Integrating Geographic Information System and Building Information Model for Real Estate Valuation

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Introduction

• The accuracy of valuation
  – the data
  – the professionality of qualified appraisers
  – the technology and tools

• GIS for real estate valuation
  – spatial data management
  – knowledge information management
  – efficient tools for spatial related analysis
  – 3D environment visualization
Introduction

• The deficiency of GIS for real estate valuation
  – not support modeling components inside of buildings

• Building Information Model (BIM)
  – an engineering data model based on the 3D digital technology and integrated of all relevant information of construction projects
  – support scheduling, cost estimation, and optimize facility management and maintenance
  – BIM for quantity take-off (cost approach)
  – BIM for green building analyses
Solution

- Integrating GIS and BIM for real estate valuation
- Real Estate Valuation System Based on BIM
  - system architecture
  - data transmission
- Sales Comparison Approach Improvement
  - BIM based analyses
Real Estate Valuation System Based on BIM

• Four layer System architecture
  • Data layer
    – valuation essential data, spatial data, valuation thematic data
  • Engine layer
    – ArcGIS Server, Terra Gate, Lucene
  • Supporting layer
    – 3D data model, 3D visualization, valuation model, green building analysis (BIM)
  • Application layer
    – software interface, system management and analysis functions
Real Estate Valuation System Based on BIM

• Data transmission
  – GIS for valuation system & BIM
  – physically independent, logically connected
  – shows in:
    • BIM model exchange
    • BIM related analyses request
    • analysis results push and extract
Sales Comparison Approach Improvement

• The 3D GIS valuation model

- Property sales data set
- Subject property

Buffer analysis

Parallel analysis

Comparing sales number $n$: $5 < n \leq 10$

Direct comparable sales set

Expanding search area

No

Add self-defined sales records

No

Yes
Sales Comparison Approach Improvement

• The 3D GIS valuation model

  Direct comparable sales set
  Impact factors determination
  Quantitative table formulation
  Impact factors analysis
  Performance matrix formulation
  Similarity calculation
  Comparable sales determination
  Sales comparison value
  Subject property value

• Refer to:
Sales Comparison Approach Improvement

• The 3D GIS valuation model
  – Impact factors determination

Regional factors:
- Regional planning
- Regional prosperity
- Transportation convenience
- Landscape
- Environmental condition
- Fundamental infrastructure
- Public facility conditions

Individual factors:
- Plot ratio
- Project scale
- Ages
- Related service facility
- Rest land use term
- Decoration
- Micro-environment
Sales Comparison Approach Improvement

• The 3D GIS valuation model
  – Quantitative table formulation based on BIM
  • generated according to the national standard or code

Daylight Quantitative Classification Table

<table>
<thead>
<tr>
<th>Classification grade</th>
<th>Description (average value of daylight factor $c$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$c &lt; 1%$</td>
</tr>
<tr>
<td>1</td>
<td>$1% \leq c &lt; 2%$</td>
</tr>
<tr>
<td>2</td>
<td>$2% \leq c &lt; 3%$</td>
</tr>
<tr>
<td>3</td>
<td>$3% \leq c &lt; 4%$</td>
</tr>
<tr>
<td>4</td>
<td>$c \geq 4%$</td>
</tr>
</tbody>
</table>
**Sales Comparison Approach Improvement**

- The 3D GIS valuation model
  - Impact factors analysis

<table>
<thead>
<tr>
<th>Regional factors</th>
<th>Impact factors</th>
<th>Descriptions</th>
<th>Analysis methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Regional planning</td>
<td>Urban master planning &amp; detailed planning etc.</td>
<td>Spatial query, spatial overlay</td>
</tr>
<tr>
<td></td>
<td>Regional prosperity</td>
<td>Distance to multilevel business area</td>
<td>Spatial measurement, network analysis</td>
</tr>
<tr>
<td></td>
<td>Transportation convenience</td>
<td>The number and distance of public transportation facilities (e.g. bus stop, subway stations, etc.) and road network service capabilities</td>
<td>Spatial measurement, network analysis, road network accessibility analysis, spatial statistics</td>
</tr>
<tr>
<td></td>
<td>Landscape</td>
<td>The view of quality and distance to ocean, lake, mountain, green, forest park or golf course etc.</td>
<td>Visibility analysis, spatial measurement, spatial statistics</td>
</tr>
<tr>
<td></td>
<td>Environmental condition</td>
<td>The air condition, noise, pollution, waste yard, incineration plant, power station, high-voltage power lines, etc. and the sunshine time</td>
<td>Spatial query, noise propagation analysis, pollutants diffusion analysis, visibility analysis, spatial statistics, BIM sunlight duration analysis, BIM community ventilation analysis</td>
</tr>
<tr>
<td></td>
<td>Fundamental infrastructure</td>
<td>The surrounded fundamental infrastructure, such as, water, electricity, gas, communications, cable, internet, wireless local area network, etc.</td>
<td>Spatial query, spatial statistics</td>
</tr>
<tr>
<td></td>
<td>Public facility conditions</td>
<td>The distance to public facilities such as school, park, sport center, hospital, bank, ATM, supermarket, shopping mall, convenience store, theatre, etc.</td>
<td>Spatial query, spatial statistics</td>
</tr>
</tbody>
</table>
Sales Comparison Approach Improvement

• The 3D GIS valuation model
  – Impact factors analysis
    • Individual factors:
      – for micro-environment: BIM indoor daylight analysis and BIM indoor ventilation analysis
Sales Comparison Approach Improvement

- **The 3D GIS valuation model**
  - **Impact factors analysis**
    - BIM sunlight duration analysis: to simulate the sun movement and result in a grid with sunlight hours on the surface of buildings.
    - BIM indoor/outdoor ventilation analysis: based on CFD analysis model, and 3D community building models to simulate the indoor/surrounding environment ventilation.
    - BIM indoor daylight analysis: based on detailed 3D building model and considering the different construction materials to calculate the daylight factor under different sunlight conditions.
Case study

- 3DGIS based single property valuation system (3DGIS-SPV)

BIM software supported by TH SOFTWARE

TH-BQ 2013: for bill quantity calculation of construction works
TH-VENT 2014: for indoor/outdoor ventilation analysis
TH-SUN 2014: for sunlight duration analysis
TH-DALI 2014: for daylight factor analysis
Case study

- BIM data loaded in 3DGISSSPV system
Case study

- Inside navigation of BIM building
Case study

• Detailed BIM data view in TH SWARE

Extract Data
Case study

- Detailed BIM data view in TH SOFTWARE

Valuation System
Case study

- BQ data extract in 3DGISSPV
Case study

• BIM based analysis
  – BIM sunlight duration analysis in TH-SUM 2014
  – BIM sunlight duration analysis results in 3DGISSPV
Case study

- BIM based analysis
  - BIM indoor/outdoor ventilation analysis in TH-VENT 2014
Case study

- BIM based analysis
  - BIM daylight factor analysis in TH-DALI 2014
Conclusions

- The purpose of this study is to provide a suitable way to enhance the valuation accuracy by integrating BIM and GIS.
- It is possible to integrate BIM for real estate valuation in cost approach and provide more advanced professional analyses.
- The application of 3DGISSPV system with BIM improves the working efficiency and the valuation accuracy.
Thank you!

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