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Evaluating the Loss of Indigenous Knowledge and Local Traditions in the Technical World: A PRISMA-ScR-Guided Scoping Review and Comparative Analysis

Parhlad Singh Ahluwalia[1]
[1] *Dr. Bhim Rao Ambedkar Law University, Rajasthan, India*
Correspondence: ahluwalia002@zohomail.in

Abstract

Background: *Indigenous and local knowledge systems encode centuries of accumulated observation about ecosystems, medicine, food, language, social organisation and ethics. Their erosion under conditions of technological modernity is widely asserted, yet the evidence for it is scattered across ecology, linguistics, anthropology, health sciences, education and digital studies, and is rarely examined as a single analytical problem.* ***Objective:*** *This paper evaluates the nature, magnitude, mechanisms and consequences of the loss of Indigenous knowledge and local traditions in the technical world, and tests whether the loss is best understood as passive decay, active displacement or adaptive transformation.* ***Methods:*** *A scoping review guided by the PRISMA-ScR reporting standard was applied to a supplied corpus of 117 records, which was screened against explicit eligibility criteria. The result was triangulated against a comparative evidence set of 17 landmark empirical studies, global assessments and institutional reports. Findings were synthesised thematically across eight disciplinary perspectives.* ***Results:*** *After removal of two records with incomplete bibliographic data and 29 off-scope records, 86 records were retained and mapped to six themes: traditional knowledge systems and practices (36.0%), digital society and algorithmic mediation (22.1%), education policy and quality assurance (17.4%), environment and climate (10.5%), language, culture and epistemology (7.0%) and research methodology (7.0%). The comparative evidence set shows that knowledge loss is measurable within a single generation, is tightly coupled to language endangerment, is accelerated by formal schooling, market integration and digital infrastructure, and carries concrete ecological and biomedical costs. A critical gap was identified: none of the 86 records was framed as a direct empirical measurement of knowledge loss in a community.* ***Conclusions:*** *Loss is neither uniform nor inevitable. It follows identifiable channels of displacement, epistemic devaluation, extraction and digital exclusion, each of which is amenable to policy. Safeguarding requires community-governed documentation, intergenerational transmission, institutional recognition and Indigenous data sovereignty rather than technological preservation alone.*

Keywords: *Indigenous knowledge; traditional ecological knowledge; local traditions; language endangerment; biocultural diversity; digital divide; epistemic justice; decolonisation; PRISMA-ScR; knowledge transmission*

1. Introduction

Every society carries a body of knowledge that is not written in textbooks, patented in laboratories or indexed in databases. It lives in the hands of a healer who knows which bark relieves fever, in the memory of a fisher who reads the sea from the colour of the swell, in the

cadence of a lullaby that carries a moral code, and in the grammar of a language that distinguishes forms of experience that other languages leave unmarked. The International Labour Organization estimates that Indigenous peoples number roughly 476 million, about 6 per cent of the world's population, spread across more than ninety countries and representing thousands of distinct cultures [1]. The knowledge held by these peoples, and by many non-Indigenous local communities, is the subject of this paper. The central concern is whether, how fast, and why that knowledge is disappearing as societies become technically organised around industrial production, formal schooling, market exchange and digital networks.

The question is not new, but it has become sharper. Early development scholarship treated local knowledge as an obstacle to be replaced by expert systems, an assumption that later work dismantled by showing that the line between Indigenous and scientific knowledge is far more porous than that framing suggested [2,3]. Since then, a substantial literature has demonstrated that Indigenous and local knowledge is empirical, adaptive and practically consequential for biodiversity conservation, climate adaptation, food security and primary health care [4-6]. At the same time, the technical world has produced forces that act on this knowledge at unprecedented scale and speed: compulsory schooling in dominant languages, labour migration, infrastructure expansion, intellectual property regimes that reward codification, and now algorithmic systems trained on data that overwhelmingly represent a small number of languages and cultures [7-9].

Three observations motivate this paper. First, loss is frequently invoked rhetorically but less often measured. Claims about the disappearance of traditions often rest on anecdote or on proxy indicators, and the proxies do not always agree. Second, loss is usually studied inside disciplinary silos. Linguists count extinct languages, ethnobotanists count forgotten plant uses, educationists analyse curricula, and digital sociologists analyse platforms, but few studies connect these strands into a single causal account [10-12]. Third, a contemporary body of scholarship, much of it emerging from South Asia, now examines traditional knowledge systems such as yoga, Ayurveda, Sanskrit textual traditions and the guru-shishya mode of transmission, alongside questions about digital culture, education reform and environmental change [13-16]. This scholarship offers an under-used comparative resource, because it places a living, textually grounded tradition in direct conversation with modern science and technology.

The paper therefore pursues an analytical rather than a purely descriptive aim. It seeks to expose the reality of knowledge loss by combining a transparent scoping review with comparative empirical evidence, and by examining the problem from several perspectives that are normally kept apart: ecological, linguistic, epistemological, health-related, technological, educational and legal. The argument advanced is that the loss of Indigenous knowledge in the technical world is best explained not by the mere arrival of technology but by the institutional arrangements through which technology is introduced, namely who controls the channels of transmission, whose knowledge counts as valid, and who captures the value of what is recorded.

1.1 Research questions

The review is organised around five questions.

- **RQ1.** What is the scale and distribution of the evidence on the loss of Indigenous knowledge and local traditions?
- **RQ2.** What does comparative empirical research show about the rate, pattern and drivers of that loss?
- **RQ3.** How do different disciplinary perspectives define and explain the problem, and where do they conflict?
- **RQ4.** What are the documented consequences of loss for ecosystems, health, language and community identity?
- **RQ5.** Which institutional and technological responses show the strongest support, and where are the evidence gaps?

1.2 Contribution

The contribution is fourfold. The paper provides a reproducible screening of a defined corpus using a recognised reporting framework. It provides a comparative table of landmark empirical findings. It provides a structured review of existing reviews and their outputs. And it proposes a four-channel model of knowledge loss that links ecological, linguistic, epistemic and digital processes within one explanatory frame.

2. Conceptual Framework

2.1 Defining the knowledge at stake

The terminology in this field is contested, and the contest is itself analytically informative. Indigenous knowledge, traditional ecological knowledge and local ecological knowledge overlap but are not synonymous. Berkes describes traditional ecological knowledge as a cumulative body of knowledge, practice and belief that evolves through adaptive processes and is handed down through generations by cultural transmission, and that includes relationships among living beings and their environment [17]. Local ecological knowledge is often used more broadly for the place-based knowledge of resource users, including those who are not Indigenous in a legal sense, and tends to be defined by experience rather than by ancestry [18]. Semali and Kincheloe, writing from an educational standpoint, stress that Indigenous knowledge is not a static archive but a way of knowing embedded in relationships, language and place [19]. Battiste argues that its recognition requires a transformation of the educational and legal structures that have historically excluded it [20].

Within a South Asian frame, the corpus reviewed in this paper extends the notion of Indigenous and local knowledge to textually codified traditions that coexist with oral and embodied practice. Work on yogic knowledge, for example, treats philosophical foundations, breathing techniques, ethical codes and the preservation of Sanskrit terminology as parts of one knowledge system whose transmission depends on teachers, language and ritual context [14,21-24]. This inclusion is conceptually important. It shows that the dichotomy between Indigenous orality and modern literacy is too crude, because traditions can be simultaneously written, performed and lived.

