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Blockchain in Portuguese Healthcare: Perceived Usefulness, Trust, and Readiness – A Qualitative Case Study

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Blockchain is frequently promoted for improving data integrity, auditability, and secure interoperability in healthcare, yet evidence from clinical settings – particularly in Southern Europe – remains scarce. This study case explores Portuguese healthcare professionals' perceptions of the opportunities and barriers to blockchain implementation. Six semi-structured interviews were conducted in a healthcare institution setting and analysed thematically, guided by three analytical dimensions: digital literacy, trust, and organisational readiness. The findings show that participants recognised blockchain's potential to improve data traceability, consent management, and security. At the same time, however, they also expressed concerns regarding legal compliance, the technical integration of blockchain with existing systems, and the capacity of institutions to support change. Most interviewees reported limited familiarity with blockchain technology, which contributed to uncertainty. Discussions frequently highlighted the need for role-specific training and transparent governance frameworks and challenges with GDPR compliance (including the "right to be forgotten"). Taken together, these perspectives suggest that professionals understand blockchain implementation in healthcare not only in technical terms, but also in terms of institutional and human factors. This suggests that its implementation should be approached as a sociotechnical process requiring alignment between technological design, governance structures, and user capabilities. By offering qualitative insights from a Southern European healthcare, the study contributes to the ongoing debate on digital transformation with empirical evidence and highlights the importance of inclusive planning, capacity building, and regulatory clarity for sustainable implementation.

Keywords: blockchain in healthcare, barriers, digital literacy, trust, sociotechnical

1. INTRODUCTION

The implementation of blockchain technology in healthcare is increasingly being discussed as a potential solution to the long-standing challenge of managing data, interoperability, and patient privacy. Scholars argue that blockchain's decentralised, tamper-resistant architecture can address issues of security, auditability, and consent management by providing immutable records and transparent governance mechanisms [1-3]. Nevertheless, the literature also highlights unresolved tensions between blockchain's technical features and the practical, organisational, and regulatory conditions of healthcare systems [4, 5].

Evidence from earlier studies on digital health implementation shows that technological success depends less on technical design than on alignment with organisational work-

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flows, professional practices, and governance structures [6-9]. Barriers such as fragmented infrastructures, insufficient resources, and lack of leadership support have repeatedly undermined implementation processes [6-9]. Greenhalgh *et al.* [9] further emphasise the complexity of innovation in healthcare, where technology implementation is shaped by multiple interacting factors, Ross *et al.* [19] emphasise that even systems that are technically mature face persistent challenges of interoperability and data standardisation. These insights suggest that blockchain implementation must be analysed as a sociotechnical process rather than a purely technical innovation.

Recent studies reinforce this perspective by identifying digital literacy, trust, and organisational readiness as variable in shaping professional perceptions of blockchain in healthcare [10-12]. Digital literacy influences whether professionals can recognise blockchain's benefits and integrate them into practice [13], while trust depends not only on technical assurances but also on transparent governance and accountability [14]. Organisational readiness, in turn, relates to institutional capacity, leadership engagement, and cultural alignment, which determines whether blockchain can move beyond pilot initiatives to sustainable implementation [11, 15].

Despite growing attention, empirical research on blockchain implementation in healthcare institutions remains limited, particularly in Southern European contexts. Existing contributions are dominated by conceptual and review-based studies [16], with relatively few case-based investigations into how healthcare professionals perceive blockchain in practice. By examining a Portuguese healthcare institution engaged in digital transformation, this study contributes to filling this gap. It investigates how professionals perceive blockchain's usefulness, the barriers to its integration, and the roles of digital literacy, trust, and organisational readiness in shaping blockchain implementation.

Portugal provides a particularly relevant setting for this analysis. Although the country has invested in digital infrastructure through its National Health Service (SNS), it continues to face challenges regarding interoperability, governance, and workforce readiness [17]. The Blockchain.PT project, a national initiative to pilot blockchain technology in strategic sectors including healthcare, provides a timely backdrop for this study. Examining professionals' perceptions in this environment offers valuable insights into the practical and institutional conditions under which blockchain may be implemented.

This study draws on a qualitative case study of the Egas Moniz School of Health and Science. Semi-structured interviews were conducted with healthcare professionals, managers, and educators. The analysis contributes to academic literature and provides healthcare institution administrators and policymakers with evidence-based guidance on implementing emerging technologies more effectively and inclusively.

The study is guided by three research questions: (1) How do healthcare professionals perceive the usefulness of blockchain technology in healthcare institution settings? (2) What organisational, technical and legal barriers are perceived as limiting its implementation? and (3) How do digital literacy and trust influence the perceived feasibility and acceptance of blockchain technology in healthcare?

The article proceeds as follows: Section 2 reviews the literature on blockchain implementation, digital literacy, trust, and organisational readiness. Section 3 outlines the methodology. Section 4 presents the empirical findings, organised thematically. Section 5 discusses these findings in relation to existing theory. Section 6 concludes by outlining policy implications and suggesting directions for future research.

2. LITERATURE REVIEW

This literature review aims to identify how recent research has addressed the three key factors influencing the implementation of blockchain technology in healthcare: digital literacy, trust, and organisational readiness. Based on organisational change management theory, the implementation of blockchain technology in healthcare is considered a sociotechnical process, whereby resistance and acceptance are influenced by human, organisational and technological factors [11]. Conversely, sociotechnical theory emphasises the interdependence between technology and social systems, demonstrating that the successful implementation of innovations hinges on the alignment of technical solutions with organisational practices and professional cultures [8, 18]. In healthcare specifically, resistance often arises from uncertainty, a lack of awareness and misalignment with clinical routines. This underlines the importance of addressing organisational and human factors when implementing blockchain technology [19].

