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Procurement Lead Time, Inventory Accuracy and Inventory Turnover as Drivers of Schedule and Quality Performance in Construction Companies in Lagos, Nigeria

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Abstract
Purpose. Late delivery and defective work remain the two most visible failures of construction projects in Nigeria, and both are routinely traced to the way materials are procured, recorded and moved. This study examines which of five materials inventory management practices (optimising procurement lead time, achieving inventory accuracy, preventing stockouts, optimising inventory turnover and ensuring supplier reliability) explain project completion timelines and project quality in established construction companies in Lagos, Nigeria.
Design/methodology/approach. A cross-sectional survey was conducted among employees of five long-established construction companies headquartered in Lagos State, selected purposively and sampled through stratified proportionate random sampling. Of 371 questionnaires administered, 345 were valid (93.0 per cent). After the measurement model was assessed for reliability and validity, the effects of the five practices on each outcome were estimated by path analysis within a structural equation modelling framework in STATA 17.
Findings. Optimising procurement lead time was the strongest predictor of both completion timelines ($\beta = 0.296$, $p < 0.001$) and project quality ($\beta = 0.267$, $p = 0.002$). Inventory accuracy ($\beta = 0.197$, $p = 0.007$) and inventory turnover ($\beta = 0.144$, $p = 0.039$) also predicted completion timelines, while inventory turnover predicted quality ($\beta = 0.205$, $p = 0.008$). Stockout prevention had no unique effect on either outcome, and supplier reliability fell just short of significance for timelines ($p = 0.067$).
Originality/value. The study separates practices that are usually treated as a single bundle and shows that schedule and quality performance depend chiefly on the speed and predictability of procurement and on keeping materials moving, rather than on holding buffer stock. The findings refine the Lean Construction view of inventory as flow and support the Resource-Based View claim that procurement routines are performance-relevant capabilities.
Practical implications. Contractors seeking to protect programme dates and workmanship should invest first in procurement planning and lead-time control, regular reconciliation of store records and stock rotation, rather than in larger safety stocks.
Keywords: materials inventory management; procurement lead time; inventory turnover; project completion; construction quality; Lagos; Nigeria
Paper type: Research paper

1. Introduction

Few things damage a contractor's standing faster than a missed handover date, except perhaps a building that fails inspection after handover. In Nigeria both failures are common, and both have a long record in the construction management literature. Surveys of Nigerian projects stretching back three decades have placed late or irregular supply of materials among the leading causes of delay and cost overrun (Aibinu & Odeyinka, 2006; Mansfield et al., 1994), and the consequences of those delays, from disputes and arbitration to abandonment, are well documented (Aibinu & Jagboro, 2002). More recent factor-analytic work still identifies late delivery of materials by

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suppliers as one of the underlying drivers of delay on Nigerian projects (Egwim et al., 2023). Quality problems follow a similar path. Where materials arrive late, contractors improvise, substitute or rush, and the resulting defects and rework add time and cost that were never in the programme (Love & Edwards, 2004).

The common thread is materials. Construction materials typically account for well over half of the cost of a building project, and they are the physical inputs without which no planned activity can start. Observational studies of site productivity have shown for many years that poor material management produces idle crews, out-of-sequence work and lost labour hours (Thomas et al., 1989; Thomas et al., 2005). In Lagos, the problem is sharpened by rising and volatile material prices, congested logistics corridors and a supply base that is fragmented and often informal (Akanni et al., 2014). Field evidence from other Nigerian cities points in the same direction: in Port Harcourt, construction SMEs attribute poor time, cost and quality performance to traditional, manual approaches to materials management, weak planning, poor inventory control and inadequate storage (Eze et al., 2020), and in Abuja, observers of live building sites recorded measurable effects of poor materials management on waste, workmanship quality and profitability (Albert et al., 2021).

What the literature has not yet settled is *which* inventory practices matter for *which* outcome. Studies of materials management in construction tend to bundle practices into a single construct or to test them against a single, aggregate measure of performance. When practices are separated, the results are uneven. A survey of contractors in Lagos, Abuja and Port Harcourt found that materials requirements planning, warehousing and first-in-first-out issuing were associated with better time and cost performance but had no significant influence on quality (Ikediashi & Udo, 2020). A Turkish study found that procurement, handling and stock-and-waste control predicted project performance while planning and logistics did not (Yıldız et al., 2024). Australian contractors, asked which materials practices most improve labour productivity, ranked the early identification of long-lead items, formal procurement plans and delivery schedules ahead of everything else (Gurmu, 2020). These findings hint that the value of an inventory practice is outcome-specific, but they do not test that proposition directly, and almost none of the evidence comes from the large, established contractors that dominate Lagos's formal construction market.

This study addresses that gap for two outcomes that clients see most directly: whether projects finish on time and whether the finished work meets specification. It examines five practices that recur in both the operations management and construction literatures: optimising procurement lead time, achieving inventory accuracy, preventing stockouts, optimising inventory turnover and ensuring supplier reliability. Two research questions guide the analysis. First, which of these practices have a unique association with project completion timelines once the others are taken into account? Second, which have a unique association with project quality? Data come from 345 employees of five long-established construction companies headquartered in Lagos State, analysed by path analysis within a structural equation modelling framework.

