

Assessment of BIM Awareness and Perceived Benefits for High-Rise Project Delivery in Lagos and Port Harcourt, Nigeria

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Abstract

Abstract: This study assessed the level of Building Information Modelling (BIM) awareness and quantifies the perceived benefits of its adoption for effective high-rise building project delivery in Lagos and Port Harcourt, Nigeria. A quantitative cross-sectional survey was conducted with a calculated sample size of 392 registered construction professionals (architects, engineers, builders, and quantity surveyors) in the two cities. A total of 298 valid questionnaires were retrieved and analysed using descriptive statistics, mean scores (1–5 scale), and the Relative Importance Index (RII). Eight refined variables measured BIM awareness: Technical Proficiency, Software Accessibility, Regulatory Framework, Educational Integration, Collaborative Readiness, Cost-Time Perception, Management Support, and Design Integration. Nine refined variables captured perceived benefits: Cost Efficiency, Schedule Optimization, Quality Enhancement, Risk Reduction, Stakeholder Communication, Sustainability Performance, Data Integrity, Lifecycle Management, and Competitive Advantage. Awareness analysis revealed that Collaborative Readiness ranked highest (Mean=3.18, RII=0.636), while Design Integration ranked lowest (Mean=1.82, RII=0.364). Technical Proficiency (Mean=2.43, RII=0.486) and Software Accessibility (Mean=2.01, RII=0.402) showed moderate but insufficient levels. Benefit analysis showed Cost Efficiency (Mean=4.77, RII=0.954) and Schedule Optimization (Mean=4.70, RII=0.940) as the most recognised benefits, whereas Competitive Advantage ranked lowest (Mean=4.46, RII=0.892). A critical perception gap of approximately 40–50% was identified across all variables – professionals perceive BIM as highly beneficial but demonstrate low practical awareness and implementation. Nigerian construction professionals are aware of BIM, but its potential benefits remain underutilised due to systemic barriers: inadequate software access, weak regulatory frameworks, and insufficient technical training. Strategic interventions include mandatory BIM policies for high-rise projects exceeding ten stories, integration of BIM into university curricula, government-subsidised software licences, and the establishment of regional BIM competence centres in Lagos and Port Harcourt.

Keywords: Awareness; Building Information Modelling (BIM); Construction Industry; High-Rise Buildings; Perceived Benefits; Project Delivery; Nigeria

1. Introduction

The global construction industry has witnessed a paradigm shift toward digitalization, with Building Information Modelling (BIM) emerging as the most transformative innovation since computer-aided design (CAD) (Azhar, 2011). BIM represents a holistic digital representation of built assets, integrating geometric, spatial, geographic, and quantitative data into a collaborative environment accessible to all stakeholders throughout a project's lifecycle (Eastman *et al.*, 2011; Sacks *et al.*, 2018). Unlike traditional two-dimensional drafting, BIM enables parametric modeling, clash detection, automated quantity takeoffs, 4D scheduling, 5D cost estimation, and 6D facility management—capabilities that directly address persistent industry challenges of cost overruns, schedule delays, and coordination failures (Azhar, 2011).

High-rise construction projects, defined as buildings exceeding ten stories or 35 meters in height, present unique complexities that magnify the value of BIM adoption (ICC, 2025). These projects involve multiple interdependent systems (structural frames, mechanical-electrical-plumbing, facades, vertical transportation), numerous specialty contractors, extensive supply chains, and prolonged construction durations (ICC, 2025). The absence of integrated digital coordination in such contexts frequently results in design clashes, rework, material waste, budget overruns exceeding 30%, and schedule delays averaging 40% beyond initial projections (Azhar, 2011; Olawumi and Chan, 2019).

Nigeria's construction sector, valued at approximately \$45 billion annually and growing at 8-10% due to rapid urbanization (NBS, 2023), presents a paradoxical scenario. Lagos and Port Harcourt (the nation's

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economic hubs) are experiencing unprecedented high-rise construction booms. Lagos alone has over 300 ongoing high-rise projects, including the Eko Atlantic City development and numerous residential-commercial TOWERS (NBS, 2023). Port Harcourt follows with significant vertical expansion driven by oil and gas sector demands.

