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REDUCING CONSTRUCTION LOGISTICS COSTS AND EMBODIED CARBON WITH CCC AND KITTING: A CASE STUDY

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INTRODUCTION

- Construction sector is considered as **one of the most polluting industries** and source of **congestion** in urban areas :
  50% of greenhouse gas production in the UK (Dadhich 2015)
  30% of the tons carried across cities in growing urban areas (Dablanc 2009).

- Suppy Chain Management provide practical tools to improve construction sites performances (Arbulu and Ballard 2004; Hamzeh et. Al 2007).
  Originally proposed to improve productivity by reducing wastes.

⇒ **Objective of this project:**
Investigate and demonstrate in a real case the applicability of improved Supply Chain Management towards a “Lean-Green deal” in construction

WHAT ARE SCM TOOLS AND WHY IS IT NOT THE NEW NORMAL?

CCC: Construction Consolidation Centre

Material from several suppliers is delivered in a warehouse and material flows are consolidated towards one or several sites.

⇒ Mossman 2008: Many benefits reported (productivity, transport reduction, safety, reliability)

⇒ BUT lack of initiative to replicate and generalise across other contexts

⇒ According to surveys (Lafhaj and Dakhli 2018): Need for economical evidences

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Kitting and Just-in-Time

Material is delivered at the exact workplace, as a kit dedicated to one or several specific task(s). Delivery is pulled by planning needs.

⇒ Tetik 2020 : on-site labour productivity improvements

⇒ Need for in depth analysis of direct and indirect costs

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Third Party Logistics

Specialized actors take over the logistics management of a project.

⇒ Eleskar 2020: productivity improvements, cost savings and increased utilisation of site assets

⇒ BUT the lack of knowledge on internal costs for logistics and the fear for unrealistic fees are barriers for a wider diffusion of the model

CONSTRUCTION LOGISTIC COST BREAKDOWN PROPOSED

	With CCC	Without CCC - traditional logistics
Direct costs	TPL arrangement (A1) Transportation costs from suppliers (A2)	Transport from supplier to the site and handling time from truck to storage zone (A1)
Indirect Costs	(B1) Managers time and fee (only linked to material)	
	(B2) Lifting equipment costs and resulting coactivity (only linked to material)	
	(B3) Overall days saved on planning for the complete project (only linked to material)	
	(B4) Productivity losses on workstation on the tasks themselves (only linked to material)	

PROCESS AND DATA COLLECTION

Supplier

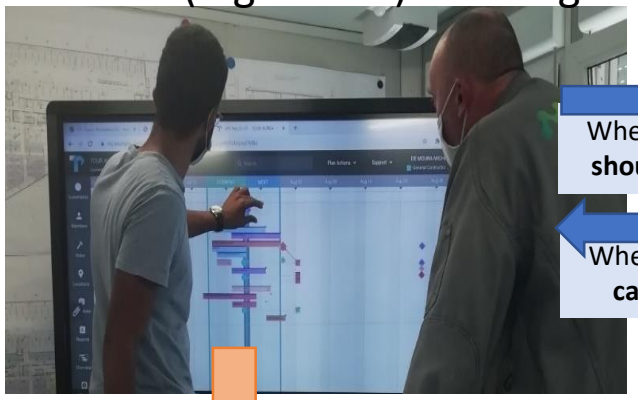
What can be kitted by suppliers ?

CCC

What is ready for delivery on site ?

