

Data Analytics for Financial Literacy and Voluntary Tax Compliance Among Small Business Owners

**Leonard U. Agwuna^{1*}, Oluwatobiloba Mide-Ibrahim², Rosita Ebere Daraojimba³, Valentina
Ochuko Obukadata⁴, Rosalyn Ezeako⁵**

¹ School of Commerce, University of KwaZulu-Natal, Durban, South Africa

² FinServe Pro, USA

³ First Bank of Nigeria Plc, Lagos, Nigeria

⁴ Valmena Signatures, Nigeria

⁵ Firma Divina Projects

* Corresponding author: Leonard U. Agwuna, lagwuna@gmail.com

Abstract

Purpose: Small business owners account for a large share of the tax gap, yet much of their noncompliance reflects confusion, poor records and disproportionate compliance costs rather than deliberate evasion. This article asks how descriptive, diagnostic, segmentation, survey and behavioural analytics can connect financial literacy to voluntary tax compliance without collapsing support into enforcement. **Design:** A critical integrative review combines deterrence economics, the slippery slope framework of trust and power, tax morale research, financial capability measurement and compliance cost studies, appraised under a predefined protocol with a publication window ending in 2024. **Findings:** Financial education reliably raises knowledge but transfers weakly to behaviour; simple rules of thumb and record-keeping routines transfer better than conceptual training. Trust in the tax authority conditions whether better understanding produces voluntary rather than grudging or avoidant compliance, and compliance costs fall most heavily on the least literate owners. **Contribution:** The article proposes the Financial Literacy, Trust and Compliance Analytics (FLiTCA) framework, which separates can-not, know-not and will-not barriers, matches segments to education, simplification or service remedies, and ranks owners by expected benefit of help rather than by suspected evasion. Seven falsifiable propositions and a stepped-wedge validation design are specified. **Implications:** Administrations should measure tax-specific literacy directly, firewall support analytics from audit selection, and judge programmes by voluntary filing, accuracy and trust rather than outreach volume.

Keywords: financial literacy, tax literacy, voluntary tax compliance, slippery slope framework, tax morale, customer segmentation, survey analytics, small business

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1 Introduction

1.1 Problem Setting and Motivation

Small and micro enterprises are simultaneously the most numerous taxpayers in most economies and the group whose compliance is hardest to verify. Owner-operated firms receive much of their revenue in cash or through platforms with patchy reporting, keep records of uneven quality and settle obligations through self-assessment. Reviews of the enforcement literature consistently find that noncompliance is concentrated precisely where third-party information is weakest, which is why the small business segment carries a disproportionate share of estimated tax gaps (Slemrod, 2019; Alm, 2019). The policy question is not only how to detect underreporting but how to help the large population of owners who intend to comply yet misunderstand deadlines, mix personal and business funds, misclassify expenses or miss payments because cash flow is volatile.

Data analytics has entered this space from two directions. Tax administrations have built risk engines that rank returns for audit, while financial service providers, accounting software vendors and advisory programmes increasingly use behavioural data to target education, reminders and bookkeeping support. The second use is the subject of this article. Yet the evidence base that links these tools to financial literacy and then to voluntary compliance is fragmented across consumer finance, public economics, fiscal psychology and information systems, and it is rarely assembled into a model that says which analytic output should trigger which support decision (Medon & Oduleye, 2024; Tonoyan et al., 2024b).

A further motivation is conceptual. Much applied work assumes a simple chain in which more financial knowledge produces better records, which produce more accurate returns. The financial education literature shows that knowledge gains transfer only partly to behaviour (Kaiser et al., 2022; Hastings et al., 2013), and the fiscal psychology literature shows that the same objective enforcement environment produces voluntary cooperation in one population and grudging, minimal compliance in another depending on trust in the authority (Wahl et al., 2010; Kirchler, 2007). An analytics programme that measures knowledge but ignores trust and burden will therefore misattribute its successes and failures.

1.2 Research Gap, Questions and Contributions

Three gaps motivate the review. First, studies of financial literacy among small business owners typically measure general numeracy and concepts such as interest compounding and diversification, whereas the knowledge that plausibly governs compliance is tax-specific: which obligations apply, when they fall due, what counts as a deductible expense and how to correct an error. Second, compliance research that incorporates trust and power rarely models literacy, while literacy research rarely models the tax authority as a relationship partner (Kirchler et al., 2008; Atkinson & Messy, 2012). Third, the analytics literature on small firms concentrates on prediction, particularly credit and audit risk, and offers little guidance on descriptive, diagnostic and experimental analytics whose purpose is to decide what help to offer (Adesuyi et al., 2024; Mbonu et al., 2021a).

The review is organised around four research questions. RQ1 asks which theoretical mechanisms link financial and tax literacy to voluntary, as distinct from enforced, compliance among small business owners. RQ2 asks which descriptive, diagnostic, segmentation, survey and behavioural analytic techniques can measure those mechanisms validly given the data realistically available about small firms.

RQ3 asks where the empirical evidence converges, where it conflicts and how the conflicts can be adjudicated. RQ4 asks what governance arrangements are required so that literacy-oriented analytics strengthens rather than undermines trust (Alm, 2019; Page et al., 2021).

The article makes four contributions. (1) It integrates the Allingham-Sandmo deterrence model, the slippery slope framework, tax morale and compliance cost research with financial capability measurement into a single causal account in which literacy operates through record quality and is moderated by trust and burden. (2) It specifies an analytics toolkit, with formal metrics and estimands, that distinguishes can-not (capacity and cost), know-not (knowledge) and will-not (motivation) barriers instead of pooling them into one risk score. (3) It proposes the Financial Literacy, Trust and Compliance Analytics (FLiTCA) framework with segment archetypes, matched interventions and seven falsifiable propositions. (4) It sets out a stepped-wedge validation design and a data governance firewall that separates support analytics from audit selection, together with threats to validity specific to survey and administrative data on small firms (Hevner et al., 2004; Wieringa, 2014). The propositions are theoretical claims drawn from the reviewed evidence; they are not reported as tested results.

2 Theoretical Foundations

2.1 Deterrence Economics: The Allingham-Sandmo Baseline and Its Limits

The canonical economic account treats reporting as a gamble. In the Allingham-Sandmo formulation, as reviewed by Slemrod (2019), a taxpayer with true income W chooses declared income X to maximise expected utility under an audit probability p , a tax rate θ and a penalty rate π applied to evaded tax:

$$E[U] = (1 - p) U(W - \theta X) + p U(W - \theta X - \pi\theta(W - X)) \quad (1)$$

The model predicts that compliance rises with p and π , and it provides the logic behind risk-based audit selection. Its well-known empirical difficulty is that observed compliance is far higher than the model implies at realistic audit rates and penalty levels, which implies that nonpecuniary motives, social norms and the perceived legitimacy of the authority carry much of the explanatory weight (Alm, 2019). For the present topic the model has a second and less discussed limitation: it assumes the taxpayer knows W , knows θ and understands the rules that map transactions into taxable income. For an owner with incomplete records and limited tax knowledge, the declared figure X differs from W because of error rather than choice, and deterrence parameters have no purchase on error. Financial and tax literacy therefore enter the deterrence model not as a preference term but as the precision with which the taxpayer observes W and the rules, a point that justifies measuring literacy separately from motivation (Kirchler, 2007; Bola-Sadipe et al., 2019).

2.2 The Slippery Slope Framework: Trust, Power and Voluntary Compliance

The slippery slope framework reframes compliance as an outcome of the relationship between taxpayers and the authority along two dimensions: trust in the authority and the perceived power of the authority to detect and sanction (Kirchler et al., 2008). Power primarily produces enforced compliance, in which taxpayers pay because they fear the consequences of not paying, while trust primarily produces voluntary compliance, in which taxpayers pay because they regard it as a civic obligation discharged toward a fair

and competent institution. Experimental evidence supports the separation. Wahl et al. (2010) manipulated descriptions of trustworthiness and power and found that both raised compliance, but that trust mainly increased voluntary compliance and power mainly increased enforced compliance, with the highest levels where both were high.

The framework matters for analytics because analytic contact is itself a signal of power. A reminder letter that cites detection capabilities, a dashboard that visibly ranks owners by risk or an unexplained information request all communicate power, and if that power is experienced as arbitrary rather than legitimate, it can shift owners from voluntary toward enforced compliance or toward avoidance (Kirchler, 2007). Conversely, analytics that produces a timely, accurate and helpful intervention, such as a correct pre-filled figure or a reminder that arrives before a deadline rather than a penalty notice after it, signals competence and benevolence, the two components of institutional trustworthiness stressed in the fiscal psychology tradition (Wahl et al., 2010). The FLITCA framework accordingly treats every analytic touchpoint as a trust event whose effect on perceived trust and perceived legitimacy should be measured, not assumed (Lilian et al., 2020).

