THE COST BENEFITS OF ALTERNATIVE LOGISTICAL SOLUTIONS IN A CONSTRUCTION PROCESS.

A costing model to predict the cost benefits of Construction Consolidation Centres during the preparation stage of a construction project within the Dutch construction sector.

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Agenda

Introduction

Theoretical background

Model development

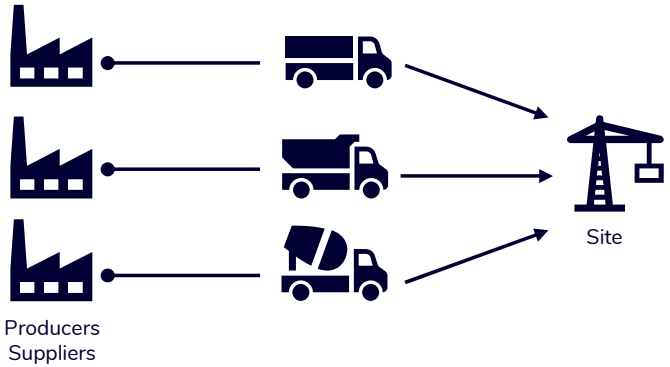
Model testing

Conclusions

Discussion

Recommendations

Traditional



50% → 80%

Turnover

(De Bes et al., 2018)

30%

Transport

(Vrijhoef, 2019)

30%

CO2 NOX PM10

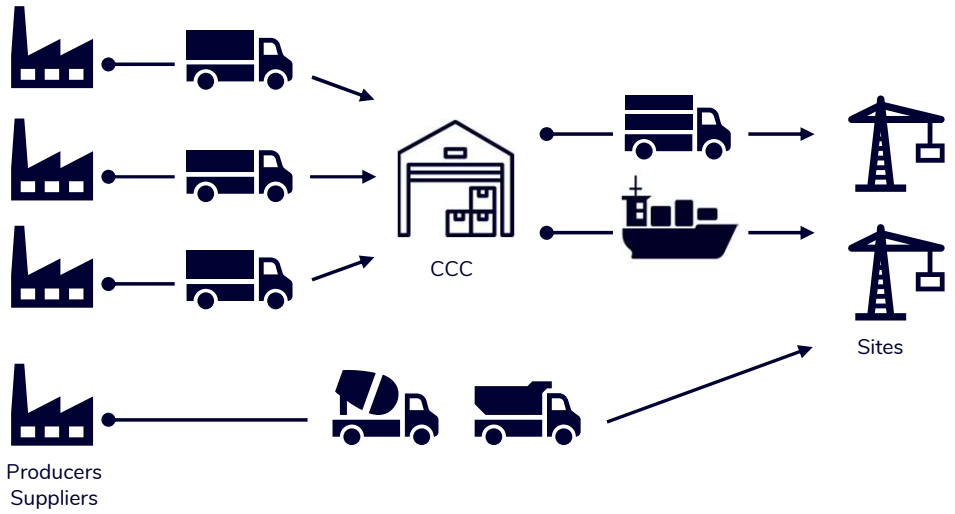
(Vrijhoef, 2019)

