

CONCEPTUAL

Towards Sustainable Hybrid Intelligence in Healthcare: Insights from Predictive AI Adoption in US Hospitals

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ABSTRACT

PURPOSE: This study aims to explore the adoption patterns of predictive Artificial Intelligence (AI) in the United States (US) and its impact on human-centric knowledge management in sustainable healthcare systems.

DESIGN/METHODOLOGY: This study conducts a conceptual interpretation of 2023–2024 data from the Office of the National Coordinator for Health Information Technology (ONC) hospital survey.

FINDINGS: Adoption of predictive AI has increased in the US hospitals, from 66% in 2023 to 71% in 2024, as predictive AI becomes more embedded in the healthcare sector. Yet large differences still exist between rural and urban hospitals. This study emphasised the growing significance of governance preparedness, ethical supervision, and mixed AI-human decision-making systems in the establishment of sustainable transformation of healthcare.

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ORIGINALITY/VALUE: The proposed Sustainable Hybrid Intelligence Framework for Healthcare is a novel contribution to the field, integrating predictive AI capabilities, governance oversight, organisational learning, and human-centric decision-making into a single analytical framework for sustainable healthcare transformation.

RESEARCH LIMITATIONS: The study focuses on data from the ONC Hospital Survey, which may limit generalisation.

PRACTICAL IMPLICATIONS: The findings imply that healthcare institutions adopting predictive AI will increasingly require governance-ready organisational structures capable of integrating algorithmic systems with human-centred clinical decision-making. The disparities in institutional readiness may influence the long-term sustainability and equity of predictive AI transformation across healthcare systems.

KEYWORDS: *Predictive Artificial Intelligence; Human-Centric AI; Sustainable Healthcare; Governance; Knowledge Management; Office of the National Coordinator for Health Information Technology.*

INTRODUCTION

The rapid adoption of predictive Artificial Intelligence (AI) technology is transforming healthcare delivery and patient-centric care in different healthcare systems (Aminabee, 2024). Hospitals and health systems have improved their analytical capabilities and are increasingly using predictive AI to assess clinical risks, prioritise clinical processes, monitor patient conditions, and inform evidence-based decision-making (Bhagat and Kanyal, 2024). This growing dependence, however, has raised concerns about ethical responsibility, human oversight, and sustainable governance of healthcare. This has led to a healthcare landscape that is increasingly defined by the responsiveness of machine-powered intelligence to clinical knowledge in the 21st century. Algorithmic systems are not sufficient for interpreting contexts, doing ethical evaluations, showing empathy, or using professional expertise in healthcare decision-making (Boussi Rahmouni *et al.*, 2025).

Predictive AI technology in hybrid healthcare intelligence systems functions as a supplement, helping to enable machine-generated predictions to support clinicians in their work, not replace them. According to Brescia *et al.* (2025), AI-driven knowledge management systems play a vital role in the overall organisation's learning, strategic planning, and long-term transformation of healthcare outcomes. However, the governance functions have a significant part in organisational development as demonstrated by the study undertaken by the Office of the National Coordinator for Health Information Technology (ONC) on urban and rural healthcare organisational settings.

This paper analyses evidence from the ONC 2023-2024 report on predictive AI adoption trends in hospitals to better understand how predictive AI systems drive sustainable change within the healthcare ecosystem, while ensuring appropriate ethical and human responsibility.

Research Questions (RQ)

RQ1: How do emerging trends in predictive AI adoption influence human-centric knowledge management within sustainable healthcare systems?

RQ2: To what extent do governance practices and human oversight mechanisms shape the sustainable and ethical integration of predictive AI in healthcare institutions?

Contribution of the Current Study

The study makes an original contribution by developing the Sustainable Hybrid Intelligence Framework, which emphasises the socio-technical dimension of the predictive AI transformation and is guided by the interplay among algorithmic systems, institutional governance, and human decision-making.