2.3 Tax Morale and Perceived Fairness

Tax morale denotes the intrinsic motivation to pay taxes, the willingness that persists after expected penalties are accounted for. Reviews identify several correlates that are relevant to small firms: perceived distributive fairness of the tax burden, procedural fairness in how the authority treats taxpayers, retributive fairness in how evaders are punished, social norms about what peers do, and reciprocity for public goods received (Alm, 2019; Kirchler, 2007). Owners of small firms often experience procedural unfairness most directly, because they deal with the authority without the intermediaries that large firms employ and because rules written for complex entities are applied to them without adaptation. When procedural fairness is low, even knowledgeable owners may treat the tax system as an adversary and use their knowledge for avoidance rather than accurate reporting (Slemrod, 2019).

Tax morale has two implications for analytics. The first concerns measurement: morale is a latent attitude measured by survey items that are vulnerable to social desirability, so survey analytics must validate the scale and, for sensitive behaviours, use indirect elicitation methods discussed in Section 4.4. The second concerns interpretation: an intervention that raises knowledge without addressing perceived fairness may produce a null or even negative effect on voluntary compliance, and an evaluation that measures only knowledge would record success where the compliance outcome shows failure. Cross-cultural research on communication and identity also shows that the meaning of fairness and reciprocity varies across communities, which argues for testing measurement invariance before comparing morale scores across language or ethnic groups of owners (Lilian et al., 2020; Amayo et al., 2023c).

2.4 Financial Literacy, Tax Literacy and Financial Capability

Financial literacy is usually defined as the combination of knowledge, skills, attitudes and behaviours needed to make sound financial decisions. The OECD/INFE pilot operationalised it through three components: financial knowledge items on concepts such as simple and compound interest, inflation and risk diversification; financial behaviour items such as budgeting, paying bills on time and monitoring finances; and attitude items such as preference for the short term over the long term (Atkinson & Messy, 2012). Financial capability extends the concept to include the opportunity to act, recognising that

knowledge is ineffective without access to suitable products and channels (Miller et al., 2015). Perceived financial well-being, in turn, captures the subjective outcome and separates current money management stress from expected future security (Netemeyer et al., 2018). For small business owners, current money management stress is a plausible mechanism linking cash-flow volatility to missed tax payments independent of knowledge.

Tax literacy is narrower and, for compliance, more proximal. It comprises knowledge of which taxes apply to the enterprise, filing and payment calendars, registration thresholds, the distinction between business and personal expenses, record retention requirements and the procedure for correcting an error. A review of education interventions shows that effects are largest on the specific knowledge taught and attenuate as outcomes become more distal (Kaiser et al., 2022), which predicts that tax-specific literacy should outperform general financial literacy as a predictor of compliance. Financial literacy nonetheless remains relevant through record-keeping and cash management: an owner who separates business and household accounts and reconciles them monthly can compute taxable income accurately, whereas one who does not will misreport regardless of intent (Drexler et al., 2014; Dogbatsey et al., 2019). The framework therefore models general financial literacy as an upstream influence on record quality and tax literacy as a direct influence on filing accuracy.

2.5 Compliance Costs and the Regressive Burden on Small Firms

Compliance costs comprise the time owners spend on record-keeping, return preparation and dealings with the authority, fees paid to accountants and software providers, and the psychological costs of uncertainty and anxiety. Because much of this cost is fixed with respect to turnover, it is regressive: studies repeatedly find that compliance costs as a proportion of turnover are highest for the smallest firms (Slemrod, 2019). The Standard Cost Model used by many administrations estimates administrative burden as the product of the time required for each information obligation, the hourly cost of that time and the number of firms and occurrences affected, which makes the burden measurable and comparable across reforms. For the present review the key point is interaction with literacy: a low-literacy owner takes longer to complete each obligation, pays more for advice and makes more errors, so the same rule imposes a higher effective burden on exactly the owners least able to bear it (Ambali et al., 2021; Eyetsemitan et al., 2022).

Burden also interacts with trust. Complex, frequently changing rules are experienced as evidence that the system is not designed with small firms in mind, which depresses procedural fairness and tax morale (Alm, 2019). Simplification measures such as presumptive regimes, turnover-based taxes, pre-filled returns and single-window registration reduce both the objective cost and the perceived unfairness, but they can also reduce the owner's need to understand the underlying rules. This creates a genuine policy trade-off that analytics can illuminate: for some segments, simplification may substitute for literacy education, while for others, simplification without understanding may leave owners exposed when they grow beyond the simplified regime (Eyetsemitan et al., 2023a; Akin-Oluyomi & Akhigbe, 2022). Proposition P4 in Section 6.3 formalises this substitution hypothesis.

2.6 Digital Engagement as the Channel of Analytics

Analytics reaches small business owners through digital channels: e-filing portals, mobile tax applications, SMS reminders, cloud accounting software, mobile money platforms and messaging

services. Digital engagement is therefore both a data source, since logins, abandoned sessions and help requests are observable behavioural signals, and the delivery channel for any intervention. The financial inclusion evidence shows that digital channels can extend services to previously unserved populations, but access, identity verification and digital skills are unevenly distributed (World Bank, 2014; Kumuyi et al., 2024b). Adoption studies of web-based payment portals in Sub-Saharan Africa emphasise perceived usefulness, ease of use, trust in the platform and infrastructure reliability as determinants of uptake (Agyei et al., 2019).

Two consequences follow. First, digital engagement data are missing not at random: owners who never log in are disproportionately those with low literacy, poor connectivity or low trust, so analytics built on platform logs systematically under-represents the owners who most need support. Second, digital-first delivery can widen compliance gaps if it improves service for engaged owners while leaving others with degraded offline channels (Michael & Ogunsola, 2023b; Jones & Ominyi, 2024b). Small business owners also frequently conduct business on personal devices, which raises information security and privacy obligations for any provider that collects their financial data, a concern documented in studies of bring-your-own-device practices and access control (Onche et al., 2023; Ladapo et al., 2023b). The framework therefore treats digital engagement as a moderator of intervention reach and as a source of selection bias that must be corrected rather than as an outcome in itself.

3 Review Protocol

3.1 Review Type and Design Rationale

The study is a critical integrative review rather than a statistical meta-analysis. The evidence is methodologically heterogeneous: randomized field experiments on financial education and tax letters, laboratory experiments on trust and power, cross-sectional surveys of owners, administrative data studies, design-oriented work on analytics systems and conceptual reviews. Pooling effect sizes across these designs would obscure rather than clarify, because the outcomes (knowledge scores, record quality, filing timeliness, declared income) are not commensurable. An integrative review allows these streams to be compared on mechanism and context and then synthesised into a model that generates testable propositions (Easterbrook et al., 2008; Dybå & Dingsøyr, 2008). The review follows the transparency expectations of the PRISMA 2020 statement where they apply to a non-meta-analytic synthesis, reporting sources, eligibility criteria, screening stages and appraisal logic, while not presenting flow counts as though the synthesis were a systematic effect estimate (Page et al., 2021).

The design science tradition provides the second methodological anchor. The FLITCA framework is an artefact intended to guide analytics practice, so its evaluation criteria include utility, coherence with kernel theories and testability, not only fit with past findings (Hevner et al., 2004; Wieringa, 2014). The review therefore extracts two kinds of material: empirical findings about mechanisms, and design knowledge about how analytics systems for financial oversight, performance monitoring and decision support are built and governed (Abetoh & Atakpa, 2024; Adelanwa et al., 2024).

3.2 Sources, Search Strings and Eligibility

Searches were specified for Scopus, Web of Science Core Collection, EconLit, SSRN, the IDEAS/RePEc index and Google Scholar, supplemented by the publication series of the OECD, the World Bank and national revenue administrations, with a publication window from January 2000 to December 2024 and a small number of earlier foundational works. The core search string combined three concept blocks: ("financial literacy" OR "tax literacy" OR "tax knowledge" OR "financial capability" OR "financial education") AND ("tax compliance" OR "voluntary compliance" OR "tax morale" OR "filing" OR "compliance cost*") AND ("small business*" OR SME* OR "micro enterprise*" OR entrepreneur* OR "self-employed"). A second string replaced the first block with analytics terms ("segmentation" OR "cluster analysis" OR "latent class" OR "survey" OR "behavioural insight*" OR "nudge" OR "randomi?ed" OR "dashboard"). A third string targeted trust and power ("slippery slope" OR "trust in authorit*" OR "enforced compliance"). Backward and forward citation tracking from the anchor works on the slippery slope framework and financial education meta-analyses completed identification (Kirchler et al., 2008; Kaiser et al., 2022).

Inclusion required that a source report empirical evidence, a validated measurement instrument, a formal model, a standard or a fully specified conceptual framework bearing on at least one FLiTCA construct: financial literacy, tax literacy, record quality, trust, perceived power, tax morale, compliance cost, digital engagement or a voluntary compliance outcome. Sources on analytics methods from adjacent domains, such as performance dashboards, audit analytics and data governance in regulated industries, were eligible when they informed a measurement or governance choice rather than a substantive claim about taxpayers (Tonoyan et al., 2024b; Atakpa & Abolaji, 2022). Exclusion applied to opinion pieces without argument, vendor material, studies of large corporate taxpayers whose compliance is driven by professional advisers, and studies using audit selection accuracy as the sole outcome, since that outcome speaks to enforcement analytics rather than literacy support (Gotel & Finkelstein, 1994).

