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THE MEDIATING ROLE OF MACHINE LEARNING IN ENHANCING THE PERFORMANCE OF QUANTITY SURVEYING FIRMS IN NIGERIA A REVIEW OF FIRM-PERFORMANCE EVIDENCE AND A PROPOSED MEDIATION FRAMEWORK

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ABSTRACT

Quantity surveying (QS) firms in Nigeria operate in a competitive and economically volatile environment in which firm-level factors such as organisational culture, innovative practice, learning leadership, and financing method have each been separately linked to firm performance and survival. Machine learning (ML) is increasingly proposed as a technology capable of enhancing QS firm performance directly, yet firm-performance research in Nigeria has not yet tested whether ML adoption instead acts as a mediating mechanism through which existing firm-level antecedents translate into improved performance. This paper reviews the empirical literature on QS firm performance in Nigeria, on the decades-long history of IT and innovation adoption within Nigerian QS practice, and on AI/ML-mediated or AI/ML-moderated firm and employee performance more broadly, with the aim of proposing a conceptual mediation framework. Drawing on twenty sources published between 2005 and 2026, the review finds consistent evidence that organisational culture, innovative practice, learning environment and leadership, and financing method each significantly predict QS firm performance or survival in Nigeria; that QS-specific technology adoption in Nigeria has progressed from basic computer usage in the mid-2000s, through moderate software and ICT adoption in the 2010s, to today's still-early engagement with AI and ML tools; and, in adjacent Nigerian sectors and in a recent Nigeria-focused systematic review of

AI for construction cost and schedule prediction, that AI/ML measurably improves firm-level outcomes and has been shown to mediate the relationship between an underlying organisational capability and perceived organisational performance. Within the QS-specific literature itself, however, no reviewed study has yet tested machine learning as a mediator of the relationship between firm-level antecedents and QS firm performance. The paper proposes a conceptual framework in which ML adoption mediates the relationship between four firm-level antecedents and four performance outcomes, illustrated with the only directly comparable direct-versus-indirect effect pattern identified in the reviewed Nigerian QS-firm literature, and concludes with directions for the framework's future empirical testing.

KEYWORDS: Machine Learning; Artificial Intelligence; Mediating Role; Firm Performance; Quantity Surveying; Nigerian Construction Industry.

1. INTRODUCTION

Quantity surveying firms in Nigeria operate within a construction industry characterised by economic volatility, intense competition, and, for many firms, a persistent struggle simply to survive. Empirical research on Nigerian QS firms has identified several firm-level factors associated with performance and survival, including organisational culture (Olanipekun, Aje, & Abiola-Falemu, 2013), innovative practice and software use (Famakin, Moyanga, & Agboola, 2022; Adegbembo, 2019), learning environment and leadership (Oyewobi, 2026), and the method by which a firm finances its operations (Awodele et al., 2024). Separately, machine learning and artificial intelligence are increasingly discussed as tools capable of transforming QS practice, from automated quantity take-off to predictive cost and risk modelling (Seidu, Young, Clack, Adamu, & Robinson, 2020; Enebe, Tswako, Letsuwa, & Anih, 2026), and are frequently framed as a direct driver of improved firm performance in their own right.

These two literatures, however, have so far developed along parallel rather than intersecting tracks. Studies of QS firm performance in Nigeria examine culture, learning, innovation and financing as antecedents of performance without incorporating ML adoption into the model. Studies of AI/ML and firm performance, meanwhile, are concentrated in adjacent sectors, manufacturing (Audu & Ihuoma, 2025), banking (Chondough & Chondough, 2022) and general organisational settings (Arafat, 2024), where AI has been shown not merely to affect performance directly but, in at least one Nigerian case, to fully mediate the relationship between an underlying organisational capability and perceived performance (Arafat, 2024).

This suggests a plausible but so far untested possibility for the QS sector specifically: that ML adoption may not simply be one more independent driver of QS firm performance, but may instead be the mechanism through which existing, well-established antecedents such as culture, learning leadership and innovative practice actually translate into improved firm performance.

