Transforming Johannesburg
Towards a low carbon and inclusive metropolis

Issues and Opportunities
Citywide Quantitative Urban Analysis

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Wits University, July 2014
Corridors of freedom

In the Executive Mayor’s State of the Nation speech he promised residents five rights including “he right to a spatially integrated and united city”

He said: “We have already pioneered the first Bus Rapid Transit system when we launched the Rea Vaya...Today we are taking transit oriented development another step forward, with the introduction of a project that will forever change the urban structure of Johannesburg and eradicate the legacy of Apartheid spatial planning.”

He promised: “Over the decade we will introduce transport corridors connecting strategic nodes through an affordable and accessible mass public transit that includes both bus and passenger rail. Along these corridors we will locate mixed income housing, schools, offices, community facilities, cultural centres, parks, public squares, clinics and libraries.

He called these corridors: “Corridors of Freedom”
How to leverage the corridors of freedom opportunities for economic efficiency, social inclusion, resilience and climate change mitigation?

How to strategize TOD for spatial transformation towards a spatially integrated and unified city?
How to make corridors of freedom a success?
ISSUES

HIGH LEVELS OF FRAGMENTATION OF SPATIAL FORMS ARE A STRONG BARRIER
TRANSFORMING SPATIAL FORMS AT GLOBAL AND LOCAL SCALE IS KEY TO LEVERAGING CORRIDORS OF FREEDOM OPPORTUNITIES

1. Inverted polycentricity

2. Fragmented and scattered urban forms

3. Fragmented and scattered densities
   - 100 fold variations in residential density
   - 50 fold variation in job density
   - Spatial mismatch between jobs and residential density

4. Spatial inequalities result in high levels of concentrated unemployment

5. Unequal density of amenities
6. Inefficient land use: low coverage ratio and low FAR

7. Uniform and rigid platting (plot subdivision) jeopardizes social inclusiveness and economic resilience

8. Housing prices reveal unsustainability and inefficiencies in land markets

9. Road Classification and Access Management has created high levels of congestion

10. Street densities are low and street patterns are disconnected and clustered, which limits walkability

As a result of these constraints, recent densification patterns do not make urban forms more inclusive, efficient and resilient
1. Inverted polycentricity
The polycentric city is the traditional pattern of city growth, with a dense and large urban core surrounded by dense sub-centers. This structure supports agglomeration economies.
Johannesburg
Inverted policentricity

Johannesburg metropolitan structure is unique and inherited from its complex history. It displays inverted polycentricity, with satellites urban areas much larger than the core of the city.
Johannesburg in the 80s
Johannesburg today
Joburg spatial organisation has been shaped by a unique topography.
Urban growth time lapse in Johannesburg

1886-1895
Urban growth time lapse in Johannesburg

1896-1900
Urban growth time lapse in Johannesburg

1901-1940
Urban growth
time lapse in
Johannesburg

1941-1960
Urban growth time lapse in Johannesburg

1961-1976
Urban growth time lapse in Johannesburg

1977-2000
Urban growth time lapse in Johannesburg

2001-2011
New urbanisation areas
A major role of the private sector
180 informal settlement, growing fast
2. Fragmented and scattered urban forms
3. Fragmented and scattered densities

- 100 fold variations in residential density
- 50 fold variation in job density
- Spatial mismatch between job and residential density
Residential densities

Scattered and fragmented

Less than 1000 inhab/km²
1000-2500 inhab/km²
2500-5000 inhab/km²
5000-10000 inhab/km²
10000-20000 inhab/km²
20000-30000 inhab/km²
30000-40000 inhab/km²
40000-50000 inhab/km²
More than 50000 inhab/km²

1644 km², 2600 inhab/km² in average (City of Joburg, census 2010)
6479 inhab/km² in average in built up areas (680 km²)
Detailed analysis reveals very different patterns, with 100-fold variations of local residential density.
Jobs densities (2001 data)

0-300 jobs/km²
301-800 jobs/km²
801-1500 jobs/km²
1501-3000 jobs/km²
3001-5000 jobs/km²
5001-10000 jobs/km²
10001-50000 jobs/km²
The major issue
The job/housing mismatch
Business densities mirror job distributions