The study makes three contributions. Empirically, it provides practice-level evidence on schedule and quality performance from a setting that is under-represented in the materials management literature, and it does so with a sample drawn from firms with formal inventory systems rather than from small informal operators. Theoretically, it brings Lean Construction Theory and the Resource-Based View to bear on the same question and shows where each explains the pattern of results and where each needs qualification. In particular, the findings suggest that schedule and quality performance respond to the speed, predictability and continuity of material flow rather than to the size of the buffers a firm holds, which is the distinction Lean Construction draws between flow and stock. Practically, the results give contractors a basis for deciding where limited managerial attention and investment should go first if programme dates and workmanship are the priority.

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The remainder of the article is organised as follows. The next section reviews the literature and develops the hypotheses. The research design, sample and measures are then described, followed by the results, a discussion of their meaning in relation to prior work and theory, and the study's implications, limitations and conclusions.

2. Literature review and hypotheses

2.1 Theoretical foundations

Lean Construction Theory. Lean thinking began in manufacturing, where it was codified as the pursuit of value through the elimination of waste, the creation of continuous flow and the use of pull rather than push signals (Womack & Jones, 1996). Koskela (1992) argued that construction could be understood in the same terms, as a production system made up of conversion activities and flows, and that much of the industry's poor performance came from managing conversions while neglecting the flows that connect them. Materials are among the most important of those flows. Ballard and Howell (1998) extended the argument by showing that work released to crews before its prerequisites are in place, materials included, is the principal source of the variability that makes construction schedules unreliable. Their remedy, formalised in the Last Planner System, was to "shield" production by making work ready before it is assigned: constraints are identified in a look-ahead window and removed before the task is committed (Ballard, 2000).

The implication for materials inventory is subtle. Lean does not say that inventory should be eliminated; it says that inventory is a symptom of unreliable flow and that the goal is to need less of it. A site that holds large stocks to guard against late deliveries pays for that protection through handling, damage, congestion and the capital tied up in idle material. A site whose deliveries are predictable can hold less and still protect the work. On this reading, practices that make material flow faster and more predictable should matter more for schedule and quality than practices that simply hold more stock. Vrijhoef and Koskela (2000) made a similar point about construction supply chains, noting that many problems that surface on site are created upstream by suppliers and procurement processes and can only be solved there.

The Resource-Based View. The Resource-Based View (RBV) explains differences in performance between firms by differences in the resources and capabilities they control. Resources that are valuable, rare, difficult to imitate and difficult to substitute can sustain an advantage (Barney, 1991), provided that they are heterogeneous across firms and that competition for them is limited (Peteraf, 1993). Later work shifted attention from what firms own to what they do with it. Sirmon et al. (2007) described value creation as a process of structuring, bundling and leveraging resources, and Teece et al. (1997) emphasised the dynamic capability to reconfigure resources when conditions change. Critics have warned that the RBV can become circular if "valuable resources" are identified only after the fact by the performance they produce (Kraaijenbrink et al., 2010), which makes it important to specify the mechanism through which a capability is expected to work.

Materials inventory management fits the capability view well. Procurement routines, store-keeping discipline, supplier relationships and the know-how to synchronise deliveries with a programme are built up over years, are embedded in people and procedures, and are difficult for a competitor to copy quickly. They are also unevenly distributed across Nigerian contractors, which is the heterogeneity the RBV requires. The RBV therefore predicts that firms with stronger inventory capabilities will deliver better project outcomes. Lean Construction adds a prediction about *which* capabilities matter most for time and quality: those that govern flow.

2.2 Project completion timelines and project quality

Project completion timelines refer to the extent to which projects are delivered within the planned schedule. Delay is the most frequently studied performance failure in construction, and studies in

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Nigeria (Aibinu & Odeyinka, 2006; Mansfield et al., 1994), Malaysia (Sambasivan & Soon, 2007) and elsewhere consistently rank material-related causes, including shortages, late delivery and slow procurement, among the leading contributors. Olawale and Sun (2010) found that UK practitioners regarded design changes, risks and uncertainties, inaccurate estimation of duration, complexity and subcontractor non-performance as the main inhibitors of time and cost control, and grouped the measures that mitigate them into preventive, predictive, corrective and organisational types, a reminder that schedule control depends as much on anticipation as on reaction.

Project quality refers to the conformity of completed work to specifications, standards and client expectations. It is often treated as the third corner of the iron triangle, but it has a different relationship with materials. A shortage delays work; a wrong, damaged or substituted material may allow work to proceed while embedding a defect. Love and Edwards (2004) showed that rework in building projects is driven largely by changes, errors and omissions, many of which arise when information and materials are not in place when work begins. In Abuja, Ogundipe et al. (2020) found that non-compliance with material specifications and inadequate scheduling of materials were among the leading barriers to effective materials management, with delay, cost overrun and ineffective allocation as the main consequences. Albert et al. (2021) observed that poor materials management on Abuja building sites had a moderate effect on the quality of work. Notably, the one Nigerian survey that tested inventory techniques against all three corners of the iron triangle found effects on time and cost but not on quality (Ikediashi & Udo, 2020), which suggests that the link between inventory and quality is real but more selective than the link with time.