This possibility is reinforced by the longer history of technology adoption within Nigerian QS practice itself. As early as 2005, a national survey found that 89% of Nigerian quantity surveyors already used computers for project cost-management services (Oyediran & Odusami, 2005), and a subsequent study found that ICT adoption significantly improved the measured service quality of QS firms (Musa, 2010). Yet adoption of more advanced tools has remained uneven: a 2011 review found that IT adoption in Nigerian QS service delivery continued to trail developed-economy benchmarks (Ibironke, Ekundayo, & Awodele, 2011), and firms were still rated only "slightly innovative" in software use and service diversification as of 2019 (Adegbembo, 2019), with poor funding and weak management commitment identified as leading barriers (Eze, Sofolahan, Adegboyega, & Saidu, 2019). This same awareness-practice gap recurs in the specifically AI/ML-focused Nigerian construction literature: a 2024 survey found that awareness of machine learning among Nigerian construction professionals is moderate to high, but adoption readiness lags well behind awareness (Loya, Eze, Awodele, Sofolahan, & Omoboye, 2024), while a 2026 systematic review found that Nigerian AI/ML construction research remains concentrated on readiness and barriers rather than on direct firm-performance modelling (Enebe et al., 2026). This paper's proposed mediation framework is one way of reading that persistent awareness-practice gap: ML's effect on QS firm performance may be real but indirect, operating through, rather than independently of, firms' existing capacity for culture-driven, learning-driven and resource-driven adaptation.

This paper's objectives are therefore fourfold: (i) to review the empirical evidence on firm-level antecedents of QS firm performance and survival in Nigeria; (ii) to review the history of IT, innovation and AI/ML adoption specifically within Nigerian QS and construction practice; (iii) to review evidence on AI/ML's mediating or moderating role in firm and employee performance in adjacent Nigerian sectors; and (iv) to synthesise this evidence into a conceptual framework proposing machine learning as a mediator between firm-level antecedents and QS firm performance, together with an agenda for the framework's future empirical testing.

2. Materials and Methods

This paper adopts a narrative review design, appropriate for synthesising two literatures, Nigerian QS-firm performance research and AI/ML-mediated firm-performance research, that have not previously been reviewed together, and for proposing a conceptual mediation model on that basis.

2.1 Search Strategy and Sources

Peer-reviewed journal articles, conference papers, and theses addressing determinants of QS firm performance or survival in Nigeria, the history of IT/innovation/AI adoption in Nigerian QS and construction practice, or the mediating or moderating role of AI/ML in firm or employee performance, were located through academic search and repository platforms. Search terms combined "quantity surveying firm," "firm performance," "survival," "ICT adoption," "machine learning," "artificial intelligence," "mediating role," and "moderating role," together with "Nigeria" and supplementary sector terms (manufacturing, banking, accounting).

2.2 Inclusion and Exclusion Criteria

Sources were included if they (a) examined a firm-level antecedent of QS firm performance or survival in Nigeria, (b) examined the adoption of IT, innovation, or AI/ML specifically within Nigerian QS or construction practice, or (c) examined AI/ML as a mediator or moderator of firm or employee performance in any Nigerian sector, or in a closely comparable international setting where no Nigerian equivalent was identified. Twenty sources meeting these criteria, published between 2005 and 2026, form the evidence base summarised in Table 1, comprising eleven QS- or Nigerian-construction-specific studies and nine AI/ML-performance studies from QS-adjacent sectors or comparator settings.

2.3 Analytical Approach

For each included source, the focus, method, and principal finding were extracted and tabulated. Findings on QS-firm antecedents were then mapped against plausible ML-mediating mechanisms to produce the conceptual mapping in Table 2, and against the structure of a formal mediation model to produce the conceptual framework in Figure 1. Because no reviewed QS-specific study reported a tested direct-versus-indirect effect pattern for ML adoption itself, the only directly comparable mediation-style result identified in the Nigerian QS-firm literature, a learning-leadership study, is presented descriptively in Figure 2 as an illustrative analog for the kind of effect pattern this paper's framework proposes to test.

3. RESULTS

3.1 Firm-Level Antecedents of QS Firm Performance in Nigeria

Table 1 summarises the twenty sources retained for synthesis. Organisational culture has been shown to significantly affect QS firm performance (Olanipekun, Aje, & Abiola-Falemu, 2013). Innovative practices, particularly QS-specific software use, significantly influenced client growth and profit growth among southwest Nigerian QS firms, although software use was, counterintuitively, negatively associated with firm-size growth in the same study (Famakin, Moyanga, & Agboola, 2022). Financing method was found to be the sole significant predictor of QS firm survival in a ten-year observational study spanning Nigeria's 2010–2020 economic contraction (Awodele et al., 2024). Most notably for this review's purposes, a PLS-SEM study of learning environment, processes and leadership found that learning leadership had no significant direct effect on organisational survival, but a significant positive indirect effect through learning organisation characteristics (Oyewobi, 2026), a full-mediation pattern directly relevant to this paper's proposed framework.

