

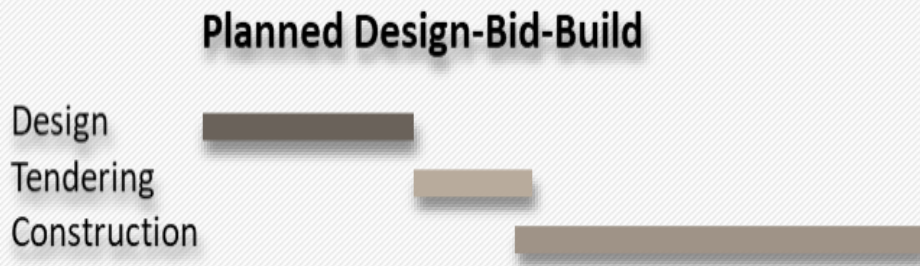


BIM FOR PRODUCTION: BENEFITS AND CHALLENGES FOR ITS APPLICATION IN A DESIGN-BID-BUILD PROJECT

Paula Mota, Fernanda Machado, Clarissa Biotto, Ricardo Mota, Bruno Mota



Design-Bid-Build Projects



“Least risky approach” for client due to certainty in design, cost and duration

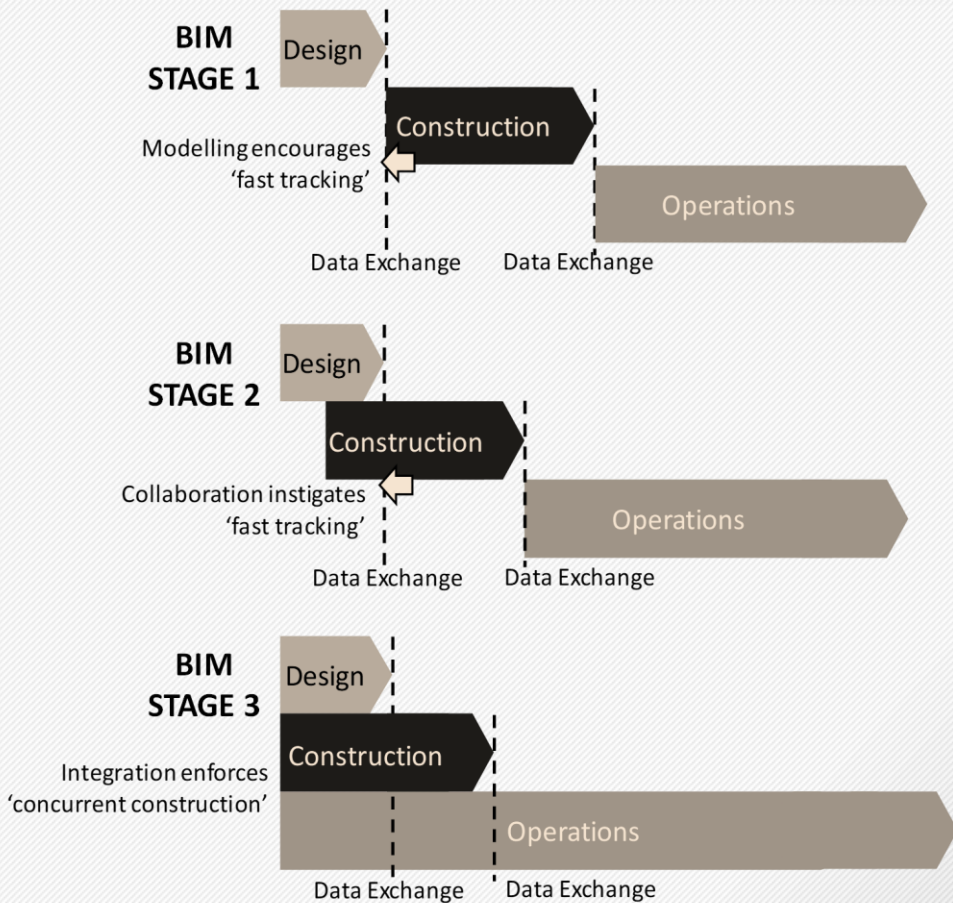
Contractor has no responsibility for design, but may suffer penalties for late completion

- Single-stage tender
- Design is completed before construction starts
- Consultant team develops detail design for client
- Contractor is appointed (usually) under a lump-sum contract

Building Information Modelling (BIM)

- BIM pulls a technological and procedural change that tends to **affect everyone involved in the construction industry** (Succar et al., 2007 cited in Guillermo et al. (2009))
- The implementation of **BIM systems requires drastic changes in current business practices** (Aouad and Arayici 2009)

Maturity at BIM Stages (Succar 2009)



Stage 1

Stakeholders deploy object-based 3D parametric software tools to generate **single-disciplinary models**.

Unsynchronised communication.

Stage 2

Stakeholders collaborate and exchange information with **other disciplinary players**. Model-based **collaboration may occur within one or between two stages** of the product development: design-design stakeholders, or **design-construction**, etc.

Unsynchronised communication.

Requires some **contractual arrangements**.

Stage 3

Integration and collaboration of stakeholders across the **project lifecycle phases**. **Synchronised communication.**

Complex analysis about constructability, operability and safety, and other nD modelling.

Requires reconsiderations of **contractual relationships**, risk-allocation and workflows.



The Case Study: BS Design Corporate Towers

BS Design Corporate Towers



- Fortaleza - Brazil
- 17 floors of commercial offices
- 4 floors for public use
- 5 floors of car parking
- Total area: 10,000m²
- Design started in 2012



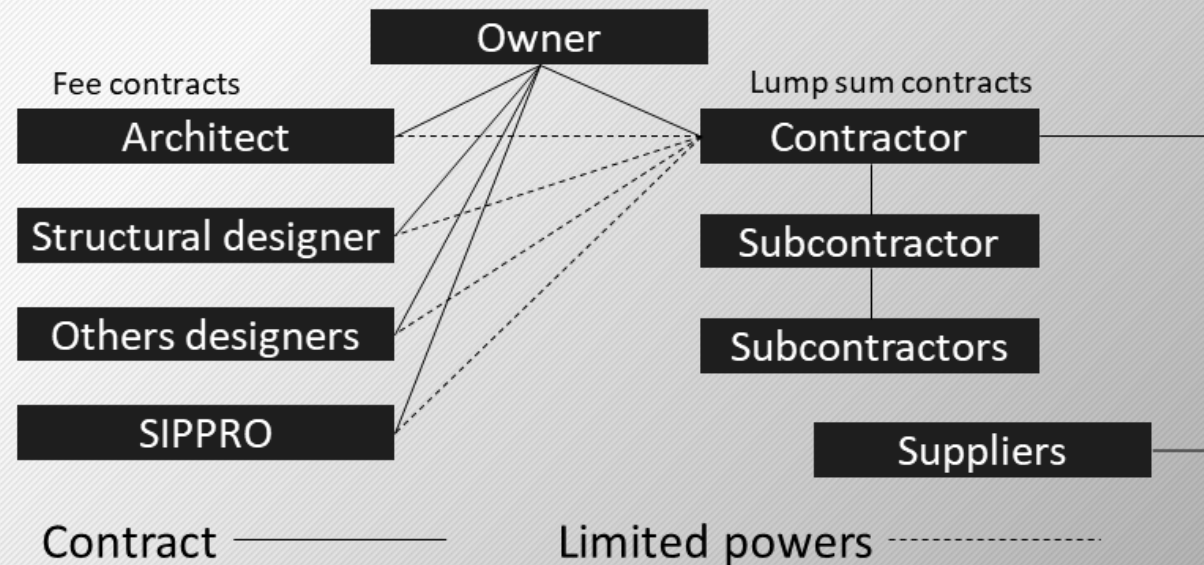
BS Design Corporate Towers

Contractual relationship among stakeholders

In 2014, owner hired a BIM Manager company to 3D BIM modelling:

