion platforms and digital collaborative platforms. Thus, it was determined to design a model with a hybridization among Design Thinking and Scrum agile methodologies, whose frameworks would need adjustments and precise adaptations by co-designing with the educational and therapeutic professionals. Once collaborators test the digital tools set accompanied by Scrum to co-design their service, the same questionnaire survey in a longitudinal period helped to recognize the expansion levels achieved.

Therefore it is proposed a hybrid approach, combining Design Thinking (DT) with the agile Scrum methodology. To enable the gradual development of a Digital Learning Ecosystem embodying these characteristics. DT is an empathetic approach to problem-solving that places the user at the forefront of the design process. By integrating agile methodologies, design thinking enables organizations to swiftly identify and address customer needs through iterative prototyping. This iterative process empowers organizations to continuously refine and improve solutions, ultimately delivering maximum value to their customers [21]; also, it incorporates mental models, tools, processes, and techniques such as design, engineering, economics, humanities, and social sciences that help strategic planning and development of services with innovation and collective social responsibility.

As an agile methodology, Scrum enables iterative development and continuous improvement of educational and rehabilitation activities. This approach allows for flexibility and adaptation as new insights emerge. An outline of another critical component is shown in Table 1.

Table 1. Key components for the Digital Learning Ecosystem Model for services to children with disabilities.

Key component	Input
<i>Design Thinking</i>	
Service Design	Applying their principles to create programs for multidisciplinary projects and interventions tailored to each child's individual needs. This involves understanding the professionals' and parents' abilities, preferences, and challenges to design effective and value-added activities for children.
User experience	Applying their principles to understand the needs, abilities, digital skills, preferences, and evaluation.
<i>Scrum Agile Methodology</i>	
Training and Capacity Building	It provides ongoing training and professional development opportunities for team members on agile culture and practice. This ensures everyone stays updated on the latest research, best practices, and technologies in inclusive education and rehabilitation.
Measurement and Evaluation	Implementing a system for monitoring, measuring, and evaluating the activities effectiveness. Data-driven insights can guide decision-making and lead to evidence-based improvements.
Community Engagement	Collaborating with the local community, schools, and other relevant organizations to create a supportive and inclusive ecosystem beyond the immediate team of professionals.

The application of Design Thinking and Scrum as agile methodologies seeks to generate new ideas on how to organize Infancy Rehabilitation Centers as well as Special Education Pre-Schools in a different mode from traditional ones. Fig. 1 represents the hybrid Digital Learning Ecosystem model adapted to the early childhood education and rehabilitation services.

The model was designed pretending to support the training on co-designing ecosystems for a holistic digital transformation. It displays the phases that intertwine DT and Scrum for this type of attention. In the model, the last phase from DT, the "Testing", is the same as the initial Backlog artifact of Scrum, because it is the starting point where a list of activities is defined.

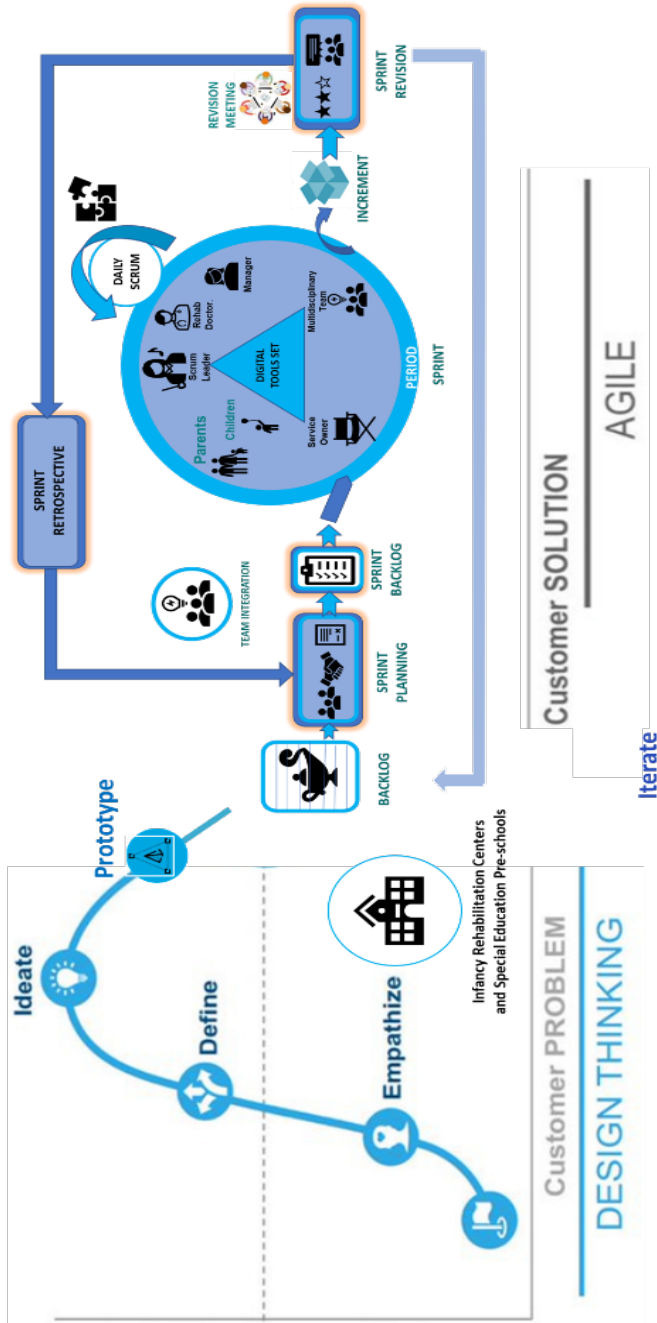


Fig. 1. Agile Model to co-Design Digital Learning Ecosystems in Services to Children with Disabilities. Own elaboration