3.3 Screening, Appraisal and Synthesis Logic

Screening was designed in three stages: title and abstract screening against the concept blocks, full-text screening against the eligibility criteria, and a relevance check that each retained source informs a named construct, mechanism, boundary condition or governance decision. Appraisal used a design-specific checklist. For randomized studies it covered allocation, attrition, outcome measurement and whether effects were reported on behaviour rather than self-reported knowledge alone. For observational studies it covered sampling frame, confounding control, temporal ordering between literacy and compliance measures, and whether compliance was measured administratively or by self-report. For survey instruments it covered reported reliability, dimensionality testing and invariance evidence. Conceptual sources were judged on coherence and proportionality of claims (Mairiza et al., 2010).

Synthesis followed a mechanism, context and outcome logic. Each finding was coded to the construct it informs, the direction and conditionality of its effect, the population and institutional setting, and the strength of design. Findings were then grouped into evidence streams, and within each stream the synthesis looked explicitly for disagreement: where two credible studies reach different conclusions, the difference was traced to population, measure, outcome or institutional context before any conclusion was drawn. Traceability between each proposition and the evidence supporting it was recorded in an evidence

matrix, following the logic of requirements traceability in which every claim should be linked backward to its source and forward to its test (Ramesh & Jarke, 2001; Cleland-Huang et al., 2012). Table 1 summarises the protocol decisions, and Figure 1 shows the flow from identification to framework construction.

Table 1. Review protocol for literacy-oriented tax compliance analytics

Protocol element	Specification for this review	Safeguard against bias
Databases and grey literature	Scopus, Web of Science, EconLit, SSRN, RePEc; OECD, World Bank and revenue administration series	Grey literature appraised with the same checklist as journal articles
Window and language	January 2000 to December 2024, English; earlier foundational models retained	Foundational works used for theory only, not as current effect estimates
Concept blocks	Literacy and capability; compliance, morale and cost; small firms; analytics; trust and power	Three strings run separately so no block dominates retrieval
Inclusion	Evidence on a FLiTCA construct among owners or self-employed; methods sources that inform measurement or governance	Relevance check links each source to a named construct or decision
Exclusion	Large corporate taxpayers; vendor material; audit-selection accuracy as sole outcome	Exclusion reason logged at full-text stage
Appraisal	Design-specific checklists for trials, observational studies, instruments and conceptual work	Self-reported compliance flagged and weighted below administrative outcomes
Synthesis	Mechanism, context and outcome coding with explicit adjudication of conflicting findings	Null and adverse results retained in the evidence matrix

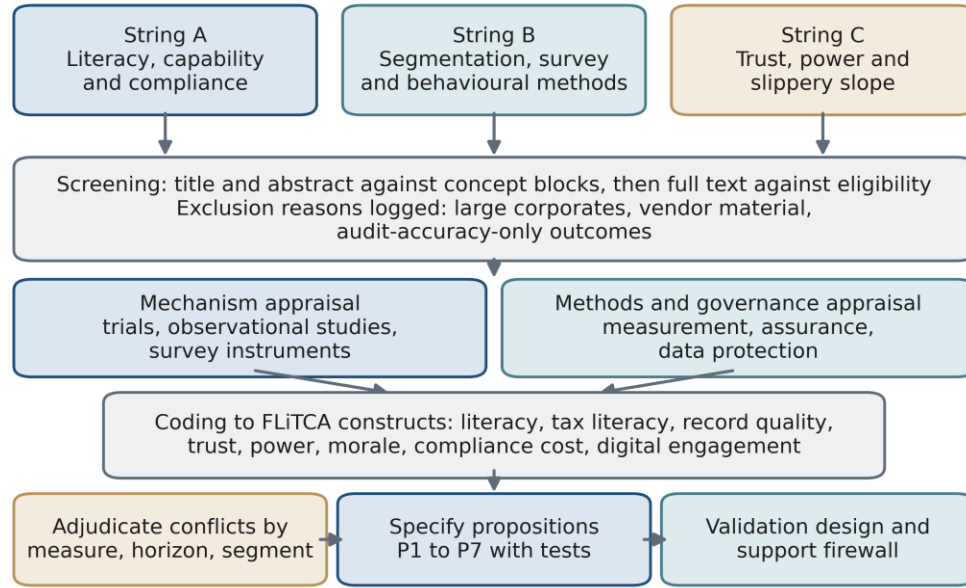


Figure 1. Review workflow from identification of evidence streams to proposition specification

Figure 1 shows that the three search strings feed parallel streams that are screened and appraised separately before being coded to FLitCA constructs. In the final stages each proposition is traced to at least two evidence streams and given a falsification test (Winkler & von Pilgrim, 2010; De Lucia et al., 2007).

4 Analytics Toolkit for Literacy-Oriented Compliance Support

4.1 Descriptive Analytics: Literacy and Compliance Baselines

Descriptive analytics establishes where owners stand before anything is changed. On the compliance side, the four conventional components of compliance (registration, timely filing, accurate reporting and timely payment) should be measured separately because they have different causes. For a cohort of registered owners with expected returns R in period t , the filing timeliness rate and the payment timeliness rate are defined as

$$FTR_t = \frac{\text{returns filed by due date}}{\text{returns expected}}, \quad PTR_t = \frac{\text{liability paid by due date}}{\text{liability assessed}} \quad (2)$$

Accuracy is harder to observe without audit, and for a support-oriented programme it should not be inferred from audit outcomes. Two non-enforcement proxies are available: the voluntary self-correction rate, the proportion of returns amended by the owner before any authority contact, and the arithmetic and classification error rate detected by validation rules at submission, such as a VAT return whose output tax does not reconcile with reported sales. Self-correction is particularly informative because it is a direct behavioural expression of voluntary compliance: an owner who discovers an error and corrects it without being asked is displaying exactly the disposition the slippery slope framework associates with trust (Kirchler et al., 2008; Bola-Sadipe et al., 2022).

On the literacy side, a composite index following the OECD/INFE structure sums knowledge, behaviour and attitude components, but for this purpose it should be complemented by a tax literacy module covering the enterprise's own obligations (Atkinson & Messy, 2012). Help-desk queries and complaints are an underused descriptive source, since complaint text reveals systematic confusion before it appears in filing data (Adeyelu, 2018). Dashboards for programme managers should display each indicator with its numerator, denominator, period and data source, and they should show the trend of compliance components for each literacy band so that divergence is visible (Ogbole et al., 2021; Tonoyan et al., 2024b). KPI design research in commercial organisations warns that indicators without an owner and an associated action degrade into reporting rituals, a warning that applies directly to compliance dashboards (Sakyi et al., 2022b; Edivri & Oteri, 2024).

4.2 Diagnostic Analytics: Separating Know-Not, Can-Not and Will-Not

Diagnostic analytics asks why a compliance gap exists. The central diagnostic contribution of this article is the separation of three barrier types that risk models typically pool. Know-not barriers are knowledge deficits: the owner does not know an obligation exists or how to meet it. Can-not barriers are capacity and cost constraints: the owner knows the obligation but lacks records, time, cash or channel access to meet it. Will-not barriers are motivational: the owner knows and can comply but chooses not to because of low morale, distrust or a deliberate evasion calculation. Each barrier calls for a different remedy (education, simplification or service, and dialogue or legitimate enforcement respectively), and misdiagnosis is costly: treating a know-not owner as will-not wastes enforcement resources and damages trust, while treating a will-not owner as know-not wastes education resources (Alm, 2019; Kirchler, 2007).

A baseline diagnostic model for timely filing F among owner i can be written as a logistic regression with an interaction between tax literacy L and trust T , controlling for compliance cost C , record quality Q and covariates X :

$$\text{logitPr}(F_i = 1) = \beta_0 + \beta_1 L_i + \beta_2 T_i + \beta_3 (L_i \times T_i) + \beta_4 C_i + \beta_5 Q_i + \gamma' X_i \quad (3)$$

The coefficient of interest for the slippery slope hypothesis is β_3 , and the mediation question, whether literacy works through record quality, is addressed by estimating the indirect effect of L on F through Q with bootstrapped confidence intervals, preferably in panel data so that literacy is measured before record quality and record quality before filing. Moderated mediation extends this to ask whether the indirect path is stronger when trust is high. Decomposition methods can partition a compliance gap between groups into portions explained by literacy, cost and trust (Medon & Oduleye, 2024; Filani et al., 2023).

