Exploring Commercial Redevelopment of Detroit Brownfields: Testing an Integrated GIS and Agent-Based Modeling Method

GEO 869 Geo Simulation

Qi Wang *
Jinwon Kim **
John Spielberg ***

Master’s Degree Student, Dept. of Construction Mgt *
Ph. D. Student, Dept. of CARRS **
Master’s Degree Student, Dept of CARRS ***
My GIS map is not bad. It’s Great!!

Do you know that this is modeling class?

My data and idea might be essential.
1. Introduction

1.1 Brownfield Redevelopment for Urban Regeneration

• Great attention of brownfield redevelopment for urban regeneration (De, 2000; Thomas, 2002; Lange & McNeil, 2004; Spielberg et al., 2008)

• Brownfield properties: abandoned, idled and potentially contaminated real property (U.S. Congress, 2002; USEPA, 2002)
1. Introduction

1.2 Importance of Brownfield Redevelopment

• The Importance of brownfield Redevelopment in local community

✓ Environmental benefits: Lange & McNeil, 2004
✓ Economic benefits: Walker, 2008; Chen et al., 2009
✓ Social benefits: Thomas, 2002
1. Introduction

1.3. Difficulties of Decision Making in Brownfield Redevelopment

• A wide range of risks that can decrease developers’ attention

• Lack of the specific research methods to support developers’ decision making in brownfield redevelopment

What is the method?
1. Introduction

1.4 Research Purpose and Specific Objectivities

**Testing Commercial Redevelopment of Brownfield**

- 1) Analyzing the influences of four factors that affect the location of brownfield for commercial purposes
- 2) Finding investment and duration per each brownfield
- 3) Calculating revenue and Return of Investment (ROI) period per each brownfield
- 4) Identifying and ranking the best candidate brownfield for commercial purposes

*Research Objectives*
1. Introduction

Brownfields in Downtown, Detroit
2. Methodology

2.1 Conceptual Model

Diagram showing relationships between various entities:
- **Developer**
  - Investment;
  - Potential Customers;
  - Time for Investment Return;
- **Resident**
  - Attractiveness to Commercial Center;
  - Monthly Expense;
  - Distance to Commercial Center;
- **Brownfield**
  - Investment;
  - Area;
  - Value;
  - Distance to Highway;
  - Distance to Park;
- **Commercial Center**
  - Value;
  - Distance to Highway;
  - Distance to Park;

The diagram illustrates the decision-making process involving Attraction and Competition between entities.
2. Methodology

2.2 Decision-Making Process

Start
Assume Select Brownfield (Bi) → Find Investment and Duration → Find Revenue and ROI → Find Best Brownfield

End

Developer

Redevelopment

Add Resident as Customer

Yes

Brownfield

Residents Evaluation

Choose Bi

Value, Distance, Transportation Convenience, etc.

Resident
2. Methodology

2.3. Decision-Making Rules

• Developers’ decision making
  ✓ Developers’ Decision-Making = \( f(\text{investment}, \text{number of customers}, \text{ROI period}) \)

• Resident decision making

\[ \text{Attractiveness to } B_i = \frac{(\alpha \times \text{value})}{(\beta \times rstdToMall) \times (\gamma \times \text{disToHighway}) \times (\delta \times \text{disToPark})} \]

Rules

1. You can....
2. You can’t....
3. You can....
4. You can’t
### 2.4 Sensitivity Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>1</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>disToHighway</td>
<td>0.1</td>
<td>2.0</td>
<td>0.1</td>
</tr>
<tr>
<td>disToPark</td>
<td>0.1</td>
<td>2.0</td>
<td>0.1</td>
</tr>
<tr>
<td>rsdtToMall</td>
<td>1</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>
3. Results

3.1 Simulation Result (Cont.)

Larger circle represents more potential customers
### 3. Results

#### 3.1 Simulation Result

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Customers Attracted by Brownfields</th>
<th>Time of Return of Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influence of Investment Capital (value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Influence of Resident to the Brownfield (rsdtToMall)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>Value</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Value</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Value</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Value</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The graphs show the trend over time for both the number of customers attracted by brownfields and the time of return of investment.
3. Results

3.1 Simulation Result

<table>
<thead>
<tr>
<th>Influence of Brownfield to Highway (disToHighway)</th>
<th>Customers Attracted by Brownfields</th>
<th>Time of Return of Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Influence of Brownfield to Park (disToPark)</th>
<th>Customers Attracted by Brownfields</th>
<th>Time of Return of Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
3. Result

3.2 Ranking of Brownfield based on Investment, Customers, and ROI

- For brownfields redevelopment, different factors will have different impacts.
- Based on different performance indicators, the ranking of the brownfields are different.

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Investment</th>
<th>Customers</th>
<th>ROI Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brownfield 9</td>
<td>Brownfield 17</td>
<td>Brownfield 17</td>
</tr>
<tr>
<td>2</td>
<td>Brownfield 2</td>
<td>Brownfield 1</td>
<td>Brownfield 16</td>
</tr>
<tr>
<td>3</td>
<td>Brownfield 16</td>
<td>Brownfield 10</td>
<td>Brownfield 1</td>
</tr>
<tr>
<td>4</td>
<td>Brownfield 10</td>
<td>Brownfield 16</td>
<td>Brownfield 3</td>
</tr>
<tr>
<td>5</td>
<td>Brownfield 1</td>
<td>Brownfield 9</td>
<td>Brownfield 10</td>
</tr>
<tr>
<td>6</td>
<td>Brownfield 3</td>
<td>Brownfield 3</td>
<td>Brownfield 2</td>
</tr>
<tr>
<td>7</td>
<td>Brownfield 17</td>
<td>Brownfield 2</td>
<td>Brownfield 9</td>
</tr>
</tbody>
</table>
### 3. Result

#### 3.3 Ranking of Brownfield based on potential competitors

For the developer, brownfield redevelopment needs to consider potential competitors.

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Investment</th>
<th>Customers</th>
<th>ROI Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B 15: $1.39 million</td>
<td>B 17: 2992</td>
<td>B 14: 0.131</td>
</tr>
<tr>
<td>2</td>
<td>B 14: $1.92 million</td>
<td>B 14: 2837</td>
<td>B 15: 0.187</td>
</tr>
<tr>
<td>3</td>
<td>B 17: $2.93 million</td>
<td>B 15: 1423</td>
<td>B 17: 0.188</td>
</tr>
</tbody>
</table>
4.1 Some Implications and Discussions through this research

- This geo-simulation modeling as powerful spatial decision supporting system for developers’ decision making in brownfield redevelopment

Some implications through this research

- The power of information
- The role of local government (How to share the information to a number of stakeholders)
4. Conclusion

4.2 Limitations

- Lack of consideration for more diverse factors and attributes
- Lack of consideration for residences in Canada (Windsor area)
- Limited scenario (only considering commercial purposes)
4. Conclusion

4.3 Future Studies

- The current model should be further verified, validated and tested

- Application of this spatial modeling for other urban areas

- Application of this spatial modeling with more local and state brownfield redevelopment programs

- Revise the model for other redevelopment end uses such as recreational, mixed use, interim uses, or alternative energy production
Q & A
SESSION