Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 47 No. 04 (2026)

From Cost Centre to Value Creator: A Mixed-Methods Study Of In-Vitro Diagnostics Commercialisation in Nigeria and the C2VC Framework

Elijah Ehika Nwadiokwu
Rome Business School, Nigeria

Abstract:- Laboratory results shape a large share of clinical decisions, yet in Nigeria, in-vitro diagnostics (IVDs) are still bought largely on price. This study however examines which commercial factors are associated with the adoption and sustainability of IVD solutions. A convergent mixed-methods design combined a survey of 80 purposively sampled stakeholders with ten key-informant interviews. All six hypothesised associations were significant in bivariate tests. In multiple regression, diagnostic value creation independently predicted market adoption (B=0.425, p<0.001) and innovative financing independently predicted organisational sustainability (B=0.351, p=0.009). Responses clustered at the lowest scale point, and when 23 straight-line respondents were excluded, only the value-creation effect and the two sustainability associations held. Interviews highlighted price-led procurement, scarce capital, differing views of value and the weight of after-sales service. From these findings I propose the Cost-Centric to Value Creation (C2VC) framework, an eight-stage guide for suppliers, hospitals and policymakers.

Keywords: in-vitro diagnostics, laboratory medicine, value-based procurement, health financing, business model innovation, Nigeria.

1. Introduction

Most clinical pathways run through the laboratory. A blood count, a troponin or a viral load result often decides whether a patient is admitted, treated or sent home. The figure usually quoted is that around 70% of clinical decisions depend on laboratory results. Hallworth has shown that this number rests on weak evidence,[1] but nobody seriously disputes the underlying point: diagnostics carry a heavy share of clinical decision-making while taking a small share of health spending.[2]

That imbalance matters most where access is poorest. The *Lancet* Commission on diagnostics estimated that close to half the world's population has little or no access to diagnostic testing, with primary care in low- and middle-income countries worst served.[3] The 2023 World Health Assembly resolution on strengthening diagnostics capacity asked member states to treat diagnostics as a core part of health systems rather than an add-on.[4] In Nigeria, the COVID-19 response exposed how thin laboratory capacity was outside a few centres, and how much depended on imported reagents and donor-funded equipment.[5]

The Researcher's personal work in collaboration with a manufacturing firm suggests that much of the problem is commercial, not technical. Hospitals and laboratories usually judge an analyser by its purchase price. Running costs, reagent supply, uptime, turnaround time and what the results do for patient management rarely enter the tender. Suppliers, for their part, often sell boxes rather than services, and walk away once installation is done. The result is a familiar pattern: equipment bought but idle, reagents out of stock, and laboratories that cannot sustain the service they were equipped to deliver.

Internationally, the industry has moved towards reagent rental, pay-per-test, leasing and managed laboratory services. These models spread the cost of equipment over its working life and tie the supplier's revenue to the test actually being performed. Value-based healthcare offers a parallel argument from the buyer's side: value should be judged by outcomes achieved per unit of cost, not by the cost of inputs alone.[6] Diagnostics fit awkwardly into that logic, because their value is informational. A test changes a decision, and the decision changes the outcome.[7] That indirect chain makes diagnostic value easy to ignore at the point of purchase.

Most of the published literature on IVDs deals with analytical performance, clinical utility or regulation. Far less has been written about how diagnostic value is *sold*, financed and sustained in health systems with weak reimbursement, fragmented procurement and limited capital. This study addresses that gap. It asks how IVDs can be commercialised in emerging markets so that buyers see them as sources of clinical and economic value rather than as costs to be minimised.

The study had three aims: (1) to test whether commercial capabilities, business model innovation, stakeholder alignment, diagnostic value creation and innovative financing are associated with market adoption and organisational sustainability; (2) to explore, through interviews, how practitioners experience these issues; and (3) to bring both sets of findings together into a practical framework.

