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Assessing the Effectiveness of Urban Intensification as an Approach to Social Sustainability in Algerian Cities: An Analytical Study Integrating GIS-AHP in the City of Bou Saâda

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Abstract

Urban planning in Algerian cities is increasingly confronted with challenges arising from haphazard urban sprawl, which has adversely affected social cohesion and the efficiency of public services. This study aims to evaluate the role of urban intensification strategies in fostering social sustainability, focusing on three fundamental dimensions: accessibility, urban diversity, and proximity. Taking the city of Bou Saâda as a case study, the research adopts a mixed-methods approach that integrates spatial analysis via Geographic Information Systems (GIS) with the Analytic Hierarchy Process (AHP) to assess four neighborhoods of varying densities. The study relies on a survey of 372 valid samples (93% response rate), supplemented by spatial data regarding road networks and service distribution. The AHP results demonstrate a clear superiority for high-density, mixed-use planning; the "Administrative District" (Le Quartier Administratif) led the social sustainability index with a score of (0.87), followed by the "Sidi Slimane" neighborhood (0.82), while low-density areas such as "Moufdi Zakaria" recorded the lowest indices (0.35). The study concludes that deliberate intensification—which prioritizes reducing access distances (less than 300 meters) and increasing the functional mix index (above 0.70)—serves as an effective tool for achieving social equity and enhancing the quality of life in medium-sized cities.

Keywords: *Urban Intensification, Urban Sprawl, Social Sustainability, Urban Diversity, Proximity, Accessibility.*

Introduction

Since the beginning of the twentieth century, rapid urban growth worldwide has posed significant challenges for planners and engineers in providing permanent, equitable, and livable socio-residential environments. This is largely attributed to the difficulty of regulating horizontal and haphazard urban growth and the subsequent inability to meet population requirements (Burton, 2000). This growth pattern has been linked to numerous social pathologies, including residential segregation, weakened social bonds, limited access to essential services, and a diminished quality of life for disadvantaged populations (Ewing et al., 2016; Frumkin, 2002).

Scholars and researchers have sought to regulate the principles of this phenomenon by conceptualizing its urban fabric and land-use patterns. Cities affected by this trend have been characterized as "scattered" or "fragmented" (Charmes, 2011). These various terminologies attempt to describe the dispersion and disintegration defining the urban fabric in its final form, collectively referred to as Urban Sprawl.

Urban sprawl has emerged as one of the most formidable urban challenges impeding contemporary sustainable development. Characterized by low-density development and a total reliance on vehicular transport to reach urban peripheries, it has become synonymous with social isolation, a lack of civic engagement, and exacerbated socioeconomic segregation (Putnam, 2000; Frumkin et al., 2004). Such challenges represent direct obstacles to realizing the social dimension of urban sustainability, social justice, and cohesion necessary for an improved quality of life (Dempsey et al., 2011).

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Optimally, the realization of sustainable development principles rests upon three equally significant pillars: the environment, society, and the economy (Klarin, 2018). While environmental and economic aspects have garnered the lion's share of academic research, the social dimensions of sustainability have yet to receive comparable attention (Pitarch-Garrido, 2018; Zainol et al., 2018).

As cities globally confront the negative externalities of haphazard urban expansion, Urban Intensification has emerged as a potential strategy to bolster sustainability across environmental, economic, and social dimensions (Næss et al., 2020). Defined as the process of increasing development density within existing urban areas, it has been widely promoted as a cornerstone for sustainable urban development (Jenks et al., 2000; Dempsey et al., 2012).

While the environmental and economic benefits of intensification—such as reduced carbon emissions, preservation of green spaces, infrastructure cost-efficiency, and improved accessibility—are well-documented (Newman & Kenworthy, 1999; Ewing & Cervero, 2010), the social impacts of increased density warrant further investigation.

The city of Bou Saâda in Algeria serves as a pertinent case study for examining the social implications of urban intensification policies. As a medium-sized historical city experiencing rapid haphazard urbanization, Bou Saâda faces challenges common to many developing urban centers, including socioeconomic disparities and a conflict between traditional and modern socio-urban patterns (Madani & Tchefrit, 2017).

