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Alternative Building Technologies for Reconstruction and Development Programme (RDP) Housing in South Africa: Comparative Performance, Sustainability and Policy Implications

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Abstract
South Africa's Reconstruction and Development Programme (RDP) has delivered millions of low-cost houses since 1994, yet housing backlogs, poor quality, and cost overruns persist. This paper examines three alternative building technologies (ABTs) Moladi removable plastic formwork cast-in-place concrete, Hydraform cement-stabilised interlocking blocks, and sandbag (bagged earth) construction and compares their performance with conventional block/brick and mortar methods across construction time, cost, quality, and sustainability criteria. A sequential mixed-methods approach was employed, including survey questionnaire and interview with contractors, government officials, and end-users purposively selected based on their knowledge of ABTs and site observation. Quantitative data from the surveys were analyzed using descriptive statistics, while qualitative interview data underwent thematic analysis. Findings indicate that all three ABTs can deliver comparable or improved quality while reducing labour skill requirements and project cycle time. Moladi scored highest in contractor perceptions of time, cost, and quality; Hydraform and sandbag systems excelled in sustainability and local material use. Key barriers include lack of South African Bureau of Standards (SABS)/ South African National Standards (SANS) standards, procurement practices favouring traditional methods, and insufficient quality assurance protocols. The study concludes that ABTs can reduce housing backlogs and improve sustainability but require coordinated regulatory and institutional changes. Recommendations include incorporating technology performance specifications in procurement, providing incentives for sustainable materials, fast-tracking certification, and promoting targeted training and pilot projects.

Keywords: Alternative building technologies, Hydraform, Moladi, RDP housing, sandbag construction, sustainability

1. Introduction
Providing affordable and adequate housing is one of the most significant social policy challenges in South Africa (Stats SA, 2023; DHS, 2022). The Reconstruction and Development Programme (RDP), enacted in the mid-1990s, was designed to address spatial and socio-economic inequities created under apartheid and to provide basic, serviced housing to low-income households (Greyling, 2010; Moolla et al., 2011). However, over two decades of delivery, the RDP programme has been characterised by backlogs, financial inefficiencies and poor quality of the completed units (Buys & Le Roux, 2013; Bailey, 2017). Defects resulting from poor workmanship and inadequate procurement practices have required substantial rectification expenditure by the state (Amoah et al., 2021; Bailey, 2017). At the same time, rapid urbanisation has increased the demand for mass housing and placed pressure on delivery systems (Turok & Borel-Saladin, 2014).

Conventional RDP housing construction in South Africa largely follows a brick/block and mortar methodology that is labour-intensive and highly dependent on skilled artisans (Twala, 2008; Greyling, 2010). This reliance on scarce skilled labour, coupled with procurement practices that often favour the lowest tender price, has contributed to delays, rework and premature building deterioration (Manomano & Tanga, 2018; Buys & Le Roux, 2013). The wider sustainability profile of conventional construction is also problematic, involving significant embodied energy, material transport, and waste generation. In many cases, the built units require high levels of maintenance and energy for thermal comfort (Deepak, 2011; Omoregie et al., 2016).

Alternative building technologies (ABTs) have been proposed as potential solutions to address delivery speed, reduce reliance on scarce skills, improve sustainability and increase opportunities for local participation (Moladi, 2022; Windapo et al., 2021). ABTs include a broad family of systems: reusable formwork systems (e.g., Moladi), interlocking block systems produced on-site (e.g., Hydraform), and low-tech earthen systems (e.g., sandbag/earthbag). Each offers potential advantages in terms of speed, waste reduction, the use of local materials, and the possibility of community involvement; however, adoption at scale is constrained (Assiamah & Danso, 2021; Adedeji & Fa, 2012).