Table 2. Framework for Agile Management Scale of effectiveness

Level No.	Level Name	Specific Measure
1	Beginner	Technical level (Ecosystem quality)
2	Intermediate	Semantic level (Information quality)
3	Advanced	Experience (Use, user satisfaction, individual impact, organizational impact)
4	Expert	Human Interaction, Human Centered Design (Service quality)

Inside all these proposed phases, leverage of digital tools and platforms is necessary to enhance communication, share data, exchange streamlined information, and support real-time updates on children's progress. So, the model admonishes the inquiry in Children's Rehabilitation and Education Service Delivery through *the Design Thinking part* to enable the design of the framework based on the *Scrum part* (See Fig. 2) to be creative together, guide and visualize the whole process.

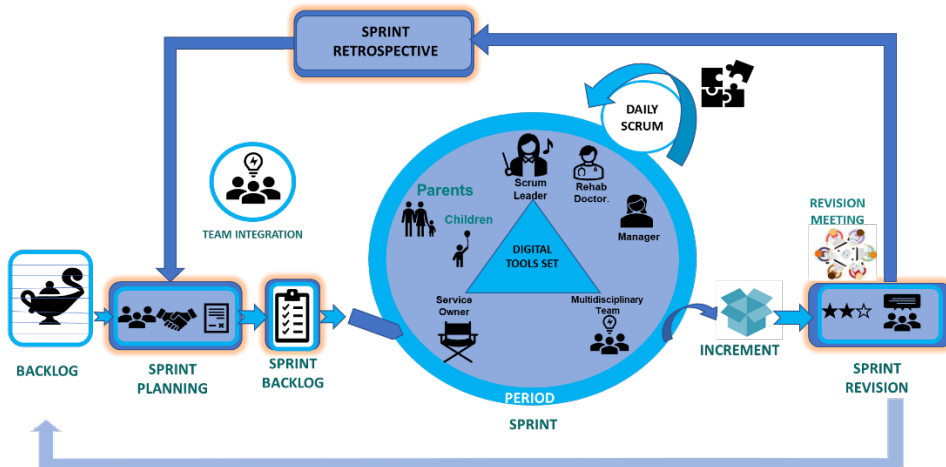


Fig.2. Framework for Agile Management in Ecosystem Model. Own elaboration

Framework for Agile Management (FAM) is a scale that measures the implementation of agile culture by increasing the use of digital tools. The effectiveness of FAM is situated on the 4-level scale mentioned before, ranging from the Technical level to the Human Interaction level, and other instruments to measure health and service quality, as shown in Table 2. The four levels of measurement in the FAM Model were defined as follows: Level 1 as Beginner is a Technical level that measures the general Ecosystem quality: adaptability, Reliability, Response time, Usability, and Ease of use,

Level 2 as Intermediate, a Semantic level that measures the Information Quality: Completeness, Ease of understanding, Well organized, Effectively presented, Useful, Up to date Level 3 as Advanced, an Experience level that measures the Effectiveness through Use; User satisfaction, Overall satisfaction, Enjoyable experience, Overall success and Level 4 as Expert, as the Human Interaction Level that measures Service Quality with Empathy, Responsiveness; beside positive aspects like enhanced learning, empowerment, time savings, work success; and Negative aspects like lack of contact, isolation, quality concerns, and technology dependence.

So, the hybrid model sets FAM gives measurement guidelines seeing the side of Design Thinking as the Strategy and the Scrum Framework side as the Implementation. The model helped to visualize, create, and communicate with a design approach by finding the value of the complete co-design and the measure that is purposed to get data and discuss the relevance, also illustrating the levels achieved by some institutions.

5 Case Study

A case study was carried out over one year in two organizations, the Cerebral Paralytic Association (APAC, by its acronym in Spanish) as the Infancy Rehabilitation Center, and the Multiple Attention Center (CAM, by its acronym in Spanish) as the Special Education Pre-school applying a Model for Co-Designing Digital Learning Ecosystems for Children with Disabilities since an agile approach to make a longitudinal comparative inside mentioned centers and schools. Fig. 3 shows the timeline of the intervention procedure.

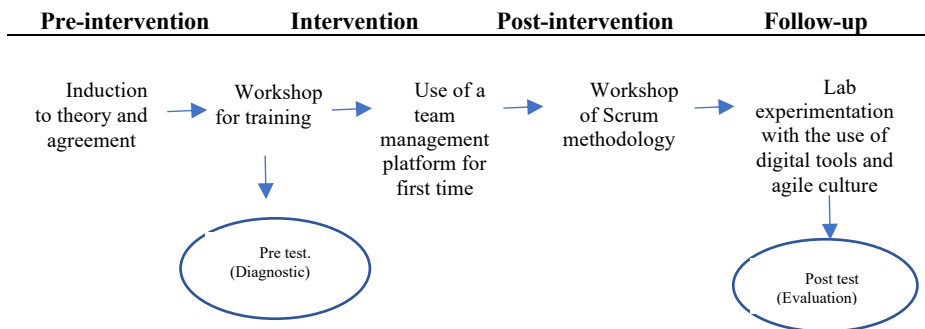


Fig. 3. Timeline of interventions.

A first survey operates as a general knowledge of the professionals in the use of digital tools, virtual platforms, or mobile apps to offer diverse services as a preliminary diagnostic, and once they use a set of digital tools for 3 work cycles, the same survey was applied again, thus evaluating the agile implementation advancement.

