IGLC 28

BERKELEY, CA 6-12 JULY 2020

28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

Implementation of Production System Design in House Building Projects: a Lean Journey in Chile

Karina Barth - Ph.D. Candidate

Marcus Sterzi - MSc

Carlos Formoso - PhD

Juan Ignácio Alliende - Eng

Daniela Bertín - Eng

Jorge Del Rio - Eng

NORIE Núcleo Orientado para a Inovação da Edificação

UFRGS UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

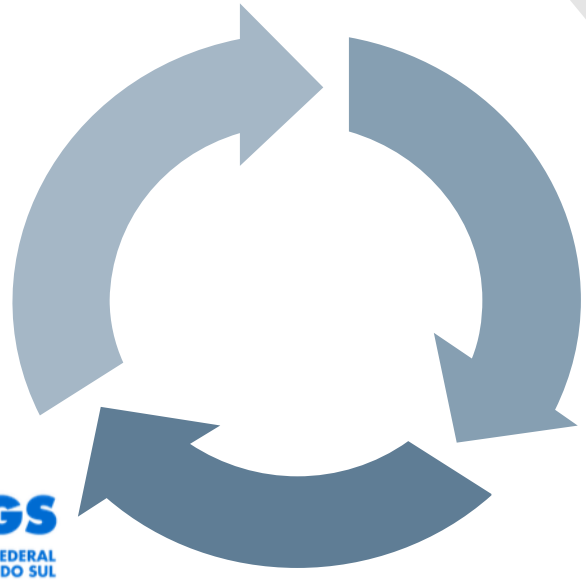
LD CONSULTING

EMPRESAS SOCOVESA

Agents involved

EMPRESAS SOCOVESA

- **Largest real estate** group in Chile.
- Both development and construction.
- **High degree of repetitiveness** in its **residential building projects**.
- More than a 100 projects in progress and sells more than 3,000 units per year.
- **The company is promoting a major Lean transformation process.**



- Research center in the University.
- **Co-Responsible for the Lean Implementation Program**.

NORIE
Núcleo Orientado para a Inovação da Edificação

UFRGS
UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

LD CONSULTING

- Lean consultancy company
- **Responsible for the Lean Implementation Program**

Production System Design (PSD) in Construction

- PSD translates **the production strategy into a set of decisions**, which establishes a structure to manage different activities, and **creates conditions for control and improvement** (Ballard et al. 2001a; Schramm et al. 2006).

- PSD consists of developing operation and process design in alignment with (Ballard et al. 2007):
  - product design,
  - the structure of supply chains,
  - the allocation of resources, and
  - design-for-assembly efforts.

- PSD **involves a set of interconnected decisions**, considering the need to improve the production system as a whole (Schramm et al. 2004).

- PSD can **potentialize the benefits of the LPS**, allowing the **early** identification of a larger range of problems (Frandson et al. 2015).

Aim of the study

- This paper reports the experience of a construction company that has implemented **PSD and the LPS over 3 years**, as part of an ongoing Lean implementation program.
- Contributions of this paper:
  - the definition of the scope and potential benefits of PSD
  - the proposition of a set of practices that can be used along the PSD stages, with emphasis on location-based planning and control

Implementation Process and Results

IGLC 28
BERKELEY, CA 6-12 JULY 2020
28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

PHASE 01

Assessment of existing situation – 2017

2 PROJECTS

- Construction sites visits for assessing planning and control system: **Evaluation protocol**

Company did not have a systematic and explicit PSD.
Lack of understanding of Lean concepts.
Large amount of WIP (based on Batch Completeness Index and Heatmaps).

PHASE 02

Development and initial testing of the Production Management System – 2017/18

3 PILOT PROJECTS

- Training course on Lean Construction
- **Implementation of PSD** (emphasis on location-based planning and control)

Lean Supporting Group: consultants and company members.
New decision category included to emphasize **layout** and **logistics planning**.
Standardized control tools: **cycle time**, **takt time**, **WIP** and **synchronization**.