Conceptual background and hypotheses

Four bodies of theory informed the design. Value creation theory separates the value a product creates for the user from the value the seller captures.[8] For IVDs, that user value is clinical (earlier and more accurate diagnosis), operational (faster turnaround, better workflow) and economic (avoided treatment and shorter stays). Business model innovation theory explains how firms change the way they deliver and charge for that value, for example by moving from a single capital sale to recurring, usage-linked revenue.[9,10] Stakeholder theory reminds us that a pathologist, a hospital finance director and a state procurement officer will each define value differently, and that adoption depends on reconciling them.[11] Diffusion of innovation theory explains why adoption is slowed by cost, complexity and poor fit with existing practice.[12]

From this background I tested six hypotheses:

- **H1.** Strategic commercialisation capability (SCC) is positively associated with market adoption (MA).
- **H2.** Business model innovation (BMI) is positively associated with MA.
- **H3.** Stakeholder alignment (SA) is positively associated with MA.
- **H4.** Diagnostic value creation (DVC) is positively associated with healthcare value creation (HVC).
- **H5.** Innovative financing models (IFM) are positively associated with organisational sustainability (OS).
- **H6.** HVC is positively associated with OS.

Competitive advantage appears in the framework as a downstream outcome but was not measured as a separate construct.

2. Methods

Design

I used a convergent parallel mixed-methods design.[13] A cross-sectional survey and semi-structured interviews were run during the same fieldwork period, analysed separately and brought together at the interpretation stage. The survey tested the six hypotheses; the interviews were used to explain and contextualise the survey results.

Setting and participants

The study was set in Nigeria. The target population was professionals with direct experience of buying, selling, using, regulating or financing IVD technologies. Because this is a small and specialised group with no usable sampling frame, I used purposive sampling within eight stakeholder categories (Table 1) so that each part of the diagnostic supply chain was represented. The aim was informed coverage of the ecosystem, not a statistically representative sample. A minimum of 70 complete responses was set in advance; 80 questionnaires were distributed and all 80 were returned complete.

Ten senior stakeholders took part in key-informant interviews. They were chosen for direct responsibility in IVD commercialisation, procurement, laboratory management, regulation or market access. They were drawn from the same stakeholder categories as the survey respondents.

Survey instrument

The questionnaire contained 39 items measuring eight constructs on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Items were adapted from the literature where possible and written for the IVD context where no suitable item existed. Content validity was checked by expert review, and the instrument was piloted for clarity and completion time; pilot responses were excluded from the main dataset. The full instrument and item-to-construct mapping are given in Supplementary material S1. Questionnaires were distributed online and in person at professional meetings, hospitals and industry events.

Interviews

Interviews followed a semi-structured guide (Supplementary material S2) covering commercial practice, procurement decisions, financing, stakeholder collaboration, regulation, market access, public–private partnerships and after-sales service. With consent, interviews were audio-recorded and transcribed verbatim.

Analysis

Data were screened for completeness and out-of-range values. Construct scores were calculated as the mean of their items. Internal consistency was assessed with Cronbach's alpha (threshold 0.70). Each hypothesis was tested with simple linear regression. Two multiple regression models were then fitted to check whether each predictor contributed independently: MA regressed on SCC, BMI, SA, DVC and IFM; and OS regressed on SCC, BMI, SA, IFM and HVC. Because 23 respondents gave the lowest response to every item, all analysis were repeated with these cases excluded (n=57). These respondents scored exactly 1 on every construct, so their contribution to the sums of squares and cross-products could be removed exactly, and the reduced-sample statistics were derived from the full-sample means, standard deviations and correlations. Applied to the full sample, the same procedure reproduced the estimates in Table 3 to within rounding. Analysis was run in IBM SPSS Statistics. Significance was set at $p<0.05$.

Interview transcripts were analysed thematically using Braun and Clarke's six phases.[14] Codes were developed inductively and grouped into themes, which were then set against the survey findings in a joint display (Table 5).

Ethics

The study was carried out as part of a Doctor of Business Administration programme and followed the programme's research ethics requirements. Participation was voluntary, written or documented informed consent was obtained from all participants, and no personal identifiers were retained in the analytical dataset.

