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Blockchain adoption readiness and sustainable taxation: the roles of Human-Centric Technological Capability and Tax Compliance Intention

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Introduction: This study extends the sustainable taxation literature by examining how Perceived Blockchain Adoption Readiness contributes to sustainable taxation through a human-centric Industry 5.0 perspective. Drawing on a context-specific application of the Stimulus–Organism–Response (S-O-R) framework, Perceived Blockchain Adoption Readiness, capturing taxpayers' subjective preparedness and willingness to engage with blockchain-enabled taxation, is positioned as a perceived technology-related stimulus, while Human-Centric Technological Capability and Tax Compliance Intention represent the organismic mechanisms, with Sustainable Taxation representing the response.
Methods: Using data from 463 GST-registered taxpayers across Tier 1 and Tier 2 cities in Tamil Nadu, India, the proposed relationships were examined using partial least squares structural equation modelling (PLS-SEM).
Results: Further, Human-Centric Technological Capability and Tax Compliance Intention sequentially mediate the association between Perceived Blockchain Adoption Readiness and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation. The findings also demonstrate that Perceived Blockchain Transparency positively moderates the relationship between Human-Centric Technological Capability and Tax Compliance Intention.
Discussion: Overall, the findings highlight the relevance of integrating blockchain-enabled technological readiness, human-centric capabilities, perceived transparency, and Tax Compliance Intention for understanding taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation within an Industry 5.0 context.

KEYWORDS
digital governance, Human-Centric Technological Capability, industry 5.0, perceived blockchain adoption readiness, Perceived Blockchain Transparency, PLS-SEM, sustainable taxation, Tax Compliance Intention

1 Introduction

The growing complexity of taxation and challenges related to tax avoidance, transparency, and administrative efficiency have increased the demand for more sustainable and robust taxation systems. There is a growing need for governments worldwide to improve tax compliance while maintaining equity, transparency, and sustainability within taxation systems, particularly as tax administrations increasingly adopt digital technologies to improve administrative efficiency and taxpayer

engagement (Bassey et al., 2022). In this dynamic environment, new technologies have gained attention for their potential to improve taxation systems by providing greater transparency, traceability, and real-time data verification (Allessie et al., 2019; Kshetri, 2017). While GST has taken a major stride in digitization, it still faces certain issues, including invoice fraud, fake input tax credit claims, slow reconciling, and lack of transparency. As a result, blockchain technology can provide an additional technological layer to enhance transparency, traceability, and administrative efficiency within current digital taxation frameworks (Allessie et al., 2019; Dai and Vasarhelyi, 2017).

In addition, as part of the digital transformation, sustainable taxation has also become a central topic in the policy and academic agenda. Sustainable taxation is a set of principles that go beyond merely raising public funds, including equity, voluntary compliance, and long-term stability of taxation systems (Alm, 2019; Bird and Zolt, 2008; OECD, 2021). Emerging technologies, such as blockchain technology, may support these objectives by enhancing transparency and traceability in tax administration, strengthening compliance-related processes, and reducing opportunities for tax evasion. Most previous studies have focused on the technological advantages of blockchain technology and given comparatively less attention to human-centric capabilities and behavioural mechanisms involved in taxpayers' engagement with blockchain-enabled taxation systems (Casino et al., 2019; Wang et al., 2019). Recent research also highlights the role of trust and perceived usefulness in blockchain adoption (Kirti et al., 2026). Research on blockchain applications further indicates that trust-related signals and the underlying characteristics of blockchain technology can shape end users' trust in blockchain applications (Völter et al., 2023). Broader research on blockchain from the information systems perspective also highlights its expanding technological applications and identifies continuing research gaps related to blockchain adoption and organisational use (Lei and Ngai, 2023). However, limited research has examined how blockchain readiness translates into human-centric capability in taxation.

The rise of Industry 5.0 further highlights the importance of understanding the interaction between humans and emerging technologies. Unlike Industry 4.0, which primarily emphasizes automation and efficiency, Industry 5.0 places greater emphasis on human-centricity and the integration of advanced technologies with human capabilities (Breque et al., 2021; Nahavandi, 2019). In this context, the Technology Acceptance Model (TAM) provides a useful perspective for explaining how individuals' perceptions of technology influence their acceptance and behavioural responses toward technology-enabled systems (Davis, 1989; Venkatesh and Bala, 2008). Human-Centric Technological Capability has particular relevance in the taxation domain, as digital literacy, cognitive ability, and adaptability may enable taxpayers to interact more effectively with blockchain-enabled tax technologies. Without adequate Human-Centric Technological Capability, the potential compliance and sustainability benefits of emerging taxation technologies may not be fully realised.

The perceived effectiveness of blockchain-enabled tax systems may also be associated with Perceived Blockchain Transparency and taxpayers' compliance-related responses. While blockchain technology presents some significant technical advantages, its complexity and lack of transparency can impact user trust and adoption (Queiroz and Wamba, 2019; Treiblmaier, 2018). Perceived Blockchain Transparency may reduce uncertainty by reflecting the potential of blockchain-enabled taxation processes to provide greater visibility, traceability, and auditability of tax-related transactions (Anomah et al., 2024; European Commission, 2023). Perceptions of technology-enabled systems can shape users' evaluations and behavioural responses (Gefen et al., 2003; Venkatesh and Bala, 2008).

This study is primarily grounded in the Stimulus–Organism–Response (S-O-R) framework, which provides a basis for examining the relationships between Perceived Blockchain Adoption Readiness and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation. In this context-specific application, PBAR is positioned as a perceived technology-related stimulus, capturing taxpayers' perceived preparedness and willingness to engage with an anticipated blockchain-enabled taxation environment, rather than an objectively observed external technological condition. Human-Centric Technological Capability and Tax Compliance Intention represent the organismic mechanisms, while Sustainable Taxation represents the response. Perceived Blockchain Transparency serves as a contextual moderator of the relationship between Human-Centric Technological Capability and Tax Compliance Intention. The study is further supported by the Technology Acceptance Model (TAM), while HCTC is conceptually informed by the human-centric principles of Industry 5.0, particularly human capability, technological adaptability, and engagement with advanced technologies.

Recent research indicates that blockchain technology in taxation is no longer an unexplored domain, with previous studies examining its applications in tax compliance, digital tax administration, and tax-policy development (Anomah et al., 2024; Lee et al., 2024; Mangoting et al., 2024). Similarly, research on Industry 5.0 has established human-centricity and human–technology interaction as important dimensions of technology-enabled transformation (Passalacqua et al., 2025; Zhang et al., 2023). Therefore, the contribution of the present study does not rest on treating blockchain technology, tax compliance, Industry 5.0, or human-centric technology as individually novel research domains. Instead, the unresolved issue concerns how these established perspectives can be integrated to explain the behavioural mechanism linking technological readiness with sustainable taxation. In particular, limited attention has been given to the sequential mechanism through which Perceived Blockchain Adoption Readiness may be associated with taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation through Human-Centric Technological Capability and Tax Compliance Intention. Accordingly, this study integrates the S-O-R perspective with the human-centric principles of Industry 5.0 to specify and empirically examine this sequential pathway, while examining Perceived Blockchain Transparency as a contextual moderator of the Human-Centric Technological Capability–Tax Compliance Intention relationship.

Thus, this research aims to answer the following questions:

RQ1: How is Perceived Blockchain Adoption Readiness associated with Human-Centric Technological Capability and Tax Compliance Intention among taxpayers?

RQ2: How do Human-Centric Technological Capability and Tax Compliance Intention contribute to sustainable taxation?

RQ3: Does Perceived Blockchain Transparency moderate the relationship between Human-Centric Technological Capability and Tax Compliance Intention?

This study contributes by examining the sequential relationships among Perceived Blockchain Adoption Readiness, Human-Centric Technological Capability, Tax Compliance Intention, and Sustainable Taxation. It also examines Perceived Blockchain Transparency as a moderator of the relationship between Human-Centric Technological Capability and Tax Compliance Intention. By integrating these relationships, the study provides a human-centric behavioural perspective on blockchain-enabled taxation in the Indian GST context.

2 Literature review, theory and hypothesis

2.1 Theoretical foundation

This study draws on the Stimulus–Organism–Response (S-O-R) framework to examine the relationships between Perceived Blockchain Adoption Readiness (PBAR) and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation (Kamboj et al., 2018; Mehrabian and Russell, 1974). PBAR captures taxpayers' perceived preparedness and willingness to engage with blockchain-enabled taxation, while blockchain technology offers potential benefits in transparency, traceability, and efficiency (Dai and Vasarhelyi, 2017; Kshetri, 2017; Yermack, 2017).

The application of S-O-R in this study is context-specific because PBAR measures subjective readiness rather than an objectively observed external technological condition. PBAR is therefore positioned as a perceived technology-related stimulus within the proposed framework because it captures taxpayers' appraisal of their preparedness to engage with an anticipated technological environment, while recognising that its individual-level, psychological content distinguishes it from an objectively measured environmental stimulus. This positioning does not imply that taxpayers' readiness is equivalent to actual blockchain infrastructure or government implementation.

The organismic component comprises Human-Centric Technological Capability (HCTC) and Tax Compliance Intention (TCI). From an Industry 5.0 perspective, HCTC encompasses digital literacy, adaptability, and effective engagement with emerging technologies (Breque et al., 2021; Nahavandi, 2019). Unlike PBAR, which concerns perceived readiness and willingness, HCTC represents taxpayers' perceived ability to understand, learn, adapt to, and use technology-enabled taxation processes. This distinction is consistent with Socio-Technical Theory, which emphasises the alignment between technological systems and human capabilities (Bostrom and Heinen, 1977). Industry 5.0 provides the human-centric theoretical perspective, while HCTC is the construct empirically examined in this study.

The Technology Acceptance Model (TAM) further supports the relevance of technology-related perceptions to users' acceptance and behavioural responses (Venkatesh and Bala, 2008). In the taxation context, taxpayers' perceptions of GST reforms may also shape their compliance-related responses (Sundari and Saravanabhavan, 2026). Accordingly, TCI represents taxpayers' willingness to comply with their tax obligations (Alm, 2019), while Sustainable Taxation (ST) captures their perceptions of the potential sustainability-related benefits of technology-enabled taxation rather than the objective sustainability performance of the existing tax system (OECD, 2021).