Number of businesses per km²

- 0 - 1.4
- 1.5 - 5
- 5.1 - 9.5
- 9.6 - 14.8
- 14.9 - 21.3
- 21.4 - 28.5
- 28.6 - 36.3
- 36.4 - 48.4
- 48.5 - 71.3
The number of businesses per km² & the number of businesses per 1000 inhabitants reveal deep spatial inequalities.
4. Spatial inequalities result in high levels of concentrated unemployment
5. Unequal densities of amenities
Unequal densities of amenities
Unequal densities of amenities

Houghton  

Northriding
The density of urban amenities varies a lot across districts
But the number of amenities per thousand inhabitants varies even more.
6. Inefficient land use: low coverage ratio and low FAR
Coverage ratio

- Melrose Arch: 29%
- Sandton: 46%
- Dayn Fern estate: 11%
- North Riding: 16%
- Houghton estate: 21%
- Maboneng: 45%
- Soweto: 27%
- Alexandra: 55%
- Bramfiserville: 26%
- Kya Sand: 36%
- Hillbrow: 48%
Floor Area Ratio is very low in most of urban types

<table>
<thead>
<tr>
<th>Area</th>
<th>Floor Area Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melrose Arch</td>
<td>1.9</td>
</tr>
<tr>
<td>Sandton</td>
<td>5.2</td>
</tr>
<tr>
<td>Dawn farm estate</td>
<td>0.2</td>
</tr>
<tr>
<td>North Riding</td>
<td>0.3</td>
</tr>
<tr>
<td>Houghton estate</td>
<td>0.6</td>
</tr>
<tr>
<td>Maboneng</td>
<td>2.5</td>
</tr>
<tr>
<td>Soweto</td>
<td>0.4</td>
</tr>
<tr>
<td>Alexandra</td>
<td>1.5</td>
</tr>
<tr>
<td>Bramfisheville</td>
<td>0.3</td>
</tr>
<tr>
<td>Kya Sand</td>
<td>0.3</td>
</tr>
<tr>
<td>Hillrow</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Paris
7. Uniform and rigid platting (plot subdivision) jeopardizes social inclusiveness and economic resilience
What are the characteristics of an efficient, resilient and sustainable platting?

Fine grain platting allows consolidation over time and makes the city resilient, diverse and adaptive to market.
Highly adaptive platting follows a mathematical regularity characteristic of scale free complex systems: Frequency of sizes follows an inverse power law.

Wall Street’s plot area scaling coefficient is similar to Paris reflecting the European origin of this part of the city (New Amsterdam) and its longer evolution. The largest plot is 2000 m².

\[ y = -0.508x + 7.9967 \]
\[ R^2 = 0.9863 \]

Source: Urban Morphology Institute
Manhattan
Madison square area

Mixed-use area
New York City
Brooklyn
Residential area

\[ y = -0.5797x + 8.4305 \]
\[ R^2 = 0.9051 \]
Hillbrow
Houghton Estate
Bramfischerville
8. Housing prices reveal unsustainability and inefficiencies in land markets
Housing prices reveal unsustainability and inefficiencies in land markets

Almost all informal shacks and over 90% of dwellings in sites and services schemes are valued at under R 20,000. What is surprising here is that over 90% of RDP houses (the public sector formal subsidized houses) are also valued at under R 20,000.

In other words, they are worth less than what it cost to build them.

This is probably the clearest indication of the poor choice of location for these settlements.
9. Road Classification and Access Management has created high levels of congestion
From grids to suburban trees

• The evolution of South African urban forms from the grid to the suburban tree is not an emergent process.
• It results directly from traffic engineering and has been entirely prescribed:
  – Road classification
  – Access management
The paradigm switch of modernism gave the street a purely functional role. In traditional urban planning, such as in European cities, streets used to be at the crossing of all urban activities such as living, working, businesses and human interactions. Streets were places for people. With modernist urban planning, streets became roads. They became the result of only the optimization of transportation flows.

“The street is a machine for circulation”  
Le Corbusier

Highly constrained network urbanism in Randhart
« It is not possible for a road to efficiently perform more than one function at a time. It must therefore function either as a mobility road, or as an activity / access street”

“Without Road Classification and Access Management, your citizens are doomed to continue with unsafe roads, streets congestion and frustration”

“If you are not convinced, there’s no hope for your city, town or country”

