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Developing Virtual Reality Environments for Trauma-Focused Cognitive Behavioral Therapy in Clinical Routine Settings: An Open-Label Case-Series Study

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This open-label case-series study examined the feasibility of implementing VR Photoscan, a cost-effective virtual reality intervention, within a community-based mental health care setting in Northern Ireland. By integrating VR Photoscan into trauma-focused cognitive behavioral therapy (TF-CBT), the study explored its acceptability among clients and therapists, and identified practical considerations for future implementation. Using a mixed-methods approach, five PTSD-diagnosed clients received TF-CBT supplemented with VR Photoscan. Symptom changes were assessed using the PTSD Checklist for DSM-5 (PCL-5) and the Clinical Outcomes in Routine Evaluation-10 (CORE-10). Additionally, semi structured interviews were conducted with three consenting clients and the participating clinical team, comprised of a service manager, four psychological therapists, and a software company manager, to explore experiences and perspectives of using the VR Photoscan intervention within therapy sessions. Results indicated a reduction in PTSD symptoms and psychological distress in most clients, suggesting VR Photoscan can be feasibly integrated into TF-CBT for PTSD. While some clinical staff were initially hesitant, they later recognized the value of VR in providing immersive, controlled environments that supported core therapeutic processes. This study offers preliminary evidence for the acceptability and practical integration of VR Photoscan within routine mental health care. Collaboration among therapists, clients, and developers was identified as a key factor in successful implementation. Given the small sample size, and lack of a control group, future research is needed to examine the comparative effectiveness of VR-assisted versus standard PTSD treatment, evaluate strategies for implementation across clinical settings, and explore conditions under which broader adoption may be feasible.

The integration of technology into healthcare has significantly accelerated, especially during the Covid-19 pandemic, transforming the delivery of care (Hollis et al., 2018; Seabrook & Nedeljkovic, 2021; Shah et al., 2022). Digital platforms now provide remote access to healthcare services, enhancing efficiency (Leigh et al., 2021; NHS, 2023). As a result, global healthcare authorities are increasingly embracing and regulating technology-based mental health interventions (Department of Health [DOH] All Ireland Digital Capability Framework, 2022; NICE, 2022, 2023; GOV UK, 2022; World Health Organization

Keywords: virtual reality; Trauma-Focused Cognitive Behavioural Therapy (TF-CBT); PTSD; VR Photoscan; mental health technology; clinical implementation

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[WHO], 2021). These policy shifts aim to improve access, quality, and outcomes in mental health services, addressing critical gaps in care.

Northern Ireland, known for its high level of mental health needs (Mental Health Foundation, 2023), faces additional challenges such as long wait times, staff turnover, and burnout, which is impeding access to essential mental health services (Department of Health [DoH], 2021; Deakin, 2022; Northern Ireland Assembly, 2020). This highlights the need for innovative approaches, with technology offering a promising solution to address these challenges. Virtual reality (VR), in particular, has shown considerable promise as a tool for mental health treatment (Hollis et al., 2018). VR enables personalized therapy, such as exposure therapy and desensitization in controlled environments, providing immersive experiences that benefit various conditions, including social phobia, panic disorder, psychosis, obsessive-compulsive disorder, and PTSD (Botella et al., 2007; Freeman et al., 2023; Kim et al., 2009; Rizzo et al., 2010; Roy et al., 2003).

Despite its potential, the adoption of VR in clinical settings faces significant barriers, including high costs, lack of standardized protocols, and limited acceptance among healthcare professionals (Best et al., 2020). This paper provides an open-label case-series study that identifies key factors influencing the implementation of a low-cost VR technique called VR Photoscan (Best et al., 2024). This mixed methods study offers insights that were gathered from a small team of professionals, including a service manager, clinical staff, and a software company, who have successfully used VR Photoscan to treat PTSD in a local mental health service.

Implementation of Digital Technology Within Mental Health Services

The integration of VR into clinical mental health treatment is in its early stages, presenting both challenges and opportunities. Understanding factors influencing its adoption is crucial for successful implementation (Proctor et al., 2010). While global examples of VR use in routine clinical settings remain limited, South Korea has emerged as a leader. Since opening its first VR clinic in 2005, the country has expanded VR applications for conditions including PTSD and dementia, and VR-based CBT for social phobia has even been recognised as a new medical technology (Kim & Kim, 2020). In contrast, VR adoption elsewhere remains limited. While specialized facilities have effectively used VR for PTSD treatment (Best et al., 2020) and there have been advancements in VR hardware, software, and implementation strategies, ongoing research is needed to bridge the gap between experimental success and real-world application in diverse clinical settings (Cullen et al., 2021).

The adoption of digital technologies, including VR, is often analyzed using models like the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) and its updated version, UTAUT-2 (Venkatesh et al., 2012). These frameworks are widely used to predict technology adoption and assess factors influencing its use in healthcare (Ammenwerth, 2019; Jones et al., 2022a). They have helped identify barriers and drivers in adopting digital tools such as mobile health services, electronic health record systems, and AI chatbots in mental health care (Liu et al., 2023; Buivydaite et al., 2022; Lovejoy, 2019). UTAUT-2, in particular, provides a nuanced view of consumer use and user experience, making it highly relevant for understanding the adoption of emerging digital mental health tools like VR.

Additionally, collaboration between individuals with lived mental health experiences and healthcare providers is essential for user-centred design in digital interventions (Davies et al., 2017). This approach ensures that digital mental health technologies align with user needs and preferences, enhancing effectiveness and accessibility (Bernaerts et al., 2024). Selaskowski et al. (2024) highlight the need for further discussion on regulatory frameworks, such as the Medical Device Regulation (EU MDR) in Europe and FDA regulations in the US, to ensure VR tool safety. However, these approval processes are often costly and time-consuming, posing barriers to research and implementation. The challenge ahead is not whether VR will be used in mental health care, but ensuring its adoption is grounded in rigorous, evidence-based research.