2.3 Inventory practices and hypotheses

Optimising procurement lead time. Procurement lead time is the elapsed time between the identification of a material need and the availability of the material at the point of use. It includes internal stages (requisition, approval, tendering and ordering) and external stages (supplier processing, transport and receipt). Long and variable lead times have two effects. They push procurement decisions further ahead of actual need, which increases forecasting error, and they encourage firms to compensate with safety stock or emergency purchasing. Lee et al. (1997) showed that long replenishment lead times amplify demand distortion along supply chains, the so-called bullwhip effect. For schedule performance, the mechanism is direct: when lead times are short and predictable, materials can be called off in line with the look-ahead programme and tasks can be released on time. Gurmu (2020) found that identifying long-lead items early and preparing procurement plans and delivery schedules were the practices contractors rated most important for productivity on multi-storey buildings. For quality, the mechanism is indirect but plausible. When procurement is slow, site teams face pressure to substitute available materials for specified ones or to compress later activities, both of which raise the risk of defects.

> ***H1a.*** *Optimising procurement lead time is positively associated with project completion timelines.*
>
> ***H2a.*** *Optimising procurement lead time is positively associated with project quality.*

Achieving inventory accuracy. Inventory accuracy is the degree to which recorded stock matches physical stock. It matters because every replenishment decision is made on the record, not on the shelf. In a study of nearly 370,000 inventory records in retail stores, DeHoratius and Raman (2008) found that 65 per cent of records were inaccurate and that inaccuracy varied systematically with operating conditions, which means it can be managed. On construction sites the problem is arguably worse, because materials move between yards, staging areas and workfaces and are

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exposed to damage and theft (Thomas et al., 2005). An inaccurate record can lead managers to believe that an item is in stock when it is not, producing a surprise shortage, or to reorder an item that is already on site. Accurate records should therefore support timely completion by reducing unplanned stoppages. Their link with quality is less obvious. Accurate records help ensure that the right specification is issued, but they say little about the condition of the material itself.

> ***H1b.*** *Achieving inventory accuracy is positively associated with project completion timelines.*
>
> ***H2b.*** *Achieving inventory accuracy is positively associated with project quality.*

Preventing stockouts. A stockout occurs when a required material is unavailable at the point of use. The conventional response is to hold safety stock, set reorder points and maintain contingency arrangements. Stockouts on construction sites are costly because they idle labour and equipment and force work out of sequence (Thomas et al., 1989). It would seem to follow that firms that invest in stockout prevention should finish on time. Lean Construction offers a more qualified view. Buffers protect production only when they are the right items in the right place; large undifferentiated stocks consume space, increase handling and may conceal the underlying unreliability of supply. If timely completion is mainly a function of predictable flow, the unique contribution of buffer stock may be small once lead time and record accuracy are controlled. The quality argument is weaker still, because having material available does not guarantee that it is the correct or undamaged material.

> ***H1c.*** *Preventing stockouts is positively associated with project completion timelines.*
>
> ***H2c.*** *Preventing stockouts is positively associated with project quality.*

Optimising inventory turnover. Inventory turnover describes the rate at which materials are consumed and replenished. High turnover means that materials spend little time in storage; very low turnover indicates overstocking, slow-moving items and capital tied up in idle stock. Turnover is not an end in itself, and pushing it too high invites shortages, but in construction a steady turnover usually reflects deliveries that are closely matched to consumption. Such matching is precisely what lean logistics aims for. For timelines, steady turnover implies that materials are arriving as they are needed. For quality, the argument is especially strong. Materials that sit too long in a Lagos site yard are exposed to heat, humidity, rain and handling damage; cement hardens, reinforcement corrodes, finishes are scratched or stained. Rotating stock so that older materials are used first, and avoiding overstocking in the first place, protects material condition and therefore workmanship. Formoso et al. (2002) found that much of the material waste on Brazilian building sites arose from poor storage and handling and could be avoided through inexpensive managerial measures, which also bear on the quality of the materials eventually installed.

> ***H1d.*** *Optimising inventory turnover is positively associated with project completion timelines.*
>
> ***H2d.*** *Optimising inventory turnover is positively associated with project quality.*

Ensuring supplier reliability. Supplier reliability is the extent to which suppliers deliver the right materials, in the right quantity and quality, at the agreed time. It is the external counterpart of the internal practices above, and in construction it is closely bound up with how purchasing is organised. Dubois and Gadde (2000) observed that construction firms tend to buy project by project, through short-term, price-driven transactions that limit the scope for supplier development. Where longer-term relationships exist, they are associated with better integration and performance (Prajogo & Olhager, 2012), and lean pilot projects that deliberately built collaboration with suppliers report improvements in both time and quality (Eriksson, 2010). In

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Nigeria, practitioners identify the free exchange of information between suppliers and sites as the most important corrective measure for supply chain lapses (Okafor et al., 2024), and late delivery by suppliers emerges as a distinct underlying cause of project delay (Egwim et al., 2023). Reliable suppliers should therefore support both timely completion and quality, the latter because they deliver to specification.

> ***H1e.*** *Ensuring supplier reliability is positively associated with project completion timelines.*
>
> ***H2e.*** *Ensuring supplier reliability is positively associated with project quality.*

Taken together, the hypotheses describe a model in which the five practices are entered simultaneously as predictors of each outcome. Because the practices tend to move together in established firms, the interest lies less in whether each is correlated with performance, which is expected, than in whether each retains a *unique* association once the others are held constant. Lean Construction implies that flow-related practices (lead time, turnover and, through its effect on lead time, supplier reliability) should retain their effects, while the stock-holding practice of stockout prevention should not.