2.2 The technical world

The phrase technical world is used here to denote the socio-technical order of industrial and digital modernity: standardised schooling, bureaucratic classification, market integration, mass

media, the internet and algorithmic platforms. Scott's analysis of high-modernist state projects supplies a useful lens. States and large institutions render complex local practice legible by simplifying it into standard categories, and in the process they discard the practical, context-dependent knowledge that he calls metis [25]. The technical world is therefore not only a set of tools. It is a mode of knowing that privileges what can be measured, standardised and transferred across contexts.

Contemporary digital scholarship extends this argument. Studies of digital displacement in technology hubs, algorithmic invisibility, algorithmic bias and techno-authoritarianism describe how digital infrastructure redistributes visibility, belonging and authority in ways that favour some forms of life over others [26-29]. These analyses concern urban labour, inequality and sovereignty rather than Indigenous knowledge in the narrow sense, but they establish the structural mechanisms through which digital systems can marginalise communities whose knowledge is oral, local or non-standard.

2.3 Mechanisms of cultural transmission

Cultural transmission theory distinguishes vertical transmission from parents to children, oblique transmission from non-parental elders and institutions, and horizontal transmission among peers [30]. Empirical work on Indigenous knowledge consistently finds that the first two channels sustain deep, place-specific skills, whereas the third dominates when children spend their time in schools and media environments organised around peer culture and external content. The study of bush skills among Cree women in subarctic Canada showed that the transmission of land-based knowledge depended on time spent on the land with experienced relatives, a condition that wage labour and schooling reduce [31]. Language is the crucial carrier across all channels, so that when a language shifts, the transmission of the knowledge encoded in it is placed at risk [32,33].

2.4 Epistemic justice and decolonial critique

A second theoretical strand concerns power. Smith argues that Western research has historically operated as an extractive and classificatory enterprise in relation to Indigenous peoples, and calls for methodologies that are accountable to communities [34]. Santos uses the term epistemicide for the destruction of knowledge systems through colonial and modern hierarchies of validity [35]. Fricker's concept of epistemic injustice clarifies the mechanism at the level of the individual, because testimony from a marginalised speaker is discounted irrespective of its accuracy [36]. Nakata's notion of the cultural interface describes the contested space in which Indigenous and Western knowledge meet, and in which neither can be assumed to be transparent to the other [37]. Sociological work on decolonising theory and on Indigenous epistemologies in the rewriting of sociological concepts supports the same direction of argument [16], and sociological analyses of language, rites of socialisation and culture treat the transmission of values as a social process that can be disrupted by changes in institutions [38-40].

2.5 Analytical model

Drawing on these strands, the paper proposes four channels through which the technical world acts on Indigenous and local knowledge.

- **Displacement of transmission time and space.** Schooling, wage work and screen-based leisure reduce the contact between knowledge holders and learners.
- **Epistemic devaluation.** Institutional hierarchies of validity treat local knowledge as anecdotal, obsolete or merely cultural.
- **Extraction and decontextualisation.** Knowledge is recorded, patented or commercialised without community control, which severs it from its custodians.
- **Digital exclusion and algorithmic erasure.** Languages and practices that lack digital representation are rendered invisible in the systems that increasingly mediate information.

These channels are not mutually exclusive, and the empirical sections test their relative support.

3. Methodology

3.1 Design and reporting standard

The study is a scoping review, chosen because the field is heterogeneous, spans multiple disciplines and contains few homogeneous experimental studies that could be pooled in a conventional systematic review. The methodological framework of Arksey and O'Malley, which structures a scoping study as identifying the question, identifying relevant studies, selecting studies, charting the data and collating and reporting results, was adopted [41]. Reporting follows the PRISMA extension for scoping reviews, which adapts the PRISMA 2020 flow-diagram logic to evidence mapping [42,43]. Methodological discussions of the PRISMA-ScR approach, including its role in transparent mapping of research landscapes for emerging researchers, informed the charting and reporting procedures [44,45].

3.2 Two evidence streams

Two streams of evidence were used, and the distinction between them is stated explicitly to prevent overstatement.

Stream A: the supplied corpus. A reference list of 117 records was supplied for this project. It was treated as a bounded corpus and subjected to a formal screening process described below. Because this corpus is a fixed set rather than the output of a database search, the review is a screening and mapping of that corpus and does not claim to be a comprehensive retrieval of the global literature.

Stream B: the comparative evidence set. To supply empirical depth that the corpus lacks, 17 landmark peer-reviewed studies, global assessments and institutional reports were assembled purposively. They were selected because they provide quantitative or comparative findings on knowledge loss, language endangerment, the ecological role of Indigenous lands, the biomedical value of traditional knowledge and digital language inequality. This stream was not screened using a database search protocol and is described as a purposive evidence set, not as a systematic sample.

3.3 Eligibility criteria

Records in Stream A were eligible if they addressed at least one of the following: (a) traditional, Indigenous or culturally embedded knowledge systems and practices; (b) language, socialisation and cultural values as channels of transmission; (c) digital, algorithmic or

technological transformation of social and cultural life; (d) environmental and climate change as a context for local knowledge and community life; (e) education systems and policies as institutional channels of transmission; or (f) research methodology and integrity relevant to the evidence base. Records were excluded if they concerned clinical or health-systems management without a traditional-knowledge dimension, or if they concerned law, public governance, geopolitics or commerce without a link to knowledge transmission. Records lacking essential bibliographic data, such as a venue or a complete title, were removed before screening.

3.4 Screening, charting and synthesis

Screening was conducted at the level of title and publication venue. Full-text assessment was not performed, and this is acknowledged as a limitation. Each retained record was charted for year, venue, language of publication and thematic category. Thematic assignment was exclusive, so that each record was allocated to the single theme that best matched its title. Synthesis was narrative and thematic. For Stream B, findings were extracted into a comparative table recording the scope, principal finding and relevance of each source.

3.5 Ethical and integrity considerations

No human participants were involved. Ethical scholarship on this topic requires attention to community consent, benefit sharing and the avoidance of extractive framing, and these principles were used to appraise the sources and to frame recommendations [34,46,47]. To protect against textual overlap, all synthesis was written independently and all claims are attributed to their sources. The literature on plagiarism detection and prevention was consulted to ensure that attribution and paraphrasing practices met accepted standards [48-50]. Automated similarity checking by the submitting author remains advisable, and no assurance of a particular similarity score can be given by the text alone.

4. Results

4.1 Screening outcome for the supplied corpus (RQ1)

The screening followed the flow summarised in Figure 1.

Figure 1. PRISMA-ScR-style flow diagram for the supplied corpus

IDENTIFICATION
Records in supplied reference list ..... n = 117
Duplicate records removed ..... n = 0
Records removed (incomplete bibliographic data) ..... n = 2

SCREENING (title and venue level)
Records screened ..... n = 115
Records excluded as off-scope ..... n = 29
Clinical and health-systems management ..... n = 17
Law, governance, geopolitics, commerce ..... n = 12

INCLUDED
Records included in narrative synthesis ..... n = 86

Of the 117 records, none was a duplicate. Two were removed because of incomplete bibliographic data. Of the 115 screened, 29 were excluded. Seventeen concerned clinical practice, hospital management, disease epidemiology, patient safety or healthcare artificial intelligence without a traditional-knowledge or cultural-transmission dimension, and twelve concerned law, public governance, geopolitics, market behaviour or civic policy [51-54]. Eighty-six records were retained.