Virtual Reality and PTSD

PTSD is a debilitating mental health condition triggered by experiencing or witnessing a traumatic event, leading to distressing symptoms like intrusive memories, flashbacks, anxiety, and avoidance behaviors (American Psychiatric Association [APA], 2013). Traditional methods such as CBT and medication are established as effective treatments (NICE, 2018), with the emergence of VR offering a complementary approach to enhance these treatments (Bisson et al., 2020; Peskin et al., 2019). Rizzo and Bouchard (2019) nevertheless emphasize the importance of clinicians applying VR in PTSD treatment with a thoughtful approach, cautioning against employing the technology solely for its novelty.

To understand the benefit of VR, it is essential to explore existing literature and theoretical foundations. PTSD typically stems from serious accidents, combat, or assault, often perpetuated by ongoing feelings of threat (Ehlers & Clark, 2000). A standard treatment for PTSD is exposure therapy, which involves revisiting traumatic memories, known as Imaginal Exposure (IE), but this can be challenging due to symptoms like avoidance (Rauch & Rothbaum, 2016; Rothbaum et al., 1999). VR offers a visceral, realistic platform that can enhance engagement and authenticity, potentially overcoming IE's limitations, which include difficulties recalling vivid trauma imagery, high avoidance, and reduced emotional engagement during sessions (Kothgassner et al., 2019; Rizzo et al., 2019). VR therapy provides a safe, controlled environment for gradual exposure, enhancing treatment efficacy (McLay et al., 2017; Miyahira et al., 2012; Ready et al., 2010; Reger et al., 2016). It also offers accessibility and convenience, allowing therapy to take place within the clinical settings without requiring clients to revisit the trauma site in person (Boeldt et al., 2019; Pittig et al., 2019).

VR has been shown to have effects similar to traditional in-vivo exposure, with some clients showing a preference for it (Garcia-Palacios et al., 2007; Carl et al., 2019). Despite the growing body of evidence showcasing the potential of VR in the treatment for PTSD, including the low-cost VR Photoscan option (Best et al., 2024), the utilization and implementation of these technologies within clinical settings to treat mental health conditions remains limited. This is due to several barriers, including high costs and the need for specialized equipment. Staff acceptability and training are also significant challenges, as many professionals are hesitant to adopt new technologies without adequate support or proof of long-term effectiveness. Additionally, the time required to integrate VR into workflows, along with regulatory and safety concerns, further hinders adoption (Cushnan et al., 2024).

Aims and Objectives

This paper aims to explore the experiences and outcomes of a small professional team who were among the first to implement a low-cost VR Photoscan intervention alongside Trauma Focused-Cognitive Behavior Therapy (TF-CBT) for PTSD treatment in their local mental health service, in Northern Ireland.

Objectives

- To explore professional perspectives on the added value and practical use of the low-cost VR Photoscan technology for PTSD treatment;
- To collect data on the changes in clinical outcomes when implementing TF-CBT assisted by VR Photoscan technology;
- To assess the implementation process, focusing on the challenges encountered and strategies employed;
- To analyze the role of collaboration among clinical staff, management, and the software company manager in ensuring the successful integration of VR Photoscan technology into PTSD treatment.

Materials and Methods

Qualitative and quantitative data were gathered using a mixed-methods approach. Five clients consented to participate in the study and agreed to undergo VR treatment. After completing the intervention, semi-structured interviews (lasting 30 to 60 minutes each) were conducted with nine participants. This group included the service manager (lead psychological therapist), four psychological therapists, the software company manager who developed the VR Photoscan environments. Of the five clients, one withdrew from treatment prior to using the VR intervention, only initial baseline scores were collected, and they were not eligible for a follow-up interview. A second client completed the treatment but declined to participate in the follow-up interview due to personal circumstances; however, their pre- and post-treatment scores are included in the analysis. As a result, only three of the five clients who underwent the VR Photoscan treatment also participated in a follow-up interview. Together this group formed the core team that successfully introduced the low-cost VR Photoscan, alongside TF-CBT to treat PTSD within the Health and Social Care Trust (see Figure 1).

Treatment Procedure

The service manager and psychological therapists, all trained to follow Ehlers and Clark's (2000) Cognitive Model of PTSD (widely recognized as a trauma-focused CBT approach for adults) to deliver TF-CBT, integrated the VR Photoscan technology into standard therapy protocols, using it during the reliving sessions. The PCL-5 was used alongside Criterion A to ensure it was cued to an index trauma. Specifically, a narrative assessment interview and screener tools were administered by a separate assessment team within the same service but independent of the therapists delivering the intervention, prior to referral to the trauma service. Following this initial screening, a second stage of assessment was conducted by clinicians involved in the study, who reviewed the materials to determine participant suitability for the study. This review process included confirming the identified index trauma and its classification as Type 1, ensuring that the PCL-5 was appropriately cued to the trauma experience. As such, five clients had personalized virtual environ-