This paper assesses whether selected ABTs meet or exceed the performance requirements of conventional construction used in RDP housing, focusing on time, cost, quality and sustainability requirements. Specifically, the objectives are: to identify the ABTs appropriate for RDP housing in South Africa and characterise their construction processes; determine the performance requirements and observed performance of conventional RDP construction; find out the time, cost, quality and sustainability performance of Moladi, Hydraform and sandbag building systems through literature synthesis and empirical stakeholder engagement; and thereafter, propose policy and practice recommendations to enable the adoption and scaling the use of suitable ABTs in subsidized housing programmes. The scope of the project is limited to single-storey low-cost housing typologies typical of the RDP programmes and to technologies that offer mass-production potential and feasibility in the South African context.

2. Materials and Methods

The study adopted a pragmatic mixed-methods research approach (Nenty, 2009; BCcampus, 2022). The rationale was to combine technical information with stakeholder perceptions to assess acceptability, practical constraints and implementation pathways. The research paradigm recognized multiple realities (stakeholders distinct and often competing priorities, experiences, and perceptions), that technical performance metrics and stakeholder perceptions both inform viability.

Primary data collection was by means of three tailored online questionnaires targeting contractors, government officials and end-users, supplemented by selected in-person interviews. 33 Contractor respondents listed in the Construction Economics and Management Database of Employers were sampled, from which 23 responses were received, translating into a response rate of 69.6% and included those with direct ABT experience. Government responses (n=11) were collected from officials engaged in RDP delivery and oversight based in the City of Cape Town. End-user perspectives (n=8) were collected through in-person interviews during a site visit to a sandbag project in Kayelitsha, an informal housing settlement in Cape Town; translation assistance was used where necessary.

Questionnaires combined closed multiple-choice items to permit descriptive frequency analysis and open-ended questions for qualitative content analysis. The contractor questionnaire inquired about current methods, perceived disadvantages, familiarity with ABT, perceived performance in terms of time/cost/quality, and barriers to adoption. The government questionnaire targeted views on standards, SABS approval processes, and reasons for avoiding ABTs. The end-user question focused on acceptability and willingness to occupy ABT houses. Quantitative responses were summarised descriptively (frequencies and simple tallies) to identify patterns (e.g., proportion of contractors familiar with each ABT). Qualitative responses underwent content analysis to identify recurring themes and interpretative patterns (Ngoy et al., 2023, and Bhandari, 2022). Findings from the literature review were integrated with empirical data to triangulate technical performance claims and stakeholder perceptions.

3. Results

3.1 Respondents' Familiarity with ABTs

The study sought to understand methods and procedures used by contractors in RDP housing projects. Responses indicated that the dominant construction method is standard block and mortar (15 out of the 23 contractors) with a minority using sandbag or Moladi in practice. Familiarity with ABTs varied, with sandbag construction being the most familiar (N=12), followed by Hydraform (N=9) and Moladi (N=6). Reasons provided for this familiarity include visible pilot projects, local NGO promotion, and the presence of suppliers.

3.2 Perceived Drawbacks Experienced by Contractors Using ABTs

Table 1 shows that contractors identified time constraints and long construction cycles as a primary drawback (8 out of the 23), followed by quality deficiencies in the long term (5 out of the 23), and under-allocation of resources (3 out of the 23). Two respondents observed no drawbacks with ABTs. These perceptions align with literature documenting slow delivery, poor workmanship, and rework costs (Buys and Le Roux, 2013; Manomano, 2013).

Table 1: Drawbacks experienced by contractors using ABTs

S/No.	Drawbacks of ABTs	No. of Responses
1	Time constraints	8
2	Quality deficiency in the long term	5
3	Under-allocation of resources	3
4	No drawbacks/downfalls	2
5	Other: Unskilled labour force	1

S/No.	Drawbacks of ABTs	No. of Responses
6	Other: Training needs of workers	1
7	Other: Corner cutting	1
8	Other: Planning of fill and quantities	1
9	Quality deficiency in the short term	0

(Source: Author's work)