100%

Nuisance

Innovation

Construction Consolidation Centres



Transport

Reduction journeys

Clean vehicles

Service at CCC

Materials stored secure

One contact for delivery

Flexible response to orders

On-site

Less storage needed

Saver work environment

Higher labour productivity

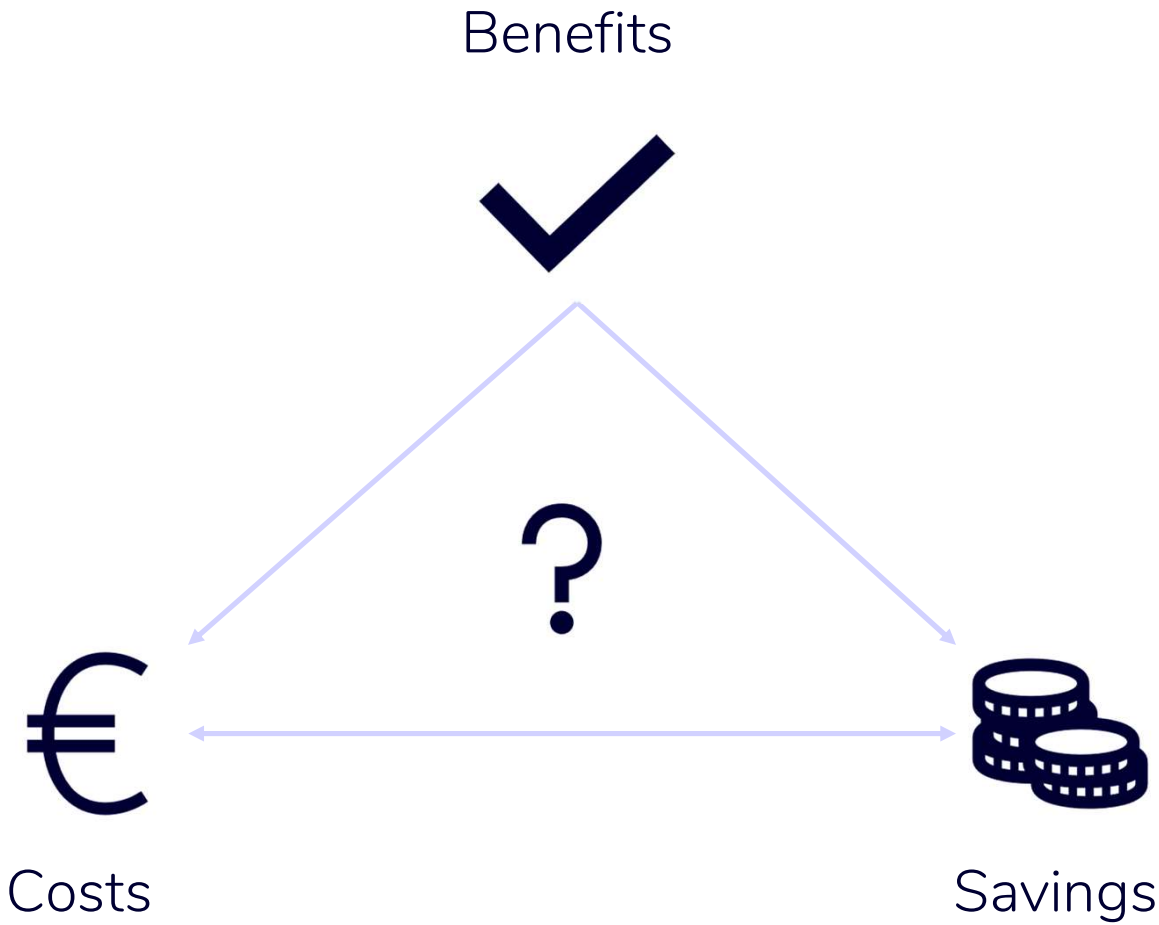
Environmental

Reduction in km

Reduction in congestion

Reduction in materials ordered damaged stolen

Problem statement



(De Bes et al., 2018)

Research question

To what extent can the logistical costs related to construction be **modelled** in the **preparation stage** of a project to **predict the impact** of the implementation of a **Construction Consolidation Centre**?

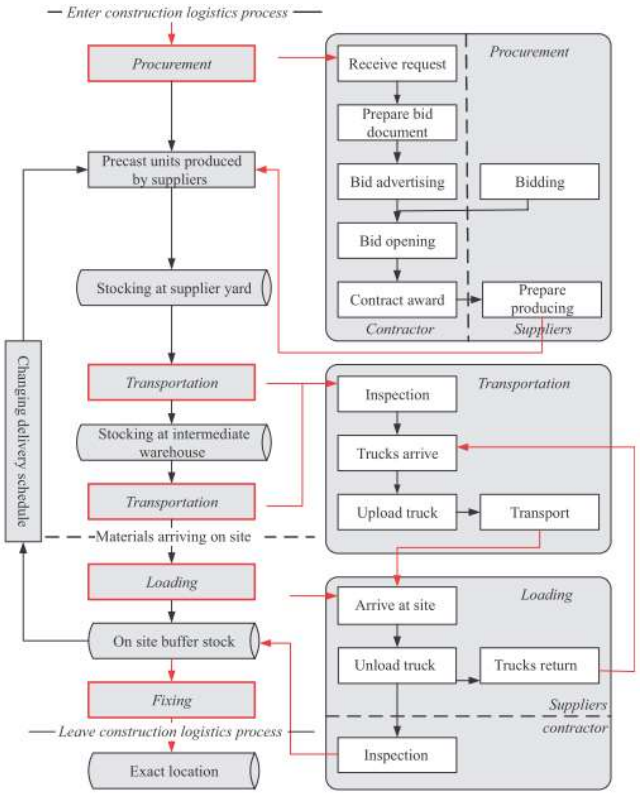
Construction Consolidation Centres

History, typologies, benefits and activities

- Logistics coordination
- Just-in-time delivery
- Buffer storage
- Day production packages
- Site logistics
- Warehousing
- Prefabrication
- Waste transport
- Shuttle service
- Express transport