3. Results

Participants

Table 1 summarises the 80 survey respondents. Medical laboratory scientists were the largest group (22.5%). Three-quarters of respondents (75.0%) had more than ten years' professional experience. Just over half worked in the private sector (52.5%), 37.5% in the public sector and 10.0% in NGOs or development agencies.

Table 1. Characteristics of survey respondents (n=80)

Characteristic	n	%
Stakeholder category		
Medical laboratory scientists	18	22.5
Laboratory managers	12	15.0
IVD distributors	12	15.0
Other healthcare/industry professionals	12	15.0

Characteristic	n	%
IVD manufacturers	8	10.0
Hospital administrators	8	10.0
Procurement officers	6	7.5
Policymakers/regulators	4	5.0
Professional experience		
<5 years	6	7.5
5–10 years	14	17.5
11–15 years	20	25.0
16–20 years	18	22.5
>20 years	22	27.5
Sector		
Private	42	52.5
Public	30	37.5
NGO/development	8	10.0

Response distribution and reliability

There were no missing item responses. The distribution of responses was, however, unusual. Of 3,120 item responses, 88.3% were coded 1, 10.2% were 2, 1.4% were 3, 0.1% were 4 and none were 5. Twenty-three respondents (28.8%) answered 1 to every item. Construct means therefore lay between 1.10 and 1.20 (Table 2). I have retained all 80 cases and report the data as collected; the implications are taken up in the Discussion. Results with the 23 straight-line respondents excluded are reported separately below.

Cronbach's alpha ranged from 0.79 (BMI) to 0.90 (HVC), so all eight scales met the 0.70 threshold (Table 2). Because alpha is inflated when most responses sit at one value, these figures should be read with caution.

Table 2. Construct descriptive statistics and internal consistency (n=80)

Construct	Items	Mean	SD	Cronbach's α
Strategic commercialisation capability (SCC)	5	1.115	0.281	0.843
Business model innovation (BMI)	5	1.100	0.240	0.791
Stakeholder alignment (SA)	5	1.158	0.327	0.866
Diagnostic value creation (DVC)	5	1.118	0.268	0.797
Innovative financing models (IFM)	4	1.106	0.302	0.869
Market adoption (MA)	5	1.105	0.246	0.817
Healthcare value creation (HVC)	5	1.200	0.426	0.901
Organisational sustainability (OS)	5	1.150	0.325	0.874

Hypothesis tests

All six hypothesised relationships were positive and significant in simple regression (Table 3). The strongest bivariate associations were IFM with OS (r=0.42) and DVC with MA (r=0.49), the latter falling outside the hypothesis set. Not every pair of constructs was related: SA and DVC (r=0.02) and IFM and MA (r=0.03) were essentially uncorrelated. The full correlation matrix is in Supplementary material S3.

Table 3. Simple and multiple regression results

Hypothesis / predictor	Outcome	B	β	t	p	Result
Simple regression						
H1 SCC	MA	0.205	0.233	2.118	0.037	Supported

Hypothesis / predictor	Outcome	B	β	t	p	Result
H2 BMI	MA	0.298	0.291	2.684	0.009	Supported
H3 SA	MA	0.208	0.276	2.535	0.013	Supported
H4 DVC	HVC	0.460	0.289	2.665	0.009	Supported
H5 IFM	OS	0.453	0.421	4.105	<0.001	Supported
H6 HVC	OS	0.296	0.388	3.713	<0.001	Supported
Model 1: market adoption[a]						
SCC	MA	0.093	0.106	1.091	0.279	
BMI	MA	0.176	0.172	1.747	0.085	
SA	MA	0.153	0.203	2.038	0.045	
DVC	MA	0.425	0.462	4.811	<0.001	
IFM	MA	−0.022	−0.026	−0.274	0.785	
Model 2: organisational sustainability[b]						
SCC	OS	−0.017	−0.015	−0.138	0.891	
BMI	OS	0.189	0.139	1.308	0.195	
SA	OS	−0.106	−0.106	−0.983	0.329	
IFM	OS	0.351	0.326	2.698	0.009	
HVC	OS	0.179	0.235	1.952	0.055	

[a]R^2=0.358, adjusted R^2=0.315, F(5,74)=8.25, p<0.001. [b]R^2=0.242, adjusted R^2=0.190, F(5,74)=4.72, p<0.001. B, unstandardised coefficient; β, standardised coefficient. Abbreviations as in Table 2.