PHASE 03

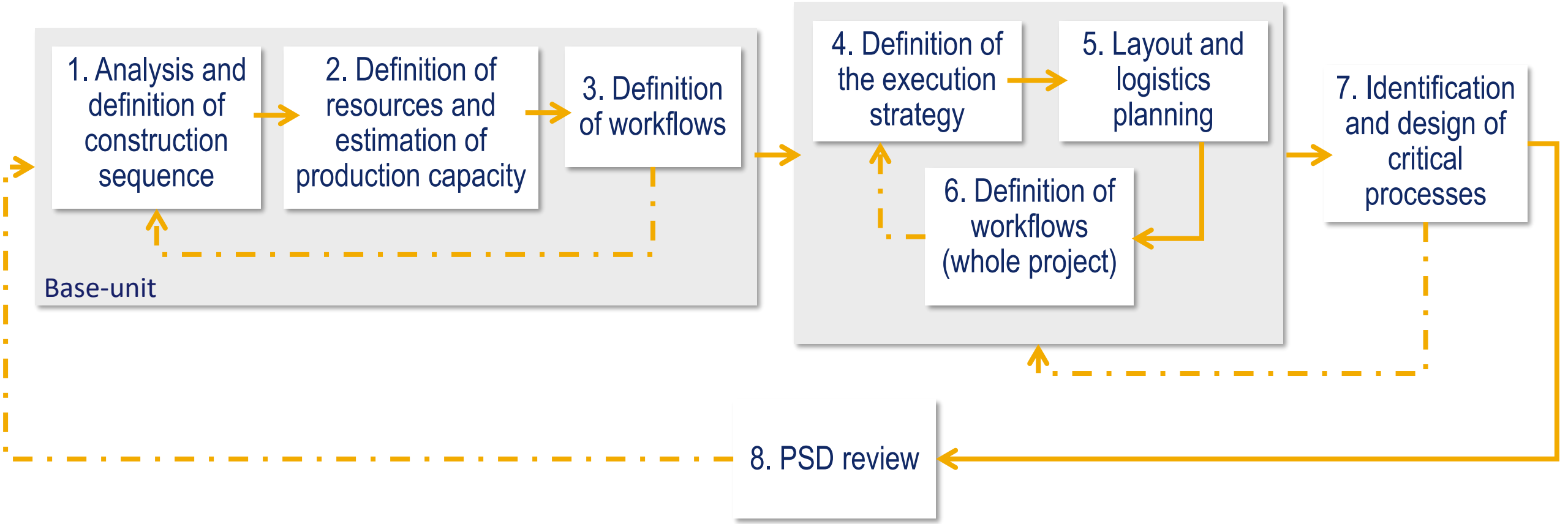
Implementation of PSD and LPS – 2018/19

5 IMPLEMENTATION PROJECTS

- Implementation of **LPS**
- Implementation of **PSD model**

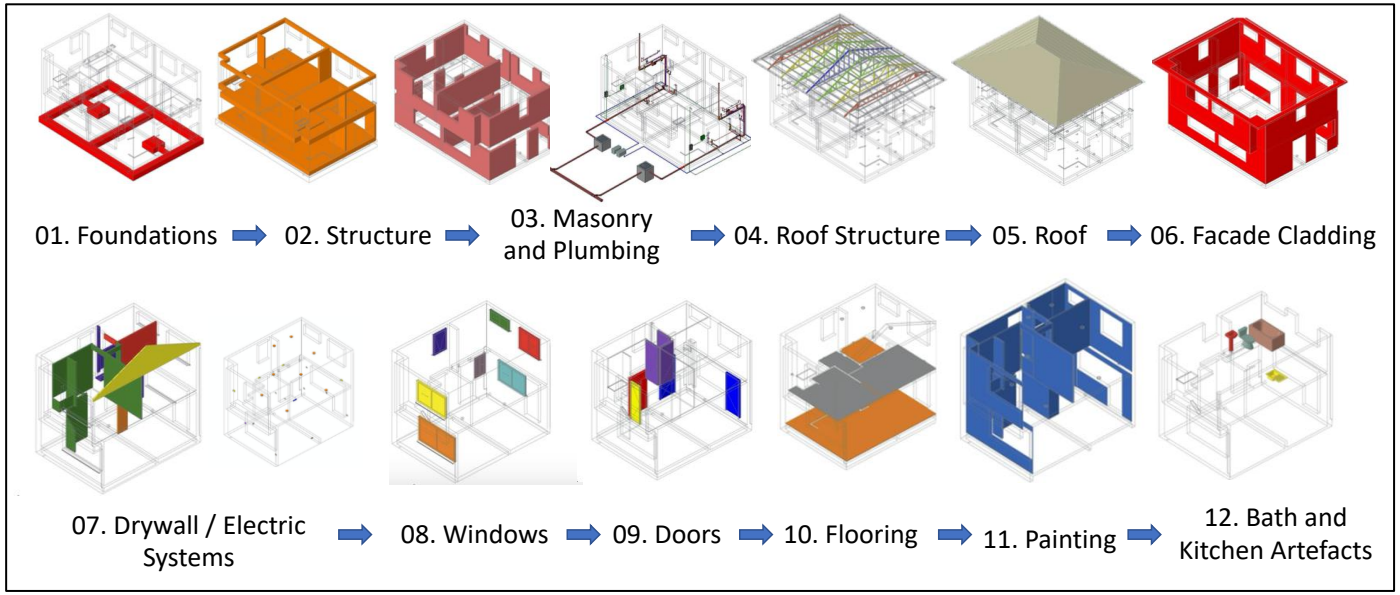
Workshop organized by the LSGroup to identify and disseminate **the benefits of implementing PSD.**
Proposition of a **PSD Guidebook**.