The model covers ten steps divided in five steps on Design Thinking part, and another five steps on Agile Scrum part (See Fig. 2). Iteration 1 applies the DT side for only this time, and after this, it seeks to be in continuous improvement of the Agile Scrum side incorporated into the organization.

As a preliminary activity, the consent of people who work in the organizations was obtained, which explained them about the protection of their personal data as well as the use of images solely for research purposes. Below, the carried-out iterations are detailed.

5.1 Iteration 1

The first feature co-designed for the digital learning ecosystem was an architecture based on services (see Fig. 1) incorporating computers, mobile devices and related technology that is reachable to most organizations. Details of every step are described below.

Empathize. - Through direct observation and informal interviews, an initial interaction began.

Define. - Since the digital learning ecosystem model supports the process and management of professional teams involved with a lot of actions and strategies to ensure effective outputs in education and rehabilitation, the technological change emerges from a much greater diversity of sources than ever before, and with an overly complex dynamism of ICT. In the same way that in business ecosystems, the value creation for the end consumer is leveraging a symbiotic relationship whereby platform owners (in this case, the Infancy Rehabilitation Center) enable others (for example, therapists, managers, and other collaborators) to create services on a platform, that has the potential to strengthen the Special Education and Rehabilitation ecosystem.

Ideate. - An architectural layer view was the proposal idea to help visualize the main roles and resources.

Prototype. - The digital learning ecosystem architecture based on services prototype was made up by four layers. At one end, the suppliers, and at the other end, the customers. In the middle, the backstage and frontstage layers a union of providers and end users (see Fig. 4).

Testing. - For the testing, the designed architecture prototype was subjected to evaluation by experts in computer science.

Sprint Planning. The first sprint planning focuses on the user's understanding of the ecosystem architecture, creating a training workshop to extend the knowledge about what means the elements 'interconnection on every layer.

Sprint. - The sprint based its work on the workshop for the organization's collaborators, discussing the prototype of the architecture and identifying the possible routes to be able to have the appropriate resources to begin the digitalization of the processes.

Scrum Daily Meetings. - In this iteration, it was considered as not necessary the Scrum Daily Meetings.

Sprint Review. - On the first Sprint Review, the first iteration yielded an increase in knowledge about how to work with the Scrum framework, it was useful like a pilot test to know Scrum by participants.

Sprint Retrospective. - The first meeting of Retrospective allows the initial planning for the next iteration and made participants remember about the ecosystem co-design and the desired objectives.

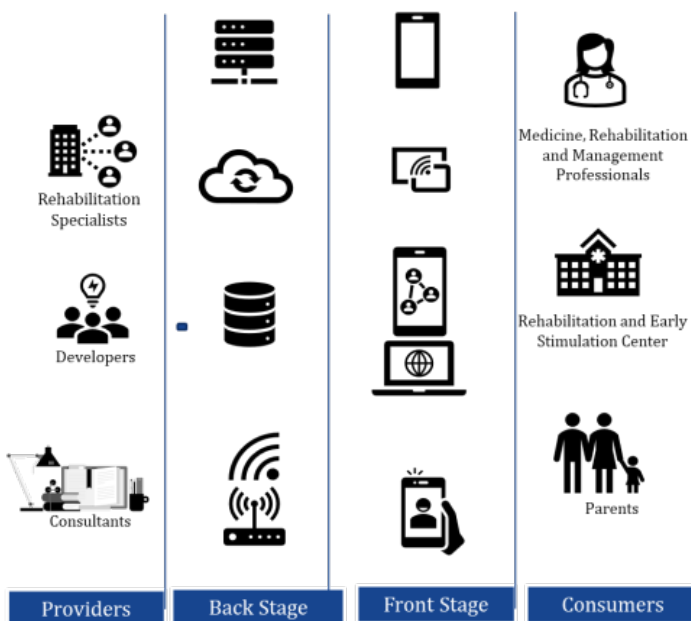


Fig.4. Digital Ecosystem Architecture based on services. Own elaboration

5.2 Iteration 2

Empathize. - In this cycle, empathizing phase was more extended. This time, empathizing brought a deeper understanding of the user, knowing physically and procedurally the Infancy Rehabilitation Center and the Special Education Pre-school, with assistance, observation, and formal interviews (see Fig. 7) covering parents and institution workers. For that purpose, the Persona tool as a user research instrument helped to understand the needs, experiences, and behavior goals of internal collaborators. Figure 7 shows interviews developed with an internal collaborator and parents.

Define. - With the knowledge generated in the empathy stage with the Persona tool and interviews, it was possible to agree on reviewing internal process manuals to compare it with their application in the real world. So, two big problems were detected in the institution: lack of communication as a main need; and more staff to further divide responsibilities in the organization as a wish of many collaborators. Therefore, a second workshop was granted for the consecutive ideation of the ecosystem.



Fig. 5. Interviews to collaborators and parents

Ideate. - The ideation of this second iteration was carried out in a workshop in the APAC association. The workshop focused on explaining the Service Journey Mapping tool and the Backlog artifact, with an invitation to create their own Service Journey Map exemplifying in a very general way the main services. For this purpose, an example on the Miro digital board was shown to them (See Fig. 6). Also, Jira, the team management platform, was presented.

Prototype. - To capture out the key tasks that drive the main processes of their special education and rehabilitation services, the workshop put the collaborators to work in teams, obtaining an initial Journey Map for the institution (See Fig. 7).