Multiple regression

The picture changed once predictors were entered together. The market adoption model explained 36% of the variance. DVC was by some distance the strongest independent predictor, and SA remained significant. SCC and IFM did not contribute independently, and BMI fell just short of significance (p=0.085). The organisational sustainability model explained 24% of the variance. IFM was the only predictor significant at the 5% level; HVC narrowly missed it (p=0.055).

In short, H1–H3 and H6 are supported as associations, but SCC, BMI and HVC add little once their overlap with other constructs is accounted for.

Sensitivity analysis

Removing the 23 straight-line respondents weakened almost every estimate (Table 4). All six associations stayed positive, but only H5 (IFM with OS) and H6 (HVC with OS) remained significant; H1–H4 no longer reached p<0.05. In the market adoption model, DVC was still a strong independent predictor (B=0.421, p<0.001), whereas SA lost significance (p=0.109). In the sustainability model, IFM sat right at the threshold (B=0.312, p=0.051) and no single predictor was clearly significant, although the model as a whole was (R^2=0.20, p=0.037). The one result that held firmly in both analyses was the independent link between diagnostic value creation and market adoption.

Table 4. Sensitivity analysis: full sample compared with straight-line respondents excluded

Relationship	Full sample (n=80) B	p	Excluding straight-liners (n=57) B	p
Simple regression				
H1 SCC → MA	0.205	0.037	0.152	0.195
H2 BMI → MA	0.298	0.009	0.241	0.078
H3 SA → MA	0.208	0.013	0.159	0.118

Relationship	Full sample (n=80) B	p	Excluding straight-liners (n=57) B	p
H4 DVC → HVC	0.460	0.009	0.353	0.095
H5 IFM → OS	0.453	<0.001	0.402	0.004
H6 HVC → OS	0.296	<0.001	0.251	0.013
Model 1: market adoption (R^2)	0.358	<0.001	0.307	0.002
SCC	0.093	0.279	0.090	0.398
BMI	0.176	0.085	0.173	0.169
SA	0.153	0.045	0.150	0.109
DVC	0.425	<0.001	0.421	<0.001
IFM	−0.022	0.785	−0.024	0.804
Model 2: organisational sustainability (R^2)	0.242	<0.001	0.203	0.037
SCC	−0.017	0.891	−0.065	0.664
BMI	0.189	0.195	0.132	0.454
SA	−0.106	0.329	−0.141	0.281
IFM	0.351	0.009	0.312	0.051
HVC	0.179	0.055	0.155	0.162

B, unstandardised coefficient. For model rows, the B column gives R^2 and p is for the overall F test. Reduced-sample estimates were derived from the full-sample summary statistics (see Methods and Supplementary material S3).

Interview themes

Five themes emerged from the ten interviews. They are summarised below.

Procurement is still driven by price. Even where interviewees recognised the clinical and operational value of a system, the purchase decision was usually made on acquisition cost, often by people with little contact with the laboratory.

Capital is the first barrier. Interviewees described laboratories that could justify an analyser clinically but could not raise the money up front. Reagent rental, pay-per-test, leasing, managed services and public–private partnerships were all mentioned as ways round this.

Value means different things to different people. Clinicians spoke about accuracy and turnaround, administrators about cost and return, and suppliers about volume and retention. Interviewees argued that a single sales pitch rarely persuades all of them.

After-sales service is part of the product. Installation, training, applications support, maintenance and, above all, reliable reagent supply were described as decisive. A cheap analyser that stands idle for want of reagents or an engineer was seen as worse than no analyser.

Partnerships offer a longer-term route. Distributor partnerships, managed services and institutional collaborations were seen as ways to share risk and keep services running beyond the initial sale.

