Investigating the effects of Construction Consolidation Centres on the resilience of Construction Logistics

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Introduction

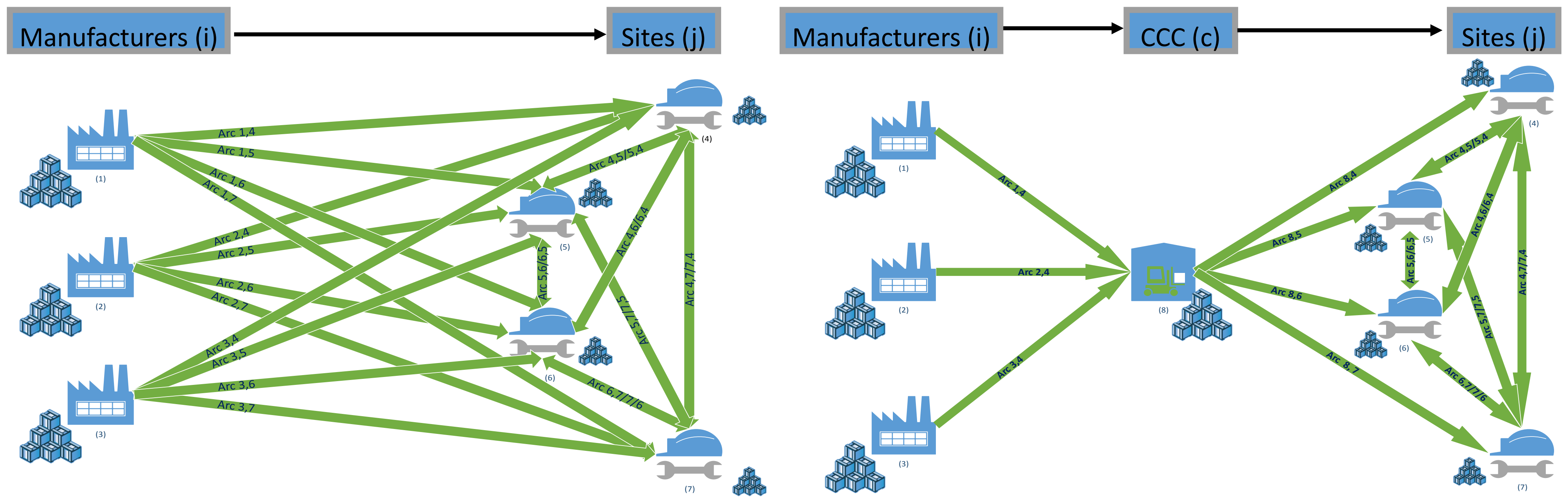
It is estimated that the construction industry loses at least £3 billion a year due to poor logistics (Rogers, 2005). The construction industry makes up around 6.4% of the UK's GDP (ONS,2016), so there is a need for an improvement in construction logistics. Construction Consolidation Centres (CCCs) have been heralded as a great solution for construction logistics in terms of efficiency, but studies have never been made into their resilience; this poster outlines the key steps in the investigation into this topic.

Modelling

The models developed were used to compare a two-stage (without a CCC) and a three-stage (with a CCC) supply chain. Both of these were modelled as a **minimum-cost flow problem** and needed to include the following features in the model implemented in **IBM ILOG CPLEX**.

MULTI-COMMODITY ↔ DYNAMIC ↔ STORAGE ↔ DISRUPTIONS

The disruption was modelled as a reduction in flow capacity across all arcs for a certain duration, and each Model was run in **regular conditions** (referred to as a) and in **disrupted conditions** (referred to as b)



Model 1: Two-Stage & Model 2: Three-Stage Supply Chain

The **objective function** that was **minimised** can be found below:

Total Cost = Transport Cost + Storage Cost

$$TC = \sum_{t\in T}\sum_{k\in P}\sum_{(i,j)\in A} TD_{ij}TC_{ij}F_{ij}^{k,t} + \sum_{t\in T}\sum_{k\in P}\sum_{i\in M} SCM_i^k IM_i^{k,t} + \sum_{t\in T}\sum_{k\in P}\sum_{j\in S} SCS_j^k IS_j^{k,t} + \sum_{t\in T}\sum_{k\in K}\sum_{c\in C} SCC_c^k IC_c^{k,t}$$