Table 1. Summary of Reviewed Studies on QS Firm Performance, Technology Adoption, and AI/ML-Mediated Firm Performance.

Study (Author, Year)	Focus	Method	Key Finding Relevant to This Review
Olanipekun, Aje & Abiola-Falemu (2013)	Effects of organisational culture on the performance of QS firms in Nigeria	Questionnaire survey; correlation analysis	Organisational culture significantly affects QS firm performance, establishing culture as a firm-level antecedent of performance
Famakin, Moyanga & Agboola (2022)	Effect of innovative practices on the growth of QS firms in Nigeria	Questionnaire survey, southwest Nigeria; multiple regression	QS software and related innovation practices significantly influenced client growth and profit growth, though software use was negatively associated with firm-size growth
Awodele et al. (2024)	Theoretical model for predicting survival of QS firms in Nigeria	Observational study of 130 firms, 2010–2020; Cox regression	Method of financing firm operations was the only significant predictor of QS firm survival during Nigeria's economic contraction phase

3.2 A History of Technology Adoption in Nigerian QS Practice

Before AI/ML can plausibly mediate QS firm performance, it is useful to establish how Nigerian QS firms have historically adopted earlier waves of digital technology, since this history sets the baseline against which any AI/ML-specific effect must be read. As early as

2005, a national survey found that 89% of Nigerian quantity surveyors already used computers for project cost-management services, with proficiency concentrated in word processing and spreadsheet functions (Oyediran & Odusami, 2005). A follow-up SERVQUAL-based study found that service-quality scores were significantly higher after firms adopted ICT, directly linking technology adoption to measurable firm performance (Musa, 2010). Despite this early uptake, a 2011 review concluded that IT adoption in Nigerian QS service delivery still trailed developed-economy benchmarks (Ibironke, Ekundayo, & Awodele, 2011), and by 2019 QS firms in Lagos and Ondo States were rated only "slightly innovative," with moderate software adoption and low service diversification despite high awareness of available tools (Adegbembo, 2019). A parallel study of the wider Nigerian construction industry identified poor funding, weak management commitment, sectoral fragmentation and clients' unwillingness to pay for innovation as the leading barriers limiting full-scale adoption of process and product innovation (Eze, Sofolahan, Adegboyega, & Saidu, 2019).

This adoption pattern, early technical engagement followed by a persistent awareness-practice gap, recurs almost exactly in the more recent AI/ML-specific literature. A study of digitalisation and project delivery found that higher levels of digitalisation adoption were associated with significantly better construction project delivery outcomes in Nigeria (Okpo, Ikediashi, & Dania, 2023), while a 2024 survey found that awareness of machine learning among Nigerian construction professionals is moderate to high, but that actual adoption readiness lags well behind awareness (Loya, Eze, Awodele, Sofolahan, & Omoboye, 2024). Barriers to BIM adoption among small and medium Nigerian construction enterprises, including cost, limited technical skill and weak organisational readiness, have been found to closely parallel the barriers to AI/ML adoption more broadly (Bamgbose, Ogunbayo, & Aigbavboa, 2024), while firms that have adopted digital technologies in heavy-engineering projects report stronger competitive positioning (Aliu, Oke, Jesudaju, Akanni, Ehbohimen, & Dosumu, 2025). Most directly relevant to this paper, a systematic review of AI for predicting construction cost and schedule performance in Nigeria, screening 1,042 records down to 35 included studies, found that AI/ML measurably improves cost and schedule prediction where it is adopted, but that the Nigerian evidence base remains concentrated on readiness, barriers and adoption conditions rather than on direct, tested links between AI/ML and firm-level performance outcomes (Enebe, Tswako, Letsuwa, & Anih, 2026). A companion systematic review reached the same conclusion: Nigerian ML-in-construction research is concentrated in

cost and schedule prediction, and firm-level performance mediation has not yet been tested (Njama-Abang, 2025).