Although the proposed S-O-R framework specifies sequential relationships through HCTC and TCI, alternative direct associations between PBAR, HCTC, TCI, and ST are theoretically plausible. The present study examines the specified pathways without implying that alternative relationships are absent. Given the cross-sectional research design, the findings are interpreted as associations within the proposed model rather than evidence of causal or temporal relationships.

2.2 Perceived blockchain adoption readiness and human-centric technological capability

Human-Centric Technological Capability represents the human capability required to engage with technology-enabled tax systems and encompasses taxpayers' digital skills, adaptability, technology-related confidence, and ability to learn and use emerging technologies. HCTC is conceptually related to, but distinct from, constructs such as digital literacy, technological readiness, and self-efficacy. While these constructs focus primarily on digital skills, preparedness to adopt technology, or confidence in performing specific tasks, HCTC is conceptualised here as an integrated, context-specific capability for effectively engaging with technology-enabled taxation systems. This capability is consistent with the human-centric principles of Industry 5.0 (Breque et al., 2021; Nahavandi, 2019) and the socio-technical perspective, which emphasises alignment between technological systems and human capabilities (Bostrom and Heinen, 1977).

PBAR captures taxpayers' perceived readiness and willingness to engage with blockchain-enabled taxation, whereas HCTC reflects their perceived ability to understand, adapt to, and use such technologies. This distinction provides the conceptual basis for examining the association between PBAR and HCTC.

In this study, HCTC is conceptualised as an underlying capability that enables taxpayers to engage with technology-enabled taxation. Digital skills, adaptability to new taxation technologies, confidence in using digital platforms, and the ability to learn and use technology are treated as related manifestations of this broader capability. The reflective specification is based on the premise that differences in taxpayers' underlying HCTC are expressed through these related indicators. Accordingly, the indicators represent observable expressions of a common underlying capability rather than

distinct components that independently combine to form the construct. This conceptualisation provides the theoretical rationale for modelling HCTC as a single reflective construct.

Within the proposed S-O-R framework, PBAR is specified as the perceived technology-related stimulus and HCTC as the organismic capability. Accordingly, taxpayers' perceived readiness may be associated with their ability to engage with blockchain-enabled taxation. Based on this proposed relationship, the following hypothesis is formulated:

H1: Perceived Blockchain Adoption Readiness is positively associated with Human-Centric Technological Capability.

2.3 Human-Centric Technological Capability, Tax Compliance Intention and sustainable taxation

Human-Centric Technological Capability refers to taxpayers' ability to understand, adapt to, and effectively use technology-enabled tax systems. It encompasses digital skills, adaptability, and human–technology interaction (Balzarova et al., 2022; Breque et al., 2021; Jussupow et al., 2021; Passalacqua et al., 2025). This human-centric orientation is consistent with Industry 5.0, which emphasises human-centricity, sustainability, and resilience in the integration of advanced technologies (Zhang et al., 2023). Recent evidence further highlights the importance of human–technology interaction competency in technology-supported decision-making (Vijayananth and Saravanabhavan, 2026a). Such capabilities can facilitate taxpayers' understanding and use of digital tax processes, thereby strengthening Tax Compliance Intention.

Tax Compliance Intention refers to taxpayers' willingness to voluntarily fulfil their tax obligations, including accurate reporting and adherence to tax regulations (Alm, 2019; Kirchler et al., 2008). Greater technological capability may therefore facilitate interaction with digital tax systems and strengthen compliance intention, consistent with empirical evidence that blockchain applications can contribute to improved taxpayer compliance (Lee et al., 2024).

In this study, Sustainable Taxation (ST) is conceptualised as a taxpayer-perceived construct capturing beliefs about the potential contribution of blockchain-enabled and digital taxation processes to fairness, long-term revenue sustainability, economic sustainability, and transparency. The construct is operationalised through four measurement items reflecting these sustainability-related dimensions. Accordingly, Sustainable Taxation in the present study refers to taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation, rather than an objective assessment of the existing tax system's sustainability performance. The empirical findings are therefore interpreted in terms of respondents' perceptions of these potential benefits and do not establish whether the benefits have been realised or whether the existing tax system has become more sustainable.

On this basis, the following hypothesis is proposed:

H2: Human-Centric Technological Capability is positively associated with Tax Compliance Intention.

H3: Tax Compliance Intention is positively associated with Sustainable Taxation.

2.4 Mediating roles of Human-Centric Technological Capability and Tax Compliance Intention

Human-Centric Technological Capability and Tax Compliance Intention represent the theoretically proposed mechanisms through which Perceived Blockchain Adoption Readiness may influence sustainable taxation. Greater perceived readiness to adopt blockchain-enabled taxation may enhance taxpayers' technological capability, which can subsequently strengthen their intention to comply with tax obligations. Prior research highlights the importance of user capabilities in technology-related behaviours (Jussupow et al., 2021; Venkatesh et al., 2012).

Tax Compliance Intention further provides a behavioural pathway through which technological capability may be associated with taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation. Taxpayers with greater technological capability may be better positioned to engage with digital tax processes and develop stronger compliance intentions. This mediation mechanism is consistent with the S-O-R perspective, whereby external stimuli influence internal states that subsequently shape behavioural responses (Kamboj et al., 2018).

Accordingly, the following hypotheses are proposed:

H4: Human-Centric Technological Capability mediates the relationship between Perceived Blockchain Adoption Readiness and Tax Compliance Intention.

H5: Tax Compliance Intention mediates the relationship between Human-Centric Technological Capability and sustainable taxation.

2.5 Sequential mediation of Human-Centric Technological Capability and tax compliance intention

This study proposes that Human-Centric Technological Capability and Tax Compliance Intention operate as sequential mediators linking Perceived Blockchain Adoption Readiness to Sustainable Taxation. When taxpayers perceive greater readiness to engage with blockchain-enabled taxation, they may develop stronger technological capabilities, which can subsequently enhance their intention to comply with tax obligations. Thus, the effect of Perceived Blockchain Adoption Readiness on Sustainable Taxation is expected to occur through a connected human-capability and behavioural pathway.

This sequential mechanism is consistent with the S-O-R framework, whereby an external stimulus influences internal states that subsequently generate behavioural responses (Kamboj et al., 2018; Mehrabian and Russell, 1974). Previous research also indicates that human capabilities are important in translating emerging technologies into behavioural outcomes (Dwivedi et al., 2021). Accordingly, the theoretical value of the

sequential mediation lies in moving beyond a direct technology taxation relationship and identifying the connected human-capability and behavioural stages through which perceived blockchain adoption readiness may be associated with sustainable taxation. The proposed sequence specifies a theoretically motivated indirect pathway for empirical examination, rather than an exclusive mechanism or a confirmed temporal ordering of events.

On this basis, the following hypothesis is proposed:

H6: Human-Centric Technological Capability and Tax Compliance Intention sequentially mediate the relationship between Perceived Blockchain Adoption Readiness and sustainable taxation.

2.6 Moderating role of Perceived Blockchain Transparency

Perceived Blockchain Transparency (PBT) refers to the extent to which taxpayers perceive blockchain-enabled taxation processes as visible, traceable, verifiable, and accountable. Blockchain technology can enhance transparency and verifiability of transaction records, potentially reducing uncertainty in digital taxation systems (Dai and Vasarhelyi, 2017; Kshetri, 2017). Perceived transparency may also improve users' understanding and evaluation of blockchain-enabled systems (Queiroz and Wamba, 2019; Treiblmaier, 2018).

In this study, PBT is proposed as a contextual factor influencing how Human-Centric Technological Capability translates into Tax Compliance Intention. Although technological capability enables taxpayers to understand and use digital tax systems, its translation into compliance intention may depend on how transparently these systems operate. Greater transparency and traceability can improve process clarity, reduce uncertainty, and help taxpayers apply their technological capabilities more effectively.

From a socio-technical perspective, technology-related outcomes depend on the interaction between individual capabilities and the technological environment (Bostrom and Heinen, 1977). Therefore, higher Perceived Blockchain Transparency is expected to strengthen the positive association between HCTC and TCI by providing greater clarity and confidence in digital tax processes. Within the S-O-R framework, PBT acts as a contextual condition influencing this relationship.

Accordingly, the following hypothesis is proposed:

H7: Perceived Blockchain Transparency positively moderates the relationship between Human-Centric Technological Capability and Tax Compliance Intention.

2.7 Conceptual framework

This study proposes a context-specific Stimulus–Organism–Response (S-O-R) framework to explain the relationships among Perceived Blockchain Adoption Readiness, Human-Centric Technological Capability, Tax Compliance Intention, and Sustainable Taxation. Perceived Blockchain Adoption Readiness represents the perceived technology-related stimulus in the proposed framework. The organismic component comprises Human-Centric Technological Capability and Tax Compliance Intention. HCTC represents taxpayers' perceived capability to engage with technology-enabled taxation, while TCI reflects their intention to comply with tax obligations. Together, these constructs represent the human capability and behavioural processes specified in the proposed framework.

The response variable, Sustainable Taxation, captures taxpayers' perceptions of the potential sustainability-related benefits of blockchain-enabled taxation, including fairness, long-term revenue sustainability, economic sustainability, and transparency. It therefore reflects perceived potential benefits rather than an objective assessment of the sustainability performance of the existing tax system. The framework specifies a sequential mediation pathway in which HCTC and TCI link PBAR with ST. It also proposes Perceived Blockchain Transparency as a moderator of the relationship between HCTC and TCI. Figure 1 presents the conceptual framework and the corresponding hypotheses.

3 Methodology

The study used a quantitative survey research design to empirically test the proposed conceptual model. Structured questionnaire was used to collect primary data from the GST registered taxpayers in tier 1 and tier 2 cities of Tamilnadu, India. The measurement items were adapted and contextualised from prior literature or developed by the researchers based on relevant theoretical concepts for the blockchain-enabled taxation context. PLS-SEM was used to test the proposed relationships, such as sequential mediation and moderation effects, and to analyze the measurement and structural model (Hair et al., 2019; Sarstedt et al., 2021).

3.1 Sample and sampling technique

The target population comprised GST-registered taxpayers in Tier 1 and Tier 2 cities of Tamil Nadu, India. This population was selected because the study examines taxpayers' perceptions and behavioural responses regarding Tax Compliance Intention and sustainable taxation in the context of blockchain-enabled taxation.