Cost accounting

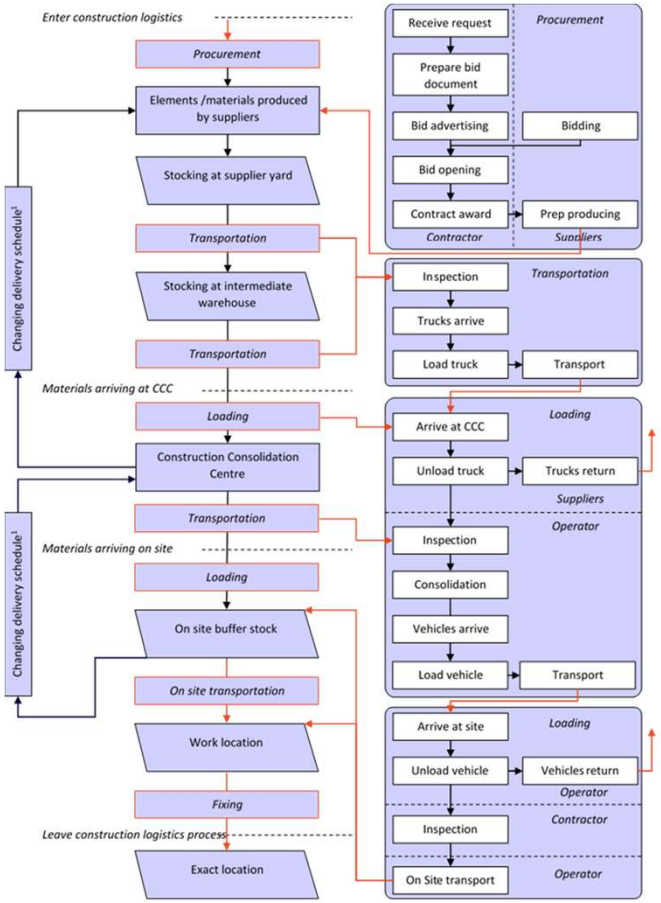
Methods, cost types, and applicability



Activity based costing framework of Yuan Fang and Thomas Ng (2011).

Framework I

Activities



Cost factors & formulas

Logistics process	Category	Resource	Costs of resource	Costs of activity	
Procurement	Labour	Staff in bidding	Pay rate	Pay rate × working time	Suppliers
	Equipment	Printer, paper fax, telephone	Depreciation rate	Depreciation rate × contract price	
	Capital	Travel costs	Travel costs rate	Travel costs rate × contract price	
Process management	Labour	Staff in process management	Pay rate	Pay rate × working time	
	Equipment	Printer, paper fax, telephone	Depreciation rate	Depreciation rate × contract price	
	Capital	Travel costs	Travel costs rate	Travel costs rate × contract price	
Storage at supplier yard	Labour	Worker (handling)	Pay rate	Pay rate × total quantity	
		Administrator	Pay rate	Pay rate × storage quantity × unit costs × duration	
	Equipment	Handling truck	Rental rate	Rental rate × total quantity	Transport
		Iron Material	Depreciation rate	Depreciation rate × total quantity	
	Material	Stow-wood	Depreciation rate	Depreciation rate × storage quantity × unit costs × duration	
	Capital	Opportunity costs frozen in inventory	Rental rate	Opportunity costs rate × duration × storage quantity × unit costs × duration	
Storage at intermediate warehouse	Capital	Rent	Rental rate	Rental rate × storage quantity × unit costs × duration	
		Opportunity costs frozen in inventory	Opportunity costs rate	Opportunity costs rate × storage quantity × unit costs × duration	
Storage at Construction Consolidation Centre	Labour	Worker (handling)	Pay rate	Pay rate × total quantity	
		Administrator	Pay rate	Pay rate × storage quantity × unit costs × duration	
	Equipment	Handling truck	Rental rate	Rental rate × total quantity	
		Iron Material	Depreciation rate	Depreciation rate × total quantity	
	Material	Stow-wood	Depreciation rate	Depreciation rate × storage quantity × unit costs × duration	
	Capital	Opportunity costs frozen in inventory	Rental rate	Opportunity costs rate × duration × storage quantity × unit costs × duration	
Transportation (to CCC)	Labour	Truck driver	Pay rate	Pay rate x total quantity × distance	CCC
		Inspector	Pay rate	Pay rate × delivery times	
	Equipment	Truck	Rental rate	Rental rate x total quantity × distance	
	Material	Stow-wood	Depreciation rate	Depreciation rate × total quantity	
		Iron material	Depreciation rate	Depreciation rate × total quantity	
Transportation (to the intermediate warehouse)	Labour	Truck driver	Pay rate	Pay rate × total quantity × distance	
		Inspector	Pay rate	Pay rate × delivery times	
	Equipment	Truck	Rental rate	Rental rate × total quantity × distance	
	Material	Stow-wood	Depreciation rate	Depreciation rate × total quantity	
		Iron material	Depreciation rate	Depreciation rate × total quantity	
Transportation (to the construction site)	Labour	Truck driver	Pay rate	Pay rate × total quantity × distance	
		Inspector	Pay rate	Pay rate × delivery times	
	Equipment	Truck	Rental rate	Rental rate × total quantity × distance	
	Material	Stow-wood	Depreciation rate	Depreciation rate × total quantity	On-site
		Iron material	Depreciation rate	Depreciation rate × total quantity	
	Capital	Penalty	Penalty rate	Penalty Rate × total quantity	
On-site storage	Material	Stow-wood (stocking	Depreciation rate	Depreciation rate × storage quantity × unit costs × duration	
	Capital	Opportunity costs frozen in on-site stocking	Opportunity costs rate	Opportunity costs rate × storage quantity × duration × unit costs × duration	
Loading and on-site transportation	Labour	Worker (handling)	Pay rate	Pay rate × total quantity	
		Truck driver (waiting)	Pay rate	Pay rate × total quantity	
	Equipment	Crane	Rental rate	Rental rate × total quantity	
		Truck	Rental rate	Rental rate × total quantity	
	Material	Iron material/pallets etc. (handling)	Depreciation rate	Depreciation rate × total quantity	

