

LEAN AND BIM INTERACTION IN A HIGH-RISE BUILDING

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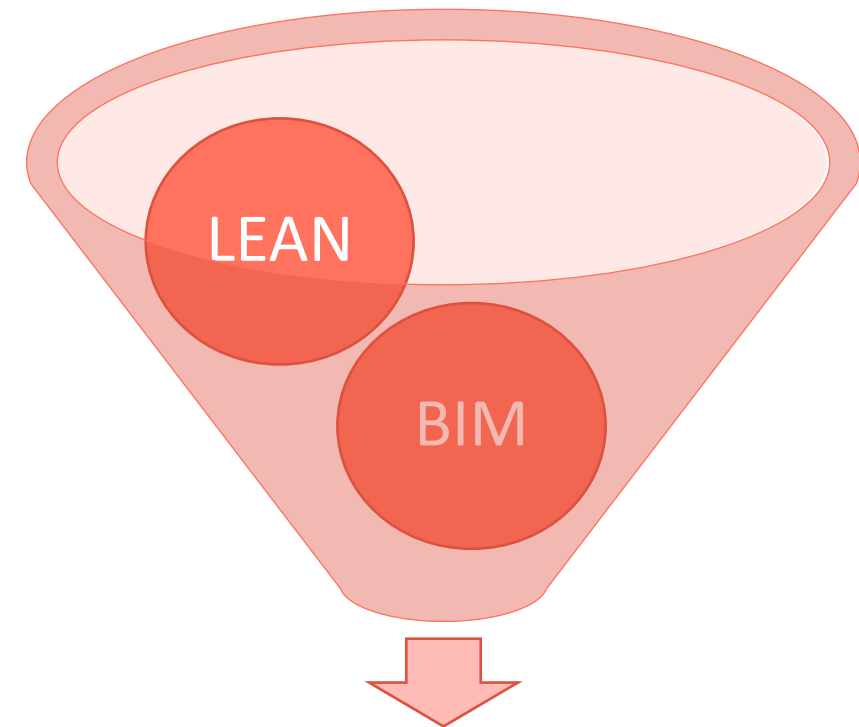
AGENDA

- Introduction
- Literature review
- Hypothesis
- Methodology
- Results
- Discussion
- Conclusions

INTRODUCTION

The emergence of Lean Construction and Building Information Modeling as two innovative methodologies to address issues (productivity, inefficiencies) was gaining more adopters in the AEC industry on a global scale.

In Lima the productivity levels were 27.9% of productive work, 36.3% of contributory work and 35.9% of non-contributory work (*Ghio V., 2000*).



Lean - BIM Relationship

LITERATURE REVIEW

Lean Construction

Methodology based on the application of the principles of Toyota production systems.

Lean Design

It is part of LPDS. Lean design comprises three processes: design concept, process design and product design.

Set Based Design (SBD)

The objective is to generate sets, different alternatives or solutions in order to evaluate them and to choose the most optimal.

Value Stream Mapping

Map the generation of value, waste and countermeasures when it is analyzed in a particular process

BIM

A modelling technology and associated set of processes to produce, communicate, and analyze building models.

