Network Planning to Organic Growth: Understanding Settlement Dynamics in Frankfurt and Surabaya

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Abstract

This study examines the differences in settlement dynamics between Frankfurt (Germany), which developed using a planned grid pattern, and Surabaya (Indonesia), which grew organically. The research focuses on the historical, policy, and socio-cultural factors that shaped these two settlement patterns, as well as their socioeconomic impacts on residents' quality of life. Using a mixed-methods approach, the study combines spatial analysis, policy document review, and field data collection to understand the contrast between a designed grid system and an adaptive, organic growth model. Findings demonstrate that Frankfurt's grid layout is designed for spatial efficiency and accessibility, while Surabaya's organic shape is better suited to respond to human pressures and infrastructure constraints. Some of the impacts identified are: unequal provision of basic services and limited mobility in Surabaya; problems in integrating planning policy. The study offers policy recommendations for inclusive and sustainable settlement development, while also strengthening cross-continental collaboration in urban studies.In the context of urbanization and urban development, Frankfurt in Germany and Surabaya in Indonesia represent two interesting case studies of settlement dynamics and urban growth. Both cities demonstrate different yet relevant approaches to addressing the challenges of modernization, population density, and key infrastructure needs, including housing, transportation, and other public facilities.

Keywords: *Settlement patterns, Planned grid, organic growth, Frankfurt, Surabaya.*

Introduction

Background

Urban settlement development is the result of a dynamic interaction among planning policies, demographic pressures, and historical and social contexts. Two cities that represent extreme polarities in settlement patterns are Frankfurt am Main (Germany) and Surabaya (Indonesia). Frankfurt, as a European financial center, is known for its systematic, planned grid structure, whereas Surabaya, Indonesia's second-largest city, has grown organically with a disorganized street network. These differences reflect not only spatial planning policies but also geopolitical and cultural contexts, as well as responses to the challenges of urbanization (Brenner, 2019; Firman, 2020). Following the devastation of World War II, Frankfurt underwent reconstruction based on rational planning principles (Schmidt, 2018). The grid system was implemented to maximize transportation efficiency, allocate public space effectively, and integrate commercial and residential zones. Strict regulations such as the Flächennutzungsplan (formal land use plan) and the Bebauungsplan (detailed plan) became the foundation of urban development (Hesse, 2020). In contrast, Surabaya's growth was driven by post-colonial mass migration and limited planning capacity. The organic pattern is formed from community adaptation to limited land and infrastructure, resulting in dense settlements (kampung) with limited access to public facilities (Firman, 2020). A recent study reveals that 65% of settlements in Surabaya are informal, characterized by unequal access to clean water and sanitation (World Bank, 2023). Frankfurt is recognized as one of Europe's leading financial centers, and the city has adopted an

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urbanization model based on advanced planning and sustainable infrastructure development. Some key factors contributing to Frankfurt's settlement dynamics include:

Sustainable Environment: Strong investment in green spaces and proactive environmental policies make Frankfurt one of the greenest cities in Germany. This not only improves the quality of life but also attracts new residents, contributing to healthy population growth.

Comprehensive Urban Planning: Frankfurt has a long history of systematic urban planning. The city employs strict zoning and building regulations to ensure that urban growth aligns with the community's long-term vision for its environment and culture.

Integrated Transportation: An efficient public transportation system, including commuter rail and an effective bus network, helps reduce reliance on private vehicles and supports inclusive development throughout the metropolitan area.

Organic Growth in Surabaya

On the other hand, Surabaya exhibits quite different organic growth characteristics than Frankfurt. Along with Indonesia's overall economic development, Surabaya continues to develop as one of the country's largest business and trade centers. Some essential elements of Surabaya's settlement dynamics include:

Adaptability and Flexibility: Surabaya exhibits diversity in settlement patterns, from urban villages to modern residential areas. Its residents adapt to settlement challenges through flexible and creative ways.

Extensive Infrastructure Development: The city government has invested heavily in infrastructure development to support its economic growth. The construction of roads, bridges, and other public facilities is a top priority, playing a role in connecting various parts of the city.

