On the Effective Width for District Heating Systems

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Halmstad University
Luis Sánchez-García
Helge Averfalk
Urban Persson
Sven Werner

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Overview

- Introduction
- Research questions
- Data
- Methodology
- Results
- Discussion
Introduction

➢ Model developed by Werner and Persson:

Specific Distribution Cost \( \propto \frac{Trench Length \cdot Average diameter}{Heat Demand} \)

➢ How to measure the pipe length → Effective width concept, \( w \)

\[
w = \frac{Land \ area}{Trench \ length} \rightarrow m^2_{ground} / m_{trench}
\]
Introduction

In previous studies:
- Effective Width dependent on Plot Ratio
- In dense areas, \( w \rightarrow 50 \text{ m} \)
- Sparse areas are mostly unknown.
- Definition of land area has not been systematic.
- Only Distribution Pipes were studied
Research questions

- What is the behaviour of effective width in sparse areas?
- What is the behaviour of effective width for both Distribution and Service pipes?
- Is the plot ratio the best independent variable?

![Graph showing effective width and plot ratio](image-url)

Effective Width according to Persson & Werner, 2010

\[ y = 61.838x^{-0.149} \]
Data

- District Heating Network of Fjernvarme Fyn (Denmark)
- 2,264 km of trench length.
- District Heating Network of Aarhus (Denmark)
- More than 2,100 km of trench length.
- Danish Cadastre (BBR) for floor areas.
Methodology

1. 1-ha-cell grid.
2. Pipe length (Distribution and Service).
3. Effective Width
4. Floor area and Number of Buildings

Method for determining the pipe length in a given cell
Methodology

Method for determining the Number of Buildings and Floor area in the cell

A

B

- Building located partially in the cell but whose address is located out of the cell
- Buildings located outside the cell, but whose area is allocated partially to the cell

One Square
- Intersecting Land Lot within cell under analysis
- Intersecting Land Lots with cell under analysis

Total Land Lot area: 5 082 m²
- Land Lot area within cell: 2 077 m².
- Fraction of land lot within cell: 0.41

Floor area in Land Lot: 2 000 m².
- Number of Buildings in Land Lot: 3

Floor area from Land Lot within cell: 0.41·2000 m² = 820 m²
- Number of buildings within cell: 3·0.41 = 1.23
Results
Which cell size is the best?

Cell Size of 1 ha

Cell Size of 100 ha
Results

Effective Width for a cell size of 16 ha.
Results

Effective Width for a cell size of 16 ha.
Key takeaways and Discussion

Key results:

- Confirmation of previous model for Distribution pipes.
- New model for **Service** pipes.
- High possibility of lower bound for effective width in high density areas.
- Number of buildings is a better estimator than plot ratio.
- Very small cells lead to poor regressions.
Key takeaways and Discussion

Some problems still remain:

– High variability of effective width for the same value of the independent variable → The estimation of costs will not be very accurate.

– Residuals are highly skewed when using the plot ratio.

– Implicit Assumption: 100% penetration in areas with pipes

– Survival bias?
THANK YOU