Integrating Building Information Modeling (BIM) with Sustainable Universal Design Strategies to Evaluate the Costs and Benefits of Building Projects

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OVERVIEW

1. Introduction
2. Objectives
3. Literature Review
4. Methodology
5. Validation
6. Conclusion
1. INTRODUCTION

- Importance of Sustainable Design (SD)
- Nation’s Population are aging!
- Importance of Universal Design (UD)
- What is the associated cost?
To integrate BIM with SUD principles and requirements in order to evaluate the benefits and costs of adopting such type of design over buildings anticipated life.
WHAT IS BIM?

Helps Designer to Visualize

(Bryde, Broquetas, and Volm, 2013):

- Design
- Associated material
- Associated Technologies
3. LITERATURE REVIEW, Early Design Stage

The objective of the early design stage of a building project is:

- To evaluate budget and performance (König, 1995).
- Play essential role toward sustainable building (Bgenstätter and Bogensta, 2010).
- Play essential role toward universal design strategies (Afacan and Erbug, 2009).
LITERATURE REVIEW, Certificates and Standards

Green building certification systems (Wang and Fowler, 2012):
- To document progress;
- Compare buildings;
- Record design and operations outcomes.

LEED
- Silver
- Gold
- Platinum

Universal Design Standards (Dhawade and Harle, 2014):
- Support usability of products.

International Standards for Seniors:
- ANSI 1986
- BSI 1979
- Fair Housing Act Design Manual 1996

Canadian National Building Code (1965-2010)
LITERATURE REVIEW, BIM

- Researchers highlighted the need of knowledge when doing the integration between different computational tools (König, 1995).

- BIM used to convert the 2D based drawing information systems into 3D object based information systems (Arayici et al. 2009)

- Multiple efforts to integrate BIM with sustainable design (Zhang and Xiao, 2013)

This research proposes a methodology to integrate BIM with SUD
4. METHODOLOGY, Approach

Data Collection -> Data Analysis and comparison -> Selection of best material and technology based on data analysis -> Apply in the proposed 3D model -> Life Cycle Cost Analysis -> Validation

Yes branch:

No branch:
METHODOLOGY, Model Components
METHODOLOGY, Model Architecture

**Input**
- Building Type
- Orientation
- Number of Floors
- SU Requirements
- Universal design standard
- SU materials and components
- Keynotes

**Data Analysis**
- Occupant Requirements
  - Health condition
- Local Standard & Other
  - Canadian National Building
- LEED Accreditation
  - Energy & Atmosphere
  - Material & Resources
  - Indoor Environment quality
  - Water Efficiency

**Criteria**
- WBS
  - MasterFormat (16 Division)
  - SUH Strategies
  - Material Specification
  - Space/circulation
  - Information resource (Published Data, Supplier/Literature)
- Cost
  - Unit cost/certificate cost

**Output Report**
- List of selected sustainable universal materials
- Cost of the selected materials and components
- LEED credit points and certification level
- 3D sustainable universal design model

uOttawa
Database Module

Collected Data → Analyze Data → Evaluate Data → Store in the Database and assign cost

- Sustainable Strategies
- Universal Strategies
- Technical Specification
- LEED
- CNBC
- Other Standards
3D Design Module

Diagram:
- External Database (Excel/Access) Module 1
- 3D Designed BIM Element
- BIM Tool Database
- DBMS
- Keynote
- Export
- LCC Tool
Life Cycle Cost Analysis Module, Components

System 1

- Material's Subsystems
  - Material type 1
    - Keynote#
  - Material type 2
    - Keynote#
  - Material type 3
    - Keynote#
  - Material type #
    - Keynote#

  → Cost
  → Area
  → Quantity
  → Volume

  → $/Unit

System 2

Cost and Benefits Cash Flow

- building initial cost
- Cash flow period
- Escalation Rate
- MARR
- Operation's Annual Cost

→ Net Present Value

Comparing with Conventional building's net present value (cash flow)

Evaluate cost and benefits
VALIDATION

Project Detail:
- One story Building
- 8,089 ft²
- Created by using Autodesk Revit.
- The material and components chosen from the database created in module 1 (database).
VALIDATION, Snapshot of customizing BIM families
VALIDATION, Cost benefits

0 1 2 3 22 23 24 25
$ 1,798,200
$ 5,986 $ 5,986 $ 5,986 $ 5,986 $ 5,986 $ 5,986

$ 1,815,325

0 1 2 3 22 23 24 25
$ 1,806,128
$ 1,197.17 $ 1,197.17 $ 1,197.17 $ 1,197.17 $ 1,197.17 $ 1,197.17 $ 1,197.17
CONCLUSION

- This presentation emphasises the importance of considering sustainable universal design strategies at the early stage of designing buildings.

- A methodology was illustrated in order to integrate BIM with SUD strategies and the result was:
  - List of selected SU materials and components
  - LEED accreditation level
  - List of sustainable universal design suggestion
  - LCC report presented in the form of cash flow.
REFERENCES

Questions / Comments