The 86 included records were published between 2023 and 2026. Sixty-six (76.7%) were published in 2025, eleven (12.8%) in 2024, five (5.8%) in 2023 and four (4.7%) in 2026. Seven records (8.1%) were published in Hindi, a feature that is itself relevant to the topic, because it indicates that part of the evidence base on language and culture is written in the language it studies [38-40,55-58]. Two publication venues accounted for the majority of records: a single arts and humanities journal contributed 39 records (45.3%) and a journal devoted to yoga and Sanatana studies contributed 29 (33.7%), while the remaining 18 (20.9%) were distributed across other venues. In 85 of the 86 records (98.8%) a common author was present, and that author was first author on 56 (65.1%). This concentration is a significant feature of the evidence base and is returned to in the discussion.

4.2 Thematic mapping (RQ1, RQ3)

Table 1 maps the included records to six themes. Percentages are calculated on the 86 included records.

Table 1. Thematic distribution of the 86 included records from the supplied corpus

Theme	n	%	Representative focus of records (reference numbers)
A. Traditional knowledge systems and practices	31	36.0	Yogic philosophy, Ayurveda, Sanskrit, guru-shishya transmission, physiological correlates of practice [13-15,21-24,55,59-81]
B. Digital society, platforms and cultural production	19	22.1	Digital displacement, algorithmic bias, techno-authoritarianism, memes, influencer culture, digital art and literature, labour and identity [26-29,82-96]
C. Education policy and quality assurance	15	17.4	National Education Policy 2020, accreditation, outcome-based education, educational disparities, missionary education [97-111]
D. Environment and climate	9	10.5	Floods, urban sprawl, climate migration, climate agreements, women and conservation, climate anxiety [58,112-119]
E. Language, culture and epistemology	6	7.0	Language and sanskar, Gandhian values and education, decolonising sociology [16,38-40,56,57]
F. Research methodology and integrity	6	7.0	PRISMA-ScR, plagiarism detection and prevention, ethics in social research [44-46,48-50]
Total	**86**	**100.0**	

Two patterns stand out. First, more than a third of the corpus concerns traditional practices, and these records divide into two tendencies, namely doctrinal and philosophical exposition and the scientific investigation of practice through physiological, neurological and clinical frames. Examples of the latter include studies of the vagus nerve, telomere length, neuroplasticity, cardiovascular outcomes, psychoneuroimmunology and biomechanics in relation to yoga [65,66,68,74,75,80]. This mirrors a broader movement in which traditional knowledge secures legitimacy in the technical world by translating itself into the vocabulary of biomedicine. Second, only six records (7.0%) focus directly on language, culture and epistemology, the domain in which the comparative literature locates the primary transmission mechanism. At the level of titles, no record was framed as a direct empirical measurement of knowledge loss in a community, such as a longitudinal ethnobotanical survey or a language vitality assessment.

4.3 Comparative empirical evidence (RQ2, RQ4)

Table 2 summarises Stream B, the comparative evidence set. The studies differ in design, scale and region, and they are presented together so that convergence and divergence can be examined.

Table 2. Comparative evidence on knowledge loss, its drivers and its consequences

Source	Design and scope	Principal finding	Relevance to the question
Maffi [10]	Conceptual review of linguistic, cultural and biological diversity	Diversity in the three domains is interdependent and threatened by common drivers	Frames loss as biocultural, not merely cultural
Sutherland [120]	Global comparison of language and species extinction risk	Language extinction risk was reported to be at least comparable to that of well-studied vertebrate groups	Supports urgency by comparison with biodiversity
Gorenflo et al. [121]	Global overlay of languages on biodiversity hotspots and wilderness areas	A large share of the world's languages occurs in areas of high biodiversity	Places knowledge loss where conservation need is greatest
Bromham et al. [122]	Global modelling of predictors of language endangerment	Endangerment is predicted by environmental and socio-economic drivers, and endangered languages are projected to increase markedly	Quantifies the trajectory of language loss
Reyes-García et al. [12]	Quantitative panel study of an Amazonian society	Measurable decline in traditional knowledge within a short period	Shows loss within one generation
Aswani et al. [18]	Global review of local ecological knowledge trends	Change is widespread and often negative but varies by context	Cautions against uniform narratives

Cámara-Leret et al. [123]	Network analysis of Indigenous knowledge in three regions	Knowledge is unevenly distributed across languages and therefore vulnerable	Explains why loss is not easily compensated
Cámara-Leret and Bascompte [11]	Analysis of medicinal knowledge across languages	Most medicinal knowledge recorded is held within single languages	Links language extinction to biomedical loss
Fernández-Llamazares et al. [124]	Expert synthesis and scientists' warning	Threats to Indigenous and local knowledge are systemic and interlinked	Provides a consensus statement on drivers
Garnett et al. [125]	Spatial analysis of Indigenous lands	Indigenous lands cover about 38 million km² across 87 countries, and intersect a large share of protected and intact areas	Shows the conservation stake in custodial knowledge
Fa et al. [126]	Spatial analysis of intact forest landscapes	About 36% of intact forest landscapes lie within Indigenous lands	Quantifies a specific ecological role
Sze et al. [127]	Pan-tropical analysis of deforestation	Indigenous lands were associated with lower forest loss than comparable unprotected lands	Supports effectiveness of Indigenous stewardship
Kornai [7]	Analysis of digital language vitality	Most languages are unlikely to attain digital vitality	Establishes digital exclusion as a loss channel
Joshi et al. [8]	Audit of language technology coverage	The large majority of languages receive little or no attention in language technology	Documents algorithmic marginalisation
World Health Organization [128]	Global survey of member states	170 member states reported use of traditional and complementary medicine	Shows scale of continuing reliance
Newman and Cragg [129]	Review of natural-product-derived drugs	Natural products and their derivatives remain a substantial source of approved agents	Shows value of preserved ethnomedical leads
Tu [130]	Historical case of artemisinin discovery	A leading antimalarial emerged from a traditional Chinese medicine text	Illustrates the cost of losing documented practice

4.4 Quantitative indicators of the problem

Several quantitative indicators deserve emphasis. UNESCO's Atlas of the World's Languages in Danger records roughly 2,500 endangered languages and reports that about 230 languages have fallen silent since 1950 [131]. The global distribution of this risk is uneven. Biocultural indices that combine linguistic, cultural and biological diversity identify tropical forest and island regions as zones of high joint diversity, and these are also the regions experiencing rapid land-use change [121,132]. At the same time, Indigenous lands are not peripheral. They span

about a quarter of the Earth's land surface and overlap a large fraction of its ecologically intact landscapes, as the spatial studies in Table 2 show [125,126]. The global assessment of biodiversity and ecosystem services concluded that nature is generally declining less rapidly in lands managed by Indigenous peoples and local communities, though it is also declining there, and that these lands are under increasing pressure [133,134].

The relationship between knowledge and the environment is bidirectional. Where land is lost or fragmented, the practices that depend on it cannot be transmitted, and where knowledge is lost, the management practices that maintain biodiversity are no longer applied. Work on sacred groves in India illustrates the pattern, because culturally protected forest patches have historically served as conservation refugia and have been threatened when the beliefs and institutions supporting them weaken [5,135]. Contemporary environmental analyses in the supplied corpus address the pressures that now intensify this dynamic, including urban sprawl, flooding, climate-induced migration and the gendered contribution of women to environmental protection [58,112-114]. These records do not measure knowledge loss, but they document the environmental disruption within which loss occurs.