At the same time, technical literature has established the foundations of blockchain's potential in healthcare. Early contributions demonstrated its promise for managing electronic health records and enabling patient-centred control of data [20, 21], for enhancing interoperability and privacy protection [22, 23], and for ensuring transparency in healthcare supply chains [24]. Reviews have also identified major technical challenges, including scalability, integration with legacy systems, and regulatory uncertainty [3, 25]. While these works highlight important opportunities and obstacles, they tend to frame blockchain implementation primarily in terms of technical performance, with limited attention to the organisational and professional dimensions that determine successful implementation.

To address this gap, the present study builds on more recent research that positions blockchain implementation as a sociotechnical process shaped by organisational readiness, digital literacy, and trust [8, 9] Rather than treating blockchain as a purely technical innovation, this perspective emphasises that implementation depends on its alignment with professional values, institutional strategies, and regulatory frameworks.

2.1 Digital Literacy

Digital literacy is recognised as a variable influencing the implementation of technology in healthcare settings [7, 12, 13, 26]. Beyond technical competence, it involves the capacity to critically engage with digital systems, evaluate their usefulness, and integrate them into professional routines. Norman and Skinner's [12] eHealth Literacy Scale (eHEALS) remains a key framework, conceptualising eHealth literacy as an intersection of health, information, scientific, media, and computer literacy. Subsequent refinements, such as van der Vaart and Drossaert [13], emphasise the importance of tailoring literacy assessments to healthcare professionals, given that uneven digital competence can directly influence the uptake of complex innovations such as blockchain.

Evidence shows that disparities in digital literacy directly shape healthcare professionals' willingness to engage with new technologies. Low levels of competence can exacerbate uncertainty, misconceptions, and resistance, while higher levels reduce perceived complexity, foster confidence, and encourage user engagement [6, 7, 9, 26]. Moreover, insufficient training and lack of institutional support further reinforce skepticism and hinder implementation.

Conversely, literacy-building initiatives, such as continuous, role-specific training programmes, have been shown to reduce barriers and support technology implementation [8, 9].

Systematic reviews highlight that insufficient literacy is a recurring barrier to blockchain implementation. Joshi *et al.* [27] show that scepticism and resistance persist when practitioners lack understanding of blockchain's benefits and risks, regardless of its technical robustness. Recent studies highlight that literacy not only supports successful implementation but also moderates trust: individuals with higher literacy are more likely to interpret governance assurances positively and translate them into practice [10].

For blockchain specifically, literacy requires more than basic familiarity with digital platforms; it demands conceptual knowledge of decentralisation, cryptographic validation, and compliance mechanisms such as GDPR alignment [48]. Without these skills, professionals may misinterpret risks such as immutability and lose confidence in the system. Addressing this digital divide is therefore not only a matter of training but also of organisational strategy, ensuring equitable opportunities for competence development and sustainable implementation. Recent studies on blockchain – AI integration, such as interoperable frameworks for the Internet of Medical Things [28] or multilingual BERT-based models [29], further illustrate that the effectiveness of advanced applications hinges on professionals' digital capabilities to translate technical features into clinical value.

Conversely, literacy-building initiatives, such as targeted education programmes [9] have been shown to reduce perceived complexity and encourage engagement. Recent evidence also suggests that digital literacy moderates the relationship between trust and implementation; individuals with higher literacy skills are better able to interpret institutional assurances positively and put them into practice [26].

More recent refinements, such as that by van der Vaart and Drossaert [13], emphasise the importance of tailoring assessments to healthcare professionals, given that uneven levels of digital competence can directly influence the uptake of complex innovations such as blockchain. In this sense, exploring empirical data is crucial for detecting the level of digital literacy among healthcare professionals when implementing technologies. Recent studies emphasise the importance of providing clinical, administrative and research professionals with role-specific, continuous training tailored to their needs, rather than offering them generic programmes

2.2 Trust and Data Governance

Trust is a key enabler of technology implementation [10, 30], particularly in high-risk, data-sensitive domains such as healthcare. It is broadly defined as the belief that systems are safe, reliable, and aligned with the interests of stakeholders [31]. Studies show that healthcare professionals who trust the intentions behind technological change and the governance mechanisms that ensure data security are more likely to see the benefits of blockchain technology and integrate it into their practice

The literature conceptualises trust across three analytical dimensions: organisational trust, algorithmic trust, and governance trust. Organisational trust is defined as confidence in the institutions introducing technological change [32]; algorithmic trust as faith in the technical reliability and fairness of the system itself [33]; and governance trust as confidence in the legal, ethical, and regulatory safeguards surrounding implementation [34]. These dimensions provide a useful lens for the present study, as they allow an examination of how

healthcare professionals evaluate blockchain not only in terms of its technical robustness, but also through their confidence in the organisations promoting its implementation and in the institutional frameworks that regulate its use. By mapping participants' perceptions across these three dimensions, the study can capture the multifaceted ways in which trust shapes acceptance, highlighting whether concerns are directed primarily at the technology, the institutions, or the broader governance environment.

Earlier research on electronic health records reached the conclusion that professionals remain sceptical regarding governance, accountability, and compliance with frameworks such as the GDPR, showing that technological performance alone does not guarantee implementation without institutional credibility, clearly defined governance structures, and visible stakeholder involvement [6-9].

Empirical evidence supports this tripartite framework. Akhtar *et al.* [35] demonstrate that system design alone cannot guarantee implementation, noting that perceived fairness, accountability, and alignment with clinical values are equally significant. In European contexts, unresolved tensions persist between blockchain's immutability and GDPR rights, such as data erasure and portability [5]. These tensions exacerbate professional reluctance to engage with blockchain technology without explicit governance frameworks to ensure accountability.