However, despite this construction surge, maximizing BIM's benefits in Nigeria remains below 15% among construction firms, compared to over 70% in the United Kingdom, 60% in Singapore, and 50% in South Africa (McGraw-Hill Construction, 2020; NBS, 2022). This deficit manifests in tangible project failures: documented design errors causing rework costs averaging 12% of contract values, coordination failures leading to schedule extensions of 6-18 months, and post-construction defects requiring expensive remediation (Eze *et al.*, 2020; Onungwa and Uduma-Olugu, 2017).

The critical gap this study addresses is the disconnect between awareness and perceived benefits. While previous studies (Uduma-Olugu and Onungwa, 2017; Aibinu and Venkatesh, 2018) have noted growing BIM awareness among Nigerian professionals, none have systematically quantified this gap or identified specific variables driving this resistance. This study therefore poses three research questions: (1) What is the current level and dimensional distribution of BIM awareness among construction professionals? (2) What specific benefits are mostly associated with BIM adoption? (3) What recommended strategies can bridge the awareness-perception gap?

2. Literature Review

2.1. Theoretical Framework: Diffusion of Innovation Theory and Technology Acceptance Model (TAM).

This study is anchored in Rogers' (2003) Diffusion of Innovation (DOI) theory, which explains how new

technologies spread through populations based on five key attributes: relative advantage, compatibility, complexity, trialability, and observability. In the context of BIM awareness and perceived benefits for high-rise project delivery in Lagos and Port Harcourt, DOI suggests that Nigerian construction professionals' adoption decisions are shaped by their assessment of BIM's superiority over traditional methods (relative advantage), alignment with existing workflows (compatibility), perceived difficulty of use (complexity), opportunities for hands-on experimentation (trialability), and visible success stories (observability). The theory is complemented by the Technology Acceptance Model (TAM) (Davis, 1989), which posits that perceived usefulness and perceived ease of use are direct determinants of technology adoption. Applying TAM, this study posits that BIM awareness translates into adoption when professionals strongly believe that BIM improves high-rise project outcomes (perceived usefulness) and view the technology as manageable despite resource constraints (perceived ease of use). Together, DOI and TAM provide a robust lens for examining the gap between BIM awareness and actual adoption, as well as for interpreting the perceived benefits reported by practitioners in Nigeria's rapidly urbanizing high-rise construction sector.

2.2. BIM Awareness: Conceptual Dimensions

Awareness of BIM extends beyond simple recognition of the acronym. Olawumi and Chan (2019) proposed a multidimensional awareness framework comprising: (a) conceptual awareness (understanding BIM principles and capabilities); (b) technical awareness (knowledge of specific software and work flows); (c) strategic awareness (appreciation of BIM's business and project management implications); and (d) collaborative awareness (recognition of BIM's role in stakeholder coordination). This study operationalizes awareness through eight refined variables that capture these dimensions (Table 1).

Table 1: Refined BIM Awareness Variables and Operational Definitions

Variable	Operational Definition	Measurement Focus
Technical Proficiency (V1)	Self-reported competence in BIM software operation	Revit, ArchiCAD, Navisworks familiarity
Software Accessibility (V2)	Availability of licensed BIM tools in workplace	Legal vs. Pirated copies, version currency
Regulatory Framework (V3)	Existence of government BIM mandates or incentives	Policy awareness, enforcement level
Educational Integration (V4)	Formal BIM training in academic/professional programs	Curriculum content, certification availability
Collaborative Readiness (V5)	Organizational capacity for multi-stakeholder digital coordination	Interoperability standards, common data environment
Cost-Time Perception (V6)	Beliefs about BIM's impact on project economics	ROI expectations, implementation cost assessment
Management Support (V7)	Leadership commitment to BIM adoption	Budget allocation, champion presence, change management
Design Integration (V8)	Application of BIM in schematic and detailed design	3D modeling, clash detection, design review frequency

2.3. Empirical Evidence on BIM Benefits

Meta-analyses of BIM benefit studies (Olawumi and Chan, 2019) consistently report: (1) cost reduction (5-15% decrease in construction costs primarily through reduced rework and optimized procurement); (2) schedule compression (7-20% reduction in project duration through 4D sequencing and clash avoidance); (3) quality improvement, 30-50% reduction in requests-for-information (RFIs) and field coordination issues; (4) safety enhancement (20-40% reduction in site incidents through construction simulation

contributes approximately 60% of Nigeria's high-rise construction volume, while Port Harcourt contributes 15%. The two cities provide complementary contexts: Lagos represents the commercial, mixed-use high-rise market; Port Harcourt represents oil-sector and residential high-rise development.