This research paper proposes urban intensification as a strategy primarily aimed at curbing urban sprawl and achieving social sustainability in Bou Saâda by encouraging inward urban development. This is facilitated through three key mechanisms: (1) Accessibility to core facilities and services; (2) Urban Diversity of various amenities; and (3) Proximity between residents, and between residents and services. These three elements function as interconnected pillars supporting the primary objective of creating a socially sustainable urban environment.

By analyzing field data through GIS, this article demonstrates how urban intensification can serve as a strategy for social stability. It draws upon both theoretical frameworks and empirical evidence, evaluated for effectiveness through Multi-Criteria Analysis (MCA) techniques.

Objectives

1. Social Implications of Urban Sprawl

Haphazard urban sprawl has precipitated a suite of socio-spatial challenges that threaten the urban fabric and social integrity of cities. The most prominent manifestations include:

- Social Isolation: Spatial fragmentation between residential zones and essential services has curtailed opportunities for social interaction, leading to the erosion of community ties.
- Disparities in Opportunity: Urban sprawl has exacerbated inequalities regarding accessibility to core services—such as education, healthcare, and recreation—thereby deepening socio-economic divides.
- Erosion of Spatial Identity: Newly developed peripheral neighborhoods often lack distinctive character and cultural resonance, which undermines the residents' sense of place and belonging.
- Diminished Quality of Life (QoL): Prolonged commuting times and logistical barriers to service accessibility have exerted a negative impact on the psychological and social well-being of the populace.
- Marginalization of Vulnerable Cohorts: The elderly, persons with disabilities, and children have become increasingly isolated due to the mobility challenges inherent in low-density, extended urban areas.

2. Urban Intensification as a Strategic Framework for Social Sustainability

Urban intensification is defined as the deliberate reconfiguration of the extant urban fabric by increasing population density and diversifying land use, while concurrently safeguarding the quality of life (QoL). This strategy offers three fundamental pillars to address socio-spatial challenges:

Accessibility, **Urban Diversity**, and **Proximity**.

Accessibility

In an academic context, accessibility denotes the capacity for all social strata to attain essential services and infrastructure with ease and at an equitable cost. This objective is operationalized through:

- Spatial Compression: Reducing the physical distance between residential clusters and core amenities.
- Integrated Transit Systems: Developing efficient and multimodal public transportation networks.
- Pedestrian-Centric Infrastructure: Designing road networks that prioritize Non-Motorized Transport (NMT), specifically for pedestrians and cyclists.
- Universal Design: Eliminating physical and architectural barriers to facilitate the mobility of persons with disabilities.

Furthermore, enhanced accessibility fosters social equity by ensuring that all residents—regardless of socioeconomic status—have commensurate opportunities to utilize public services, thereby mitigating marginalization and social exclusion.

Urban Diversity

Urban diversity refers to the functional and morphological heterogeneity within the urban fabric, encompassing a multiplicity of uses, functions, and residential typologies. This includes:

- Residential Mix: Diversifying housing models (e.g., apartments, detached units, and co-housing) to accommodate varying socioeconomic demographics.
- Mixed-Use Development: Integrating commercial, residential, recreational, and administrative functions within the same spatial domain.
- Placemaking and Multi-functional Public Realms: Providing public spaces that attract diverse age groups and social backgrounds.
- Heritage Integration: Preserving architectural heritage and harmonizing it with contemporary urban elements.

Consequently, urban diversity promotes social cohesion by creating vibrant environments that stimulate interaction among diverse social groups and prevent the formation of socially isolated enclaves.

Proximity

Proximity entails the spatial contraction between various urban components (housing, employment, services, and leisure), which achieves the following:

- Reduction in Commuter Burden: Minimizing the temporal and financial costs associated with daily mobility.
- Spontaneous Sociability: Increasing opportunities for informal encounters among residents, which strengthens community ties.
- Encouragement of Active Mobility: Facilitating walking and cycling as primary modes of transport.
- Natural Surveillance: Enhancing the perception of safety through increased "eyes on the street" and informal social control.

Ultimately, proximity contributes to the accumulation of Social Capital and improves the overall quality of life by reallocating time previously lost to long-distance commuting toward meaningful social engagement and personal well-being.