Due to the absence of a comprehensive sampling frame, purposive sampling, a non-probability sampling technique, was employed. Respondents were selected based on their eligibility as GST-registered taxpayers and their relevant experience with GST-related tax activities and compliance processes (Etikan et al., 2016; Saunders et al., 2011). Structured offline questionnaires were administered to eligible respondents, who were provided an opportunity to clarify the questionnaire items when necessary (Sekaran, 2016).

A total of 524 questionnaires were distributed, of which 497 were returned, yielding an initial response rate of 94.8%. After screening, 34 responses were excluded due to incomplete or inconsistent responses. Consequently, 463 valid responses were retained for the final analysis, representing an effective response

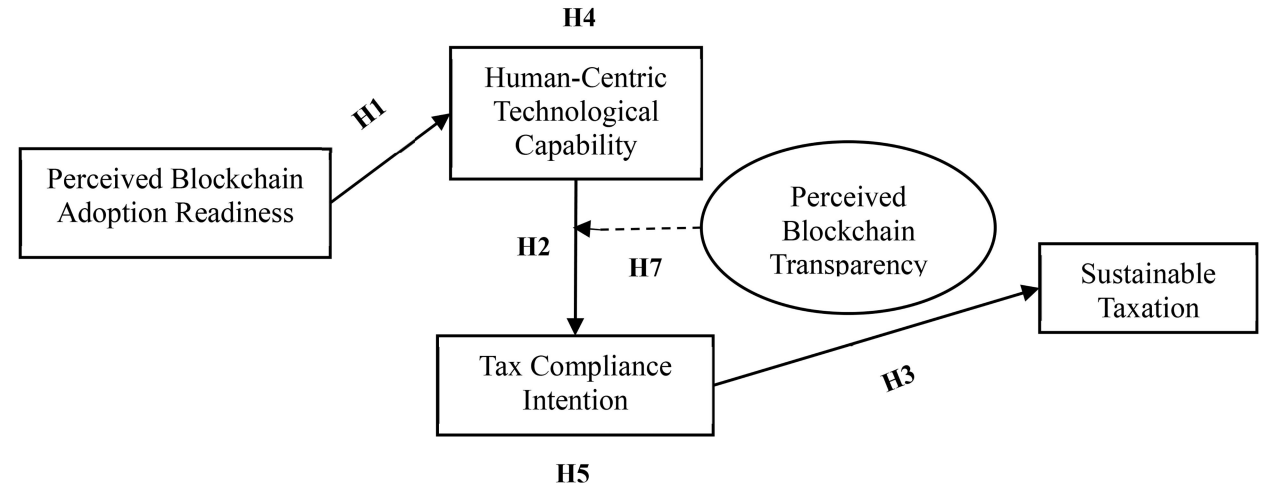

FIGURE 1
Conceptual framework.

rate of 88.4%. An *a priori* power analysis using G*Power indicated a minimum required sample size of 119 respondents (Figure 2). The final sample of 463 respondents therefore substantially exceeded the minimum required sample size and was considered adequate for the proposed PLS-SEM analysis (Faul et al., 2009; Hair et al., 2019; Sarstedt et al., 2021).

Because purposive sampling is a non-probability sampling technique, the final sample cannot be considered statistically representative of the entire GST-registered taxpayer population in Tamil Nadu. Furthermore, the study focuses on GST-registered taxpayers from selected Tier 1 and Tier 2 cities in Tamil Nadu and does not include a separately representative sample of rural taxpayers or taxpayers from other Indian states. Therefore, the findings are interpreted within the context of the sampled urban and semi-urban taxpayer groups and should not be directly generalised to rural areas, the entire GST-registered taxpayer population of Tamil Nadu, or nationwide Indian GST settings.

3.2 Constructs and questionnaire design

The constructs were measured using multi-item measures adapted and contextualised from prior literature or developed by the researchers based on relevant theoretical concepts, as summarised in Table 1. The measurement model is based on the S-O-R model which consists of a technological stimulus, organismic mechanisms and a behavioural response, while Perceived Blockchain Transparency is treated as a moderating construct (Jacoby, 2002; Mehrabian and Russell, 1974).

Perceived Blockchain Adoption Readiness (PBAR) was operationalised as a perceived technology-related stimulus and measured through four items capturing taxpayers' subjective preparedness and willingness to engage with blockchain-enabled taxation (Kshetri, 2017; Venkatesh et al., 2012). These items reflect individual perceptions of readiness to engage with an anticipated blockchain-enabled taxation environment rather than objective measures of technological infrastructure or government implementation.

Human-Centric Technological Capability (HCTC) was measured using four researcher-developed items informed theoretically by Venkatesh et al. (2012), rather than directly adopted from an existing measurement scale. The items were contextualised to blockchain-enabled taxation and capture taxpayers' digital skills for using blockchain-based tax systems (HCTC1), adaptability to new technologies used in taxation (HCTC2), confidence in using digital platforms for tax-related activities (HCTC3), and ability to learn and use blockchain-enabled tax applications (HCTC4). Consistent with the conceptualisation in Section 2.2, the four items were specified as reflective indicators of the underlying HCTC construct. Tax Compliance Intention was measured through four items that reflect taxpayers' willingness and intent to comply with their tax obligations (Alm, 2019). The moderating variable, Perceived Blockchain Transparency (PBT), was measured using four items indicating the visibility, traceability, clarity and accountability of the taxation process enabled by blockchain technology. The four items measuring Sustainable Taxation (ST) capture taxpayers' perceptions of the potential contributions of technology-enabled taxation to fairness, long-term revenue sustainability, economic

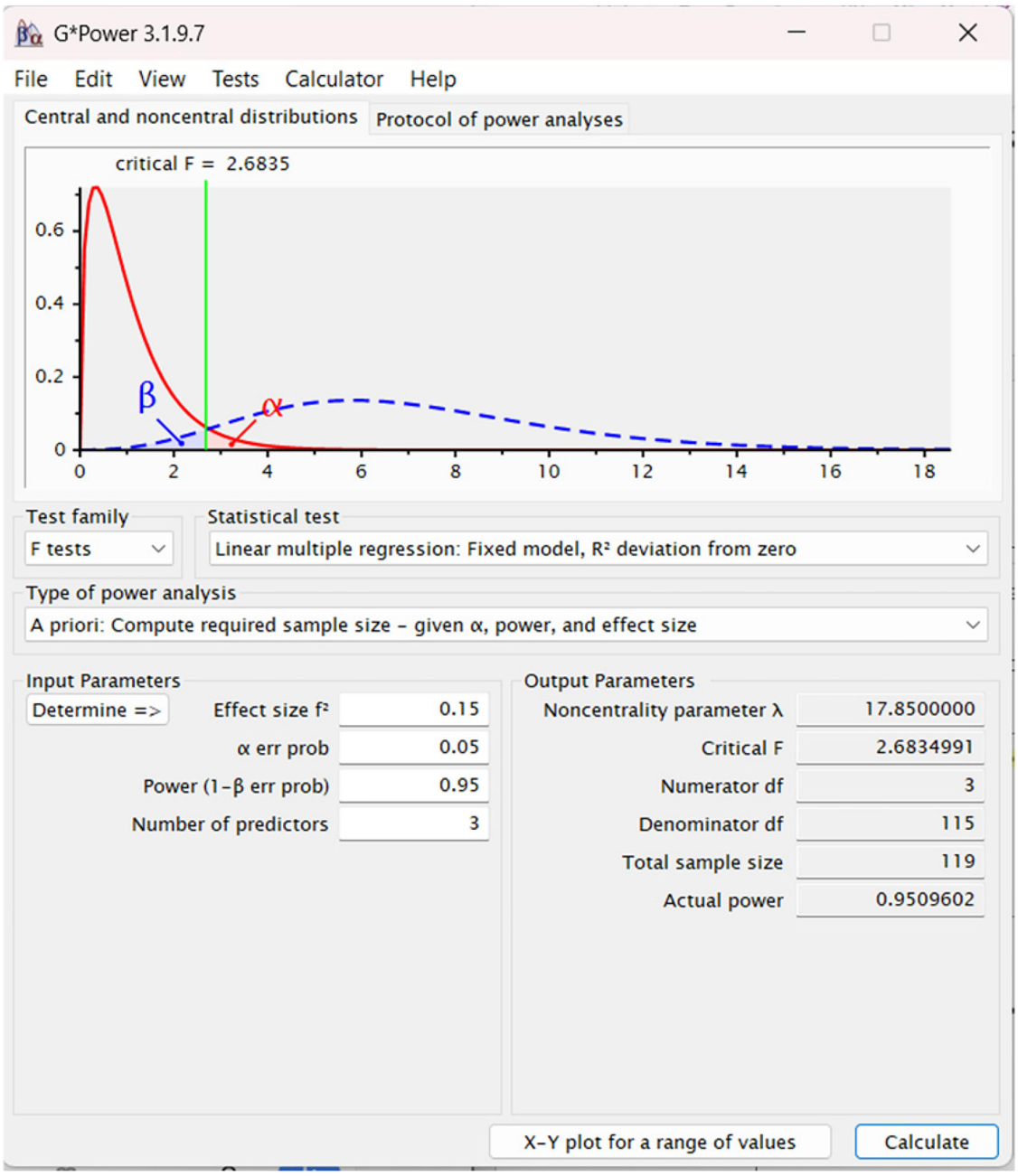

FIGURE 2
A priori power analysis for the minimum required sample size.

sustainability, and transparency. Thus, ST captures taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation rather than an objective assessment of the existing tax system's sustainability performance.

The questionnaire comprised three parts: (i) an introduction and informed consent, (ii) demographic questions, including income, and (iii) construct measurement items. The final instrument contained 20 items across the five constructs, measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Hair et al., 2019). The five-point format was selected to facilitate clear and accessible responses in the structured offline survey. Before the main survey, the questionnaire was pilot-tested with 52 respondents in Chennai, Tamil Nadu, selected through purposive sampling. The pilot study aimed to assess the clarity and suitability of the questionnaire for the main data collection. The measurement items were also reviewed by experts for relevance and clarity, and no specific modifications were suggested. The questionnaire was administered in English; therefore, translation was unnecessary. Responses from the pilot study were excluded from the final empirical analysis.

Table 1 shows the operationalization of constructs, measurement indicators and sources, while Supplementary Appendix A lists the measurement items for this study.

TABLE 1 Operationalization of constructs.