- clash detection,
- quantity take-offs,
- structural analysis,
- studies of lighting,
- manufacturing pre-casted elements, etc

In total, 18 disciplines were modelled



BS Design Corporate Towers

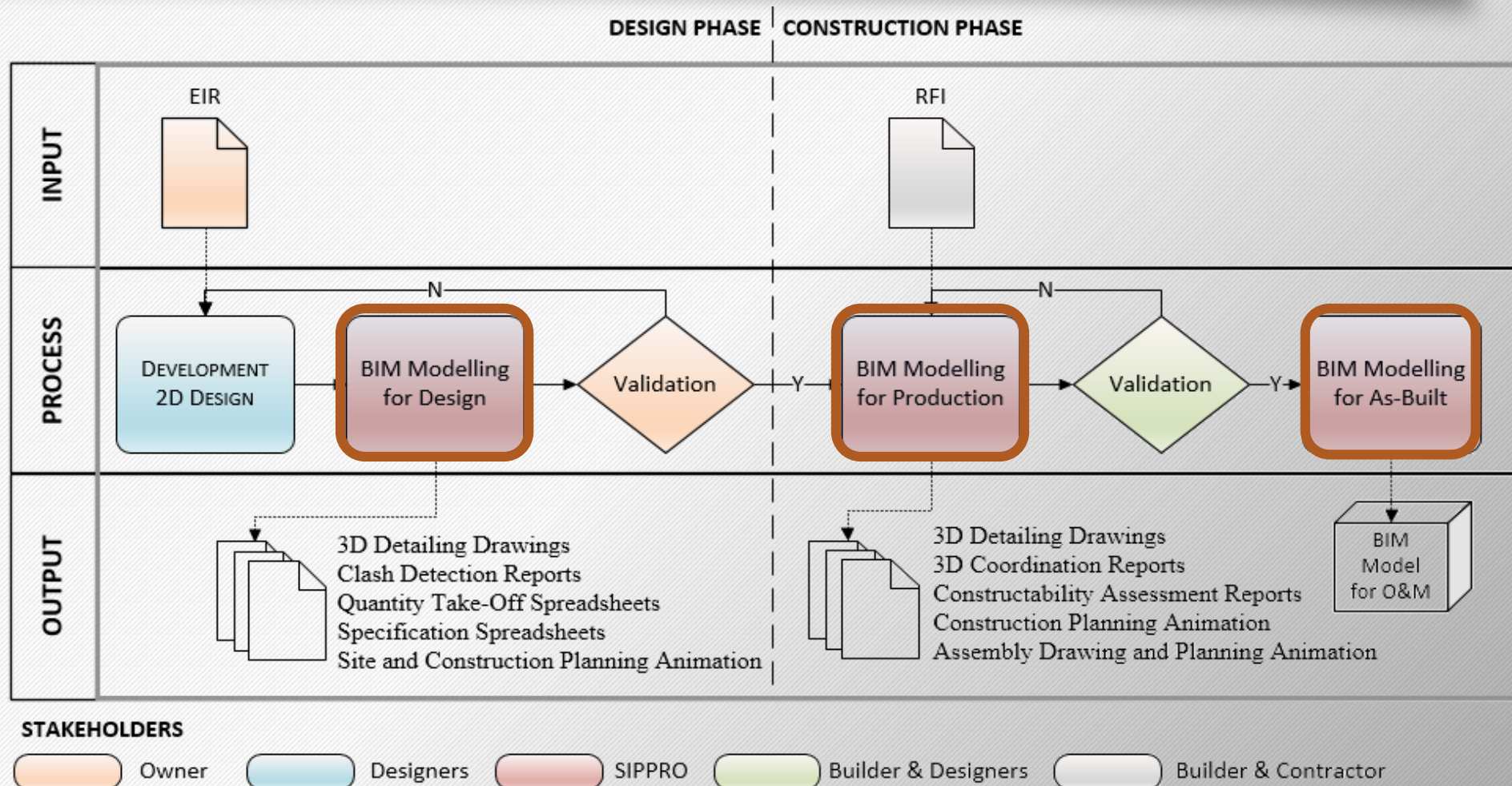
Planned Design-Bid-Build



Actual Design-Bid-Build



BIM Modelling Process



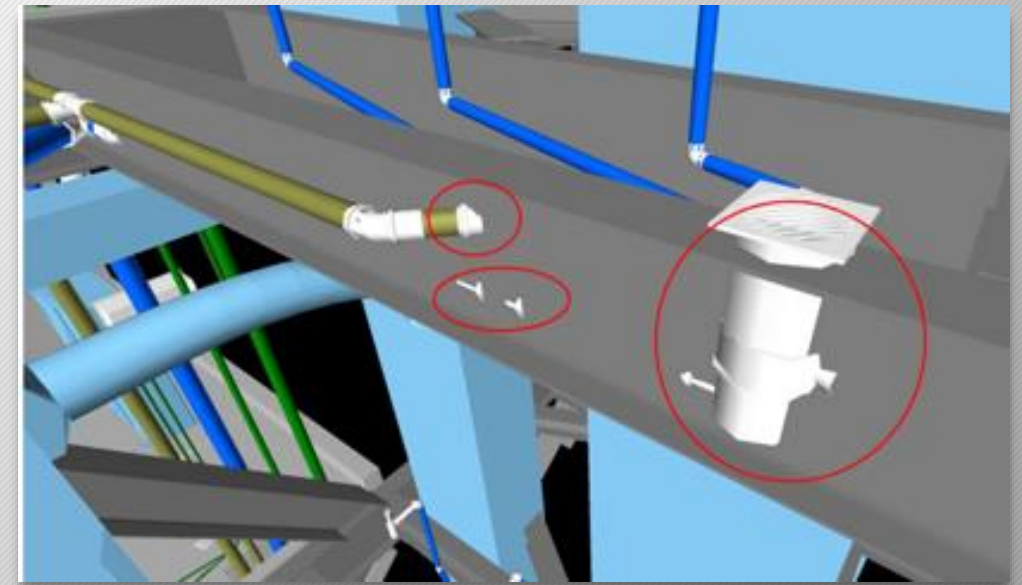
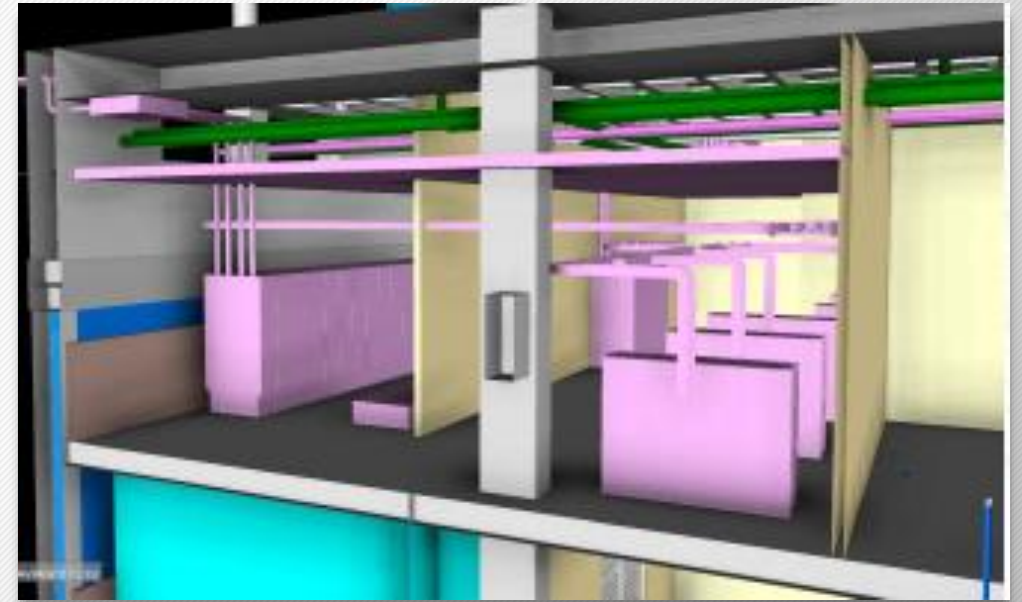
Demands From Design

