Optimizing Material-Related Costs Using Dynamic Site Layout and Supply Chain Planning

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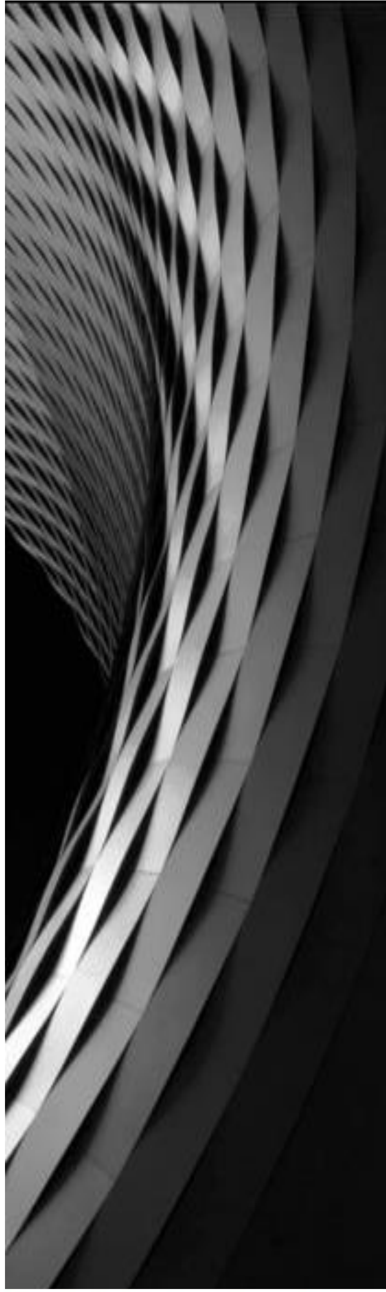
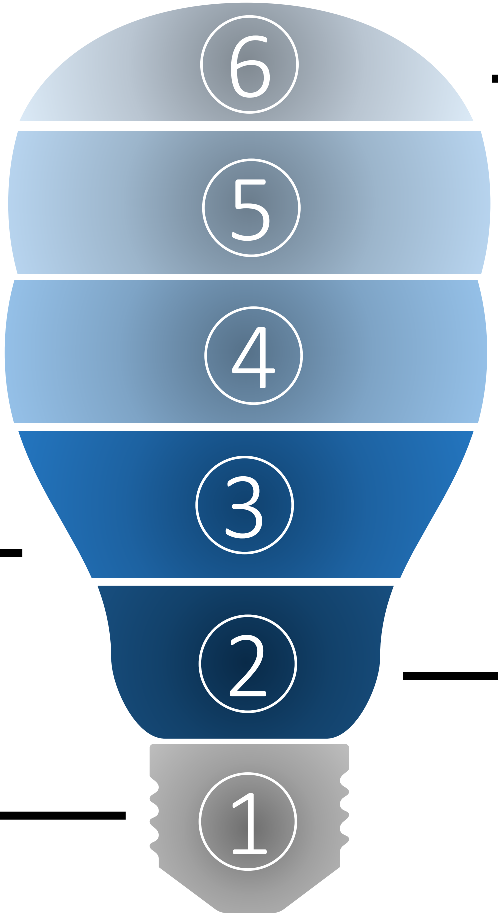


Outline



1. Topic Introduction
2. Problem Statement
3. Methodology
4. Simulation Results
5. Discussion
6. Conclusion

Introduction

Space in a Construction Site

- Temporary facilities
- Material storage areas
- Ongoing construction works

Often Considered **LIMITED**

(Said & El-Rayes, 2013), (Mossman, 2007)

Introduction

Seven groups of resource flow needed to complete a certain task

- Construction Design
- Components and **Materials**
- Workers
- Equipment
- Space
- Connecting Works
- Addition to External Conditions

Right Time

Right Quantity

Desired Quality

Cost Reduction

&

Value Addition

(Koskela, 2000), (Lange & Schilling, 2015)

Introduction

When Are Material-Related Costs Incurred on Site?

- Material movement into the site from laydown areas or storage facilities
- Material transportation to installation area
- Push nature of activities

(Tommelein, 1994), (Alves, Tommelein, & Ballard, 2006)

Introduction

Why Dynamic Site Layouts?

(Said & El-Rayes, 2013)

Gap Statement

Different methods and models in the academic literature addressing material handling in a construction site have focused on:

- On-site congestion
- Logistics cost
- Project schedule
- Material flow to the site
- Dynamic site layout planning

The impact of how all those individual factors act and interact with one another in a single production system to incur material moving costs has been understudied.