Underlying theory	Construct	Measurement indicators	Sources
S-O-R Model (Stimulus)	Perceived Blockchain Adoption Readiness (PBAR)	Readiness to adopt blockchain-enabled tax systems; preparedness to use blockchain-based tax services; perceived readiness to adapt to blockchain-based tax processes.	(Kshetri, 2017; Venkatesh et al., 2012)
S-O-R Model (Organism)	Human-Centric Technological Capability (HCTC)	Digital skills for using blockchain-based tax systems; adaptability to new taxation technologies; confidence in using digital tax platforms; ability to learn and use blockchain-enabled tax applications	Researcher-developed items; theoretically informed by Venkatesh et al. (2012)
S-O-R Model (Moderating Variable)	Perceived Blockchain Transparency (PBT)	Visibility of tax-related information; traceability of tax transactions; clarity of blockchain-enabled tax processes; perceived accountability of blockchain-based taxation	(Gefen et al., 2003; McKnight et al., 2002)
S-O-R Model (Organism)	Tax Compliance Intention (TCI)	Willingness to comply with tax rules; intention to report tax information accurately; intention to fulfil tax obligations voluntarily; intention to adhere to applicable tax regulations.	(Alm, 2019)
S-O-R Model (Response)	Sustainable Taxation (ST)	Perceived potential sustainability-related benefits of technology-enabled taxation relating to fairness, long-term revenue sustainability, economic sustainability, and transparency.	(OECD, 2021)

3.3 Data analysis technique

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS to estimate the proposed measurement and structural models, including the hypothesised sequential mediation and moderation effects (Hair et al., 2019; Sarstedt et al., 2021). The analysis followed two stages: assessment of the measurement model and evaluation of the structural model. The measurement model was assessed for internal consistency reliability, convergent validity, and discriminant validity. Internal consistency reliability was assessed using Cronbach's alpha and composite reliability (CR), while convergent validity was evaluated using outer loadings and average variance extracted (AVE) (Hair et al., 2019). Discriminant validity was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio (Fornell and Larcker, 1981; Henseler et al., 2015). The structural model was evaluated by calculating path coefficients and their significance through a bootstrapping resampling procedure (5,000 samples) (Hair et al., 2019). The explanatory power of the model was measured by R^2, and predictive relevance by Q^2predict (Shmueli et al., 2019). Further, variance inflation factor (VIF) was analysed for the model's robustness. Indirect and interaction effect analysis was used to examine the effects of mediation and moderation (Sarstedt et al., 2021).

4 Results

The empirical findings were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). First, the measurement model was evaluated to establish reliability and validity, followed by assessment of the structural model to test the hypothesised direct, mediating, and moderating effects.

4.1 Demographic profile of respondents

The respondents' demographic profile is presented in Table 2. The sample comprised 53.6% male and 46.4% female respondents, indicating a relatively balanced gender distribution. Respondents were predominantly aged 26–35 years (33.7%), followed by those aged 36–45 years (28.5%).

In terms of educational qualification, graduates constituted the largest group (50.8%), followed by postgraduates (23.6%). The largest turnover groups were ₹25–50 lakhs (28.5%) and ₹10–25 lakhs (26.1%). Individuals (45.4%) and proprietors (25.5%) represented the largest taxpayer groups. The service (36.1%) and trading (29.8%) sectors constituted the largest business categories. Most respondents were registered under the regular GST scheme (78.2%). Regarding technology usage, 52.1% of respondents reported an intermediate level. Blockchain awareness was primarily basic (36.3%) or moderate (28.5%). Respondents were drawn from Chennai, Coimbatore, Madurai, Trichy, Salem, and other locations across Tamil Nadu.

4.2 Measurement model assessment

Prior to conducting the structural model analysis, the measurement model was assessed to determine indicator reliability, internal consistency, convergent validity, discriminant validity and collinearity in line with the recommended practices in PLS-SEM (Hair et al., 2019; Sarstedt et al., 2021).

4.2.1 Indicator reliability

The indicator reliability of the reflective measurement model was assessed using standardized outer loadings. As reported in Table 3 and illustrated in Figure 3, the outer loadings ranged from 0.677 to 0.920. All indicators except PBT2 exceeded 0.70;

TABLE 2 Demographic profile of respondents.

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	248	53.6
	Female	215	46.4
Age (years)	18–25	85	18.3
	26–35	156	33.7
	36–45	132	28.5
	46 and above	90	19.5
Educational qualification	SSLC	17	3.7
	HSC	79	17.0
	Graduate	235	50.8
	Postgraduate	109	23.6
	Others	23	4.9
Annual turnover (₹)	Below ₹10 lakhs	68	14.7
	₹10–25 lakhs	121	26.1
	₹25–50 lakhs	132	28.5
	₹50 lakhs–₹1 crore	89	19.2
	Above ₹1 crore	53	11.5
Type of taxpayer	Individual	210	45.4
	Proprietor	118	25.5
	Partnership	82	17.7
	Company	53	11.4
Nature of business	Manufacturing	104	22.5
	Trading	138	29.8
	Service	167	36.1
	Others	54	11.7
GST registration type	Regular	362	78.2
	Composition	101	21.8
Technology usage level	Beginner	121	26.1
	Intermediate	241	52.1
	Advanced	101	21.8
Blockchain awareness	Not aware	96	20.7
	Basic	168	36.3
	Moderate	132	28.5
	High	67	14.5
Location	Chennai	104	22.5
	Coimbatore	78	16.8
	Madurai	72	15.6
	Trichy	68	14.7
	Salem	61	13.2
	Others	80	17.3

PBT2 recorded 0.677. Although PBT2 was slightly below the 0.70 threshold, it was retained because its loading exceeded 0.60 and its retention was supported by the subsequent reliability and validity assessments (Chin, 1998; Hair et al., 2019). Overall, the outer loadings provide satisfactory evidence of indicator reliability, and no indicators were removed (Hair et al., 2019; Sarstedt et al., 2021).

Accordingly, the measurement model meets the required criteria and can proceed to subsequent reliability, validity, and structural model assessments.

TABLE 3 Outer loadings of latent constructs.

Construct	Indicator	Outer loading
Perceived blockchain adoption readiness	PBAR 1	0.920
	PBAR 2	0.882
	PBAR 3	0.862
	PBAR 4	0.828
Human-centric technological capability	HCTC 1	0.780
	HCTC 2	0.868
	HCTC 3	0.784
	HCTC 4	0.757
Tax compliance intention	TCI 1	0.767
	TCI 2	0.862
	TCI 3	0.822
	TCI 4	0.798
Perceived blockchain transparency	PBT 1	0.734
	PBT 2	0.677
	PBT 3	0.753
	PBT 4	0.760
Sustainable taxation	ST 1	0.796
	ST 2	0.759
	ST 3	0.781
	ST 4	0.753

4.2.2 Internal consistency reliability and convergent validity

As shown in Table 4, internal consistency reliability is acceptable for all the constructs. Cronbach's alpha ranges between 0.718 and 0.896, above the acceptable level of 0.70 (Nunnally and Bernstein, 1994). Similarly, the composite reliability measures (ρa and ρc) exceed the threshold of 0.70 (ρc between 0.821 and 0.928), indicating satisfactory internal consistency reliability (Hair et al., 2019).

Average variance extracted (AVE) was used to provide an indication of convergent validity. AVE values ranged from 0.535 to 0.763, exceeding the threshold of 0.50 (Fornell and Larcker, 1981). Although Perceived Blockchain Transparency recorded the lowest AVE (0.535), the value remained above the recommended threshold of 0.50, supporting convergent validity. In summary, the measurement model demonstrates sufficient reliability and convergent validity to test the structural model.

4.2.3 Discriminant validity

Discriminant validity was assessed using the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) ratio. As presented in Table 5, the square root of the AVE for each construct, represented by the diagonal values, exceeds the corresponding inter-construct correlations, thereby satisfying the Fornell–Larcker criterion (Fornell and Larcker, 1981).

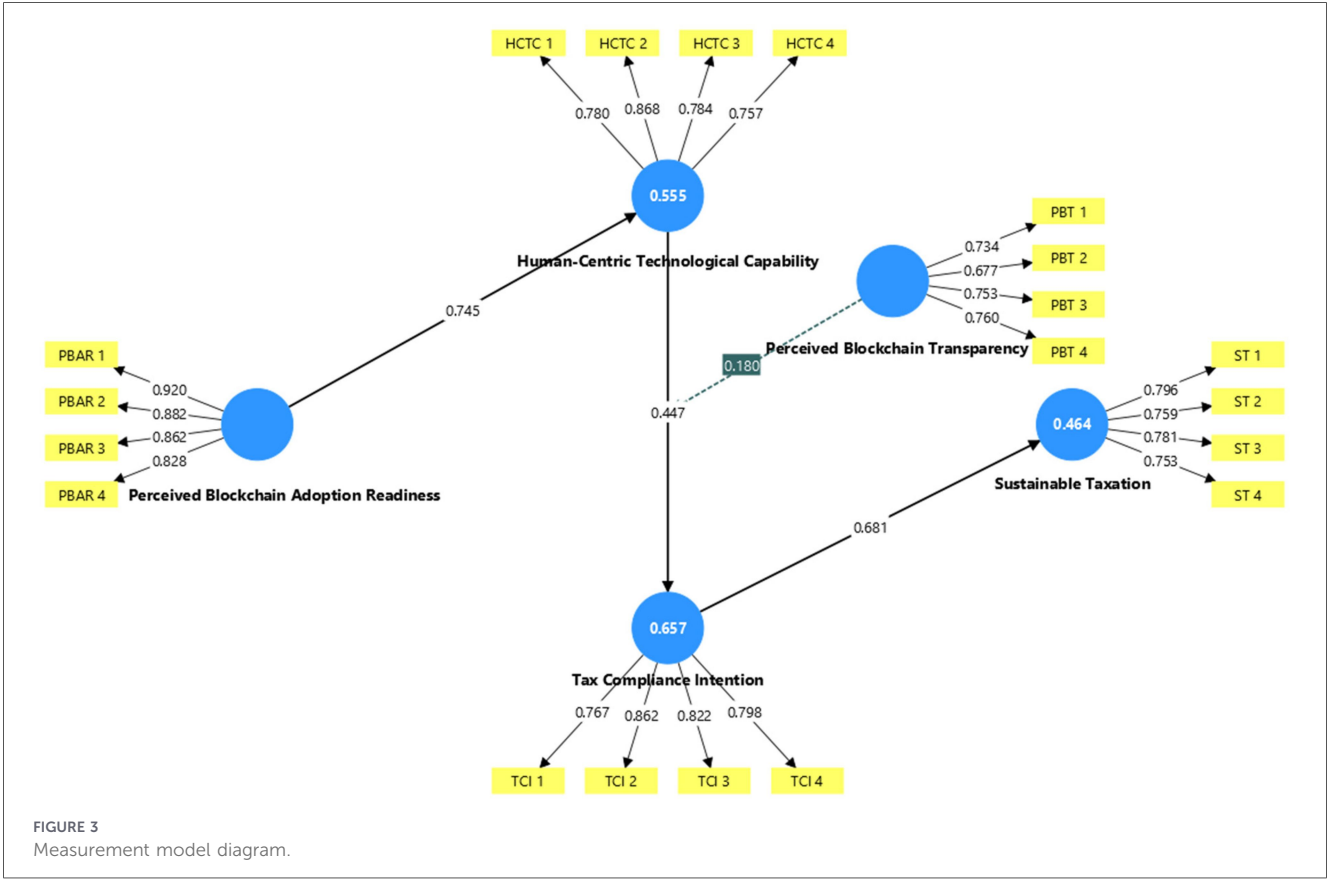

FIGURE 3
Measurement model diagram.