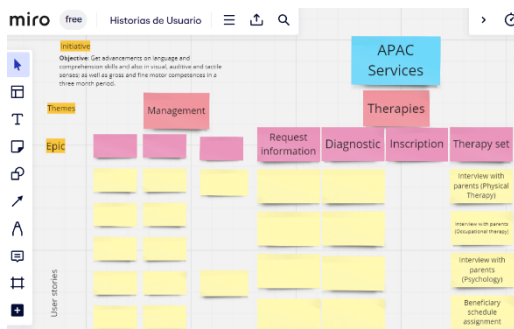


Fig. 6. Miro board with epics and user stories. Own elaboration



Fig.7. Journey Mapping exercise in workshop.

Test.- For the testing, a *measuring instrument* with base in [18] was applied to make a diagnostic about digitalization knowledge and user experience. Then, it was agreed to create the real Journey Mapping for the institution to confirm the knowledge acquisition. To achieve this, micro-learning material with information about User Stories, User Journey Mapping and Backlog concepts were delivered to all the teams, asking them to work on a week period doing their Department User Stories. Examples from Sensorial area and the Operative direction evidence of these work is described on table 3.

Table 3. User stories in the Rehabilitation Center

Rehabilitation Centre area	User stories
Sensorial Therapy	<ol style="list-style-type: none"> 1. As physical therapist, I want a practical valuation tool to establish precise objectives and have results with scientific evidence. 2. As physical therapist, I want to learn from all the other areas of the institution to offer an interdisciplinary service and facilitate the patient and their families 'process. 3. As physical therapist I want be updated to offer a better service. 4. As physical therapist, I want to look for a work tool with base in functionality and independence to have results in short, medium, and long term.
Operative Direction	<ol style="list-style-type: none"> 1.As Operative director I want an institution's own General Intervention Program to base our services. 2. As Operative director I want to design strategies that support the institution's potential. 3. As Operative director I want to raise awareness and support the mental health of all the involved in our services.

On the Jira platform, a project was created, and all the information of tasks revealed in every user stories board of the institution's areas was migrated as an initial *Backlog*.

Sprint Planning. - With a backlog already pre-defined in Jira, Sprint Backlog 1 (SB2) was created. For this purpose, the *Storytelling* tool helped us to have this planning visible in various channels: on the Jira platform, on Miro board, in the APAC Management Office, and in Therapy Rooms.

Sprint. - Sprint 1 consisted in following activities expected to be completed in a month: Everyday Education and Rehabilitations Services; Brief report on Jira platform according to the group or special needs for a child, as well as pending activities in the organization; Digitalization of user's medical records and Scrum daily meetings with a research wall.

Scrum Daily Meetings. - During the Sprint, the Scrum Daily meetings supported the track progress, a personal communication promoting, and task advances monitoring.

Sprint Review. - Once the Sprint month was completed, a meeting for Sprint review returned the following information:

- a) Everyday Education and Rehabilitations Services ran smoothly.
- b) The reports on the Jira platform still need practice from the collaborators of the institution.
- c) The digitalization of users' medical records has been slower than expected due to not receiving documentation from the children's relatives.
- d) Scrum daily meetings are still an unknown event on structure.

So, it was essential to designate a team that uploads information to the platform and to plan strategies to make this activity more fluid; As *Sprint Increase* it was documented the creation of a strategy for receiving the documents for digital file faster; and appoint a person to conduct the Scrum Daily Meetings of each Sprint.

Sprint Retrospective. - This event documented the performed Sprint 1 Retrospective. The process, tools, interactions, and Sprint Increase were analyzed. Thus, the improvement tasks were added in Backlog for the next Sprint.

5.2 Iteration 3

In this cycle, phases were reduced since the strategic part of DT has been carried out, so it was focused only on Scrum five phases that receive and generate information for Backlog, Sprint Backlog 2 (SB2) and Sprint Increase 1 (SI2) artifacts.

Sprint Planning. - This Sprint Planning was coordinated in response to goals achieved with activities from last iterations. Two activities were added to *Backlog* in Jira creating the *Sprint Backlog 3 (SB3)*. Table 4 show the main points of this event.

Sprint. - The third Sprint consisted of doing the activities expected to be completed following Sprint Planning 2 in two months.

Table 4. Sprint Planning for 3rd iteration.

Previous Activity (SP2)	Current progress	Plan design	Activity (SP2) (SB2)
1. Everyday Education and Rehabilitation Services	Normal progress	Continuation	1. Everyday Education and Rehabilitation Services
2. Write a brief report on the Jira platform according to the group or special needs of a child, as well as pending	Intermittent Progress	Upload more data to Jira per week	2. Extend the report on the Jira platform according to particular needs for a group of children and pending activities.

activities in organization			
3. Digitalization of users' medical records	Low progress	Request cooperation from parents in sending documents for records, either by transportation or digital means	3. Reminder to parents for the creation of digital records
4. Scrum daily meetings with a research wall	Normal progress but with doubts	Reinforce information on how to conduct Scrum daily meetings	4. Scrum daily meetings with research wall (face to face or using Miro)
-	-	-	5. Categorize activities by Epics on the Jira platform
-	-	-	6. Training on Scrum culture

Scrum Daily Meetings. - With the clarification of doubts, the tracking progress still controlled the iteration 3 for all involved roles.

Sprint Review. - After the two month-period, a meeting for Sprint review returned the following information:

- a) Everyday Education and Rehabilitations Services ran smoothly.
- b) The reports on the Jira platform are better entrenched
- c) New medical records have been received by school transportation and on digital formats.
- d) Scrum daily meetings are easier to carry on.
- e) The creation of epics was easy, but it is essential to categorize in suitable groups for better control on the platform.
- f) New challenges for continue to adopt agile culture.