According to available records, the Table 2 gives a detailed analysis of construction professionals in Lagos and Rivers State.

Table 2: Construction Professionals

Profession	Lagos State	Rivers State
Architects	1,489	261
Builders	415	159
Structural Engineers	10,585	3,706
Quantity Surveyors	1277	323
TOTAL	13,766	4,449

Source: NIA, NIOB, NSE and NIQS (2024) – Membership registers obtained directly from each professional body; not publicly archived.

identifying hazard exposures); (5) sustainability (10-25% improvement in energy performance through integrated analysis).

However, these benefits are context-dependent. In developing economies, adoption barriers substantially moderate outcomes (Olawumi and Chan, 2019; Enegbuma *et al.*, 2016). Primary barriers identified in Nigerian studies include: high software costs (\$2,000-5,000 per license annually), inadequate internet infrastructure for cloud collaboration, shortage of trained professionals (estimated deficit of 5,000 BIM-literate practitioners), and absence of national BIM standards or mandates.

2.4. Research Gap Synthesis

Existing literature demonstrates two critical gaps: (1) Measurement inadequacy: most Nigerian studies use generic awareness questions (e.g., "Are you aware of BIM?") rather than dimensional assessments; (2) Sector specificity: few studies focus exclusively on high-rise projects despite their unique coordination demands.

3. Materials and Methods

A cross-sectional quantitative survey design was employed, appropriate for measuring current awareness levels and perceived benefits across a defined population. This design enables statistical generalizability while capturing professional perspectives unaffected by observational or experimental biases.

3.1. Population of the Study

Lagos and Port Harcourt were selected as Nigeria's most intensive high-rise construction markets. Lagos

Hence, the population of the research is 18,215 construction professionals.

3.1.1. Sampling Size

The sample size for the study population was calculated using the Taro Yamane formula.

$$n = \frac{N}{1 + N(e)^2}$$

$$N = \frac{18,215}{1 + 18,215(0.05)^2} = 392$$

3.1.2. Sampling Technique

Stratified purposive sampling was employed. Stratification by profession ensured proportional representation. Purposive selection required: (a) minimum 5 years construction experience; (b) involvement in ≥ 2 high-rise projects; (c) current employment with design or construction firm. Within strata, convenience sampling distributed questionnaires to accessible professionals during industry meetings and via professional networks.

3.2. Method of Data Collection

A structured questionnaire comprising three sections was developed. Questionnaire face validity was established through review by three BIM experts (two academics, one industry practitioner). The experts rated all 17 items (8 awareness, 9 benefits) as 'relevant' or 'highly relevant' (content validity index = 0.94). They suggested minor wording changes to improve clarity for respondents (e.g., replacing 'common data environment' with 'shared project folder'), and confirmed that the 5-point Likert scale was appropriate. No items were deleted or added. Reliability was tested through pilot study (n=30 professionals in Abuja),

yielding Cronbach's alpha coefficients of 0.87 (awareness section) and 0.91 (benefits section), exceeding the 0.70 acceptability threshold.

4. Results and Discussion

Upon carrying out basic analysis of the data gathered, the descriptive statistics were used to analyze the questions addressing the research questions raised earlier in the study.

Table 3 shows the level of awareness of Building Information Modelling (BIM) in high-rise construction projects. Collaborative Readiness (RII=0.636): Respondents demonstrated moderate awareness of BIM's role in stakeholder coordination, document sharing, and integrated project delivery. This suggests that professionals recognize BIM as primarily a communication tool rather than a comprehensive management platform. Regulatory Framework (RII=0.388) and Design Integration (RII=0.364): Very low awareness of government BIM policies (unsurprising given Nigeria's absence of BIM mandates) and minimal application in actual design workflows. Only 11.4% of respondents reported using BIM for clash detection or parametric modeling.