Table 1. Summary of hypotheses

Practice	**Project completion timelines**	**Project quality**
Optimising procurement lead time (OPLT)	H1a (+)	H2a (+)
Achieving inventory accuracy (AIC)	H1b (+)	H2b (+)
Preventing stockouts (PS)	H1c (+)	H2c (+)
Optimising inventory turnover (OIT)	H1d (+)	H2d (+)
Ensuring supplier reliability (ESR)	H1e (+)	H2e (+)

3. Methodology

3.1 Research design and setting

The study used a quantitative, cross-sectional survey design. Lagos State was chosen because it is Nigeria's largest urban economy and its principal construction market, because materials-related delays and overruns on Lagos projects are well documented (Akanni et al., 2014; Ikediashi & Udo, 2020), and because its contractors combine paper-based and digital inventory practices to varying degrees. The article reports one part of a larger doctoral investigation of materials inventory management and construction performance; the analyses presented here concern schedule and quality outcomes only.

3.2 Population and sampling

The population comprised the 4,260 employees of five long-established construction companies with registered headquarters in Lagos State: Cappa & D'Alberto Plc (established 1932; 1,190 employees), Costain West Africa Plc (1948; 745), Reynolds Construction Company (Nigeria) Ltd (1956; 625), EL-ALAN Construction Company (Nigeria) Ltd (1982; 450) and ITB Nigeria Ltd (1995; 1,250). The firms were selected purposively against six criteria: a registered head office in Lagos State; establishment before 2000; active involvement in large-scale projects in Lagos between 2019 and 2024; evidence of formal materials inventory management and some use of digital tools for inventory or procurement; employment of the relevant professional staff; and willingness to grant access. The purpose of these criteria was to ensure that respondents worked in organisations where the practices under study actually existed and could be meaningfully rated. Informal and unregistered contractors, whose processes are largely undocumented, were excluded. Within the firms, employees were stratified by functional category (management, technical and operational staff), and respondents were drawn from each stratum by proportionate random

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sampling. Cochran's formula for a proportion, with 95 per cent confidence, a 5 per cent margin of error and p = 0.5, gave a target of 384, which was allocated across the firms in proportion to their workforce. During fieldwork 13 sampled employees were unavailable, so 371 questionnaires were administered. Of these, 345 were returned complete and usable, a response rate of 93.0 per cent. The usable sample exceeds the minimum of 200 cases commonly recommended for structural equation modelling and provides more than 60 cases for each of the five structural paths estimated per outcome model (Kline, 2016; Memon et al., 2020).

Table 2 summarises the respondents' profile. Most were men (71.9 per cent), which reflects the gender composition of technical roles in Nigerian construction. Six in ten had more than ten years of industry experience, almost 88 per cent held at least a higher national diploma or bachelor's degree, and 84.9 per cent were site engineers, procurement and inventory staff or project managers, the groups most directly involved in planning, ordering, receiving and using materials.

Table 2. Profile of respondents (n = 345)

Characteristic	Category	Frequency	Per cent
Gender	Male	248	71.9
	Female	97	28.1
Age (years)	20–29	69	20.0
	30–39	137	39.7
	40–49	100	29.0
	50 and above	39	11.3
Industry experience (years)	0–5	56	16.2
	6–10	82	23.8
	11–15	100	29.0
	16–20	63	18.3
	21 and above	44	12.8
Highest qualification	Below HND/bachelor's	42	12.2
	HND/bachelor's degree	170	49.3
	Master's degree	89	25.8
	Doctorate	44	12.8
Position	Site engineer	115	33.3
	Inventory/procurement staff	93	27.0
	Project manager	85	24.6
	Other	52	15.1

3.3 Instrument and measures

Data were collected with a structured questionnaire whose items were adapted from prior studies of construction materials management and reworded for the Nigerian context. The draft was reviewed for content and face validity by three academics in project and construction management and pre-tested with a small group of construction professionals in Lagos. All constructs were measured with five items on a five-point scale from 1 (strongly disagree) to 5 (strongly agree), and construct scores were formed as item means; treating multi-item Likert scores as approximately interval is defensible at this sample size (Norman, 2010).

The five predictors were measured as follows. *Optimising procurement lead time* captured whether delays in material procurement are reduced to meet schedules, whether procurement timelines are clear, whether supplier agreements specify delivery times, whether procurement processes are reviewed to shorten lead time and whether emergency procurement arrangements exist. *Achieving inventory accuracy* captured whether records are accurate and current, whether physical counts match records, whether material usage is tracked reliably and whether discrepancies are

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investigated promptly. *Preventing stockouts* captured safety stock, routine monitoring of stock levels, early-warning arrangements, rapid replenishment through suppliers and contingency plans. *Optimising inventory turnover* captured avoidance of overstocking, monitoring of turnover, planning to minimise excess stock and prioritising materials close to expiry or obsolescence. *Ensuring supplier reliability* captured consistent supplier quality, regular supplier evaluation, relationships with dependable suppliers and contractual commitments on quality and delivery.

The two outcomes were measured from the respondents' perspective. *Project completion timelines* captured whether materials management contributes to timely completion, whether material availability reduces delays, whether procurement efficiency supports the schedule, whether projects are rarely delayed by shortages and whether inventory practices help the firm meet client deadlines. *Project quality* captured whether reliable supply ensures high-quality output, whether quality materials are used consistently, whether accurate inventory reduces the use of substandard materials, whether timely availability prevents rushed work and whether supplier reliability maintains quality standards. Both outcomes therefore reflect perceived performance of projects executed by the firm, not objective schedule variance or defect rates.