TABLE 4 Reliability and convergent validity statistics.

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Perceived blockchain adoption readiness	0.896	0.899	0.928	0.763
Human-centric technological capability	0.810	0.822	0.875	0.637
Tax compliance intention	0.829	0.832	0.886	0.661
Perceived blockchain transparency	0.718	0.730	0.821	0.535
Sustainable taxation	0.775	0.777	0.856	0.597

TABLE 5 Discriminant validity assessment using the Fornell-Larcker criterion.

Construct	PBAR	HCTC	ST	TCI	PBT
Perceived blockchain adoption readiness	0.873				
Human-centric technological capability	0.745	0.798			
Sustainable taxation	0.735	0.676	0.773		
Tax compliance intention	0.707	0.707	0.681	0.813	
Perceived blockchain transparency	0.587	0.586	0.633	0.700	0.732

Additionally, all HTMT values reported in Table 6 were below the conservative threshold of 0.90 (Henseler et al., 2015). However, the relatively high values for Perceived Blockchain Adoption Readiness–Sustainable Taxation (HTMT = 0.880) and Perceived Blockchain Adoption Readiness–Human-Centric Technological Capability (HTMT = 0.863) indicate conceptual proximity and warrant careful interpretation. This proximity is theoretically understandable because these constructs concern related aspects of taxpayers' engagement with emerging technologies. Nevertheless, PBAR represents taxpayers' perceived preparedness to engage with blockchain-enabled taxation, whereas HCTC represents the human capability to understand, adapt to, and effectively use technology-enabled taxation systems.

Further, the HTMT inference analysis presented in Supplementary Appendix A, Table A2 provides additional support for discriminant validity. For the PBAR–HCTC pair, the 95% confidence interval for HTMT was 0.810–0.912, which excludes 1.00. Together with the satisfactory Fornell–Larcker results, these findings support the empirical distinctiveness of the constructs.

4.2.4 Collinearity diagnostics

Collinearity among the predictor constructs was assessed using variance inflation factor (VIF) values, as reported in Table 7. The VIF values ranged from 1.000 to 1.574, remaining well below the commonly accepted threshold of 5.0 and the more conservative threshold of 3.3, indicating that problematic collinearity is not present among the predictor constructs (Hair et al., 2019; Kock, 2015). These results indicate that collinearity is unlikely to bias the estimation of the structural model.

4.2.5 Model fit indices

The model-fit results presented in Table 8 warrant cautious interpretation. The estimated model produced an SRMR of 0.126 and an NFI of 0.671, while the saturated model yielded an SRMR of 0.092 and an NFI of 0.692. These values indicate relatively weak global model fit and do not provide strong evidence of close approximate fit. Although PLS-SEM emphasises variance explanation and prediction, global fit indices remain relevant to assessing the adequacy of the proposed model (Hair et al., 2019; Sarstedt et al., 2021).

The structural model explained 55.5% of the variance in Human-Centric Technological Capability, 65.7% in Tax Compliance Intention, and 46.4% in Sustainable Taxation ($R^2 = 0.555$, 0.657, and 0.464, respectively). The positive $Q^2_{predict}$ values (0.552, 0.623, and 0.477) reported in Table 9, indicate predictive relevance under the predictive assessment

TABLE 6 HTMT ratio.

Construct	PBAR	HCTC	ST	TCI	PBT	PBT × HCTC
PBAR						
HCTC	0.863					
ST	0.880	0.840				
TCI	0.813	0.849	0.838			
PBT	0.743	0.756	0.872	0.868		
PBT × HCTC	0.141	0.114	0.175	0.096	0.270	

TABLE 7 Collinearity assessment (VIF).

Predictor relationship	VIF
Perceived blockchain adoption readiness -> Human-centric technological capability	1.000
Human-centric technological capability -> Tax compliance intention	1.522
Tax compliance intention -> Sustainable taxation	1.000
Perceived blockchain transparency -> Tax compliance intention	1.574
Perceived blockchain transparency × Human-centric technological capability -> Tax compliance intention	1.046

TABLE 8 Model fit indices.

Fit Index	Saturated model	Estimated model
SRMR	0.092	0.126
d_ULS	1.774	3.324
d_G	0.796	0.918
Chi-square	1,919.61	2,047.359
NFI	0.692	0.671

TABLE 9 Structural model evaluation results: R^2, Q^2, RMSE, and MAE.

Endogenous construct	R^2	Q^2predict	RMSE	MAE
Human-centric technological capability	0.555	0.552	0.671	0.521
Tax compliance intention	0.657	0.623	0.616	0.475
Sustainable taxation	0.464	0.477	0.726	0.588

employed. VIF values ranging from 1.000 to 1.574 indicate no apparent problematic collinearity among the specified predictors. Although the measurement model demonstrated satisfactory reliability, convergent validity, and discriminant validity, these results assess distinct aspects of model performance and do not establish the adequacy of the overall model specification.

Although reliability, convergent validity, discriminant validity, and collinearity were assessed, these diagnostics do not rule out all forms of measurement misspecification. No alternative structural specification or systematic model-modification procedure was evaluated in the present analysis. Consequently, it remains unclear whether the weak global fit reflects measurement misspecification, omitted structural relationships, or other aspects of model specification. The hypothesised relationships should therefore be interpreted as findings within the estimated model, rather than as evidence that the overall model specification is fully adequate. The weak global fit limits confidence in the adequacy of the proposed model, notwithstanding the statistically significant hypothesised relationships. Future research should investigate theoretically justified alternative measurement and structural specifications to determine whether the observed relationships remain robust and whether alternative specifications provide better global model fit.

4.2.6 Assessment of common method bias

Given the cross-sectional, self-reported nature of the data collected from a single respondent source, common method bias (CMB) was assessed using Harman's single-factor test and the full-collinearity VIF approach. Harman's single-factor test indicated that the first unrotated component accounted for 32.853% of the total variance, below the commonly used 50% threshold (Podsakoff et al., 2003). Additionally, the full-collinearity VIF values ranged from 2.169 to 2.933, below the recommended threshold of 3.3 (Kock, 2015). Together, these results provide no indication of substantial CMB based on the diagnostic procedures employed, although the possibility of residual method-related bias cannot be completely ruled out. The detailed VIF results are presented in Supplementary Appendix A, Table A5.

4.3 Structural model assessment

Following the assessment of the measurement model, the structural model was evaluated to examine the hypothesised relationships among the latent constructs. Assessment of the structural model in PLS-SEM includes the significance and magnitude of the path coefficients (β), the amount of variance explained (R^2) and the predictive relevance of the model (Hair et al., 2019; Sarstedt et al., 2021). The findings are discussed in Figure 4 and Tables 9–13.

4.3.1 Direct effects and hypothesis testing

The bootstrapping procedure with 5,000 bootstrap samples was used to assess the statistical significance of the hypothesised structural paths. The path coefficients and corresponding hypothesis-testing results are reported in Table 10. Figure 3 presents the measurement model, while Figure 4 displays the bootstrapping results for the structural model.

The results suggest that all direct paths are positive and significant, supporting the proposed model. Perceived Blockchain Adoption Readiness was positively and significantly associated with Human-Centric Technological Capability ($\beta = 0.745$, $t = 34.447$, $p < 0.001$), supporting H1. The finding indicates that higher perceived readiness to adopt blockchain-enabled tax systems is associated with greater Human-Centric Technological Capability. Moreover, Human-Centric Technological Capability was positively and significantly associated with Tax Compliance Intention ($\beta = 0.447$, $t = 11.993$, $p < 0.001$), supporting H2. This finding suggests that greater Human-Centric Technological Capability is associated with stronger Tax Compliance Intention.

Lastly, Tax Compliance Intention was positively and significantly associated with Sustainable Taxation ($\beta = 0.681$, $t = 28.279$, $p < 0.001$), supporting H3. Given the perceptual nature of the Sustainable Taxation measure, this result indicates that taxpayers reporting stronger compliance intentions also tend to report more favourable perceptions of the potential sustainability-related benefits of technology-enabled taxation. It should not be interpreted as evidence that compliance intention objectively improves the sustainability of the existing tax system.