LITERATURE REVIEW

The literature emphasises the importance of predictive AI in healthcare delivery and highlights its role in human decision-making, upholding ethical standards and providing patient-centred care. Under the Healthcare 5.0 definition, AI is expected to complement healthcare personnel and promote collaborative decision-making processes (Boussi Rahmouni *et al.*, 2025; Hassan *et al.*, 2025). Cheungpasitporn *et al.* (2026) found that predictive AI significantly improves the accuracy of diagnoses, enhances patient care through improved monitoring and workflow efficiency, and enables healthcare providers to evaluate patient care risk in complex scenarios. These findings strengthen the validity of Human-Centric AI Theory and demonstrate that AI will complement human intelligence by enhancing it through its use in professional healthcare scenarios (Horvatić and Lipic, 2021). Human-centric AI approaches positively influence patients' trust and maximise the benefits of both technological advancement and human sensitivity, further optimising patient care. Overall, research on hybrid intelligence shows that using AI in collaboration with healthcare professionals yields better patient outcomes than using AI in competition with them (Derek and Watson, 2025).

Another indication that predictive AI is becoming increasingly popular is the importance of the Knowledge Management Theory, proposed by Nonaka and Takeuchi (1998). Conventionally, health institutions relied on tacit knowledge, clinical practice, and interpretations to make decisions (Van Houten, 2023). But with AI-based systems, the landscape of healthcare knowledge environments is being revolutionised as data analysis and predictive modelling become feasible and evidence-based organisational learning becomes possible. According to Brescia *et al.*

(2025) and Jankauskas *et al.* (2026), AI-driven knowledge management enhances organisational collaboration and decision-making. These authors further noted the growing role of AI in shaping cardiovascular medicine in data-rich environments that encompass electronic records, wearable devices, and electrocardiography. Also, the integration of AI has been shown to significantly impact cardiovascular imaging, heart failure management, acute coronary syndromes, and cardiac surgery. Finally, AI-based technological interventions can effectively detect subclinical diseases and improve individualised prevention strategies.

Recent studies continue to examine predictive AI through a sustainable healthcare systems approach, which highlights the need to maintain an equilibrium between rapid technological progress and ethical governance (Goktas and Grzybowski, 2025). Additionally, a study highlights that to make sustainable healthcare systems work, there is a need for adaptive governance structures, workforce preparedness, and ongoing organisational support, so healthcare innovations don't just appear briefly and then fade out (Lennox *et al.*, 2018). Furthermore, the sustainability discussion also touches on environmental responsibility because healthcare systems contribute to resource consumption and environmental pollution. So, it becomes necessary to pursue technologically efficient approaches that remain environmentally sustainable, rather than “efficiency- only” thinking. By bringing Human-Centric AI Theory together with Knowledge Management Theory and a sustainable healthcare systems approach, organisations can effectively adopt predictive AI, thereby supporting organisational learning, governance-mediated structures and sustainable healthcare.

RESEARCH METHODOLOGY

The study adopts a conceptual secondary data analysis using institutional data from the ONC (2025) data brief, ‘Hospital Trends in Use, Evaluation, and Governance of Predictive AI 2023-2024’ (<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>). The ONC’s brief is based on the American Hospital Association (AHA) Information Technology Supplement survey. It presents national-level compilations of: predictive AI adoption, hospital characteristics, governance structures, evaluation mechanisms, and monitoring practices. The relevant dataset was chosen to focus on institutional AI transformation and AI governance preparedness in the healthcare sector.

Research analysis is further supported by a literature synthesis to interpret predictive AI adoption trends and governance practices in the United States (US) hospitals. The methodological approach was selected to examine emerging trends in predictive AI adoption across US hospitals and their implications for human-centred knowledge management and sustainable healthcare transformation. Rather than treating the ONC (2025) data as purely statistical evidence, the study conducts a descriptive analysis of institutional adoption patterns, governance practices, and organisational transformation processes within broader socio-technical and sustainability contexts.

Conceptual Development

An iterative interpretive review process was employed to identify recurring organisational, governance, and human-centred themes across the literature and ONC institutional indicators:

- human oversight,
- organisational learning,
- ethical governance,
- trust and accountability,
- workforce augmentation,
- knowledge sharing practices, and
- sustainability readiness.

These concepts were grouped as shown in Table 1 into broader analytical themes that informed the interpretation of the ONC findings.