Storage Cost Manufacturer + Storage Cost Site + Storage Cost CCC (only for Model 2)

Decision Variables:

- Production
- Flow
- Inventory (Manufacturer, Site, CCC)

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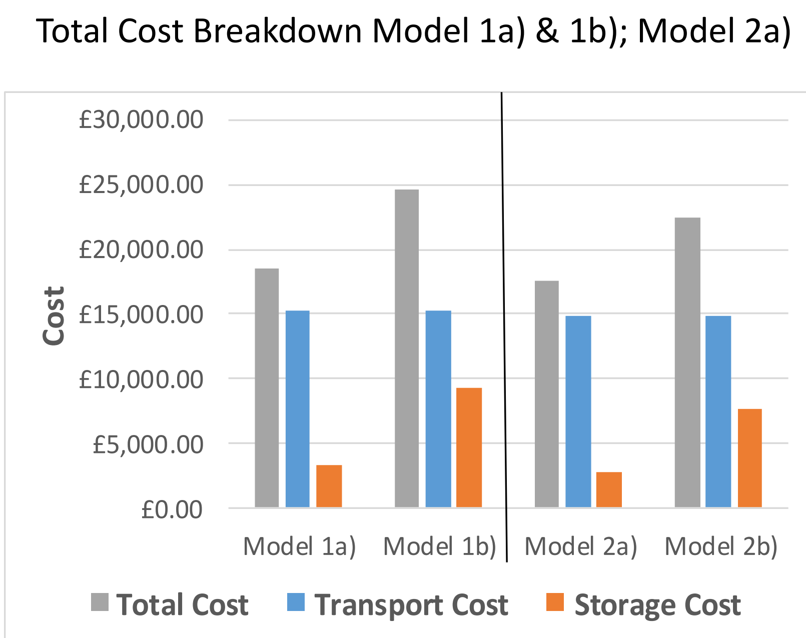
Results



The figure and table show that both the initial total cost is lower when the CCC is utilised, and there is a smaller percentage increase in costs due to disruptions. This is because the CCC provides cheaper short-term storage closer to the site. Demonstrated by the relatively smaller increase in storage cost due to disruption. Both models have almost no change in transport cost, a clear limitation of the model.

	Model 1a)	Model 1b)	Percentage Change	Model 2a)	Model 2b)	Percentage Change
Transport Cost	£15,235.10	£15,321.40	1%	£14,831.60	£14,832	0.00%
Storage Cost	£3,320	£9,300	180%	£2,720	£7,620	64.30%
Total Cost	£18,555.10	£24,621.40	33%	£17,551.60	£22,452	21.83%

The main **limitations** of the model are below; for an improvement in results these limitations would have to be changed. In addition, other limitations include **discounting supply of raw materials**, **production** and **reverse logistics costs** and a **large time-step** (1 day).

NO CONSOLIDATION — Individual vehicles not being modelled, thus no consolidation occurs in Model 2.

DISRUPT CERTAIN ARCS — Model disruption on specific arcs instead of over whole network.

TRANSPORT COST — Disruption on network should also cause changes to transport costs.

Conclusions and Further Work

There are many advantages to using CCCs, this work is only the start to determining whether one of these reasons is the improved resilience of the Construction supply chain. Model 2 has shown the ability to stay more cost-effective than Model 1 when subjected to network-wide disruption. These results could be different when just disrupting one link on the network, a more realistic scenario, the results will be dependent on the characteristics of the network and its connectivity. Although it is more cost-effective under disruption, it not a quantification of the resilience; it could still help investors to understand that CCCs are economically feasible and are cost-effective even in variable conditions.

In addition to the limitations with the model mentioned in the section above, some additional improvements and **future work** related to both the model and the entire body of work.

RESILIENCE FRAMEWORK — Universal quantification method for resilience of any network.

EXISTING CCCs — Compare resilience of existing CCCs in London using resilience framework.

INTRODUCE STOCHASTICITY — Model either demand or disruptions on network stochastically to account for unpredictability.

LOCATION PROBLEM — Find the optimal location of any potential new CCCs in London.

References

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Rogers, P. (2005) Strategic forum for construction, 2005, Improving construction logistics. In: *Report of the Strategic Forum for Construction Logistics Group*. 2005