4.3 Segmentation: Grouping Owners by Support Need

Segmentation translates diagnostic insight into operational groups that can receive different support. Because the relevant indicators mix continuous scores (literacy, trust), ordinal responses (perceived burden) and categorical attributes (sector, registration regime, channel preference), mixed-data methods are appropriate. Latent class analysis models the joint distribution of indicators as a mixture of K classes and selects K by the Bayesian information criterion together with interpretability, while k -prototypes clustering combines Euclidean distance on numeric variables with a matching dissimilarity on categorical ones. Segment stability should be checked by bootstrap resampling, with the adjusted Rand index

between original and resampled solutions reported; segments that dissolve under resampling cannot anchor a programme (Sakyi et al., 2022a; Sanni et al., 2022).

Customer analytics and marketing research provide the operational discipline for segment use, including the link between service analytics and sustained relationships (Sakyi et al., 2022). Attribution modelling shows how easily outcomes are credited to the last contact rather than to the sequence of contacts that produced them, a bias that affects evaluation of multi-touch compliance campaigns (Sanni et al., 2022). Federated and lifecycle-aware data management allows such analysis across partners without pooling raw records (Sanni et al., 2023). Funnel analysis identifies where owners drop out of a process, such as registration started but not completed, which is a direct pointer to can-not barriers (Sanni & Wedraogo, 2024). Process optimisation frameworks for micro-enterprises apply the same funnel and bottleneck logic inside the firm, which helps a support programme locate whether an owner's difficulty lies in record capture, reconciliation or submission (Eyetsemitan et al., 2024b). Forecasting research on cross-channel campaigns stresses that uncertainty around predicted response should be reported rather than suppressed (Wedraogo & Sanni, 2024). Two constraints distinguish compliance segmentation from commercial practice. Segment definitions must avoid protected attributes as direct inputs, and the allocation of support must be auditable for disparate treatment, since a segmentation that concentrates reminders on one community and education on another could itself be perceived as unfair (Komi, 2023; Uchechi et al., 2022).

4.4 Survey Analytics: Valid Measurement of Latent Constructs

Literacy, trust, perceived power, tax morale and perceived burden are latent constructs measured by questionnaire, so their quality depends on psychometric validation. Internal consistency should be reported with both Cronbach's alpha and McDonald's omega, since alpha assumes equal loadings that rarely hold. For k items with variances σ_i^2 and total score variance σ_x^2 ,

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum_i \sigma_i^2}{\sigma_x^2} \right) \quad (4)$$

Dimensionality should be tested by confirmatory factor analysis, checking that trust and perceived power load on separate factors as the slippery slope framework requires, and reporting conventional fit indices such as the comparative fit index and the root mean square error of approximation. Where owners are compared across languages, regions or sectors, measurement invariance should be tested in the sequence of configural, metric and scalar models; without scalar invariance, differences in mean trust between groups cannot be interpreted as real differences (Netemeyer et al., 2018; Atkinson & Messy, 2012).

Compliance items are sensitive, and direct questions about underreporting invite socially desirable answers. Indirect methods reduce this bias. In the list experiment, respondents are randomly assigned to report how many items on a list apply to them, with the treatment list including the sensitive behaviour; the difference in mean counts estimates prevalence without any individual disclosing. Randomized response techniques achieve a similar protection by introducing a known random component into each answer. Survey data should, wherever consent permits, be linked to administrative filing records so that self-reported compliance can be validated, and the linkage itself requires a documented purpose limitation (Aliliele et al., 2024a; Atakpa & Abolaji, 2022). Where open-ended responses, adviser notes and administrative records must be combined, AI-enabled methods for synthesising stakeholder

survey data can speed coding and triangulation, provided that automated classifications are checked against a human-coded sample (Obukadata et al., 2024).

4.5 Behavioural Insight and Experimental Analytics

Behavioural analytics tests which interventions change behaviour. Randomized trials of letters, text reminders and simplified forms have become the standard evaluation instrument for tax communications (Slemrod, 2019). Relevant message families include deadline reminders, social norm messages stating that most local businesses file on time, public goods messages linking taxes to visible services, deterrence messages emphasising detection, and procedural messages explaining how to get help. The slippery slope framework predicts that their effects on voluntary compliance should differ: norm, public goods and help messages should work through trust and morale, while deterrence messages work through perceived power and may reduce morale among owners who were already trying to comply (Kirchler et al., 2008; Wahl et al., 2010).

For targeting support, the correct estimand is the conditional average treatment effect, the expected improvement in compliance if an owner with characteristics x receives the intervention:

$$\tau(x) = E[Y_i(1) - Y_i(0) | X_i = x] \quad (5)$$

Ranking owners by estimated $\tau(x)$, known as uplift targeting and evaluated by Qini or uplift curves, directs help to those who will benefit from it. This is conceptually distinct from ranking by the probability of noncompliance, which directs attention to those most likely to fail whether or not help would change the result. The distinction is the analytic core of support-oriented compliance analytics: a high-risk owner with a will-not profile may have low uplift from education, while a moderate-risk owner with a know-not profile may have high uplift (Borah et al., 2022; Nnabueze et al., 2023).

5 Evidence Synthesis

5.1 From Financial Knowledge to Compliance Behaviour

The strongest and most consistent finding in the education literature is that interventions raise knowledge. A meta-analysis of randomized experiments found that financial education improves financial knowledge by an amount comparable to other educational interventions and improves downstream behaviours such as budgeting, saving and credit management by smaller amounts (Kaiser et al., 2022). Earlier reviews were more pessimistic about causal evidence (Hastings et al., 2013; Collins & O'Rourke, 2010), but the positions are reconcilable. Knowledge effects are robust; behavioural effects exist but are smaller, decay over time and depend on the proximity between what is taught and the behaviour measured. A review focused on developing economies similarly reports positive effects on savings and record-keeping but weaker effects on outcomes such as loan repayment (Miller et al., 2015).

The most directly relevant evidence for small business owners comes from comparing training formats. In a field experiment with microentrepreneurs, rule-of-thumb training that taught simple heuristics, such as keeping business and personal cash in separate drawers and paying oneself a fixed salary, improved record-keeping and financial practices, whereas standard accounting training did not produce comparable improvements (Drexler et al., 2014). This finding carries two implications for tax compliance. The first is

that record quality, the mediator in the FLITCA model, is more responsive to behavioural routines than to conceptual knowledge. The second is that the owners who benefit most from simplified heuristics are those with the lowest baseline skills, which aligns with the regressive burden argument of Section 2.5.

Evidence on tax-specific knowledge is thinner but consistent with the proximity principle. The fiscal psychology literature documents that subjective understanding of tax law is low among self-employed taxpayers and that complexity is associated with both unintentional errors and the perception that the system is unfair (Kirchler, 2007). Studies of data-driven reporting systems in regulated institutions show that automated validation at the point of submission catches classification errors that education alone does not prevent (Bola-Sadipe et al., 2022). The adjudicated conclusion for RQ3 is that literacy is necessary for voluntary compliance but operates mainly through record-keeping routines and tax-specific knowledge, and that general financial literacy scores are weak direct predictors of filing behaviour.

5.2 Trust and Power as Moderators of Literacy Effects

The slippery slope evidence supports three claims relevant to literacy. First, trust and power are empirically separable and have distinct effects on voluntary and enforced compliance (Wahl et al., 2010). Second, voluntary compliance is associated with trust in the authority's competence and fairness rather than with fear of detection (Kirchler et al., 2008). Third, broader reviews of compliance motivation conclude that deterrence explains only part of observed compliance and that norms, morale and legitimacy explain much of the remainder (Alm, 2019). Taken together, these findings imply that the compliance consequences of literacy depend on the trust context. An owner who understands the rules and trusts the authority has both the ability and the motive to report accurately. An owner who understands the rules but distrusts the authority has the ability to report accurately but also the ability to exploit ambiguity, so rising literacy in a low-trust context may increase aggressive avoidance rather than compliance.

The evidence for this moderation is suggestive rather than direct, and the review found no study that measured literacy, trust and administratively observed compliance in the same sample of small firms. The two literatures have simply developed in parallel. Organisational research on safety culture offers a useful analogy: training in hazard knowledge produces safer behaviour mainly where leadership has established a climate in which workers believe reporting will be treated fairly, and it produces concealment where they do not (Obogo et al., 2019a; Obogo et al., 2023). Studies of human error causation similarly distinguish slips arising from lack of knowledge from violations arising from motivational conditions, the same separation the know-not and will-not categories make for tax (Obriki & Arumosoye, 2020). Proposition P2 converts the trust moderation claim into a testable interaction.

5.3 Compliance Costs, Simplification and Record-Keeping

The compliance cost literature establishes regressivity, and the education literature establishes that simple routines outperform complex training for low-skill owners. Their combination suggests that simplification and literacy support are partial substitutes for the least literate owners and complements for more capable ones. Simplified regimes reduce the knowledge required to comply, so for owners near the bottom of the literacy distribution they may produce larger compliance gains than any feasible education programme (Slemrod, 2019). For owners with moderate literacy, simplification frees time and attention that can be used to maintain better records, so it complements education. The evidence on standard

operating procedures and Lean methods in small businesses supports the complementarity argument: structured routines reduce error and variability in small enterprises precisely because they externalise knowledge into process (Eyetsemitan et al., 2022; Ambali et al., 2021).