Table 1: Analytical Themes and Extracted Concepts from ONC (2025) Findings

<i>Extracted Concepts</i>	<i>Analytical Theme</i>
AI implementation growth, workflow integration	Predictive AI Adoption Maturity
Human oversight, accountability, and bias evaluation	Human-Centric AI Governance
Organisational learning, knowledge sharing	Knowledge Management Capability
Workforce support, clinician augmentation	Human-AI Collaboration
Long-term operational resilience	Sustainable Healthcare Transformation

Source: Compiled by authors from ONC (2025)

(<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>)

Themes were derived from the literature and institutional indicators and are not representative of a statistical analysis of the data. The ONC (2025) institutional indicators were thus used descriptively to support the conceptual interpretation of organisational transformation, preparedness for governance, and the development of hybrid intelligence in healthcare systems. The analytical process also led to the development of the Sustainable Hybrid Intelligence Framework for Healthcare. This framework combines predictive AI skills, governance oversight, human-AI collaboration, and organisational learning into a comprehensive blueprint of sustainable healthcare transformation.

ETHICAL STATEMENT

The study uses publicly available secondary data from the ONC (2025) report; therefore, no data privacy or ethical concerns are involved.

FINDINGS AND ANALYTICAL INTERPRETATION

Predictive AI Adoption Maturity

According to ONC (2025) data, as shown in Table 2, the hospital adoption rate of predictive AI systems increased from 66% in 2023 to 71% in 2024, representing an estimated 5% increase.

Table 2: Predictive AI Adoption Indicator 2023 vs 2024

Indicator	2023	2024	Derived Change
Predictive AI Adoption	66%	71%	+5% growth

Source: Compiled by authors from ONC (2025)
(<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>)

The results indicate a shift from experimental use of predictive AI tools to their integration into healthcare systems. While predictive AI tools are often viewed as standalone technologies, they are increasingly being integrated into clinical decision support, patient risk prediction, workflow process efficiencies, and administrative coordination. But as predictive AI is increasingly adopted, it could trigger broader challenges for healthcare digital transformation, such as risk management and handling vast amounts of clinical information. Analytical AI makes technology increasingly useful in generating a wealth of digital information, while predictive AI offers ways to transform that data into organisational intelligence for healthcare institutions (Zong and Guan, 2025). Hence, based on ONC’s findings, the current level of adoption among US hospitals increasingly reflects a transition from experimental adoption towards institutionalised predictive AI integration.

Institutional Disparities in AI Transformation (RQ1)

Another major takeaway from the ONC (2025) data is considerable variations in predictive AI adoption across hospital types, particularly between rural and urban hospitals. The difference in adoption rates between rural and urban hospitals, at 56% and 81%, respectively, was 25 percentage points, as shown in Table 3.

Table 3: Rural-Urban Adoption Gap

Hospital Type	Predictive AI Adoption (2024)	Rural-Urban Adoption Gap = 81-56 = 25 percentage points
Rural Hospitals (n=751)	56%	
Urban Hospitals (n=1329)	81%	

Source: Compiled by authors from ONC (2025)
(<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>)

The 25-percentage rural-urban adoption gap indicates that predictive AI systems in US hospitals are not uniformly implemented in healthcare institutions. AI solutions seem better suited to urban hospitals, which tend to have greater technological readiness for innovation, well-established electronic health record systems, and sufficient resources and institutional support.

Rural hospitals, on the other hand, could face constraints in infrastructure capacity, staffing, and access to technological investment. This finding directly addresses RQ1, indicating that healthcare transformation through predictive AI remains unevenly adopted.

This is similar to the situation for independent and system-affiliated hospitals in 2024, as shown in Table 4. The table compiles ONC (2025) data, showing that the predictive AI adoption ratio at system-affiliated hospitals was 86%, which outperformed the 37% at independent hospitals, yielding a ratio of 2.32.

Table 4: Affiliation Adoption Ratio

Hospital Category	Predictive AI Adoption (2024)	Affiliation adoption ratio = $86 \div 37 = 2.32$
Independent Hospitals	37%	
System-Affiliated Hospitals	86%	

Source: Compiled by authors from ONC (2025)

(<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>)

The gap indicates that the use of predictive AI cannot be attributed solely to the availability of technology but also to the concentration of institutional capabilities. Shared governance, central funding, organisational learning, and technological systems that support a large-scale rollout are all considered to be positively associated with hospitals' affiliation, making them more likely to benefit from AI adoption. Therefore, findings indicate that predictive AI transformation remains strongly influenced by the concentration of institutional capabilities and infrastructural readiness.

