



Lean Construction Congress

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Prefabrication: Introduction and
learnings from Finnish cases

Antti Peltokorpi, Aalto
University

Prefabrication - Agenda of the session

- **Introduction, barriers, Finnish cases, impacts**
 - *Antti Peltokorpi, Aalto University*
- **Platform based design for assembly**
 - *Phil Langley & Jami Cresser-Brown, Bryden Wood UK*
- **Turnkey hospital operating room**
 - *Mikael Sokolnicki, Inoroom*
- **Comment speeches and open discussion**
 - *Jessica Kelley, Southlands Industries*
 - *Timo Kekkonen, SRV*

MEP Prefabrication – Learnings from Finland

- **Technical building services prefabrication as a focus research area of Building 2030 consortium**
- **1. year research (2017-2018)**
 - *Mapping potential MEP prefabrication solutions*
 - *Analyzing barriers and enablers for prefabrication*

TWO KEY TAKEAWAYS:

→ *Three new process tasks needed in projects:*

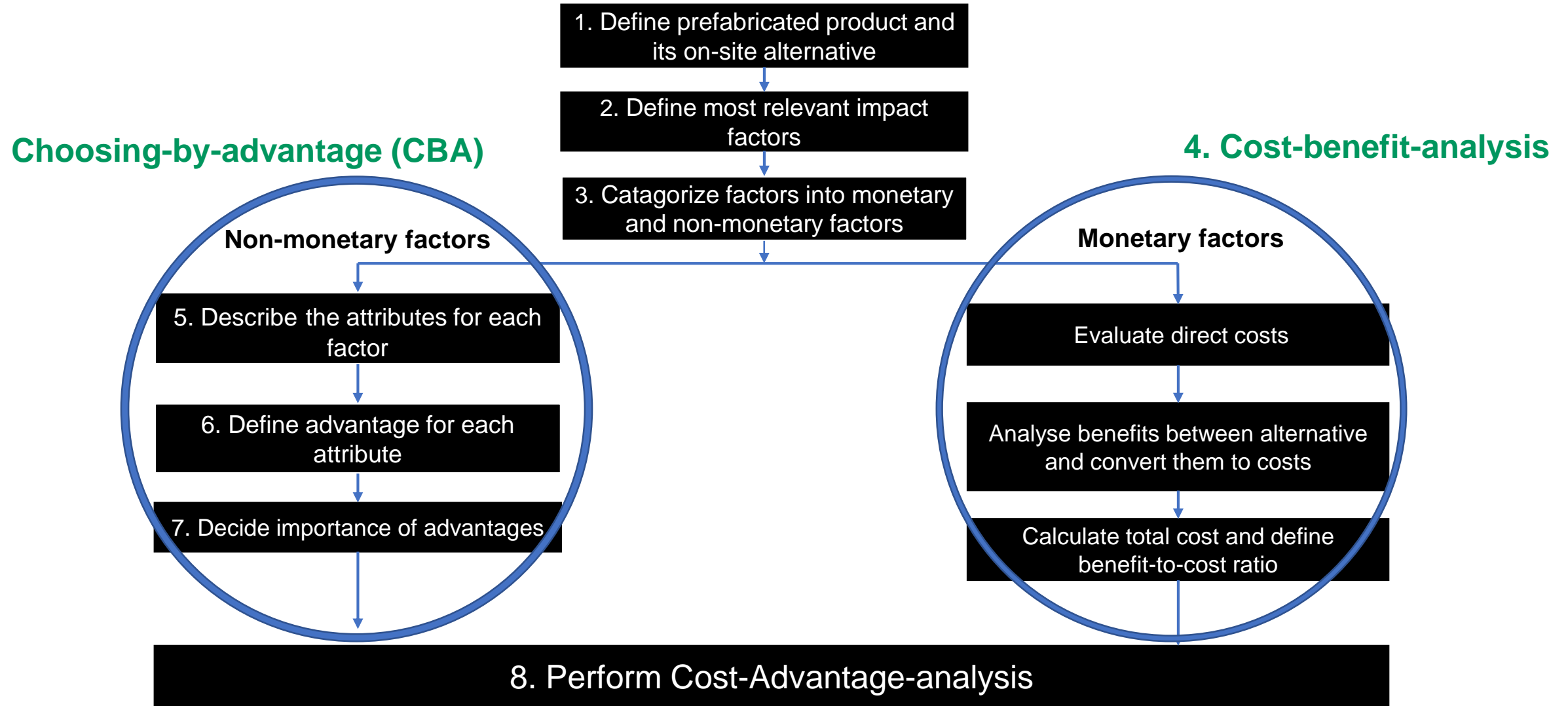
- **Prefabrication program** connected to the specific project targets
- **Fabrication and installation level BIM design** of prefabricated products
- **Detailed production planning** including logistics and JIT deliveries

→ **New process needed to better evaluate the impacts of MEP prefabrication**

How to consider multiple impacts of prefabrication?