Table 4 presents the perceived benefits most associated with the adoption of Building Information Modelling (BIM) in high-rise construction projects, Cost Efficiency (RII=0.954): 97.6% of respondents

agreed/strongly agreed that BIM reduces construction costs. This aligns with international literature but contrasts with Nigeria's actual implementation rates, suggesting a disconnect between perceived potential and realized outcomes. Sustainability ranked 3rd (RII=0.938): Surprisingly high recognition of BIM's environmental benefits (energy analysis, material optimization, waste reduction) given low sustainability focus in Nigerian construction codes. This indicates evolving professional values potentially driven by international client demands. Competitive Advantage (RII=0.892): While still strong, this relative ranking suggests that professionals perceive BIM benefits as primarily project-level rather than firm-level market differentiators.

4.1. Discussion of Results Interpretation of Awareness Findings

The finding that Collaborative Readiness ranks highest (RII=0.636) while Design Integration ranks lowest (RII=0.364) reveals a critical paradox in Nigerian BIM perception. Professionals understand BIM's communication benefits but do not translate this understanding into technical application. This aligns with Rogers' DOI theory's "knowledge-persuasion gap" the stage where innovation awareness exists but adoption decisions remain pending due to insufficient trialability and observability (Rogers, 2003).

Comparatively, this awareness profile differs from developed economies. In the UK, where BIM Mandate

Table 3: Level of awareness of Building Information Modelling (BIM)

Variables	Mean	RII	Ranking	Category
Collaborative Readiness (V5)	3.18	0.636	1 st	Moderate
Technical Proficiency (V1)	2.43	0.486	2 nd	Low
Educational Integration (V4)	2.37	0.474	3 rd	Low
Management Support (V7)	2.30	0.460	4 th	Low
Cost-Time Perception (V6)	2.05	0.410	5 th	Low
Software Accessibility (V2)	2.01	0.402	6 th	Low
Regulatory Framework (V3)	1.94	0.388	7 th	Very Low
Design Integration (V8)	1.82	0.364	8 th	Very Low
Composite	2.260	0.453	-	Low

Interpretation: RII; 0.8 = High, 0.6-0.79 = Moderate, 0.40-0.59 = Low, <0.40 = very low

Source: Researcher's Field work, 2026

Table 4: Perceived Benefits of BIM

Variables	Mean	RII	Ranking
Cost Efficiency (B1)	4.77	0.954	1 st
Schedule Optimization (B2)	4.70	0.940	2 nd
Sustainability Performance (B3)	4.69	0.938	3 rd
Risk Reduction (B4)	4.66	0.932	4 th
Stakeholder Communication (B5)	4.65	0.930	5 th
Quality Enhancement (B6)	4.56	0.912	6 th
Data Integrity (B7)	4.53	0.906	7 th
Lifecycle Management (B8)	4.47	0.894	8 th
Competitive Advantage (B9)	4.46	0.892	9 th
Composite	4.61	0.922	-

Source: Researcher's Field work, 2026

Level 2 has been compulsory for public projects since 2016, technical proficiency and design integration consistently rank highest (NBS, 2022). In Singapore, where the Building and Construction Authority mandates BIM for projects exceeding 5,000 m², regulatory framework awareness is near-universal. Nigeria's profile; high collaboration awareness but low technical awareness, represents an early-stage diffusion pattern where professionals have been exposed to BIM concepts through conferences and literature but lack hands-on experience.

The very low regulatory framework awareness (RII=0.388) is particularly significant. Without government mandates, BIM remains voluntary, and voluntary adoption rarely exceeds 15-20% of any industry (Rogers, 2003). This explains the perception gap (Table 5): professionals see no immediate consequence for non-adoption, no client requiring BIM deliverables, and no competitor penalized for lacking BIM capability.

However, the gap between benefit perception (RII=0.922) and current adoption (evidenced by awareness of technical variables at RII=0.453) represents a classic "value-action gap" documented in behavioral economics (Sheeran and Webb, 2016). Professionals believe BIM valuable but do not act due to perceived adoption barriers outweighing individual benefits. This explains the third-place ranking of Competitive Advantage (RII=0.892)—without widespread adoption, BIM does not yet differentiate firms in the Nigerian market, reducing the business case for early investment.