Past cases

CCC Utrecht

Interviews and meetings

Reviews of documents

Previous research

Findings

No previous research and data on the activities related to the process of the supplier

The other aspects need modifications of formulas

Calculation is possible

De Trip

Constructed : 2016
Contractor: Boele & van Eesteren
Function: 253 apartments
1500 m2 commercial

Voorzetgebouw

Constructed : 2018
Contractor: Boele & van Eesteren
Function: 13000 m2
office / retail

Noordgebouw

Constructed : 2019
Contractor: Dura Vermeer
Function: 16 apartments
160 hotel rooms
Offices , Retail
Entrance to central station

The new model

Findings

Definitions and aspects

Transport (traveling, waiting & loading)

Handling at the CCC

Storage at the CCC

Production of workday packages

Unloading on-site

Transport on-site

Fixing

Supplier of tiles					
Total pallets	222	m2 pallet			
	222	load carrier			
	17.000	m2 production			
Max. pallets	32	st.	Be-combi		
Rent price of truck	€ 80,00	/h			
Pay rate runners	30	/h			
Pay rate supplier	35	/h			
Pay rate employees CCC	35	/h			
Cost related to Transport in the traditional process					
Supplier > site	90	Km	1,50	h	
Load factor	40	%	12	load carrier	
Journeys	19,0	st.	1710	km	
1. Transport cost	**€ 2.280,00**				
Cost related to loading/unloading in the traditional process					
Supplier > site	1,0	h/journey	19	h	
4. Loading cost	**€ 1.520,00**				
Cost related to waiting of trucks in the traditional process					
Supplier > site	0,5	h/journey	9,5	h	
7. Waiting cost	**€ 760,00**				
Cost in the traditional process					
Cost in the traditional process					
Cost in the traditional process					
Cost for unloading on-site in the traditional process					
Planning Fixing	136	weeks	680	days	
Pay rate staff supplier	€ 40,00	/h	1	times a day	
Unloading	0,75	h/day	1	n staff	
Time	510	h			
13. Unloading cost	**€ 20.400,00**				
Cost for on-site transport in the traditional process					
Pay rate staff supplier	€ 35,00	/h	680	days	
On-site transport	2	h/day	1	n staff	
Time	1360	h			
15. Running cost	**€ 47.600,00**				
Cost for fixing in the traditional process					
Pay rate staff supplier	€ 35,00	/h	680	days	
Dayproduction	25	m2			
Fixing	13,25	h/day	2	n staff	
Time	9010	h			
17. Fixing cost	**€ 315.350,00**				