- **Lean process analysis**
- Spatial analysis
- Selection and Specification based on constructability analysis
- Visual communication
- Clash detection
- Quantity take-off
- Construction planning
- Construction logistics



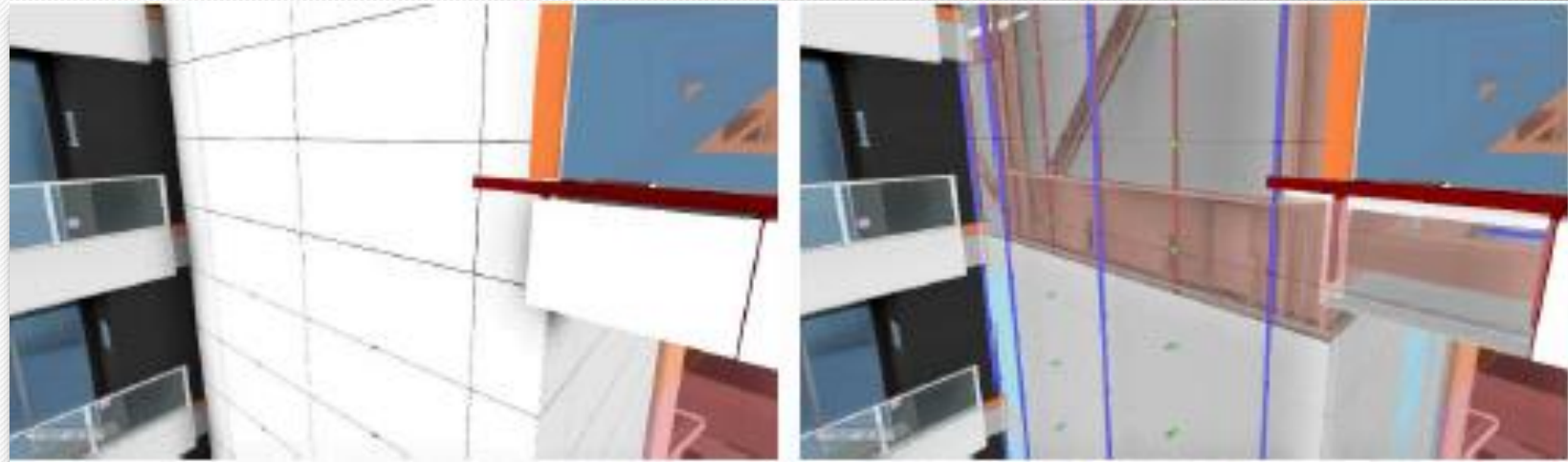
Demands From Design

- Lean process analysis
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Demands From Design

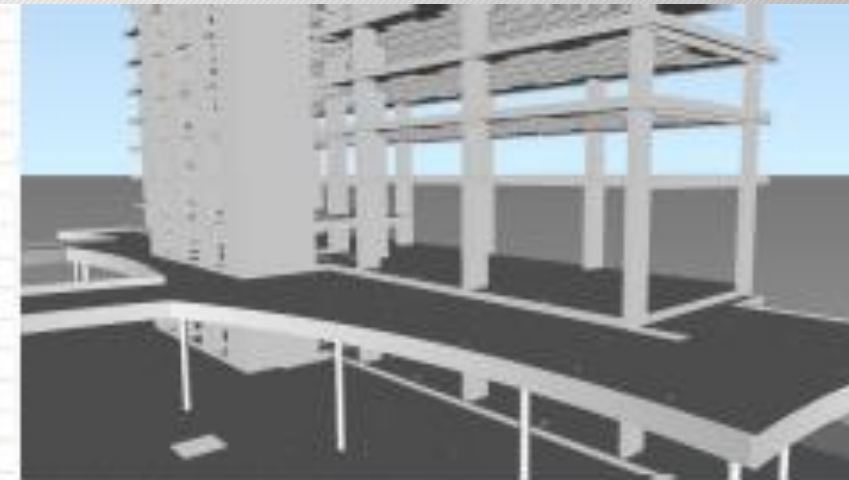
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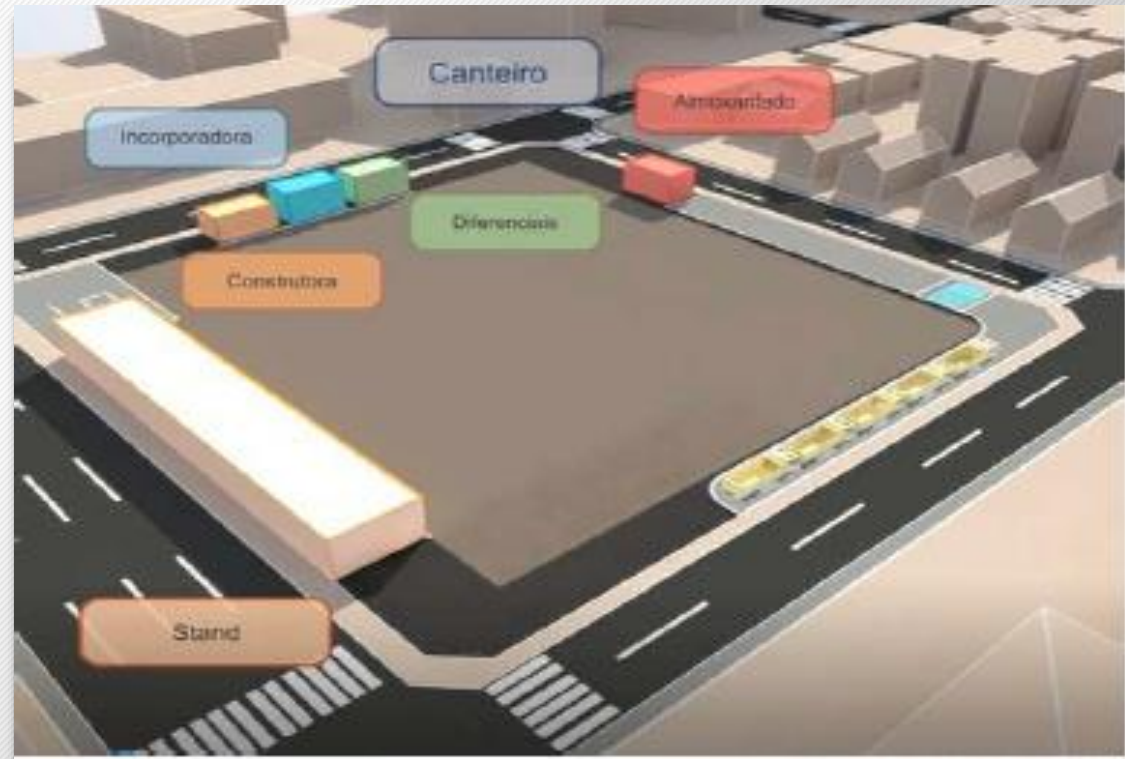
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1º PAVIMENTO	
PILARES	
Setor 01	Volume (m³)
Setor 02	Volume (m³)
VIGAS	
Setor 01	Volume (m³)
Setor 02	Volume (m³)
LARES	
Setor 01	Volume (m³)
Setor 02	Volume (m³)
ESCALADA	
Setor 01	Volume (m³)
Setor 02	Volume (m³)
TOTAL	
1º Pavimento	Volume (m³)