(El-Rayes 2013) , (Turanoglu & Akkaya, 2017), (Bascoul and Tommelein, 2017), (Tommelein and Zouein 1993)

Research Objective

How can we decrease material-related costs on site through the use of dynamic site layout and supply chain strategies?

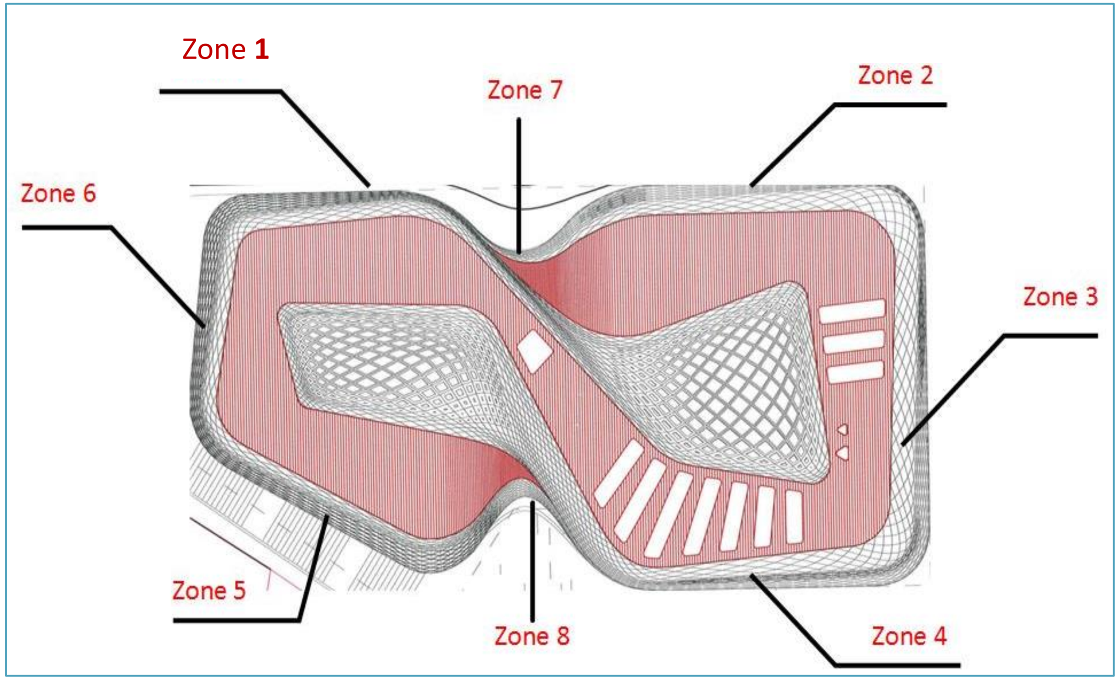
What's the Main Problem?