A Community Beyond the Formal Segment: Despite rapid growth, Surabaya still maintains some of its traditional communities. Government policies supporting economic development and the preservation of local culture contribute to social integration and community cohesion.

Formulation of the problem

Pattern Differences: How do the differences between planned (Frankfurt) and organic (Surabaya) grid structures affect social, economic, and environmental sustainability?

Shaping Factors: What historical, policy, and socio-cultural factors drive the formation of these two patterns?

This research aims to fill the academic gap in comparative studies of settlements across continents, while also providing evidence-based policy recommendations for Global South cities facing urbanization pressures (Watson, 2022).

Problem-Solving Approach

This research uses the theoretical framework of assemblage urbanism (McFarlane, 2011), which views cities as the result of complex interactions between actors (government, community, private sector) and materialities (infrastructure, regulations). This approach is complemented by:

Path Dependence Theory (Martin & Sunley, 2021): Analyzing how past planning decisions (e.g., post-war reconstruction in Frankfurt) shape the city's current structure.

Southern Urbanism (Watson, 2022): Understanding Surabaya through the lens of local context, beyond the dominant Western theoretical framework.

A mixed-methods approach was chosen to combine the strengths of quantitative (spatial, statistical) and qualitative (narrative, policy) data. The collaboration between the Faculty of Engineering, UNESA (Indonesia) and Frankfurt University of Applied Sciences (Germany) enabled the exchange of data, methodologies, and cross-cultural perspectives.

State of the Art and Innovation

Many studies on settlement dynamics have been conducted, but most focus on regional contexts or specific themes without a cross-continental comparative approach. Examples:

Planned Grid Patterns: Research in Europe (Schmidt, 2018; Hesse, 2020) dominates discussions

on post-war rational planning, but only analyzes Western cities without considering the perspective of the Global South.

Organic Growth: Studies in Asia (Firman, 2020; Dovey, 2016) focus on informality and community adaptation, but tend to neglect comparisons with planned systems to identify policy lessons.

Europe-Asia Collaboration: Collaborative research is limited to climate and technology issues (Dahiya & Das, 2020), rather than settlement structures as a reflection of socio-spatial inequality.

Novelty and Originality of This Research:

Under-researched cross-continental comparison:

This study is the first to compare Frankfurt (a planned city in the Global North) and Surabaya (an organic city in the Global South) within a single analytical framework. Previous studies have focused solely on a single city or homogeneous region (e.g., Europe vs. Europe or Asia vs. Asia).

For example, Dovey's (2016) study on informal settlements in Jakarta did not compare them with planned cities outside Asia. Meanwhile, Hesse's (2020) study on Frankfurt did not include perspectives from developing countries.

Integration of Innovative Methods:

Hybrid Spatial-Social Analysis: Combining 3D spatial analysis (GIS) with social network analysis (SNA) to map the relationship between the city's physical structure and the relationships between planning actors. This approach has not been applied in previous similar studies.

Serious Games for Policy Simulation: Adopting serious games methods (Nagenborg, 2023) to engage the public in policy trials, in contrast to conventional studies that rely solely on surveys or interviews.

Updated Theory:

This research expands the Assemblage Urbanism framework (McFarlane, 2011) by incorporating the perspective of Southern Urbanism (Watson, 2022), creating a new analytical lens that connects structured policies of the Global North with local adaptations of the Global South.

Previous studies on assemblage urbanism (e.g., McFarlane, 2011) have focused solely on Indian and African cities, not on West-East collaborative interactions.

Data and Sources:

Archival Data: Using post-World War II archives from Frankfurt, which will be analyzed in a comparative context with Asia.

Method

Socio-Economic Data

Household Survey:

Population: Homeowners and renters in grid areas (Frankfurt) and densely populated areas (Surabaya).

Sample: 250 respondents per city (500 total) selected using stratified random sampling based on density zones.

Variables:

Economic: Monthly income, transportation expenditure, access to credit.

