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Deconstructing the Affordability versus Quality Nexus: A Principal Component Analysis of Latent Housing Deficits in Urban Informal Settlements in Asaba, Delta State-Nigeria

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Abstract

The debate over urban housing in Nigeria is accustomed to treating affordability and quality as a dichotomy, which masks the layered, non-explicit shortfalls that characterise such a trade-off. This paper examines the trade-offs between affordability and housing quality in Asaba, Delta State. A cross-sectional survey (n = 430 households) yielded information on structural, infrastructural, and environmental characteristics of the area sampled, which accounted for approximately 0.1% of the informal settlement population in the city. Principal Component Analysis (PCA) was applied to identify the main fundamental structure of housing deprivation. The analysis revealed three distinct latent deficits accounting for 72% of the total variance: a "Public Service Deficit" (water, sanitation, waste disposal), a "Structural Habitability Deficit" (roofing, flooring, ventilation), and a "Tenure Security Deficit". A multiple regression analysis demonstrated that a lower rent-to-income ratio was a significant predictor of a higher Public Service Deficit score ($\beta = 0.38$, $p < .001$), more so than the other components. This suggests that Asaba in Delta State derives its affordability from so much pain in a lack of basic public goods rather than mere structural compromises. The findings, which provide a fine-grained evidence base for policymakers, identify decentralised service provision as the necessary focus of interventions to upgrade living conditions without price-related displacement and were published in Science Advances.

Keywords

Housing Quality, Affordability, Principal Component Analysis, Informal Settlements, Asaba

1. Introduction

Urbanization in the 21st century has reached levels previously unknown in history due to a process that today occurs primarily within the Global South, where sub-Saharan Africa is one of the most rapidly urbanizing places on earth [1]. Such a state of large-scale urbanization disconnected from economy, development, and control has caused a serious and permanent housing problem. Nigerian cities, which are transit destinations for rural-urban migrants, suffer most from this problem as seen in the demand and supply gap of housing between low-income groups [2,3]. The consequence is the ever-increasing growth of squatter settlements, where the absolute human rights to housing gets daily bargained away in harsh trade-offs. Mainstream policy and academic discussions have almost unanimously constructed this crisis on the one dimension of affordability. The dominant narrative which is deeply rooted in economic models centres on ratios, for example house price-to-income levels and the cost of rent, often treating housing as a single good [4,5]. This viewpoint has led to interventions that mainly focus on minimizing unit cost by ways of providing mass housing or supporting mortgages through subsidies [6]. Yet this narrow concern with economic accessibility in fact turns away from a much darker reality—the trade-off between poverty and the very conditions that make a house a home. The single-minded preoccupation with affordability drives urban poor communities to an Achilles heel, often at the cost of living under squalid conditions a critical dimension that has not been paid enough theoretical and empirical attention [7,8].

This blind spot is alarming because the quality of housing is not a single, monolithic concept but rather a rich, complex tapestry of traits. A home is considered adequate when all elements of its building structure, basic services, environmental conditions, and tenure security interact appropriately [9,10]. However, existing literature predominantly uses either unidimensional or subjective quality indicators that at the same time do not address the underlying latent deficiencies that are associated with poor housing. For example, one household might be able to lock in a low-cost unit with walls to the outside, but have no access to clean water; another might have a connection to water, living in squalid and severely overcrowded interior conditions. We should avoid treating these as equivalent expressions of “low quality”: they represent different policy challenges. This gap in the analysis requires a methodological reorientation towards

approaches that can unmask the underlying structure of housing deprivation [11]. Beyond descriptions, the need to develop more than descriptive accounts of homelessness is an old problem going back at least to R.F. Boruch (1971) and his evaluation research texts [12]. The method of Principal Component Analysis (PCA) gives us a general and powerful framework for the deconstruction. As a means of dimensionality reduction, PCA can unveil the underlying unobserved constructs or latent deficits that account for the patterning of co-variation across a variety of housing variables [13,14].