3.3 Evidence for AI/ML as a Mediator or Moderator of Firm Performance

Beyond the construction-specific literature reviewed in Section 3.2, further evidence for AI/ML's mediating or moderating role comes from adjacent Nigerian sectors. An exploratory review of BIM, big data, AI and ML in QS practice (UK-focused) found that these technologies are reshaping QS roles and creating both a skills-gap risk and new opportunities for QS professionals serving data-driven clients, without formally testing a mediation model (Seidu, Young, Clack, Adamu, & Robinson, 2020). A study of Nigerian construction professionals, including quantity surveyors, identified institutional, behavioural, cost, knowledge, infrastructure, technical and trust factors as critical to AI diffusion (Tunji-Olayeni, Aigbavboa, & Oke, 2022). Within Nigerian manufacturing, AI was found to significantly influence firm performance, with a reward system moderating the strength of that relationship (Audu & Ihuoma, 2025); within Nigerian commercial banking, AI significantly affected employee performance, moderated by intellectual capital (Chondough & Chondough, 2022). Most directly relevant methodologically, a study of accounting information system quality and organisational performance found that information-system quality had no significant direct effect on perceived organisational performance, but that AI application fully mediated the relationship (Arafat, 2024), an explicit precedent for treating AI/ML as a mediator, rather than merely a direct driver or moderator, of firm performance.

3.4 An Illustrative Mediation Pattern from the QS-Firm Literature

While no reviewed QS-specific study has tested ML adoption as a mediator, the learning-leadership study identified in Section 3.1 provides a directly comparable illustration, within the same Nigerian QS-firm population, of exactly the direct-versus-indirect effect pattern this paper's framework proposes to test for ML adoption. Figure 2 presents these reported path coefficients.

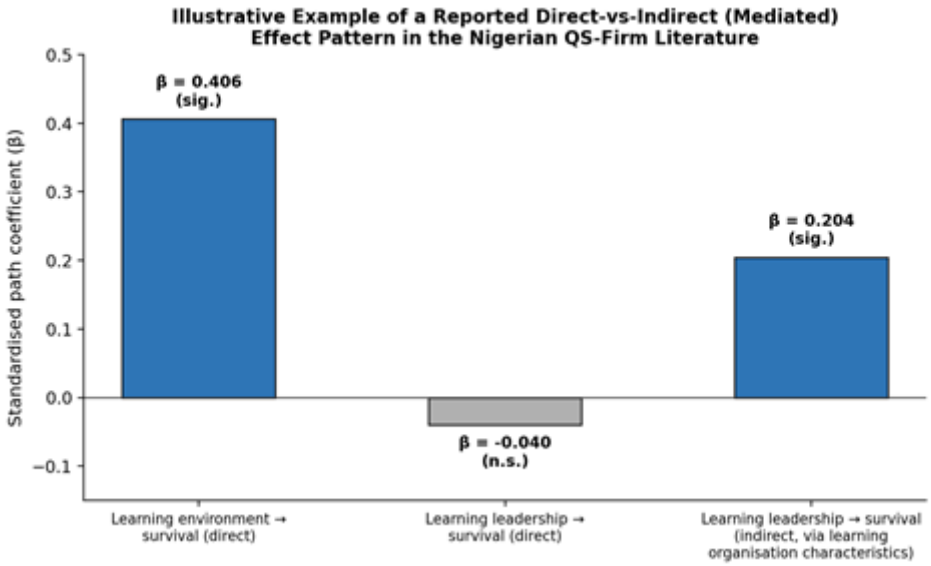


Figure 2 above presents real reported path coefficients illustrating a full-mediation pattern found in the Nigerian QS-firm literature, used here as an analog for the kind of effect this paper's framework proposes to test for ML adoption specifically.

3.5 A Proposed Mediation Framework

Building on the antecedents identified in Section 3.1 and the mediation/moderation precedents identified in Section 3.2, this paper proposes the conceptual framework shown in Figure 1: four firm-level antecedents, innovative practices, organisational culture, learning environment and leadership, and method of financing and firm resources, are hypothesised to influence QS firm performance both directly and indirectly through ML adoption as a mediating mechanism, encompassing cost estimation, risk prediction, automated take-off, and decision-support applications. Table 2 maps each antecedent to a plausible ML-mediating mechanism and the performance outcome it is expected to affect most strongly, drawing on the specific mechanisms identified in the reviewed literature.