Evidence from accounting systems and reconciliation controls adds a practical dimension. Reconciliation routines and workflow redesign in emerging-market organisations reduce the gap between recorded and actual cash positions, which is the arithmetic precondition for accurate tax declarations (Dogbatsey et al., 2019). Strategic accounting systems that integrate bookkeeping with regulatory reporting reduce the number of separate compliance tasks (Bola-Sadipe et al., 2019), and CRM and workflow automation in small practices shows that automation reduces administrative time when it is matched to the actual process rather than imposed wholesale (Eyetsemitan et al., 2024a). Frameworks that translate obligations such as VAT, PAYE, withholding tax and income tax accounting into explicit SME compliance workflows pursue the same end, converting rule knowledge that many owners lack into sequenced tasks they can follow (Eyetsemitan et al., 2021). The conflict in this stream concerns whether simplification reduces the incentive to learn. The balance of evidence suggests that the concern is real for owners approaching regime thresholds but secondary for the majority, which is why the framework recommends threshold-proximity analytics that trigger education when an owner's turnover approaches the boundary of a simplified regime (Uchechi et al., 2018).

5.4 Digital Channels, Inclusion and the Engagement Paradox

Digital channels make compliance cheaper for owners who use them and generate the behavioural data on which analytics depends. Financial inclusion evidence shows that digital payment and account access expand participation in the formal financial system, but that account ownership does not automatically translate into active use (World Bank, 2014). Adoption research identifies trust in the platform, perceived ease of use and reliability as the main determinants of uptake, and privacy-preserving identity verification is presented as a precondition for inclusion rather than an optional feature (Agyei et al., 2019; Kumuyi et al., 2024b).

This produces what the review terms an engagement paradox. The owners about whom analytics knows most are those who log in, file digitally and use accounting software, and they are disproportionately the literate, trusting and already compliant. The owners about whom analytics knows least are those whose compliance support needs are greatest. An analytics programme built on platform data will therefore estimate intervention effects mainly on the population that needs them least and may allocate support toward engaged owners because their response is measurable. Correcting this requires sampling designs that deliberately include offline owners, inverse probability weighting for digital engagement in effect estimation, and a policy commitment to maintain assisted channels (Akhigbe et al., 2024; Eyetsemitan et al., 2023b).

5.5 Adjudicating Conflicting Findings

Three conflicts in the evidence require explicit adjudication, and Table 2 summarises them alongside the convergent findings. The first concerns whether financial literacy matters for compliance at all. Observational studies often find strong associations, while experimental studies of general financial education find modest behavioural effects. The adjudication is that the observational association is inflated by confounding with education, firm size and formality, and that the causal effect exists but runs

mainly through tax-specific knowledge and record-keeping routines (Hastings et al., 2013; Drexler et al., 2014). The second conflict concerns whether deterrence messages help or harm. Deterrence messages raise short-run payment in many letter trials, while fiscal psychology predicts damage to voluntary compliance. Both can be true because they measure different outcomes on different horizons: immediate payment captures enforced compliance, whereas the trust-mediated effect would appear in subsequent-period voluntary filing and self-correction, which few trials measure (Slemrod, 2019; Wahl et al., 2010).

The third conflict concerns digital delivery. Studies of digital adoption report efficiency and reach gains, while inclusion research warns of exclusion. The adjudication is that both are conditional on the digital access distribution and on whether assisted channels are retained; average effects hide opposite effects in different segments (World Bank, 2014; Agyei et al., 2019). Across all three conflicts the methodological lesson is the same: conclusions depend on whether studies measure knowledge or behaviour, short-run or sustained outcomes, and average or segment-specific effects. The FLiTCA propositions are therefore written at the segment level and specify the outcome horizon on which they should be tested.

Table 2. Evidence streams, convergent findings, conflicts and adjudication

Evidence stream	Convergent finding	Conflicting evidence	Adjudication used in FLiTCA
Financial education	Education reliably raises knowledge; behaviour effects are smaller and decay	Strong observational literacy associations versus modest experimental effects	Causal path runs mainly through tax-specific knowledge and record routines
Training format	Rules of thumb improve record-keeping among micro-owners	Standard accounting training shows weak transfer	Deliver routines first, concepts second, for low-literacy segments
Trust and power	Trust drives voluntary, power drives enforced compliance	Deterrence letters raise short-run payment	Measure voluntary outcomes on later periods; judge power by legitimacy
Compliance cost	Burden is regressive and highest for the smallest firms	Simplification may weaken the incentive to learn rules	Simplify broadly; trigger education near regime thresholds
Digital channels	Digital filing lowers cost for engaged owners	Exclusion of offline and low-trust owners	Weight for engagement; retain assisted channels as a design rule

6 The FLiTCA Framework

6.1 Components and Causal Logic

The Financial Literacy, Trust and Compliance Analytics (FLiTCA) framework, shown in Figure 2, organises the synthesis into three layers. The data layer combines owner surveys, administrative filing and payment records, and platform interaction logs, each with a documented purpose and linkage consent. The analytics layer applies the descriptive, diagnostic, segmentation and experimental methods

of Section 4 to produce barrier profiles and uplift estimates. The behavioural layer contains the causal model: general financial literacy improves record quality; tax literacy and record quality jointly determine filing accuracy and timeliness; trust in the authority moderates whether improved capability becomes voluntary compliance or avoidance; compliance cost reduces the effective capability of low-literacy owners; and digital engagement moderates reach (Kirchler et al., 2008; Atkinson & Messy, 2012).

Two design principles distinguish FLiTCA from generic compliance analytics. The first is remedy matching: analytic outputs map to one of three remedy families (education and routines for know-not barriers, simplification and assisted service for can-not barriers, dialogue and legitimate procedural enforcement for will-not barriers), and every analytic output is required to name its remedy family. The second is the support firewall: data collected or inferred for support purposes are not used for audit selection, a principle that protects the candour of survey responses and the trust effect of support contacts (Mbonu et al., 2018; Atakpa & Abolaji, 2022). Outcome and trust data feed back into segment definitions each cycle, an organisational learning loop (Arumosoye & Obriki, 2021; Obriki et al., 2022a).

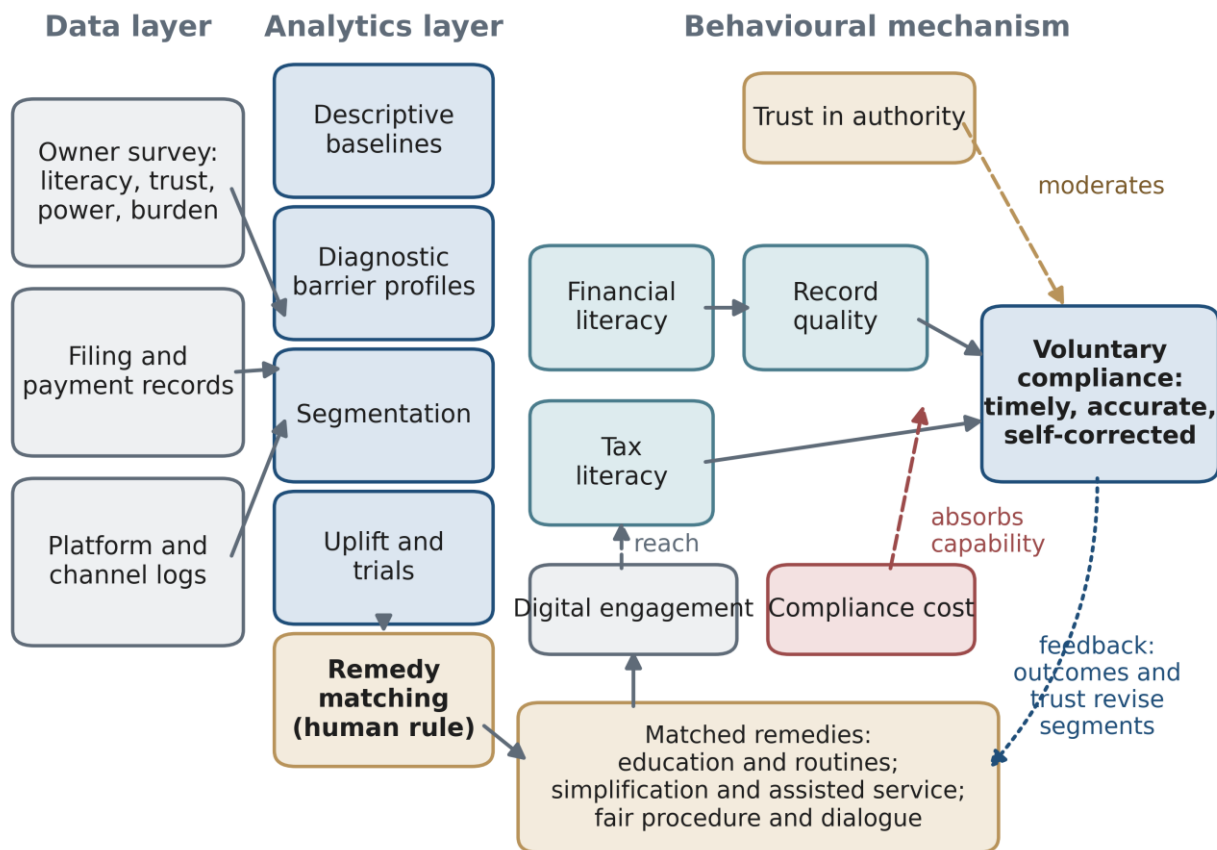


Figure 2. The FLiTCA framework: data sources, analytics modules, behavioural mechanism and feedback