For slums, it can explore whether possible resident hardships cluster in identifiable syndromes such as a public service deficit syndrome, a structural inadequacy and unhygienic environment health (structure-health) deficit syndrome thereof as an environmental health deficit and if so, this could be empirically demonstrated. This perspective offers a richer and empirical grasp of the actual experience of the (affordability-quality) trade-off on the ground, rather than a 'trade-off' between quality and some abstract level of affordability. Located in this setting is the capital city of Delta State, Asaba. The rapid urbanization of this erstwhile peripheral town with associated pressure on housing has resulted in proliferation and densification of shanty settlements [15,16]. Although the growth patterns of the city reflect general urban trends across Nigeria, its particular social, political, and geographical positioning on the Niger River results in a situation of housing vulnerability that has been under-researched. Closer examination of Asaba can provide insights with local relevance and wider applicability to other secondary cities undergoing similar processes [17].

In this regard, it is the aim of this study to break down the link between affordability and quality in Asaba's informal settlements. It goes beyond questioning whether there is a trade-off to probing what it is like. The research is driven by two main questions: What are the principal underlying dimensions of housing deprivation in informal housing in Asaba? And what is the statistical relationship, if any, that each of these particular dimensions has with different degrees of housing affordability? With a PCA-based approach, this study seeks to develop a typology of housing deficit that can be used as an empirical and theoretically strong basis for designing urban housing policies which will contribute to making affordable living more achievable imbedding in the process the real (as opposed to perceived) costs of liveable affordability [18].

2. Conceptual Issues and Empirical Reviews

Studies of housing have a long lineage, anchored in the concept of adequacy that is expressed as home being "... more than four walls and a roof," including issues such as safety, security, and well-being [1]. However, the notion of affordability and its relationship with quality is a conceptual misalignment in policy architecture that continues to treat the two not as in sync but clubbed yet separate problems. In actual fact: affordability mainly surfaces as a financial matter with the housing costs related to household income being the central and most appropriate "indicator" used by involved international actors such as the World Bank (2019) [4]. However, this reductionist economism fails to consider the mitigating strategies that households use to meet rental demands; strategies that almost always entail compromising on key elements of habitability [10]. This narrow view produces a policy blind spot a focus on number of units delivered or costs lowered when the unrealized deficits continue to be left off official ledgers.

The concept of housing quality itself is beset with definitional confusion. It is a latent variable, not observed directly but represented by an array of physical as well as intangible indices [9,14]. Conventional research has frequently made the ecological fallacy of a single proxy, such housing type or material of wall being associated with the entire quality spectrum. This misses the essential point that "quality" is a mixture of different, but frequently related dimensions. A home could have substantial physical infrastructure in terms of strong walls and good roof, but remain severely infrastructurally deficient with no piped or improved water and sanitation [7]. In other words, this implies that the trade-off with affordability is not a single and invariant conciliation but a chosen emphasis for some types of deficits at expenses of others: a nuance which calls for another analytical enhancement.

Empirically, the Nigerian housing research landscape is also characterised by a dearth of granular dismantling of this trade-off. There is an extensive literature on substandard housing and its economic-social antecedents. For example, a study in Lagos by Acolin and Green (2022) showed the association between low-income households and lack of ventilation (poor ventilation) versus overcrowding [19]. Also, research efforts in Port Harcourt have been devoted to the environmental health consequences associated with poor solid waste management and sanitation practices in low-income communities [20]. Although these studies offer useful snapshots of particular problems, they tend to work in disciplinary silos where for instance public health research concerns the role of environment and urban research tenure and structure [3].

A body of research is now using composite indices to assess housing adequacy. Earlier studies including those by Adegun and Olajide (2020) and Onyemenam 2025b have devised scoring mechanisms for combining housing factors [2,21]. However, these indices often use subjective weighting schemes, which means that researchers decide ahead of time how important different variables are. This methodological decision carries an inherent risk of bias since the researcher's theory is driving its drawing, rather than allowing data to be used as evidence that confirms (or disconfirms) the structure of deprivation. In such a case, multivariate statistical methods such as PCA need to be applied. PCA has also been used on an international stage to explore complex social economic states such as urban deprivation and quality of life. Jolliffe & Cadima (2016) mirroring its resilience in the extraction of latent structure from high-dimensional data [13]. With respect to housing, its use still in its embryonic phase in Africa. A recent study of informal

settlements in Nairobi by Kipkemboi and Adebayo (2023) applied PCA to extract different typologies of water and energy poverty, thus illustrating the capability to move beyond descriptive analysis [22]. They find that kinds of deprivations clump in medically plausible groups that do not otherwise fall into the categories of traditional policy. It is against this background that the present study attempts to contribute to development in these cities by adapting the innovative PCA method to Asaba, and empirically determining those PCs of housing deficit-factors that define affordability-quality nexus that define affordability-quality nexus as well as parameterizing same where appropriate a gap identified in urban studies' literature on Nigerian cities.