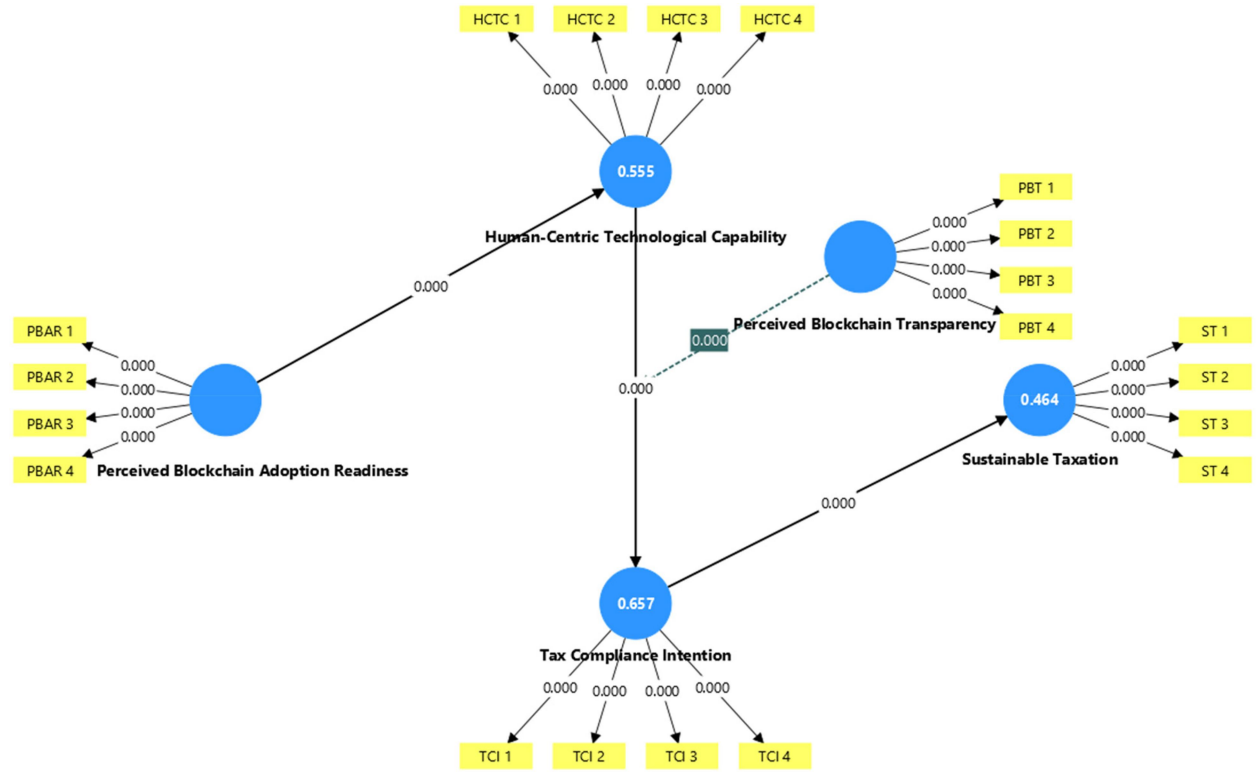

FIGURE 4
Structural model with bootstrapping results.

TABLE 10 Structural path coefficients and hypothesis testing.

Hypothesis	structural path	β (path coefficient)	*t*-value	*p*-value	Hypothesis support
H1	Perceived blockchain adoption readiness → Human-centric technological capability	0.745	34.447	<0.001	Supported
H2	Human-centric technological capability → Tax compliance intention	0.447	11.993	<0.001	Supported
H3	Tax compliance intention → Sustainable taxation	0.681	28.279	<0.001	Supported

In summary, the findings offer strong support for the structural relationships, with Perceived Blockchain Adoption Readiness showing the strongest association with Human-Centric Technological Capability.

4.3.2 Structural model evaluation: explanatory power (R^2) and predictive performance (Q^2predict)

The explanatory power of the structural model was assessed using the coefficient of determination (R^2). Based on the commonly used guidelines of Hair et al. (2019), R^2 values of 0.25, 0.50, and 0.75 provide reference points for weak, moderate, and substantial explanatory power, respectively. The model recorded R^2 values of 0.555 for Human-Centric Technological Capability (HCTC), 0.657 for Tax Compliance Intention (TCI), and 0.464 for Sustainable Taxation (ST). These results indicate moderate explanatory power for HCTC and TCI, while the R^2 value for ST falls between the weak and moderate reference points.

Predictive performance was assessed using the PLSpredict procedure, following Shmueli et al. (2019), with 10-fold cross-validation and 10 repetitions. Table 9 reports Q^2predict, root mean squared error (RMSE), and mean absolute error (MAE) for the endogenous constructs. The Q^2predict values were 0.552 for HCTC, 0.623 for TCI, and 0.477 for ST. The corresponding RMSE values were 0.671, 0.616, and 0.726, while the MAE values were 0.521, 0.475, and 0.588, respectively.

The predictive loss-comparison results reported in Supplementary Appendix A, Table A3, compare the predictive performance of PLS-SEM with the naïve indicator-average (IA) benchmark. The average loss differences were −0.646 for Human-Centric Technological Capability (HCTC), −0.643 for

TABLE 11 Mediation analysis results.

Hypothesis	Structural path	*B* (path coefficient)	*t*-value	*p*-value	2.50%	97.50%	Hypothesis support
H4	Perceived blockchain adoption readiness → Human-centric technological capability → Tax compliance intention	0.333	10.398	<0.001	0.267	0.395	Supported
H5	Human-centric technological capability → Tax compliance intention → Sustainable taxation	0.305	10.608	<0.001	0.246	0.358	Supported

TABLE 12 Sequential mediation analysis results.

Hypothesis	Sequential path	Indirect effect (β value)	*t*-value	*p*-value	2.50%	97.50%	Hypothesis support
H6	Perceived blockchain adoption readiness → Human-centric technological capability → Tax compliance intention → Sustainable taxation	0.227	9.139	<0.001	0.179	0.275	Supported

TABLE 13 Moderation analysis results.

Hypothesis	Moderating effect	Interaction (β)	*t*-value	*p*-value	2.50%	97.50%	Hypothesis support
H7	Perceived blockchain transparency × Human-centric technological capability → Tax compliance intention	0.180	7.153	<0.001	0.130	0.228	Supported

Tax Compliance Intention (TCI), and −0.493 for Sustainable Taxation (ST), with an overall average loss difference of −0.594. All reported comparisons were statistically significant ($p < 0.001$). The negative loss differences indicate that PLS-SEM produced lower prediction loss than the naïve indicator-average benchmark for all three endogenous constructs under the reported comparison procedure. These findings support better predictive performance relative to this benchmark; however, they should not be interpreted as evidence of superiority over all alternative prediction models.

4.3.3 Mediation analysis

4.3.3.1 Indirect effects

The mediation effects were tested using a bootstrapping approach (5,000 resamples) and are shown in Table 11. The results reveal that all indirect effects are positive and significant at $p < 0.001$, supporting the hypothesised mediation relationships (Hair et al., 2019).

Perceived Blockchain Adoption Readiness has a significant indirect association on Tax Compliance Intention via Human-Centric Technological Capability ($\beta = 0.333$, $t = 10.398$, $p < 0.001$), and thus H4 is supported. This finding suggests that greater Perceived Blockchain Adoption Readiness is associated with greater Human-Centric Technological Capability, which in turn is associated with stronger Tax Compliance Intention.

In addition, Human-Centric Technological Capability also has a significant indirect effect on Sustainable Taxation through Tax Compliance Intention ($\beta = 0.305$, $t = 10.608$, $p < 0.001$), supporting H5. This suggests the importance of Tax Compliance Intention in the relationship between Human -Centric Technological Capability and sustainable taxation.

Overall, the findings highlight the role of cognitive and behavioural processes in explaining the association between technology-related perceptions and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation.

4.3.3.2 Sequential mediation analysis

To examine the sequential mediation effects, bootstrapping was conducted with 5,000 resamples, as shown in Table 12. The results show that the sequential indirect effect is positive and highly significant ($p < 0.001$), thus supporting the research hypothesis (Hair et al., 2019).

In particular, Perceived Blockchain Adoption Readiness has an indirect effect on Sustainable Taxation through the sequential path of Human-Centric Technological Capability and Tax Compliance Intention ($\beta = 0.227$, $t = 9.139$, $p < 0.001$), thus supporting H6.

The finding suggests that Perceived Blockchain Adoption Readiness is associated with greater Human-Centric Technological Capability, which is subsequently associated with stronger Tax Compliance Intention and more favourable perceptions of the potential sustainability-related benefits of technology-enabled taxation. This result supports the proposed sequential indirect association within the specified model; it

does not establish that blockchain readiness produces objectively sustainable tax-system outcomes.

Overall, the findings support the proposed sequential indirect association within the specified model, but do not establish that this is the only possible pathway or confirm temporal ordering among the constructs.

4.3.4 Moderation analysis

The moderating role of Perceived Blockchain Transparency (PBT) in the relationship between Human-Centric Technological Capability (HCTC) and Tax Compliance Intention (TCI) was examined using the two-stage approach in PLS-SEM. The direct effect of PBT on TCI was positive and statistically significant ($\beta = 0.324$, $t = 12.094$, $p < 0.001$), indicating that higher perceived blockchain transparency was associated with stronger tax compliance intention.

As presented in Table 13, the interaction between Perceived Blockchain Transparency and Human-Centric Technological Capability was positive and statistically significant in its association with Tax Compliance Intention ($\beta = 0.180$, $t = 7.153$, $p < 0.001$, 95% CI [0.130, 0.228]). This result supports H7, indicating that the positive relationship between HCTC and TCI becomes stronger as perceived blockchain transparency increases.

The simple-slope analysis generated using the PLS-SEM algorithm further illustrates the relationship between HCTC and TCI at low (−1 SD), mean, and high (+1 SD) levels of PBT (Figure 5). The conditional direct-effects results show that the corresponding coefficients increase from 0.267 at low PBT to 0.447 at the mean and 0.628 at high PBT. All three conditional effects were positive and statistically significant ($p < 0.001$; see Supplementary Appendix A, Table A4). These findings are consistent with the positive interaction effect and provide further evidence that perceived blockchain transparency strengthens the positive relationship between human-centric technological capability and tax compliance intention.

5 Discussion

5.1 Overview of the study

This study examines the relationship between Perceived Blockchain Adoption Readiness and Sustainable Taxation through human and behavioural mechanisms. Based on the S-O-R model, Perceived Blockchain Adoption Readiness is regarded as the stimulus, whereas Human-Centric Technological Capability and Tax Compliance Intention are treated as two sequential mediating variables between the technological stimulus and Sustainable Taxation. The ultimate response outcome of the proposed framework is Sustainable Taxation.