So, it was important to understand and differentiate groups of activities for Epics creation, but also to practice the process more times; on the matter of agile culture training keep creating strategies to learn the approach. *Sprint Increase 2* was identified.

Sprint Retrospective. - Documentation was done here. This event was overall for documented new tasks to add in *Backlog*:

- a) Create another project in Jira to track the achieved milestones and evaluate the effectiveness of therapies and educational interventions for children.
- b) Use Miro to collaboratively gather feedback from therapists and educators regarding the strategies employed in Sprints 1 to 3. Analyze their input to identify areas for improvement and potential adjustments to future sessions.
- c) Evaluate interaction and integration with Miro and Jira tools for managing tasks and collaboration, identifying challenges and enhancements needed to streamline the workflow.
- d) Explore new tools with Artificial Intelligence.

After Sprint 3 ended, the second *survey application* was conducted for APAC Association collaborators to measure the performance using digital tools and the Scrum framework. With the results, the level institution was placed at level 1 as Intermediate.

The three work iterations conducted for the research study aimed at the continuous co-creation of the Digital Learning Ecosystem for disabled children services through a co-design approach it yielded valuable insights and progress. The iterative process allowed for a systematic exploration of user needs, ideation of solutions, prototyping, testing, and continuous refinement.

Throughout the iterations, various tools were employed, including empathizing with users, defining key issues, ideating potential solutions, prototyping the digital ecosystem architectures, the until now unknown user journey map by the organization's professionals, the utility of a research wall and an advance on digital competences. With the Testing, the effectiveness of the proposed solutions was evaluated, and sprint planning ensured focused execution of tasks.

Key findings from the iterations included a deeper understanding of user needs, identification of critical issues such as communication gaps and staffing shortages, and improvements in digitalization processes and Scrum framework adoption. The iterative nature of the research allowed for ongoing adaptation and refinement of strategies based on feedback and insights gained during each phase.

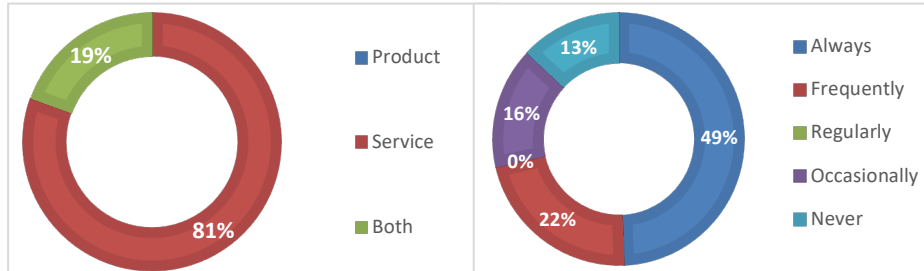
Overall, the three work iterations demonstrated the efficacy of a Co-design approach in creating a tailored Digital Learning Ecosystem for Services for Children with disabilities. As it is seen, the hybrid model proposes ten phases that create a completely new environment in the services process for Infancy Rehabilitation Centers and Special Education Pre Schools that attend children with disabilities, and therefore, their families. Each one of these created innovative products thanks to the information generated as the recognition of the ecosystem architecture, valuable feedback from internal collaborators and parents, user stories for backlog creation, adequate Sprint Plannings, and the increments for iteration.

The instrument for pre-test and post-test surveys described the effectiveness of the hybrid model combining agile methodologies by exploring the success and adoption model since an e-learning perspective, identifying to the institution's professionals as the students in a sense of partners that co-design together. It allowed to measure the technical system quality, service quality, content and information quality, use, user perceived satisfaction, and individual impact. Through the surveys conducted with the users, the effectiveness of the provided insights into the factors that contribute to user satisfaction and overall success. The iterations carried out on case study underscores the importance of a quality educational system that requires a technical system to enhance user satisfaction from individual to impact on the organizational, becoming aware of the need to optimize the use of hybrid systems, performance in the context of special education and rehabilitation for children with disabilities.

5 Results

The results obtained through the preliminary survey and the survey applied after the third Sprint had a descriptive analysis to compare the impact of co-designing with

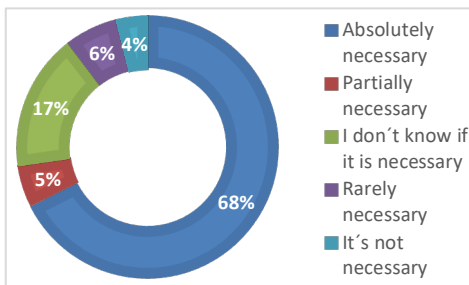
collaborators working under the digital learning ecosystem model. The Graphs 1a to 7a shows the results obtained in the pre-test before Sprint 1, and the graphs 8 to 12 detail the results of the post-test after Sprint 3.



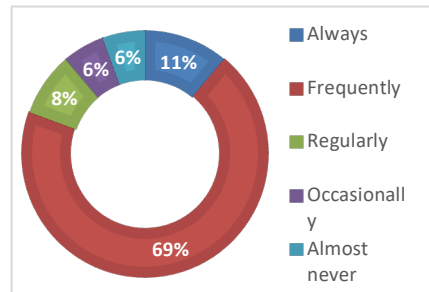
Graph 1. Type of Work Focus (Product vs. Service)

Graph 2. Frequency of Service Evaluations

Graph 1 illustrates the distribution of work activities based on whether they are focused on delivering a product or a service. The majority, comprising 81%, provides a service, indicating that a significant portion of the efforts is directed toward service-oriented activities. Conversely, 19% of the activities are geared towards creating or delivering a product. Graph 2 represents the Frequency with which Rehabilitation Centers and Special preschools conduct evaluations pertaining to their services. The results show that the highest frequency is 'Always' at 49%, indicating that almost half of the centers consistently evaluate their services. Following this, 'Frequently' is reported at 22%, while 'Occasionally', 'Regularly', and 'Never' have frequencies of 16%, 0%, and 13% respectively. This suggests a relatively regular evaluation process, with a significant emphasis on consistent assessments in these rehabilitation centers.