Impact factor	Expected impact based on earlier research	Expected mechanism
Direct work and material costs	Lower, neutral or higher	Decreases labor and material costs because trade bottlenecks are reduced, less material waste
Waste and disposal	Reduced	Enables recycling and JIT material deliveries, components ordered to exact lengths
Safety	Improved	Reduces dangerous onsite working conditions (scaffolding, ladders), less traffic on site
Ergonomics	Better	Controlled work heights, tool weights, and environmental conditions
Project schedule	Compressed	Speeds up the assembly time, reduces staging on site, better coordination between trades
Quality	Equal or Better	Standardized working methods, clear quality control points in a stable environment, product certifications
Surrounding environment	Favorable	Less (noise, logistics) disturbance to neighbors, more environmental friendly
Design costs	First increase, later decrease	Requires more detailed designs but enables reuse of existing designs
Design flexibility	Decreased	Late customer changes are not possible
Sub-trade coordination costs	Reduced	Decreases needed coordination between subs, fewer coordination costs
Material management on site	Reduced	Materials are delivered in bigger units
Procurement	Harder, neutral or easier	Better productization (material and installation) and easier to purchase
Maintenance	Equal or Favorable	Makes maintenance easier if maintenance is considered during the design of the prefabricated products

Process of prefabrication impact evaluation



Cost-benefit-analysis – An example

- ❑ **Evaluate direct cost:** Direct costs include material, labor (factory and installation) and transportation costs of prefabricated modules; define responding costs in the conventional method
- ❑ **Analyze other benefits between the alternatives and convert them to costs:** This analysis takes into account indirect costs including other monetary factors, such as time-related costs, additional design costs, costs of injuries etc.

❑ Triple effect of time reduction (12 → 11 m):

1. Reduced contractor's general and site costs (8-9 costs)
2. Reduced capital costs
3. Improved project margins; team moving earlier to the next profitable project

Total Cost of a Conventional Bathroom = 8500 €	
Monetary Factors	Cost difference of Modular Bathroom
<i>Direct cost (material, labor, transportation and installation)</i>	+375 €
<i>Indirect costs</i>	
Quality (defects)	-320 €
Waste	-40 €
Schedule (Project margins)	-1364 €
Schedule (Site costs)	-150 €
Schedule (Capital cost)	-210 €
Total cost	6791 €
Benefit/Cost ratio = 8500/6791 = 1.25 >1	

