Cyber Humanities and Digital Sustainability: Emerging Frameworks for Future Research

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Abstract

Background: The convergence of computational technologies with humanistic inquiry has generated the interdisciplinary domain of cyber humanities, prompting critical questions about how digital infrastructures can sustain scholarly knowledge over time. Digital sustainability—encompassing the longevity, accessibility, and ecological viability of digital systems—has emerged as an urgent concern for research communities worldwide.

Objective: This article examines the theoretical and practical frameworks at the intersection of cyber humanities and digital sustainability, mapping existing paradigms and identifying research gaps that demand scholarly attention.

Methods: A systematic review of peer-reviewed literature (2015–2025) was conducted, supplemented by comparative analysis of twelve institutional digital sustainability frameworks and structured assessment of technology adoption metrics across forty-two research institutions.

Results: Findings reveal significant inconsistencies in digital preservation standards, a notable gap between technology adoption rates and institutional sustainability planning, and an emerging consensus around FAIR (Findable, Accessible, Interoperable, Reusable) data principles as a unifying framework.

Conclusion: Cyber humanities and digital sustainability are mutually reinforcing domains requiring integrated policy, interdisciplinary collaboration, and standardized metrics. A proposed convergence framework offers actionable directions for future research.

Keywords: cyber humanities, digital sustainability, digital preservation, FAIR principles, knowledge ecosystems, computational humanities, technology adoption

1. Introduction

The twenty-first century has witnessed an unprecedented digitisation of cultural artefacts, scholarly texts, and institutional knowledge. Alongside this proliferation, a novel disciplinary formation—cyber humanities—has emerged to theorise and operationalise the intersection of humanistic inquiry with digital technologies. Cyber humanities encompasses computational text analysis, digital archiving, machine-assisted cultural heritage preservation, and the application of artificial intelligence to historical and literary corpora [1, 2].

Simultaneously, the concept of digital sustainability has gained traction as researchers confront the fragility of digital ecosystems. Unlike physical artefacts, digital objects are subject to format obsolescence, server dependencies, and energy consumption pressures that complicate long-term preservation [3]. The question of how scholarly knowledge survives across technological generations is no longer merely technical but deeply ethical and institutional [4].

This article advances the proposition that cyber humanities and digital sustainability are not parallel concerns but deeply interdependent frameworks. A digitally unsustainable infrastructure undermines the long-term validity of humanistic scholarship, while a cyber humanities approach uninformed by sustainability principles risks perpetuating ecologically and archivally irresponsible practices [5, 6]. The following sections map the conceptual terrain, review existing scholarship, propose an integrative framework, and outline future research directions.

2. Related Work

The foundational literature of digital humanities established the intellectual parameters for computational approaches to cultural inquiry [7]. Scholars such as Burdick *et al.* [8] and Berry [9]] articulated the epistemological stakes of applying algorithmic methods to humanistic questions, while Terras *et al.* [10] consolidated the methodological vocabulary of the field. These contributions, however, largely bracketed questions of long-term digital viability.

Digital preservation studies, originating in library and archival science, developed independently through frameworks such as the Open Archival Information System (OAIS) and the Digital Preservation Coalition's maturity model [11]. The FAIR principles, articulated by Wilkinson *et al.* [12], represented a significant step toward formalising data sustainability in research contexts, though their application to humanities datasets has remained uneven [13].

More recently, scholars have begun to examine the ecological dimensions of digital scholarship. Bates *et al.* [14] quantified the carbon footprint of large-scale text digitisation projects, while Pasek [15] introduced the concept of a computational humanities carbon budget. Meanwhile, institutional studies by Lavoie and Dempsey [16] documented the economic unsustainability of fragmented preservation strategies. This article synthesises these strands, arguing that their convergence constitutes an emergent research frontier.

3. Cyber Humanities Framework

Cyber humanities, as conceptualised here, refers to the ensemble of digital methods, computational tools, and networked infrastructures deployed in the service of humanistic research. It differs from digital humanities in its explicit attention to the cybernetic dimensions of research—that is, the feedback loops between data, algorithms, researchers, and institutional systems that shape knowledge production [17].

Three theoretical pillars underpin the cyber humanities framework. First, computational reflexivity requires that scholars interrogate the algorithmic assumptions embedded in their digital tools, recognising that text mining, sentiment analysis, and image recognition carry epistemological presuppositions that inflect research outcomes. Second, infrastructural legibility demands transparency in the digital architectures sustaining scholarly work, including server provenance, data governance policies, and access protocols. Third, temporal responsibility obliges researchers to consider the future accessibility of their digital outputs, embedding sustainability planning into the research design phase rather than treating it as an afterthought [18].

These pillars interface directly with sustainability concerns. Computational reflexivity enables more energy-efficient algorithmic choices; infrastructural legibility supports interoperability standards; and temporal responsibility provides the motivational framework for long-term digital preservation. Together, they constitute a cyber humanities framework that is sustainability-aware by design rather than by remediation [19]].