3.4 Data collection and ethics

Questionnaires were administered at the firms' head offices by the researcher and two trained research assistants, with an electronic version made available for staff working on remote sites. Participation was voluntary, respondents were informed about the purpose of the study, and no names or identifying details were collected. Ethical clearance was obtained from the Faculty of Management and Social Sciences, Lead City University, Ibadan, before fieldwork began.

3.5 Measurement assessment

Table 3 reports indicator reliability, internal consistency and convergent validity for the seven constructs used here. All standardised loadings exceeded 0.70, Cronbach's alpha ranged from 0.813 to 0.863, composite reliability from 0.903 to 0.917 and average variance extracted (AVE) from 0.651 to 0.690. Each construct therefore met the conventional thresholds of 0.70 for loadings, alpha and composite reliability and 0.50 for AVE (Fornell & Larcker, 1981; Hair et al., 2019).

Table 3. Reliability and convergent validity

Construct	Items	Loadings (range)	Cronbach's α	Composite reliability	AVE
Optimising procurement lead time (OPLT)	5	0.801–0.872	0.813	0.917	0.690
Achieving inventory accuracy (AIC)	5	0.801–0.831	0.852	0.912	0.674
Preventing stockouts (PS)	5	0.799–0.853	0.838	0.911	0.671
Optimising inventory turnover (OIT)	5	0.805–0.845	0.863	0.915	0.683
Ensuring supplier reliability (ESR)	5	0.799–0.811	0.838	0.903	0.651
Project completion timelines (PCT)	5	0.807–0.842	0.857	0.912	0.675
Project quality (PQ)	5	0.799–0.837	0.817	0.912	0.675

Discriminant validity was assessed with the Fornell–Larcker criterion (Table 4). Both outcome constructs were clearly distinct: the square root of each AVE (0.822 for both) exceeded every correlation involving that construct. Among the five practices, however, the criterion was only partly met. Eight of the ten correlations among them (0.814 to 0.855) exceeded the square root of the AVE of at least one of the two constructs concerned, the highest being between procurement

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lead time and supplier reliability (r = 0.855). This pattern is substantively plausible. The five practices are distinct activities, but established firms tend to run them as one materials management system, so firms that perform well on one tend to perform well on the others. It does mean that the practices share a large amount of variance, and their separate coefficients must be read with that in mind. A heterotrait–monotrait assessment (Henseler et al., 2015), which requires item-level correlations, is recommended for future work with this instrument.

Table 4. Inter-construct correlations and square roots of AVE (diagonal)

	OPLT	AIC	PS	OIT	ESR	PCT	PQ
OPLT	**0.831**						
AIC	0.837	**0.821**					
PS	0.822	0.824	**0.819**				
OIT	0.844	0.821	0.794	**0.826**			
ESR	0.855	0.835	0.828	0.814	**0.807**		
PCT	0.751	0.729	0.695	0.717	0.724	**0.822**	
PQ	0.698	0.671	0.642	0.680	0.672	0.650	**0.822**

Note. All correlations significant at $p < 0.01$ (two-tailed).

The same overlap appears in the collinearity diagnostics. Variance inflation factors for the five practices ranged from 4.254 (stockout prevention) to 5.497 (procurement lead time), with tolerances from 0.182 to 0.235. These values are below the conventional ceiling of 10 but above the stricter threshold of 5 for procurement lead time and supplier reliability (Hair et al., 2019). Collinearity of this size inflates standard errors and makes it harder for any single practice to reach significance, so a non-significant path is best interpreted as the absence of a *unique* effect after the other practices are controlled, not as evidence that the practice is irrelevant. Linearity checks showed a significant linear component and no significant deviation from linearity ($p = 0.436$), and a Glejser test showed no evidence of heteroskedasticity.

Because predictors and outcomes came from the same respondents, procedural remedies against common method variance were applied: anonymity was assured, predictor and outcome items were placed in separate sections of the questionnaire, and items were reviewed for clarity to reduce ambiguity (Podsakoff et al., 2003). No statistical test for common method bias was performed, and the possibility cannot be ruled out.

3.6 Analysis

The hypotheses were tested by path analysis within a structural equation modelling framework in STATA 17, with the five practices entered simultaneously as predictors of each outcome. This approach estimates each practice's unique contribution while holding the others constant and reports a standard error and confidence interval for every path. Model fit was evaluated against the criteria of Hu and Bentler (1999). Standardised path coefficients (β) are reported, and hypotheses are supported where $p < 0.05$. The proportion of variance explained in each outcome (R^2) was derived from the inter-construct correlation matrix.

4. Results

4.1 Model fit and explanatory power

The structural model showed good fit to the data: RMSEA = 0.040, CFI = 0.96, TLI = 0.98 and SRMR = 0.051. Each index meets the cut-offs recommended by Hu and Bentler (1999), namely RMSEA close to or below 0.06, CFI and TLI of 0.95 or above, and SRMR of 0.08 or below. The chi-square statistic was significant, which is common at this sample size and is not on its own taken as evidence of misfit (Kline, 2016). Together the five practices accounted for 61.2 per cent of the variance in project completion timelines and 53.0 per cent of the variance in project quality. Practices therefore explained schedule performance somewhat better than quality, a first indication

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that the link between inventory management and quality is less complete.