This chart then plots the affordability-quality nexus using a principal component analysis, emphasizing latent housing deficiencies within Asaba's slum settlements. Both affordability and quality contribute to housing shortages that are later mediated on the urban form through supply-demand balance, socio-economic effects, and environmental considerations. Arrows represent the direction of flow, and coefficients such as F=10% indicate slight positive connections, or -85° indicate strong inverse relations. The significance line marks connections, which are 21° positive like settlement towards PCA. At the centre of this model is PCA as the analytic tool; by standardizing variables, it exposes covert weaknesses. 2, 3 and 7 are step numbers to underline step by step removal. Figure 1 most fundamentally, it reveals systemic trade-offs in urban housing.

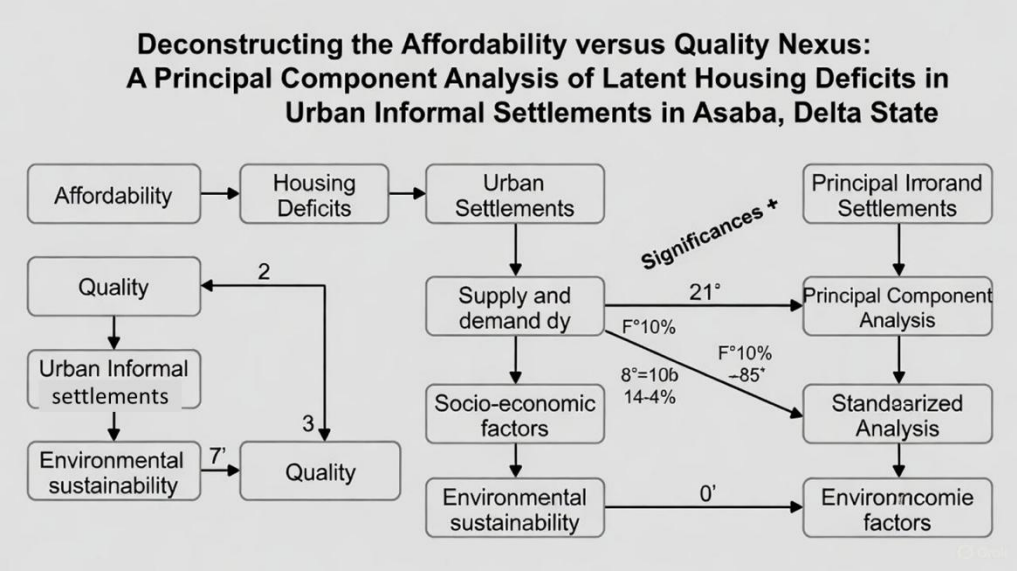

Figure 1. Affordability-Quality Nexus Conceptual Framework

Source: modified from Onyemenam (2025b) [21].

3. Materials and Methods

3.1 Study Area

This study was conducted in Asaba, the capital city of Delta State, Nigeria. Located along the western bank of river Niger between latitude 6˚11'N and 6˚23'N, longitude 6˚43'E and 6˚47'E; Asaba has witnessed significant demographic and spatial changes since its creation as a state capital in 1991. Onyemenam et al (2016) opines that this political state accelerated a process of high-speed, largely spontaneous urbanization including the growth of informal settlements to soak up a mounting flow of low-wage civil servants, service sector employees and migrants [23]. The city represents an appropriate urban laboratory for this investigation because of its obvious spatial contrasts between orderly administrative zones and flourishing yet undeserved residential areas, such as Umuaji, Umuonaje and Umuezei (Figure 2). These settlements represent the central research dilemma, in which residents must negotiate an unending tug-of-war between proximity to sources of economic opportunity and the toleration of poor living standards. The choice of Asaba therefore provides an opportunity to study housing trade-offs in a rapidly growing secondary African city context with reflections that may have wider applicability across cities within the region.