Synthesis: The Implementation Ecosystem

Integrating findings reveals that BIM adoption in Nigeria requires simultaneous, coordinated interventions across four ecosystem dimensions:

1. Technical Infrastructure: Software accessibility (RII=0.402) is insufficient. The average BIM software license costs \$2,500 annually (NBS,

Table 5: Perception Gap

Dimensions	Benefits RII	Awareness RII	Gap
Collaboration	0.930	0.636	+0.294
Cost-Time	0.947	0.410	+0.537
Design Integration	0.912	0.364	+0.548
Technical	0.906	0.486	+0.420
Composite	0.922	0.453	+0.469

The composite gap of +0.469 means benefit recognition is 103% higher than actual awareness

Source: Researcher's Field work, 2026

Interpretation of Perceived Benefit

Universal strong agreement with all nine benefit variables (RII range 0.892-0.954) suggests that Nigerian professionals are not skeptical about BIM's potential value. This finding contradicts earlier studies (Aibinu and Venkatesh, 2018) that reported moderate benefit perceptions. The difference likely reflects increased international exposure; Nigerian professionals now work on projects with international partners (Chinese, Lebanese, European contractors) who bring BIM workflows, demonstrating observable advantages.

The highest ranking of Cost Efficiency (RII=0.954) is theoretically consistent. High-rise projects in Nigeria commonly experience 20-40% cost overruns (Uduma-Olugu and Onungwa, 2017), primarily due to design changes, rework, and material waste, all directly addressable by BIM capabilities (clash detection, quantity takeoffs, visualization). Professionals who have witnessed projects with 15-20% lower rework costs due to basic clash detection understand BIM's financial value intuitively (Azhar, 2011).

2022), comparable to a junior engineer's annual salary in Nigeria. Pirated software lacks updates, technical support, and interoperability, perpetuating low proficiency.

2. Human Capital: Technical proficiency (RII=0.486) exceeds software access, indicating motivated professionals learning through online resources (YouTube tutorials, MOOCs) despite workplace constraints (NBS, 2022). However, without formal certification pathways, proficiency remains unverified and non-transferable.
3. Regulatory Environment: Absent government policy (RII=0.388) removes adoption pressure. Countries with successful BIM diffusion (UK, Singapore, Finland) all implemented phased mandates with 3-5 year lead times, enabling industry preparation while creating adoption necessity.
4. Educational Integration: Educational integration (RII=0.474) shows limited university BIM instruction. Most Nigerian construction graduates complete degrees without BIM training (NBS,

2023), entering workforce requiring retraining an inefficient human capital development model.

5. Conclusion and Recommendations

This study examined BIM awareness and benefits for high-rise project delivery in Lagos and Port Harcourt. Three principal findings emerge:

First, BIM awareness in Nigeria is dimensional and uneven, moderate for collaboration (RII=0.636) but very low for regulatory frameworks (RII=0.388) and design integration (RII=0.364). The composite awareness level (RII=0.453) indicates that while BIM is not an unknown concept, practical implementation capability remains severely underdeveloped.

Second, perceived benefits are universally strong (RII=0.922 composite), with cost efficiency (RII=0.954) and schedule optimization (RII=0.940) most recognized. This high benefit perception coexists paradoxically with lesser maximization of benefits, defining an awareness-perception gap of +0.469 RII points, representing unfulfilled potential rather than resistance to BIM concepts.

Third, the awareness-perceived benefit gap is not monolithic but varies by variable. Collaboration shows moderate gap (+0.294), suggesting near-term adoption feasibility, while design integration shows large gap (+0.548), indicating deeper structural barriers requiring systemic intervention.

6. Recommendations

Based on the findings and conclusions of this study, it is evident that to bridge the gaps and improve BIM awareness and benefits for project delivery, the following recommendations are proposed:

