A new method of network design for urban distribution: The case of gasoline distribution.

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Presentation Overview

- Background
- Objective
- Approach and Contribution
- Methodology
- Sample Description
- Results
- Conclusions
Due to competition, organizations constantly are looking to develop new and better ways of delivering their products to their clients.

The opening of the hydrocarbon industry represents an important opportunity to emerging or global companies to enter local markets, and a huge challenge for those already established.

In the oil/hydrocarbon industry the products of the competing companies are extremely similar, so companies compete by finding, extracting, producing and/or distributing petroleum and its derivatives in a more efficient way than their competitors.
Objective

To propose a new method of designing networks, applied to the analysis of hydrocarbon distribution.
The method uses techniques of outliers filtering, and traditional methods combined into a single heuristic.

One of the main contributions of this study is the fact that the method has the ability to group client nodes based on their “reachability”, which is a local density measure derived from outliers’ detection.

“Reachability” is calculated based on vehicle autonomy.

The new method determines simultaneously the capacity and location of the distribution hubs (e.g. depots) based on demand and client’s location.

The new method distinguishes between non-efficient visits (i.e., based on cost), and efficient visits.
Methodology

Three scenarios to compare the performance of the new method:

1. Actual

2. Center of Gravity

3. New Method
Methodology

We define:
- \( K \): Client nodes set to be evaluated
- \( D_0 \): Distance set in the generated group
- \( R_0 \): Client nodes set to visit in the generated group
- \( \mathcal{R} \): Generated group set
- \{()\}: Empty set
- \( d_{j,i} \): Transit distance in meters from client node \( j \) to client node \( i \), (or from origin when \( j=0 \) to client \( i \), or from last visited client node to the origin when \( i=0 \))
- \( k \): Maximum values of indexes \( j \) and \( i \) in the set
- \( i \): Index of client nodes as destination \( \in I \)
- \( j \): Index of client nodes as origin \( \in J \)
- \( I \): \( 0,1,2,...k \)
- \( J \): \( 0,1,2,...k \)

**Step 0 Initialisation**
1. Set \( K = \{(1,2,3...k)\} \)
2. Set \( K' = K \)
3. Set \( j = 0 \)
4. Set \( D_0 = \{()\} \)
5. Set \( R_0 = \{()\} \)

**Step 1 Group iterative building**

1. **Identify client nodes**
   1.1 Find nearest client node
   1.1.1 Find nearest client node
   Yes:
      - Are there any \( i \in K' \), with
      - \( d_{j,i} + d_{i,0} < \text{Threshold} \)?
      Yes:
      - Find min \( (d_{j,i}), i \in K' \)
      - Add \( d_{j,i} \) to \( D_0, i \in \text{min} (d_{j,i}) \)
      - Add \( d_{i,j} \) to \( D_0, i \in \text{min} (d_{j,i}) \)
      - Is there other \( d_{j,i} = \text{min} (d_{j,i}), i \in K' \)?
      Yes:
      - Go to 1.1.1
      No:
      - Add \( i \) to \( R_0, i \in \text{min} (d_{j,i}) \)
   No:
   - Print \( \mathcal{R} \)
   End

No:
- Print \( \mathcal{R} \)
End
Sample Description

76 Terminals

• Daily volume:
  1.2 million barrels (Total)
  15,973 barrels (Average)

• Interdistance:
  Average: 374 miles
### Annual distribution costs savings – cost-efficient distribution terminals

<table>
<thead>
<tr>
<th></th>
<th>Center of Gravity</th>
<th>New Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual distribution costs savings (USD millions)</strong></td>
<td>$ 173.3</td>
<td>$ 456.2</td>
</tr>
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</table>

### Annual distribution costs savings – all terminals

<table>
<thead>
<tr>
<th></th>
<th>Center of Gravity</th>
<th>New Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual distribution costs savings (USD millions)</strong></td>
<td>$ 363.1</td>
<td>$ 863.3</td>
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</table>
Conclusions

• Focus on network designs and their impact on distribution costs (exclusively), but does not analyze the cost-benefit.
• More sophisticated algorithms could be explored to increase accuracy and saving, however the tradeoff may be the applicability of these new tools.
• “Reachability” based on vehicle autonomy, makes it more realistic for application purposes.
• Simple method and thus, facilitate implementation
Thank you

Questions?

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