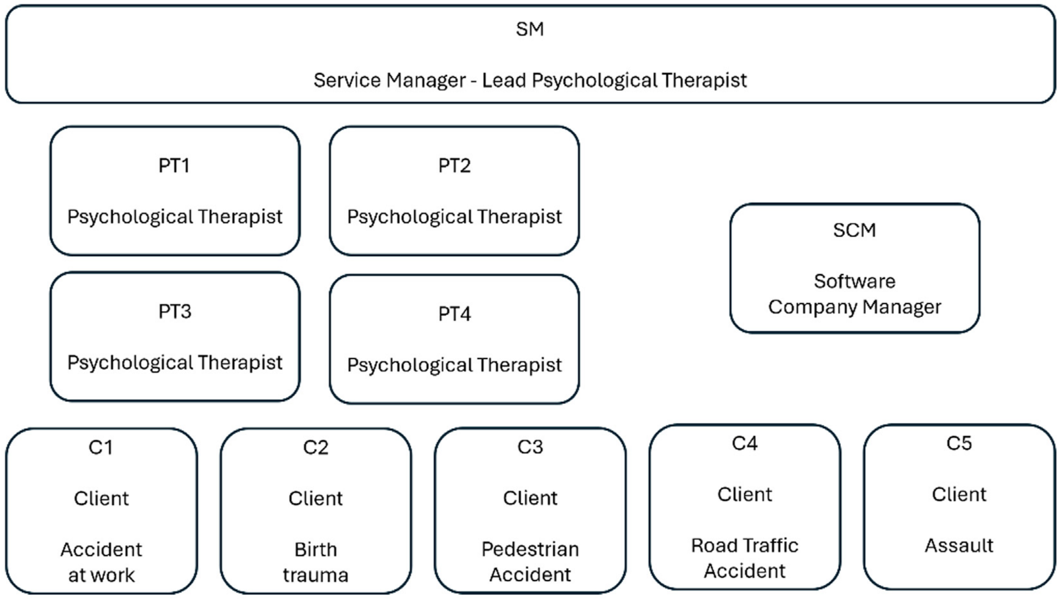

Fig. 1. Participant Roles and Identifiers.

ments created for them, which were used to enhance their therapeutic experience. The standard course of TF-CBT consists of 12–14 sessions, each lasting 60–90 minutes. Ethical approval was granted before recruitment began.

Intervention Development

Low-Cost VR Photoscan

This technology involves capturing real-world images using smartphones or tablets. The images are subsequently uploaded to a secure online platform with concise descriptions of key areas of interest. Images are then transformed by the software company into high-quality 3D images using the open-source software Blender and subsequently implemented in a VR environment using Unity. The resulting environments are compiled as an APK file and sent to a Meta Quest 2 headset to allow for an immersive VR Photoscan experience. Users can navigate the VR Photoscan environment with six degrees of freedom, with real-time additions of objects like cars and people. User-friendly menus provide instructions and track progress. Lighting, weather, and sound are adjustable to simulate different conditions. Notably, these virtual environments are created without specialist equipment, reducing production times and costs (see Table 1). A distinctive feature of the VR Photoscan approach is its focus on idiographic environments, individually tailored virtual re-creations of trauma-related settings based on each client's experience. This personalized design aims to enhance therapeutic relevance and engagement, aligning with broader movements toward user-centred and context-specific digital interventions. Within each environment, clients had the ability to transition between the traumatic environment and a designated safe space. These features were intentionally incorporated into the VR Photoscan environment by a click of a button to allow clients to regulate their emotions and reduce distress, creating a supportive environment for gradual trauma processing. Safe spaces included serene forest scenes with calming bird sounds and lush greenery, as well as mountain ranges accompanied by soothing ambient sounds. While traditional exposure therapy discourages avoidance during distress, the option to transition into a safe space was incorporated to support emotional safety, especially in early sessions. This approach was guided by clinical judgment and aimed at reducing dropout risk and maintaining engagement within a real-world service context.

The following five-step process, originated by Best et al. (2024), outlines how real-world trauma locations are transformed into immersive VR environments for therapeutic use, supporting effective and controlled trauma exposure therapy (see Table 1). Importantly, the VR environments recreated the location and contextual elements of the trauma, but not the traumatic event itself. This allowed therapists to guide clients through imaginal reliving using the environment as a contextual cue.

Staff Training and Equipment

Clinical staff received 2 on-site training days combining a theoretical introduction and hands-on experience with Meta Quest 2 headsets and the relevant software. Staff also had an opportunity to take the devices home to familiarize themselves before using with clients. Additional assistance was provided by the service manager, who had previous experience supervising a VR-based project for public speaking anxiety. The software company involved supplied a protocol with a step-by-step guide to ensure that the imagery was collected in systematic way so that virtual environments could be created.

Data Collection

Quantitative

Quantitative data were collected through pre- and post-intervention scores, in line with the routine practice of the participating mental health service. This process was used to assess changes in PTSD symptoms and overall psychological distress, providing an evaluation of the effectiveness of the intervention.

Outcome Measures

This study used two key outcome measures. The PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013) and the Clinical Outcomes in Routine Evaluation-10 (CORE-10, Barkham et al., 2013; Evans et al., 2000). The PCL-5 is a 20-item self-report measure designed to assess PTSD symptoms based on DSM-5 criteria. Each item is rated on a scale from 0 (*not at all*) to 4 (*extremely*), resulting in a total score that ranges from 0 to 80. This tool can be used to track symptom changes over time, screen for PTSD, or provide a provisional diagnosis. A score between 31 and 33 is indicative of probable PTSD (Blevins et al., 2015). The CORE-10 is a brief, 10-item measure of psychological distress designed for use in routine psychological therapies (Barkham et al., 2013). Each item is rated on a 5-point Likert scale, with total scores ranging from 0 to 40. Higher scores reflect greater psychological distress, offering a snapshot of mental well-being and providing insight into client progress throughout the intervention.

Qualitative

At the conclusion of the intervention, qualitative data were gathered by members of the research team (JC and PB) through semistructured interviews with both clinical staff, clients and the software company manager, conducted via their preferred platforms (e.g., Zoom, Microsoft Teams). All interviews were conducted individually to allow for open discussion and minimize potential influence from other participants. A structured topic guide was used to ensure consistency in questioning (Dicicco-Bloom & Crabtree, 2006). While both groups were asked similar core questions, additional questions were posed to clinical staff, focusing on the practicalities of delivering the intervention.

Data Analysis

Descriptive statistics were calculated for the PCL-5 and CORE-10 scores at baseline and post-intervention. Mean scores and standard deviations were computed to provide an overview of the changes across the sample. Qualitative data from semistructured interviews with clinical staff and clients were analyzed using Reflexive Thematic Analysis (RTA) as outlined by Braun and Clarke (2020; 2021). RTA emphasizes the active role of the researcher in identifying and interpreting patterns within the data, recognizing the influence of subjectivity throughout the analytical process. To support this approach, transcripts were generated using Sonix transcription soft-

Table 1
Five-Step Guide to VR Photoscan

Step	Details
Step 1	Through interview with the participant the therapist gathers descriptive data relating to scene where the trauma took place i.e., precise location, time of day, vantage point etc.
Step 2	A site visit is conducted whereby various 2D images are captured via smartphone or similar device from multiple angles. Audio clip (3 minute) is also recorded using the voice recorder app on mobile devices.
Step 3	Images are reviewed and then emailed via encryption to software developer with a narrative provided by the therapist to highlight salient areas of interest.
Step 4	The location images will then be imported into a 3D-software Blender, which enables the sculpting of images into 3D Objects. These 3D-objects are then exported into Unity software where they are created into an environment.
Step 5	This environment is then built as an android package (APK) file and transferred to the VR headset.