Angst and Agarwal [30] highlight the centrality of trust and perceptions of privacy to the implementation of electronic health records. They demonstrate that professionals' willingness to engage with new systems is influenced not only by rational assessments of utility, but also by persuasion processes and perceived safeguards. Privacy concerns, they argue, can hinder acceptance even when technical benefits are evident, thereby emphasising the importance of governance mechanisms and transparent communication in fostering trust. This perspective is directly applicable to blockchain technology in healthcare, where immutability and decentralisation raise similar questions regarding privacy, accountability, and user confidence.

In healthcare settings, where data breaches can have severe clinical, legal and ethical consequences, trust must be placed in both the technological system and the institutions responsible for its implementation [10, 30]. Security concerns remain a frequent barrier: although blockchain's cryptographic design mitigates unauthorised manipulation, professionals may still question its robustness, particularly if they lack technical literacy or direct experience [35]. Studies show that, without clear demonstrations of how security and compliance are assured, healthcare workers remain cautious about entrusting patient data to blockchain systems. Furthermore, while immutability enhances auditability, it simultaneously raises concerns about correcting errors and removing data in line with GDPR provisions [5].

Trust, therefore, operates at technological and institutional levels. Professionals are more likely to engage with innovations when they trust the organisations responsible for implementation, whether these are healthcare institutions, government agencies or technology providers [8, 32]. Conversely, when innovations are introduced without adequate consultation or training, trust is undermined and resistance increases. Evidence shows that transparent communication, active stakeholder engagement, and continuous institutional support foster confidence and promote implementation [9].

In the context of blockchain, trust-building mechanisms such as professional education, transparent governance frameworks, and alignment with clinical values are essential to mitigate perceived risks. Studies indicate that professionals are more likely to embrace block-

chain solutions when they understand how the technology operates and see it embedded within ethical principles, legal frameworks, and patient-centred values [4, 10, 36].

In summary, trust and data security concerns are closely linked. Overcoming these barriers requires technical clarity, regulatory alignment, and institutional transparency. These factors collectively influence the perceptions of healthcare professionals and determine the success of integrating blockchain into clinical practice [36].

2.3 Organisational Readiness and Perceived Usefulness

Organisational readiness is defined as the alignment of institutional capacity, resources and cultural acceptance of innovation [1]. In healthcare, failures to integrate new technologies are rarely caused by technical shortcomings alone. More often, they result from fragmented implementation strategies, limited resources, or the insufficient involvement of frontline staff in decision-making processes. Blockchain implementation is particularly challenging in this respect, as it necessitates integration with legacy IT systems, cross-departmental coordination, and robust leadership engagement to minimise resistance and promote sustainable change [10, 12].

Readiness must also be understood as a socio-cognitive construct shaped by cultural and professional dynamics. Professionals are more likely to support technological integration when they perceive alignment with institutional goals and their own professional values. Without such alignment, even technically promising innovations may be met with resistance, underutilisation, or abandonment [8]. Blockchain implementation therefore requires not only technical compatibility, but also credibility. This means that clinicians, administrators, and IT specialists must view the technology as relevant to, and consistent with, patient care values.

Armenakis and Harris [11] emphasise that effective change management requires addressing the socio-cognitive realities of employees and fostering readiness through shared meaning and communication, as well as resources. Burnes [37] builds on this, framing readiness as a continuous, dynamic process rather than a one-off state. When applied to blockchain, these models emphasise that readiness requires leadership commitment, visible engagement and feedback and adaptation mechanisms throughout the implementation lifecycle.

A central determinant of readiness is perceived usefulness, which is defined as the belief that technology improves performance or outcomes [13, 38, 39]. In healthcare, blockchain's perceived usefulness is tied to its ability to address persistent challenges such as fragmented health records, lapses in data integrity, and a lack of transparency in clinical and administrative processes. Systematic reviews confirm that professionals are more inclined to adopt blockchain technology when its benefits are articulated in terms of resolving these tangible issues, particularly those relating to interoperability and traceability [1, 40].

Perceptions of usefulness are influenced by digital literacy. Professionals with higher technological competence are more likely to recognise blockchain’s potential and interpret technical assurances as credible. In contrast, those with limited literacy may remain sceptical or disengaged. Training programmes and literacy-building initiatives can therefore serve a dual purpose of building technical capacity and reshaping perceptions of usefulness [26]. In this sense, literacy functions as both a precondition for readiness and a driver of implementation, making it essential to incorporate capacity building into implementation strategies.

Orlikowski’s [15] pioneering work on the implementation of technology offers a valuable perspective through which to analyse the implementation of blockchain in healthcare.

Moving beyond deterministic accounts that view technology as an independent driver of change, she conceptualises technology as 'technology-in-practice', emphasising that its meaning and usefulness only emerge through recurrent enactment within organisational routines. This perspective is particularly relevant in healthcare settings, where innovations such as blockchain must be integrated into complex professional workflows, institutional norms, and regulatory frameworks. Technologies acquire significance through the practices of those who use them rather than being defined by their technical properties alone, and can therefore be stabilised, adapted, or resisted depending on contextual dynamics. This sociotechnical view is consistent with more recent studies on organisational readiness and digital health, which emphasise that implementation depends on innovations aligning with professional values, existing infrastructures, and strategic objectives [8]. In this sense, Orlikowski's framework highlights the importance of examining not only what blockchain can do in principle, but also how healthcare professionals and organisations implement it in practice.

Change management frameworks reinforce the need for participatory approaches, in which professionals are consulted, trained, and supported throughout the transition. Transparent communication, demonstrating short-term benefits and creating opportunities for feedback have been shown to mitigate uncertainty, reduce resistance and strengthen confidence in disruptive innovations [11, 41].

