Harnessing the Power of Alternative Transport Data: Data-Driven Case Studies in the MENA Region

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SETS Group is a network of professional services firms dedicated to planning, designing, engineering, advisory services, and facility management.
Mindsets is the strategy consulting arm of SETS Group. We work with decision makers to create value, uncover opportunities, manage risk, and make sound strategic decisions.

**STRATEGY & DECISION ANALYSIS**
- Strategic Management
- Investment Analysis
- Risk Analysis
- Data to Decision
- Business & Digital Transformation

**Data to Decision**
- Business Data Mining
- Blockchain Advisory
- Artificial Intelligence Systems
- Business Intelligence

**Investment Analysis**
- Due Diligence
- Valuation
- Mergers & Acquisitions
- Divestitures

**Strategic Management**
- Strategy Development
- Strategic Plan
- Business Plan
- Operating Model
- Strategy Implementation
- Portfolio Prioritization

**Risk Analysis**
- Cost Risk Analysis
- Schedule Risk Analysis
- Risk Assessment
- Integrated Risk Management
- Tailored Analytical Services

**Business & Digital Transformation**
- People & Organization
- Operational Excellence
- Digital Transformation
- Change Management

* PPP CoE: Public Private Partnerships Center of Excellence
SMART Ring Road
Bustiest Urban Highway in the Middle East and North Africa region.

Roughly 110 km of paved road encircling 450 km² of Cairo, with an average width of 45 meters, and a total of 156 structures.
Cairo’s Ring Road  [Context Matters when it comes to reporting and collection of data….]

Informal Transit Hubs
Informal Waiting Areas
Direct Staircases into the Highway
Residential Areas within ROW
Direct Staircases into the Highway
Designated Microbus Stops
Formal Shaded Bus Stop

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Cairo’s Ring Road [Mapping Transport and Landuse Activities and Population Density]

Mapping all transport activities [driving, pedestrians, public transit, direct access, bridges, parking areas, waiting areas], landuse and population density.

Segmenting Ring Road into sections for further analysis and indicators reporting.
## Towards a SMART Ring Road [Safety, Mobility, Accessibility, and Reliability of Transport]

<table>
<thead>
<tr>
<th>Domain</th>
<th>Local Indicators</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY (S)</td>
<td></td>
<td>Total number of reported accidents in 2016-2017 normalized by length of segment.</td>
</tr>
<tr>
<td>Presence of Pedestrian Access Points (PAP)</td>
<td></td>
<td>Total number of observed PAP normalized by length of segment.</td>
</tr>
<tr>
<td>Average Speed</td>
<td></td>
<td>Average speed was measured from travel time data for three peaks: AM peak, Midday and PM peak: 7-10 am, 12-3 pm and 4-7 pm respectively.</td>
</tr>
<tr>
<td>Presence of Informal Waiting Areas/Stops (IWA)</td>
<td></td>
<td>Total number of observed IWA normalized by length of segment.</td>
</tr>
<tr>
<td>Presence of Built Stops (BS)</td>
<td></td>
<td>Total number of observed BS normalized by length of segment and land-use.</td>
</tr>
<tr>
<td>Presence of Large Stops/Informal Parking (LISP)</td>
<td></td>
<td>Total number of observed LISP normalized by length of segment and land-use.</td>
</tr>
<tr>
<td>Presence of Transit Hubs (TH)</td>
<td></td>
<td>Total number of observed TH normalized by length of segment and land-use. The presence of transit hubs along the road adds to a more “accessible” option for public transit users.</td>
</tr>
<tr>
<td>Mobility (M)</td>
<td></td>
<td>Average Speed was measured from travel time data for three peaks: AM peak, Midday and PM peak: 7-10 am, 12-3 pm and 4-7 pm respectively.</td>
</tr>
<tr>
<td>Presence of Built Stops (BS)</td>
<td></td>
<td>Total number of observed BS normalized by length of segment.</td>
</tr>
<tr>
<td>Presence of Informal Waiting Areas/Stops (IWA)</td>
<td></td>
<td>Total number of observed IWA normalized by length of segment.</td>
</tr>
<tr>
<td>Accessibility (A)</td>
<td></td>
<td>Presence of Informal Waiting Areas/Stops (IWA) Total number of observed IWA normalized by length of segment and land-use.</td>
</tr>
<tr>
<td>Presence of Built Stops (BS)</td>
<td></td>
<td>Total number of observed BS normalized by length of segment.</td>
</tr>
<tr>
<td>Presence of Informal Waiting Areas/Stops (IWA)</td>
<td></td>
<td>Total number of observed IWA normalized by length of segment and land-use.</td>
</tr>
<tr>
<td>Reliability of Transport (RT)</td>
<td></td>
<td>Average Travel Time Reliability (Buffer Time Index*) According to US FHWA (Federal Highway Administration), buffer time index represents the percentage of extra buffer time (or time cushion) that most travelers add to their average travel time when planning trips to ensure on-time arrival. The higher the Buffer time index the more unreliable the roadway segment is.</td>
</tr>
</tbody>
</table>