Methods Results Discussion

Results and Methodological Analysis

Methodological Framework

The study employed a descriptive-analytical methodology, characterized by a mixed-methods approach that facilitates the triangulation of data through:

- Field Research: Utilizing structured questionnaires and direct on-site observations.
- Quantitative Analysis: Implementing the Analytic Hierarchy Process (AHP) to weight and evaluate variables.
- Spatial Analysis: Generating maps and spatial indicators via Geographic Information Systems (GIS).

Study Sample and Data Collection

A total of 400 questionnaires were administered across the four targeted neighborhoods, with an equal distribution of 100 surveys per district. The sample was carefully stratified to encompass various age groups and educational backgrounds, ensuring a representative cross-section of the local populace. The data collection phase yielded 372 valid responses, representing a robust 93% response rate.

The distribution of valid responses per neighborhood is as follows:

- Sidi Slimane: 95 responses (95% return rate).
- Administrative District: 94 responses (94% return rate).
- 24 February: 92 responses (92% return rate).
- Moufdi Zakaria: 91 responses (91% return rate).

Integrated Quantitative and Spatial Analysis (GIS-SIG) Results

The residents' perceptions were quantified using a 5-point Likert scale (where 5 represents "Excellent"). The findings across the three core criteria are detailed below:

Accessibility Indicator

The analysis reveals a significant correlation between urban density and accessibility.

- The Administrative District achieved the highest mean score (4.5/5), characterized by a minimal average travel time of 6 minutes.
- Sidi Slimane followed with a score of 4.3/5 and an average travel time of 8 minutes.
- 24 February recorded a moderate score of 3.2/5 with a 12-minute travel time.
- Moufdi Zakaria exhibited the lowest performance (2.1/5), with travel times extending to 18 minutes.

Urban Diversity Indicator

Urban diversity was evaluated based on the variety of services and the degree of land-use mix (functional mix):

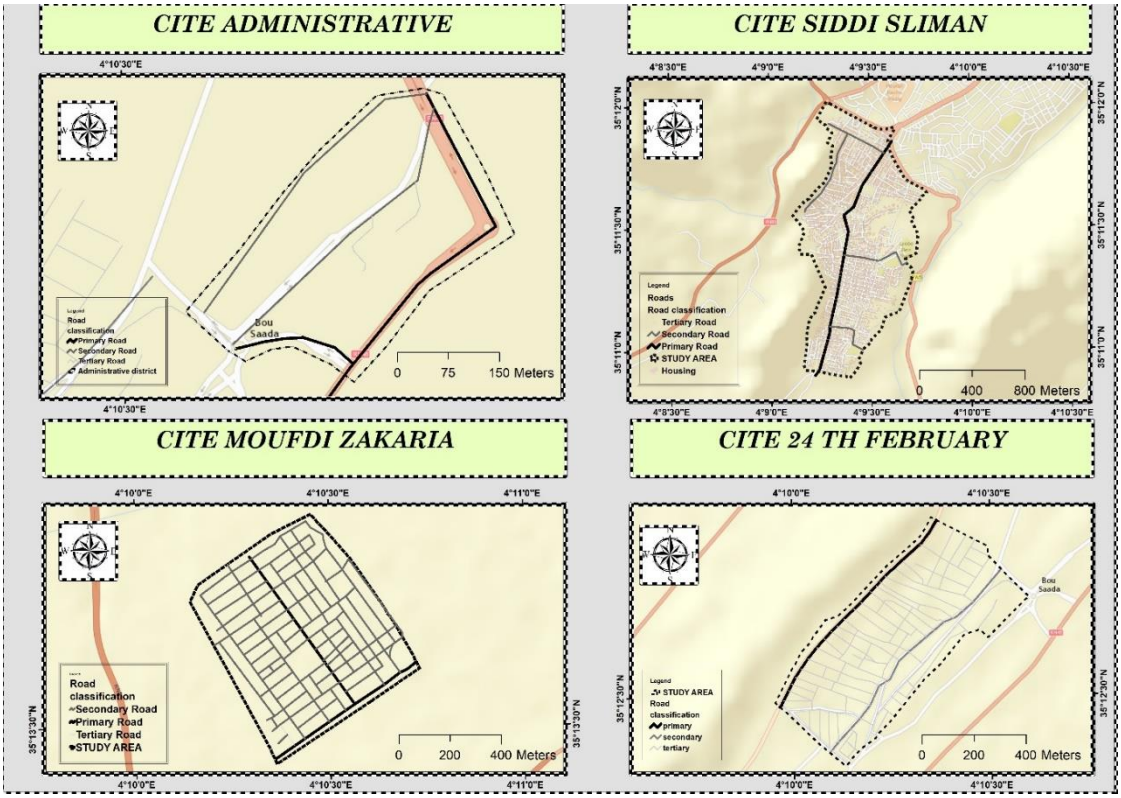
- The Administrative District: Demonstrated superior performance in service diversity (4.6/5) and land-use integration (4.7/5).
- Sidi Slimane: Scored high in service variety (4.2/5) and functional mix (4.0/5).
- 24 February: Showed moderate levels of service diversity (3.3/5) and a lower functional mix (2.8/5).
- Moufdi Zakaria: Recorded the lowest indices for both service variety (2.4/5) and land-use mix (2.0/5).