5. Related Research Reviews and Their Outputs

A defensible assessment of the field requires evaluating what existing reviews have concluded, how they were conducted, and where their outputs diverge. This section reviews eight bodies of review literature and states the output of each.

5.1 Reviews of knowledge loss and its drivers

The most direct review of the problem is the scientists' warning on threats to Indigenous and local knowledge systems. It integrates evidence from many regions and identifies the pressures of land dispossession, language loss, formal education systems that do not recognise local knowledge, market integration, and the lack of political recognition [124]. Its output is a consensus statement and a set of recommendations, not a pooled effect size, and its strength lies in breadth rather than in quantitative precision. A complementary review of global trends in local ecological knowledge concluded that change is widespread but heterogeneous, and warned against both romantic and fatalistic generalisations [18]. A synthesis of research on traditional ecological knowledge and global environmental change reviewed findings on how knowledge responds to environmental and social shifts and drew policy implications about the need to support community-level transmission and to avoid treating knowledge as a static resource [136]. Taken together, these reviews converge on the claim that loss is real and multi-causal, but they differ in how much weight they attribute to external pressure compared with internal cultural change.

5.2 Reviews linking language and knowledge

The review of linguistic, cultural and biological diversity traces the emergence of the biocultural diversity concept and concludes that the three domains are linked by co-evolutionary and co-threatening processes [10]. Book-length syntheses reached similar conclusions from linguistic evidence, arguing that the loss of a language entails the loss of a repertoire of knowledge, taxonomic categories, narrative forms and ways of reasoning that cannot simply be translated [33,137]. The empirical analysis of medicinal knowledge across languages added quantitative force, because it indicated that much medicinal knowledge is

unique to individual languages [11]. The educational critique advanced by Skutnabb-Kangas goes further and treats the suppression of minority languages in schooling as a form of cultural harm that has consequences for knowledge transmission [138]. The outputs of this group of reviews are consistent: language is the most reliable single indicator of knowledge vulnerability.

5.3 Reviews of Indigenous stewardship and conservation outcomes

Reviews of the contribution of Indigenous and local communities to conservation find that their lands and management systems are associated with comparable or better ecological outcomes than many formal protected areas, while also warning that outcomes depend on rights, governance and the integrity of local institutions [127,139,140]. A review of Indigenous biocultural knowledge in Australian ecosystem management documented the practical contribution of such knowledge to land and sea management and noted the barriers to its integration with scientific frameworks [141]. A review of contributions to ecological restoration argued that Indigenous and local practices offer both techniques and governance models for restoring degraded ecosystems [142]. These reviews have a distinct output, a policy claim that custodianship is effective conservation, and they directly link knowledge retention to environmental outcomes.

5.4 Reviews of knowledge integration and multiple evidence bases

Several reviews address how different knowledge systems can be brought into dialogue. The multiple evidence base approach proposes that Indigenous and local knowledge and science be treated as parallel, complementary systems that contribute to shared assessment, not as sources to be converted into a single scientific format [143]. The assessment methodology developed for the global biodiversity assessment elaborates principles for working with Indigenous, local and scientific knowledge and has become a reference for institutional practice [144]. A concise policy commentary argued that integration should recognise the contexts and protocols of Indigenous knowledge holders and warned of tokenism [145]. A comparative reflection on the relationship between Western science and traditional knowledge argued that each can learn from the other when differences are acknowledged [146]. Broader reviews of locally based knowledge, values and practices for nature identified common principles across regions and emphasised that knowledge is not a commodity but a relational system [147]. The output of this literature is methodological, specifically a set of principles for equitable co-production of knowledge.

5.5 Reviews in health and food systems

Reviews of traditional food systems found that dietary change among Indigenous peoples toward market-sourced foods was associated with nutritional and health consequences as well as with the erosion of food knowledge and cultural practice [148,149]. A review of the value of plants used in traditional medicine for drug discovery argued that ethnomedical information improves the efficiency of identifying bioactive compounds [150], and a later review of natural products as drug sources showed their continuing significance in therapeutic development [129]. The global survey of traditional and complementary medicine documented the breadth of national policies and the scale of use [128]. In South Asian contexts, the supplied corpus contributes studies that examine Ayurvedic constitutional typology in relation to yogic practice, the sattvic principles of traditional diet in relation to nutritional science, and yoga in

relation to depression, cardiovascular health, stress and immune function [15,59,70,75,80]. The output of the health literature is therefore twofold: evidence of the therapeutic value of traditional knowledge and evidence that this value is realised only when knowledge, practitioners and biodiversity remain available.

5.6 Reviews of digital and algorithmic inequality

Reviews of language technology have found a stark imbalance in the languages that receive computational attention, and have argued that the resulting inequality in digital capability will deepen existing marginalisation [7,8]. A critique of the field has called for decolonising speech and language technology by shifting from extraction toward community-led design [151]. Work on large language models has warned that scale-oriented training practices amplify dominant-language and dominant-culture perspectives and impose environmental and social costs [9]. In parallel, work on Indigenous data governance has produced frameworks for control over data, such as the CARE principles, and an Indigenous-led position paper on artificial intelligence has articulated protocols for relationships between Indigenous communities and technology developers [47,152,153]. Studies in the supplied corpus on algorithmic bias, invisibility, digital displacement and the governance of digital sovereignty belong to the same family of concerns, although they address different populations [26-29]. The consistent output is that technological inclusion without governance reproduces extraction.

5.7 Reviews of intellectual property and benefit sharing

Analyses of intellectual property and traditional knowledge argue that conventional regimes, which reward novelty and individual authorship, are structurally mismatched with collective, intergenerational knowledge, and that this mismatch facilitates misappropriation [154,155]. International instruments have responded. The Convention for the Safeguarding of the Intangible Cultural Heritage established an international framework for the recognition of living traditions [156]. The Nagoya Protocol set out rules for access to genetic resources and fair sharing of benefits [157], the United Nations Declaration on the Rights of Indigenous Peoples affirmed rights to maintain, control and protect cultural heritage and traditional knowledge [158], and the 2024 treaty adopted under the World Intellectual Property Organization introduced disclosure requirements for patents that rely on genetic resources and associated traditional knowledge [159]. The output of this literature is normative and legal, and its gap is implementation.

5.8 Reviews of education and policy

Reviews of Indigenous knowledge in education argue that sustainable development agendas cannot be achieved without recognising local knowledge in curricula and learning, and that the integration of knowledge systems requires a philosophy of articulation, not assimilation [160,161]. In the Indian context, the supplied corpus contains extensive analyses of the National Education Policy 2020, including its sociological implications for equity, identity and social stratification, and critical assessments of its drawbacks [98,103,111]. A separate group of studies analyses national accreditation and quality assurance frameworks, including their outcome-based orientation and their effects on academic quality and research [100-102,105,106,108]. Historical work on missionary education in southern Travancore documents an earlier episode in which a new educational system reshaped local knowledge transmission [97]. These studies do not test the effect of such systems on Indigenous knowledge retention,

but they describe the institutional channels, namely curriculum, assessment standards and accreditation indicators, through which knowledge is validated or overlooked. The analytical implication is that quality standards set at national scale can marginalise local knowledge if they lack indicators for it.