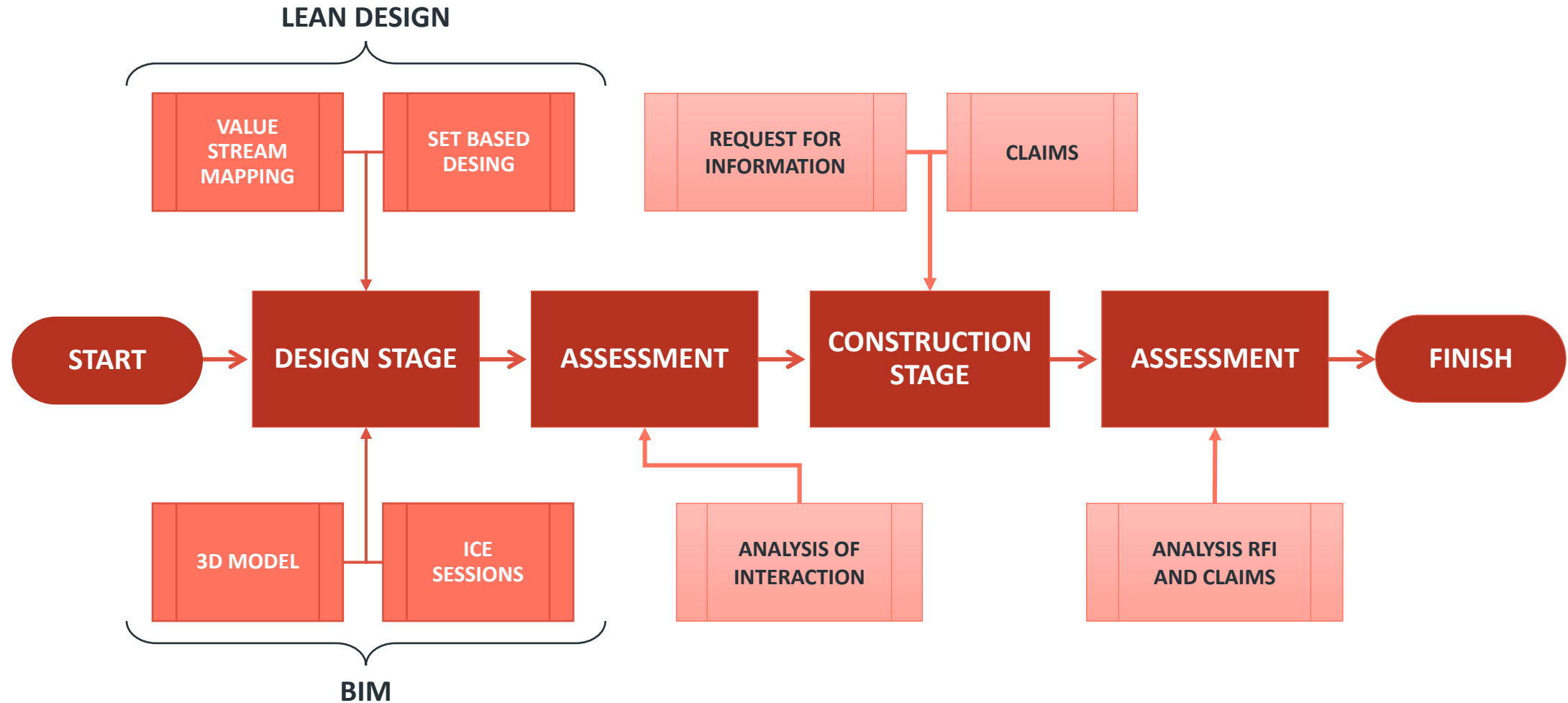
Integrated Concurrent Session (ICE)

Collaborative work that involves different stakeholders.

HYPOTHESIS

The hypothesis that these tools (set based design, value stream mapping, a 3D model, and integrated concurrent sessions) would provide a positive interaction since they would address problems earlier (design phase) and facilitate the reduction of restrictions (i.e. less requests for information and fewer claims) in the construction phase.