3.3 Comparison of ABTs in Terms of Time, Cost and Quality Requirements

Table 2 compares three ABTs including Moladi, Sandbag, and Hydraform against contractor-relevant performance criteria. On the time metric, Sandbag scores highest (9), followed by Hydraform (8) and Moladi (7), indicating Sandbag is fastest. For cost, Moladi and Sandbag tie (5 each) and Hydraform scores lower (4), suggesting Hydraform is the costliest in this assessment. All three technologies score equally on quality (6), and none is recorded as worse on quality. The "worse" counters show Sandbag has one negative mark for time and two for cost, and Hydraform one for cost, while Moladi has no "worst" marks, implying Moladi is not rated lowest in any category. In sum, Sandbag appears to maximise speed (with some cost/time variability), Moladi is balanced (no worst-case flags), and Hydraform offers strong time performance but at a higher cost.

Table 2: Comparison of ABTs in Terms of Time, Cost and Quality Requirements

Performance Requirements	Moladi	Sandbag	Hydraform
Better in terms of Time	7	9	8
Better in terms of Cost	5	5	4
Better in terms of Quality	6	6	6
Worse in terms of Time	0	1	0
Worse in terms of Cost	0	2	1
Worse in terms of Quality	0	0	0

(Source: Author's work)

It can be deduced from Table 2 that, in terms of time, cost, and quality, contractors view Moladi as the best alternative to current conventional methods of construction used in RDP houses in South Africa.

3.4 Stakeholder Acceptance and Social Perceptions

The study sought to understand whether end-users would be concerned with the use of ABTs in constructing their RDP houses. Responses from the eight respondents are presented in Figure 1.

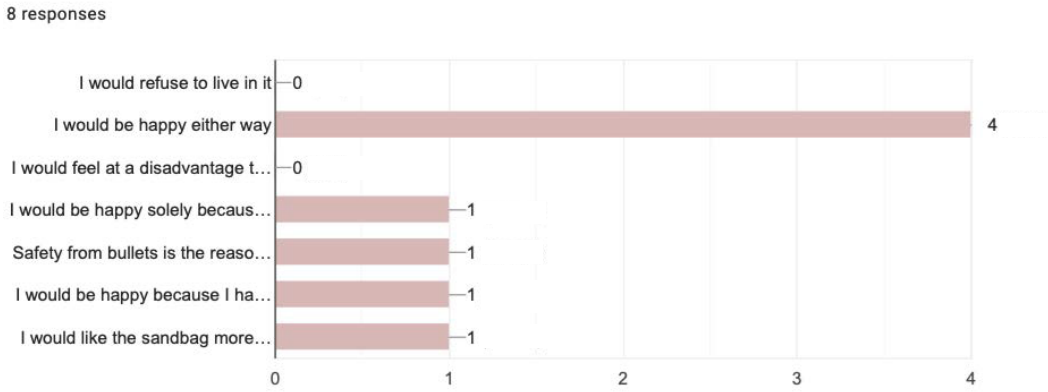

Fig 1: End-Users' Choice of Construction Used in RDP Housing
(Source: Author's work)

Figure 1 shows that half the respondents (4/8) said they would "be happy either way," indicating general indifference to the building method so long as they get a house. The remaining four respondents (each 1/8) chose specific positive reasons: one would be happy because they have been waiting for a house for a long time, one cited improved safety from bullets, one said they would be happy solely because of safety, and one preferred sandbag more because standard RDP houses allow moisture through and have much cracking. No respondents said they would refuse to live in the house or feel disadvantaged. Overall, end-users appear largely accepting of alternative building methods, with a few valuing particular benefits (safety or sandbag approach).

3.5 Government Officials' Perception of the Use of ABTs in Housing Construction

The study aimed to understand government officials' perspectives on ABT use in housing construction. From government officials' perspectives, there are two clear points. First, there is significant caution within the public sector about SABS approval requirements. Five of the 11 respondents indicated "yes" and 5 "maybe" when asked whether the National Building Regulations' SABS requirement could threaten ABT implementation (only one said "no"). Secondly, officials primarily view the SABS approval pathway as a materials-testing process, with most written replies (6 of 8) referring to testing as the mechanism for approval. A minority reported uncertainty about the exact steps.