PSD Company Model



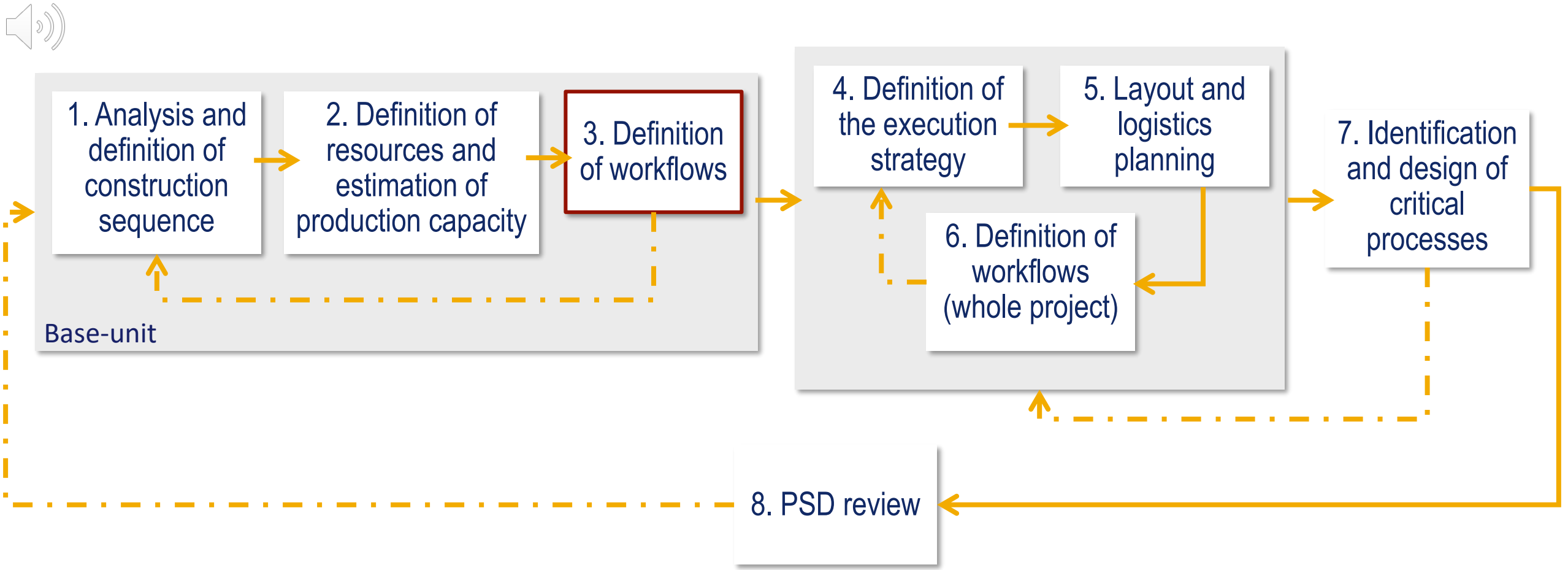
PSD Company Model: Decision Categories

1. Analysis and definition of construction sequence (base-unit)

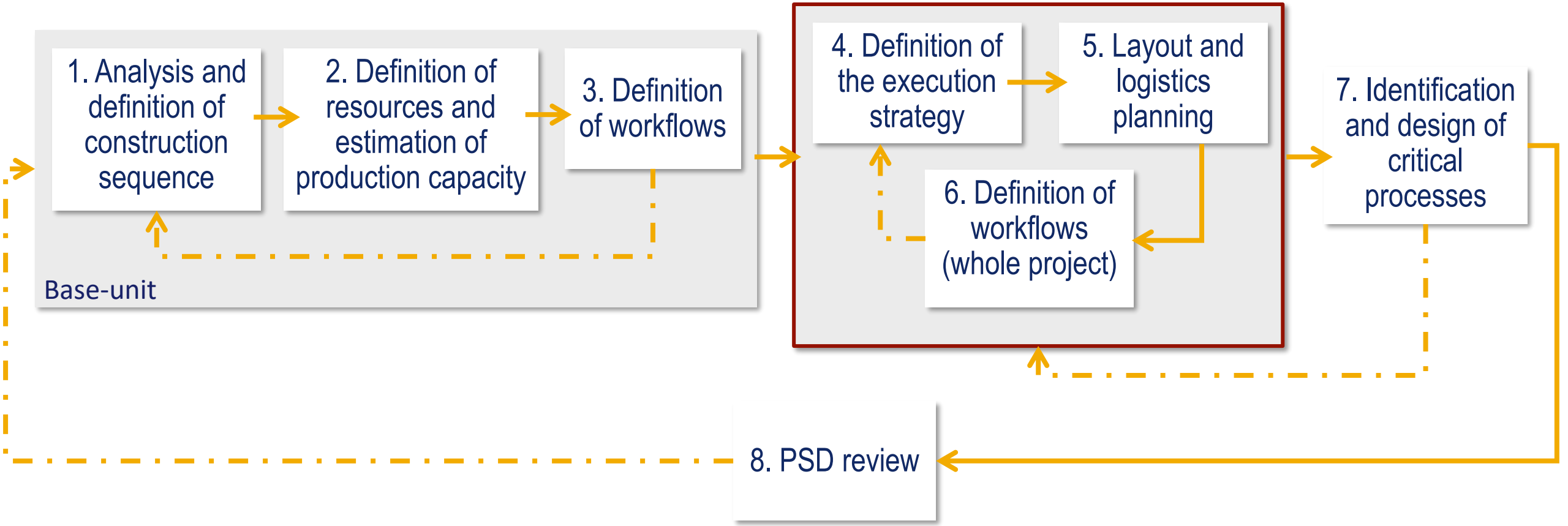


2. Definition of resources and estimation of production capacity (base-unit)