Proximity Indicator

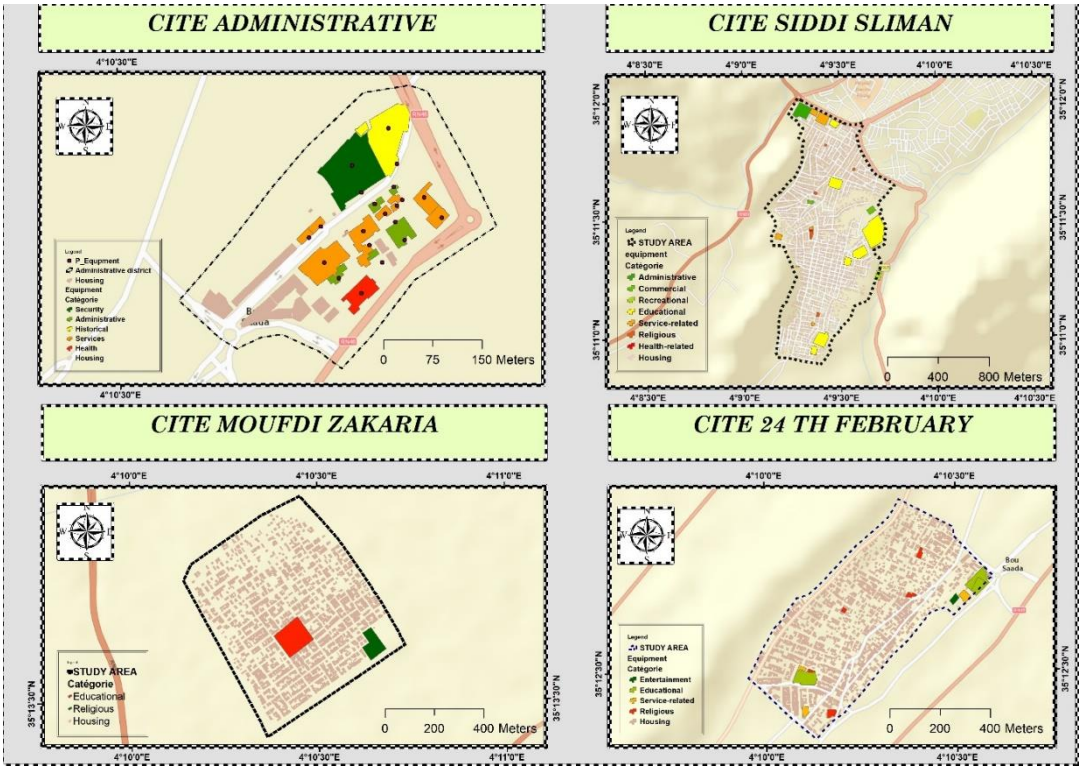
Proximity was assessed relative to healthcare, commercial, and educational facilities:

- The Administrative District: Ranked highest for proximity to healthcare facilities (4.6/5) and commercial retail hubs (4.7/5).
- Sidi Slimane: Showed strong proximity to retail outlets (4.5/5) and educational institutions (4.4/5).
- 24 February: Exhibited moderate proximity, particularly concerning educational facilities (3.5/5).
- Moufdi Zakaria: Demonstrated the lowest levels of proximity, specifically regarding healthcare infrastructure (2.2/5).