Officials identified several practical reasons why ABTs have been avoided in RDP projects. Concerns centre on assurance of structural quality and regulatory compliance, perceived cost and programme implications, and limited familiarity or market penetration of methods such as Hydraform or sandbag systems. Other factors noted include potential end-user resistance, uncertain availability of locally suitable materials, and the perception that novel methods require additional oversight and technical capacity, which the delivery system does not yet consistently provide.

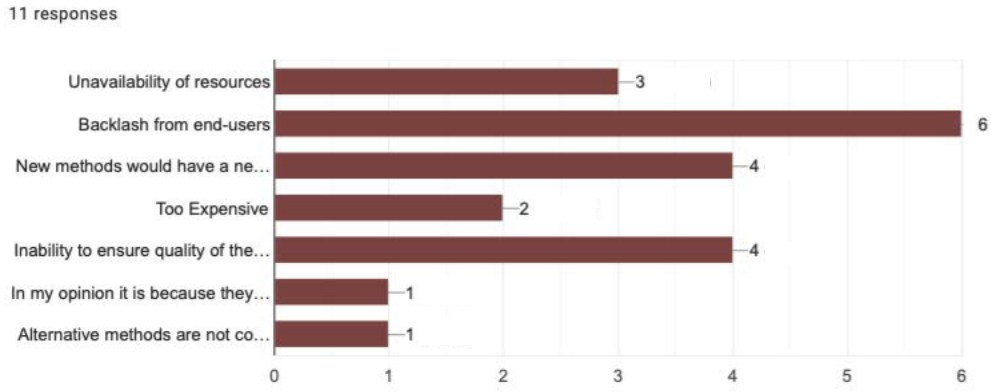

Fig 2: SA Government Officials' Perception of Why the Government Has Been Avoiding the Use of ABTs in RDP Housing Projects
(Source: Author's work)

It can be inferred from this government official's viewpoint presented in Figure 5 that if ABTs are to be mainstreamed, the regulatory and approval pathway must be clarified and streamlined.

4. Discussion

4.1 Time, Cost and Quality Performance

Comparative evidence shows distinct trade-offs among the three ABTs. Contractors ranked sandbag and Hydraform highest on speed, and Moladi slightly lower, while cost perceptions favoured Moladi and Sandbag equally over Hydraform. All three ABTs scored similarly on quality, although contractor survey responses flagged quality concerns as a significant drawback of ABTs and time constraints or long cycles as the single most cited problem. These results align with the literature review, which states that Hydraform and sandbag can reduce material and labour costs and production waste (Deepak, 2011; Omoregie et al., 2016; Aligamhe et al., 2020), while Moladi's reusable formwork and single-pour workflow yield high repeatability and low rework (Moladi, 2022). The contractors' aggregated scoring (Table 3) suggests Moladi presents the most balanced option for substituting conventional blockwork in RDP projects, not because it is superior on every metric, but because it avoids strong "worse case" flags and fits regulatory and engineering norms more readily (concrete-based structural logic). However, Hydraform and sandbag demonstrate important sustainability and local content advantages that Moladi cannot match in terms of embodied carbon metrics.

4.2 Stakeholder Familiarity, Operational Constraints and Acceptance of ABTs

Empirical findings show that contractor familiarity with ABTs is uneven. Sandbag is the most widely known (in the Western Cape), followed by Hydraform and Moladi. Familiarity is driven by local pilots, NGO promotion, and supply presence rather than systematic procurement. Those same contractors reported practical drawbacks, chiefly time/cycle issues, resource allocation, training, and occasional corner-cutting, that mirror documented problems in RDP delivery (Buys and Le Roux, 2013; Manomano, 2013). Importantly, end-user sentiment surveyed here was broadly accepting, as 4/8 of a small sample said they would be "happy either way," and none would refuse an ABT house outright. This highlights a tension between delivery efficiency and social acceptability;

effective adoption requires community engagement and demonstration projects to foster trust. This suggests that social acceptability is not the principal barrier; instead, practical delivery and institutional endorsement are.