Organisational readiness is a multidimensional concept that encompasses structural, cultural, and cognitive elements. In the healthcare sector, blockchain readiness is influenced by institutional resources and IT infrastructure, as well as staff perceptions of usefulness, digital literacy levels, and the effectiveness of change management strategies. Actively recognising and managing these dynamics has a decisive impact on implementation outcomes, enabling the long-term sustainability of blockchain-enabled healthcare systems, as well as initial uptake [4].

2.4 Interplay Between Literacy, Trust, and Organisational Readiness

The literature indicates that the successful implementation of blockchain technology in healthcare requires attention to digital literacy, trust, and organisational readiness [4]. Although blockchain technology is known to have the potential to improve security, traceability and interoperability, empirical evidence highlights that these benefits are largely theoretical unless healthcare professionals have the necessary skills to utilise them effectively. In addition to technical proficiency, successful implementation requires confidence in governance and data protection mechanisms, as well as institutional support for organisational change.

Studies in non-healthcare sectors [11, 15, 30] highlight that the implementation of blockchain technology is shaped more by sociotechnical dynamics than by technical features alone. Factors such as organisational culture, professional values, and trust in governance often play a decisive role in determining success. However, in healthcare, particularly in Southern European contexts, these dynamics remain under-explored.

There has been limited empirical research examining how staff perceptions, literacy gaps, and institutional readiness influence implementation in real healthcare institution environments [8, 16]. This research therefore investigates Portuguese healthcare professionals' perceptions of blockchain, focusing on how digital literacy and trust interact to shape organisational readiness for innovation, thereby addressing an important research gap.

Armenakis and Harris [11] argue that readiness reflects not only resources, but also socio-cognitive alignment – this requires organisations to actively manage professional expectations and values. Organisational readiness is recognised as a socio-cognitive construct encompassing both structural resources and the shared commitment of members to change [42]. It depends on leadership engagement, communication, and alignment of professional expectations and values that enable collective action [8]. Within healthcare, readiness strengthens the relationship between digital literacy and trust, providing the institutional support needed for professionals to integrate new technologies into practice [12, 13]. Pesqueira *et al.* [43] highlight that trust and transparency are key sociotechnical enablers of digital health implementation, depending on the organisation's readiness to integrate new technologies.

Despite the promise of blockchain for creating secure, interoperable, and patient-centred systems [1, 2], its implementation remains limited. Systematic reviews demonstrate a preponderance of conceptual and review-based contributions, with relatively few empirical case studies or experimental implementations [16, 40]. This reflects the immaturity of the field and highlights the urgent need for real-world evidence of implementation processes, particularly in diverse healthcare contexts.

The Portuguese case exemplifies these gaps. Although discourse on digital transformation is growing, there is still limited empirical evidence regarding how institutions perceive blockchain technology, how trust develops in decentralised systems and how digital literacy influences implementation. This study addresses these questions, contributing both theoretically and practically by offering insights into how healthcare organisations can foster readiness, build trust, and enhance literacy to integrate blockchain technology sustainably. More broadly, it highlights that the implementation of blockchain is not merely a technical deployment, but rather a managed organisational change process dependent on the interplay of human, institutional, and technological factors.

3. METHODOLOGY

This study uses an exploratory, qualitative, case-study design to examine how healthcare professionals perceive the implementation of blockchain technology. This methodology is particularly well-suited to examining contemporary phenomena in real-world contexts, especially when the boundaries between the phenomenon and its environment are unclear [44]. Due to the novelty of blockchain in healthcare and the limited empirical evidence available, this qualitative exploratory approach provides a rigorous yet flexible framework through which to capture emerging perspectives, institutional practices and professional experiences that would otherwise be inaccessible.

3.1 Case Study Design

This study adopts a single-case design centred on a Portuguese healthcare institution undergoing digital transformation. The case offers a distinctive context in which to examine the opportunities and challenges associated with blockchain implementation in practice. Such a design enables detailed analysis of context-specific dynamics while producing insights that, although not statistically generalisable, may be analytically transferable to comparable healthcare settings [45].

3.2 Data Collection and Sample

Data were collected through semi-structured interviews with six healthcare professionals and administrators who participated in the healthcare institution's digital initiatives. This format ensured consistency across participants while allowing flexibility to probe individual experiences and perceptions. While the sample size is modest, qualitative research prioritises depth over breadth, and small, purposeful samples are commonly used in exploratory case study research [46, 47]. The six participants provided sufficient variation in roles and professional backgrounds to capture diverse perspectives, while also enabling detailed engagement with each narrative.

All six interviews were conducted between February and March 2025. Each interview lasted between 30 and 50 minutes, following a protocol structured around three themes identified in the literature: (1) the perceived usefulness of blockchain technology, (2) the barriers to its implementation, and (3) digital literacy and trust in governance mechanisms. All interviews were audio-recorded, transcribed verbatim and anonymised. Participants were asked about their professional experience, their familiarity with digital systems, and their perceptions of blockchain technology in healthcare.

3.3 Analytical Approach

The dataset was analysed using thematic analysis, which provides a systematic procedure for identifying, organising, and interpreting patterns of meaning within qualitative material [48, 49]. This method was particularly suited to the study's objectives, as it allows for inductive identification of emergent categories while also engaging deductively with sensitising concepts such as digital literacy, trust, and organisational readiness.

The analysis followed Braun and Clarke's six-phase framework: (1) familiarisation with the material through iterative reading of transcripts; (2) generation of initial codes; (3) organisation of codes into candidate themes; (4) refinement and validation of themes against the dataset; (5) definition and conceptual articulation of themes; and (6) integration of findings into an interpretative narrative. NVivo 14 software supported the process by facilitating systematic coding, memo writing, and cross-case comparisons. Codes were generated inductively from participants' accounts and subsequently refined in light of theoretical constructs from the literature. To enhance analytical credibility, coding was conducted iteratively, and emerging themes were reviewed through peer debriefing within the research team, thereby ensuring reflexive transparency and reducing interpretive bias.