The design of the study was quantitative in nature, and primary data was collected from 463 GST taxpayers from Tier 1 and Tier 2 cities of Tamil Nadu, India, and analysed through PLS-SEM. The proposed model explores the direct effect,

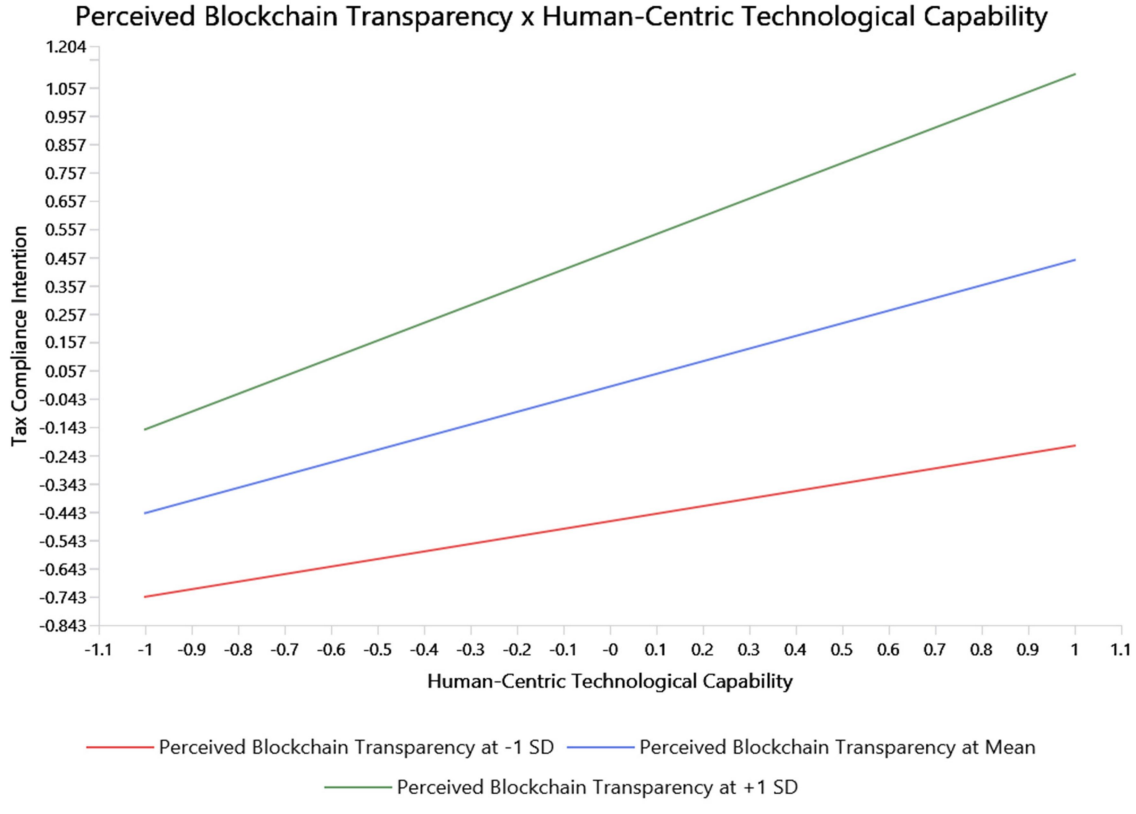

FIGURE 5
Moderating effect of perceived blockchain transparency on the HCTC–TCI relationship.

mediation effect, sequential mediation, and moderation effect to give a comprehensive understanding of the relationship between Perceived Blockchain Adoption Readiness and sustainable taxation. Overall, the study provides an integrated perspective on how Industry 5.0-oriented technological capabilities and human behavioural factors are associated with taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation.

5.2 Summary of key findings

The structural model results indicate positive and statistically significant relationships among the principal constructs of the proposed framework. Perceived Blockchain Adoption Readiness is positively associated with Human-Centric Technological Capability, which is in turn positively associated with Tax Compliance Intention. Tax Compliance Intention also exhibits a positive association with taxpayers' perceptions of Sustainable Taxation. These findings provide empirical support for the proposed relationships within the study sample. However, the relationship between Tax Compliance Intention and Sustainable Taxation should be interpreted as an association between behavioural intention and perceived sustainability-related benefits, rather than evidence of actual improvements in the sustainability of the tax system.

Additionally, the mediation results show that Human-Centric Technological Capability mediates between Perceived Blockchain Adoption Readiness and Tax Compliance Intention, and Tax Compliance Intention mediates between Human-Centric Technological Capability and Sustainable Taxation. The sequential mediation analysis additionally confirms that Perceived Blockchain Adoption Readiness is indirectly associated with Sustainable Taxation through Human-Centric Technological Capability and Tax Compliance Intention.

Finally, the moderation analysis shows that the relationship between Human-Centric Technological Capability and Tax Compliance Intention is positively moderated by Perceived Blockchain Transparency. Overall, the findings highlight the interconnected roles of technological readiness, human-centric capability, compliance intention, and Perceived Blockchain Transparency in explaining taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation within an Industry 5.0-oriented context.

5.3 Theoretical discussion

5.3.1 Blockchain technology adoption and human capability enhancement

The positive relationship between Perceived Blockchain Adoption Readiness and Human-Centric Technological Capability is consistent with technology-adoption research, which emphasises users' interaction and adaptation to digital technologies (Kshetri, 2017; Venkatesh et al., 2012). It also aligns with the Industry 5.0 perspective, which emphasises the integration of advanced technologies with human capabilities and places human-centricity at the centre of technological transformation (Nahavandi, 2019; Passalacqua et al., 2025; Zhang et al., 2023). However, the finding extends these perspectives by showing that blockchain readiness in taxation is associated not only with technological acceptance but also with taxpayers' capability to engage with and adapt to technology. This highlights the importance of considering human capability when examining blockchain-enabled taxation.

From a socio-technical perspective, the finding indicates that technological readiness needs to be complemented by human capabilities to enable effective engagement with digital taxation systems (Bostrom and Heinen, 1977). Within the S-O-R framework, Perceived Blockchain Adoption Readiness represents the stimulus, while Human-Centric Technological Capability represents the organismic mechanism through which the technological stimulus is associated with subsequent behavioural outcomes (Jacoby, 2002). Thus, the finding adds a human-capability dimension to the technology-to-behaviour pathway and supports the Industry 5.0 principle that technological advancement should remain human-centred.

5.3.2 Behavioral role of human capability and compliance

The positive relationship between Human-Centric Technological Capability and Tax Compliance Intention is consistent with prior technology-adoption research showing that users' capabilities facilitate effective engagement with complex digital systems (Jussupow et al., 2021; Venkatesh et al., 2012). Recent evidence also indicates that trust and human-centred interaction with technology-supported information systems can influence behavioural decision-making processes (Vijayananth and Saravanabhavan, 2026b). The finding extends this literature by connecting Human-Centric Technological Capability with a taxation-specific behavioural outcome. In the context of blockchain-enabled taxation, taxpayers' digital literacy, adaptability, and ability to understand technology-supported tax processes may contribute to stronger compliance intentions. Therefore, the study's results indicate that humans' competence is not only relevant to the use of technology but also to the behavioural processes involved in digital tax compliance.

Within the S-O-R framework, Human-Centric Technological Capability and Tax Compliance Intention represent the organismic mechanisms through which a technological stimulus is translated into taxation-related outcomes (Jacoby, 2002). This interpretation is consistent with the socio-technical perspective, which emphasises alignment between technological systems and human capabilities (Bostrom and Heinen, 1977). Therefore, the finding provides a human-centred interpretation of technology-enabled tax compliance: technological implementation alone may not be sufficient to generate favourable behavioural responses when taxpayers lack the capabilities required to understand and engage with the system.

5.3.3 Pathway to sustainable taxation

The positive relationship between Tax Compliance Intention and taxpayers' perceptions of Sustainable Taxation aligns with taxation research highlighting the importance of taxpayer

cooperation in effective revenue administration and governance (Alm, 2019; Kirchler et al., 2008). The finding extends this perspective by examining the association between Tax Compliance Intention and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation. The measurement items cover perceived contributions to fairness, long-term revenue sustainability, economic sustainability, and transparency. The positive relationship indicates that stronger compliance intentions are associated with more favourable perceptions of these potential benefits. This finding reflects taxpayers' reported perceptions and should not be interpreted as evidence of objective improvements in the sustainability of the existing tax system.

In the S-O-R approach, Sustainable Taxation is the reaction to the technological and behavioural processes that preceded it (Jacoby, 2002). The finding therefore suggests that the contribution of Perceived Blockchain Adoption Readiness to Sustainable Taxation is not simply a direct technology-to-outcome relationship. Instead, the proposed framework indicates an indirect pathway in which technological readiness is associated with human-centric capability and Tax Compliance Intention, which are subsequently associated with sustainable taxation. This understanding enhances the behavioural view on blockchain-facilitated taxation.

5.3.4 Sequential mediation mechanism

The sequential mediation finding provides an integrated explanation of the associations between Perceived Blockchain Adoption Readiness and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation. The results identify an indirect pathway in which perceived technological readiness is associated with Human-Centric Technological Capability, which is subsequently associated with Tax Compliance Intention and, in turn, with perceptions of these potential benefits. This interpretation is consistent with the specified sequential mediation model while recognising that the cross-sectional survey does not establish temporal causality or demonstrate actual improvements in tax-system sustainability. This extends technology-adoption perspectives by demonstrating that human capability and behavioural intention jointly form an intervening pathway between technological readiness and taxation outcomes.

The finding also strengthens the application of the S-O-R framework by specifying the organismic process more precisely. Human-Centric Technological Capability represents the human-capability stage, while Tax Compliance Intention represents the subsequent behavioural stage through which the technological stimulus is associated with the response (Kamboj et al., 2018; Mehrabian and Russell, 1974). On an Industry 5.0 perspective, the result also indicates that human-centric capability can serve as a mediator between the technology-related readiness and the behavioural and taxation-related outcomes. This interpretation is not intended to suggest that the study represents the broader dimensions of Industry 5.0; rather the study emphasizes the focus on the human-centric aspect for the specific pathway of behaviour investigated in this study. This extends the socio-technical perspective by highlighting the importance of aligning technological innovation with human capacities (Bostrom and Heinen, 1977).

5.3.5 Moderating role of perceived blockchain transparency

The positive interaction between Perceived Blockchain Transparency and Human-Centric Technological Capability in predicting Tax Compliance Intention indicates that the association between technological capability and compliance intention is stronger when perceived transparency is higher. This finding suggests that transparency, through greater process visibility, clarity, and reduced uncertainty, may help taxpayers apply their technological capabilities more effectively to tax-related activities. This interpretation is consistent with previous research highlighting the importance of transparent and reliable information in shaping users' responses to digital systems (Gefen et al., 2003; McKnight et al., 2002).