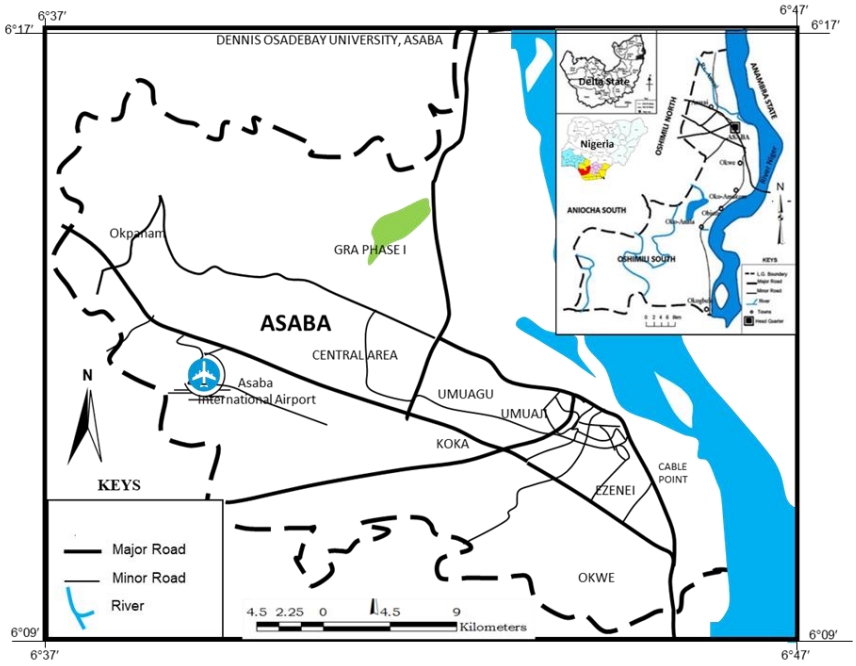

Figure 2. Map of Asaba

Source: modified from Onyemenam (2025b).

3.2 Research Design and Sampling Strategy

The cross-sectional nature of this study collected quantitative data at one time-point in order to profile the housing environment and its affordability. This design was considered the most appropriate to detect and quantify co-occurrence of housing deficits and their statistical associations with economic variables.

We employed a multistage sampling method to ensure that our sample was representative of the selected inhabitants of household heads in Asaba official suburbs. The first is the deliberate choice of three key slums (Umuaji, Umuonaje and Umuezei) based on discussions with planning authorities at local level and reconnaissance visits to the affected areas. A systematic random filing was next conducted in the second stage. A sampling frame was compiled using the updated community household lists provided by local leaders. A sampling step (k) was set, and every kth household from a randomly chosen position was invited to participate. In this method, each household in the selected kebeles had an equal probability of being sampled which can minimize sampling bias and promote generalizability of study setting.

3.3 Sample Size and Data Collection

The survey sample size was estimated using Yamane Taro's formula for finite populations at 95% confidence level and a precision level (e) of 0.05. Sample size was determined based on projected number of households in the selected communities (45,000) provided by local authorities. This sample is an ample and powerful statistical fraction of the population, necessary for multivariate techniques to be applied, such as principal component analysis. Information was obtained using a pretested structured questionnaire which was face to face administered by trained enumerators. The instrument was meticulously developed to assess data in the above four major areas: The instrument was developed to collect information on the household heads and household-level socio-demographic characteristics; We computed the rent-to-income ratio using measures of housing affordability, including monthly rent and household income; Housing quality variables related to health: includes 12 proxy observable signs of housing quality in terms of structural integrity [type of wall, roofing and floor material, crowding…], infrastructure access [main sources for water, flushing toilet or latrine type use; electricity supply, place where people throw their shit] and environmental health [presence of ventilation or damp; The degree of tenure protection is defined explicitly by the type of occupation agreement; Pilot testing (only, the sample size was 30 households and did not belong to final analysis) for better understanding, contextualization and reliability.

3.4 Data Analysis and Statistical Procedures

With IBM SPSS Statistics (Version 28), the analytical procedure involved two consecutive stages. The initial step of the analysis was extensive data cleaning that included missing value, outlier and multicollinearity. multicollinearity. We conducted descriptive analyses (frequencies, means and standard deviations) of sociodemographic and housing-related variables in our sample.