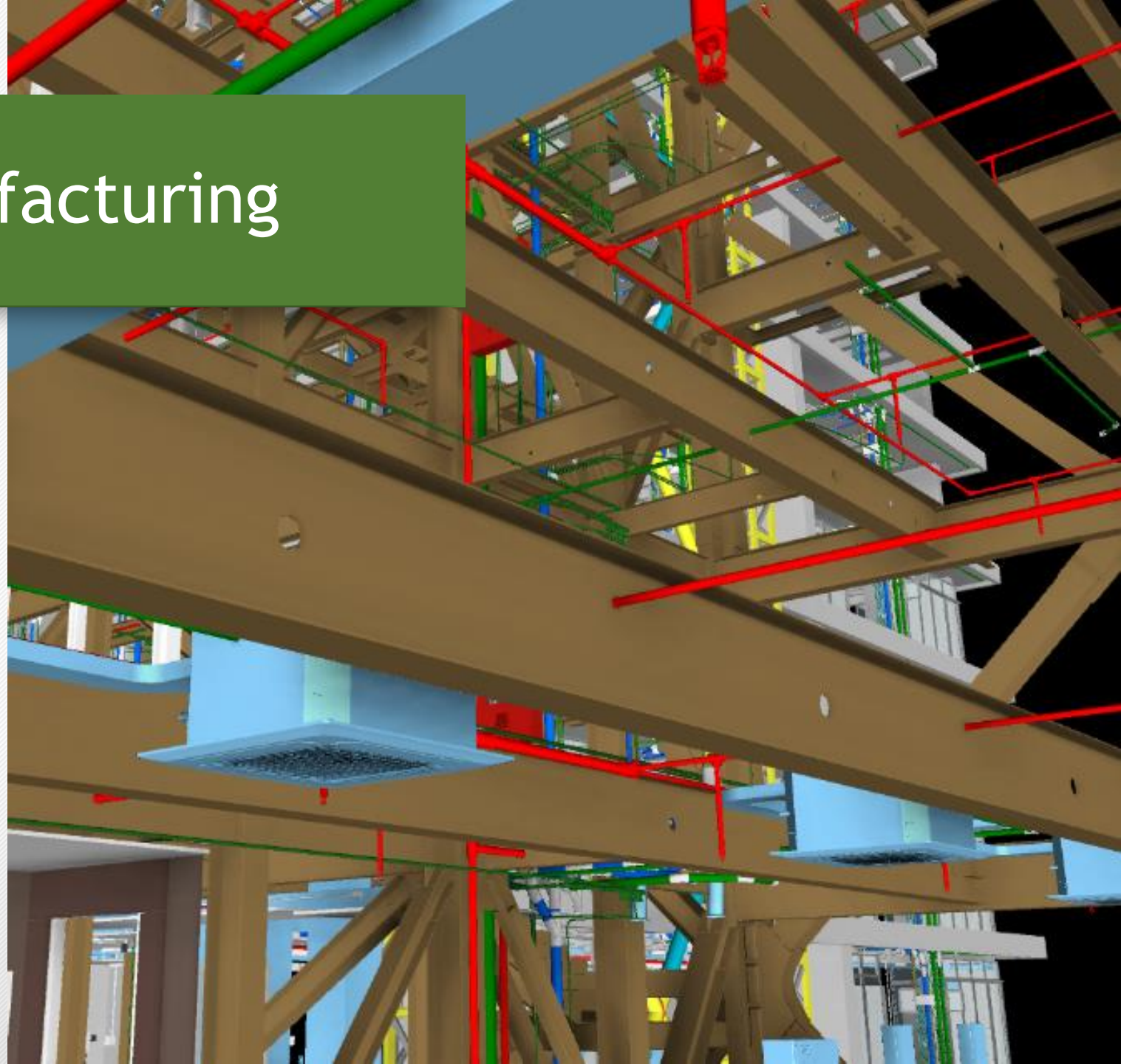
Demands From Design

- Lean process analysis
- Spatial analysis
- Selection and Specification based on constructability analysis
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- Clash detection
- quantity take-off
- Construction planning
- **Construction logistics**