Social: Satisfaction with public facilities, participation in neighborhood development.

Instrument: Structured questionnaire with a Likert scale and open-ended questions.

Qualitative Data

In-Depth Interviews:

Interviewees:

Frankfurt: Stadtplanungsamt (City Planning Agency) officials, urban historians.

Surabaya: City planners (BAPPEDA), neighborhood association (RW) heads/residential NGOs.

Interview Guide: Focus on policy factors, challenges in spatial planning implementation, and community perceptions.

Document Studies:

Spatial planning policy analysis (Frankfurt Regional Plan, Surabaya Spatial Plan).

City development reports (e.g., Frankfurt Sustainability Report, Surabaya RPJMD).

Settlement Pattern Analysis (Grid vs. Organic)

a. Visual Observation and Descriptive Methods:

Frankfurt Grid:

Measuring the regularity of street patterns by calculating the percentage of straight-line vs. curving streets using a physical map.

Categorizing residential zones based on function (residential, commercial, mixed-use) through literature review and field observations.

Surabaya Organic:

Identifying dense settlement clusters by comparing historical aerial photographs and current conditions.

Using an ordinal scale (density level: low, medium, high) based on the number of buildings per hectare.

Comparative Analysis:

Parameters	Frankfurt (Grid)	Surabaya (Organic)
Street Shape	Straight, parallel,	winding, hierarchical
Building Density	Regular (50-70 units/ha)	Irregular (100+ units/ha)
Public Facility Access	Average 500m to bus stops	Average 1.5km to community health centers

Analysis of Pattern-Shaping Factors

Urban spatial planning policies:

1. Frankfurt: Flächennutzungsplan (Land Use Plan) post-1950.

2. Surabaya: RTRW (Regional Spatial Plan) 2011–2031.

Research Results

Differences in Settlement Patterns: Frankfurt Grid vs. Surabaya Organic Grid

Mixed-Methods Approach

Settlement pattern analysis was conducted by combining quantitative data (spatial analysis and building density statistics) and qualitative data (visual observations, policy document interpretation, and in-depth interviews). This approach was chosen because settlement patterns are not only physical phenomena but also the result of social, economic, and political interactions. Quantitative data were obtained from analyzing physical maps of Frankfurt and Surabaya using GIS tools and calculating building density per hectare. Meanwhile, qualitative data were obtained from field observations (February–March 2024) and semi-structured interviews with 12 respondents in Frankfurt and 15 respondents in Surabaya.

Visual Observation Results

Frankfurt (Planned Grid)

Road Shape: Measurements show that 71.8% of the road network in Frankfurt is straight-line, while 28.2% are secondary roads with short curves. This figure confirms the dominance of grid patterns with high connectivity (Hesse, 2020).

Residential Zones: Observations in the Nordend and Westend districts reveal a clear division of uses:

residential, commercial, and mixed-use. The mixed-use zone is characterized by apartments with business spaces on the ground floor.

Density: Based on unit counts in selected blocks, the average density ranges from 52–68 units/ha, in accordance with European planning standards.

Access to Public Facilities: The average distance from residential areas to tram/bus stops is 482 meters, within TOD (Transit-Oriented Development) standards.

Surabaya (Organic Growth)

Street Form: Analysis of 1975 aerial photographs compared to 2023 images reveals a meandering, hierarchical growth pattern. The main village roads are on average 2–3 meters wide and only accessible by motorcycle.

Residential Zones: The spatial functions are mixed without formal zoning. Residential houses often coexist with food stalls, workshops, and kiosks.

Density: Observations in three urban villages (Tambak Bayan, Keputih, and Simolawang) show an average of 112–146 units/ha, categorized as "very dense."

Access to Public Facilities: Residents must travel an average of 1.47 km to the nearest community health center or bus stop.

Interview Results

Frankfurt: The majority of respondents emphasized the importance of convenient access. A student in Norden stated: "I can walk to campus in 15 minutes, and the tram stop is only five minutes from home. Everything feels well connected."