Table 5 sets the two strands side by side.

Table 5. Joint display of survey and interview findings

Issue	Survey evidence	Interview evidence	Combined interpretation
Diagnostic value	DVC strongest independent predictor of MA (B=0.425, p<0.001), robust to sensitivity analysis	Value lies beyond the price of the analyser	Demonstrating value is central to adoption
Stakeholders	SA predicts MA independently in full sample (p=0.045) but not with straight-liners excluded (p=0.109)	Each group defines value differently	Tailored value propositions likely matter; survey support is tentative

Issue	Survey evidence	Interview evidence	Combined interpretation
Financing	IFM associated with OS in both analyses; independent effect borderline when straight-liners excluded (p=0.051); unrelated to MA	Capital shortage is the first barrier	Financing sustains services more than it drives initial uptake
Business models	BMI associated with MA bivariately; not independent (p=0.085)	Rental, pay-per-test and managed services widely discussed	Promising, but overlaps with other factors
Commercial capability	SCC associated with MA bivariately; not independent (p=0.279)	Price-led procurement limits value selling	Capability alone does not overcome price-led buying

4. Discussion

Main findings

The clearest finding is that how strongly stakeholders associate diagnostics with clinical, operational and economic value is the factor most closely linked to market adoption. It was the only independent effect that survived the exclusion of straight-line respondents. Stakeholder alignment also carried independent weight in the full sample, but not in the sensitivity analysis, so that result should be treated as tentative. Innovative financing was unrelated to adoption but was associated with organisational sustainability in both analyses. Put cautiously, value appears to get a diagnostic solution through the door, while the financing arrangement may decide whether the service survives.

The interviews help explain that split. Interviewees described a buying process run by people far from the laboratory and focused on the purchase price. In that setting, the supplier who can show what a test does for patients and for the hospital's costs, and who can speak to each decision-maker in their own terms, has the better chance of being chosen. Whether the analyser is still running two years later depends on reagent supply, service cover and a payment model that matches the laboratory's cash flow. These findings sit comfortably with the Lancet Commission's argument that access to diagnostics fails on affordability and supply chains as often as on technology.[3]

The weaker independent effects of commercial capability and business model innovation are worth noting. Both were associated with adoption on their own, but both overlapped with value creation and stakeholder alignment. One reading is that new business models and stronger sales capability help mainly because they make value easier to demonstrate and share, not as stand-alone levers.

Implications for practice and policy

For manufacturers and distributors, the findings argue for selling outcomes rather than specifications: building business cases around cost per reportable result, turnaround time, uptime and avoided treatment, and tailoring them to clinicians, laboratory managers and finance staff. Service, training and reagent continuity should be priced and promised as part of the offer, not treated as afterthoughts.

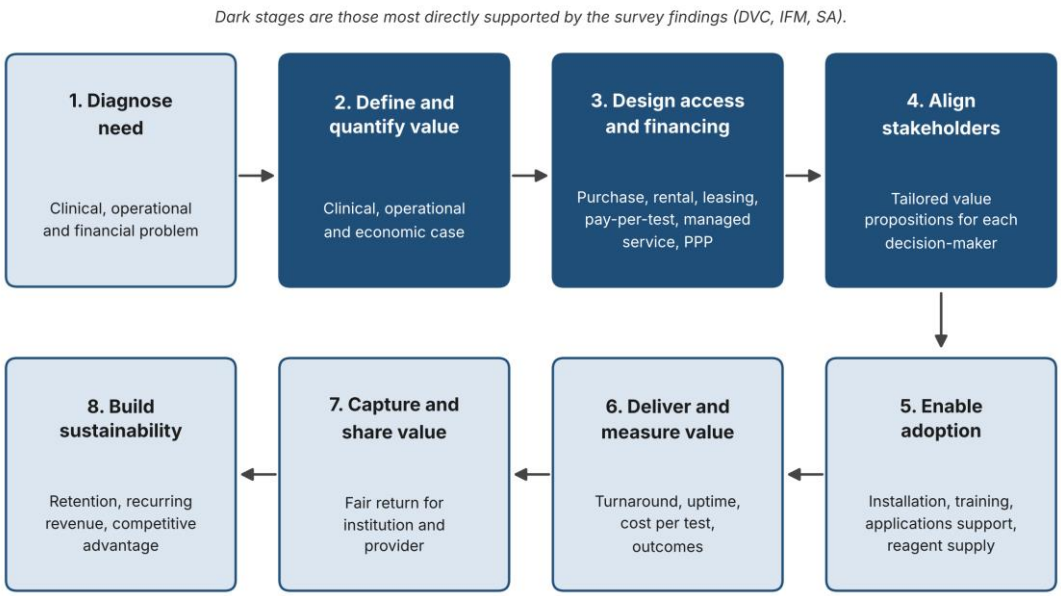
For hospitals and state procurement agencies, the message is that the lowest bid is often not the cheapest option. Tender criteria could include total cost of ownership, guaranteed uptime, reagent supply terms and service response times. Flexible financing, including reagent rental and pay-per-test contracts, deserves a place in public procurement rules, with safeguards against lock-in and inflated reagent pricing.