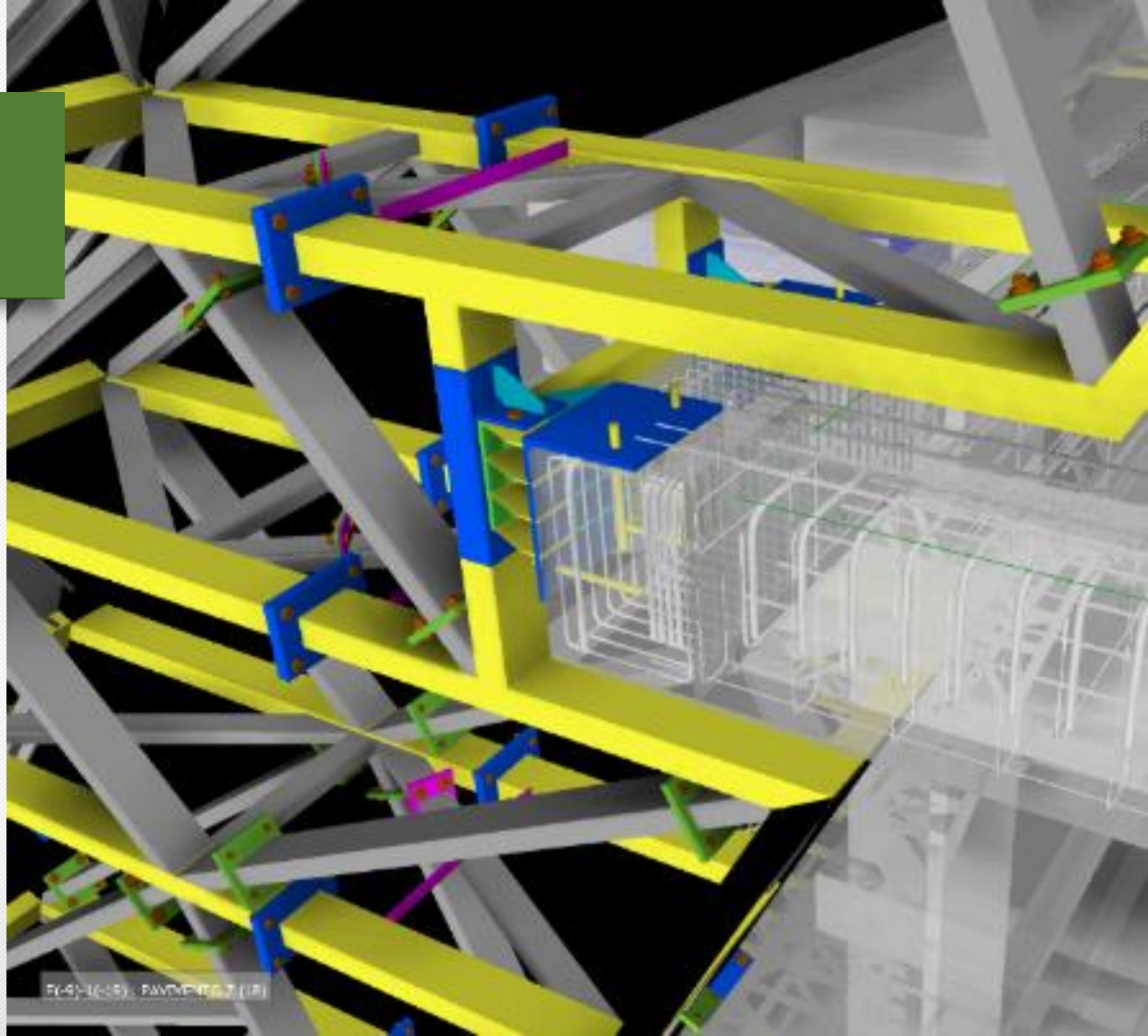
Demands from Manufacturing

- Sheet Steel forming and site set-out based on constructability analysis
 - 2800 mark-ups holes in steel beams saved R\$1,128,000.00
≈ £250,000.00



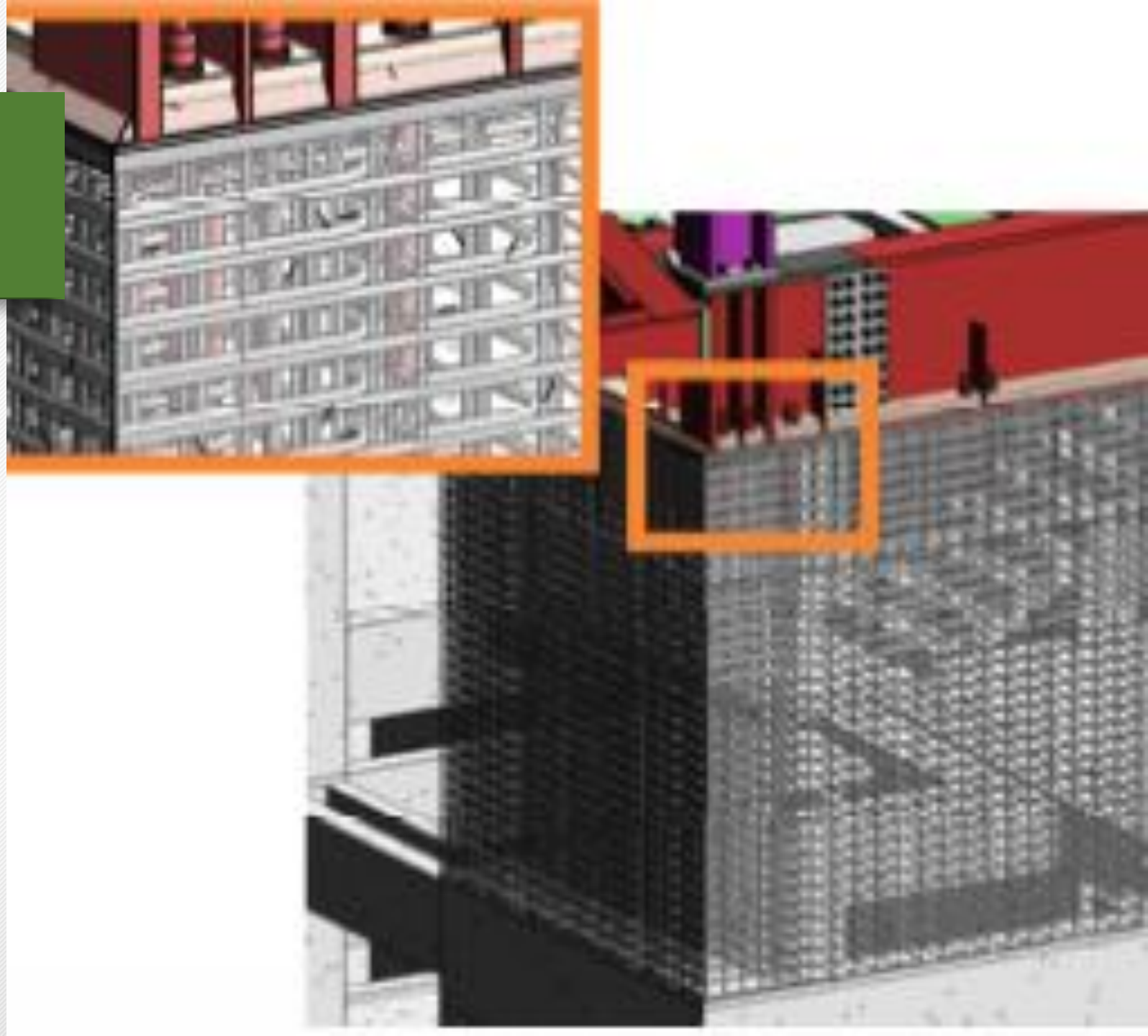
Demands from Construction

- **Constructability analysis**
- Quantity take-off
- Structural analysis
- Field BIM
- Construction planning