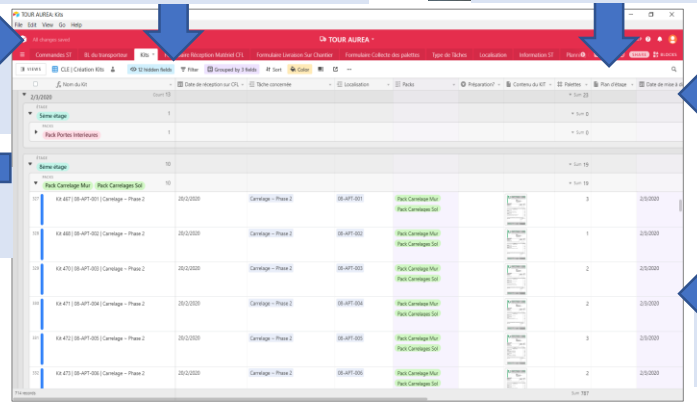
Deliveries by TPL operator

LPS (digitalized) meetings



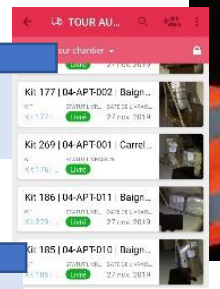
When the task **should** start ?

When the task **can** start ?



When the kit was delivered ?

When the kit was actually used ?



Phone App

Kit Data management Platform

Additional discussions with subcontractors (bi-weekly)

⇒ **What would have happened in a traditional way ?**

Data collection of "what actually happened" integrated to process

Focused time measurements and access to actual project's accounting

⇒ **What are the impacts ?**

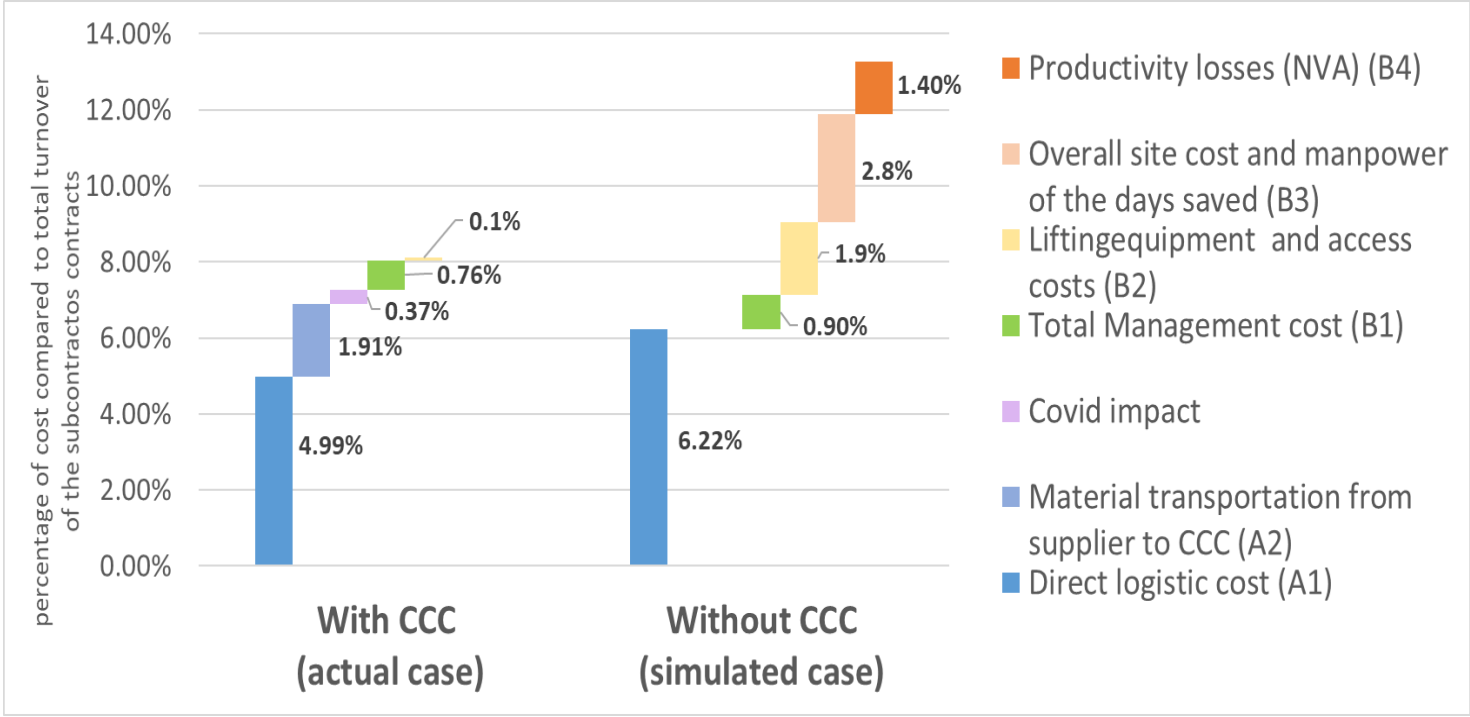
Data Collection for the actual case ("with CCC") and simulated case ("traditional logistics")