The central band carries the hypothesised causal chain, and the moderators above and below it identify where the chain can break: low trust diverts capability into avoidance, high compliance cost absorbs capability before it reaches the return, and low digital engagement prevents interventions from arriving at

all. The remedy-matching node is placed between analytics and intervention to make explicit that no analytic score acts directly on an owner; a human-governed rule translates each barrier profile into a support offer (Adelanwa et al., 2024; Ilodigwe & Adesemoye, 2024a).

6.2 Segment Archetypes and Matched Interventions

Applying the barrier logic to the joint distribution of literacy, trust and burden yields a set of archetypes that a latent class or k-prototypes solution would be expected to recover, although the actual number and shape of segments must be established empirically in each population. Table 3 describes five archetypes, their diagnostic signatures, the compliance motive the theory attributes to each, the matched intervention and the metric by which success should be judged. The archetypes are theoretical expectations derived from the synthesis, not reported clusters (Sakyi et al., 2022a; Kirchler, 2007).

Two features of the archetypes deserve comment. The confident avoider, with high literacy and low trust, is the segment where literacy education is predicted to be counterproductive and where improving procedural fairness, for example through transparent dispute handling and timely refunds, is the lever. The overwhelmed trier, with low literacy, high trust and high burden, is the segment where compliance failures are least intentional and most responsive to simplification, and where deterrence messaging is predicted to cause the greatest damage to morale. The final column of Table 3 assigns each segment a distinct primary metric, because metrics must fit the decision each unit faces (Sakyi et al., 2022b).

Table 3. FLiTCA segment archetypes, theorised motives and matched interventions

Archetype	Diagnostic signature	Theorised motive	Matched intervention	Primary success metric
Capable cooperator	High tax literacy, high trust, low burden	Voluntary compliance	Light-touch reminders; recognition; pre-filled data	Retention of on-time filing; self-correction rate
Overwhelmed trier	Low literacy, high trust, high burden	Intends to comply; error-prone	Simplification, rule-of-thumb routines, assisted filing	Error rate at submission; filing timeliness
Uninformed newcomer	Low tax literacy, recent registration, moderate trust	Know-not barrier	Onboarding calendar, obligation checklist, first-return support	First-year filing rate; deadline knowledge
Cash-constrained filer	Adequate literacy, volatile cash flow, late payment not late filing	Can-not barrier	Instalment options, payment-date alignment, cash-flow tools	Payment timeliness; arrears duration
Confident avoider	High literacy, low trust, aggressive positions	Will-not; low morale	Procedural fairness, dispute transparency, legitimate follow-up	Perceived fairness; voluntary disclosure

6.3 Propositions and Falsification Tests

The synthesis yields seven propositions. Each is stated with the evidence that would falsify it, so that the framework can be rejected in part or in whole by empirical work; Figure 3 depicts the two relationships behind P2 and P5 (Hevner et al., 2004; Runeson & Höst, 2009).

P1 (mediation). The effect of general financial literacy on accurate and timely filing is mediated by record quality, and the direct effect is small once record quality is controlled. Test: in panel data with an audited record-quality score measured between literacy and filing, the indirect effect should be significant and larger than the direct effect. P1 is falsified if the indirect effect's confidence interval includes zero while the direct effect remains substantial (Drexler et al., 2014).

P2 (trust moderation). The positive association between tax literacy and voluntary compliance strengthens as trust in the authority rises, and under low trust higher literacy is associated with more aggressive reporting positions. Test: a positive β_3 in equation (3) with voluntary self-correction as the outcome, and a negative literacy slope for the lowest trust tercile. P2 is falsified if β_3 is null or negative across adequately powered samples (Kirchler et al., 2008; Wahl et al., 2010).

P3 (specificity). Tax-specific literacy explains more variance in filing accuracy than general financial literacy. Test: nested models with a likelihood ratio test for the incremental contribution of each literacy measure. P3 is falsified if general literacy's incremental contribution equals or exceeds that of tax literacy (Kaiser et al., 2022; Atkinson & Messy, 2012).

P4 (substitution). Among low-literacy owners, simplification produces larger compliance gains than literacy education, whereas among moderate-literacy owners the two are complements. Test: a factorial trial crossing education with simplification, analysed by literacy band. P4 is falsified if education matches or exceeds simplification in the low-literacy band or if no positive interaction appears in the moderate band (Slemrod, 2019; Eyetsemitan et al., 2022).

P5 (matching). Segment-matched interventions outperform uniform messaging on voluntary compliance without raising perceived coerciveness. Test: randomization of owners to matched and uniform arms, with voluntary filing and a validated perceived-coercion scale as co-primary outcomes. P5 is falsified if matched arms do not outperform uniform arms or do so only by raising perceived coercion (Alm, 2019).

P6 (digital threshold). Digital interventions improve compliance only above a threshold of digital access and skill, and below it digital-first delivery widens compliance gaps relative to assisted channels. Test: heterogeneity of treatment effect across a digital access index with pre-registered cut-points. P6 is falsified if effects are homogeneous across the index (World Bank, 2014; Agyei et al., 2019).

P7 (firewall disclosure). Disclosing that survey and support data are firewalled from audit selection increases candour in sensitive survey items and increases trust relative to non-disclosure. Test: randomized disclosure framing with list-experiment prevalence estimates and trust scale scores as outcomes. P7 is falsified if disclosure produces no change or reduces candour (Kirchler, 2007; Aliliele et al., 2024a).

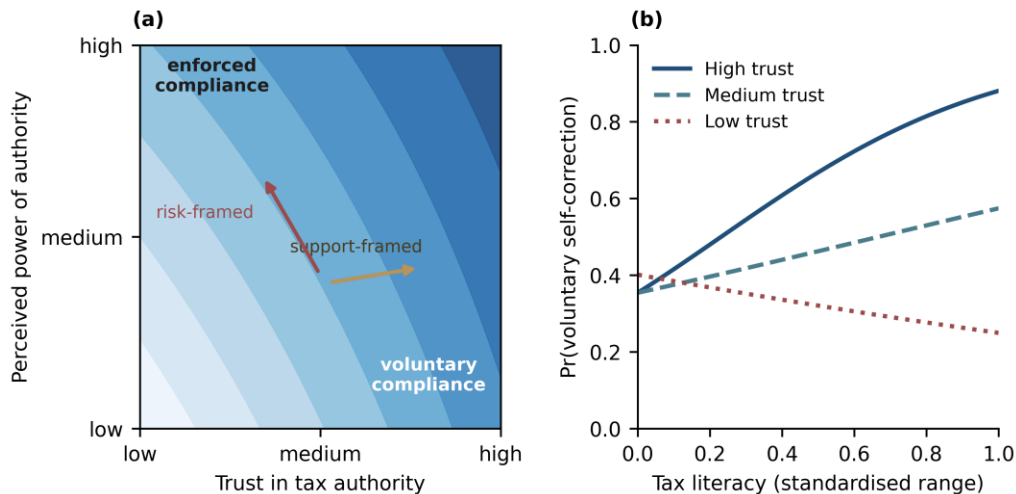


Figure 3. Theorised relationships: (a) the slippery slope plane of trust and power; (b) the trust-moderated literacy effect stated in P2 (illustrative curves, not estimates)

Figure 3 visualises the two relationships on which the framework's distinctiveness rests. Panel (a) locates voluntary and enforced compliance on the trust and power plane and marks the trajectory that analytics contact can induce: support-framed contact moves owners toward higher trust, whereas arbitrary risk-framed contact moves them toward higher perceived power and lower trust. Panel (b) draws the hypothesised P2 interaction, with a positive literacy slope under high trust and a flat or negative slope under low trust. The curves are illustrative and derived from the theory; they are included to show what a confirming and a disconfirming pattern would look like (Kirchler et al., 2008; Wahl et al., 2010).