4. Materials and Methods

This study employed a mixed-methods research design integrating systematic literature review, comparative framework analysis, and quantitative assessment of technology adoption indicators.

Systematic Review: A comprehensive search of the Web of Science, Scopus, and JSTOR databases was conducted using the terms 'cyber humanities,' 'digital sustainability,' 'digital preservation,' and 'computational humanities.' The search was restricted to peer-reviewed publications from 2015 to 2025. An initial yield of 847 articles was screened against inclusion criteria—relevance to the intersection of computational methods and sustainability—yielding a final corpus of 134 articles for full-text analysis.

Comparative Framework Analysis: Twelve institutional digital sustainability frameworks were selected from diverse geographic and disciplinary contexts, including the British Library Digital Preservation Strategy, the Digital Preservation Coalition Roadmap, and the Library of Congress Digital Preservation Program. Frameworks were evaluated against a codebook of thirty-two sustainability indicators spanning technical, ecological, governance, and social dimensions.

Quantitative Assessment: Technology adoption data were collected through a structured survey administered to research leads at forty-two academic institutions across North America, Europe, and Asia-Pacific. The survey instrument, validated through a pilot round with eight institutions, measured adoption rates, perceived barriers, and sustainability integration scores for seven major cyber humanities technology categories.

5. Results and Comparative Analysis

The systematic review identified three dominant research clusters: (1) computational methods for cultural heritage (38% of corpus), (2) data governance and FAIR principles implementation (31%), and (3) ecological sustainability of digital infrastructure (31%). Cross-cluster analysis revealed that only 14% of reviewed studies explicitly addressed the intersections of all three clusters, confirming the presence of a significant research gap.

Table 1 presents a comparative analysis of key cyber humanities technologies across dimensions of domain application, institutional adoption rate, sustainability index, and research impact. Natural language processing and cloud computing demonstrated the highest adoption rates (74% and 83% respectively), consistent with their broad applicability and mature tooling ecosystems. Blockchain recorded the lowest adoption (38%) despite its theoretical utility for provenance tracking, likely due to energy consumption concerns and implementation complexity.

Table 1: Comparative Analysis of Cyber Humanities Technologies

Technology	Domain	Adoption Rate (%)	Sustainability Index	Research Impact
Natural Language Processing	Text Analysis	74	High (0.82)	Very High
Computer Vision	Image & Archive	61	Moderate (0.67)	High
Knowledge Graphs	Linked Data	52	High (0.78)	High
Blockchain	Provenance & IP	38	Moderate (0.5[9])	Moderate
Machine Learning	Pattern Recognition	6[9]	High (0.75)	Very High
AR / VR	Cultural Heritage	44	Moderate (0.61)	Moderate
Cloud Computing	Data Infrastructure	83	High (0.80)	High

The comparative framework analysis of institutional sustainability strategies revealed significant heterogeneity. North American institutions scored highest on technical interoperability metrics (mean: 0.74/1.00) but lagged on ecological sustainability indicators (mean: 0.52/1.00). European frameworks demonstrated stronger governance structures, reflecting GDPR influences, while Asia-Pacific institutions showed rapid improvement in open access indices, rising from 41% to 58% over the study period.

Table 2 presents the digital sustainability indicators framework developed from this comparative analysis, establishing benchmarks against which institutional performance can be assessed. The Carbon Footprint per Query indicator (gCO_2eq/query) and Energy Use Efficiency (PUE ratio) showed improving trajectories, reflecting broader cloud industry sustainability commitments. However, Ethical Compliance Score and Open Access Index remained below benchmark in the majority of surveyed institutions.

Table 2: Digital Sustainability Indicators Framework

Indicator	Category	Measurement Unit	Benchmark Score	Current Status
Carbon Footprint per Query	Environmental	gCO_2eq / query	< 0.3 g	Improving
Data Longevity Score	Preservation	Years / format cycle	> 25 years	Moderate
Open Access Index	Accessibility	% open repositories	> 60%	Developing
Interoperability Rate	Technical	Linked datasets (%)	> 70%	Improving
Energy Use Efficiency	Environmental	PUE ratio	< 1.4	Good
Ethical Compliance Score	Governance	% FAIR compliance	> 80%	Developing
Researcher Adoption Rate	Adoption	% using digital tools	> 65%	Good

6. Discussion

The results illuminate a structural tension at the heart of contemporary digital humanities: institutions are rapidly adopting sophisticated computational tools without corresponding investment in the sustainability infrastructures necessary to preserve their outputs [20]. This gap is not merely administrative but epistemological—scholarship conducted on transient or inaccessible digital bases is scholarship with a compromised claim to the cumulativity that characterises rigorous inquiry.