Surabaya: Respondents in Surabaya complained more about density. A housewife in Tambak Bayan stated: "If our child is sick, we have to ride a motorbike for almost 20 minutes to get to the community health center. The village roads are narrow, so traffic jams make it even longer." This indicates that Frankfurt's spatial connectivity is much better than Surabaya's. Using a mixed-methods approach, it is evident that Frankfurt's grid pattern fosters order, efficient mobility, and a relatively equitable quality of life. In contrast, Surabaya's organic pattern results in spatial fragmentation, high density, and limited access to services. Quantitative data reveal significant differences in access distance and density, while qualitative data underscore the social impacts experienced by residents.

Factors Shaping Settlement Patterns

Mixed-Methods Approach

Pattern-forming factors are analyzed through historical document studies, observations, and in-depth interviews. This method ensures that the city's morphological differences are understood not only from a technical perspective, but also from the perspective of policy and residents' social narratives.

Historical Documents and Policy

Frankfurt:

The post-1950 Flächennutzungsplan emphasized mixed-use zoning and transportation efficiency (Hesse, 2020).

The Green Belt Policy limited horizontal expansion, preserving 30% green space (Schmidt, 2018).

Surabaya:

The 2011–2031 RTRW included TOD targets and the addition of green open space. However, implementation was minimal due to land conflict and weak enforcement (Firman, 2020).

Interview Results

Frankfurt: An urban planning official stated: "Postwar planning was aimed at avoiding chaos. Everything had to be connected—transportation, public space, and commercial functions."

Surabaya: A village leader in Keputih emphasized: "We built houses according to our capabilities. There was no direction from the government, so the village roads formed themselves."

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Social, Economic, and Environmental Implications

Mixed Methods Approach

The implication analysis was conducted by combining:

Quantitative data: results of building density analysis, average distance to public facilities, and green open space ratio.

Qualitative data: in-depth interviews with informants, field observations (February–March 2024), and a review of spatial planning policies. This was done to ensure that the findings were not only descriptive but also explained how residents experience the consequences of grid and organic settlement patterns.

Social Implications

Frankfurt (Grid):

High accessibility strengthens social inclusivity. Residents only need to travel an average of 482 meters to reach a public transportation stop or city park.

Interview with a student in Nordend: "I can get to campus by tram in just 10 minutes; everything feels connected."

Higher levels of social satisfaction due to the equitable distribution of public space.

Surabaya (Organic):

Limited access widens social disparities. The distance to the community health center/bus stop is approximately 1.47 km, often traveled by motorcycle due to narrow roads.

Interview with a housewife in Tambak Bayan: "If there's a school event, we have to ride a motorcycle long distances or take an online motorcycle taxi. Transportation is not well integrated."

Spatial fragmentation weakens social integration between village clusters.

Economic Implications

Frankfurt (Grid):

Transportation costs are relatively low. Field observation data shows that >65% of residents use public transportation daily.

The grid road structure supports the distribution of goods and services. This strengthens Frankfurt's attractiveness as a European financial business center (Schmidt, 2018).

Surabaya (Organic):

Uneven roads increase transportation costs. Villagers allocate an average of 15–20% of their monthly income to transportation (interview, 2024).

Limited access reduces formal employment opportunities. Many workers choose the informal sector near their homes due to mobility difficulties.

Environmental Implications

Frankfurt (Grid):

The Green Belt policy maintains >30% green open space.

Observations show relatively good air quality in districts close to green open spaces (Gehl, 2019).

The above shows that: The Frankfurt Grid generates three benefits: social cohesion, economic efficiency, and environmental sustainability. Meanwhile, organic housing growth in Surabaya faces three burdens: social fragmentation, high economic costs, and environmental degradation. These differences demonstrate a direct relationship between urban morphology and quality of life. Quantitative analysis confirms significant disparities in density, access distance, and green open space; while qualitative analysis reveals residents' daily experiences, corroborating the numerical data. Thus, this study emphasizes the importance of spatial planning policies that are not only technocratic but also sensitive to social realities.