From a socio-technical perspective, the finding highlights that the relationship between human capability and behavioural intention is associated with the characteristics of the technological environment. Within the S-O-R framework, Perceived Blockchain Transparency acts as a contextual condition influencing the translation of the organismic capability (HCTC) into behavioural intention (TCI). Thus, the result supports the proposed moderating role of transparency in the human-centric taxation framework.

5.4 Contributions of the study

This study contributes to the literature on digital taxation, blockchain-enabled taxation, and sustainable taxation by developing a human-centric behavioural explanation of how perceived technological readiness is associated with taxpayers' perceptions of potential sustainability-related benefits.

First, the study extends the S-O-R framework by specifying Human-Centric Technological Capability as an intermediate human-capability mechanism linking perceived technological readiness with subsequent behavioural intention. It clarifies the role of human capability within the proposed blockchain-enabled taxation context without claiming HCTC as an entirely new construct. Second, the study applies the human-centric perspective of Industry 5.0 to digital taxation by examining taxpayers' technological capability, adaptability, and ability to engage with emerging technologies. Industry 5.0 is used as a theoretical perspective rather than a directly measured construct.

Third, the study identifies a sequential mediation pathway (PBAR → HCTC → TCI → ST), providing a more detailed explanation of how perceived technological readiness is associated with taxpayers' perceptions of potential sustainability-related benefits through successive human-capability and behavioural mechanisms. Fourth, the study extends the S-O-R framework by identifying Perceived Blockchain Transparency as a contextual moderator of the relationship between HCTC and TCI. This highlights the relevance of perceived transparency in understanding how technological capability is associated with compliance intention.

Finally, the study contributes contextually by examining these relationships among GST-registered taxpayers in selected Tier 1 and Tier 2 cities of Tamil Nadu, India. It provides context-specific empirical insights into the human and behavioural dimensions of potential blockchain-enabled taxation in an emerging-economy GST setting.

5.5 Practical and managerial implications

This study offers context-specific practical and managerial implications based on the perceptions of 463 GST-registered taxpayers from selected Tier 1 and Tier 2 cities in Tamil Nadu, India. The findings provide insights for tax administrators, businesses, and technology providers operating in or considering blockchain-enabled taxation within similar urban and semi-urban GST contexts. They suggest that potential blockchain-enabled taxation should consider taxpayers' human and behavioural capabilities alongside technological development.

For tax administrators and policymakers considering future blockchain-enabled GST applications in contexts similar to the sampled cities, taxpayer capability should be incorporated into digital-tax planning. Training programmes, awareness initiatives, guidance materials, and taxpayer support services could strengthen taxpayers' understanding of emerging digital-tax processes. The applicability of these initiatives to rural areas and other regions requires further empirical assessment. The findings also highlight the relevance of Industry 5.0 principles in promoting inclusive, accessible, and human-centred taxation processes. The moderating role of Perceived Blockchain Transparency suggests that technological capability may be more strongly associated with compliance intention when digital-tax processes are perceived as transparent and understandable. Therefore, future systems could incorporate clear information on transaction verification, data processing, and compliance procedures.

For businesses and GST-registered taxpayers, the findings highlight the relevance of digital skills and internal tax-technology capabilities. Businesses could strengthen employees' digital competencies and their ability to engage with emerging digital-tax systems to support accurate reporting and compliance-related activities. For technology developers and fintech firms, the findings emphasise user-centred design. Simple interfaces, multilingual accessibility, understandable information, and appropriate audit-trail visibility could facilitate taxpayer engagement. Overall, future digital-tax transformation should consider technological innovation alongside taxpayer capability, perceived transparency, and human-centred governance.

These practical implications are primarily relevant to the sampled Tier 1 and Tier 2 city taxpayer context in Tamil Nadu and should not be interpreted as universally applicable recommendations for all GST taxpayers across India without further validation.

5.6 Policy implications

The findings provide context-specific policy considerations for future digital-tax reforms based on the perceptions of GST-registered taxpayers from selected Tier 1 and Tier 2 cities in Tamil Nadu, India. These considerations may be relevant to similar urban and semi-urban GST settings, particularly if blockchain-enabled features are considered for taxation processes. However, given the purposive non-probability sampling approach and geographical coverage of the study, the findings should not be interpreted as providing nationally representative evidence or as directly applicable to all Indian GST taxpayers, particularly those in rural areas and other states.

First, the relationship between Human-Centric Technological Capability and Tax Compliance Intention highlights the importance of taxpayer capability in future digital-tax transformation within contexts similar to the sampled cities. Tax authorities operating in comparable urban and semi-urban settings in Tamil Nadu may consider preparing specific programmes, training, guidance materials, and support mechanisms to help taxpayers and businesses understand and participate in emerging digital-tax processes. The suitability and effectiveness of such initiatives in rural areas and other Indian states would require further investigation.

Secondly, the future development of a blockchain-based GST application may include appropriate protections with regard to Data Privacy, Cyber security, Procedural fairness, and mechanisms for dealing with errors in the system or difficulties with Technology compliance. These considerations can help to guarantee that technological transformation is aligned with human-centered principles.

These policy implications are provided to aid in further consideration of possible applications of the GST to blockchain and are not intended as policy recommendations for a running blockchain tax regime. The present study examines taxpayers' perceptions and expectations regarding a potential blockchain-enabled taxation environment; therefore, further evidence from actual implementation would be required to assess the effectiveness of specific policy measures.

Furthermore, these policy considerations are limited to the geographical and respondent characteristics of the present sample and should not be treated as direct policy recommendations for nationwide implementation without evidence from more geographically diverse and representative samples.

5.7 Limitations and future research

This study has several limitations that provide opportunities for future research.

First, the study uses cross-sectional data, which limits the ability to establish temporal relationships and stronger causal inferences, including the directionality between Perceived Blockchain Adoption Readiness and Human-Centric Technological Capability. Future longitudinal or panel research could examine their potential reciprocal relationship and the dynamics of Tax Compliance Intention.

Second, the study findings capture taxpayers' perceived readiness and expectations toward potential blockchain-enabled taxation rather than their actual responses following implementation. Should blockchain-enabled tax systems be operationalised in the future, subsequent research could revisit these relationships using evidence from actual implementation to examine whether perceived readiness is associated with actual

technology use and tax compliance behaviour. In addition, the study did not estimate an alternative structural model incorporating the direct paths from PBAR to TCI, PBAR to ST, and HCTC to ST; therefore, the robustness of the proposed indirect relationships to these alternative paths remains unverified. Future research should examine these alternative structural relationships and investigate temporal ordering using longitudinal data.

Third, although Harman's single-factor test and the full-collinearity VIF approach provided no indication of substantial common method bias, the possibility of residual bias arising from the cross-sectional, self-reported data cannot be completely ruled out. Future studies could address this limitation by incorporating multiple data sources, administrative tax records, and behavioural measures, alongside additional statistical techniques such as marker-variable approaches or an unmeasured latent method factor, where appropriate.

Fourth, the purposive non-probability sample from selected Tier 1 and Tier 2 cities in Tamil Nadu limits the generalisability of the findings. The results cannot statistically represent all GST taxpayers in Tamil Nadu or India, particularly rural taxpayers and those in other states. Future studies should use probability-based sampling across urban, semi-urban, and rural areas and include other stakeholders, such as tax practitioners and administrators, to validate the findings.

Although the study included respondents with diverse demographic and business characteristics, measurement invariance across subgroups based on age, educational qualification, business turnover, and blockchain awareness was not assessed. Therefore, the equivalence of the measurement model across these groups remains unverified. Future research should employ the Measurement Invariance of Composite Models (MICOM) procedure and, where subgroup sample sizes are adequate, conduct multi-group analysis to examine whether the structural relationships differ between respondents with lower and higher levels of blockchain awareness.

6 Conclusion

This study examined the relationships between Perceived Blockchain Adoption Readiness and taxpayers' perceptions of the potential sustainability-related benefits of technology-enabled taxation through a human-centric behavioural framework. Drawing on the Stimulus–Organism–Response (S-O-R) perspective, the study examined Human-Centric Technological Capability and Tax Compliance Intention as sequential mediating mechanisms and Perceived Blockchain Transparency as a moderator.

The empirical findings, based on 463 GST-registered taxpayers from selected Tier 1 and Tier 2 cities in Tamil Nadu, India, indicate that Perceived Blockchain Adoption Readiness is positively associated with Human-Centric Technological Capability, which is in turn positively associated with Tax Compliance Intention. Tax Compliance Intention is also positively associated with taxpayers' perceptions of Sustainable Taxation. The mediation results further identify an indirect pathway linking perceived blockchain readiness with these sustainability-related perceptions through human-centric capability and compliance intention. In addition, Perceived Blockchain Transparency positively moderates the relationship between Human-Centric Technological Capability and Tax Compliance Intention, indicating that this association is stronger at higher levels of perceived transparency.

The study contributes to the digital taxation literature by highlighting the importance of human capability and behavioural intention in understanding taxpayers' responses to potential blockchain-enabled taxation. It also extends the application of the S-O-R framework by identifying a sequential human-centric pathway and a contextual role for perceived transparency. These findings suggest that future digital-tax transformation should consider taxpayer capabilities, transparency, accessibility, and human-centred system design alongside technological development.

However, the findings should be interpreted within the scope of the study. The cross-sectional design does not establish causal or temporal relationships, and the measures capture taxpayers' perceptions and intentions rather than actual blockchain adoption or improvements in tax-system sustainability. Furthermore, the purposive non-probability sample from selected Tier 1 and Tier 2 cities in Tamil Nadu does not statistically represent all GST taxpayers in Tamil Nadu or India. Future research using longitudinal designs, actual implementation data, and geographically diverse probability-based samples could further validate and extend the proposed framework.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The Institutional Ethics Committee (Human Studies), Vellore Institute of Technology (VIT) reviewed and approved this study before data collection. The approval number for the study is VITBS/IECH/2026/2 March 2026/023. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MR: Investigation, Methodology, Data curation, Writing – review & editing, Conceptualization, Software, Visualization, Formal Analysis, Writing – original draft. SN: Resources, Writing – original draft, Investigation, Conceptualization, Validation, Writing – review & editing, Funding acquisition, Methodology, Supervision.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declared that generative AI was not used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/journals/human-dynamics/articles/10.3389/fhumd.2026.1983558/full#supplementary-material

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