Graph 3 - Need for Agile Methodology for Processes Efficiency

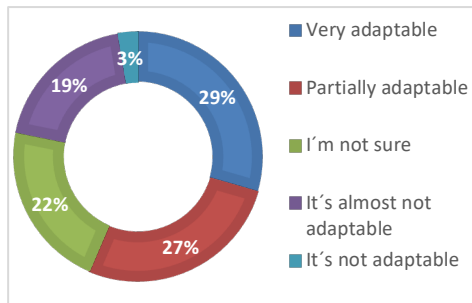


Graph 4 - Use of Digital Tools for Team and Process Management

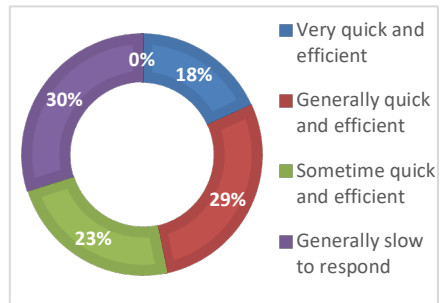
Graph 3 portrays the perceived necessity of implementing an agile methodology to enhance process efficiency. The results indicate a strong inclination towards the adoption of agile methodologies, with 68% considering it as necessary. A smaller percentage, 5%, view it as partially necessary, while 17% are unsure if it's needed. Additionally, 6% regard it as rarely necessary, and 4% believe it's not necessary. This

reflects a predominant consensus on the importance of agile methodologies for optimizing processes and workflow efficiency.

Graph 4 showcases the frequency of employing digital tools for team and process management. A significant majority, 69%, utilize these tools frequently, indicating a strong reliance on digital platforms for managing teams and processes. Following this, 11% use them always, highlighting a consistent integration of digital tools in their workflow. Additionally, 8% use them regularly, and 6% use them occasionally and never respectively. This emphasizes the prevalent utilization of digital tools, showcasing their importance in efficient team and process management.



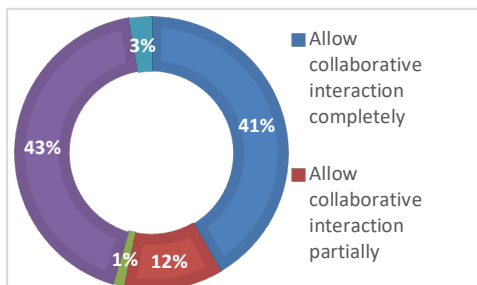
Graph 5. Adaptability of the Organizational Ecosystem



Graph 6. Response Time in Organizational Ecosystem

The graph 5 represents the perceived adaptability within the organizational ecosystem. The data showcases that a notable portion, 29%, view the organization as highly adaptable, indicating a strong capacity to respond and adjust to changes effectively. Following this, 27% consider the organization to be partially adaptable, implying a recognition of adaptability but with room for improvement. Additionally, 22% express uncertainty about the adaptability level, 19% perceive it as almost not adaptable, and a smaller fraction, 3%, believes the organization is not adaptable. This illustrates varied perceptions regarding the adaptability of the organizational ecosystem.

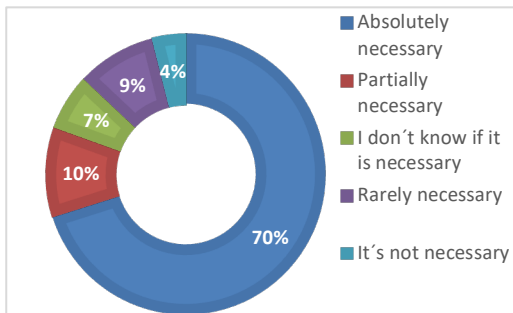
Graph 6 displays the perceived response time within the organizational ecosystem. A significant portion, 30%, perceive the response as slow, suggesting potential delays in the system's reaction to various circumstances. In contrast, 18% believe the response is very fast and efficient, while 29% consider it fast and efficient. Furthermore, 23% view the response as sometimes fast and efficient. Interestingly, no respondents find the response to be very slow, indicating that despite perceived delays, there is a consensus that the response time is not at the extreme end of slowness.



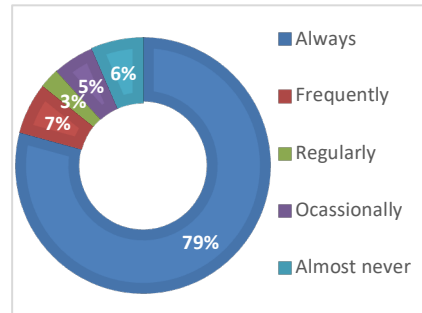
Graph 7. Ecosystem Tools for Interaction and Collaboration

On Graph 7, the assessment of ecosystem tools in facilitating interaction and collaboration within a system. A significant percentage, 41%, affirms that these tools completely enable collaborative interaction, emphasizing their pivotal role in promoting teamwork and shared efforts. 12% believe the tools only partially facilitate collaborative interaction, suggesting room for improvement. Merely 1% find these tools to occasionally enable collaborative interaction. However, a notable 43% express that the tools rarely or almost never support collaborative interaction, highlighting a perceived limitation in the ecosystem's collaborative potential. Finally, a small fraction of 3% contends that the tools outrightly do not support collaborative interaction. This diverse range of perspectives portrays varying levels of satisfaction and utilization of the tools in promoting collaborative interaction within the ecosystem

After the three work cycles, some percentages in results significantly changed. As an essential change, the digital tools usage increase, as well as the perception on response time and adaptability of the new ecosystem. For users, the interaction and collaboration were perceived as more meaningful, reducing the feeling of working in an ecosystem that hardly encouraged these features, the results of the post-test after the third sprint 3 are described below.