Methodology

1. Gathering Intel
2. Case Study
3. Conceptual Model
4. Base Case Scenario
5. Improved Scenario

Case Study

GRC units Held on Rack

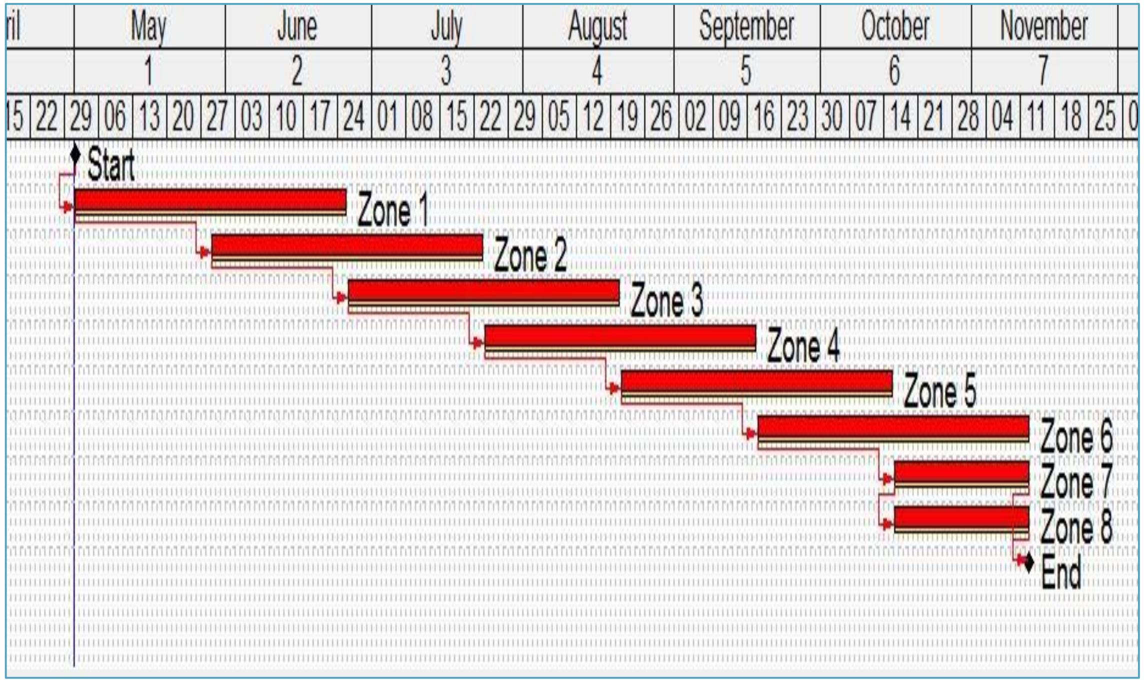


GRC Installation Zones

Case Study

Zone number	Number of GRC units (Qz_i, i = 1:8)	Total GRC area per zone (m^2)	Installation period (weeks)
Zones 1,3,5	350	4550	8
Zones 2,4,6	700	9100	8
Zones 7,8	175	4550	6

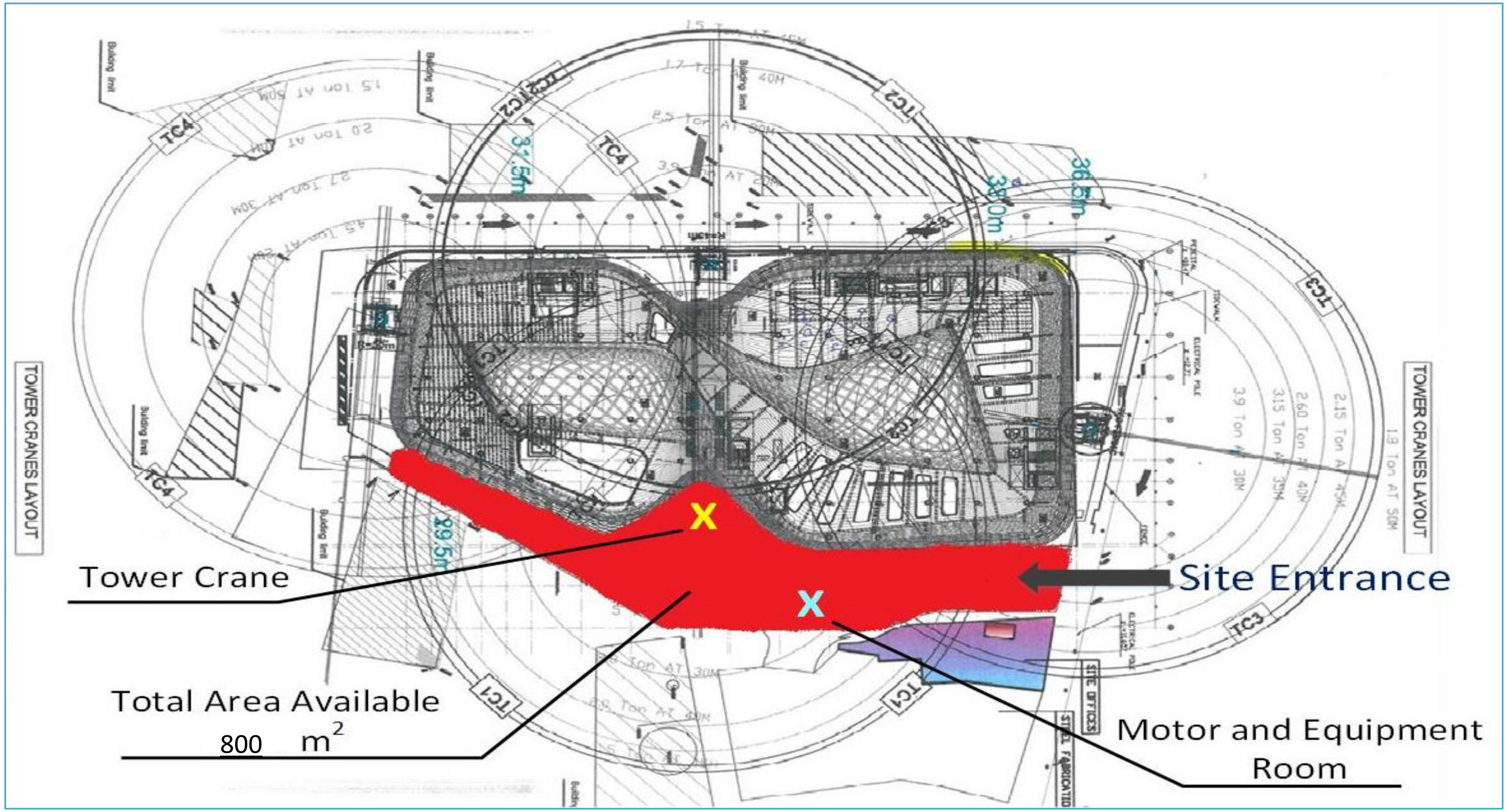
GRC Quantities and Equivalent Areas per Zone