PSD Company Model



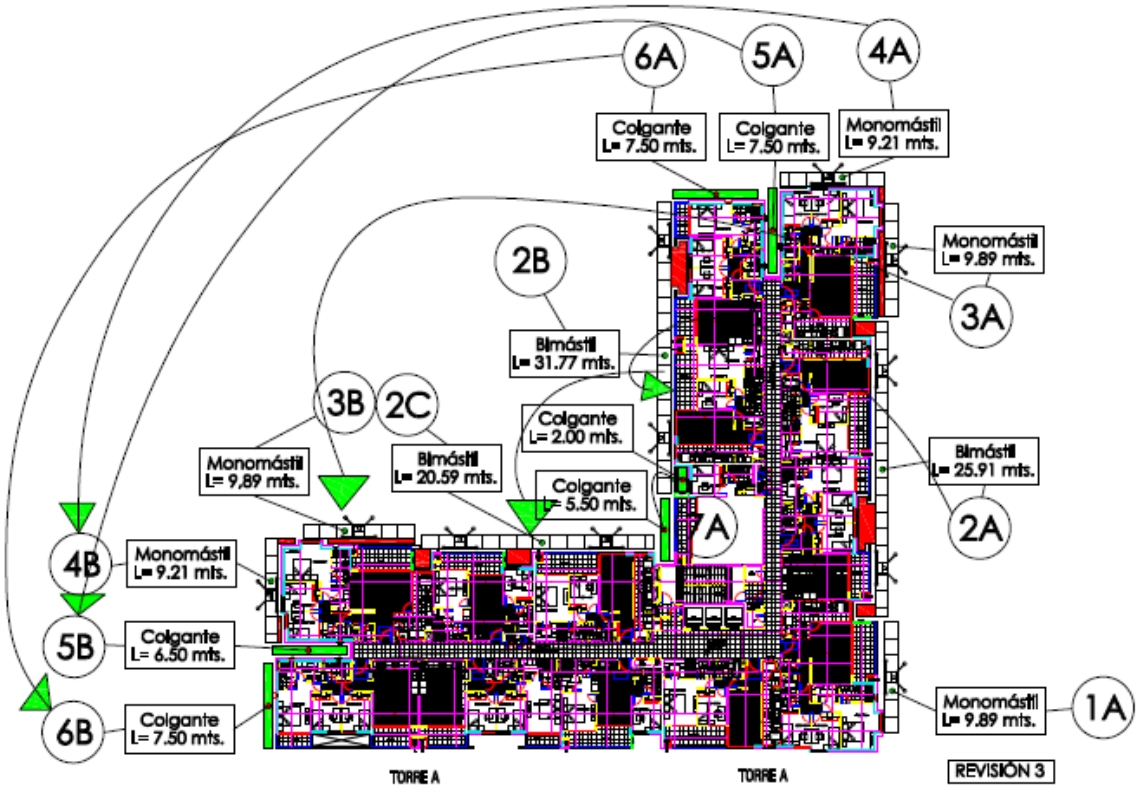
PSD Company Model



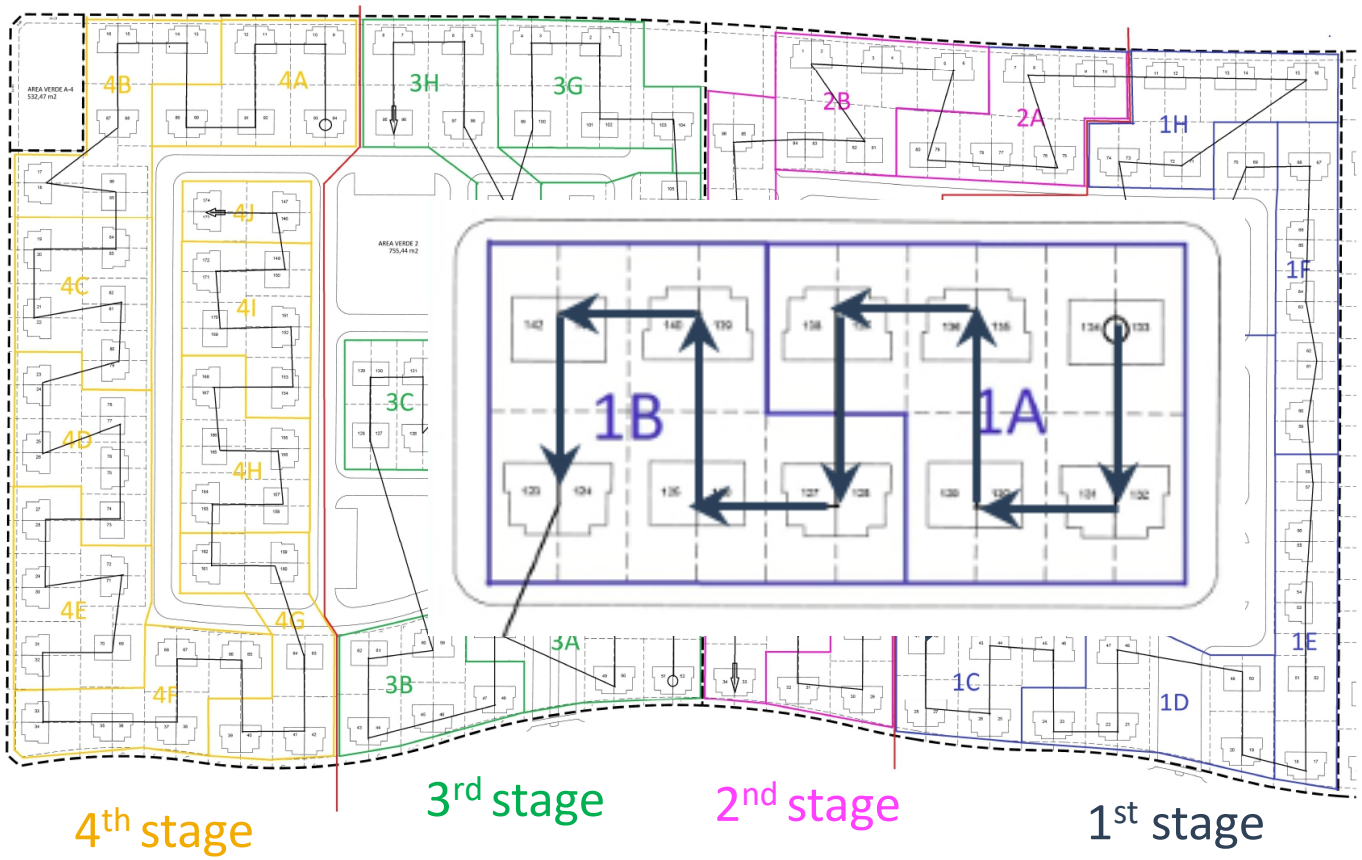
PSD Company Model: Decision Categories

IGLC 28
BERKELEY, CA 6-12 JULY 2020
28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