6.4 A Worked Illustrative Scenario

Consider a revenue administration working with a microfinance network that serves some thousands of retail and service owners under a turnover-based simplified regime. Descriptive analytics shows that filing timeliness is acceptable but payment timeliness is low and that self-correction is almost absent. A survey with an OECD/INFE-style literacy module, a tax literacy module and slippery slope trust and power items, linked with consent to filing records, supports diagnostic modelling. Suppose the latent class solution recovers a large overwhelmed-trier class, a cash-constrained class concentrated in seasonal trades and a small confident-avoider class. Under FLiTCA the administration would not respond with a uniform deterrence letter (Medon & Oduleye, 2024; Sakyi et al., 2023).

Instead, the cash-constrained class would be offered payment dates aligned to its seasonal cash cycle and an instalment option; the overwhelmed triers would receive a rule-of-thumb routine (weekly separation of business takings, a one-page obligation calendar) and assisted filing through the microfinance officer; and the confident avoiders would receive a transparent explanation of how disputed positions are resolved and an invitation to a pre-filing consultation. A stepped rollout would allow each component to be evaluated against its segment metric. The scenario also illustrates the firewall: survey responses indicating aggressive positions would inform the design of the fairness intervention but would not be passed to the audit function. Revenue assurance work in service organisations shows how data-driven

leakage analysis can be used to fix processes rather than to blame individuals, the stance the scenario adopts (Sakyi et al., 2023; Jones & Ominyi, 2021).

7 Validation Design and Ethical Governance

7.1 Empirical Test Design

The preferred validation design is a stepped-wedge cluster randomized trial in which clusters, such as tax offices, business associations or microfinance branches, cross from control to FLITCA-guided support in a randomized order. The design suits the setting because all clusters eventually receive the programme, which is ethically and politically important when the intervention is support rather than sanction, and because staggered rollout separates programme effects from calendar effects such as filing seasons and policy changes (Wieringa, 2014; Hevner et al., 2004). The primary analysis model for outcome Y of owner i in cluster j at period t is

$$Y_{ijt} = \mu + \beta_t + \theta D_{jt} + u_j + \varepsilon_{ijt} \quad (6)$$

where β_t are period fixed effects, D_{jt} indicates that cluster j has crossed to the intervention by period t , u_j is a cluster random effect and θ is the intervention effect. Where randomization is infeasible, a difference-in-differences design exploiting staggered adoption across regions is the fallback, with event-study plots to check pre-trends. Primary outcomes should be voluntary filing timeliness and self-correction measured administratively; secondary outcomes should include payment timeliness, trust and perceived fairness measured by validated scales, and perceived compliance burden (Tonoyan et al., 2023; Atakpa & Fobellah, 2023).

Process evidence is essential because the propositions concern mechanisms. The evaluation should record whether owners received the intended intervention, whether record quality changed before filing outcomes did, and whether trust measures moved in the predicted direction. Pre-registration of hypotheses, subgroups and analysis plans limits analytic flexibility, and power calculations must account for intra-cluster correlation, which for compliance outcomes within a business association can be substantial (Easterbrook et al., 2008; Anioke & Atima, 2023a). Validation of the analytics pipeline itself should follow software assurance practice, with explicit test cases for data transformations and user acceptance testing with frontline staff before deployment (Ammann & Offutt, 2016; Eyetsemitan et al., 2023b).

7.2 Assuring the Analytics Pipeline

Analytic errors in a support programme are not harmless: a misclassified segment receives the wrong remedy, and a broken linkage can expose survey responses to the wrong function. The pipeline should therefore be tested with the discipline used for other critical software. Test adequacy criteria from software engineering provide a vocabulary for this, distinguishing statement, branch and data-flow coverage of the code that computes indicators (Zhu et al., 1997), and systematic testing practice emphasises designing cases for boundary values, such as owners exactly at a regime threshold or returns filed on the due date (Myers et al., 2011; Kaner et al., 1999). Surveys of unit testing practice show that

developers often test the easy paths and neglect edge cases, which in a compliance context are the cases most likely to be misclassified (Daka & Fraser, 2014).

When pipelines change, regression testing should be prioritised toward components whose failure would affect segment assignment or the firewall; test case prioritisation research offers ordering criteria that maximise early fault detection (Catal & Mishra, 2013; Li et al., 2007). The software testing process standard provides a documented structure for test planning, design and completion reporting (ISO/IEC/IEEE, 2018), and the software engineering body of knowledge situates these activities within a quality management lifecycle (IEEE Computer Society, 2014). Traceability from each indicator back to its data source and forward to the decision it informs should be maintained, since information retrieval research on traceability shows that links not recorded at creation are costly and error-prone to recover later (Borg et al., 2014). Quality assurance regimes in inspection-heavy engineering fields show that documented standards are only effective when inspection is independent and results are acted upon, a principle that applies equally to analytic quality control (Atta et al., 2021; Atta et al., 2022).

7.3 Ethical Safeguards and the Support Firewall

The central ethical risk of literacy-oriented compliance analytics is function creep: data collected to help owners are repurposed to target them. The FLiTCA firewall addresses this through purpose limitation, technical separation and disclosure. Purpose limitation means that support data, including survey responses, barrier profiles and uplift scores, are processed only for support allocation and programme evaluation. Technical separation means that these data sit in an environment with access controls that exclude audit selection systems, following privacy-preserving architecture principles for regulated analytics and data sensitivity classification with regulatory traceability (Atakpa & Abolaji, 2022; Aliliele et al., 2024a). Disclosure means that owners are told, in plain language, what data are used and that they are not used for audit selection, which P7 predicts will strengthen trust (Mbonu et al., 2018).

Security obligations are proportionate to the sensitivity of combined financial and attitudinal data. Zero trust architecture, which requires every access request to be authenticated and authorised regardless of network location, is appropriate for systems that link survey and administrative data (Ahmed et al., 2021; Adegbite et al., 2020). Risk-based assurance should address data availability as well as confidentiality, since a support portal that fails near a filing deadline itself causes noncompliance (Fadayomi et al., 2019). Public filing services also need documented defences against network amplification attacks (Jimoh & Ahmed, 2024), and emerging AI assistants that answer owners' tax questions require protection against prompt injection and excessive agency before they are trusted to give guidance (Nwakamma et al., 2024b). Regulatory readiness for AI governance, including requirements for transparency and human oversight of automated decisions, provides a further reference point (Ominyi et al., 2024b).

Fairness auditing completes the safeguards. Segmentation and uplift models should be audited for disparate allocation of support across regions, sectors, gender and language groups, and an accurate model can still be unfair if its errors fall unevenly, a pattern documented for forecasting models allocated across districts (Komi, 2023). Table 4 sets out the principal threats to validity for FLiTCA evaluations and their mitigations, and Figure 4 shows the governance architecture.

Table 4. Threats to validity in literacy and voluntary compliance analytics, with mitigations

Validity type	Topic-specific threat	Consequence	Mitigation
Construct	General financial literacy score used as proxy for tax knowledge	Understates literacy effects; misdirects education	Separate tax literacy module; test P3 explicitly
Construct	Self-reported compliance inflated by social desirability	Overstates compliance and programme effects	List experiments; link to administrative filing records
Internal	Engaged owners self-select into digital support	Effects confounded with prior trust and literacy	Stepped-wedge randomization; engagement weighting
Internal	Deterrence embedded in support messages	Trust effect masked by power effect	Pre-test message framing; measure perceived coercion
External	Evidence drawn from consumer samples, not owners	Mechanisms may not transfer to firms	Owner samples stratified by sector and regime
Statistical conclusion	High intra-cluster correlation within	Overconfident effect estimates	Cluster-robust inference; ICC-based power analysis
Ethical	Support data leak into audit selection	Loss of candour and trust; unfair targeting	Firewall, access control, disclosure and audit logs

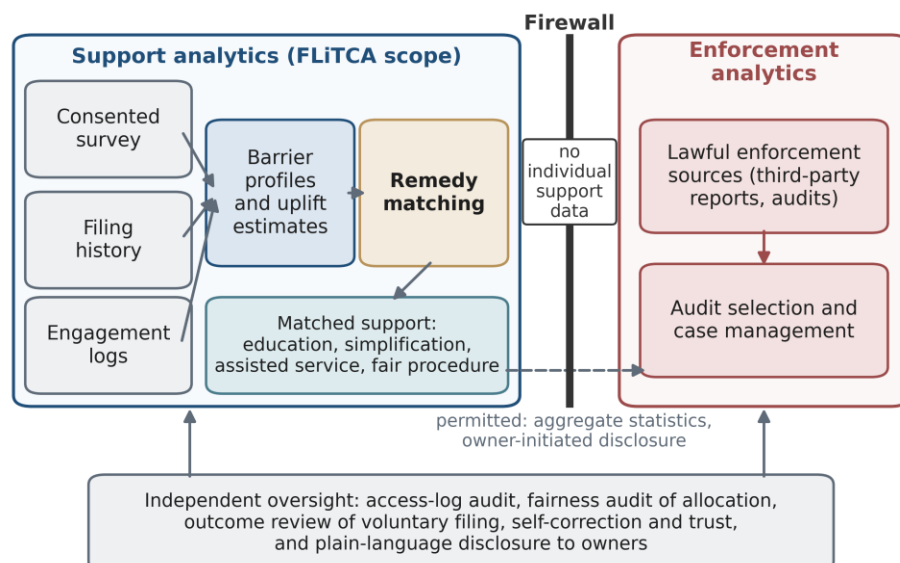


Figure 4. Governance architecture separating support analytics from enforcement analytics

Figure 4 shows the two analytic pipelines that coexist in a tax administration. The support pipeline takes consented survey data, filing histories and engagement logs, produces barrier profiles and uplift estimates, and routes them through remedy matching to education, simplification or assisted service. The enforcement pipeline, which lies outside the scope of this article, uses its own lawful data sources for audit selection. The only permitted flows between them are aggregate programme statistics and owner-initiated disclosures, and an independent oversight function audits access logs, fairness metrics and outcomes on both sides. The design treats separation as an engineered property to be tested, not as a policy statement (Ilodigwe & Adesemoye, 2024b; Anichukwueze et al., 2022).