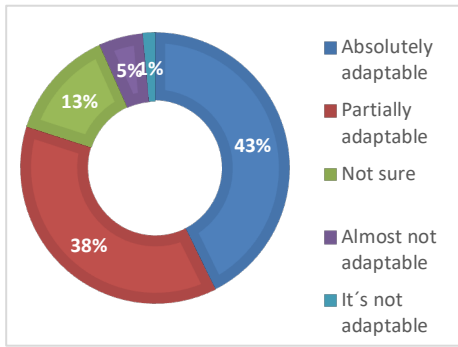
Graph 8. Adaptability of the Organizational Ecosystem



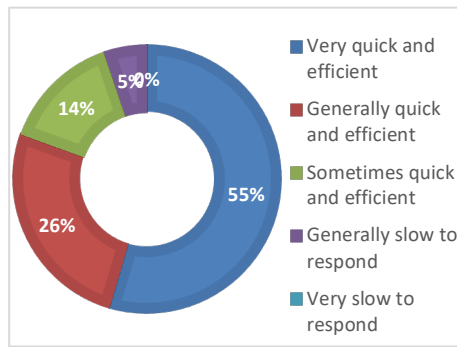
Graph 9. Response Time in Organizational Ecosystem

Graph 8 After Sprint 1, results on the necessity of an agile methodology implementation are like the first survey, this time with a 70% inclination, against a 4% that still believe it is unnecessary. So, it's a strong work to create a work culture with agile methods, but most collaborators still think it is necessary.

Graph 9 An increase to a 79% began using purposed tools, 7% utilize these tools frequently, 3% use them regularly, 5% occasionally and 6% seldom used them, highlighting how it begins to be integrated into their workflow and processes, but still not cover a complete use.

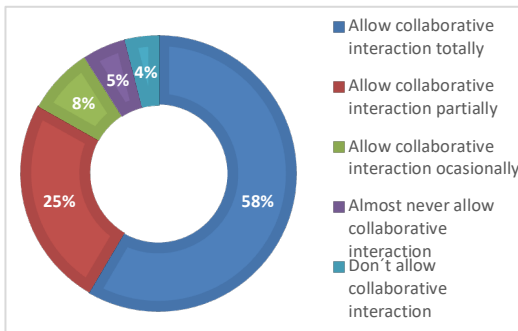


Graph 10 - Adaptability of the Organizational Ecosystem



Graph 11 - Response Time in Organizational Ecosystem:

On Sprint 3, the graph 10 of adaptability in organizational ecosystem data showcases that 43% view the organization as highly adaptable, which represents an increase of 14%, followed by 38% to be partially adaptable, so the perception now is about more capacity of adaptability. Graph 11 displays 55% of a rapid and efficient time of response in the ecosystem, 26% think the time of response is generally quick and efficient, and 14% only see speed and efficiency occurring only sometimes. It continues with the opinion that it is never so slow to respond.



Graph 12 Ecosystem digital tools for support interaction and collaboration

Lastly, in the graph 12, 58% affirms on this second Sprint that the tools they are working on now allow collaborative interaction. On the other hand, there are still opinions of Almost never allowing collaborative interaction with a 5% or that do not enable collaborative interaction with a 4%. So, it will be necessary to investigate the reasons for this negative perception.

7 Discussion

Co-Design a Digital Learning Ecosystem model for organizations of Services for Children with Disabilities aimed to foster effective collaboration and promotes to enhance the professional digital competences by integrating two methodologies geared towards agile project management and user-centric focus. Crucially, the iterative nature

of the project scope, characterized by multiple cycles with distinct closures and deliveries, ensured a systematic refinement process. By blending Design Thinking and Scrum, the model facilitated the creation of working prototypes for early user feedback and tackling technically intricate tasks. This approach emphasized learning from failures and streamlining processes through standardized protocols and guidelines.

Comparison on table 5 show slight but significant changes in some analyzed dimensions as the detection of delivery approach must be a service, the increasing on digital tools usage while allowing collaborative interaction, the speed with which the time response can vary, as well as the agile culture implementation as necessary.

Table 5. Comparison before and after model application

	Pre-test (Diagnostic)	Post-test (Evaluation)
Delivery approach	Both (Service and product)	Service
Service evaluations	Always	Always
Digital tools usage for team and process management	Frequently	Always
Ecosystem adaptability	Very adaptable	Absolutely adaptable
Ecosystem time response	Generally slow	Very quick and efficient
Interactivity and collaboration	Almost never	Always
Agile implementation	No	Yes

Furthermore, it coordinated cross-functional teams comprising therapists, psychologists, medical specialists, educators, and other stakeholders involved in the interactions developed. Interaction is fundamental in any field, as humans is necessary to maintain key relationships for work success and development advances. Shaping the context of education and rehabilitation of children with disabilities as a digital ecosystem still requires a redefinition of these services that must filled with information and practice with users. To improve these spaces, the proposed model represents a support for their services' design promoting a multi-channel interaction.