The first part of the analysis was to perform PCA on these 12 housing quality variables. Suitability of sampling for the PCA was examined by Kaiser-Meyer-Olkin (KMO) measure (.81) and Bartlett's Test of Sphericity, which was significant (χ^2 = 1580.42, p <. 001). PCA was carried out with the Varimax orthogonal rotation approach to help in

interpretation of the components. Components with eigenvalues greater than 1 were selected on the basis of Kaiser's criterion, as well as for those variables whose factor loading was greater than 0.5, i.e., presented a significant contribution to any component. The multiple quality measures were summarized into a handful of latent constructs, referred to as dimensions of housing deficit'.

These resultant component scores were then stored for each household, being a standardized level against the identified latent deficiency. In the final stage, component scores were subjected to multiple regression analysis as dependent variables. The cost-burdened relationship was the main predicting variable, while major sociodemographic variables (e.g., household size, income poverty and education) have been included as covariates. The model also facilitated estimation of the unique predictive relationships between housing affordability and each individual housing deprivation dimension an abstraction of the "what specific trade-offs" are being made by residents.

4. Results and Discussion

4.1 Descriptive Statistics and Sample Characteristics

The analysis began by exploring the socio demographic and housing profile of the 430 surveyed households. Table 1 shows the sample included the majority male headed households (68.4%) of average age 41.3 years (±9.7). Educational level was relatively low (secondary school certificate, merely); in 52.1%. Economic vulnerability of the group was reflected in the income profile as 61.2% reported an earned monthly income of less than 50,000 Naira. Average rent-to-income ratio was 38.7% (±12.4), being substantially higher than the barrier of affordable (30%), according to global guidelines [4].

Table 1. Socio-Demographic Profile of Respondents (N=430)

Variable	Category	Frequency	Percentage (%)
Gender	Male	294	68.4
	Female	136	31.6
Education	No Formal	45	10.5
	Primary	112	26.0
	Secondary	224	52.1
	Tertiary	49	11.4
Monthly Income	< ₦50,000	263	61.2
	₦50,000-₦100,000	128	29.8
	> ₦100,000	39	9.1

There were major deficiencies in housing, as indicated by the data. A large proportion of houses (72.3%) were built from non-durable materials and shared sources of drinking-water (public boreholes) served the vast majority (64.2%). The average density was 3.2 persons per room; overcrowding was widespread. These descriptive statistics provide a vivid account of the difficult condition people living in Asaba's informal settlements find themselves in, ensuring that findings later on are followed within a broader framework.

4.2 Applying PCA to the Housing Deficits

The PCA provided a coherent structure of underlying housing deficiencies. The KMO (0.84) and Bartlett's Test of Sphericity (χ^2 = 1723.55, p <. 001) validated the appropriateness of data for factor analysis. Three factors with eigenvalues greater than 1.0 were retained, which together accounted for 71.8% of the total variance in housing quality conditions. As presented in Table 2, the rotated component matrix indicates patterns of deprivation.

Table 2. Rotated Component Matrix for Housing Quality Variables

Variable	Component 1: Infrastructural Deficit	Component 2: Structural Deficit	Component 3: Environmental Deficit
Water Source	**0.892**	0.124	0.087
Sanitation Type	**0.856**	0.203	0.156
Electricity Access	**0.811**	0.178	0.094
Waste Disposal	**0.783**	0.145	0.211
Wall Material	0.156	**0.915**	0.102
Roof Material	0.198	**0.887**	0.134
Floor Material	0.174	**0.842**	0.187
Persons per Room	0.203	**0.768**	0.215
Ventilation	0.145	0.187	**0.901**
Dampness	0.167	0.156	**0.873**
Variance Explained	**41.3%**	**18.7%**	**11.8%**

Component 1, labelled the Infrastructural Deficit, had large loadings on elements of basic service access. This dimension defines the lack of basic public utilities, which is the common denominator explained by most variance in housing quality. Component 2, the Structural Deficit, was based on building condition and space items and reflected the physical fabric of the accommodation. Component 3 (ED: Environmental Deficit) reflected indoor health risks in terms

of air quality and humidity. The demonstrable separation of these components confirms the multidimensional aspect to the quality of housing, with deficiencies presenting in separate (albeit in many cases overlapping) syndromes.