1. Mandate BIM for public-funded high-rise projects above ten storeys: The Federal and State Governments (Lagos and Rivers) should issue a phased mandate requiring BIM Level 1 (3D modeling with clash detection) for all new public high-rise buildings by 2027, and BIM Level 2 (collaborative common data environment) by 2030. This will directly address the very low regulatory framework awareness (RII=0.388) and create institutional pressure that turns perceived benefits into actual implementation.
2. Establish regional BIM competence centres in Lagos and Port Harcourt: Professional bodies (NIA, NIOB, NSE, NIQS) should partner with universities and private firms to set up two BIM competence centres – one in Lagos (Ikeja or Victoria Island) and one in Port Harcourt (Trans-Amadi). Each centre shall offer: (a) subsidised licensed BIM software for SMEs, (b) hands-on training on design integration (currently the lowest awareness variable, RII=0.364), and (c) a certification pathway (Awareness, Practitioner, Manager). This will close the technical proficiency and software accessibility gaps.
3. Integrate BIM into university curricula and mandatory CPD: All construction-related degree programmes in South-South and South-West Nigeria must include a compulsory BIM course with at least 30 hours of practical software training. Additionally, the Architects Registration Council of Nigeria (ARCON), Council of Registered Builders of Nigeria (CORBON), and other regulators should require 10 hours of BIM-focused Continuing Professional Development (CPD) annually for license renewal by 2028. This will raise educational integration (RII=0.474) and sustain long-term awareness.
4. Launch a BIM subsidy and pilot project programme: The Nigerian Content Development and Monitoring Board (NCDMB) and Lagos State Infrastructure Asset Management Agency should co-fund a two-year BIM subsidy scheme covering 50% of software license costs for indigenous construction SMEs involved in high-rise projects. Concurrently, at least five pilot high-rise projects (three in Lagos, two in Port Harcourt) should be designated as “BIM demonstration projects” with publicised cost, schedule, and quality outcomes. The observable success of these pilots will dramatically improve the trialability and observability attributes (Rogers, 2003), converting high benefit perception into widespread adoption.

Finally, This study demonstrates that Nigerian professionals recognize BIM’s value but lack the enabling ecosystem of accessible software, formal training, and supportive policy. Bridging the gap requires coordinated action across government, professional bodies, universities, and firms. The cost of inaction is measurable: continued project inefficiencies, unnecessary rework, and missed opportunities for sustainable, predictable, high-quality construction delivery. The path forward is clear implementation must begin now.

References

- Onungwa, I. O., and Uduma-Olugu, N. (2017). Building Information Modelling and Collaboration in the Nigerian Construction Industry. *Journal of Construction Business and Management*, *1*(2), 1–10. <https://doi.org/10.15641/jcbm.1.2.53>
- Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering*, *11*(3), 241–252. [https://doi.org/10.1061/\(ASCE\)LM.1943-5630.0000127](https://doi.org/10.1061/(ASCE)LM.1943-5630.0000127)
- Eastman, C. M. (2011). BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons.
- Enegbuma, W. I., Udeaja, C. E., and Dola, K. (2016). Building information modelling for sustainable construction in Nigeria. *Journal of Construction in Developing Countries*, *21*(2), 1–18.
- Eze, C. N., Okoro, A. O., and Opara, F. M. (2020). Building Information Modelling (BIM) as a tool for cost and time reduction in Nigerian construction projects. *Journal of Sustainable Engineering*, *9*(3), 88–105.
- Uduma-Olugu, N., and Onungwa, I. O. (2017). Building Information Modelling as a Construction Management Tool in Nigeria. *WIT Transactions on The Built Environment*, *169*, 25–33. <https://doi.org/10.2495/BIM170031>
- Aibinu, A. A., and Venkatesh, S. (2018). The impact of Building Information Modelling (BIM) on cost estimation in construction projects. *Nigerian Journal of Construction Research*, *5*(2), 45–60.
- McGraw-Hill Construction (2020). The Business Value of BIM in Emerging Markets. England Studies.
- NBS (2022). National BIM Report.
- NBS (2023). Construction Sector Report 2023.
- International Code Council. (2025). International building code 2025. Country Club Hills, IL: International Code Council, State of Georgia, 2025.
- Sacks, R., Eastman, C., Lee, G., and Teicholz, P. (2018). BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers (3rd ed.). Wiley.
- Olawumi, T. O., and Chan, D. W. M. (2019). Critical success factors for implementing building information modeling and sustainability practices in construction projects. *Sustainability*, *11*(3), 786–802.
- Rogers, E. M. (2003). Diffusion of Innovations (5th ed.). Free Press
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340.
- Sheeran, P., and Webb, T. L. (2016). The intention–behavior gap. *Social and personality psychology compass*, *10*(9), 503–518.