4.2 Project completion timelines

The left-hand panel of Table 5 reports the effects of the five practices on completion timelines. All five coefficients were positive, but only three were significant. Optimising procurement lead time had the largest effect (β = 0.296, z = 3.79, p < 0.001, 95% CI [0.143, 0.450]), supporting H1a. Achieving inventory accuracy also had a significant positive effect (β = 0.197, z = 2.70, p = 0.007, 95% CI [0.054, 0.341]), supporting H1b, as did optimising inventory turnover (β = 0.144, z = 2.06, p = 0.039, 95% CI [0.007, 0.281]), supporting H1d.

Two hypotheses were not supported. Preventing stockouts had a small and clearly non-significant coefficient (β = 0.060, z = 0.86, p = 0.388), so H1c was rejected. Ensuring supplier reliability came close to significance (β = 0.138, z = 1.83, p = 0.067, 95% CI [−0.009, 0.286]); its confidence interval only barely includes zero, but by the criterion adopted H1e was not supported.

4.3 Project quality

The right-hand panel of Table 5 shows a narrower pattern. Only two practices had significant effects on quality. Optimising procurement lead time was again the strongest predictor (β = 0.267, z = 3.10, p = 0.002, 95% CI [0.098, 0.436]), supporting H2a, and optimising inventory turnover was the second (β = 0.205, z = 2.67, p = 0.008, 95% CI [0.054, 0.355]), supporting H2d. Achieving inventory accuracy had a positive but non-significant effect (β = 0.141, z = 1.74, p = 0.081), as did ensuring supplier reliability (β = 0.129, z = 1.55, p = 0.120). Stockout prevention again had almost no unique effect (β = 0.037, z = 0.49, p = 0.623). H2b, H2c and H2e were therefore not supported.

Table 5. Path estimates for project completion timelines and project quality

Path	**β (PCT)**	**SE**	**z**	**p**	**95% CI**	**β (PQ)**	**SE**	**z**	**p**	**95% CI**
OPLT → outcome	0.296	0.078	3.79	<0.001	[0.143, 0.450]	0.267	0.086	3.10	0.002	[0.098, 0.436]
AIC → outcome	0.197	0.073	2.70	0.007	[0.054, 0.341]	0.141	0.081	1.74	0.081	[−0.017, 0.299]
PS → outcome	0.060	0.069	0.86	0.388	[−0.076, 0.195]	0.037	0.076	0.49	0.623	[−0.112, 0.187]
OIT → outcome	0.144	0.070	2.06	0.039	[0.007, 0.281]	0.205	0.077	2.67	0.008	[0.054, 0.355]
ESR → outcome	0.138	0.075	1.83	0.067	[−0.009, 0.286]	0.129	0.083	1.55	0.120	[−0.034, 0.291]
R^2	0.612					0.530				

Note. PCT = project completion timelines; PQ = project quality; OPLT = optimising procurement lead time; AIC = achieving inventory accuracy; PS = preventing stockouts; OIT = optimising inventory turnover; ESR = ensuring supplier reliability. Standardised coefficients; n = 345.

4.4 Summary of hypothesis tests

Table 6 summarises the decisions. Five of the ten hypotheses were supported. Two practices, procurement lead time and inventory turnover, predicted both outcomes. Inventory accuracy predicted timelines but not quality. Supplier reliability fell short for both, narrowly so for timelines. Stockout prevention predicted neither, and its coefficients were the smallest in both models.

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Table 6. Summary of hypothesis decisions

Hypothesis	Path	β	p	Decision
H1a	OPLT → PCT	0.296	<0.001	Supported
H1b	AIC → PCT	0.197	0.007	Supported
H1c	PS → PCT	0.060	0.388	Not supported
H1d	OIT → PCT	0.144	0.039	Supported
H1e	ESR → PCT	0.138	0.067	Not supported
H2a	OPLT → PQ	0.267	0.002	Supported
H2b	AIC → PQ	0.141	0.081	Not supported
H2c	PS → PQ	0.037	0.623	Not supported
H2d	OIT → PQ	0.205	0.008	Supported
H2e	ESR → PQ	0.129	0.120	Not supported

The contrast between the bivariate and multivariate results deserves attention. Every practice was strongly correlated with both outcomes (r = 0.642 to 0.751), yet several lost significance once the others were controlled. Stockout prevention illustrates the point most clearly: its correlation with completion timelines was 0.695, but its unique contribution was close to zero. What predicted performance, in other words, was not inventory management in general but the specific practices concerned with how quickly and steadily materials move.

5. Discussion

The central finding is that schedule and quality performance in these Lagos contractors depend on a small subset of inventory practices, and that the subset is defined by flow rather than by stock. Procurement lead time and inventory turnover, the two practices most directly concerned with how fast and how steadily materials move from order to installation, were the only ones that predicted both outcomes. Stockout prevention, the practice most closely associated with holding buffers, predicted neither. This section considers each result and then what the pattern means for theory.

5.1 Procurement lead time as the main lever

Procurement lead time was the strongest predictor of both completion timelines and quality. For timelines, the result fits a long line of evidence. Nigerian delay studies have repeatedly ranked slow procurement and late delivery of materials among the main causes of overrun (Aibinu & Odeyinka, 2006; Egwim et al., 2023; Mansfield et al., 1994), and Australian contractors place the early identification of long-lead items, procurement planning and delivery scheduling at the top of the practices that protect productivity (Gurmu, 2020). The present study adds two things. It shows that lead time retains a substantial unique effect even when four other inventory practices are held constant, and it shows that the effect is of similar size for quality.