4. Definition of the execution strategy



Execution path of critical processes not included in BU: **Facades**

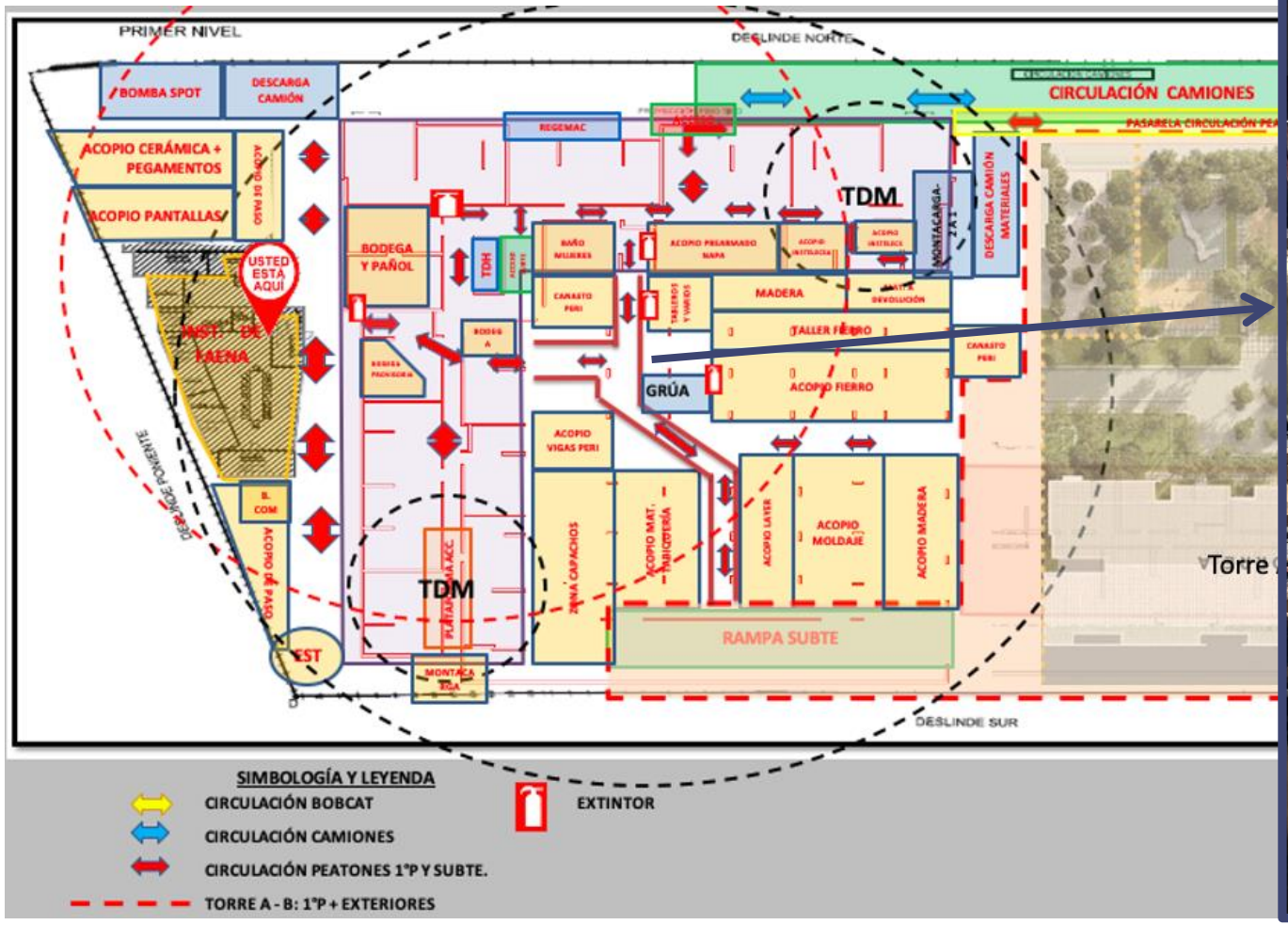


Work areas ("small projects") and **execution path** of BU processes

PSD Company Model: Decision Categories

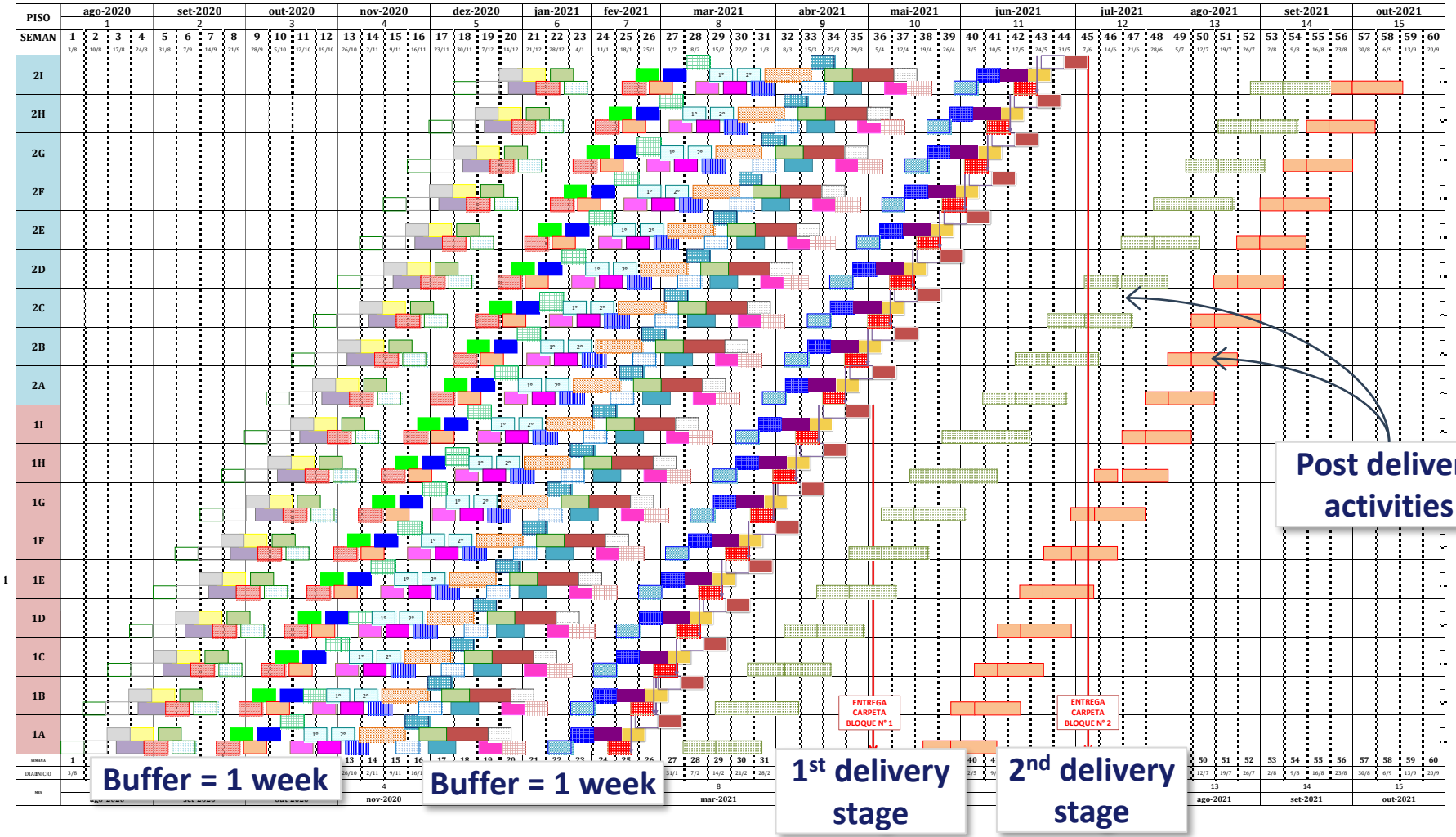
IGLC 28
BERKELEY, CA 6-12 JULY 2020
28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