Governance Readiness and Ethical Oversight (RQ2)

The ONC (2025) data show that hospitals using predictive AI are establishing additional governance structures to assess system performance, monitor for bias, and oversee system operations at the organisational level. Three governance variables, i.e., accuracy evaluation, bias evaluation, and monitoring practices, were averaged to provide a composite indicator of governance readiness. The governance readiness score was calculated to be 78.3%, as shown in Table 5.

Table 5: Governance Variable

Governance Variable	Percentage	Governance Readiness Score = $(82+74+79) \div 3 = 78.3\%$
Accuracy Evaluation	82%	
Bias Evaluation	74%	
Monitoring Practices	79%	

Source: Compiled by authors from ONC (2025)

(<https://healthit.gov/data/data-briefs/hospital-trends-use-evaluation-and-governance-predictive-ai-2023-2024/>)

The results indicate that hospitals are aware of potential challenges in deploying predictive AI, including algorithmic bias, inaccurate predictions, and over-reliance on AI systems for decision-making. The Governance readiness score indicates that organisations are ready to adopt AI solutions

in their daily healthcare operations. However, clear formal governance policies are lacking, which makes AI implementation a significant challenge. As a result, hospitals and other healthcare institutions appear to hesitate to take further steps to implement responsible AI more deeply within their systems. The findings address RQ2 by demonstrating that sustainable AI integration depends not only on adoption but also on governance maturity.

In the human-centred approach, the increased focus on evaluation and monitoring practices helps ensure accountability and transparency, maintaining human oversight in AI-integrated healthcare delivery (Williamson and Prybutok, 2024). The outcomes also indicate that holistic AI transformation and integration rely on the capacity of healthcare organisations to instil a culture of continuous governance that fosters organisational trust and responsible innovation. Hence, readiness for governance is one of the most important aspects of sustainable, long-term transformational change in healthcare.

Human-AI Knowledge Dynamics

As predictive AI becomes increasingly institutionalised and embedded, the transition towards hybrid intelligence environments that extend beyond human judgment in decision-making continues. The transition towards predictive AI adoption represents not just technological adoption, but a restructured organisational knowledge system. The conceptual interpretation suggests that AI predictive systems play an important role as organisational knowledge intermediaries by transforming vast clinical information into predictive knowledge and insights that influence organisational coordination, risk assessment, and clinical prioritisation. Thus, the decision-making continuum in healthcare shifts, giving part of the power to algorithms and part to people. It is a manifestation of a wider shift, from tacit knowledge-dependent healthcare to data-driven knowledge management structures.

While predictive systems rely on correlations in historical data and modelling, it is the ethical judgement, situational interpretation, and patient-specific contextual understanding that healthcare professionals require. This means that while predictive accuracy can help inform clinical decisions, it is certainly not always sufficient in situations involving ethical dilemmas, social complexities, or unusual medical conditions. This transition reflects a broader epistemological shift in healthcare systems, in which algorithmic prediction increasingly coexists with professional judgement to shape organisational decision-making.

Sustainable Healthcare Transformation

Overall, the findings suggest that predictive AI implementation in US hospitals is beginning to shift from technology rollout to a process for institutional healthcare transformation. The growth in adoption, governance scope, and organisational gap implies that effective use of predictive AI will require a symbiotic relationship among the three capacities: technology, governance, and organisational capacity. It further aligns with Environmental, Social, and Governance (ESG)

principles in compliance with regulatory shifts and stakeholder demands (Capodagli *et al.*, 2025). From an ESG perspective, responsible AI promotes equitable access to digital health innovations and supports long-term organisational sustainability through ethically-informed decision-making.

An analytical interpretation of this transformation is introduced in this study through the human-centric institutional AI readiness perspective, which suggests that sustainable integration of AI is a function of three mutually intertwined factors: predictive AI adoption, governance readiness, and human-centred institutional oversight, as compiled in Table 6.