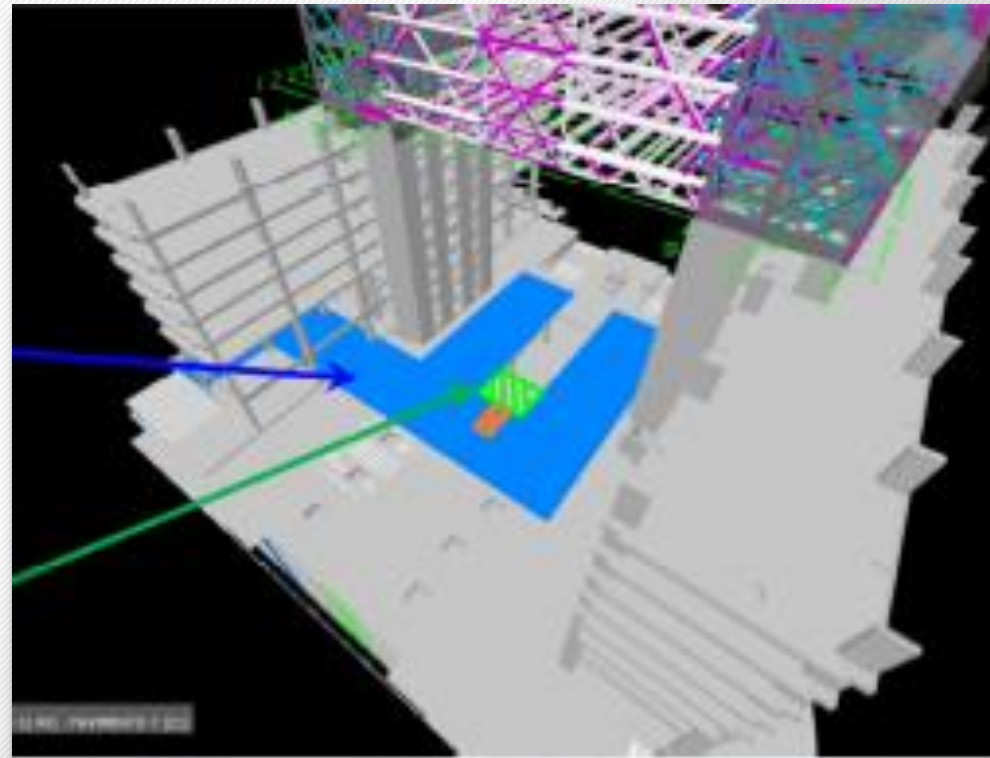
Demands from Construction

- **Constructability analysis**
- Quantity take-off
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- Construction planning



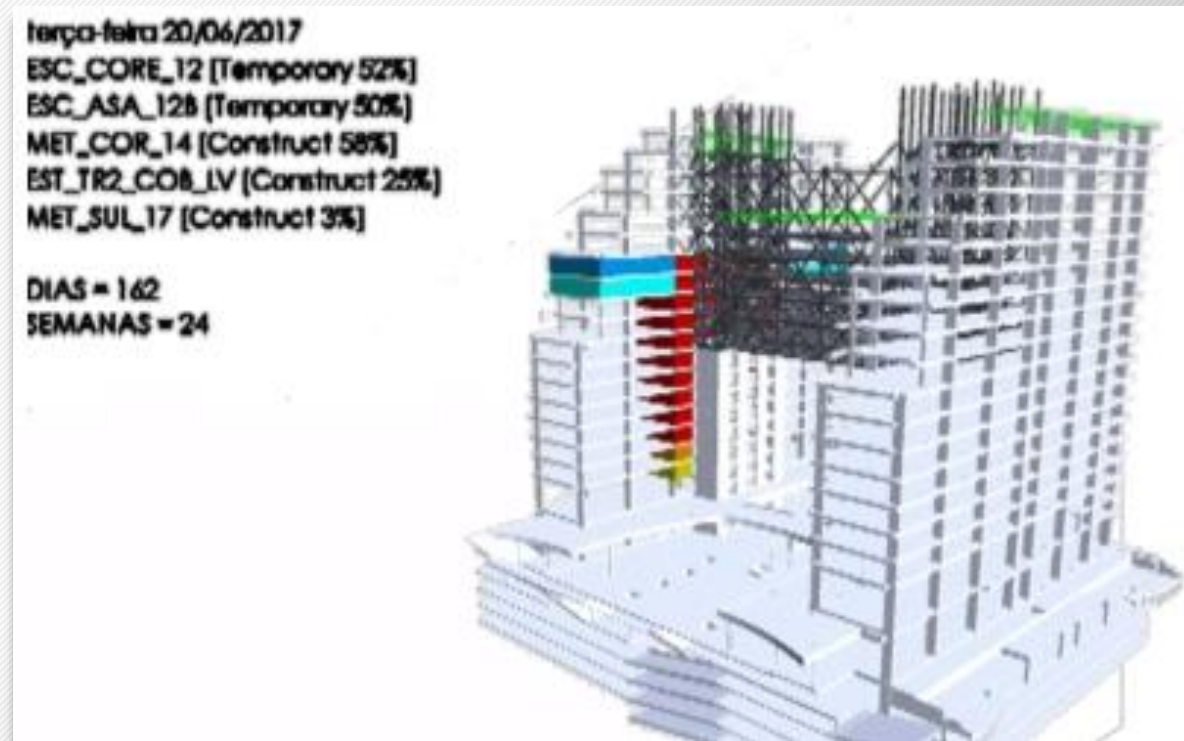
Demands from Construction

- Constructability analysis
- Quantity take-off
- **Structural analysis**
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- Construction planning



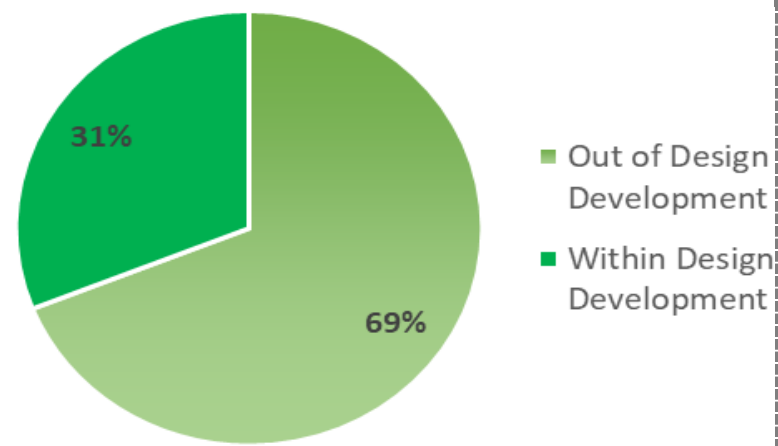
Demands from Construction

- Constructability analysis
- Quantity take-off
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- **Construction planning**

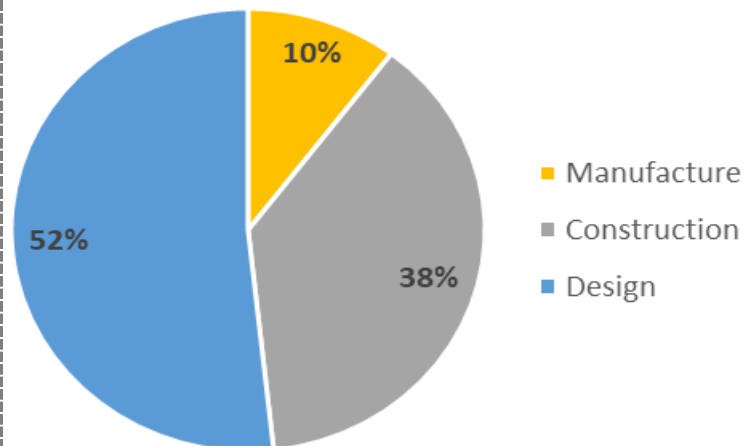


Results Analysis

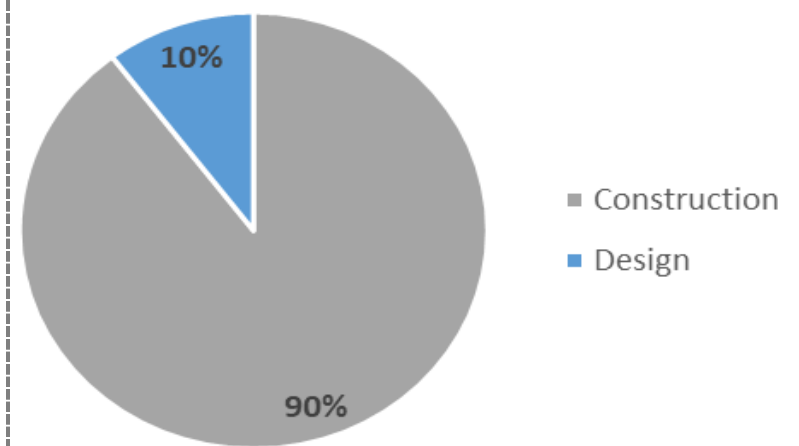
- **29 design solutions** divided in 7 categories:
 1. If the **solution** was **part** of the **design process**, or if it was requested as an extra information out of the design development;
 2. The **nature of the solution**: if it regarded the manufacturing, construction or design process;
 3. In which **phase** of the product development process the solution was generated: during design or construction;
 4. **Who requested** the development of the solution (builder, designers or SIPPRO);
 5. **Who generated** the solution (builder, designers, SIPPRO or manufacturer);
 6. **Who validated** the solution (builder, designers, SIPPRO, manufacturer or developer); and,
 7. If the effort to develop the solution was **part of the contract** between SIPPRO and the developer.