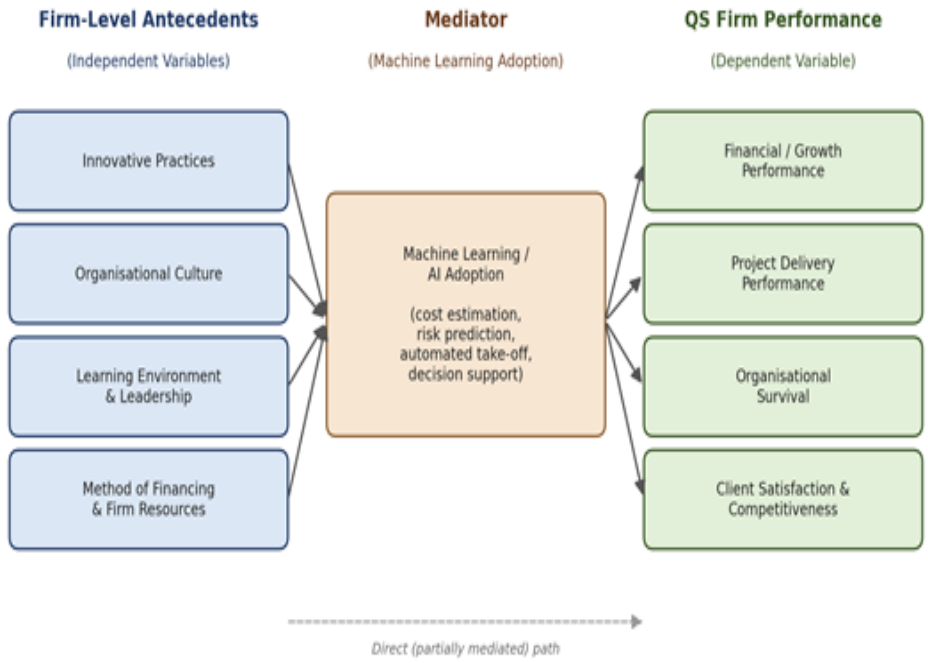


Figure 1 above presents the proposed conceptual framework, in which machine learning adoption mediates the relationship between four firm-level antecedents and four QS firm performance outcomes.

Table 2. Mapping of Firm-Level Antecedents to Hypothesised ML Mediating Mechanisms.

Firm-Level Antecedent	**Hypothesised ML Mediating Mechanism**	**Performance Outcome Most Affected**
Innovative practices / QS software use	ML-enabled automated quantity take-off and cost-estimation tools built on existing QS software investment	Client growth; profit growth
Organisational culture	A culture receptive to data-driven decision-making enables staff to trust and act on ML-generated cost/risk predictions	Overall firm performance
Learning environment & leadership	Learning-oriented leadership supports staff training and experimentation needed to embed ML tools into routine practice	Organisational survival
Method of financing / firm resources	Financing capacity determines whether a firm can invest in ML/AI tools and training rather than relying on manual methods	Organisational survival; competitiveness

4. CONCLUSION

The reviewed literature establishes, separately, that organisational culture, innovative practice, learning leadership and financing method each significantly predict the performance

or survival of Nigerian quantity surveying firms, and that artificial intelligence has been shown, in adjacent Nigerian sectors, to mediate the relationship between an underlying organisational capability and perceived organisational performance, and to moderate the relationship between AI use and employee performance. No reviewed study, however, has yet tested machine learning specifically as a mediating mechanism within the QS-firm performance literature itself. Given the directly comparable full-mediation pattern already documented for learning leadership within the same Nigerian QS-firm population, and the precedent for AI as a full mediator of organisational performance in the accounting information-systems literature, this paper concludes that testing ML adoption as a mediator, rather than assuming it acts only as a direct driver of QS firm performance, is both a plausible and a currently untested extension of the existing Nigerian QS-firm performance literature.

5. Research Directions

Building on the gaps identified in this review, four directions for future research are proposed:

1. Empirical testing of the proposed mediation model. The framework proposed in this paper should be tested using structural equation modelling on a sample of Nigerian QS firms, following the PLS-SEM approach already applied successfully to a closely related mediation question within the same firm population.

2. Firm-size and resource-based moderation analysis. Because financing method was found to be the sole significant predictor of QS firm survival in the reviewed literature, future research should examine whether firm size or financial resources moderate the strength of the proposed ML-mediation pathway, following the moderation approach used in the reviewed manufacturing and banking studies.

3. Disaggregation of ML adoption by application type. Future research should disaggregate "ML adoption" into its specific applications, automated take-off, cost prediction, risk modelling, decision support, to test whether different applications mediate different performance outcomes, rather than treating ML adoption as a single undifferentiated construct.

4. Comparative mediation studies across professional-services sectors. Given that AI's mediating role has so far been demonstrated in accounting information systems but not yet in quantity surveying specifically, comparative studies across Nigerian professional-services sectors (quantity surveying, accounting, architecture) would help establish whether ML's

mediating role is a general professional-services phenomenon or specific to particular firm types.

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