Table 6: Dimensions for Institutional Implications

<i>Dimension</i>	<i>Institutional Implication</i>
Predictive AI Adoption	Expansion of data-driven clinical and operational systems
Governance Readiness	Development of accountability and monitoring structures
Human Oversight	Preservation of ethical and contextual decision-making

Source: Compiled by authors

The study indicates that predictive AI can be more easily integrated into hospital workflows when supported by robust institutional resources and governance systems. By comparison, hospitals with weaker infrastructural and organisational capacities will undergo slower digital transformation, thus perpetuating inequities in digital healthcare development.

Notably, the findings show that technological change does not equate to sustainable transformation. While predictive AI can enhance efficiency and predictive power in operations, the sustainability of healthcare systems necessitates institutional structures that simultaneously foster transparency, trust in the system and ethical responsibility. This is why governance readiness becomes a key factor in ensuring the long-term sustainability of AI in healthcare institutions.

Table 7 summarises the analytical processes adopted to evaluate each research question.

Table 7: Analytical Process for RQs

<i>Research Question</i>	<i>Data Used</i>	<i>Analytical Method</i>	<i>Interpretation</i>
RQ1: How does predictive AI adoption influence sustainable healthcare transformation?	Adoption rates, rural-urban differences, and affiliation differences	Trend analysis and comparative analysis	Evaluates institutional transformation and organisational readiness
RQ2: What role do governance and oversight play in sustainable AI integration?	Accuracy evaluation, bias evaluation, and monitoring practices	Composite governance readiness score and thematic interpretation	Evaluates governance maturity and responsible AI implementation

Source: Compiled by authors

Sustainable Hybrid Intelligence Framework for Healthcare

The Sustainable Hybrid Intelligence Framework for Healthcare is proposed in this study, based on the ONC report, and a synthesis of literature around the concept of sustainable hybrid intelligence, as depicted in Figure 1. This framework elaborates on the integration of predictive AI in the healthcare

system and how to achieve human-centred governance, organisational accountability and long-term sustainability. The proposed framework introduces a new paradigm, dividing the predictive AI transformation process into four phases: technological competence, governance capabilities, human oversight, and organisational learning. Former research into predictive AI in healthcare has studied how AI is used, the ethics of using AI, and human-centred AI. Conversely, this approach provides a single analytical framework, built around the findings from the ONC dataset that capture these dimensions. The concept thus provides a more thorough understanding of the developed transition path of healthcare institutions towards sustainable hybrid intelligence systems.

In 2024, predictive AI's use was more pronounced than in 2023, with 71% of healthcare organisations reporting they used technology in their operations, versus 66% in 2023, which demonstrates its increasing use as it moves beyond clinical trials and pilot testing. The other readiness indicators of bias evaluation, monitoring and accuracy assessment also highlighted the increasing emphasis on ethical governance in AI applications in a healthcare context. In addition, the differences between the rural and urban areas, and between independent hospitals and system-affiliated hospitals, revealed that organisational skills, hospital infrastructure readiness, and institutional learning capacity play an important role in sustainable AI-driven transformation.

These results were all combined to show that transforming healthcare sustainably is not a simple technological uptake. Simply, predictive AI integration seems to rely on the interplay among institutional resources, governance, organisational learning systems, and human decision-making systems. The intended motivation behind this synthesis was thus to create a connecting framework that integrates all of these different dimensions and aspects into one connecting model of sustainable hybrid intelligence in healthcare.