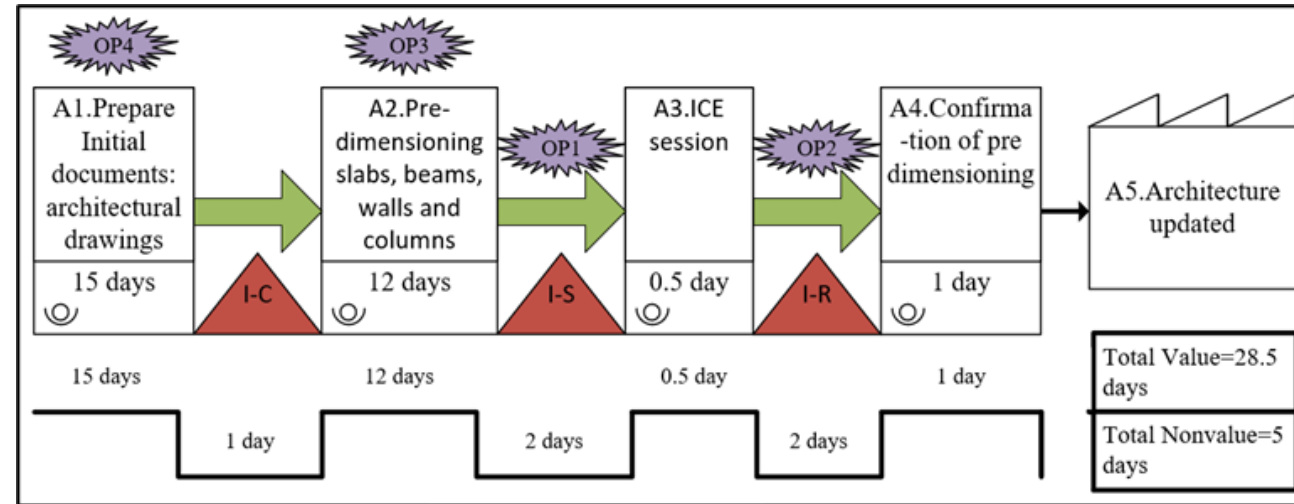
METHODOLOGY



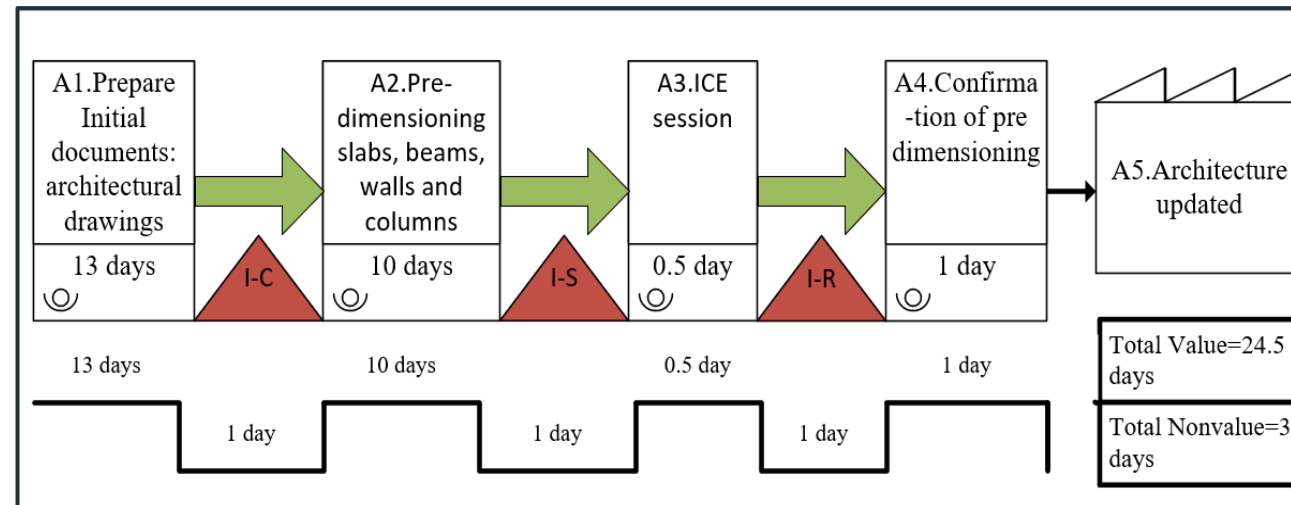
RESULTS

VSM and ICE Sessions

The total value time of the value activities is 24.5 days, which means a 14% reduction compared to the former VSM. The reduction in duration of activity 1 (A1) and activity 2 (A2) was the cause of that time saving.



Actual VSM



New and committed VSM

RESULTS

Set Based Design and 3d Model

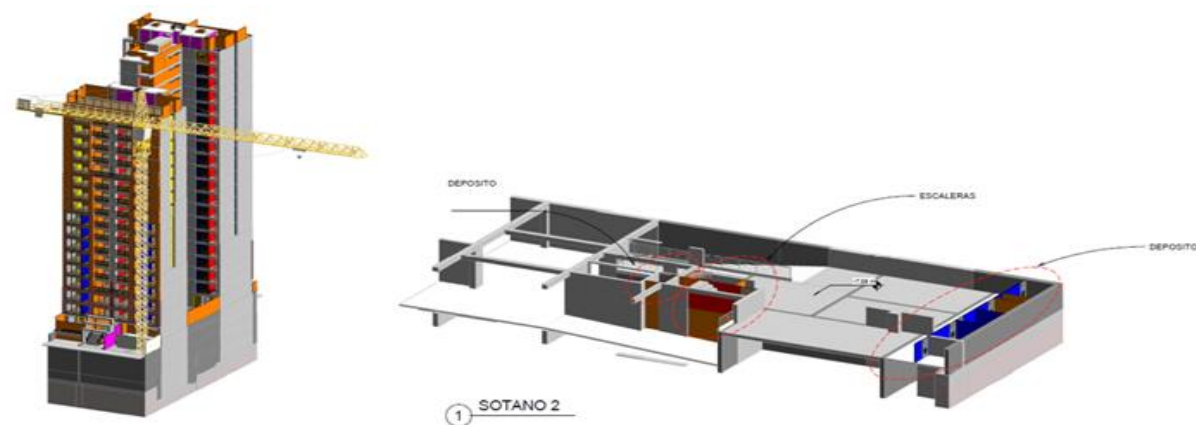
Comparison between different options

Option 1: It is to use a mixture of simple spread footing with strap footing with the disadvantage that the length of the vertical elements (columns and shear walls) have to increase in order to make it possible for footings to reach the ground with enough bearing capacity