5.9 Synthesis of the review literature

Across the reviewed bodies of work, five convergent outputs can be stated. First, loss is real, measurable and multi-causal. Second, language is the strongest correlate of vulnerability. Third, Indigenous stewardship yields conservation and health value, which means that loss has external costs. Fourth, integration is feasible only under conditions of equity and community control. Fifth, digital and legal systems can either accelerate or mitigate loss depending on who governs them. Two divergences also appear. Reviews in ecology and linguistics tend to emphasise external pressure and irreversibility, whereas reviews in anthropology and education often emphasise adaptation and agency. The next section examines these perspectives in more detail.

6. Analysis from Different Perspectives

6.1 The ecological perspective

From an ecological standpoint, knowledge loss matters because local knowledge is a functional component of social-ecological systems. Berkes and colleagues argued that traditional ecological knowledge provides feedback-based management practices, including rotational harvesting, taboos, seasonal restrictions and monitoring of ecosystem change, that function as adaptive management [4]. Community-based conservation studies add that the effectiveness of local institutions depends on the continued vitality of knowledge and norms [162]. Local indicators of climate change, such as shifts in phenology and species distributions noticed by resource users, provide fine-grained observation that is often absent in instrument records [6,163]. The ecological reality exposed is therefore that the loss of knowledge reduces the information base and the institutional capacity available for responding to environmental change. The scale of environmental stress documented in the corpus, for instance the analyses of flood dynamics, socio-economic vulnerability and adaptation strategies in Asian countries, indicates that communities with weakened local knowledge will be less able to draw on inherited adaptive repertoires [112,115-117]. This is an inference from combining the two literatures, and direct evidence remains to be generated.

A cautionary note applies. Indigenous custodianship does not guarantee ecological harmony, and some local practices have been associated with resource depletion. The better-supported claim is that Indigenous and local management is frequently as effective as formal protection and is more socially legitimate where rights are secure [139,140]. The conservation case for knowledge retention should therefore be framed as one of recognising rights and supporting institutions, not as an assertion that tradition is inherently sustainable.

6.2 The linguistic and cultural perspective

The linguistic perspective identifies language as the infrastructure of knowledge. When a language is displaced, vocabulary for plants, animals, kinship, weather and ritual is lost, and so is the narrative and ethical repertoire encoded in proverbs and stories. The finding that

medicinal knowledge is overwhelmingly language-specific indicates that this loss cannot be remedied by translating a subset of terms into a dominant language [11]. Predictive modelling of endangerment suggests that without intervention the number of endangered languages will rise steeply, and that infrastructure and socio-economic change are central drivers [122].

The sociological scholarship in the supplied corpus examines related processes in India, where language, sanskar and culture are treated as interdependent. Studies of the sociological significance of sanskar for the development of language and culture, and of the sociological dimensions of culture and socialisation, emphasise that values are reproduced through family and community practice and are susceptible to institutional change [38-40]. Analyses of Gandhian life values and Gandhi's approach to education with reference to morality and life skills provide a normative counterpoint, because they present an indigenous educational philosophy that places ethical and practical formation at the centre of learning [56,57]. Work on Sanskrit as a vehicle for preserving yogic knowledge and on the guru-shishya tradition as a mechanism for authentic transmission locates a living example of the language-knowledge relationship, in which precision of terminology and the teacher-student bond serve as safeguards of fidelity [13,14]. A distinctive feature of such systems is that their transmission is explicitly institutionalised, which contrasts with many orally transmitted systems where transmission is embedded in everyday life and therefore more exposed to disruption by schooling and migration.

6.3 The epistemological and decolonial perspective

The epistemological perspective contends that the primary problem is not the absence of knowledge but its disqualification. The critique of colonial research methods and the concept of epistemicide describe a long history in which Indigenous knowledge was classified as superstition, folklore or raw data to be processed by science [34,35]. The notion of epistemic injustice clarifies why the harm is not only material, because it concerns the denial of credibility to knowers [36]. The cultural interface framework argues that a productive relationship must acknowledge the specificity of both systems [37].

Sociological work on decolonising sociology argues for the rewriting of sociological theory in light of Indigenous epistemologies, a move that aligns disciplinary change with the epistemic argument [16]. Studies of Jnana yoga and epistemology, of Vedantic and Samkhya philosophical foundations, and of the epistemic structure of the Yoga Sutras illustrate that South Asian traditions possess articulated theories of knowledge, perception and mind, which contest the assumption that non-Western knowledge systems are merely practical [21,22,55,69,72]. This matters for the analysis, because a tradition that has its own epistemology cannot be adequately evaluated using only the criteria of another. Comparative work on mindfulness in yoga and Buddhist meditation, and on Buddhist philosophy as a tool for mind management, similarly demonstrates how contemplative traditions can be examined both on their own terms and through neuroscience [60,79].

An important tension remains. Translating traditional practice into biomedical language increases legitimacy in the technical world but risks narrowing the tradition to what instruments can measure. Studies that connect yoga with neuroplasticity, telomere length, the vagus nerve and the chemical balance of respiration are valuable demonstrations of a bridge, yet they also show the pattern identified by Scott, in which the legible aspects of practice are retained while its contextual and ethical dimensions recede [25,65,66,68,73]. The corpus itself contains a

corrective, because it also includes work on the ethical foundations of yoga in dharma, the role of karma yoga in social action, and the metaphysical framework of practice [22,24,76]. The reality exposed is that scientific validation can be a route to survival and a route to reduction at the same time.

6.4 The health and biomedical perspective

From a health perspective, the loss of traditional knowledge has measurable opportunity costs. Natural products and their derivatives have been a major source of therapeutic agents, and the discovery of artemisinin from a traditional Chinese medicine text illustrates how documented traditional practice can yield a first-line antimalarial [129,130]. Ethnomedical information improves the efficiency of selecting plants for investigation, which makes the knowledge itself, and not only the plants, a resource [150]. The finding that medicinal knowledge is concentrated in single languages implies that language loss reduces the discoverable pharmacopoeia [11]. At the population level, the transition from traditional to market-based diets among Indigenous peoples has been associated with adverse nutritional outcomes, which indicates that food knowledge loss has a direct health effect [148,149].

Traditional health knowledge is not only a source of molecules. It is also a source of practices, such as breathing, posture, diet, contemplative discipline and constitution-based lifestyle, that are increasingly studied for health outcomes. The corpus includes studies that examine yogic breathing in relation to respiratory chemistry, yoga in relation to cardiovascular health, depression, stress and immune function, and traditional dietary principles in relation to modern nutrition [59,70,73,75,80]. A caution is warranted. Titles alone do not indicate study quality, and the evidence base for any specific claim must be assessed from the full texts. The analytical point is the structural one, that traditional health knowledge persists in the technical world primarily when it has been adapted to institutional research and clinical frameworks, which implies that knowledge systems lacking such translation are more vulnerable.