The C2VC framework

Drawing the survey and interview findings together, I propose the Cost-Centric to Value Creation (C2VC) framework (Fig 1). It sets out eight stages: (1) diagnose the clinical, operational and financial need; (2) define and quantify the value of the solution; (3) design access and financing; (4) align stakeholders; (5) enable adoption through installation, training and support; (6) deliver and measure value; (7) capture and share value between provider and institution; and (8) build sustainability and competitive advantage. Stage 2 rests most firmly on the

survey findings; stages 3 and 4 have weaker and less consistent support. The other stages draw on the interviews and the wider literature and have not been tested empirically here.

Fig 1. *The Cost-Centric to Value Creation (C2VC) framework for IVD commercialisation.*



Strengths and limitations

The study brings together perspectives from across the IVD supply chain, from manufacturers to regulators, in a setting that is rarely studied, and it combines survey data with practitioners' accounts.

Several limitations need to be stated plainly. The most important is the response distribution. Nearly nine in ten responses were at the lowest scale point and almost three in ten respondents gave the same answer to every item. Taken literally, this would mean that most respondents disagreed that diagnostics improve clinical decision-making, which is hard to reconcile with the interviews. Possible explanations include reversed scale anchors on some forms, a data-entry or coding error, or low engagement (straight-lining).[15,16] The original response forms and respondent-level data could not be re-examined for this submission, so none of these explanations can be ruled out. Excluding the 23 straight-line respondents weakened most associations, which shows how far the full-sample results depend on them. Restricted variance of this kind can distort both correlations and reliability estimates, so the regression results should be treated as provisional. The sample was purposive and modest, the design cross-sectional, and all measures were self-reported, which raises the risk of common method bias.[15] The constructs measure perceptions rather than observed adoption or financial performance. The interview findings are reported as summarised themes without verbatim quotations or a breakdown of interviewee roles, which limits how far readers can judge them. Finally, the work is set in Nigeria, and its transferability to other markets needs to be tested.

Future research

Further work should repeat the survey with a revised instrument that includes reverse-worded items and attention checks, use larger samples across several countries, and apply confirmatory factor analysis once the data allow. Longitudinal studies that track utilisation, uptime, cost per test and service continuity under different financing models would give a much firmer test of the framework than perception data can.

5. Conclusion

In this study, the perceived value of diagnostics was the factor most consistently linked to IVD adoption, and financing arrangements were linked to whether services last. Other associations, including stakeholder alignment,

did not survive the exclusion of straight-line respondents. The findings should be read alongside the clear limitations of the survey data. Even so, they support a simple shift in the question buyers and suppliers ask: from "How much does the analyser cost?" to "What will this service do for our patients and our budget, how will we pay for it, and how will we know it is working?" The C2VC framework is offered as a practical starting point for that conversation.

