The use of FTA to evaluate the contribution of BIM Platform to the environmental quality on rehabilitated buildings

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1. INTRODUCTION
2. ENVIRONMENTAL CERTIFICATION
3. BIM AND SUSTAINABLE DESIGN
4. CASE STUDY
   1. AQUA HQE and BIM Platform for rehabilitation process
   2. The use of Fault Tree Analysis
5. DATA ANALYSIS AND CONCLUSION

ACKNOWLEDGMENT

**Purpose:** This article is part of a PhD Thesis, and presents the results of the analysis of the potentialities of BIM Platform through the use of FTA – Fault Tree Analysis Method.
Introduction

Since the 1990’s, the civil construction industry is facing different challenges regarding innovation in both: design process and construction management.

The increment of discussions around sustainable construction has led to the spread of different “green” rating systems.

In this scenario, the rehabilitation of existing buildings seems to be an important measure for sustainability, as it enables the extension of the buildings’ life through the improvement of environmental performance for occupants.
Introduction

• This paper presents a case study where the BIM platform has been used for the rehabilitation of an existing building, aiming the inclusion of the requirements of AQUA environmental certification.

• The FTA (Fault Tree Analysis) has been used to evaluate the faults during design management process in order to identify BIM contribution to the process.
Research Strategies:

- Literature review
  - Design management
  - Sustainability
  - Rehabilitation of buildings

- Case study
  - Field observations
  - Review of design documents
  - Project supervision
  - Data analyse through FTA method.
Environmental Certifications

1990:
- BREEAM

1993-9
- HQE
- BEAM
- LEED

2007
- LEED first certification in Brazil

2008
- AQUA-HQE first certification in Brazil
Environmental Certifications

New conditions for design management:

• Refine design process introducing environmental requirements since the beginning (conceptual phase);

• Necessity to work on a platform where building information was not fragmented into different archives (designs, spreadsheets, reports);

• Take interoperability as a pre-requisite for sustainable design.
BIM and sustainable design

• BIM - Building Information Modeling - allows interoperability through a unique model that matches design solutions.

• The model can allow the simulation of environment performance before construction process, helping professionals to find the best solutions.
BIM and sustainable design

• The management of the design process that intends to incorporate environmental requirements can benefit from the adoption of Building Information Modeling (BIM) through the anticipation of construction incompatibilities, clash detection, simulation of environmental performance, among other benefits.
Case study

• A case study has been carried out in a company headquartered in Rio de Janeiro city
• The purpose was to evaluate the contribution of BIM Platform during the design rehabilitation process aiming AQUA HQE certificate.
Case study

Architecture: Roberto Luiz Gandolfi, José H. Sanchotene, Abraão Aniz Assad, Luis Fortes Netto, Vicente de Castro Neto e José Maria Gandolfi

Burle Marx’s Garden
Case study – AQUA-HQE environment profile for the rehabilitation

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<thead>
<tr>
<th>Category</th>
<th>Level</th>
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<tr>
<td>Hygrothermal comfort</td>
<td>Top-performing</td>
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<td>Olfactory comfort</td>
<td>Top-performing</td>
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<td>Air quality and health</td>
<td>Top-performing</td>
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<tr>
<td>Energy management</td>
<td>Top-performing</td>
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<tr>
<td>Maintenance – permanence of environmental performance</td>
<td>Performing</td>
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<tr>
<td>Integrated choice of the products</td>
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<td>Waste management</td>
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<tr>
<td>Visual comfort</td>
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<td>Quality of spaces</td>
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<td>Acoustic comfort</td>
<td>Basic</td>
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<td>Building’s relationship with its immediate environment</td>
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<tr>
<td>Water management</td>
<td>Basic</td>
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<tr>
<td>Water quality and health</td>
<td>Basic</td>
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Case study

The doctoral research has four stages:

- **First:** identify the environmental quality defined for the rehabilitation of the building aiming AQUA HQE certificate;

- **Second:** keep up with the modeling process of the existing building using BIM platform (the modeling process involved laser scanning with the use of drones associated with photogrammetry);

- **Third:** evaluate if BIM model has helped architects during the design features required to meet the environmental targets;

- **Fourth:** use FTA to identify the problems related to the design process of the rehabilitation of the building, using BIM Platform.
FTA applied to case study

- The **Fault Tree Analysis**, is a deductive analysis to resolve an **unwanted event** exhaustively searching for the causes of failure, thus clearly showing all the different interfaces that are necessary to reach the undesired event (top event).
FTA applied to case study

- The undesired top event that was explored is: "The environment quality profile of the building has not been established collaboratively."

The environment quality profile of the building has not been established collaboratively.
FTA applied on case study

Among the evidences of **FTA** two intermediate events should be highlighted:
- environmental profile has been established before the beginning of design process and;
- the design team wasn’t completely formed in the beginning of the process.
Data analysis

- If BIM Platform had been considered since the beginning of the rehabilitation process it probably would bring more efficiency and transparency to the process, not only in what refers to meet the sustainable requirements as to the preparation of the necessary documentation for certification.

- FTA method revealed that BIM has not been used aiming the improvement of the environmental performance of the rehabilitated building.

- BIM has been adopted uniquely for its potential in use-operation and maintenance phase.
Data analysis

• The problems identified through FTA, indicate aspects to be considered in BIM implementation – particularly aiming the improvement of environmental performance on existing buildings – as:
  • The necessity of team qualification in the potential offered by BIM Platform;
  • The necessity to review the design process, since Building Information Modeling defines a new design method; and
  • The necessity to harmonize the environmental requirements for the proper rehabilitation of the building.
Conclusions

• BIM Platform should be considered since the beginning of the rehabilitation process, particularly considering the necessity to improve the environmental performance of buildings.

• The design management process should be revised considering the potentialities of BIM Platform.

• Professionals should be trained on BIM possibilities before the initial phase of design.

• The environmental targets should be established since the conceptual phase of rehabilitation process with the design team, collaboratively (integrative design).
Final considerations:

• FTA analyses **highlighted the necessity to overcome the sequential view of the design process** in order to guarantee integrated decisions aiming architecture high environmental quality.

• BIM can be helpful in this process towards the **modernization of design decision making** since conceptual phase of buildings.
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Thank you

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