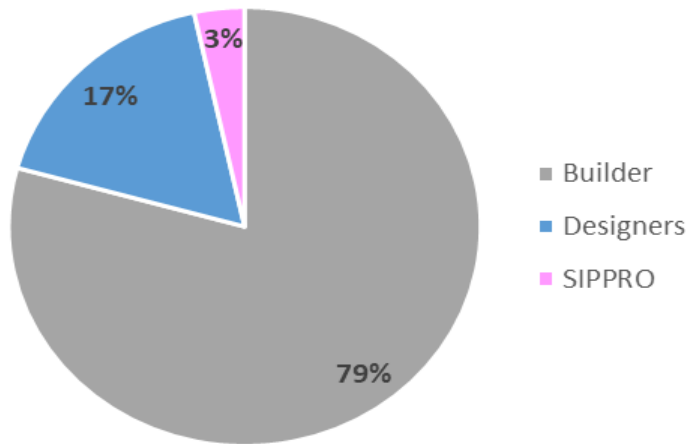
Solutions requested and developed out of the design phase.



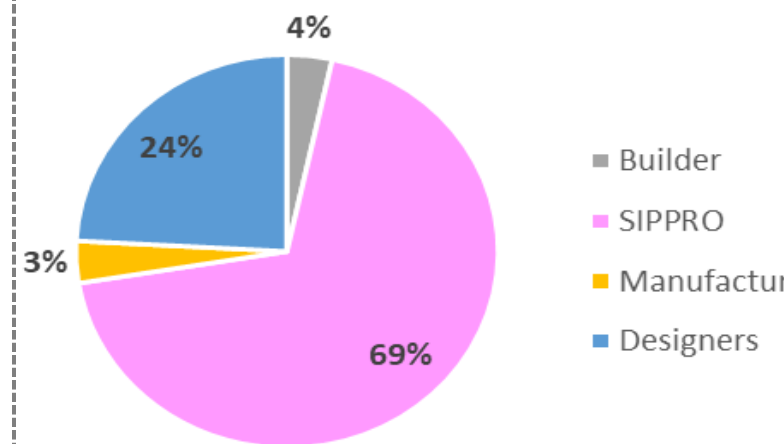
Nature of solutions: manufacture, construction or design origin.



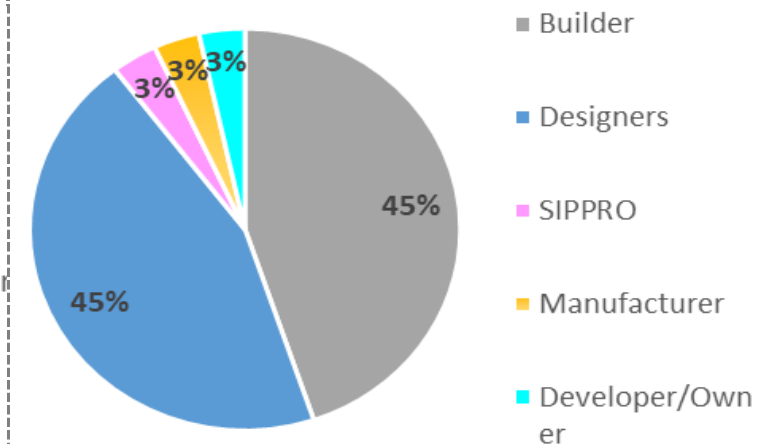
Phase when the solution was developed: design or construction.



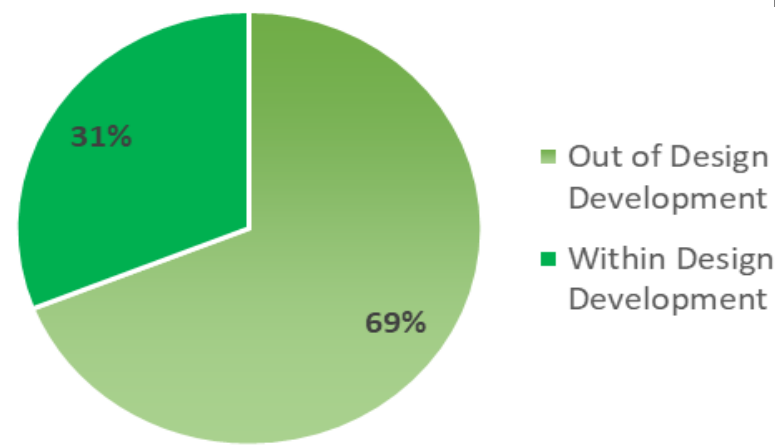
RFI requester.



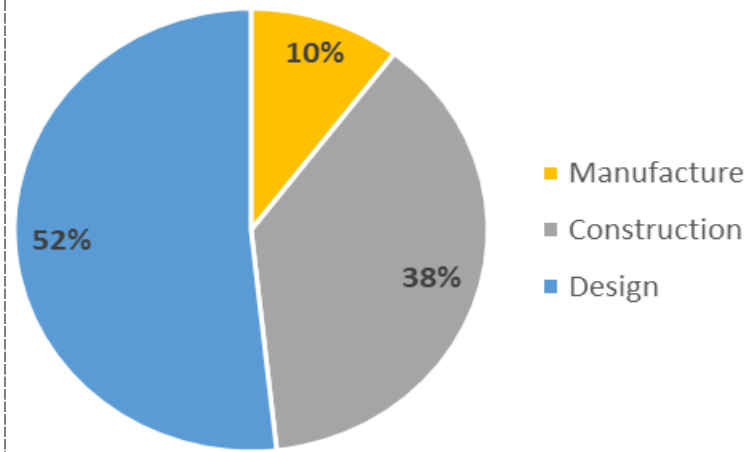
Solution developer.



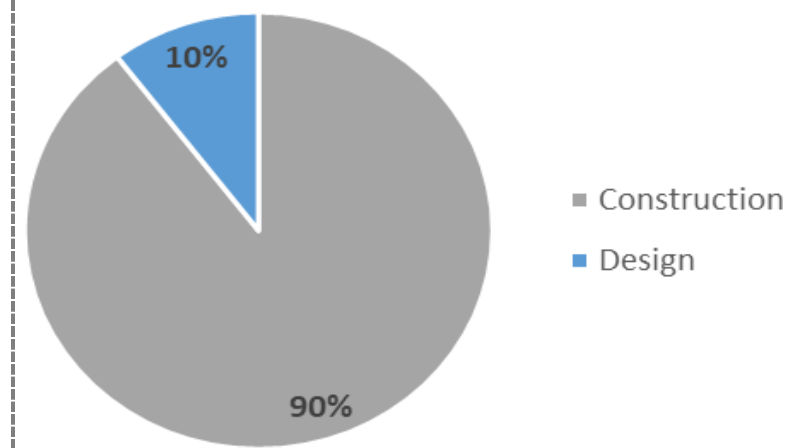
Solution validator.