Cost related to Transport for the process including CCC					
Supplier > CCC	90	Km	1,50	h	
Load factor	90	%	28	load carrier	
Journeys	8,0	st.	720	km	
2. Transport cost	**€ 960,00**				
CCC > site	10	Km	0,33	h	
Load factor	90	%	28	load carrier	
Journeys	8,0	st.	80	km	
3. Transport cost	**€ 213,33**				
Cost related to loading/unloading for the process including CCC					
Supplier > CCC	1,0	h/journey	8	h	
5. Loading cost	**€ 640,00**				
CCC > site	0,5	h/journey	4	h	
6. Loading cost	**€ 320,00**				
Cost related to waiting of trucks for the process including CCC					
Supplier > CCC	0,05	h/journey	0,4	h	
8. Waiting cost	**€ 32,00**				
CCC > site	0,00	h/journey	0	h	
9. Waiting cost	**€ 0,00**				
Cost related to handeling at the CCC					
Handling cost	€ 5,00	/load carrier			
10. Handling cost	**€ 1.110,00**				
Cost related to storage at the CCC					
Storage cost	€ 0,40	/day	€ 2,00	/week	
Storage cycle	2	weeks	10	days	
11. Storage cost	**€ 888,00**	€			
Storage cycle	3	weeks	15	days	
11. Storage cost	**€ 1.332,00**	€			
Cost related to consolidation at the CCC					
Planning Fixing	113	weeks	563	days	
Pay rate staff CCC	€ 35,00	/h	2	n staff	
Consolidation	0,3	h/day			
Time	187,7	h			
12. Consolidation cost	**€ 13.139,58**				
Cost for unloading on-site for the process including CCC					
Planning Fixing	113	weeks	563	days	
Pay rate runners	€ 30,00	/h	1	times a day	
Unloading	0,2	h/day	2	n staff	
Time	112,6	h			
14. Unloading cost	**€ 6.757,50**				
Cost for on-site transport for the process including CCC					
Pay rate runners	€ 30,00	/h	563	days	
On-site transport	0,23	h/day	2	n staff	
Time	129,5	h			
16. Running cost	**€ 7.771,13**				
Cost for fixing for the process including CCC					
Pay rate staff supplier	€ 35,00	/h	563	days	
Dayproduction	30,19	m2			
Fixing	16	h/day	2	n staff	
Time	9010	h			
18. Fixing cost	**€ 315.350,00**				

Action research

Participation in the project organisation

Testing the model

Missing model input resulted in scenario tests

Standardised modes of transport, average distances, variety of load factors, variety of storage periods

Validation with experts

A survey with statements

Operator of the CCC, and project managers of the contractor

Wonderwoods

Current Case

Findings Model input

Project related data

Material quantities, locations, modes of transport

Experience-based data

Cost related to activities at the CCC

Generic cost data

Labour costs, production speed, equipment costs

Findings activities

Transport (traveling, waiting & loading)

Handling at the CCC

Storage at the CCC

Experts Model input

Mention that the project related data becomes available in a later stage of the project

Mention that the model and results provide insight into the costs for the tested activities

Agree that the other activities should be included in the model

Research question

To what extent can the **logistical costs** related to construction be **modelled** in the **preparation stage** of a project to **predict the impact** of the implementation of a **Construction Consolidation Centre**?

Logistical costs related to construction

Transport (travelling, waiting, loading)

Costs at the CCC (handling, storage, consolidation)

Cost on-site (unloading, transport, fixing)

Modelling requires input

Project related data

Experience-based data of the CCC

Generic cost data

Predicting the impact in the preparation stage

At the start only averages and estimations, results in just insights for scenarios

Supplier selection, planning and detailed information on materials and the site.

will increase the predictability of the impact

Discussion & limitations

Research

Focussed on Design-bid-built

Potential for design changes

Focussed on Business Economics

Potential for societal cost savings and investments

Model

Benchmarking

Compares traditional with new at a moment in time

Impact of project organisation

Process decisions could impact the outcome

Example: buffer storage, can be short without mistakes

Research

Missing activities, cost categories, and experience based data

Procurement, process management, storage at supplier

Costs of capital

Measure the impact of activities included in the model

Innovations for personnel and waste collection

Significant reductions

Different process

Factors for implementation

Data, project team, financial transparency, and time

Monitor the Wonderwoods project

Measure actual transport distances, waiting and loading times etc.

Practice

Communication structures

Structured formats

Saves time

Transparency

Theoretical cost savings only lead to savings when implemented in contracting stage of a project

Invest in data

Measure the performance of projects, will help to prove the benefits

Generic cost data

Use the expertise of companies that are specialised in collecting generic cost data


Thank you for listening!