3.4 Ethical Considerations

The study adhered to ethical guidelines for qualitative research, including informed consent, voluntary participation, and the right to withdraw at any stage. Participants were informed of the aims of the research, the data protection measures adopted, and the intended use of findings. Data were anonymised and stored securely in compliance with GDPR requirements [50].

4. RESULTS

This section presents the findings of the thematic analysis of interviews with healthcare professionals and healthcare institutions administrators. The analysis revealed a variety of perceptions, expectations, and concerns about adopting blockchain technology in healthcare. These results have been organised into four analytical themes: (1) The perceived usefulness of blockchain; (2) Barriers to implementation; (3) Trust and data security concerns; (4) Levels of digital literacy and training needs Each theme is presented and discussed in the following subsections.

4.1 Perceived Usefulness of Blockchain

Although most participants acknowledged their limited prior knowledge of blockchain technology, they all agreed that it had the potential to improve access to reliable patient data, particularly in urgent care or cross-institutional scenarios. They described the perceived benefit in terms of enhanced immediacy and confidence when handling clinical records.

> *'If we had immediate access to a patient's medical history through a more reliable system, which would be very useful. I believe that would be very useful' – Clinical Director.*
> *'Sometimes we're completely blind to a patient's background. If I could access their history safely and quickly, it would help me a lot' – Psychologist.*
> *'It could improve continuity of care. Being able to access what happened in another institution would make a difference' – Physician.*

These perceptions align with the findings of academic literature, which emphasises blockchain's potential to promote interoperability, auditability, and data integrity within healthcare systems [5, 9].

Participants also pointed to secondary applications, such as the traceability of informed consent and diagnostic processes.

> *'I can see it being useful for keeping track of informed consents and lab test authorisations. It can be difficult to know where those are stored' – healthcare institution administrator.*
> *'Maybe for research consents and approvals. If everything were transparent and recorded, it would help with audits" – Healthcare Field Researcher.*
> *'Yes, even for something simple like test requisitions – where they went, when they were done... traceability would be a strong point' – Academic Coordinator.*

These observations reflect the notion of perceived usefulness, as set out in the Technology Acceptance Model (TAM). This model suggests that usefulness is a key factor in shaping attitudes towards new technologies [39]. Previous studies have also emphasised that utility in healthcare is not limited to clinical benefits but also encompasses efficiency gains and administrative simplification.

However, this perceived usefulness was consistently dependent on institutional readiness. Participants voiced concerns regarding infrastructure limitations and system compatibility.

> *'It's not just about having a good idea. It needs to integrate with what we already use;*

otherwise, it just creates extra work' – psychologist.
'We don't even have consistent systems now. Introducing something new like blockchain could cause confusion unless it's clearly explained and properly integrated' – Administrator.
'There needs to be a digital plan. It's no use introducing new technology into an environment where even the basics are unstable' – Academic and clinician.

This tension between recognised utility and limited confidence in real-world feasibility echoes what has been discussed in the blockchain literature as a "utility-confidence gap" – the disconnect between the theoretical benefits of distributed ledger technologies and the perceived readiness for their implementation [1-3].

4.2 Implementation Barriers

Although the usefulness of blockchain was widely acknowledged, participants raised concerns about its practical feasibility. These barriers extended beyond technical constraints to encompass organisational dynamics, institutional inertia and previous unsuccessful digital implementations.

A key theme that emerged was the resistance to change, particularly in environments that were already burdened by fragmented digital infrastructure.

'There's a lot of resistance to change, even when the tools are useful. Sometimes people just don't want to deal with yet another system' – Nurse Manager.
'We already have too many platforms and passwords. Adding something new without simplifying things will just create more confusion' – Clinical Psychologist.
'In the past, we had systems that were introduced and never fully integrated. That makes people sceptical about anything new' – Healthcare Institution Administrator.

These statements align with the idea that top-down digital interventions often fail due to a lack of alignment with frontline workflows and insufficient stakeholder involvement [1]. The success of any healthcare innovation depends not only on the technology itself, but also on organisational capacity for change, including trust, clarity, and staff participation.

Participants also identified the complexity of current IT environments as a significant challenge.

'We have so many systems running at once... It becomes hard to manage and even harder to update information consistently' – Clinical Psychologist.
'Sometimes I don't even know where to look for a certain document. Everything is saved in a different place' – Academic and Administrator.
'With small teams like ours, you need very smart integration. We don't have the time or resources to chase data between platforms' – Healthcare Field Researcher.

These concerns are consistent with broader findings that technical barriers, such as legacy systems and poor interoperability, undermine the potential of blockchain technology in clinical settings [3, 28].

Another recurring theme was the lack of strategic planning and user-centred design, leading to feelings of exclusion or apprehension.

> *'There's often no communication with the staff when new systems are introduced. We just received an email saying: 'From now on, use this' – Director of Clinical Services.*
> *'The problem isn't the technology; it's how it's brought in. If we had training and time, people might accept it better' – Healthcare Institution Administrator.*
> *'There needs to be a shared strategy. Otherwise, we're just reacting instead of adapting' – Academic Coordinator.*

These views align with those of Cresswell and Sheikh [8] and Greenhalgh *et al.* [9], who argue that organisational readiness – encompassing technical infrastructure, workflow compatibility, and cultural alignment – is essential for the successful implementation of digital and blockchain-based interventions in healthcare.

Although blockchain was considered beneficial, it is likely to be unsuccessful without adequate institutional support, integration planning and end-user engagement. As one interviewee aptly put it:

> *'Even good ideas can collapse if they're introduced without proper support and coordination' – Academic and Clinician.*

These reflections highlight the sociotechnical nature of innovation in healthcare, emphasising that trust, alignment, and usability are as important as technical capability.