Note. Adapted from Best et al. (2024).

ware, after which the research team familiarized themselves with the data. Initial codes were then inductively generated without the use of a preset framework, carried out independently by two members of the research team (JC and PB), who then met to discuss and refine codes and emerging themes. In line with the reflexive approach, interrater reliability was not calculated, as the process emphasized interpretation over consensus. Disagreements were resolved through discussion and shared reflection, ensuring diverse perspectives were considered during theme development. These codes were organized into potential themes using NVivo 14, a qualitative data analysis software that facilitates the systematic organization and categorization of data. The themes were further refined and synthesized to develop a coherent narrative, offering a rich and in-depth understanding of the intervention's impact. It is important to note that although patients and providers were analyzed within the same thematic framework, responses were interpreted with attention to role-specific context. Given the small and heterogeneous sample, the analysis aimed to identify illustrative rather than exhaustive themes.

Results

Virtual Environment Creation

Five VR Photoscan environments were created (Table 2), each accompanied by a brief description of the trauma event (note that some details have been altered to ensure client confidentiality). On average, virtual environments took 2 working days to create using VR Photoscan (Table 3). VR Photoscan was integrated into the TF-CBT protocol at key therapeutic junctures rather than used as a standalone intervention. Therapists primarily used VR during imaginal exposure (reliving) and to support memory updating once cognitive shifts were achieved. It was also applied during stimulus discrimination tasks and was used as preparation for in-vivo site visits where appropriate. Across cases, therapists used the virtual environments in an average of three or four sessions, applying techniques such as imaginal reliving, memory updating, stimulus discrimination, and preparing for site visit.

Survey Data

Pre-intervention PCL-5 scores had a mean of 51 (SD = 11.4), while post-intervention mean scores were 19.2 (SD = 27.2), indicating a reduction in PTSD symptoms. Similarly, CORE-10 scores had a pre-intervention mean of 17.6 (SD = 7.2) and a post-intervention mean of 11.2 (SD = 11.7), showing an overall decrease in general psychological distress. Changes exceeding the ±1.96 threshold on the RCI were classified as statistically reliable improvements or deteriorations. Additionally, CSC was assessed by comparing posttreatment scores to the established clinical cut-off scores for the PCL-5 (31–33) and CORE-10 (11) to determine whether participants moved from a clinical to a nonclinical range. The results, presented in Table 3, show three participants improving and demonstrating reliable and clinically significant change on the PCL-5, with one participant showing no change. Similarly, three participants improved on the CORE-10, showing reliable and clinically significant change as well, with one participant experiencing a reliable increase in symptoms. However, given the small sample size, these findings should be interpreted with caution (see Table 3).

Interview Data

Nine interviews were held, comprised of the Service Manager (SM), four Psychological Therapists (PT1, PT2, PT3, PT4), the Software Company Manager (SCM) and three of the clients: the client who had an accident at work (C1), the client who experienced birth trauma (C2), and the client involved in a RTC (C4). One client (C3) completed the therapy but declined to participate in a follow-up interview due to personal circumstances. Another client (C5) disengaged early in treatment and was therefore not eligible for a follow-up interview. Notably, PT4 did not directly treat a client using the intervention but was involved in the screening process and was interviewed to provide insights on the technology and its implementation. The following themes were identified (see Figure 2):

Theme One: From Hesitation to Acceptance: Evolving Attitudes Toward VR in Trauma Therapy

This theme captures how therapist and client attitudes evolved from initial hesitation to active acceptance of VR. Most therapists and clients had no prior experience with the technology and initially expressed practical concerns, such as technical unfamiliarity or limited access to Wi-Fi. As one therapist noted, "*I was nervous about … how to use it … my room doesn't have Wi-Fi*" (PT1). Clients also expressed uncertainty, with one stating, "*I wasn't sure exactly what it entailed… it scared me a bit*" (C1).

However, after training and hands-on use, perceptions shifted. Therapists reported growing confidence, and clients highlighted the unexpected accuracy and

Table 2
Narrative of Virtual Environments

ID	VR Photoscan Environment	Narrative of trauma and environmental features	Specific Techniques in which VR Photoscan was used
C1	Accident at work	The client was a male in his late 50s who fell off a roof while working in a residential area. While in the simulation, the user could trigger noises associated with the trauma, such as a nearby sound of a lawnmower and imagery of a ladder lying on the ground next to him.	Imaginal Reliving[a] Memory Updating[b] Stimulus Discrimination[c] Preparing for site visit[d]
C2	Birth Trauma	The client was a female in her early 40s who experienced a traumatic birth. Imagery was taken of a local maternity room and used to recreate the virtual environment. Objects included a hospital bed and various pieces of medical equipment. Sounds of the heart rate monitors were also included.	Imaginal Reliving[a] Memory Updating[b] Stimulus Discrimination[c]
C3	Pedestrian Accident	The client was a female in her early 60s who was hit by a vehicle while crossing the road. The VR environment replicated the bright midday conditions of the accident site, focusing on elements such as traffic light changes and the beeping sound of the pedestrian crossing.	Imaginal Reliving[a] Memory Updating[b] Stimulus Discrimination[c] Preparing for site visit[d]
C4	Road Traffic Collison (RTC)	The client was a male in his 50s who witnessed a fatal car crash and served as the first responder at the scene. A rural landscape was recreated to depict the location where the incident occurred.	Imaginal Reliving[a] Memory Updating[b]
C5	Assault	The client was a male in his 20s who was assaulted while walking home. Specific objects, such as lampposts and cement paving were replicated from images of the trauma site.	DNA Withdrew before VR was used