Dr John Sampson
South African Road Federation
<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Mobility</th>
<th>Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Function</td>
<td>alternate functional descriptions determining function</td>
<td>Class number</td>
<td>Distance between parallel roads (km)</td>
</tr>
<tr>
<td>Mobility</td>
<td>vehicle priority, vehicle only, long distance, through, high order, high speed, numbered, commercial, economic, strategic; route, arterial road or highway.</td>
<td>1</td>
<td>Principal arterial (freeway) exclusively</td>
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<tr>
<td>Mobility</td>
<td>vehicle priority, vehicle only, long distance, through, high order, high speed, numbered, commercial, economic, strategic; route, arterial road or highway.</td>
<td>2</td>
<td>Major arterial predominant</td>
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<tr>
<td>Mobility</td>
<td>vehicle priority, vehicle only, long distance, through, high order, high speed, numbered, commercial, economic, strategic; route, arterial road or highway.</td>
<td>3</td>
<td>Minor arterial major</td>
</tr>
<tr>
<td>Access/Activity</td>
<td>access, mixed pedestrian and vehicle traffic, short distance, low order, low speed, community, street access, turning and crossing movements are allowed, the majority of traffic has an origin or destination in the immediate area, the function of the road is to provide a safe environment for vehicles and pedestrians using access points</td>
<td>4a</td>
<td>Collector, commercial discourage</td>
</tr>
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<td>Access/Activity</td>
<td>access, mixed pedestrian and vehicle traffic, short distance, low order, low speed, community, street access, turning and crossing movements are allowed, the majority of traffic has an origin or destination in the immediate area, the function of the road is to provide a safe environment for vehicles and pedestrians using access points</td>
<td>4b</td>
<td>Collector, residential discourage</td>
</tr>
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<td>5a</td>
<td>Local street, commercial prevent</td>
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<td>6a</td>
<td>Walkway, pedestrian priority ban</td>
</tr>
<tr>
<td>Access/Activity</td>
<td>access, mixed pedestrian and vehicle traffic, short distance, low order, low speed, community, street access, turning and crossing movements are allowed, the majority of traffic has an origin or destination in the immediate area, the function of the road is to provide a safe environment for vehicles and pedestrians using access points</td>
<td>6b</td>
<td>Walkway, pedestrian only ban</td>
</tr>
</tbody>
</table>
40 years of Road Classification and Access Management later...

RACM has massively fed urban sprawl.

Because of urban sprawl, the highway system is reaching its limits with under-capacity causing traffic congestion, notably in the vicinity of major hubs.
10. Street densities are low and street patterns are disconnected and clustered, which limits walkability.
Most of the street patterns have been created recently following modernist principles.
Street network typology in Joburg
Street length per km²

Cumulated street length per km² (km/km²)

Road Classification and Access Management (RCAM)
Street network typology in Joburg
Average distance between intersection

Average distance between intersections (m)

<table>
<thead>
<tr>
<th>Period</th>
<th>Average Distance</th>
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</thead>
<tbody>
<tr>
<td>1886-1895</td>
<td>92</td>
</tr>
<tr>
<td>1896-1900</td>
<td>110</td>
</tr>
<tr>
<td>1901-1940</td>
<td>181</td>
</tr>
<tr>
<td>1941-1960</td>
<td>139</td>
</tr>
<tr>
<td>1960-1976</td>
<td>166</td>
</tr>
<tr>
<td>1977-2000</td>
<td>184</td>
</tr>
<tr>
<td>2001-2011</td>
<td>140</td>
</tr>
</tbody>
</table>

RCAM
Street network typology in Joburg
Number of intersections per km²

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Intersections per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1886-1895</td>
<td>125</td>
</tr>
<tr>
<td>1896-1900</td>
<td>59</td>
</tr>
<tr>
<td>1901-1940</td>
<td>37</td>
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<td>1941-1960</td>
<td>76</td>
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<td>1960-1976</td>
<td>29</td>
</tr>
<tr>
<td>1977-2000</td>
<td>33</td>
</tr>
<tr>
<td>2001-2011</td>
<td>39</td>
</tr>
</tbody>
</table>
Street network typology in Joburg

Entrance points per km²

Towards gating and control urbanism
Street networks have moved toward clustering, disconnection and control.