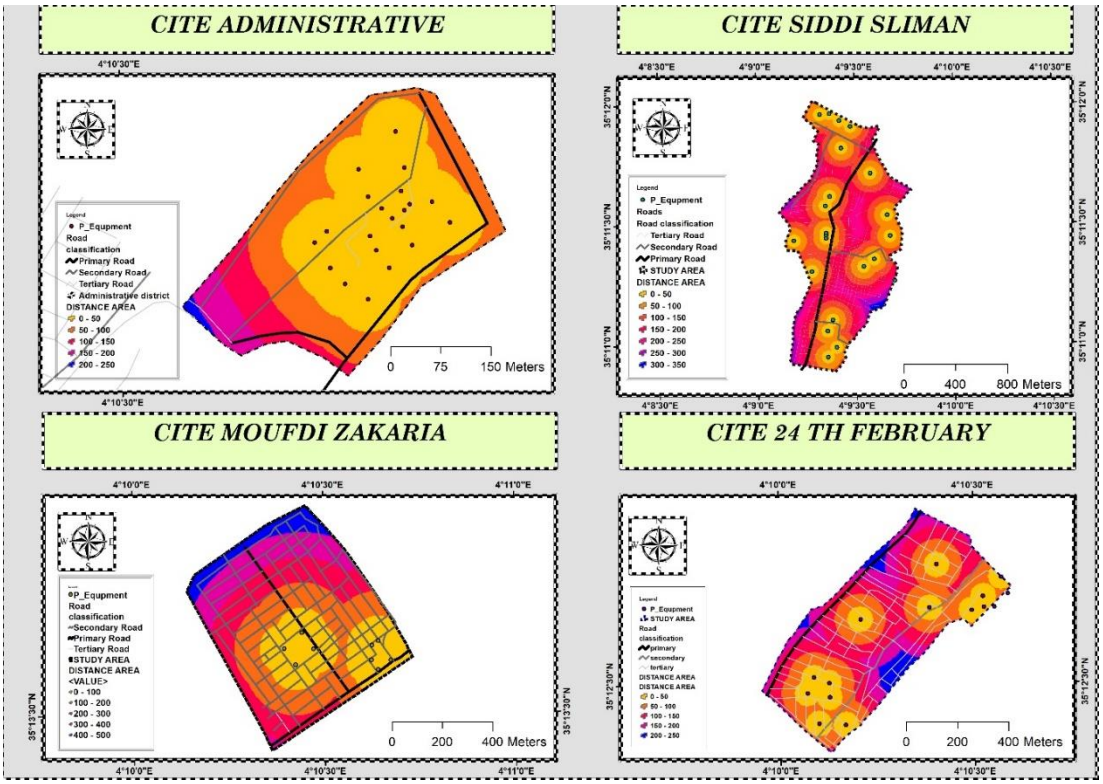
The transportation network within the four study areas: An analytical illustration of accessibility thresholds."



Urban Diversity and Functional Integration of Residential Units, Amenities, and Services Across the Four Neighborhoods."



"The Sphere of Influence: Evaluating the Proximity of Urban Facilities to Residential Units as a Determinant of Accessibility."



Spatial Analysis Results (GIS)

The GIS analysis revealed distinct disparities in the distribution of urban facilities.

Table 1: Spatial Indicators by Neighborhood

Neighborhood	Total Facilities	Facility Density (units/km²)	Average Distance (m)	Functional Mixing Index
Administrative District	267	106.8	280	0.85
Sidi Slimane	179	99.4	320	0.78
24 February	93	44.3	580	0.52
Moufdi Zakaria	57	35.6	920	0.35

Correlation Between Survey Results and GIS Analysis

There is a high degree of correlation between the residents' survey findings and the spatial data generated via GIS.

- Accessibility: Residents' evaluations of accessibility align strongly with GIS indicators. The Administrative District recorded the highest levels of accessibility due to high facility density and short average distances. Conversely, Moufdi Zakaria exhibited lower standards, characterized by low density and longer distances, reflecting the accuracy of residents' spatial perceptions.
- Urban Diversity: High ratings for diversity and mixed-use development were observed in the Administrative District and Sidi Slimane, consistent with their high functional mixing indices. Conversely, peripheral neighborhoods recorded lower ratings, matching their weak spatial indicators.
- Proximity: Survey data regarding resident satisfaction with the proximity of facilities in central neighborhoods supports the low average distance indicators shown in GIS maps. This relationship is inverted in peripheral neighborhoods, where distances increase and proximity decreases, validating the reliability of the integrated socio-spatial data.