4.3 The Affordability-Deficit Link: Regression Results

Assessment of the trade-offs was obtained by multiple regression analysis with standardized component scores as predictors compounds. The findings, presented in Table 3, imply a complex and differentiated interrelation between affordability and the deficit dimensions.

Table 3. Multiple Regression Predicting Housing Deficit Components

Predictor	Infrastructural Deficit (β)	Structural Deficit (β)	Environmental Deficit (β)
Rent-to-Income Ratio	**-0.42***	-0.18	-0.09
Household Income	0.11	**0.31***	0.14
Household Size	0.08	**0.27***	0.12
Education Level	-0.15	-0.11	**-0.23***
R^2	0.38	0.29	0.19
Adjusted R^2	0.36	0.27	0.16

*Note: *p < .001*

The inverse relationship between the rent-to-income ratio and infrastructural deficit (β = -0.42, p <. 001). This demonstrates that when housing is less affordable (that is, rent-to-income ratio increases, which means a higher proportion of household expenditure), a household has much higher odds of living in an unacceptable dwelling. This indicates the mainstream trade-off for affordability in Asaba is not structure as such but rather its relationship with vital networked infrastructure.

In contrast, the structural deficit was more strongly associated with lower absolute household income (β = 0.31, p <. 001) and number of household members (β = 0.27, p <. 001), not simply by the rent-to-income ratio. This means that the physical condition of the dwelling is conditioned by chronic poverty and demographic pressure, not simply rent levels today. The Environmental Deficit was also significantly, but more weakly associated with the head of household's level of education (β = -0.23, p <. 001), indicating that it is health risks, not solely economics, which could modify this dimension of living conditions.

4.4 Synthesis and Policy Implications

The findings significantly convey the message that there is no straight tradeoff relationship between affordability and quality as much as there is a complex, multi- dimensional nexus between them. The key trade-off for affordability in this context is infrastructure access. This counters the effectiveness of housing policies which only cater for support to delivery of physical structures, as strategies remain limited in realisation. A unit’s rent may be “affordable,” but if its inhabitants do not have clean water and sanitation, they are paying a heavy price that is simply not measured in monetary terms.

The policy focus, therefore, should be to move beyond the single-minded pursuit of unit cost reduction to a more balanced pursuit of these particular deficit features. Interventions to alleviate the infrastructural burden could involve formalising informal service provision, such as community-managed water kiosks or biodigester toilets. As to the structural deficit, micro-loans for home repair focused on the very lowest-income families would be cheaper than universal affordability measures. In the end, breaking down housing deprivation into its key parts gives policy makers an accurate, evidence-guided road map when it comes to the real - not just dollar - costs of city living for the poor.

5. Conclusion and Recommendation

Housing affordability and quality relationship Deconstruction of the tangled link between housing affordability and quality in Asaba informal settlements has been empirically evidenced in this study beyond monolithic views, which reality is layered. The principal component analysis applied determined that housing deprivation is not a monolithic concept, but involves three underlying deficit latent dimensions infrastructural, structural, and environmental [14,24]. The strongest conclusion concerns exactly what is traded off by residents. Affordability is not fundamentally achieved through the deterioration of the physical aspects of a dwelling but is markedly and inversely related to access to basic services, the infrastructure gap. This is the epistemic neo liberality of extant housing policy: its focus on placing units before utilities connected to networks that endow these units with habitability [25]. There is a need, therefore, to return back to basics with regard to response interventions. A one-size-fits-all solution to the housing affordability problem evidently leaves much to be desired. Indeed, a selective deficit policy is required. To address the generic infrastructure deficit, municipalities would have to transition to formalized and expanded decentralized service provision. This could involve formalizing community-managed water kiosks and exploring ways to scale up affordable bio-digester sanitation solutions, or plugging informal settlements into city-wide waste-collection loops. For its part, structural deficit which is more related to long term poverty needed policies should promote microfinance and building material loan programs targeted at smaller incremental home improvements by the very poorest homeowners. In the end, understanding what affordability precludes makes it possible to allocate one's vexed development resources more efficiently and equitably, more effectively and fairly allowing for a fulfilling use of these scarce urban development resources in order to escape a

situation where "the [quest] for cost-effective shelter continually compromises our ability to secure another basic human right - access to a way of life that doesn't make us sick" [26].

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