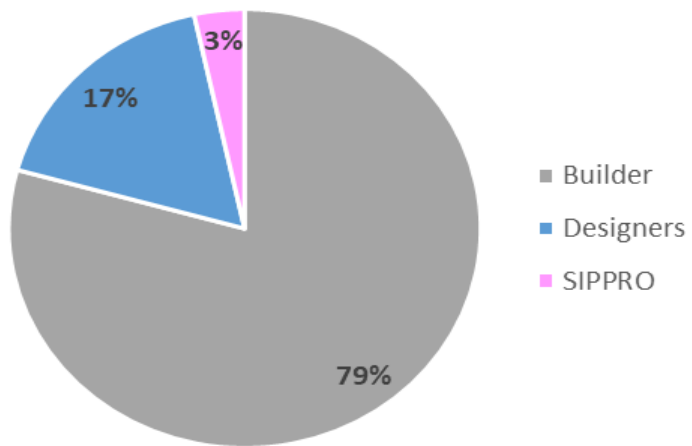
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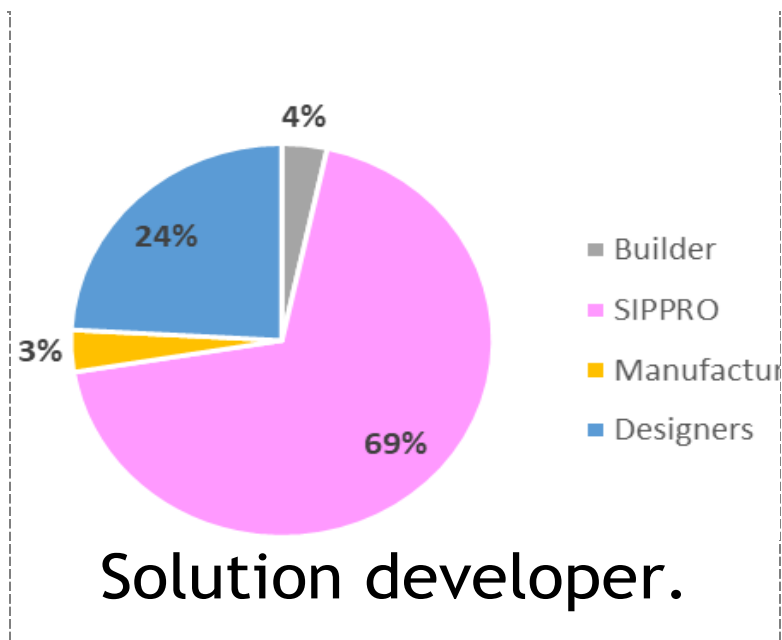
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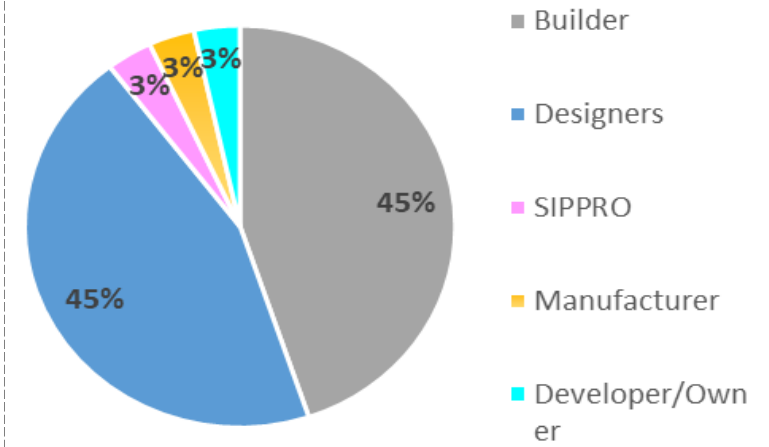
Phase when the solution was developed: design or construction.



RFI requester.

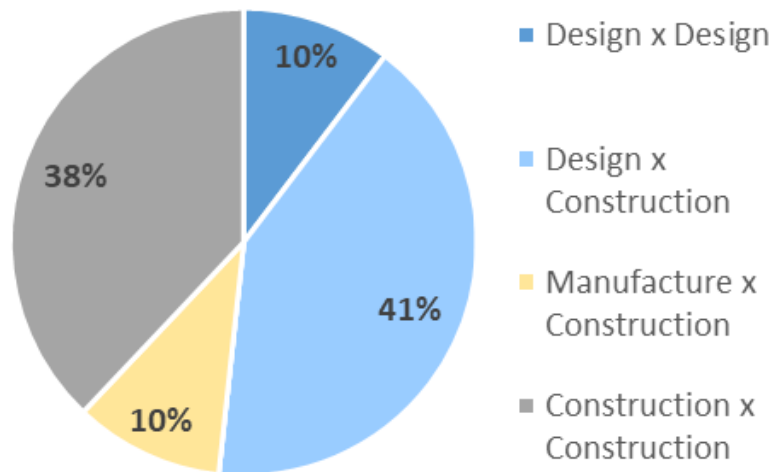


Solution developer.

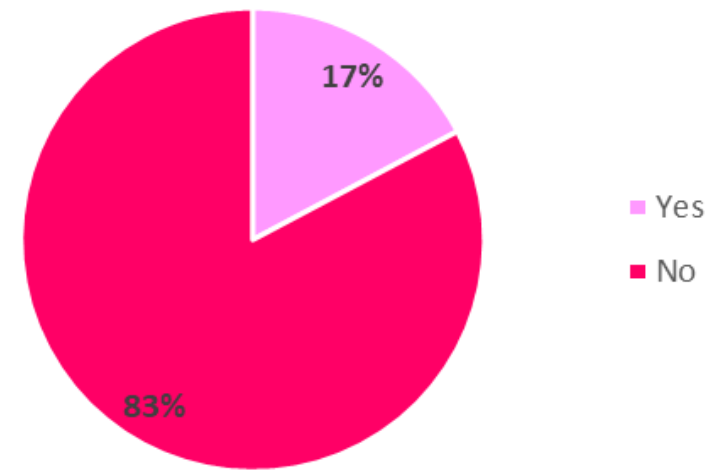


Solution validator.

Results Analysis



Nature of solution v.s. Phase it was requested.



Solutions part of the SIPPRO's contract scope.

Conclusive Discussion

- Several demands from design, manufacturing and construction occurred due to the lack of detailed information in the drawings/models → high volume of design solutions developed during the construction phase.
- The main responsible for generating new design solutions for production was the consultant company SIPPRO.
 - new skilled player to generate the BIM for production models,
- The D-B-B stimulates Stage 1 of BIM Maturity, although the project achieved Stage 2.
- Other procurement routes that promote concurrent engineering should be adopted to implement BIM throughout the design and construction phases.
- AEC industry needs to overcome contractual issues, i.e., to predict an early contractor involvement to design the production system aligned to the product design.

Acknowledgements

- SIPPRO - Solutions for Production Planning
- BSPAR Developer and Construction
- Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES)