### Conceptual Model

**Dimensions:**
- Safety
- Mobility
- Accessibility
- Reliability of Transport

**Index:**
- 0-2
- 2-4
- 4-6
- 6-8
- 8-10

**Concept:**
 Sustainable Urban Mobility in Cairo
1 SMART Ring Road

2 Beirut Transport Improvement Plan
To identify hot spot locations on the study area and formulate mitigation measures that are differentiated by the following intervention features:

- **Cost**
- **Scope**
- **Timeline**

The measures are then packaged into three intervention schemes:

1. **Quick Wins**
2. **Medium Interventions**
3. **Major Interventions**
Beirut Transport Improvement Plan [Hot Spots Identification and Immediate Interventions Schemes]
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1 SMART Ring Road
2 Beirut Transport Improvement Plan
3 Power of Transport Network Companies Data
Transportation Network Companies – Ride Hailing Companies…

City Planning and Traffic Operations

Ride-Hailing Wealth of Data across Multiple Cities

Data Science and Machine Learning

Careem

Cairo Data Sharing Strategy

As part of its vision to simplify and improve the lives of people, build an awesome organization that inspires and continuing our support for governments in urban planning and public policy, Careem is proud to partner with SETs on the Cairo Data sharing project.

This project is under Careem’s Data sharing strategy which was developed in 2018 and aims to build on Careem’s ongoing efforts of uplifting communities, supporting infrastructures, and solving local problems.

With this data sharing strategy, Careem plans to lead by example as the Arab world’s most valuable startup, operating in more than 15 countries, with 9 billion rides taken with Careem to date and 100 billion projected by 2030. We have come to understand the value and the quality of the data collected from our trips and our responsibilities in a region where data is scarce and inaccurate.

As populations in cities grow, the need for understanding their movement patterns in order to better plan and accommodate more people in transit becomes critical. Careem can now provide unparalleled data sets and data science to enhance governments to support critical short to long term transportation planning and policy decisions. Harnessing the power of our aggregated historical data that illustrates the movement patterns of people will make cities smarter, will improve the welfare of citizens and will make it more attractive for tourists to visit.

We have chosen SETs as our first partner in our data sharing efforts, due to their history of excellence and exemplary work in the data science, analysis and urban mobility in Egypt and beyond.

Careem has taken on the costs and efforts of extracting, anonymizing and aggregating the data insuring the protection and privacy of our customers while enabling the urban planning and policy environments.

We aim to take data sharing to the next level. The main reason for awarding SET's the access to our data is their proposal to include capacity building for Egyptian urban planners and government officials as part of the project. This fits in with Careem’s data sharing mission to not just provide the data, but also ensure governments and partners are able to use it to inform policy and planning decisions.
Harnessing the Power of Transport Network Companies Data
Harnessing the Power of Transport Network Companies Data

**Congestion Patterns / Times**

**Distance Patterns – Short Trips**

**Fare / Distance Variations**

**Inter-City Patterns and Matrices**

**Intra-City Patterns and Matrices**

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Harnessing the Power of Transport Network Companies Data

- Trips used the Ring Road – How Vital?
- Cairo OD Flows – How Vibrant?
Roadway Automatic Safety Features Detection – “environment” perspective

Traffic Signs  Marking  Curbs  Barriers  Buildings  Trees  Billboards  Fence
Pedestrians  Cars  Buses  Public Transportation  Motorcycles  Heavy Vehicles  Light Poles
Roadway Automatic Safety Features Detection – Mapping Roadway Classes

Data Collection (Image/100m) → Detect Critical Road Features → Feature Annotation

Model Training → Model Testing & Validation

Developing Road Features Detector → Determine KPI's → Developing Roads Safety Indicator

[Map showing Cairo and Alex Road with distances and road categories.]