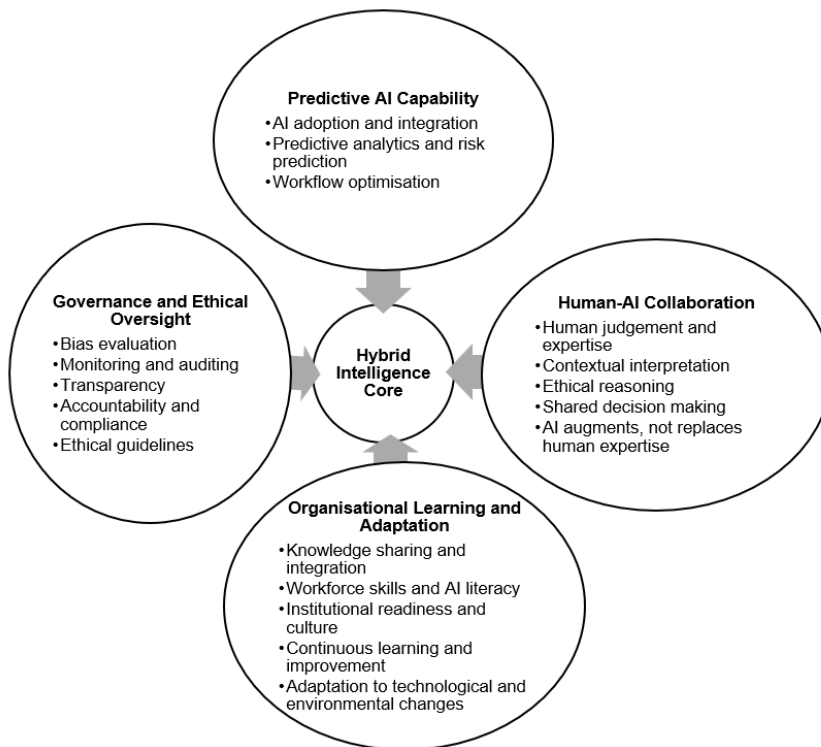


Figure 1: Sustainable Hybrid Intelligence Framework for Healthcare

Source: Constructed by authors

RECOMMENDATIONS

The study validates Knowledge Management Theory by highlighting the growing role of predictive AI in knowledge processes within organisations through data-driven decision systems. Further, Dumitriu (2024) suggests that knowledge management prevents waste of money, time and human resources. This leads to the conclusion that sustainable healthcare transformation is a socio-technical process that requires combining predictive capability, ethical governance, and human-centred organisational adaptation. To enhance AI governance, it is important for healthcare organisations to monitor AI usage regularly, conduct bias audits, and implement accountability mechanisms. Digital infrastructure enhancements in rural and resource-poor hospitals deserve policy support to minimise structural inequities in the use of AI. To effectively leverage human-AI partnerships, there is a need for AI literacy and preparedness among the workforce in the healthcare industry. Governance practices and structures must be action-oriented, incorporating technological capability in relation to sustainability and organisational learning goals.

LIMITATIONS

The study used aggregated secondary data from ONC, which hindered in-depth data-driven outcomes. In addition, this research was conducted with hospitals in the US, thereby affecting the generalisability of findings beyond the healthcare system.

Despite these limitations, this study provides a significant explanation of how sustainable healthcare systems can be led in reliance on human-AI partnerships and governance practices. Policymakers and future researchers can further explore this possibility in a pilot model based on primary research.

CONCLUSIONS

This research focused on trends in predictive AI adoption and the subsequent impacts on human-centric knowledge management in healthcare systems aimed at sustainability. The analysis highlights the growing adoption of predictive AI tools in healthcare settings within hybrid AI environments integrating human expertise. It also reveals that the sustainable predictive AI transformation approach is not only about technology but also requires governance readiness, organisational learning capability and constant human oversight to make it a reality. The Sustainable Hybrid Intelligence Framework for Healthcare contributes to the existing body of literature by combining predictive AI capabilities, governance oversight, human-AI collaboration, and sustainability perspectives in healthcare transformation. In conclusion, the research suggests that institutions play a critical role in ensuring the sustainable development of healthcare systems by balancing technological innovation with ethical responsibility, operational effectiveness, organisational strength, and human-centred decision-making.

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BIOGRAPHY



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Rahaman Hasan, PhD, is a Senior Lecturer at Canterbury Christ Church University. He specialised in Entrepreneurship during his PhD from the University of Essex, UK. Rahaman is an active researcher with a specific interest in Entrepreneurship, Entrepreneurial Behaviour, Street Food, SMEs, Marketing and UK Higher Education (UKHE). Rahaman has over 19 years of work experience in the UKHE, which includes extensive experience in teaching, assessment and quality assurance in the sector. Furthermore, providing academic training and workshops to academics and professionals is his special skill. Rahaman is a Senior Fellow at the Higher Education Academy (SFHEA).