Application of the Analytic Hierarchy Process (AHP)

The AHP method was applied to weight three primary criteria: **Accessibility**, **Urban Diversity**, and **Proximity**. This process integrated qualitative survey results (on a 1–5 scale) with quantitative GIS indicators for four neighborhoods in Bou Saâda. The analysis confirms that urban intensification enhances social sustainability, as high-density neighborhoods demonstrated superior social outcomes.

Weighting Criteria via the Proposed AHP Matrix

A scientific weighting was proposed to reflect social sustainability priorities: **Accessibility (0.45)**, **Urban Diversity (0.30)**, and **Proximity (0.25)**. These weights were calculated through pairwise comparisons (Saaty scale), yielding a Consistency Ratio (**CR**) of **0.03**, which is well within the acceptable threshold of < 0.1.

Criterion	Accessibility	Urban Diversity	Proximity	Weight
Accessibility	1	3	5	0.45
Urban Diversity	1/3	1	3	0.30
Proximity	1/5	1/3	1	0.25

Integrated Survey and GIS Data

The following data aggregates mean scores from 372 respondents with objective GIS indicators:

Neighborhood	Accessibility (Survey / Density)	Urban Diversity (Survey / Mixing Index)	Proximity (Survey / Distance m)	Population Density (inh/km²)
Administrative District	4.55 / 106.8	4.65 / 0.85	4.65 / 280	11,800
Sidi Slimane	4.35 / 99.4	4.25 / 0.78	4.55 / 320	15,200
24 February	3.25 / 44.3	3.35 / 0.52	3.55 / 580	8,500
Moufdi Zakaria	2.15 / 35.6	2.45 / 0.35	2.25 / 920	4,200

Final AHP Classification Results

The final scores were calculated using the formula: $\sum (\text{Criterion Mean} \times \text{Weight})$, with GIS data normalized (0–1) for compatibility.

Neighborhood	Final AHP Score	Social Sustainability Rank
Administrative District	0.87	1 (Excellent)
Sidi Slimane	0.82	2 (Very Good)

Neighborhood	Final AHP Score	Social Sustainability Rank
24 February	0.58	3 (Moderate)
Moufdi Zakaria	0.35	4 (Weak)

Discussion and Recommendations

The results reveal a strong positive correlation between "Compact City" characteristics and social sustainability indicators.

1. Models of Success: The Administrative District and Sidi Slimane achieved the highest sustainability rates (0.87 and 0.82). This is attributed to the high integration of residential and service components, with average access distances as low as 280 meters. This pattern fosters social interaction and reduces reliance on motorized transport.
2. Expansion Challenges: Conversely, Moufdi Zakaria serves as a negative model of low-density urban sprawl. Spatial dispersion (920m average distance) and a low functional mixing index (0.35) have negatively impacted resident satisfaction and social cohesion, leading to "social isolation".

Policy Recommendations

1. Functional Injection Strategy: It is recommended to increase the functional mixing index by at least 20% in low-density neighborhoods by repurposing vacant plots or ground floors for commercial and social services.
2. Enhancing Accessibility Networks: Pedestrian paths in sprawling neighborhoods should be restructured to reduce travel time, aiming to reach the 6–8 minute standard observed in central districts.

Conclusion

Urban intensification serves as a potent strategy for mitigating the socio-spatial challenges arising from **urban sprawl**, thereby fostering **social sustainability** within Algerian urban centers. The case study conducted in the city of **Bou Saâda** demonstrates that the three pivotal dimensions of urban intensification—**accessibility**, **urban diversity**, and **proximity**—constitute the fundamental pillars for establishing cohesive and sustainable urban communities.

The implementation of this strategy necessitates the adoption of an integrated approach that synthesizes insights derived from the traditional urban fabric with contemporary advancements in urban planning and design, while maintaining a primary focus on the social dimensions of urban development. Ultimately, the successful application of this intensification framework in Bou Saâda offers a scalable model for other Algerian cities grappling with comparable developmental pressures.

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