<table>
<thead>
<tr>
<th>Roadway Classes</th>
<th>KMs Traveled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Highways</td>
<td>176</td>
</tr>
<tr>
<td>Regional Primary Highways</td>
<td>62.3</td>
</tr>
<tr>
<td>Primary Arterials</td>
<td>74.2</td>
</tr>
<tr>
<td>Secondary Arterials</td>
<td>21.5</td>
</tr>
<tr>
<td>Primary Collectors</td>
<td>29</td>
</tr>
<tr>
<td>Local Roads</td>
<td>8.4</td>
</tr>
<tr>
<td>Total</td>
<td>371.4</td>
</tr>
</tbody>
</table>
### Pedestrians and Vehicles
- Pedestrians
- Cars
- Buses
- Public Transportation
- Motorcycles
- Heavy Vehicles
- Tricycle
- ADV
- Tuk Tuk

### Road Features
- Traffic Sign
- Marking
- Curbs
- Barriers
- Light Poles
1. SMART Ring Road
2. Beirut Transport Improvement Plan
3. Power of Transport Network Companies Data
4. Roadway Automatic Safety Features Detection
5. Mapping Cities Air Quality
One effective way to improve public health in response to these unsustainable traffic-related pollutants is to better understand the spatial variability of these pollutants.

...in relation to traffic, land-use, the built environment, and other related factors (e.g. metrology) in order to develop innovative policies and guidelines able to reduce the impact of traffic-related air pollution on health. Therefore, data on air pollution, air quality, and traffic/human activities are needed.

New generation of small, portable, cheap air sensors could revolutionize pollution measurements for citizen scientists and governments alike.
Greater Cairo in the largest metropolis in the region with over 23 M people in area of ~ 1700 Km2

Over 3.5 Million Vehicles, 36,000 km of Paved Roads
Over 20 Million Daily Motorized Person Trips

Over 23 Million People
Area of 1,709 km²

51% Urban Landuse
(Mixed - Mostly Residential)
Mobile Monitoring of Black Carbon Levels and Development of Exposure Surfaces Reflecting Traffic-Related Air Pollution: The Case of Cairo

BC is the most strongly light-absorbing component of particulate matter (PM). BC is emitted directly into the atmosphere in the form of fine particles (PM2.5). (BC) pollution is associated with traffic emissions.

- May – August 2017
- 12 Routes (Length 526 KM)
- 6 to 9 Rounds/Route
- Total VKT 3,300 KM
- Total Hours 150 Hr
- 7:00 am – 7:00 pm
Mobile Monitoring of Black Carbon Levels and Development of Exposure Surfaces Reflecting Traffic-Related Air Pollution: The Case of Cairo

- 6 Variables Families
- 8 Buffers (25, 50, 100, 200, 300, 500, 750, to 1000 m)

**Land Use Regression Model**

<table>
<thead>
<tr>
<th>Variables Families</th>
<th>Description</th>
<th>Estimation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use</td>
<td>Land Use ([1 to 19]) area normalized by buffer ([j area].</td>
<td>$L_{ij} = \frac{\text{Land Use}<em>{ij}}{\text{Buffer Area}</em>{ij}}$</td>
</tr>
<tr>
<td>Road/Rail Length</td>
<td>Length of road per road class ([1 to 7]) normalized by buffer ([j area].</td>
<td>$R_{ij} = \frac{\text{Road/Rail Length}<em>{ij}}{\text{Buffer Area}</em>{ij}}$</td>
</tr>
<tr>
<td>Distance-to</td>
<td>Distance from segment centroid to: Airport, Nile, Public Transport hubs, Rail, Arterials and Highway</td>
<td>Euclidean distance</td>
</tr>
<tr>
<td>Population</td>
<td>Weighted average pop. density for different zones ([1 to 44]) within buffer ([j].</td>
<td>$P_{ij} = \frac{\sum \text{PopCount} \times \text{Zone Area}<em>{ij}}{\text{Buffer Area}</em>{ij}}$</td>
</tr>
<tr>
<td>Heavy Trucks</td>
<td>Dummy variable representing heavy trucks presence.</td>
<td>$0$ (no Heavy Trucks), $1$ otherwise</td>
</tr>
<tr>
<td>Traffic</td>
<td>Traffic Congestion Index based on image processing of Google Traffic-color coded maps; color ([j), buffer ([j].</td>
<td>$T_{ij} = \frac{\sum \text{Congestion Index}<em>{ij} \times \text{Color Factor}</em>{ij}}{\text{Buffer Area}_{ij}}$</td>
</tr>
</tbody>
</table>

**Predict Black Carbon on each City Cell**

- Generation of Cell Size (50 x 50 m) and Buffer
- Example of Cell Mapping along Tahrir Square
Mobile Monitoring of Black Carbon Levels and Development of Exposure Surfaces Reflecting Traffic-Related Air Pollution: The Case of Cairo

- Average modeled BC in Cairo is $14 \mu g/m^3$
- Average modeled BC in Downtown Cairo is $16 \mu g/m^3$
- BC values exceeds $50 \mu g/m^3$ in some areas.
developed the first Open Data Platform in the MENA Region with the goal of advancing the concept of open data, data sharing, data standards to act as a Knowledge Platform.