[a] Clients are guided to vividly recall and narrate their traumatic memory while immersed in a relevant VR environment, enhancing emotional engagement and memory processing.
[b] Incorporates new, corrective information into the trauma memory during VR exposure to reduce distress and challenge unhelpful beliefs linked to the trauma.
[c] Helps clients distinguish between trauma-related triggers and safe cues by contrasting current safe environments with the recreated trauma context.
[d] VR is used as a preparatory tool to simulate real-world exposure, allowing clients to mentally rehearse and reduce anxiety before an actual return to the trauma site.

emotional power of the VR environments. One client reflected, "*I didn't think it would be so accurate... it's helped me in a lot of ways*" (C1). This evolution reflects the principles of the Unified Theory of Acceptance and Use of Technology (UTAUT), where perceived usefulness and ease of use drive acceptance (Venkatesh et al., 2003).

Safety and Control

Participants valued VR for its ability to offer a controlled, therapeutic exposure environment. The service manager described it as "*Essentially in vivo exposure, in the office*" *(SM),* and therapists reported clients feeling safer and more prepared for real life triggers. As one client put it, "*I don't know how I would have reacted if I hadn't had the virtual reality*" *(C1),* with another client adding: "*To actually see it in a virtual world, to see that location as part of your therapy when your therapist is there with you ... for me it was hugely beneficial*" *(C4).*

Flexibility

The flexibility of VR also became a key advantage. Therapists found it allowed them to adapt sessions in real-time, tailoring therapy based on the responses of the client. One therapist highlighted: "*We could use it for restructuring and reintegrating the new memory... it makes it more real*" *(PT2).* Clients similarly valued this, citing how immersive elements helped recover or contextualize traumatic memories: "*I was surprised at how much it could, and did, bring back memories and actual accurate noises and that of the environment that I was remembering*" *(C2).* This paved the way for the second theme, which explores the therapeutic potential of VR Photoscan in more depth.

Theme Two: Unlocking the Therapeutic Potential of VR Photoscan

This theme explores how VR Photoscan supported and extended the therapeutic process, offering value

Table 3
Summary of VR Photoscan Intervention Details and Outcome Measures

ID	VR Photoscan Environment	Length of Creation	Number of Sessions Used	Pre PCL-5 Score	Post PCL-5 Score	Reliable Change Index	Clinically Significant Change	Pre CORE-10	Post CORE-10	Reliable Change Index	Clinically Significant Change
C1	Accident at work	2.5 days	4	68	60	-1.01	No	18	26	2.56	No
C2	Birth Trauma	1.5 days	4	52	3	-6.19	Yes	18	2	-5.11	Yes
C3	Pedestrian Accident	2 days	3	48	8	-5.05	Yes	10	2	-2.56	Yes
C4	RTC	2 days	3	36	6	-3.78	Yes	13	4	-2.87	Yes
C5	Assault	2 days	Withdrew	51	DNA	N/A	N/A	29	N/A	N/A	N/A
Average	N/A	2 days	3.6	51.0 (11.4)	19.2 (27.2)	N/A	N/A	17.6 (7.2)	11.2 (11.7)	N/A	N/A

beyond the exposure itself. The service manager reflected on this broader impact: "*I imagined that there will be something happening in the exposure itself. That would be the function of the therapy, and it's actually so much more about the debrief afterwards too*" (SM). This insight highlighted VR Photoscan's contribution not only to the exposure process but to postexposure reflection and emotional processing, a critical component of trauma-focused therapy. One therapist similarly commented on its therapeutic strength despite initial challenges: "*I just saw how powerful this was … despite finding it very distressing at the start. I thought it was amazing. I actually thought how much easier it is to do this [exposure therapy] and how quickly the trauma resolved*" (PT2).

Supporting the Therapeutic Process

Therapists and clients described how VR Photoscan helped make exposure therapy feel more real, immersive, and effective. As one therapist explained: "*I think it makes it more real for the client as well. A more real-world experience than if we're just sitting there talking about it and reliving it in that way*" (PT2). Clients reported that the VR environment helped fill memory gaps and made it easier to visualize trauma-related settings:

> "*It was basically able to obviously link up parts that were missing*" (C1).
> "*[It provided the] opportunity to visualize outside of the mind, you know, in some sort of reality, that that room, that experience, that bringing you back to that time without having to, you know, rely on your own memories or conjure that up in your own mind*" (C2).

For one client, VR Photoscan proved effective enough that a site visit was no longer necessary: "*I think we had agreed that it wasn't necessary, that what we had done was probably enough*" (C2).

Accuracy of the Environment

The second subtheme centres on the value of realism. While environments were not always perfect replicas of the trauma site, participants consistently emphasized that perceived accuracy, not perfection, was what mattered. For example, a prebuilt hospital environment was modified to resemble a maternity ward, with small details like a cot and child-friendly decor: "*They made this one more like a maternity ward. So, there was a cot. I think there's some pictures on the walls to make it look more child friendly*" (PT2).