GRC Installation Schedule

Case Study

Available storage area for GRC units equivalent to 100 units

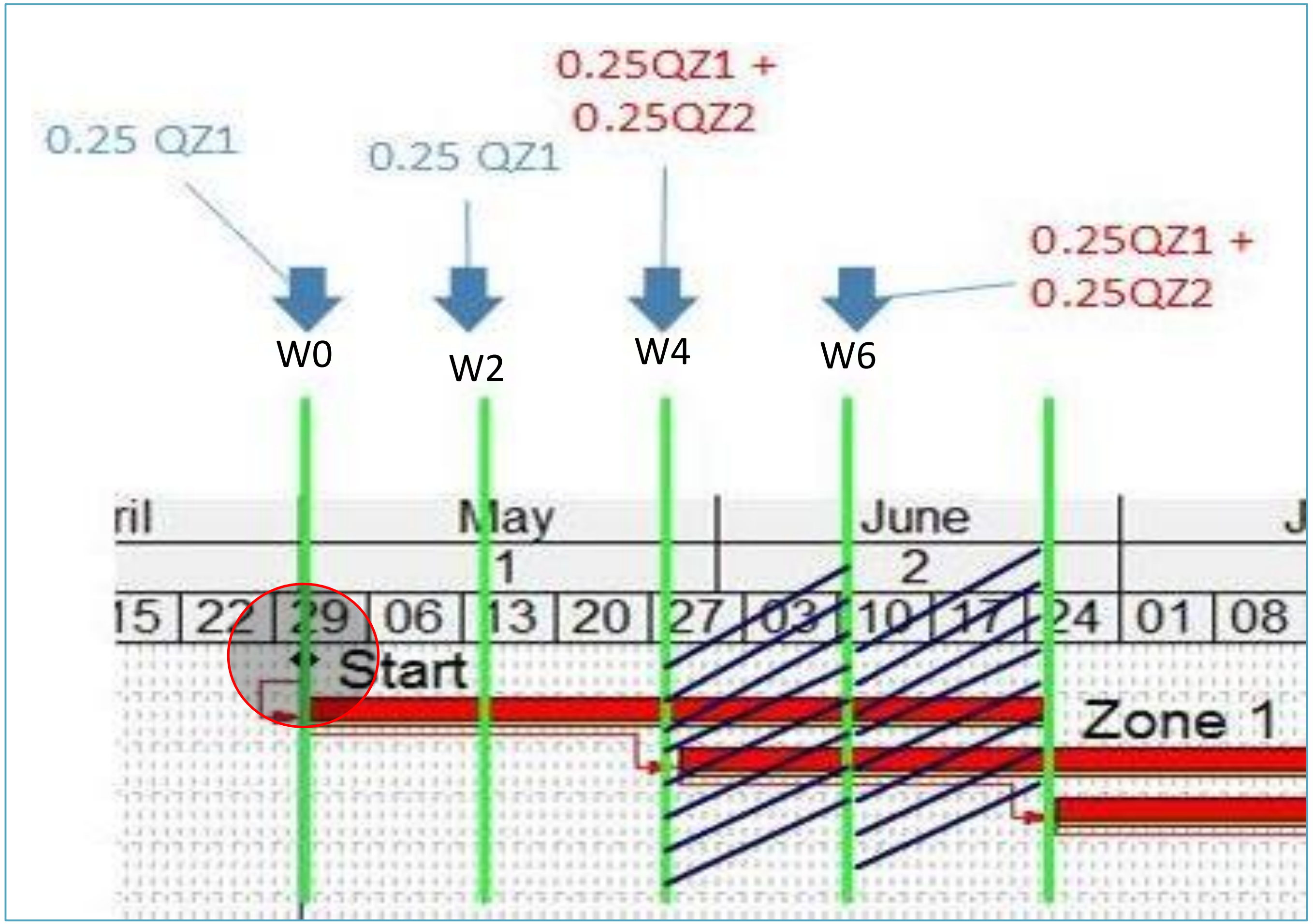


Site Layout Plan