Option 2: It is to implement micro piles as foundation in order to reach the appropriate soil with enough bearing capacity.

Option 3: it is to include a semi-basement floor. By adding a floor the level of the last basement is lowered. This inclusion decreases the length of columns and shear walls.

Category	Option 1	Option 2	Option 3
Cost \$	53,731	41,791	150,775
Benefits \$	0	0	104,000
Net Cost	-53,731	-41,791	-46,775
Duration (days)	14	21	21



3d model (left) and lower basement (right)

RESULTS

Request for information and claims at construction phase

There are 174 RFI in total in project 1 which means 23.3% of reduction from project 2 . The ones that are design related are the categories: design issues and clashes that represent 10% and 31% respectively in project 1. Those two categories sum up 71 RFI in total which represents 37.1% of reduction from project 2.

Category	Project 1 (Lean and BIM interaction)		Project 2 (without Lean and BIM implementation)	
	Quantity	Percentage	Quantity	Percentage
Scope change	47	27%	52	23%
Queries	56	32%	62	27%
Design issues	17	10%	32	14%
Clashes	54	31%	81	36%
Total	174	100%	227	100%

Table 1. RFI by category for project 1 and project 2

There are 90 claims in total in the case study (project 1). The ones that are design related are the categories: design issues and clashes that represent 24% and 3% respectively. Those two categories sum up 48 claims. Nevertheless, in terms of cost those two categories represent 54% of the total claims cost.

	Claims Quantity	Claims Percentage	Claims Cost \$	Claims Cost Percentage
Scope change	20	22%	26.124	29%
Queries	22	50%	15.386	17%
Design issues	45	24%	47.982	53%
Clashes	3	3%	1.186	1%
Total	90	100%	90.679	100%

Table 2. Claims by category for project 1

DISCUSSION

Participants found useful tools such as VSM and Ice sessions because they had the opportunity to see the changes that occurred in the design process by reducing the total time of value and non value activities.

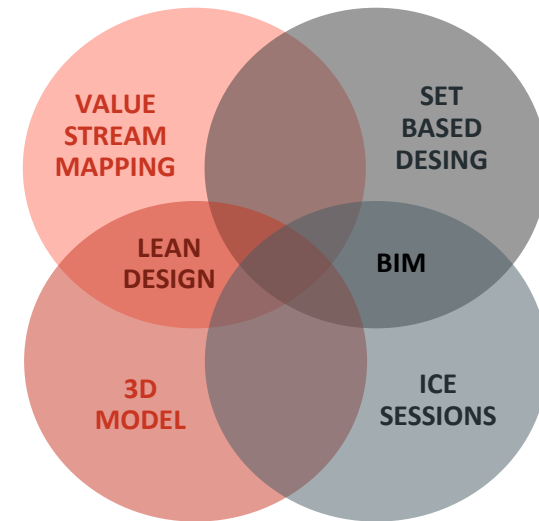
In the case of SBD and a 3D model there are less people interested in replicating the experience. A plausible explanation is related to the demand for knowledge in technology that is necessary in this interaction and the resistance to change by senior engineers with more than 20 years of experience in the industry. The design teams had 60% of participants with a seniority level.

CONCLUSIONS

All four tools (VSM, SBD, 3D model and ICE session) demonstrate the existence of the positive interaction between the lean principle: “decide by consensus, consider all options” and the BIM functionality “visualization of form”.

Nevertheless, the findings in this case study suggest another new interaction between the lean principle “focus on concept selection” with the BIM functionality “visualization of form”. This interaction is not registered in the matrix shown by Sacks et al. (2010).

In this new positive interaction, set based design and a 3D model plays a pivotal role because a better understanding of different design alternatives early in the design phase can be reached if a model is shown to the decision makers.



THANK YOU!

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