The software company manager reflected on their role of adding the relevant stimulus to the hospital environment, stating: "*I suppose that's adding to the realism … that's very simple and straightforward to do*" (SCM). The therapist involved went on to say, "*Despite that not being the perfect environment, not the exact environ-*

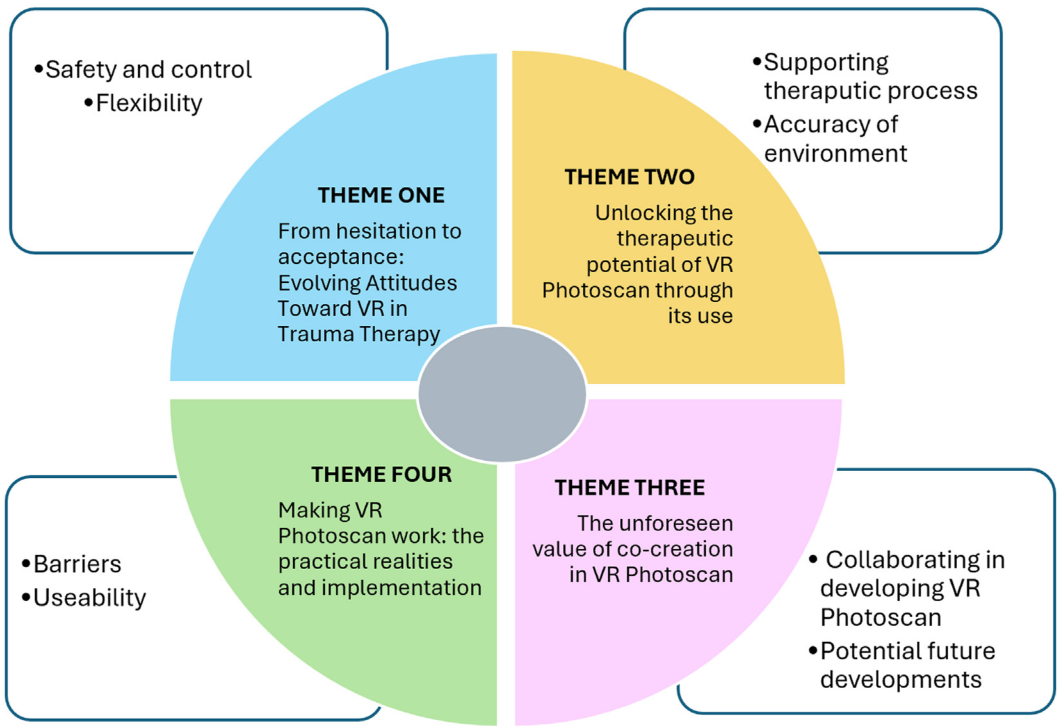

Fig. 2. Overview of the 4 Key Themes and Subthemes.

ment that they were in, we've had such a positive outcome" (PT2). Two clients affirmed this sentiment by saying:

> "*I was surprised at how, how real it could feel at times, you know, and how much it could bring back... reliving some of the experiences that were troublesome to me*" *(C2).*
> "*As good as the virtual reality was, you know, all the important features were there, it wasn't perfect*" *(C4).*

Both the service manager and software company manager reinforced this idea:

> "*Places that hadn't stitched together very well, towards the skyline, the client didn't pay any attention to that's whatsoever, it wasn't really important to him*" *(SM).*
> "*If you look at it closely, you can see that they're photos. But again, that detail was enough for that client*" (SCM).

Together, these reflections suggest that a good enough representation, focused on key visual and emotional cues, was sufficient to support therapeutic outcomes. VR Photoscan's adaptability and ease of customization contributed to its clinical utility, even without flawless replication.

Theme Three: The Unforeseen Value of Co-Creation

As VR Photoscan was integrated into practice, an unexpected benefit emerged. The therapeutic value of co-creating environments with clients. Therapists described how gathering detailed input about trauma locations supported emotional engagement and agency. One therapist recalled: "*It was obviously something to identify early on, like where was the location ... So, I used [the Streetview functionality of] Google Maps, and that was nearly like an exposure in itself for the client*" *(PT1).* Another therapist described the process as inherently narrative: "*There's just power in that . . . just telling your story . . . they could tell us some trauma and we could go and build the environment*" *(PT3).* The service manager agreed that this preparatory phase itself held therapeutic value: "*There was a lot of preambles and build-up to that [using the VR]. And I do think that there is something therapeutic in that, just prepping the client*" *(SM).*

Collaborating in Developing VR Photoscan

Co-creating VR environments helped strengthen the therapeutic alliance by involving clients in shaping the tools used in their treatment. One therapist emphasized the value of client knowledge: "*They know the environment best. They were the person who was there, so it might be good in collaboration with them to be able to design that*" *(PT2).* The service manager echoed this: "*I think you could co-design that with your client and promote collaboration ... co-design helps that sort of working alliance and therapy relationship*" *(SM).* These reflections align with wider health and social care movements that value co-creation as a means of improving user engagement and outcomes. VR Photoscan, in this context, supports a more collaborative and personalised therapeutic process.

Potential Future Developments

Participants also envisioned ways to enhance co-creation further. One therapist suggested a library of prebuilt environments for common trauma settings: "*If we had environments that were prebuilt ... like held in a library or a stockpile . . . For example, the maternity ward, the ICU ward, just a hospital ward in general*" *(PT2).* The software manager saw the potential for clinicians to customize environments directly: "*It might get to the stage where maybe even the clinicians themselves could go into the VR . . . and start dragging and building*" *(SCM).* Such developments could further empower therapists and clients, reducing reliance on developers and enabling real-time customization during sessions. Finally, the service manager noted VR Photoscan's broader applicability beyond PTSD: "*That exposure component could be used equally in OCD, and various anxiety presentations like social anxiety, agoraphobia, and specific phobias... exposure is an element that's common to tons of different therapies*" *(SM).*

Theme Four: Making VR Work: The Practical Realities and Implementation

This final theme explores the practical and logistical challenges of implementing VR Photoscan in clinical practice. While participants recognized VR Photoscan's potential, they noted logistical challenges. One significant issue was the time required for setup, charging devices, and uploading content. One therapist noted: "*It does take a bit of extra time to set it up to make sure it's charged, to make sure it's uploaded... just part of the planning session, I suppose*" (PT1). Another noted that this extra time should be formally recognized: "*It needs to be like accounted for in their caseload and in their job plan because it probably is going to take a bit longer... people need to feel like they have the time and space to use it*" *(PT3).*

A key part of the VR Photoscan process involved capturing images at trauma sites, a task that fell outside therapists' usual responsibilities, creating logistical and emotional challenges. While the service manager described it as quick "*literally a few minutes*" (SM), one therapist reported delays waiting for students to leave, saying it took "*maybe half an hour*" (PT1). Taking photos in public spaces also caused discomfort. The service manager admitted it "*felt a bit conspicuous*" (SM), while a therapist found it "*very uncomfortable... and just the overall experience was very unpleasant*" (PT1). These reflections highlight that, beyond the technical tasks, there are also emotional and logistical considerations when capturing images for VR.