8 Discussion

8.1 Theoretical Implications

The review has three theoretical implications. First, it relocates financial literacy within compliance theory. In the deterrence model, literacy has no natural place because the taxpayer is assumed to know income and rules; in the slippery slope framework, literacy appears only implicitly as subjective knowledge. FLiTCA positions literacy as the precision with which owners observe their own income and obligations, which makes unintentional noncompliance a distinct, theorised outcome with its own remedies (Slemrod, 2019; Kirchler et al., 2008). This clarification matters because it predicts that deterrence parameters and literacy interventions act on different parts of the compliance gap and should not be evaluated against one another on the same outcome.

Second, the framework joins the financial capability and fiscal psychology traditions through a moderation claim: trust determines whether capability becomes voluntary compliance. This generates a prediction that neither tradition makes alone, namely that literacy programmes in low-trust environments can have null or negative effects on voluntary compliance even while raising knowledge. Third, the article extends the slippery slope framework by treating analytic contact as a trust event, so that the choice between risk-framed and support-framed analytics becomes a determinant of the trust and power climate rather than a neutral technical decision (Wahl et al., 2010; Alm, 2019).

8.2 Practical Implications

For tax administrations, the principal implication is to establish support analytics as a function with its own mandate, data and success metrics, separate from risk and audit. Its dashboards should report voluntary filing, self-correction, payment timeliness and trust by segment, and every indicator should be paired with the remedy it triggers (Tonoyan et al., 2024b; Sakyi et al., 2022b). Tax literacy should be measured directly and periodically through a short validated module rather than inferred from general financial literacy surveys.

For advisers, accountants, microfinance institutions and software providers, the implication is to embed rule-of-thumb routines and obligation calendars into the tools owners already use, since routines transfer better than concepts (Drexler et al., 2014; Ogbole et al., 2021), and to train advisers with realistic case simulation rather than lectures (Ebhojie et al., 2023b). For business associations, peer norms are a lever: norm information is credible when it comes from peers, and associations are natural clusters for stepped-wedge evaluation. For policymakers, the regressive burden evidence argues for simplification targeted at

the lowest literacy segments, coupled with threshold-proximity education to prevent owners from being stranded when they outgrow simplified regimes (Ambali et al., 2021; Falemi et al., 2024).

8.3 Counter-Arguments and Boundary Conditions

Four objections could be raised against this design. The first is that the support firewall wastes information: if survey data reveal aggressive positions, an administration might argue it has a duty to act. The response is that the information exists only because owners were promised it would not be used against them; breaching that promise would destroy the instrument and, according to the slippery slope framework, damage trust more widely. The firewall does not prevent enforcement; it requires enforcement to rely on its own lawful sources (Kirchler, 2007; Mbonu et al., 2021). A second counter-argument is that segmentation is paternalistic or stigmatising. This risk is real, which is why segments are defined by support need, disclosed in neutral terms and audited for disparate allocation (Komi, 2023).

A third counter-argument is that literacy is a distraction from structural drivers such as tax rates, corruption and weak public services. The framework accepts that these drivers set the trust context and that literacy analytics cannot compensate for a predatory or ineffective state. This defines a boundary condition: in very low-trust environments FLiTCA predicts that literacy interventions will have little effect on voluntary compliance, and resources are better directed at procedural fairness and service quality (Alm, 2019; World Bank, 2014). Further boundary conditions include highly informal economies where most owners are unregistered, so that registration rather than filing is the relevant margin; regimes with extensive third-party reporting, where literacy matters less because income is already visible; and very small populations where segmentation is statistically unstable. Research on market entry barriers in highly regulated sectors adds that regulatory complexity can itself be a barrier to formalisation that no amount of analytics removes (Sanni & Attah, 2023c; Ominyi & Anichukwueze, 2022b).

9 Limitations and Future Research Agenda

9.1 Limitations

The review has limitations that bound its claims. It is an integrative rather than a systematic meta-analytic review, and its conclusions rest on qualitative adjudication of heterogeneous evidence rather than pooled estimates. The central moderation claim, that trust conditions the compliance effect of literacy, is inferred by combining two literatures that have rarely been studied in the same sample, so it should be treated as a hypothesis with strong theoretical grounds rather than an established result. Much of the financial education evidence comes from consumer samples, and transfer to business owners is assumed rather than demonstrated (Kaiser et al., 2022; Hastings et al., 2013). The restriction to English-language sources may under-represent evidence from francophone and lusophone administrations, and publication bias may overstate positive intervention effects in the letter-trial literature.

The analytics methods drawn from adjacent fields, including performance dashboards, marketing analytics, laboratory quality systems and software assurance, are used for their methodological lessons, not as evidence about taxpayers, but the transfer of those lessons requires validation in tax settings (Yusuf & Abdulrazaq, 2018; Ogbete et al., 2018). Resource-limited clinical laboratories and blood collection networks illustrate how quality systems degrade when staffing and data infrastructure are thin,

and the same constraints affect small tax offices that would operate FLiTCA (Ogbete et al., 2022; Ogbete et al., 2023). Finally, the archetypes in Table 3 are theorised, and real segment structures will vary with sector mix, tax regime and culture (Lilian et al., 2020).

9.2 Future Research Agenda

Five research priorities follow. First, studies should measure general financial literacy, tax literacy, trust, perceived power, burden and administratively observed compliance in the same owner samples, which would allow direct tests of P1 to P3. Second, factorial field experiments crossing education with simplification would test the substitution hypothesis P4 and inform the allocation of scarce programme resources. Third, letter and message trials should add subsequent-period voluntary outcomes and trust measures, allowing the short-run deterrence effect to be weighed against any longer-run morale cost (Wahl et al., 2010; Slemrod, 2019). Fourth, methodological work is needed on correcting the engagement paradox, including linkage of offline survey samples to platform data and sensitivity analyses for data missing not at random (World Bank, 2014; Atakpa & Fobellah, 2023).

Fifth, the firewall principle should itself be studied: P7 can be tested by randomizing disclosure language, and comparative institutional research could examine whether administrations that separate support and enforcement analytics achieve higher voluntary compliance over time. Leadership and safety culture research suggests that sustained behavioural change depends on leaders modelling the stance they ask others to adopt, so qualitative work on how revenue officials interpret support analytics would complement the quantitative agenda (Arumosoye & Obriki, 2024; Obogo et al., 2019b; Obriki & Arumosoye, 2019). Readiness research suggests testing whether FLiTCA-supported owners remain compliant through economic shocks (Arumosoye & Obriki, 2023; Obogo et al., 2019). Work on dispute resolution and contract liability indicates that clear procedures reduce conflict, a proposition worth testing for tax dispute handling among confident avoiders (Uchechi & Ominyi, 2019; Eze et al., 2024b; Eze et al., 2022b). Cross-border digital trade and multinational cash management add a final frontier, since owners selling across borders face compounded literacy demands (Dada et al., 2021a; Tonoyan et al., 2023).

10 Conclusion

Voluntary tax compliance among small business owners depends on more than knowing the rules. It depends on keeping records that make accurate reporting possible, on compliance costs that the least capable owners can bear, and on a relationship with the tax authority in which understanding is used to cooperate rather than to avoid. Data analytics can strengthen each of these conditions when it is designed to diagnose why owners fall short and to match them with the help that fits, rather than to score them for suspicion.

The FLiTCA framework sets out how this can be done: measure tax-specific literacy and trust directly, separate know-not, can-not and will-not barriers, segment owners by support need, target help by expected benefit, and keep support data firewalled from enforcement. Its seven propositions are stated so that they can be confirmed or rejected in the field. Administrations, advisers and platforms that adopt this stance can expect to judge their programmes by what matters most for small firms and for public revenue

alike: returns filed on time, errors corrected voluntarily and a growing willingness to comply without being compelled.

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Competing interests

The authors declare no competing interests.

Data availability

No new data were generated or analysed in this study; all sources are cited in the reference list.

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