5. Layout and logistics planning



PSD Company Model: Decision Categories

6. Definition of workflows (whole project)



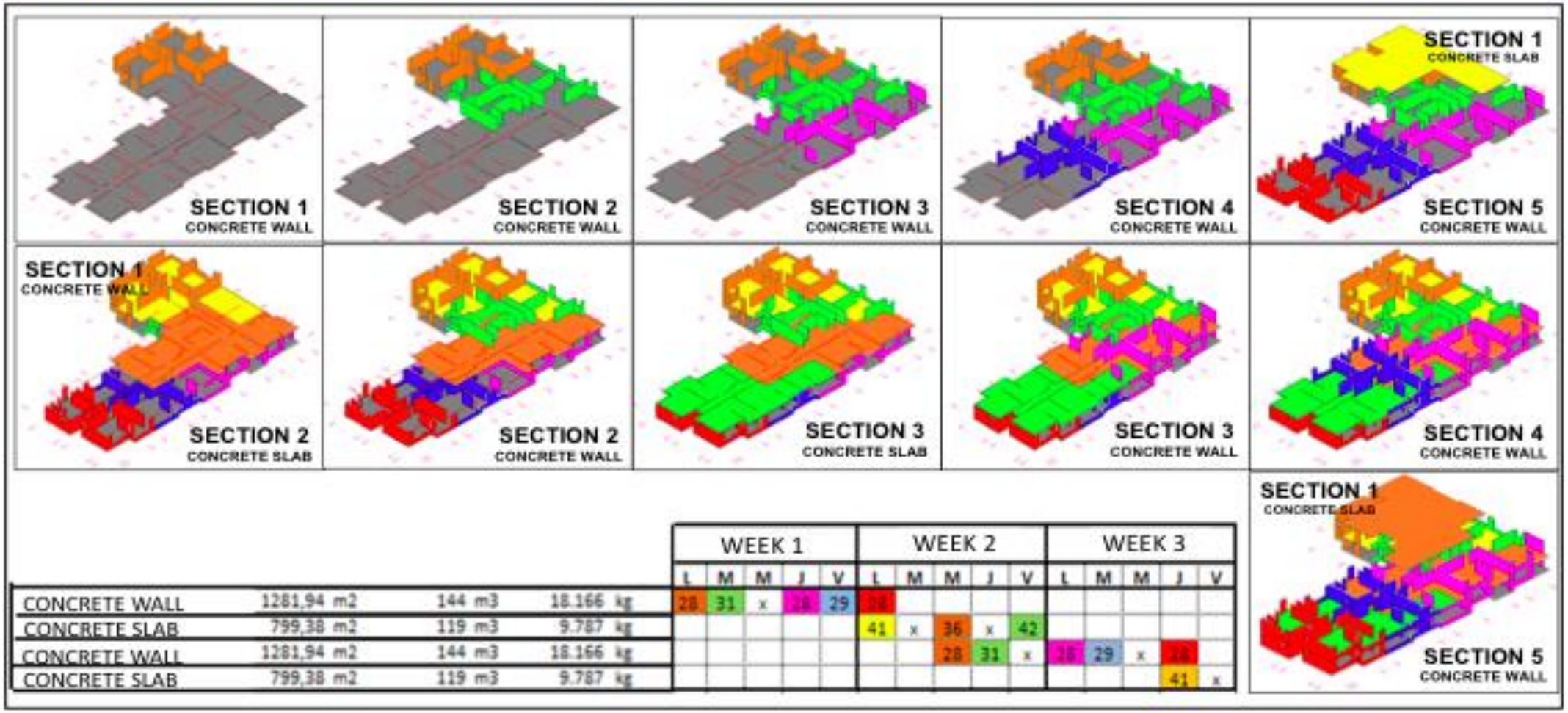
Line of Balance with Wagon System

PSD Company Model

IGLC 28
BERKELEY, CA 6-12 JULY 2020
28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

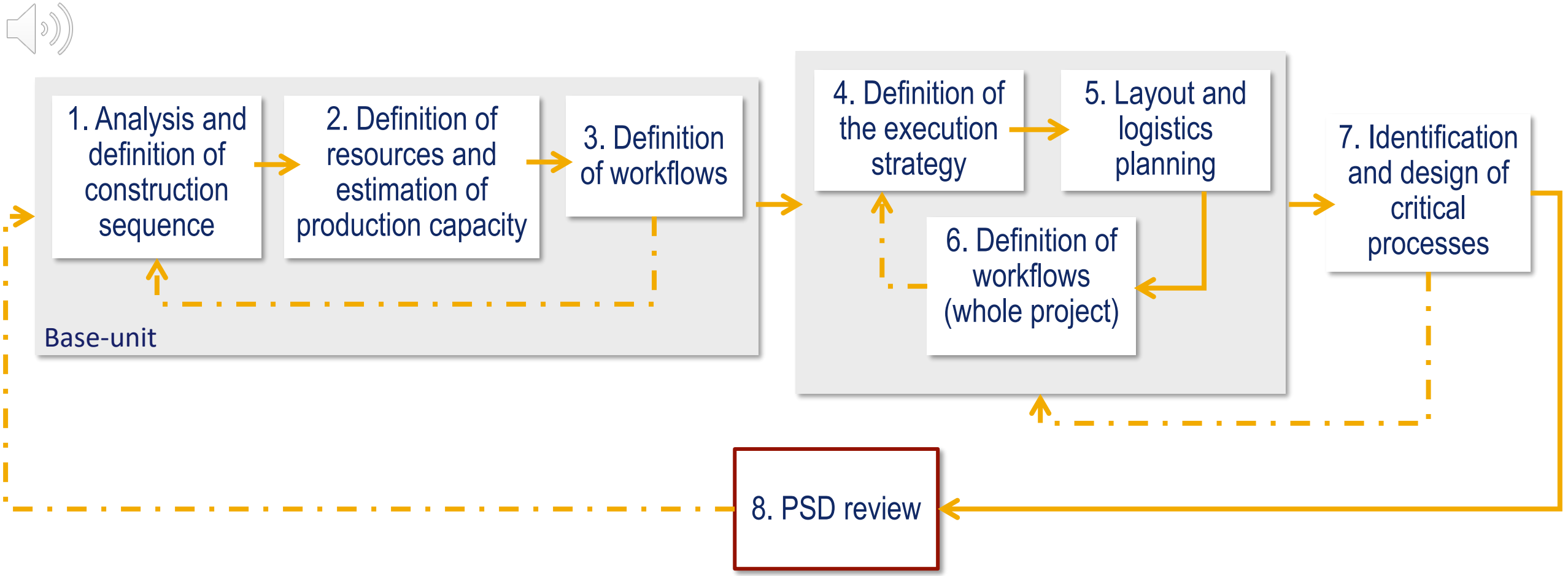
7. Identification and design of critical processes