Some limitations prevented the comprehensive coverage of several important aspects, since co-design goes further traditional participants as suppliers and customers. While the integration of new tools and methods in our research endeavors holds promise for enhancing the interaction and satisfaction of users until end-users, particularly families and children receiving educational and rehabilitative services, there were several limitations and areas for future exploration. Despite increases in the perception of improved interaction and the progress in migration towards a digital process, the acquisition of a good level in digital skills is a challenge when implementing the proposed model. The analysis sheds light on several key aspects of the results findings.

Firstly, it is evident that the utilization of technology, digital resources, and the adoption of an agile culture remain relatively novel within the contexts surveyed. This underscores the need for increased awareness and training initiatives to foster an effective integration of the hybrid digital learning ecosystem, the collaborative nature of using digital tools and embracing an agile culture as new requires ongoing interaction

characterized by adaptability to changes and the utilization of new artifacts. While the model with co-designing demonstrates positive acceptance and perception, there is a recognized need for adjustments to ensure a more comprehensive agile implementation. These adjustments should align with co-design principles, as well as medical methods and considerations of public relations.

Additionally, it becomes apparent that the successful execution of the model requires face-to-face training sessions with research project participants. Finally, the levels delineated within the Framework for Agile Management offer valuable insights into the principal changes observed concerning knowledge acquisition and the practical application of the model within the surveyed contexts. These findings collectively underscore the importance of iterative refinement and ongoing development in achieving a full implementation of agile methodologies in pedagogic and therapeutic contexts.

Future research is needed to explore how to improve the Digital Learning Ecosystem model implementation and ensure the meaningful involvement of children's families in the co-creation process. Secondly, while early digital storage of intervention strategies has shown potential to positively impact user experiences, additional studies are warranted to assess the long-term effectiveness and scalability of this model. Moreover, exploring the integration of emerging technologies such as machine learning and artificial intelligence in managing digital files and personalized backlogs could further enhance its utility. Thirdly, stakeholder engagement through digital platforms has facilitated broader participation and perspectives. Yet, future efforts should focus on refining strategies for sustaining stakeholder engagement and leveraging online communities to promote continuous learning and collective action.

Lastly, measuring metrics related to agile methodologies, Scrum practices, and co-designing processes with the guidance of experts will be crucial for assessing the effectiveness and refinement of the model. In addition to these areas of focus, future work should also delve into the potential of telerehabilitation and telehealth to extend services beyond geographical limitations and enhance support for caregivers and professionals through online interactions.

8 Conclusion

Nowadays, the agile culture is immersed in many industries as a core part of the organizational structure, as well as the use of technology, which goes hand in hand with each other, nevertheless, in spaces for special education and rehabilitation therapies for children with disabilities. Nevertheless, very few infancy rehabilitations centers or special education pre-schools rarely use agile methodologies, or these are almost unknown, like many others disruptive trends. Furthermore, even if they may be familiar with the technology, their resources, time, and the most appropriate adoption are not enough. It's important that people who work on these places, recognize their current ecosystem with weaknesses and strengths to acquire agile and digital skills that allow expand their services landscape, thus entering to a new dynamic of practical application.

A model that integrates technology and digital tools play a relevant function when it is accompanied with knowledge, continuous training, and instructional guides of agile methods. The improvements sought for an effective implementation growth will not only be touched through technology, but it must be reinforced the traditional way of working, establishing a wealth of knowledge to complete a vision to face the future through light management that link creativity and sensitivity leveraging the best of systems thinking and design. To make it a meaningful and valid experience for any partaker, research laboratories inside these organizations are an excellent solution to obtain priceless information working under a co-design approach.

The findings contribute in two dimensions, the body of knowledge in digital interactions among cross-functional teams for special education and rehabilitation services, highlighting the importance of user-centered design and iterative development processes; and the whole system rethinking of specialized services to children with disabilities, with an emphasis in the core parts of user research and co-design to encourage the expression, the discussion and the ideas with learning purposes and professional improvement.

As theoretical implications, the research could contribute to the advancement of theories related to interdisciplinary collaboration, participatory design, and agile implementation in the context of educational and rehabilitation services for children with disabilities. generating new perspectives on the integration of digital technology in these fields and its impact on user experience and treatment outcomes. The social implications of this approach could have a positive impact on society by improving the quality of life for children with disabilities and their families by promoting more active involvement of end-users in the design and delivery of services, customer satisfaction and social inclusion can be increased. Basing the way of working under an agile approach could provide more government resources to schools or associations too. Additionally, by extending services through digital technologies, geographical barriers can be overcome, making access to healthcare and education for marginalized communities.

For the professional practitioners on education, rehabilitation, and healthcare, the model could benefit to adopt more collaborative, user-centered, and agile practices. This may require a shift in organizational culture and staff training to adapt to new methodologies and digital tools. However, in doing so, practitioners can improve the efficiency of their services, increase customer satisfaction, and enhance outcomes for children with disabilities.

This brings to key areas of future work firstly, because is essential the collaboration and meaningful involvement of children and families in the co-creation process. Secondly, the metrics measures related to agile methodologies, Scrum practices, and co-designing processes will be crucial for assessing the model's effectiveness Thirdly, refine strategies for sustain online communities is crucial for stakeholder engagement through digital platforms.

Furthermore, complementary investigation is needed to assess the long-term effectiveness and scalability of early digital storage of intervention strategies, including the integration of emerging technologies like artificial intelligence, and finally, explore telerehabilitation and telehealth's potential to extend services and support caregivers and professionals through online interactions may continue to change the direction of

special education and rehabilitation services. It will be key to theorize more deeply about a concept of the design-teaching-rehabilitation-digitization quartet paradigm.

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