6.5 The technological and digital perspective

The technological perspective is the most direct test of the question posed in the title. Digital systems affect Indigenous and local knowledge through three mechanisms. The first is representation. Languages that lack digital resources are less able to participate in search, translation, speech recognition and generative systems, and the evidence suggests that the large majority of languages are effectively invisible to language technology [7,8]. The second is mediation. Social media, streaming and gaming platforms occupy attention and time that might otherwise be used for intergenerational transmission. Studies of digital dopamine and doomscrolling, which examine the neuropsychology of social media use and mental fatigue, indicate the scale of attention capture, although they concern different populations and outcomes [84,86]. Studies of digital minimalism as social resistance document counter-movements that seek to reclaim attention and community [83]. The third is governance. Data about Indigenous communities may be collected, commodified and used without consent, and the question of who owns, controls and accesses knowledge in digital form is therefore central [47,164].

The corpus provides a series of studies of digital culture whose relevance lies in their analysis of identity and belonging. Work on memes as cultural capital shows how digital communities generate identity and resistance through shared symbols [85]. Analyses of influencer culture

and neoliberal identity examine self-branding as a mode of identity formation under platform capitalism [88]. A study of the weaponisation of nostalgia examines how pop culture and national identity are mobilised for political ends, a process that is relevant for understanding how traditions can be selectively invoked, simplified and instrumentalised [90]. Studies of the changing value of art in a post-digital economy, of artistic authorship under generative systems, and of literature in the digital age raise comparable questions about authorship, authenticity and cultural value, which are also questions about collective, anonymous and intergenerational authorship in traditional arts [82,94,96]. Studies of digital displacement in technology hubs, smart cities and spatial justice, remote work and social capital, platform labour and the gig economy, and quiet quitting examine how work and urban form change community life [26,27,87,91,93,95]. These records are not about Indigenous knowledge, but they document the destabilisation of the community structures within which transmission occurs. A final cluster examining invisible domestic labour, post-pandemic intimacy and family dynamics, and the broader effects of automation on household life identifies changes in the sites of intergenerational contact [89,92].

The perspective is not wholly pessimistic. Digital tools have been used by Indigenous communities for archiving, language teaching and community governance, and an Indigenous-designed content management approach has demonstrated that digital archives can embed community protocols for access [164]. The position that technology is neutral is untenable, but so is the position that it is inevitably destructive. The decisive variable is governance. Indigenous data sovereignty frameworks assert collective rights over data and prescribe responsibilities, ethics and benefit for communities [47,153], and Indigenous-led protocols for artificial intelligence emphasise relationality, reciprocity and consent [152]. The reality exposed is that digital technology produces loss when it is deployed as an extractive and homogenising infrastructure, and may support retention when communities hold decision-making power.

6.6 The educational and policy perspective

Formal education is simultaneously a threat and a potential ally. The evidence from studies of knowledge loss indicates that time in formal schooling is associated with reduced acquisition of traditional skills where curricula do not include them and where instruction occurs in a dominant language [12,31]. The linguistic critique of education reinforces the point [138]. Yet curricula can also be redesigned to incorporate local knowledge, and the sustainable development literature argues that such integration is necessary for relevance and equity [160,161].

In India, the National Education Policy 2020 articulates an aim of rooting education in Indian knowledge traditions, languages and values. The corpus includes mixed-methods and empirical analyses of awareness, attitudes and social stratification under the policy, studies of its equity, identity and structural implications, and a critical analysis of its educational drawbacks [98,103,111]. Taken together, these treatments suggest that policy intent and implementation outcomes may diverge, and that effects on social stratification require attention. Analyses of educational disparities, which examine structural inequities, legislative frameworks and reform needs, complement this literature [109]. A separate body of work evaluates the national quality assurance and accreditation system in higher education, covering strategic planning, outcome-based education, research and innovation, student learning outcomes and the effectiveness of accreditation [100-102,105-108,110]. The relevance to the present question is indirect and

inferential. Accreditation frameworks specify the indicators by which institutions are evaluated, and indicators shape institutional priorities. Where indicators do not recognise Indigenous or local knowledge, institutions have limited incentive to teach, document or research it. This inference should be tested empirically by examining whether any indicator in such frameworks addresses local knowledge.

The historical case of missionary education in southern Travancore is instructive for a different reason. It shows that educational systems introduced from outside can transform access to opportunity while also reorganising the transmission of local culture, and that the effects are ambivalent [97]. Contemporary technology-led educational initiatives, including large corporate programmes for educational upliftment, and corporate learning and development ecosystems, represent a similar pattern in which a technical system defines the content and format of learning [99,104]. The reality exposed is that education systems are the single most consequential institutional channel, and that the presence or absence of local knowledge in assessment frameworks may be a stronger determinant of retention than the stated aims of policy.

6.7 The socio-economic and legal perspective

The socio-economic perspective emphasises that knowledge loss is correlated with changes in livelihood. When households move from land-based subsistence to wage labour, the occupational context of knowledge disappears. Studies of the gig economy, platform poverty and worker identity examine precarity in contemporary labour markets, which indicates that the dominant alternative to traditional livelihoods is not always stable and may not provide the cultural continuity that communities seek [27,91]. Environmental pressures such as flooding, urban sprawl and climate-induced migration displace communities from place-based knowledge settings, and migration breaks the chain between elders and youth [113-116]. The analysis of climate anxiety and youth activism across cultures further indicates that younger generations are mobilising around environmental futures, which may create openings for knowledge exchange between generations [119]. The contribution of women to environmental conservation in the global setting is relevant here because women are frequently the custodians of seed, food, medicinal and domestic knowledge [58]. This claim is supported by the broader ethnobiological literature on gendered knowledge and by the study of knowledge transmission among Cree women [31].

The legal perspective stresses misappropriation. The documented history of biopiracy, in which knowledge held by communities is patented by outsiders, illustrates the extraction channel [154,155]. The normative response has included disclosure and benefit-sharing regimes [157,159], and rights frameworks for cultural heritage and for Indigenous peoples [156,158]. A common limitation across these instruments is that they protect knowledge largely as property or heritage, and may not secure the conditions of transmission, namely time, land, language and teacher-learner relationships. The legal reality exposed is that formal protection and living continuity are different goals.

6.8 The psychological and identity perspective

Identity is both a consequence and a driver of knowledge loss. When a tradition is stigmatised, members may withdraw from transmitting it, and when it is valorised, members may re-engage. Studies in the corpus on contemplative traditions and mental health, including Raja yoga and

psychological development, Bhakti yoga in digital communities and mindfulness in comparative neuroscience, indicate a growing interest in the psychological functions of traditional practice [71,77,79]. The analysis of Bhakti practice in virtual communities is especially relevant to the debate, because it suggests that devotional traditions can adapt to digital environments while changing their social form [77]. This is an example of transformation, not simple loss. A traditional practice that moves online may maintain its content, although it may lose the embodied, co-present and place-bound dimensions that previously structured it. The relevant question is therefore not whether a tradition survives, but which of its functions survive.

6.9 The counter-perspective: change, adaptation and the risk of romanticism

A rigorous analysis must engage the strongest counter-argument. Cultures have always changed, and knowledge systems have always been revised through contact, trade and innovation. The concept of tradition as a fixed inheritance is itself a modern construction, and a rhetoric of loss may freeze communities in an imagined past and deny them the agency to adopt new technologies. The review of local ecological knowledge trends reported heterogeneity, with decline in many contexts and persistence or change in others, which supports this caution [18]. The dismantling of the binary between Indigenous and scientific knowledge likewise cautions against treating either as a bounded, unchanging entity [2]. The study of nostalgia as political mythmaking in the corpus adds a related warning that invocations of tradition can serve contemporary political projects [90].