Workstation map for critical process



				WEEK 1					WEEK 2					WEEK 3				
				L	M	M	J	V	L	M	M	J	V	L	M	M	J	V
CONCRETE WALL	1281,94 m2	144 m3	18.166 kg	28	31	x	28	29	28									
CONCRETE SLAB	799,38 m2	119 m3	9.787 kg						41	x	36	x	42					
CONCRETE WALL	1281,94 m2	144 m3	18.166 kg								28	31	x	28	29	x	28	
CONCRETE SLAB	799,38 m2	119 m3	9.787 kg														41	x

PSD Company Model



Benefits of Implementing PSD

- **Formalizing and making explicit planning decisions**:

  Key decisions on the design of the production system were made with the participation of main stakeholders

- **Reduction in uncertainty**:

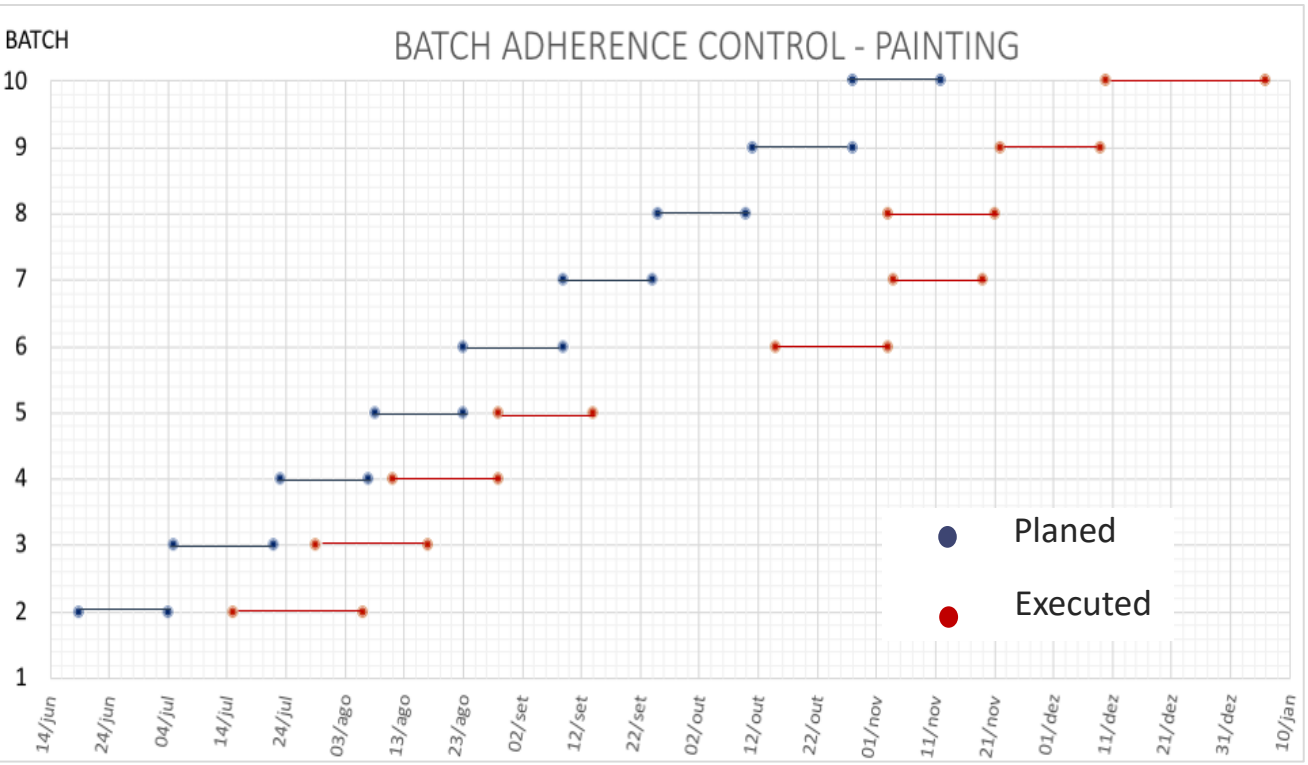
  PSD helps identifying production system limitations and critical processes.