Barriers and Usability

Participants identified several key barriers to the implementation of VR Photoscan, including time constraints, resistance to new technology, unfamiliarity with VR, and technical challenges. The service manager stressed the need for careful planning and procedural support to ensure smooth implementation, indicating: "*That takes a little bit more forethought and preparation*" (SM). This point was reinforced by the software manager, who emphasized the importance of involving therapists in the design and development of processes: "*It's impossible for us to know exactly what's needed by the client. So, it's really . . . listening to the experts . . . being guided by them [*therapists*]*" (SCM).

Resistance from therapists was a key concern as some participants anticipated reluctance to adopt VR Photoscan at a larger scale. One therapist reflected on this concern, stating: "*It's hard to roll it out... new technology can be met with a lot of resistance... I think the VR would just be like a step too far*" (PT3). The service manager offered a contrasting perspective, arguing that anticipated resistance may not always materialize: "*there might be an anticipated reticence, which we're not seeing. And it seems to be acceptable*" (SM). Lack of familiarity with VR technology was also discussed, as the software manager explained, most therapists had little or no experience using VR, leading to hesitation and caution: "*People are still quite standoffish with it and kind of put their guard up*" (SCM). This point was echoed by the service manager, who acknowledged that therapists needed to develop new technical skills to feel confident with VR systems: "*It's a different skill set as well. You need to be a little savvy around the technology...I think that would be a first hurdle for some people*" (SM).

To address this, participants emphasized the need for intuitive systems and accessible guidance. The software manager outlined their goal: "*The big thing for us is to make it as user-friendly as possible*" (SCM). One therapist suggested the development of a user guide to help ease the process: "*It would be just like a very good user guide with videos, if possible, step by step, with pictures even about like this is how*" (PT4). Clients also noted early technical difficulties, but said these were manageable with experience:

> "*There was a few... at times, technical issues around getting into the program... But once I had done it a few times it was very familiar*" (C2).
> *My only hiccup that I really had was, when it was my own fault really... probably in my nervousness, I had to say that*

I've touched a button, and I've obviously changed something" (C4).

These insights suggest that successful implementation will require not only reliable technology but also adequate time, training, and support to ensure therapists can adopt VR confidently and effectively in practice.

Discussion

This study aimed to evaluate the experiences and outcomes of a small professional team in Northern Ireland as they pioneered a low-cost VR Photoscan intervention integrated with TF-CBT for treating PTSD within a local mental health service. Below are the key findings and insights, structured according to the study's primary objectives.

Objective 1: To Explore Professional Perspectives on the Added Value and Practical Use of the Low-Cost VR Photoscan Technology for PTSD Treatment

There were mixed initial opinions on VR in therapy, with some therapists excited and others hesitant. However, education and direct use shifted views positively, showing initial doubts did not hinder its integration. Lindner et al. (2019) found similar trends among cognitive behavior therapists, suggesting attitudes were no longer a barrier to VR adoption in clinical practice. One therapist was concerned that VR exposure might be overwhelming, a common issue in exposure therapy (Hembree et al., 2003; Pittig et al., 2019). However, witnessing rapid client recovery altered their perspective. The control element in VR exposure (Boeldt et al., 2019) likely played a crucial role in this shift. Interviews highlighted VR's control and adaptability as advantages. Therapists consistently found VR effective in reshaping and integrating new memories. Furthermore, a study examining the experiences of providers using VR in clinical treatment (Vincent et al., 2021) found that VR usage led to heightened client-patient engagement and greater autonomy over their treatment process. The ability for the client to easily put on and take off the VR headset was mentioned as a factor in conducting effective therapy sessions in this study, allowing smoother transitions between virtual and real-world settings. This flexibility enabled therapists to tailor sessions to client needs, enhancing effectiveness and outcomes.

One therapist collaborated with the software company manager to adapt a prebuilt hospital environment to resemble the client's trauma site. Though not an exact replica, it proved highly effective in therapy, suggesting precise replication may not be essential for exposure therapy. Interviewees who conducted site visits reported "unease and self-consciousness" when photographing public places, indicating that preproduced, adaptable environments could offer similar therapeutic benefits while avoiding public photography concerns. Additionally, Freedman et al. (2010) found positive outcomes using VR without direct traumatic imagery, instead providing contextual backdrops for imaginal exposure. This suggests VR's therapeutic power lies in creating a safe, controlled immersive setting rather than exact real-world replication, offering greater flexibility in therapeutic applications.

Objective 2: To Collect Data on the Changes in Clinical Outcomes When Implementing TF-CBT Assisted by VR Photoscan Technology

While the aggregate data were encouraging, with reductions observed in PTSD symptoms and psychological distress, it is important to clarify that only three of the four clients who completed treatment demonstrated both reliable and clinically significant improvement. One client showed no meaningful change, highlighting the variability in individual response and the need for cautious interpretation of findings from such a small sample. Nonetheless, these results are broadly consistent with evidence supporting exposure-based therapy for PTSD (Ehlers & Clark, 2000; Foa et al., 1999; Resick et al., 2002). Therapists found the intervention well tolerated, facilitating imaginal reliving, memory updating, and stimulus discrimination. This highlights the seamless integration into TF-CBT protocols, including Ehlers and Clark's (2000) Cognitive Model of Persistent PTSD used for this study. Unlike prior studies requiring expensive equipment and specialist knowledge, this study demonstrates the feasibility of the VR Photoscan approach. Personalized VR environments were created in about 2 days, reducing financial and logistical barriers, aiding routine clinical workflows (Best et al., 2020; Rizzo et al., 2019). A client who skipped a site visit further highlights VR's potential to reduce reliance of site visits. If widely implemented, this method could improve service efficiency, reallocating therapist time and resources. Highlighting a paradox where the initial effort required to implement the VR Photoscan ultimately results in time and cost savings by improving therapists' use of time and reducing operational demands (Schwartzman et al., 2012).