4.3 Regulatory and Institutional Barriers

The research corroborates that institutional barriers are as critical as technical performance in determining ABT adoption. Government officials' responses confirm a key institutional constraint that SABS/NBR approval processes are perceived as potentially threatening to ABT adoption. Officials primarily described material testing as the route to SABS approval but acknowledged uncertainty and opacity in the process. This aligns with broader literature on standards and institutional lock-in, which suggests that South African codes and procurement are oriented towards conventional materials. A lack of harmonised performance standards for ABTs also inhibits client, insurer, and lender confidence (Windapo et al., 2021; van der Watt, 2022). Thus, even where ABTs offer clear advantages (local material use, lower embodied energy, community engagement), regulatory friction, supply-chain, and quality-assurance gaps prevent their scaling.

The NBR and SANS frameworks require materials and elements to perform to defined criteria, but ABTs often lack specific SANS designations, creating uncertainty for approving authorities and contractors. Government respondents emphasised SABS testing and approval as a potential threat to ABT adoption unless clear, efficient pathways exist. Another issue is public procurement and contracting practice. Public procurement typically emphasises price and prescriptive methods, favouring existing contractors with conventional capabilities. Contracts rarely specify functional performance targets that would allow contractors to propose alternative methods meeting performance requirements (time/cost/quality). This leads to risk aversion and lock-in to traditional methods, as contractors fear penalties for unfamiliar technologies (Ratshitanga, 2017; Manomano & Tanga, 2018).

4.4 Implications of the Findings for Policy and Practice

The findings imply a differentiated adoption pathway rather than a single replacement for conventional blockwork, and that no single "best" technology for all contexts. Instead, fit-for-purpose selection depends on site conditions (e.g., soil quality, access), delivery priorities (speed versus embodied carbon), contractor capacity, and institutional readiness. Moladi is attractive where regulatory certainty, rapid finish quality, and conformity with structural norms are priorities like mass RDP blocks with external financing and formal approvals. Hydraform and sandbag offer stronger sustainability and local economic benefits (reduced cement, local soils, community labour). They could be preferable in contexts where material supply and skills can be developed, and where lifecycle carbon is a programme objective. However, for ABTs to move from pilots to scale requires three linked enablers: clear, technology-specific testing and acceptance pathways (SABS/NHBRC/Agrément SA); operational pilots generating independent performance data (time, costs, durability, maintenance) and documented QA protocols; and procurement and finance instruments (green budget lines, performance-based contracts, bulk equipment hire models) that internalise whole-life benefits and reduce upfront contractor risk.

In summary, ABTs can satisfy many RDP performance requirements. However, they will only scale if policy, standards, and delivery systems are adapted to manage their specific risks and ensure consistent quality.

5. Conclusion

The study found that ABTs can deliver measurable improvements in construction speed, reduced reliance on scarce skilled artisans, lower materials wastage, and enhanced opportunities for community involvement. Moladi demonstrates the strongest performance in terms of rapid delivery and perceived contractor confidence regarding time, cost, and quality outcomes. Hydraform and sandbag systems offer greater potential for reduced embodied carbon and local material use, as well as better prospects for skills transfer and local enterprise development. Institutional barriers, including unclear standards, risk-averse procurement practices, and limited incentives, were identified as key constraints to scale adoption of ABTs in housing construction.

Based on these findings, the study concludes that ABT adoption could help reduce the housing backlog while improving environmental outcomes and local economic participation; however, this requires coordinated regulatory and institutional change. The study therefore recommends that government address regulatory limitations to ABT use by providing performance-based standards, pilot projects, targeted training, and procurement reform to leverage demonstrated technical advantages. Policy makers should integrate ABTs into the procurement process of subsidised housing programmes to offer a pathway to accelerate delivery, improve sustainability, and promote local economic participation. The construction industry, including contractors, should view ABT use as an opportunity to diversify business models and reduce exposure to labour shortages and quality claims.

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