The mechanism for timelines is the one Ballard and Howell (1998) described: work can only be shielded from disruption if its prerequisites arrive before it is released, and short, predictable lead times make that possible without carrying large stocks. Lead time also matters upstream. When the gap between ordering and delivery is long and uncertain, firms must forecast further ahead, errors grow and are amplified along the chain (Lee et al., 1997), and site managers fall back on expediting and ad hoc purchasing. The questionnaire items that defined this practice, which included clear procurement timelines, delivery provisions in supplier agreements and periodic review of procurement processes, describe a procurement function that is planned rather than reactive.

The quality effect is less often discussed but has a clear logic. When materials are late, site teams in Lagos face strong pressure to keep crews working, and the available options are rarely good ones: substitute a material that is to hand, accept a lower grade from an alternative supplier, or compress later activities to recover the programme. Each raises the risk of defects and rework.

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Rework itself is driven largely by changes, errors and omissions that appear when work begins before its inputs are fully in place (Love & Edwards, 2004). Ogundipe et al. (2020) found that non-compliance with material specifications and inadequate material scheduling were the leading barriers to effective materials management in Abuja, which points to the same link between procurement timing and conformance. Earlier Nigerian work found inventory techniques related to time and cost but not to quality (Ikediashi & Udo, 2020). The present results suggest that quality does respond to inventory management, but to particular practices, of which procurement lead time is the most important.

5.2 Inventory turnover and the condition of materials

Inventory turnover predicted both outcomes, and its effect on quality ($\beta = 0.205$) was larger than its effect on timelines ($\beta = 0.144$). The quality result is best explained by what happens to materials that sit too long. Lagos's climate is hot and humid with heavy seasonal rainfall, site storage is often improvised, and cement, steel, timber and finishes all deteriorate with time and handling. Firms that avoid overstocking and use older materials first install materials in better condition. The turnover items in this study included the prioritised use of materials close to expiry or obsolescence, which is close to the first-in-first-out issuing that Ikediashi and Udo (2020) found widely used among Nigerian contractors. Formoso et al. (2002) showed that much of the material loss on building sites stems from storage and handling and can be prevented through inexpensive managerial measures, and Thomas et al. (2005) argued that separating long-term storage from staging and workface areas reduces double handling and damage. Turnover is, in effect, a summary measure of whether those principles are being applied.

The timeline effect is consistent with lean logistics. Steady turnover means that deliveries track consumption, so that materials are neither missing nor piled up in the way of the work. The effect was the smallest of the three significant predictors of timelines, which is plausible: turnover reflects the rhythm of supply, but schedule performance depends first on whether items arrive at all and when.

5.3 Inventory accuracy: important for time, not for quality

Inventory accuracy had a significant effect on completion timelines but not on quality. The contrast is informative. Accurate records matter for schedule because every ordering and issuing decision relies on them. When records overstate stock, a planned activity discovers a shortage only when it starts; when they understate stock, money and space are wasted on duplicate orders. DeHoratius and Raman (2008) showed that record errors are pervasive even in well-managed retail chains, and construction sites, where materials move between yards, staging areas and workfaces, give many more opportunities for records and reality to diverge (Thomas et al., 2005). Quality depends less on whether the count is right than on whether the item counted is the right specification and in good condition, which accuracy alone does not guarantee. The coefficient for quality was positive ($\beta = 0.141$) and its p-value (0.081) was not far from the threshold, so accuracy may still play a supporting role, perhaps by reducing the occasions on which substitutes are used.

5.4 The null result for stockout prevention

The most striking result is that stockout prevention, despite strong bivariate correlations with both outcomes, had virtually no unique effect on either. This should not be read as saying that stockouts do not matter; a shortage of a critical item can stop a site. The finding says something narrower and more useful: once a firm's lead times, records and turnover are taken into account, the additional effort it puts into safety stocks, monitoring and contingency arrangements adds little to schedule or quality performance.

Two explanations fit the evidence. The first is theoretical. Lean Construction treats buffers as a

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cost paid for unreliable flow, not as a source of performance (Koskela, 1992). A firm whose procurement is fast and predictable already has most of the protection that safety stock provides; a firm whose procurement is slow cannot fully compensate by holding more, because undifferentiated stocks are expensive, congest the site and deteriorate. Stockout prevention, on this view, is largely an outcome of good flow rather than an independent driver of performance. The second explanation is statistical. Stockout prevention correlated 0.794 to 0.828 with the other four practices, so much of what it measures is shared with them. Its unique variance is small, and its unique effect is correspondingly hard to detect. Both explanations point to the same practical conclusion: buffer stock is a weak substitute for fixing procurement.

5.5 Supplier reliability: an effect that travels through lead time

Supplier reliability narrowly missed significance for completion timelines ($p = 0.067$) and was not significant for quality ($p = 0.120$). This is surprising at first sight, given that Nigerian studies identify late supplier delivery as a key underlying cause of delay (Egwim et al., 2023) and that collaboration with suppliers is associated with better time and quality outcomes elsewhere (Eriksson, 2010; Prajogo & Olhager, 2012). The explanation lies in the overlap between supplier reliability and procurement lead time, which correlated at 0.855, the highest correlation among the practices. Reliable suppliers are, in large part, what makes lead times short and predictable. When both are in the model, lead time captures most of their shared contribution. A reasonable interpretation is that supplier reliability affects schedule and quality mainly through its effect on lead time, an indirect path this study did not test but which future work should. The construction industry's habit of buying project by project through price-driven transactions (Dubois & Gadde, 2000) may also mean that, for many purchases, the firms studied do not have stable enough relationships for reliability to act independently of the procurement process.

