Texas A&M Transportation Institute

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
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Background

- 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

Photos source: TTI Photo Library

Objective

To propose a new method of designing networks, applied to the analysis of hydrocarbon distribution.

Approach and Contribution

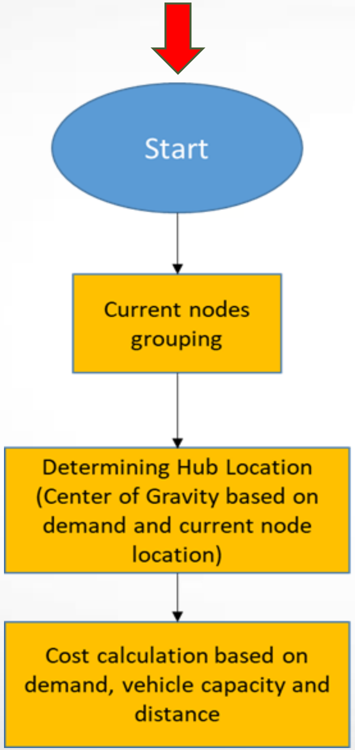
- The method uses techniques of outliers filtering, and traditional methods combined into a single heuristic.
- One of the main contributions of this study is the fact that the method has the ability to group client nodes based on their “reachability”, which is a local density measure derived from outliers’ 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 costt), and efficient visits.

Methodology

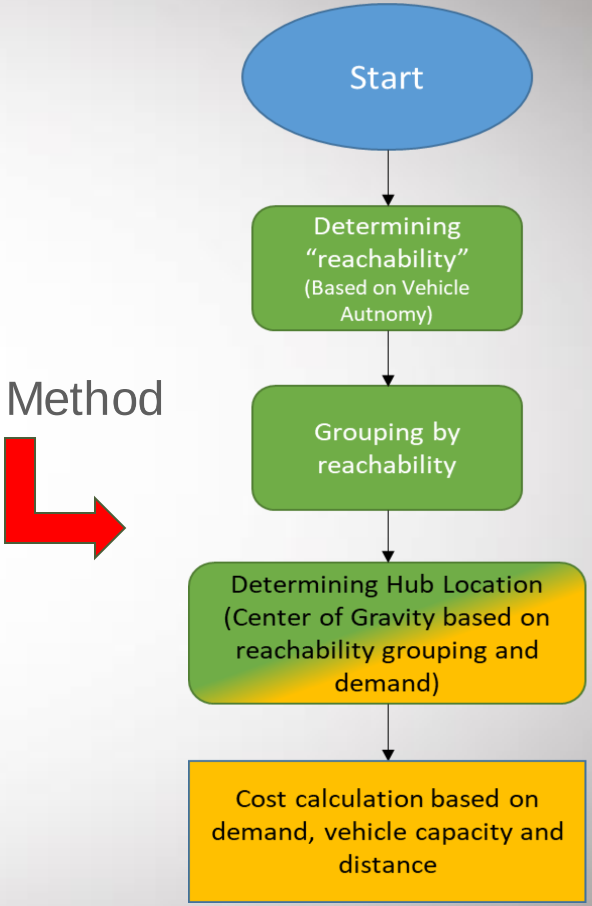
Three scenarios to compare the performance of the new method:

1. Actual

2. Center of Gravity



3. New Method



Methodology

Algorithm´s "reachability" grouping decision

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
$\Re$: 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 indixes 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
- *0.1 Set K = {(1,2,3…k)}*
- *0.2 Set K´ = K*
- *0.3 Set j = 0*
- *0.4 Set D_0 = {()}*
- *0.5 Set R_0 = {()}*

Step 1 *Group iterative building*
- ***1.1*** *Identify client nodes*
  Is K´ ≠ {()}?
  - ***1.1.1*** *Find nearest client node*
    Yes:
    - *Are there any $i \in K´$, with $d_{j,i} + d_{i,0} <$ Threshold?*
      Yes:
      - *Find min ($d_{j,i}$), $i \in K´$*
        Add $d_{j,i}$ to D_0, $i \in$ min ($d_{j,i}$)
        Add $d_{i,j}$ to D_0, $i \in$ min ($d_{j,i}$)
        Is there other $d_{j,i}$ = min ($d_{j,i}$), $i \in K´$?
        Yes:
        - *Go to 1.1.1*
        No:
        - *Add i to R_0, $i \in$ min ($d_{j,i}$)*
      No:
      - *Print $\Re$*
        End
    No:
    - *Print $\Re$*
      End

Sample Description

76 Terminals

- Daily volume:
  - 1.2 million barrels (Total)
  - 15,973 barrels (Average)
- Interdistance:
  - Average: 374 miles

Results

Annual distribution costs savings – cost-efficient distribution terminals

Annual distribution costs savings (USD millions)	
Center of Gravity	New Method
$ 173.3	$ 456.2

Annual distribution costs savings – all terminals

Annual distribution costs savings (USD millions)	
Center of Gravity	New Method
$ 363.1	$ 863.3

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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