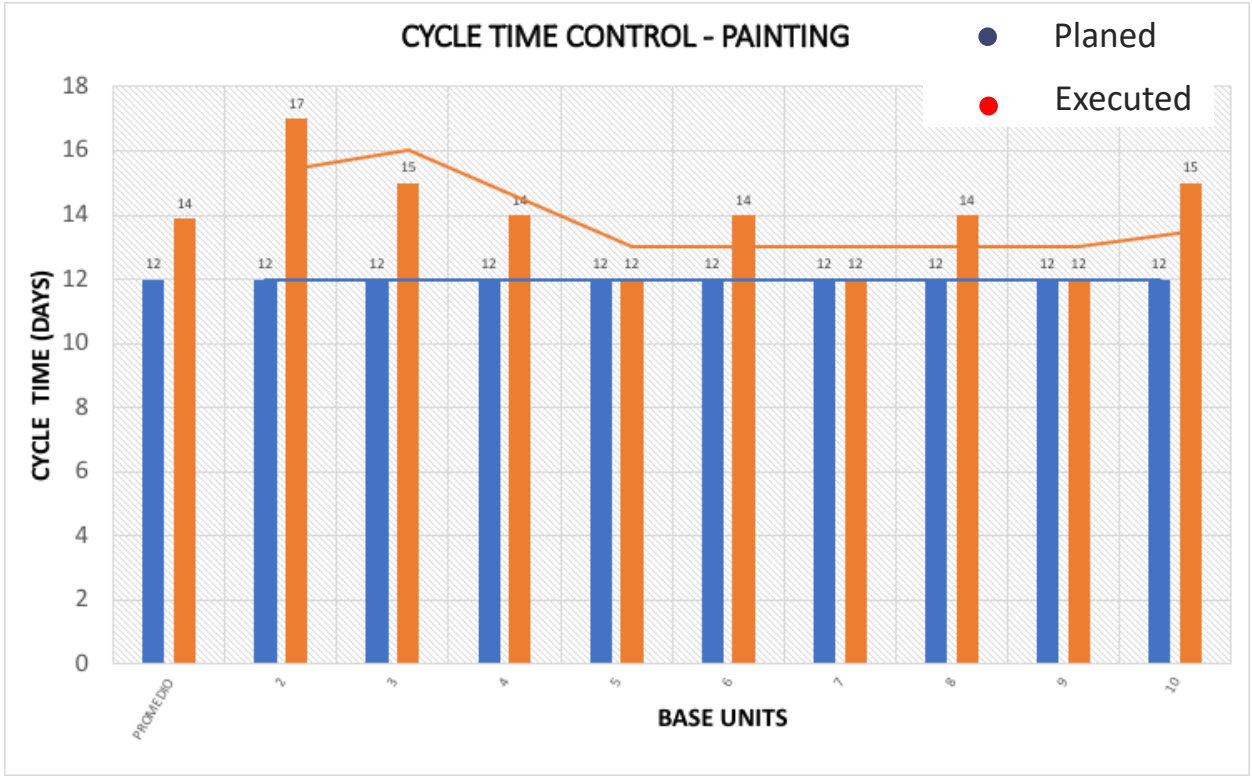
Examples of PSD meetings

Benefits of Implementing PSD

IGLC 28
BERKELEY, CA 6-12 JULY 2020
28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

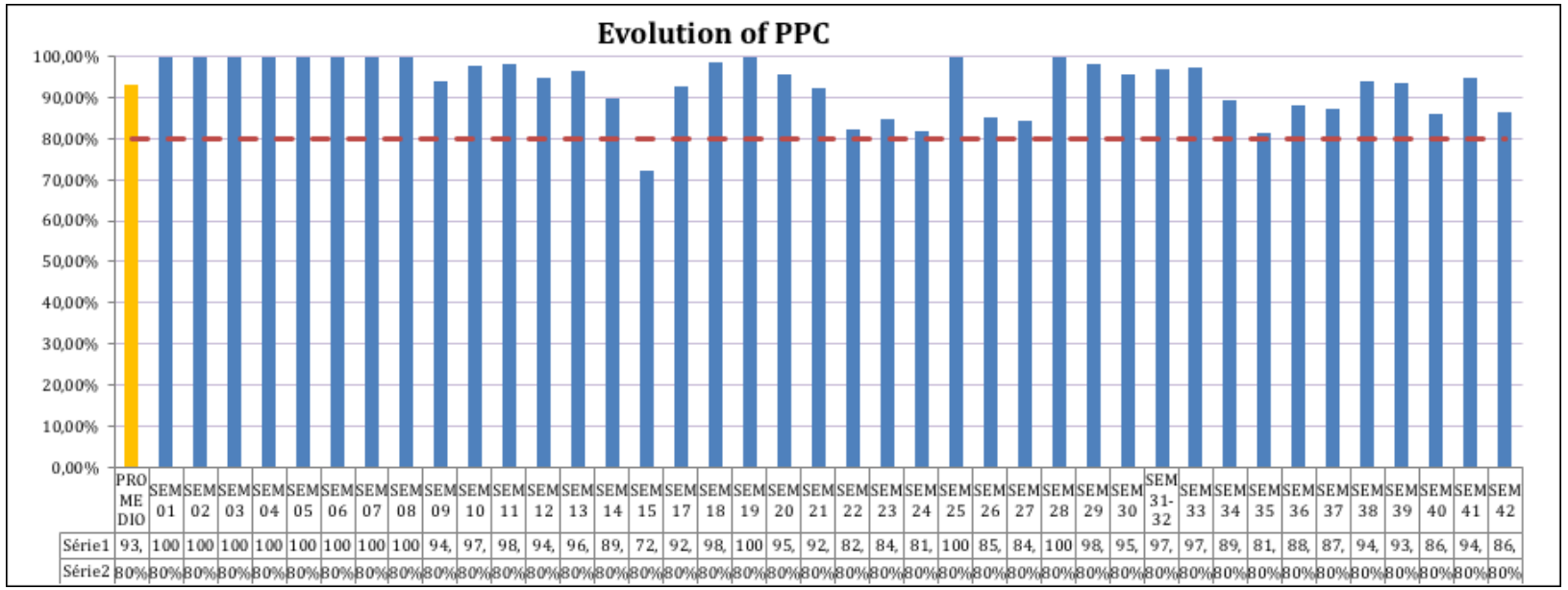
- **Improving planning accuracy**: considering multiple alternatives of construction systems and subsystems
- **Facilitating the adoption of cycle time and takt time control**: provides information in a systematic way





Benefits of Implementing PSD

- **Increasing engagement of stakeholders**
- **Improving production stability**



	PROMEDIO	SEM 01	SEM 02	SEM 03	SEM 04	SEM 05	SEM 06	SEM 07	SEM 08	SEM 09	SEM 10	SEM 11	SEM 12	SEM 13	SEM 14	SEM 15	SEM 17	SEM 18	SEM 19	SEM 20	SEM 21	SEM 22	SEM 23	SEM 24	SEM 25	SEM 26	SEM 27	SEM 28	SEM 29	SEM 30	SEM 31-32	SEM 33	SEM 34	SEM 35	SEM 36	SEM 37	SEM 38	SEM 39	SEM 40	SEM 41	SEM 42
Série1	93,	100	100	100	100	100	100	100	100	94,	97,	98,	94,	96,	89,	72,	92,	98,	100	95,	92,	82,	84,	81,	100	85,	84,	100	98,	95,	97,	97,	89,	81,	88,	87,	94,	93,	86,	94,	86,
Série2	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%

Evolution of PPC

Sequence and
WIP control

Conclusions

Pro ed PSD model X Previous studies:

- It was **tested and implemented** on several residential projects in a systematic way
- Provides more emphasis on **location-based planning and control**, **layout and logistics** studies during pre-construction stages
- Advances in terms of **cycle time**, **takt time**, **WIP** and **synchronization** analysis before construction
- Generates information concerning the **production system as a whole**
- Produces a set of **standardized tools** to be used to **monitor** the implementation of PSD

Data have been collected by the research team and, in the near future, the main results achieved will be systematically reported.

IGLC 28

BERKELEY, CA 6-12 JULY 2020

28th ANNUAL CONFERENCE OF THE
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

THANK YOU!

Karina Barth – karina@ldconsulting.com.br

Marcus Sterzi - marcus@ldconsulting.com.br

NORIE Núcleo Orientado para a Inovação da Edificação

UFRGS UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

LD CONSULTING

EMPRESAS SOCOVESA