The study also highlights a common challenge in trauma therapy: client attrition. One client withdrew before engaging with their customized VR environment, reflecting the high dropout rates in trauma-focused therapies, where emotional intensity and readiness impact engagement (Edwards-Stewart et al., 2021; Lewis et al., 2020). While a limitation, this also presents an opportunity to explore strategies for improving client retention and readiness in trauma therapy.

Objective 3: To Assess the Implementation Process, Focusing on the Challenges Encountered and Strategies Employed

A key challenge in bridging the gap between VR research and clinical implementation is the lack of practical guidelines (Best et al., 2020; Cullen et al., 2021), making it difficult for researchers and therapists to translate findings into real-world applications. Interviews highlighted unanimous agreement among stakeholders on the need for careful planning when integrating VR in clinical settings. Establishing a robust research foundation is crucial for broader adoption (Bertrand & Bouchard, 2008; Graham et al., 2006). Resistance to VR use, due to lack of familiarity, was noted by some therapists and the software developer. However, the service manager reported no resistance in this study, instead emphasizing the importance of intuitive, user-friendly systems and training resources. Aligning with digital capability strategies like Ireland's All-Ireland Digital Capability Framework (DOH, 2022) and the EU's DigComp 2.2 Framework (Vuorikari et al., 2022) can better equip healthcare professionals through education and training, dispelling misconceptions about VR use (Kramer et al., 2010; Zainab et al., 2023).

Interviewees also described both practical and emotional challenges associated with using the VR Photoscan. While the service manager, who had previous experience with VR, found the process straightforward, therapists unfamiliar with the technology reported discomfort and logistical difficulties, especially when capturing images at trauma sites. Public visibility and time constraints contributed to feelings of unease. These findings reflect initial implementation experiences and suggest that adaptation to the approach may take time and require ongoing support. While the study demonstrates that VR Photoscan is both feasible and acceptable within a clinical setting, it remains unclear whether the therapeutic benefits of VR-enhanced exposure outweigh the added complexity of implementation, including therapist training and session preparation. Future research should explore not only whether outcomes are improved, but also under what conditions VR adds the greatest value. It may be particularly helpful for clients who are unable or unwilling to engage in imaginal or in vivo exposure, such as when trauma sites are inaccessible, too distressing to visit, or difficult to visualise. In this way, VR may offer a flexible adjunct to traditional exposure methods, rather than a replacement, with specific relevance for certain clinical presentations.

Objective 4: To Analyze the Role of Collaboration Among Clinical Staff, Management, and the Software Developers in Ensuring the Successful Integration of VR Technology Into PTSD Treatment

Collaboration between clinical staff, management, and the software company was crucial for the successful implementation of the VR Photoscan. Each group contributed specialized expertise, therapists provided therapeutic input, management aligned technology with service goals, and the software company tailored the system to clinical needs. This partnership streamlined technical aspects and facilitated integration into practice, making the experience positive for all involved. The software developer emphasized the need for clear guidance from mental health professionals to shape the VR Photoscan scenarios effectively. Bell et al. (2020) highlight the importance of expert involvement in VR design, ensuring credibility and effectiveness, a sentiment echoed by participants. This aligns with the existing literature base that emphasizes the importance of incorporating stakeholder (therapist and client) input throughout the thorough development process for any technological applications (Kip et al., 2019).

The findings emphasized the significance of collaboration and narrative engagement in the VR Photoscan therapy sessions, highlighting the therapeutic benefits during the preparation phase. Collecting narratives to accurately create trauma-related environments not only ensures environmental accuracy but also acts as preliminary exposure therapy. Tools like Google Streetview begin exposing clients to their trauma safely and in a controlled manner. Involving clients in gathering narratives and designing the VR Photoscan environment enhances their sense of control and agency, strengthening the therapeutic relationship and empowering them in their therapeutic journey. The suggestion to allow for customization and flexibility allows for a more interactive, responsive, and tailored therapeutic process to suit the needs of the client (Vianez et al., 2022; Jones et al., 2022b). The idea of having a complimentary library of prebuilt environments, ready to be customized, suggests how VR could be more readily integrated into therapeutic practices. This resource could streamline the preparation phase but also expand the accessibility of the VR to more clients and therapists. Crucially, the therapists recognized that the versatility of the application of the VR Photoscan therapy could extend beyond PTSD to include a wide range of conditions such as OCD, social anxiety, and other phobias, across various therapeutical settings.

Strengths and Limitations

A key strength of this study is its focus on the actual use of VR in a routine clinical setting including all relevant stakeholders, contrasting with many studies that rely on opinions from individuals who have not used VR technology or have only used it in specialised settings. The study demonstrates that the VR Photoscan intervention integrated well with standard TF-CBT protocols, particularly in the reliving and stimulus discrimination components. However, limitations are evident, including a small sample size and the absence of a control group, which limits the ability to generalize whether client outcomes were a result of the TF-CBT itself or the VR Photoscan intervention.

Conclusion

In summary, this study has demonstrated how the VR Photoscan technology is a practical and effective tool for the treatment of PTSD, with clients showing measurable improvements. The findings highlight that the VR Photoscan is not only tolerable for clients but accepted among therapists once the results and benefits are demonstrated. Additionally, the creation of the VR Photoscan environments is efficient, typically taking only 2 days, making it highly adaptable to routine clinical settings. Therapists emphasized the VR Photoscan's control, adaptability, and its ability to provide a safe and immersive therapeutic environment, shifting the focus from precision to practicality. Despite these strengths, a gap remains between VR research and clinical practice, highlighting the need for clear, practical guidelines. Interdisciplinary collaboration and training are essential for successful integration, and involving both therapists and clients in the development process ensures that VR technologies are tailored to diverse therapeutic needs.

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