The counter-perspective is valuable, but it does not dissolve the problem. Three arguments limit its force. First, the rate matters. Evidence that knowledge measurably declines within a few years in a society undergoing rapid change indicates a process faster than normal cultural turnover [12]. Second, irreversibility matters. When knowledge held in a single language is lost, there is no alternative repository from which it can be recovered [11,123]. Third, agency matters. The relevant distinction is between change chosen by a community and change imposed through unequal institutions, and the evidence reviewed suggests that much of the present loss belongs to the second category. The defensible position is that loss should be evaluated by the degree of community control over change, not by the mere fact of change.

6.10 Comparative synthesis across perspectives

The first seven perspectives differ in how they define the problem and in the remedy they favour. The ecological perspective defines it as reduced adaptive capacity of social-ecological systems, driven by land loss and institutional weakening, and favours secure rights and support for local institutions. The linguistic and cultural perspective defines it as erosion of the carrier of knowledge through language shift and schooling, and favours language revitalisation and intergenerational use. The epistemological and decolonial perspective defines it as the disqualification of knowers through hierarchies of validity, and favours epistemic parity and community-led method. The health and biomedical perspective defines it as loss of therapeutic and nutritional resources through language loss, diet change and habitat loss, and favours documentation under community control and ethical bioprospecting. The technological and digital perspective defines it as exclusion and extraction through representation gaps, attention capture and data capture, and favours Indigenous data sovereignty and community-led design. The educational and policy perspective defines it as the absence of local knowledge from curricula and standards, and favours inclusive indicators and mother-tongue instruction. The

socio-economic and legal perspective defines it as livelihood change and misappropriation, and favours benefit-sharing, disclosure and rights frameworks. The psychological perspective cuts across all of these by asking which functions of a tradition survive a change of form.

This comparison shows that the perspectives are complementary and that no single remedy suffices. It also shows that the remedies share a common structure, namely that they transfer authority to communities over the conditions of knowledge transmission.

6.11 Regional comparison

Comparing regions clarifies which findings travel and which do not. In the Amazon, the quantitative evidence concerns the speed of change, because panel data from a single society show that knowledge can decline measurably over a short period when schooling, market contact and wage opportunities expand together [12]. Earlier work among the Piaroa of Venezuela had already linked acculturation to ethnobotanical knowledge loss and drawn attention to the demographic and evolutionary conditions under which skills are or are not reproduced [165]. In subarctic North America, the central variable is access to land and to the opportunity to learn from experienced elders, and the Cree evidence shows that transmission is fragile when that opportunity is displaced by other time commitments [31]. In Australia, the literature emphasises the practical value of biocultural knowledge for land and sea management and the institutional barriers that keep it at the margins of formal ecosystem science [141]. In the tropical forests of Asia, Africa and Latin America, spatial analyses suggest that Indigenous lands are associated with lower rates of forest loss, which ties the retention of custodial practice to a global environmental benefit [126,127].

South Asia presents a different configuration. India combines very high linguistic and cultural diversity with a long tradition of codified knowledge, an extensive formal education system, a large digital population and acute environmental pressure. Sacred groves, for example, document an older local conservation institution whose persistence depends on belief and community management [135]. The supplied corpus adds a contemporary layer, with studies of yogic and Ayurvedic knowledge, of Sanskrit and the guru-shishya tradition, of sociological processes of cultural reproduction, and of environmental stress in Asian countries [13-15,39,112]. The comparison with the Amazonian and Arctic cases suggests that South Asian traditions with institutional anchors, such as texts, teachers and lineages, may have more channels for survival, whereas local ecological and artisanal knowledge without such anchors may be as exposed as in other regions. This is a hypothesis, and testing it would require direct measurement in Indian communities.

Africa, the Pacific and the Arctic are under-represented in the evidence assembled here, which is itself a finding about the geography of research attention. The scientists' warning draws on a wider range of regions and stresses that the drivers are global, although their local expression varies [124,147]. A cautious conclusion is that the four channels operate everywhere, but that their relative weight differs: schooling and market integration dominate in the Amazon and the Arctic, institutional validation in India, intellectual property in biodiversity-rich regions, and digital exclusion in all of them.

6.12 Cross-stream triangulation

The two evidence streams can be read against each other. Stream B shows that loss is measurable, language-linked and consequential. Stream A shows how a large cluster of contemporary scholarship frames the same landscape through traditional practice, cultural reproduction, digital change and policy. Three points of convergence emerge. Both streams treat language and teacher-learner relationships as carriers of knowledge [13,14,33]. Both treat education and institutional recognition as decisive [98,101,138]. Both identify digital systems as a site of risk and opportunity [8,28,29]. Two points of divergence also emerge. Stream B is dominated by empirical measurement of knowledge held by Indigenous and local communities, whereas Stream A is dominated by interpretive and doctrinal analysis of codified traditions and by sociological analysis of digital life. Stream B centres Indigenous peoples as knowledge holders and research partners, whereas Stream A treats tradition more broadly as a cultural heritage of a national society. These differences reflect different research purposes, and they argue for a research design in which interpretive and measurement approaches are combined.

7. Discussion

7.1 What the evidence exposes

Four conclusions follow from the combined analysis. First, the loss of Indigenous knowledge in the technical world is demonstrable and not merely asserted. The most robust quantitative evidence comes from the comparative stream, particularly the study showing measurable loss within a short period, the analysis showing that medicinal knowledge is concentrated in single languages, and the global modelling of language endangerment [11,12,122]. Second, the supplied corpus does not itself generate such evidence. Its distinctive contribution is to document living traditions that are being actively translated, taught and reinterpreted in contemporary India, and to analyse the digital, educational and environmental conditions within which they operate [13,14,26,103]. This is valuable comparative material, since it shows that traditions with codified texts, specialised language and formal teacher-student structures are developing strategies of adaptation that orally transmitted traditions often lack.

Third, the corpus displays a structural feature that must be stated plainly. Almost all included records share a common author, and a small number of venues account for most of them. This pattern is not a defect in the underlying scholarship, but it limits the diversity of perspective in the corpus and the independence of its evidence. A review that relied on this corpus alone would reproduce a single research programme's framing. This is the reason why the comparative stream is indispensable, and why the integration of independent sources is a condition of credibility.

Fourth, the evidence shows an asymmetry between what is studied and what is lost. The corpus is rich on traditional practices that have a prestigious textual and institutional base, such as yoga, and thin on direct measurement of the loss of everyday local knowledge among communities without such a base. Only six of 86 included records addressed language, culture and epistemology directly, and none measured loss empirically at the level of titles. This is an evidence gap, and it implies that tradition systems with the strongest institutional support are best documented while the most vulnerable are least documented.

7.2 The four-channel model revisited

The analysis supports all four channels but with differing strength. The displacement of transmission time is best supported by the empirical evidence on schooling, wage labour and the effect of on-land experience on skill acquisition [12,31]. Epistemic devaluation is supported by the theoretical literature and by the pattern in which traditions seek legitimacy through biomedical translation [35,36,66,68]. Extraction is well documented in the legal and ethnobotanical literature [154,155]. Digital exclusion has the most direct quantitative support in the language technology literature but the least support in studies of actual knowledge retention, and this is a priority for research [7,8]. The channels interact. For example, language shift reduces the capacity to resist devaluation, and digital exclusion amplifies the effect of educational displacement.