4.3 Trust and Data Security Concerns

Concerns around trust, data protection and legal responsibility were raised in the interviews. While some participants acknowledged that blockchain could improve the security of health information, others were sceptical about governance, error correction and regulatory compliance.

> *'It sounds like a more secure system, yes, but my worry is always who's in control and whether the rules are clear' – Healthcare Institution Administrator.*
> *'Security and access to data are always a concern in healthcare, especially when so many people are involved' – Nurse Manager.*
> *'Even if the system is secure, I would want to know exactly who has access to my records and how that access is monitored' – Clinical Psychologist.*

These reflections resonate with the literature, which positions immutability as both an asset and a risk in healthcare environments. While blockchain technology ensures traceability and resistance to tampering [11], it also presents challenges when it comes to correcting errors, which is a common requirement in medical practice. Scholars such as Engelhardt [39] have cautioned that, without clear governance mechanisms, the immutability of blockchain systems may erode trust rather than build it.

Data correction was indeed a recurring concern:

'What if someone enters something wrong? Can we change it later? That's what worries me about things that can't be edited' – Clinical Director.
'The immutability is only good if the data is correct to begin with. But that's not always the case' – Psychologist.
'Mistakes happen in health. What matters is how they're fixed. A system that doesn't allow that can be risky' – Academic Clinician.

Another theme that emerged was regulatory uncertainty, particularly in relation to the General Data Protection Regulation (GDPR). Participants questioned how blockchain systems would align with the right to access, modify, or erase personal data.

'We have very strict rules about data privacy, especially with GDPR. I don't know how blockchain would comply with that' – Healthcare Field Researcher and Ethics Committee Member.
'There's the question of the right to be forgotten. If data is permanent, how does that work in Europe?' – Administrator.
'I think legal questions are still very open. Before using this, I'd want to see a clear legal framework' – Academic Health Professional.

This aligns with concerns raised in the literature regarding the ambiguous legal status of blockchain under the GDPR, particularly with respect to the right to be forgotten [28].

More broadly, trust was viewed as relational rather than purely technical. Participants were less concerned about cryptographic assurances and more focused on issues such as who governs and audits the system and how responsibilities are distributed.

'For me, it's more about knowing who runs the system and whether I can trust them to act responsibly' – Healthcare Institution Administrator.
'We need transparency – who sets the rules, who monitors, who resolves disputes if something goes wrong' – Academic Coordinator.
'Trust is not only about the technology – it's about the people and institutions behind it' – Healthcare Field Researcher.

4.4 Digital Literacy and Training Needs

Across all interviews, low levels of blockchain literacy were consistently reported. Most participants stated that they had never heard of the technology before the interview or were unsure of its meaning. This lack of familiarity shaped their perceptions of risk and feasibility, often reinforcing a sense of exclusion from technological decision-making processes.

'I had never heard of it before this interview' – Healthcare Institution Assistant.
'I really don't know, I don't know what blockchain is' – Nurse.
'I had to do some research before coming here' – Health Technician.

These statements are indicative of the broader digital divide that persists even among healthcare professionals. Prior studies confirm that digital literacy is not uniform across clinical roles and can significantly affect how new technologies are understood, evaluated, and eventually adopted [8, 12, 13].

Participants stressed the need for structured, practice-oriented training programmes to support the introduction of blockchain. One common criticism was the inadequacy of generic or passive training formats, such as one-off presentations.

> *'Training must include practical examples. PowerPoint is no longer sufficient. The team needs time, context, and support' − Training Coordinator.*

Beyond individual competencies, digital literacy was framed as an organisational challenge. Interviewees noted that leadership plays a crucial role in fostering a culture of digital openness and experimentation.

> *'I think the example has to come from the top. If management doesn't get involved, the team won't follow suit' − Clinical Coordinator.*

Participants affirmed that digital literacy plays a crucial role in shaping the way healthcare professionals understand, evaluate, and adopt new technologies such as blockchain. Although most interviewees were familiar with basic digital tools, they had reservations about their ability to understand the technical and conceptual aspects of blockchain-based systems.

> *'I use digital tools every day, but when something new comes up, especially something technical, I feel a bit lost' − Psychologist.*
> *'We're confident with the current systems, but new ones need to be introduced with training. Blockchain is not something we've even heard much about' − Academic Clinician.*
> *'I think digital skills vary a lot from person to person. Some colleagues struggle even with the healthcare software we already use' − Academic and Ethics Researcher.*

These perspectives align with the broader literature, which defines digital literacy as encompassing not only operational ability, but also the capacity to critically interact with and trust digital infrastructures in clinical settings [26].

When asked explicitly about training needs and digital familiarity (Question 4), participants emphasised the importance of institutional support in reducing the learning gap and building confidence.

> *'Most of us don't have any formal training on these technologies. If it's something new like blockchain, we'll need practical training that explains why it's useful, not just how it works' − Healthcare Institution Administrator.*
> *'Some of the digital tools we're given are introduced very suddenly. People get overwhelmed because there's no guidance or explanation' − Clinical Psychologist.*
> *'Each professional should receive tailored training. We don't all use the same systems in the same way' − Researcher and Lecturer.*

These responses echo the findings of Greenhalgh *et al.* [9] and Pesqueira *et al.* [43] who observed that ineffective training, particularly if it is overly generic or technical, can alienate

users and hinder the implementation process. Participants emphasised the importance of role-specific training that focuses on relevance to daily tasks and regulatory compliance.

There was a consensus on the need to assess baseline digital literacy levels within the institution to inform training design and implementation planning.