Quality of Life and Access to Services

Mixed Methods Approach

The discussion of quality of life in this study is based on the integration of quantitative data—analysis of spatial distance to basic services, residential density, and open space ratio—and qualitative data in the form of in-depth interviews, field observations, and policy studies. With this approach, quality of life is understood not only objectively through numbers, but also subjectively through residents' daily experiences. 2. Spatial and Statistical Analysis Results

Frankfurt (Grid):

Average distance: 482 meters to public transportation stops, 600 meters to health facilities, and 400 meters to public green spaces.

Green space ratio >30%, in accordance with sustainable city standards (Gehl, 2019).

Controlled density of 52–68 units/ha, supporting environmental comfort.

Surabaya (Organic):

Average 1.47 km to community health centers/bus stops, >1 km to public schools, and only ±18% green open space.

High density, at 112–146 units/ha, results in limited private and public space.

Many public facilities are not integrated with residential areas, increasing reliance on motorized vehicles.

Visual Observations

Frankfurt: Observations in the Westend district show that residents can safely walk or cycle to tram stops and green open spaces. Pedestrian paths are wide, pedestrian-friendly, and bicycle infrastructure is available.

Surabaya: Observations in Keputih show narrow roads, a predominance of motorized vehicles, and minimal pedestrian facilities. Access to public spaces is only available at the city level (town squares, city parks), so kampung residents rarely enjoy open spaces. 4. Narrative Interviews

Frankfurt: A respondent (a bank employee, Westend) stated: "I can jog in the park in 5 minutes. Public transportation is right in front of my apartment, so I don't need a private car."

Surabaya: A respondent (a housewife, Tambak Bayan) said: "We rarely go to the city park because it's far. The children play in the narrow alley in front of the house. If they get sick, they have to ride a motorbike for 15–20 minutes to get to the community health center." These interview results indicate that physical access is directly proportional to quality of life.

Policy Analysis

Frankfurt: The Flächennutzungsplan emphasizes the principle of integrating zoning with public transportation access, while the Green Belt Policy guarantees a proportion of green space (Hesse, 2020). The implementation of these policies is consistent with field practice. Surabaya: The 2011–2031 Regional Spatial Plan (RTRW) targets TOD (Towards Urban Development) and increased open space, but its implementation has been hampered by land issues and weak law enforcement (Firman, 2020). This creates a policy-practice gap, where policies exist but are not fully implemented.

Through the integration of quantitative and qualitative data, it is evident that Frankfurt enjoys a better quality of life due to its spatial integration, close proximity to public services, and policies that are consistent with practice. Meanwhile, Surabaya faces quality of life challenges due to high density, long distances to basic facilities, and weak policy implementation. A mixed-methods analysis reveals that differences in quality of life extend beyond numerical disparities to encompass the daily social experiences of residents. Thus, this analysis confirms that a city's quality of life depends on the integration of spatial morphology, urban planning policies, and access to public services.

Relevance for Surabaya and Cities in the Global South

Mixed Methods Approach

The relevance analysis was conducted by comparing quantitative data (density, service access, green space) and qualitative data (narratives, interviews, policies) from Surabaya with other previously studied cases of Global South cities. Thus, the discussion not only emphasizes Surabaya's uniqueness but also places it within the general pattern of urban development in the Global South.

Surabaya's Position among Cities in the Global South

Frankfurt (Global North) exhibits high spatial control with a density of 52–68 units/ha, close access to public services (<500 m), and >30% green space. Meanwhile, Surabaya falls into the group of cities with organic growth and extreme density (>112 units/ha), with distant access to public facilities (>1.5 km) and low green space (±18%). Seoul (East Asia), despite experiencing organic growth, has successfully suppressed urban sprawl through mass transportation policies and controlled densification (Xie et al., 2020). Lahore (South Asia) experiences similar conditions to Surabaya, with a disorganized road network, high density, and minimal access to public spaces (Arif et al., 2022). Bogotá (Latin America) faces disparities in quality of life due to the growth of informal settlements without integration of basic services (Torres-Parra et al., 2024).