7.3 Comparative reading: oral, codified and digital traditions

A comparative reading of the evidence yields a typology of vulnerability. Orally transmitted, place-bound knowledge, such as local ecological and medicinal knowledge, is the most vulnerable, because it depends on continuous contact between generations, a particular language and access to land [11,31]. Codified traditions with textual canons and formal teacher lineages, exemplified in the corpus by yogic and Vedantic systems, are more resilient to some forms of disruption but face the risks of reduction, commodification and decontextualisation [13,21,62,78]. Digital-native cultures, such as meme communities and online devotional groups, show rapid innovation and rapid change, and their knowledge is vulnerable to platform dependency [77,85]. Each form is exposed to a different channel of loss, and each requires a different strategy.

The comparison also nuances the claim that technology is the cause. Evidence from the Hatha yoga tradition, which has been analysed as an evolution from tantric origins to a global phenomenon, shows that a tradition may be transformed and globalised through modern channels while being altered in emphasis, content and social meaning [62,78]. Whether this is loss, adaptation or both depends on the criterion applied. By the criterion of continuity of practice, it is survival, and by the criterion of continuity of meaning and context, it is partial loss. The analysis therefore recommends that evaluations specify their criterion explicitly.

7.4 Reflexivity on the evidence base

A review of this kind must examine its own evidence critically. The first issue is independence. When a body of work is produced by a small number of authors and published in a small number of venues, convergence among its records cannot be treated as independent confirmation, and the weight given to its claims should be adjusted accordingly. The second issue is the relationship between breadth and depth. Several records in the corpus are large, multi-dimensional analyses, and others are short conceptual essays, yet title-level screening treats them identically. The third issue is the difference between a tradition and the research about it. A large number of studies of yoga does not show that the underlying knowledge is secure, because scholarly attention may even accompany commodification [62,67,78]. The fourth issue is voice. The strongest ethical position in this field is that communities should be partners and not only subjects, and that outputs should be accountable to them [34,47]. Many records in the corpus are analyses by academic authors of traditions, texts and social processes, and the extent to which community custodians participated in their design cannot be determined

from titles. These reflections do not weaken the conclusions about the existence of loss, which rest mainly on the independent comparative stream, but they qualify the conclusions about how loss is being understood and addressed.

The reflexive analysis also clarifies a methodological lesson. A transparent screening process makes the structure of an evidence base visible, including its concentration, its gaps and its silences. In this case the screening shows that the apparatus of scholarship on tradition is considerably larger than the apparatus of measurement of loss. That imbalance is a research finding in its own right, because policy that relies on interpretive scholarship alone will lack the quantitative baselines needed to judge whether any intervention is working [18,44,124].

8. Implications for Policy and Practice

Five implications follow, each tied to the evidence reviewed.

Support transmission, not only documentation. Documentation preserves records but does not reproduce practice. Resources should prioritise the conditions of transmission, namely time on the land, intergenerational contact, language use in homes and schools, and the economic viability of knowledge-based livelihoods [31,32,166]. The International Decade of Indigenous Languages provides an international frame for such action [166].

Recognise knowledge in educational standards. Curricula, assessment frameworks and accreditation indicators should include explicit provision for local knowledge, taught in mother tongues where possible, and should be evaluated for their effects on retention [101,103,160,161]. In India, where national policy emphasises the integration of Indian knowledge traditions, empirical monitoring of how that aim is implemented is a priority [98,111].

Establish Indigenous data sovereignty. Digital documentation and artificial intelligence applications should be governed by community-controlled protocols consistent with the CARE principles, and developers of language technology should adopt community-led approaches [47,151,152]. Digital archives should be designed to embed community-defined access rules [164].

Reform benefit-sharing and disclosure. The new international disclosure requirements and the Nagoya framework should be implemented with national mechanisms that ensure communities share in benefits and can contest misappropriation [154,157,159].

Treat knowledge integration as co-production. Institutions that use Indigenous and local knowledge in assessment, conservation or health programmes should apply principles of parity and consent, and avoid reducing knowledge to data inputs [143-145]. For traditions that pursue biomedical validation, validation should be pursued alongside, not instead of, preservation of ethical and contextual dimensions [24,67,76].

8.1 Priority research agenda

The review identifies five research priorities. The first is longitudinal measurement of knowledge retention across generations in a range of regions, using comparable instruments so that rates of change can be compared [12,18]. The second is direct testing of the relationship

between formal education indicators and local knowledge outcomes, including a systematic content analysis of national curricula and accreditation frameworks for the presence of local knowledge indicators [98,100,102,105]. The third is empirical evaluation of digital interventions, including community-governed archives, language applications and speech technology, against measures of use and intergenerational transfer and not merely of content volume [151,164]. The fourth is comparative study of codified and oral traditions, so that the apparent resilience of institutionally anchored systems can be tested rather than assumed [13,30,69]. The fifth is full-text appraisal and quality grading of studies that translate traditional practice into clinical and physiological frames, so that the evidence for specific claims is clearly separated from the cultural prestige of the tradition [65,70,75,80]. A research programme that addresses these priorities would address the main gaps identified in this review and would reduce dependence on a narrow range of venues and authors.

9. Limitations

The study has limitations that qualify its conclusions. The scoping review applied to a supplied corpus rather than a database search, so it maps the corpus and not the global literature. Screening was at the level of titles and venues, and full-text appraisal was not performed, which means that thematic classification may misrepresent the content of some records and that no judgment can be made about the quality of individual studies. Consistent with scoping methodology, no formal risk-of-bias assessment was undertaken [41,42]. The corpus is concentrated in a small number of venues and authors, and 2025 publications dominate, which limits independence and temporal range. The comparative evidence set was assembled purposively, and numerical details drawn from it should be verified against the original sources before reuse. Table 2 summarises findings in condensed form, and the qualifications in the original papers are necessarily lost. The thematic assignment was exclusive, but many records straddle categories. Finally, the evidence is dominated by studies from Latin America, North America, Australia and South Asia, and under-represents Africa, the Pacific and the Arctic, where knowledge systems are equally at risk.

10. Conclusion

The loss of Indigenous knowledge and local traditions in the technical world is an empirical reality that is best understood as a product of institutional arrangements and not of technology in itself. Comparative research shows that knowledge declines measurably within a generation, that it is bound to language and to land, and that its loss imposes costs on ecosystems, health and cultural identity [11,12,125]. The mapping of 86 eligible records from the supplied corpus indicates that contemporary scholarship, particularly in South Asia, is vigorously analysing traditional knowledge systems and their interaction with digital, educational and environmental change, but that direct empirical measurement of loss remains rare [14,16,26,103].

The four-channel model proposed here offers a structure for further work. Displacement of transmission, epistemic devaluation, extraction and digital exclusion each have identifiable mechanisms, and each can be addressed through policy that transfers authority to communities. The most promising strategies share a common principle: communities must govern the conditions under which their knowledge is documented, taught, validated and used. Technology can serve this principle through community-controlled digital archives, language technology and data governance, but it cannot substitute for the social relationships through which knowledge is lived.

Future research should prioritise longitudinal measurement of knowledge retention across generations, evaluation of educational and accreditation indicators for local knowledge, and studies of the digital transformation of traditions that distinguish between the survival of practice and the survival of meaning. The question posed at the outset has an answer that is neither fatalistic nor complacent: much is being lost, but the pathways of loss are known, and so are the means of mitigating it.

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