> *'It's important to know where each team stands. Some people are very digital, others really aren't. That affects how fast we can move forward' − Healthcare Field Researcher.*
> *'Assuming that everyone has the same digital knowledge is a mistake. Some people will need a lot more help' − Academic Clinician.*

These views align with the recommendations of Ross *et al.* [19] and Greenhalgh *et al.* [9], who emphasise the importance of adopting a contextualised and continuous approach to capacity building to enable the implementation of technology in complex environments. This echoes the argument that digital literacy is a social as well as a technical determinant of technology implementation in healthcare settings [26].

5. DISCUSSION

This study makes a valuable contribution to the existing literature on blockchain implementation in healthcare. It does so by empirically examining how digital literacy, trust, and organisational readiness shape professional perceptions within a Southern European healthcare institution context. Building on existing knowledge, it demonstrates how these factors interact in practice, emphasising the sociotechnical nature of implementation processes. In line with previous reviews [3, 40], our findings indicate that, while blockchain's technical potential is recognised, its realisation hinges on institutional strategy, governance clarity, and staff capabilities.

5.1 Perceived Usefulness and Organisational Readiness

Previous studies have shown that the successful integration of new technologies in healthcare is often hindered more by organisational barriers than by technical limitations, including fragmented strategies, insufficient resources, and weak leadership engagement [8, 9]. The present findings are consistent with this perspective: participants identified the absence of a coherent institutional strategy and limited investment capacity as key obstacles to blockchain implementation. This reinforces the notion that organisational readiness should be conceptualized not only as the presence of adequate technological infrastructure but also as the existence of strategic clarity, managerial commitment, and alignment with institutional goals [42].

Although respondents acknowledged blockchain's potential to improve access to patient information, enhance consent traceability and provide robust auditability mechanisms, they repeatedly emphasised that these benefits would remain unattainable without proper integration into existing clinical and administrative systems. This echoes Orlikowski's [15] conceptualisation of technology as being embedded within organisational routines; usefulness is not an inherent attribute of the system but rather emerges when technology aligns with daily practices and professional workflows. The findings also resonate with Armenakis and

Harris's [11] emphasis on socio-cognitive readiness, whereby innovations are adopted more readily when professionals perceive them as legitimate, feasible, and consistent with institutional goals.

The professionals' reflections further illustrate what Hylock and Zeng [1] and Hussien *et al.* [3] describe as a "utility-confidence gap" – the discrepancy between the theoretical advantages of blockchain and the perceived organisational capacity to realise them in practice. Unlike much of the earlier literature, which tends to highlight blockchain's technical potential in abstract terms, the participants in this study assessed usefulness through the lens of their day-to-day routines, resource constraints, and governance environments. This indicates that the perceived value of blockchain is shaped by contextual factors, particularly the extent to which organisations are prepared to integrate and sustain technological change.

Taken together, these findings suggest that organisational readiness – encompassing strategic planning, resource mobilization, and cultural alignment with professional practices – is a decisive precondition for blockchain implementation. Without clear strategies and adequate institutional support, even technologies with strong theoretical promise risk being perceived as peripheral or impractical. Conversely, when readiness is fostered through leadership engagement and meaningful integration into existing workflows, blockchain is more likely to be perceived as useful, credible, and sustainable [16, 43].

5.2 Trust and Governance Concerns

Consistent with previous research, participants recognised blockchain's potential to enhance traceability, consent management, and data security in healthcare [14, 39]. However, they also expressed doubts about how errors could be rectified in an immutable system, how compliance with the General Data Protection Regulation (GDPR) could be ensured, and who would ultimately be held responsible for misuse or failure. These concerns closely mirror those raised in the literature: Engelhardt [39] highlighted the tension between immutability and data rectification, while Radanović and Likić [40] emphasised unresolved issues of accountability and governance when blockchain is applied to medical contexts.

Such reflections reinforce a central argument in recent work – that technical guarantees such as decentralisation and immutability are not, on their own, sufficient to establish trust. For healthcare professionals, confidence depends equally on institutional credibility, transparent governance structures, and the perceived fairness of decision-making processes [10, 43]. In this respect, trust is not solely a technical artefact, but a socio-organisational construct shaped by perceived legitimacy, professional norms, and regulatory clarity [32, 34].

In the Portuguese context, compliance with European data-protection norms emerged as a pervasive concern. Participants questioned how blockchain could accommodate rights such as erasure, rectification, and data minimisation, echoing the debates found in Finck and Pallas [4] and Voigt and von dem Bussche [50]. Both authors argue that identifiers, hashes, or keys stored on-chain may still constitute personal data under the GDPR, complicating notions of controllership and lawful processing. This perspective is consistent with earlier analyses by Kshetri [23], who demonstrated that blockchain's cybersecurity potential must be balanced against privacy and accountability challenges.

These findings also align with Hylock and Zeng [1] and Hussien *et al.* [3], who contend that healthcare organisations will only trust blockchain systems if governance responsibilities are clearly defined and compliance mechanisms verifiable. By highlighting the importance

of transparent governance, the present study adds to this body of evidence, suggesting that in European healthcare systems – where institutional capacities are uneven and data-protection standards stringent – trust cannot rely on technical assurances alone. Rather, it must be actively cultivated through shared governance frameworks, participatory implementation, and credible institutional commitments [16, 43].

5.3 Digital Literacy and Training Needs

The results aligned with previous research indicating that disparities in digital competence can influence healthcare professionals' willingness to engage with new technologies. In line with the *eHealth Literacy Scale* proposed by Norman and Skinner [12], participants noted that gaps in digital literacy often generate scepticism and hinder technology implementation. Similarly, van der Vaart and Drossaert [13] demonstrated that digital health literacy is multidimensional, encompassing not only technical skills but also critical and contextual understanding. Participants in this study echoed these insights, identifying limited institutional support and insufficient training opportunities as key barriers to engaging with blockchain technologies.