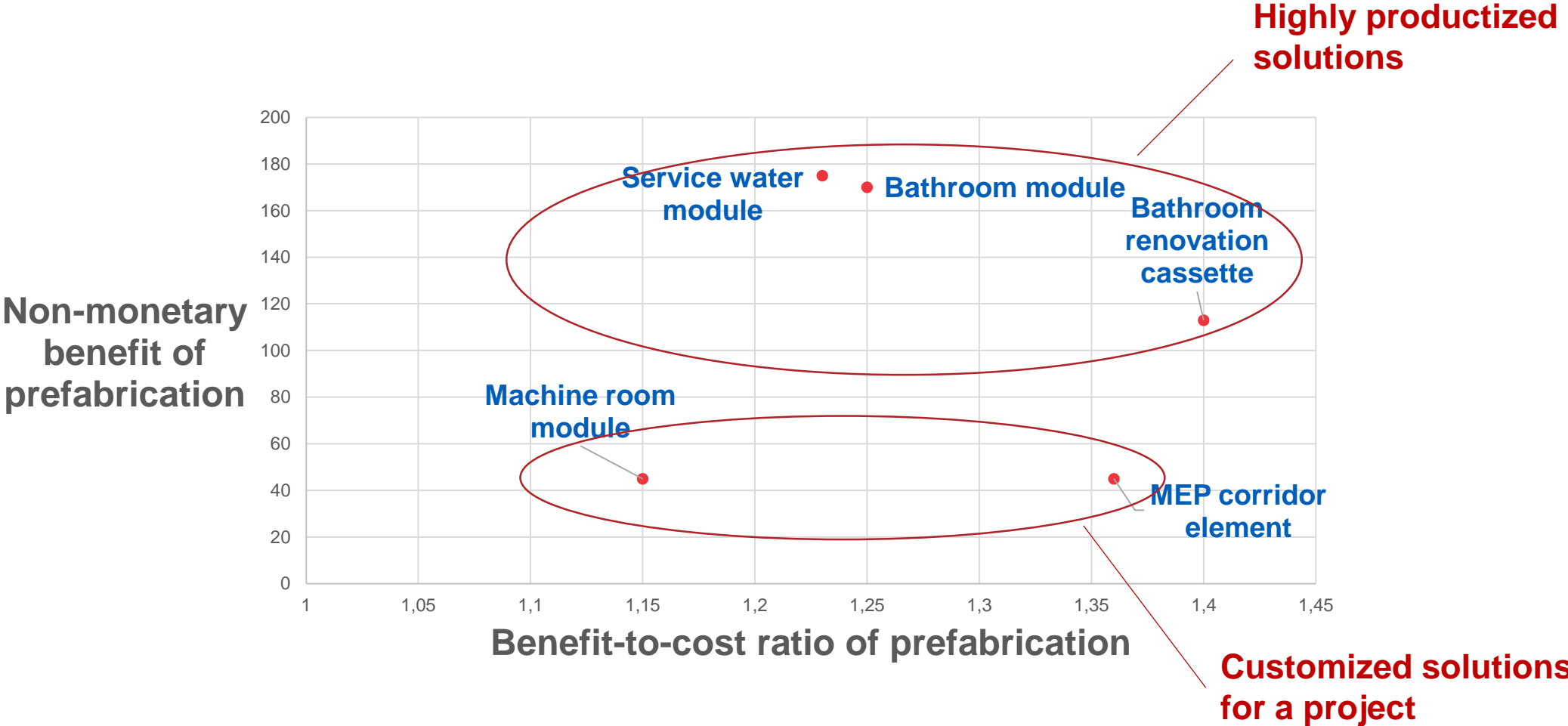
Choosing-by-advantage (CBA) analysis of non-monetary factors

Three phases:

- ❑ First, based on subjective criteria and each advantage, decide which single advantage is **the most essential** and give certain points (e.g. 100) for that.
- ❑ Then, based on subjective knowledge decide the (lower) points of the other advantages **comparing to the highest points**.
- ❑ **Sum up** the importance points (IofAs) for both alternatives

Factors (Criteria)	Alternative 1: Modular bathroom	Alternative 2: Conventional
1. Customer value (Higher is better)	Attributes: Involves intelligent feature Adv: Customers value remarkably additional features	<u>Att: Impossible to monitor energy consumptions</u> Adv: Imp:
	Importance: 100	
2. Project schedule (Shorter is better)	Att: Fast to construct Adv: 30 days faster to construct	<u>Att: Slow when constructed onsite</u> Adv: Imp:
	Imp: 60	
3. Work coordination (smooth flow is better)	Att: Less worker on small space Adv: Remarkably easier to coordinate work on site	<u>Att: more people working in same place</u> Adv: Imp:
	Imp: 50	
4. Design flexibility (Easier is better)	<u>Att: lack of design flexibility</u> Adv: Imp:	Att: Possible to change the design Adv: Easier to change the design Imp: 60
5. Risk (Lower is better)	Att: Installed the whole bathroom at a time Adv: Lower the material risk then conventional	<u>Att: Installed by collecting several parts of the bathroom</u> Adv: Imp:
	Imp: 45	
6. Transportation (Lower is better)	<u>Att: Bigger units needs to be transported</u> Adv: Imp:	Att: Smaller units needs to be transported Adv: Easier to transport Imp: 25
Total Importance points	255	85

Two-axis analysis: Monetary and Non-monetary benefits



Conclusions

- **Prefabrication requires long-term development investments both in product and process**
 - **Target primarily in productized solutions (product families), not in project-specific solutions**
 - **Considering the impacts widely and from multiple actors perspectives**
 - **Most of the benefits (and disadvantages) indirect; not self-evident but should be materialized through co-designed new process**
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