High income urban areas: Toward gating and clustering

Low income areas: Toward less and less connectivity
Increase in clustering and control in Tshwane

Maximum betweenness centrality vs. Relative clustering coefficient for Brooklyn, Irene, and Silver Lakes.
The collapse in the number of entrance points makes congestion issues worse
Number of intersections per km²

International best practice for high walkability

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Intersections per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melrose Arch</td>
<td>38</td>
</tr>
<tr>
<td>Sandton</td>
<td>13</td>
</tr>
<tr>
<td>Dayn fern estate</td>
<td>22</td>
</tr>
<tr>
<td>North Riding</td>
<td>49</td>
</tr>
<tr>
<td>Houghton estate</td>
<td>22</td>
</tr>
<tr>
<td>Maboneng</td>
<td>78</td>
</tr>
<tr>
<td>Soweto</td>
<td>50</td>
</tr>
<tr>
<td>Alexandra</td>
<td>52</td>
</tr>
<tr>
<td>Bramfishedville</td>
<td>42</td>
</tr>
<tr>
<td>Hillbrow</td>
<td>65</td>
</tr>
</tbody>
</table>
Cumulated street length per km²

<table>
<thead>
<tr>
<th>Location</th>
<th>Cumulated street length km/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melrose Arch</td>
<td>12</td>
</tr>
<tr>
<td>Sandton</td>
<td>6</td>
</tr>
<tr>
<td>Dayn fern estate</td>
<td>7</td>
</tr>
<tr>
<td>North Riding</td>
<td>10</td>
</tr>
<tr>
<td>Houghton estate</td>
<td>9</td>
</tr>
<tr>
<td>Maboneng</td>
<td>16</td>
</tr>
<tr>
<td>Soweto</td>
<td>16</td>
</tr>
<tr>
<td>Alexandra</td>
<td>14</td>
</tr>
<tr>
<td>Bramfisherville</td>
<td>13</td>
</tr>
<tr>
<td>Hillbrow</td>
<td>16</td>
</tr>
</tbody>
</table>
Average distance between intersections

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melrose Arch</td>
<td>202</td>
</tr>
<tr>
<td>Sandton</td>
<td>203</td>
</tr>
<tr>
<td>Dayn fern estate</td>
<td>144</td>
</tr>
<tr>
<td>North Riding</td>
<td>158</td>
</tr>
<tr>
<td>Houghton estate</td>
<td>255</td>
</tr>
<tr>
<td>Maboneng</td>
<td>80</td>
</tr>
<tr>
<td>Soweto</td>
<td>205</td>
</tr>
<tr>
<td>Alexandra</td>
<td>200</td>
</tr>
<tr>
<td>Bramfisherville</td>
<td>183</td>
</tr>
<tr>
<td>Hillbrow</td>
<td>115</td>
</tr>
</tbody>
</table>

International best practice for high walkability

Distance between intersections (m)
RECENT DENSIFICATION PATTERNS
DO NOT MAKE URBAN FORMS MORE INCLUSIVE, RESILIENT AND EFFICIENT

4 patterns of densification in Joburg

Hillbrow
Bramfischerville
Northriding
Houghton
4 districts with recent densification patterns

Hillbrow
Bramfischerville
Houghton Estate
Northriding
Equivalent urban areas for 5000 inhabitants
Hillbrow
Densification in the city center
Through over occupancy

The urban fabric remains the same, but the floor area per inhabitant drops.
Bramfischerville
Bramfischerville
Backyarding densification
(shacks)

From an extremely low FAR (0.14) to a very low FAR (0.3)
Houghton Estate
Densification in residential districts
Plot subdivision under market pressure

Densification through subdivision of plots in Houghton Estate
Northriding
Densification patterns in Northern residential areas

Densification within the gates

Example of a new development
Northriding, March 2014

2007: Fast urbanization

2013
First urban amenities: schools, shops and areas with economic activity
The 5 “P’s” of Transit Orientation

- people
- physical form
- performance
- places
- ped/bike connectivity
TOD compact urban forms are dense, accessible, mixed use and adaptive

**Articulated density**
- Residential density matches with job density
- Human density matches with transit infrastructure capacity
- High gross built density
- High density of amenities

**Accessibility and proximity**
- Each part of the city is easily accessible
- Easy access to public transit infrastructures
- Seamlessly interconnected transit infrastructures
- Daily amenities accessible by foot (shops, health, education, culture, sport)
- Intense street network (high number of intersections per km²)

**Mixed use and adaptive**
- Jobs, housing and retail are mixed on the city, district, community and building scale
- Land use is highly flexible
Opportunities of Corridors of Freedom

• Integrate local and regional planning
• Build transit systems that maximize development potential
• Strategize about ways to encourage the development of high performing communities around transit stations
• Generate new tools for economic development, real estate and investment issues
• Improve affordability and livability for all members of the community
• Respond to imperatives for climate change and sustainability
Thank you for your attention