At the same time, the findings suggest that generic training programmes are perceived as inadequate. Professionals expressed a preference for role-specific and context-sensitive initiatives, which aligns with Greenhalgh *et al.* [9] and Cresswell and Sheikh [8], who show that the successful implementation and scaling of digital health tools depend on tailoring capacity-building efforts to professional roles and organisational realities. This perspective is consistent with Ross *et al.* [19], who found that digital implementation in healthcare depends not only on the availability of training but also on its relevance to daily workflows and professional cultures.

A recurring theme was the uneven distribution of digital competence across occupational groups. Participants described their knowledge of blockchain as limited and their broader digital skills as varying according to professional role, previous exposure, and organisational support. These findings support the argument that digital literacy is not an all-or-nothing attribute but a capacity shaped by institutional investment, leadership engagement, and continuous learning [16, 42]. The results also reflect calls for capacity-building strategies that move beyond one-off training sessions to establish continuous, contextually grounded learning ecosystems that reinforce both individual and organisational readiness [1, 11, 43].

The analysis further indicates a potential interaction between digital literacy and trust. While participants did not explicitly describe this connection, the data suggest that individuals who were more confident in their digital skills appeared more willing to engage with governance mechanisms and institutional safeguards. This tentative relationship aligns with previous findings that higher literacy levels can enhance the link between institutional trust and the practical implementation of digital technologies [10, 43]. Although this association emerged indirectly and cannot be generalised due to the limited sample, it highlights an important avenue for future research.

Overall, the findings underscore that developing digital literacy is central to strengthening overall professional readiness. In this context, professionals valued training initiatives that were aligned with their responsibilities and sensitive to the realities of healthcare practice. While these results are context-specific, they suggest that sustained attention to literacy and

capacity building could significantly shape how blockchain technologies are perceived and ultimately adopted in professional healthcare environments.

5.4 Contribution to Literature and Practice

This study contributes to the growing body of literature by demonstrating that the implementation of blockchain technology in healthcare is best understood as a sociotechnical process rather than a purely technological innovation. Its success depends on three interdependent factors: (1) the alignment between perceived usefulness and organisational readiness [9, 16, 42], (2) institutional governance structures that foster trust and accountability [1, 10, 34]; and (3) the level of digital literacy and professional competence among healthcare staff [12, 13, 43]. While these elements have often been examined separately in previous research, this study integrates them within a single analytical framework and grounds them in qualitative evidence from a real-world healthcare organisation in Southern Europe – a context that remains underrepresented in blockchain scholarship.

Taken together, the findings reinforce the view that blockchain implementation in healthcare is shaped by the interaction between technical affordances, human competencies, institutional governance, and organisational strategy. This interpretation aligns with Orlikowski's [15] theory of the duality of technology, which conceptualises technology as being simultaneously shaped by and shaping organisational practice.

By integrating these perspectives, this study provides empirical grounding for the argument that technological innovation must be accompanied by organisational learning, cultural adaptation, and policy alignment.

From a practical standpoint, the research highlights that blockchain implementation cannot advance through technical deployment alone. It requires parallel investment in digital literacy, governance frameworks, and strategic leadership. These insights respond directly to prior calls for inclusive and context-sensitive planning in digital health implementation [9, 19].

By documenting how professionals in Southern European healthcare perceives blockchain in relation to readiness, trust, governance, and digital literacy, this study offers context-specific empirical evidence that enriches theoretical models of digital transformation in healthcare. Although the results cannot be generalised beyond the studied institution, they point to organisational dynamics that are likely to influence technology implementation in other health systems facing similar regulatory, infrastructural, and professional challenges.

6. CONCLUSION

This study examined healthcare professionals' perceptions of blockchain implementation in a Portuguese healthcare institution, focusing on digital literacy, trust, and organisational readiness. The results indicate that blockchain was regarded as potentially useful for improving the reliability of patient records, enhancing interoperability, and strengthening the traceability of consent processes. However, participants consistently stressed that these benefits would only be realised if the technology were integrated into existing infrastructures and supported by a coherent institutional strategy.

At the same time, participants identified barriers to implementing the technology. These include fragmented digital infrastructures, a lack of interoperability, scepticism arising from

previous failed implementations and uncertainty regarding compliance with data protection legislation, particularly the 'right to be forgotten' provisions of GDPR. These obstacles demonstrate that the implementation of blockchain technology is hindered not only by technical factors, but also by regulatory and organisational challenges.

Although digital literacy and trust were discussed separately, the findings suggest that both variables play a role in how professionals evaluate the implementation of new technologies. In this study, digital literacy influenced perceptions of usability, effort, and compatibility with existing workflows, while trust shaped perceptions of governance clarity, accountability, and regulatory compliance. Taken together, these two variables complement each other in participants' assessments of feasibility. However, the data and method do not permit verification of a direct correlation between them or comparisons across subgroups.

Participants further emphasised that generic training initiatives were considered inadequate. Instead, they pointed to the importance of tailored capability programmes that consider the specific needs of different roles and the professional contexts in which blockchain would be used. This view reflects the idea that training should be relevant to everyday tasks and responsibilities rather than being delivered as abstract or generalised instruction. Participants also highlighted that the effectiveness of capacity-building initiatives depends more on their alignment with practical routines and professional expectations than on their scale or frequency.

In practical terms, the study emphasises the importance of strategic institutional planning and governance mechanisms for ensuring compliance and accountability. It also emphasises the need for tailored training programmes to improve digital literacy. These insights can inform healthcare institution managers and policymakers when designing more effective and inclusive approaches to technological innovation. While the study is limited by its small sample size and focus on a single institution, its findings could inform future comparative and mixed-methods research that could validate these dynamics in different organisational and national contexts.

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