6. Declarations

Ethics approval. The study was conducted within a Doctor of Business Administration programme in accordance with the programme's research ethics requirements. It involved adult professionals only, collected no clinical or patient data, and retained no personal identifiers.

Informed consent. All participants gave informed consent before taking part.

CRediT authorship contribution statement. Sole author: conceptualisation, methodology, investigation, formal analysis, data curation, visualisation, writing – original draft, writing – review and editing.

Funding. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Declaration of competing interest. The author is employed by a manufacturer of in-vitro diagnostic products. The study was carried out independently as part of the author's doctoral programme, and the employer did not fund or direct it.

Data availability. The respondent-level data are not available for sharing. Summary statistics sufficient to reproduce the regression and sensitivity analyses, including the full correlation matrix, are provided in the supplementary material.

Declaration of generative AI and AI-assisted technologies in the writing process. During the preparation of this work the author used Claude (Anthropic) to edit the language, restructure and condense the manuscript from a longer thesis, and to recompute the regression and sensitivity estimates from the reported summary statistics, and Grammarly to check grammar and spelling. After using these tools, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Acknowledgements. The author thanks the survey respondents and interviewees for giving their time and sharing their experience.

References

[1] Hallworth MJ. The '70% claim': what is the evidence base? *Ann Clin Biochem* 2011;48:487–8. https://doi.org/10.1258/acb.2011.011177

[2] Rohr UP, Binder C, Dieterle T, et al. The value of in vitro diagnostic testing in medical practice: a status report. *PLoS One* 2016;11:e0149856. https://doi.org/10.1371/journal.pone.0149856

[3] Fleming KA, Horton S, Wilson ML, et al. The Lancet Commission on diagnostics: transforming access to diagnostics. *Lancet* 2021;398:1997–2050. https://doi.org/10.1016/S0140-6736(21)00673-5

[4] World Health Organization. Strengthening diagnostics capacity. Resolution WHA76.5. Geneva: WHO, 2023. https://www.who.int/activities/strengthening-diagnostics-capacity

[5] Naidoo D, Ihekweazu C. Nigeria's efforts to strengthen laboratory diagnostics – why access to reliable and affordable diagnostics is key to building resilient laboratory systems. *Afr J Lab Med* 2020;9:1019. https://doi.org/10.4102/ajlm.v9i2.1019

[6] Porter ME. What is value in health care? *N Engl J Med* 2010;363:2477–81. https://doi.org/10.1056/NEJMp1011024

[7] Parmigiani G. Uncertainty and the value of diagnostic information, with application to axillary lymph node dissection in breast cancer. *Stat Med* 2004;23:843–55. https://doi.org/10.1002/sim.1623

[8] Bowman C, Ambrosini V. Value creation versus value capture: towards a coherent definition of value in strategy. *Br J Manag* 2000;11:1–15. https://doi.org/10.1111/1467-8551.00147

[9] Teece DJ. Business models, business strategy and innovation. *Long Range Plann* 2010;43:172–94. https://doi.org/10.1016/j.lrp.2009.07.003

[10] Spieth P, Schneckenberg D, Ricart JE. Business model innovation – state of the art and future challenges for the field. *R&D Manag* 2014;44:237–47. https://doi.org/10.1111/radm.12071

[11] Donaldson T, Preston LE. The stakeholder theory of the corporation: concepts, evidence, and implications. *Acad Manage Rev* 1995;20:65–91. https://doi.org/10.5465/amr.1995.9503271992

[12] Rogers EM. *Diffusion of innovations*, 5th edn. New York: Free Press, 2003.

[13] Creswell JW, Plano Clark VL. *Designing and conducting mixed methods research*, 3rd edn. Thousand Oaks, CA: SAGE, 2018.

[14] Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101. https://doi.org/10.1191/1478088706qp063oa

[15] Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J Appl Psychol* 2003;88:879–903. https://doi.org/10.1037/0021-9010.88.5.879

[16] Meade AW, Craig SB. Identifying careless responses in survey data. *Psychol Methods* 2012;17:437–55. https://doi.org/10.1037/a0028085