CASE STUDY DESCRIPTION

- 14 floors tower, €35M budget
- Site access limited and low storage capacity on site
- City of Differdange: 28.000 inhabitants
- First implementation of CCC and TPL in Luxembourg
- Trade selected for the experimentations:
  HVAC, bathtubs/showers, tile/parquets flooring, sanitary equipment and joineries (internal and external doors)
- 744 pallets in total

RESULTS: OVERALL COSTS

- The estimated **cost of logistics was at least 13.3% of the turnover** of the lots considered.
- Decreased by 39%, **down to 8.1%**.
  Due to productivity improvement and reduced coactivity.



Overall Cost breakdown in percentage of the total turnover of the lots studied

RESULTS: EMBODIED CARBON

- 49 deliveries on site from CCC
- 144 deliveries from suppliers would have been necessary without CCC

Task	With CCC	Without CCC	Impact
Ventilation	10.12	10.4	-2.69%
Bath/Shower	0.61	0.8	-23.75 %
Sanitary equipment	0.64	0.6	+6.7%
Tiles	3.79	1.9	+99.5%
Doors	10.91	34.2	-0.68
Total (in T of CO2)	**26**	**48**	**- 46 %**

Embodied carbon in T of CO2

⇒ Overall **66% reduction of truck entering urban area** and **46% decrease of embodied Carbon**

- Discrepancies on the carbon emissions depending on supplier's location

⇒ In order to maximise environmental impact, the use of the CCC model should be assessed case-by-case

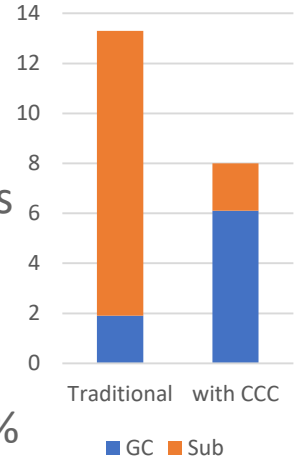
DISCUSSIONS

A step towards Holistic Lean Construction approach

- The collaborative framework of **LPS facilitated** the gathering of the actual material needs and constraints.
- Reliable and constantly updated status of material enabled to start weekly meeting with a **trusted workable backlog**.

Costs and gain sharing

- Most of the costs were transferred from subcontractors to General Contractor



- A contribution of 5% of turnover paid by subcontractors was considered a win-win by all stakeholders.

COVID-19 and coactivity reduction

- Kitting helped to streamline workflows and thus reduce coactivity
- According to GC, CCC worked as a buffer for materials during the lockdown:
  CCC could contribute to improve construction sector's resilience.

CONCLUSIONS

CCC + Kitting +TPL **can be successfully applied** in order to **reduce both environmental impacts and overall costs** of logistics in construction.

The project being the first of its kind in the country, the scope is limited **and more studies are needed** to validate authors findings.

The **cost breakdown proposed in this paper can be applied in other project**, in order to assess logistics costs.

An **extended knowledge of the products** to be delivered as well as full traceability of the materials condition was required.

⇒ Product Data templates
⇒ Construction Digital Twin

THANK YOU!

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