5.6 Theoretical implications

The pattern of results supports Lean Construction Theory more specifically than any general claim that inventory management improves performance. The practices that mattered most are those that govern flow; the practice that represents stock did not matter once flow was accounted for. The findings therefore lend empirical weight, in a developing-economy setting, to Koskela's (1992) argument that construction performance depends on managing flows rather than conversions, and to the Last Planner principle that reliable work depends on making prerequisites ready (Ballard, 2000). They also qualify a common objection to lean in volatile supply environments, namely that firms in places like Lagos must hold large buffers to survive. The evidence here suggests that, among established contractors, it is the firms with better procurement flow, not those with bigger buffers, that report better schedule and quality performance.

For the RBV, the findings support the claim that materials management capabilities are performance-relevant, but they also show that the capability is not a single undifferentiated resource. Different components of the same bundle had different effects on different outcomes, which is consistent with the view that value depends on how resources are bundled and deployed (Sirmon et al., 2007). Specifying which component works through which mechanism is also a partial answer to the charge that resource-based explanations are circular (Kraaijenbrink et al., 2010). Here, the mechanism is named in advance: practices that make material flow fast and steady protect schedule and quality, while practices that hold stock do not, once flow is accounted for.

6. Implications, limitations and conclusion

6.1 Practical implications

For contractors whose priority is to protect programme dates and workmanship, the results suggest an order of investment. The first priority is procurement lead time. In practice this means preparing

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a materials schedule linked to the construction programme before mobilisation, identifying long-lead and imported items at the outset, streamlining internal requisition and approval steps that add days without adding control, writing delivery dates and remedies into supplier agreements, and reviewing lead-time performance as a routine management indicator. Much of the delay in Nigerian procurement is internal, created by approval chains rather than by suppliers, and it can be reduced without new technology.

The second priority is turnover and stock condition. Site managers should order to the look-ahead programme rather than in large speculative lots, organise storage so that older stock is issued first, and protect materials from weather and handling damage. Because turnover was the second strongest predictor of quality, these routines should be treated as part of quality assurance, not only as store-keeping. Quality and stores staff should agree which materials are approved for issue, and incoming deliveries should be inspected before acceptance.

The third priority, for schedule in particular, is record accuracy. Regular reconciliation of store records against physical counts, prompt investigation of discrepancies and recording of transactions at the point of movement give site managers the information they need to call off materials at the right time. Barcode systems can help, but the discipline of counting and reconciling matters more than the tool.

Finally, the results caution against treating safety stock as a remedy for schedule problems. Where stockouts are frequent, the more effective response is to shorten and stabilise lead times and improve records, so that buffers can be smaller and better targeted. Supplier development remains important, but its benefits for time and quality appear to come mainly through faster and more predictable procurement, so supplier performance should be evaluated on lead-time reliability as well as on price.

6.2 Limitations and future research

Several limitations qualify these conclusions. First, the design is cross-sectional, so the associations reported cannot on their own establish cause and effect. It is possible, for example, that firms with better-performing projects find it easier to plan procurement, rather than the reverse. Longitudinal designs that track practices and outcomes over successive projects would help to settle the direction of influence.

Second, both predictors and outcomes were measured through the perceptions of the same respondents in a single questionnaire. Procedural remedies were applied, but no statistical test for common method bias was performed, and some of the very high correlations among the practices may partly reflect a shared response tendency (Podsakoff et al., 2003). The outcome measures also capture perceived rather than recorded performance. Future studies should combine survey data with project records such as schedule variance, defect logs and rework costs.

Third, the practices are strongly intercorrelated, discriminant validity among them was only partly established, and collinearity is moderate to high. The non-significant paths should therefore be interpreted as the absence of unique effects, not as proof that those practices are irrelevant. Item-level analysis using the heterotrait–monotrait ratio (Henseler et al., 2015), and models that test indirect paths such as supplier reliability acting through lead time, are natural next steps.

Fourth, the five firms were selected purposively and are among the largest and longest-established contractors in Lagos. The findings support analytical generalisation to similar firms in Lagos and comparable Nigerian cities, not statistical generalisation to all contractors. Small and informal firms, which make up much of the Nigerian industry and rely more heavily on manual methods (Eze et al., 2020), may show a different pattern; for them, basic buffering may matter more than it does for firms whose procurement systems are already established. Replication in other regions of Nigeria and among smaller firms would test how far the flow-over-stock pattern travels.

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6.3 Conclusion

This study set out to identify which materials inventory practices explain schedule and quality performance among established construction companies in Lagos. Among five practices tested together, procurement lead time was the strongest and most consistent predictor of both completion timelines and quality. Inventory turnover predicted both outcomes, with a notably strong effect on quality, and inventory accuracy predicted timelines. Stockout prevention had no unique effect on either outcome, and supplier reliability narrowly missed significance for timelines, probably because its influence travels through lead time.

The message for theory is that what protects time and quality is the flow of materials, not the stock of them, which gives Lean Construction Theory empirical support in a supply environment often thought too volatile for lean principles to apply. The message for practice is that contractors should look first to the speed and predictability of their procurement and to the condition and rotation of their stocks. Larger buffers, on this evidence, are not the answer to late or defective work; better flow is.

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