The cyber humanities framework proposed here addresses this tension by embedding sustainability considerations within the research lifecycle rather than delegating them to post-project preservation efforts. Computational reflexivity, for instance, encourages researchers to select algorithms not only for analytical power but for energy efficiency and interpretability—choices that simultaneously improve research quality and reduce ecological impact. Similarly, infrastructural legibility requirements push institutions toward interoperable, standards-compliant data practices that facilitate both current collaboration and future access.

The FAIR principles represent the most institutionally traction-gaining expression of digital sustainability in research contexts, yet their implementation remains patchy. Survey data indicate that humanities researchers frequently encounter barriers related to technical capacity, institutional incentive structures, and disciplinary norms that undervalue data sharing. Addressing these barriers requires not technical solutions alone but cultural change within academic institutions, including revised research evaluation criteria and dedicated sustainability training for early-career researchers.

Emerging digital ecosystems—including decentralised web architectures, linked open data networks, and federated learning platforms—offer promising infrastructural solutions but introduce new governance challenges. The interdisciplinary character of cyber humanities positions it well to navigate these challenges, drawing on archival science, information ethics, computer science, and the humanities to develop holistic responses. Future research should prioritise longitudinal studies of institutional sustainability trajectories and experimental evaluation of integrated cyber humanities curricula.

7. Conclusion

This article has demonstrated that cyber humanities and digital sustainability constitute an emergent and urgent research frontier. Through systematic review, comparative framework analysis, and institutional survey, it has established that significant gaps persist between digital tool adoption and sustainability integration, that existing frameworks are geographically and disciplinarily uneven, and that a coherent integrative framework—grounded in computational reflexivity, infrastructural legibility, and temporal responsibility—offers a productive path forward.

The digital humanities community stands at a critical juncture. The infrastructural choices made in the coming decade will determine whether the digital turn in humanistic scholarship produces a durable intellectual legacy or a fragile one. By foregrounding sustainability as a constitutive rather than supplementary concern, cyber humanities can position itself as both a methodologically rigorous and ethically responsible field for the twenty-first century and beyond.

Future research should develop standardised sustainability assessment tools for humanities digital projects, investigate the ecological impacts of large language models deployed in humanistic research, and establish international consensus on FAIR implementation standards tailored to humanities data characteristics.

References

1. Gold MK, Klein LF. Digital humanities: The expanded field. Minneapolis (MN): University of Minnesota Press; 201[9].
2. Schreibman S, Siemens R, Unsworth J, editors. A new companion to digital humanities. 2nd ed. Chichester (UK): Wiley-Blackwell; 2016.
3. UNESCO. Recommendation on the ethics of artificial intelligence and digital heritage. Paris: UNESCO Publishing; 2021.
4. Owens T. The theory and craft of digital preservation. Baltimore (MD): Johns Hopkins University Press; 2018.
5. Risam R. New digital worlds: Postcolonial digital humanities in theory, praxis, and pedagogy. Evanston (IL): Northwestern University Press; 2018.
6. Drucker J. The digital humanities coursebook: An introduction to digital methods for research and scholarship. London: Routledge; 2021.
7. Berry DM. Understanding digital humanities. London: Palgrave Macmillan; 2012.
8. Burdick A, Drucker J, Lunenfeld P, Presner T, Schnapp J. Digital humanities. Cambridge (MA): MIT Press; 2012.
9. Berry DM, Fagerjord A. Digital humanities: Knowledge and critique in a digital age. Cambridge: Polity Press; 2017.
10. Terras M, Nyhan J, Vanhoutte E, editors. Defining digital humanities. Farnham (UK): Ashgate; 2013.
11. Consultative Committee for Space Data Systems (CCSDS). Reference model for an open archival information system (OAIS). CCSDS 650.0-M-2. 2012.
12. Wilkinson MD, Dumontier M, Aalbersberg IJ, *et al*. The FAIR guiding principles for scientific data management and stewardship. Sci Data. 2016;3:160018.
13. Sáez JM, Cano EV. Digital competence and FAIR principles in the humanities: a European survey. J Digit Inf. 2021;22(1):45–67.
14. Bates J, Lin Y, Goodale P. Data journeys: capturing the sociotechnical practices of environmental data creation and use. Big Data Soc. 2020;7(1):1–12.
15. Pasek A. Managing carbon and data flows: twin transitions of the carbon copy. Cult Mach. 2021;21:1–22.
16. Lavoie B, Dempsey L. Thirteen ways of looking at… digital preservation. D-Lib Mag. 2004;10(7/8).
17. Jockers ML. Macroanalysis: digital methods and literary history. Urbana (IL): University of Illinois Press; 2013.
18. Flanders J, Jannidis F, editors. The shape of data in digital humanities: modeling texts and text-based resources. London: Routledge; 201[9].
19. Gil A, Ortega É. Global outlooks in digital humanities: multilingual practices and minimal computing. In: Gold MK, Klein LF, editors. Doing digital humanities. London: Routledge; 2016. p. 22–34.
20. Borgman CL. Big data, little data, no data: scholarship in the networked world. Cambridge (MA): MIT Press; 2015.

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