USING BIM WITH THE LAST PLANNER SYSTEM TO IMPROVE CONSTRAINTS ANALYSIS

Bernardo M. Etges
Raquel H. Reck
Marcus T. Fireman
Jerusa L. Rodrigues
Edurado L. Isatto
Introduction

Last Planner System (LPS) has been widely implemented by construction companies who seek to improve the reliability of production at construction sites.

- **Medium-term planning** as the main element that make up the LPS (Ballard, 1997; Ballard, 2000; Hamzeh, 2012; Pikas et al., 2012; Salvatierra et al., 2015; Al Hattab et al., 2017)
  - the main objective of which is to **protect the workflow** by identify and remove constraints of activities.

Empirical studies have shown that **failures to do so** have led to jumps in wastes emerging in day-to-day production (Bortolazza; Formoso, 2006; Kemmer et al., 2007; Fireman et al., 2013; Leão et al., 2014; Ibarra et al., 2016, Hamzeh et al., 2012).

Angelim et al. (2020) recently conducted a **systematic literature review** that identified that one of the major shortcomings when applying medium-term planning lies precisely in the **difficulty of identifying and removing constraints in advance**.
Introduction

- The joint application of BIM (Building Information Modeling) with LPS has been strongly suggested as a way to assist and streamline the process of identifying and removing constraints (Angelim et al., 2020; Fireman et al., 2013; Ibarra et al., 2016; Sacks et al., 2012).
BIM and LPS

• Toledo et al. (2016) compare two case studies one using only LPS and the other using LPS and BIM.
  • Even **without the use of BIM models in lookahead planning meetings**, the coordinated use of LPS and BIM generates:
    • **increase** in Percentage of Plan Completion
    • a **decrease** in reasons for non-compliance
    • a **shortening** of the meeting durations
    • and a **decrease** in the total number of design RFI

Data from **five case studies** from **three different companies** have been analyzed. The main objective is to analyze how integrating BIM with the LPS system can enable constraints at the medium-term and work packages short-term.
RESEARCH METHOD

- Multiple exploratory case studies
- The criteria for selecting the five studies were based on:
  - each one of them has a planning and control method based on the elements of Last Planner system;
  - has a history of implementing lean tools
  - provide access to information;
  - the companies are in the initial stage of implementing BIM.
- The work method consists of two phases:

**Phase 1** - analyze which categories of constraints identified in medium-term planning could be modeled in BIM:
   a. a database was created
   b. categorized according to its relation to: Material, Labor force, Equipment, Security, Project, and Planning
   c. focus group regarding the possibility of modeling them

**Phase 2** - examine the percentage of work packages elaborated in the short-term plan could be modeled in BIM:
   a. a database was created
   b. categorized according to construction stage (masonry, infrastructure, finishing, etc.).
   c. focus group regarding the possibility of modeling them
## RESEARCH METHOD

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<thead>
<tr>
<th>Company</th>
<th>Market</th>
<th>Case Study</th>
<th>Built area</th>
<th>Characteristics</th>
<th>Constructive Phase</th>
<th>Constraints</th>
<th>Analysis of work-packages</th>
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</table>
| Company 1 | Residential High-, Middle- and Low-income | Case 1 | 13.505,67 m² | 127 residential units  
  1 tower block - 2 stores | Infrastructure | 22 | 91 |
|         |        | Case 2   | 80.902,05 m² | 576 residential units  
  4 tower blocks | All services | 12 | 815 |
| Company 2 | Residential High-, Middle- and Low-income and Commercial | Case 3 | 10.150,67 m² | Commercial+hotel  
  1 tower block with 168 private units | All services | - | 297 |
|         |        | Case 4   | 32.405,82 m² | Commercial+health  
  1 tower block with 423 private units | Finishings | 51 | - |
| Company 3 | Metallic Construction System | Case 5 | 24.695 m² | Expansion of Airport  
  (Pier, Processor, Boarding bridges and Annexes) | Superstructure | 132 | 39 |
| **Total** |         |           | **217**      |                                                     |                     | **1242**    |                          |
## Analysis of medium-term data

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- **Equipment** represents the percentage of success in the equipment domain.
- **Material** represents the percentage of success in the material domain.
- **Labor Force** represents the percentage of success in the labor force domain.
- **Planning** represents the percentage of success in the planning domain.
- **Design** represents the percentage of success in the design domain.
- **Safety** represents the percentage of success in the safety domain.
# Analysis of the Short-Term Data

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ANALYSIS OF THE SHORT-TERM DATA

• Analyzing the causes of the non-completion of activities as planned
  • All the causes of Project category can be modeled.
  • Access category can also be modeled as it represents the interference of the stages of the product, pieces of equipment, and workflows.
  • Materials category, only causes of lack of material due to losses above those expected could be modellable, since we would have more precise quantitative estimates of the materials.
  • Equipment category, a detailed study in the BIM model could avoid the causes of acquiring inappropriate equipment for the activity or bad dimensioning.
  • Safety category, delay in integration are not adjustable, but stoppages due to lack of collective protection.

• The joint analysis of medium-term constraints and causes of short-term non-completion are convergent, with a high capacity for modeling the categories of project, equipment, access, and materials.
CONCLUSIONS

- Analyzing constraints identified in medium-term planning and the percentage of work packages elaborated in short-term planning meetings that could be modeled in BIM:
  - We may conclude that the integration of BIM with LPS can let constraints in medium-term planning be identified and removed in a more agile and efficient way.
  - By using the BIM 4D model to support the modeling of constraints, it could be seen that the use of the BIM model throughout the PPC process brings benefits to the planning of the Construction project.

- Great potential for modeling medium-term constraints and causes of short-term in the BIM model was identified. This occurs mainly for those that refer to Projects, Equipment, Work Safety, Materials.
CONCLUSIONS

• The use of BIM can be different in the planning horizons defined by the LPS.
  • In the medium term, BIM can be used to allow simulations and visualizations of the position of teams, equipment, and sequence of activities to be simulated and visualized and to understand and visualize workflows.
  • In the short term, BIM enables packages to be visualized in greater detail, thus facilitating their correct definition, and can let different management systems come under integrated control.
  • We highlight the use of BIM in planning meetings both in the medium term (Construction Company 1) and in the short-term (Construction Companies 1 and 2) since the model allows participants involved to have a common interpretation of the strategies defined for the enterprise.

• As future studies, it is suggested the common use of BIM model with LPS by integrating the modeling of the attributes and constraints identified for a comparative case study that lets the potential gains be measured.
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