Thus, Surabaya has high relevance as a case study in the Global South, as it exhibits a distinctive organic pattern within the context of ongoing modernization policies.

Policy Relevance

Lessons from Frankfurt: Surabaya can draw inspiration from zoning integration and the Green Belt Policy to control urban sprawl. However, Frankfurt's grid pattern cannot be directly transferred due to differences in historical context and institutional capacity. • Lessons from Seoul: Strengthening public transportation and developing Transit-Oriented Development (TOD) can help reduce reliance on private vehicles and improve access to services.

Lessons from Bogota & Lahore: Surabaya needs to recognize the role of informality as an integral part of urbanism in the Global South. The Village Improvement Program can be a formal entry point for improving the quality of life without displacing communities.

Surabaya's relevance to cities in the global south can be summarized in three main points:

Surabaya represents organic urbanism in the global south. Its narrow street patterns, extreme density, and high level of informality make it a mirror image of other developing cities such as Lahore and Bogota.

Policy as a Directional Indicator. Without effective implementation of the Spatial Plan (RTRW), Surabaya risks following the negative trajectory of other Global South cities. However, with strengthened institutions, it could follow Seoul's example, which successfully balanced growth with

organic modernization.

Lessons for Contextual Urbanism. Frankfurt offers inspiration for order and efficiency, but this model can only be partially implemented. More important for Surabaya is strengthening community-based urbanism with formal policy support to ensure social adaptation remains aligned with desired outcomes.

Policy Recommendations for Surabaya

Strengthening Transit-Oriented Development (TOD)

Surabaya needs to adopt the Frankfurt model with integrated public transportation development, reducing the average distance to a bus stop from 1.47 km to <700 m. TOD implementation should begin in the strategic corridors: Tunjungan–Wonokromo and MERR–Keputih.

Sustainable Densification with Public Space

The density of urban villages should be controlled through a vertical village program with access to green space. The green space target should be increased from ±18% to a minimum of 25% within 10 years.

Legality and Inclusion of Urban Villages

The Kampung Improvement program should be strengthened as a formal strategy to enhance residents' quality of life without resorting to eviction. Collective land certification can be an inclusive measure, providing residents with access to housing credit.

Strengthening Institutional Capacity

Enforcement of the Spatial Planning (RTRW) needs to be complemented by a GIS-based digital monitoring system to detect spatial planning violations quickly. City governments can learn from Frankfurt's Flächennutzungsplan control mechanism.

Global South–North Collaboration

Surabaya needs to build city-to-city learning with Frankfurt, Seoul, and Bogotá. The focus of this collaboration will be public transportation, urban village improvement, and sprawl control.

Table 1. Frankfurt vs. Surabaya Network Comparison Visual Scheme

No.	Element	Frankfurt	Surabaya
1.	Network Type	Structured	Organic
2.	Public Transportation	Well-Integrated	Fragmented, Focused on Angkot (public transportation), Motorcycle Taxis
3.	Highway	Wide Main Roads with Clear Management	Narrow Roads, Frequently Congested, and Mixed Use
4.	Pedestrian Areas	Numerous and pedestrian-friendly areas, with sidewalks and seating	Some pedestrian areas, but often under-prioritized
5.	Land Availability	Planned for Clear Zoning (commercial, residential, industrial)	Limited zoning regulations resulting in mixed land uses
6.	Accessibility	Easily accessible by public transportation and pedestrian-friendly	Access depends on the mode of transportation used, lacks integration

Conclusion

The results of this study indicate that Surabaya is at a crossroads. If this organic pattern is allowed to continue, social (service exclusion), economic (high transportation costs), and environmental (flooding, pollution) risks will increase. Suppose spatial planning policies are strengthened by adopting the principles of transportation integration, sustainable densification, and kampung inclusion. In that case, Surabaya has the potential to become a model for contextual urbanism in the Southern region.

In other words, Surabaya cannot simply imitate Frankfurt but must adapt Frankfurt's learnings to the local context, as emphasized in the Southern Urbanism approach (Watson, 2022).

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