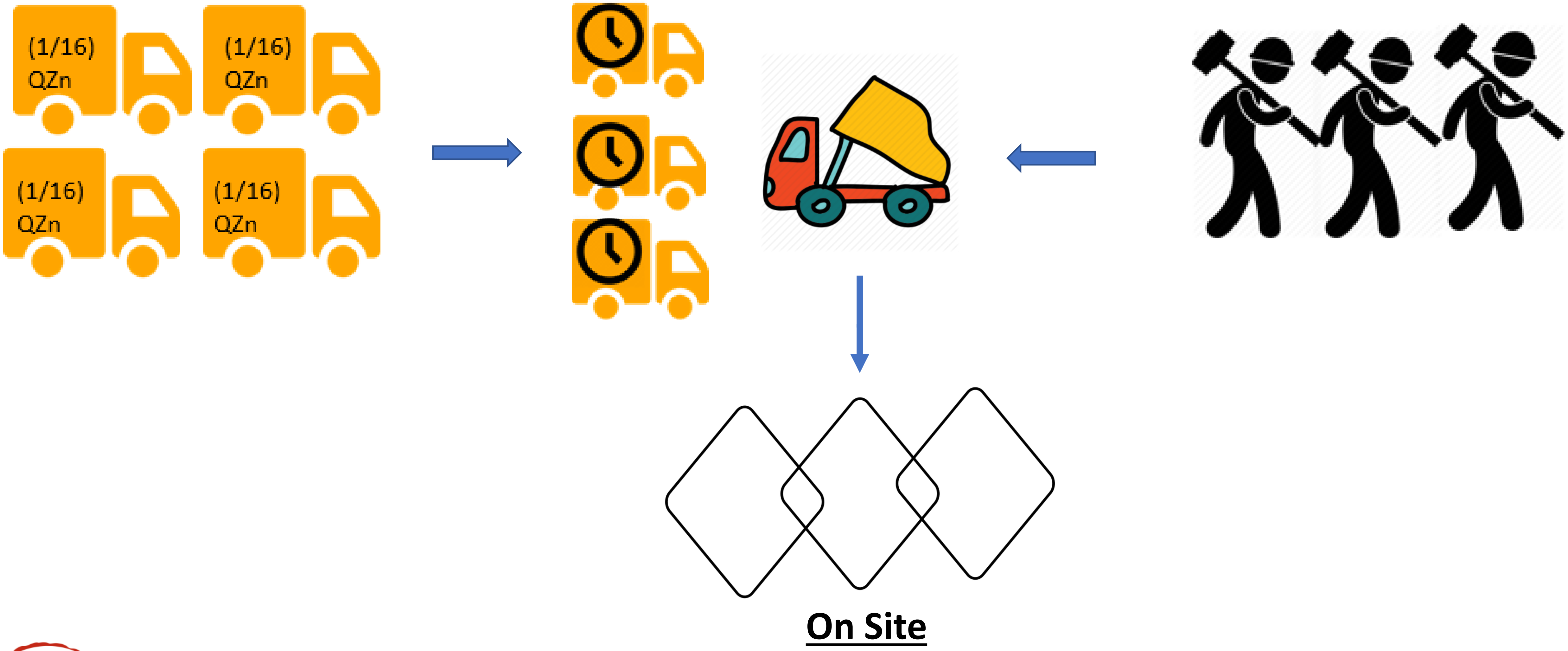
Conceptual Model

Bi-weekly delivery per zone

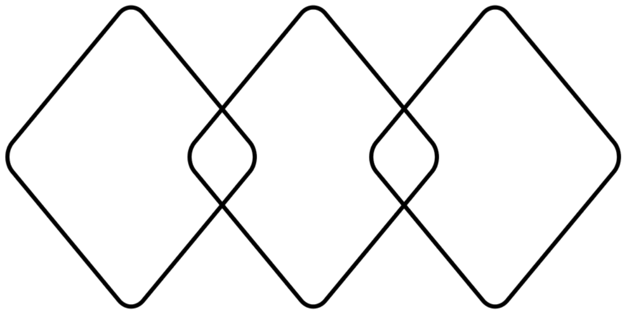
One delivery = ¼ of the quantity per zone

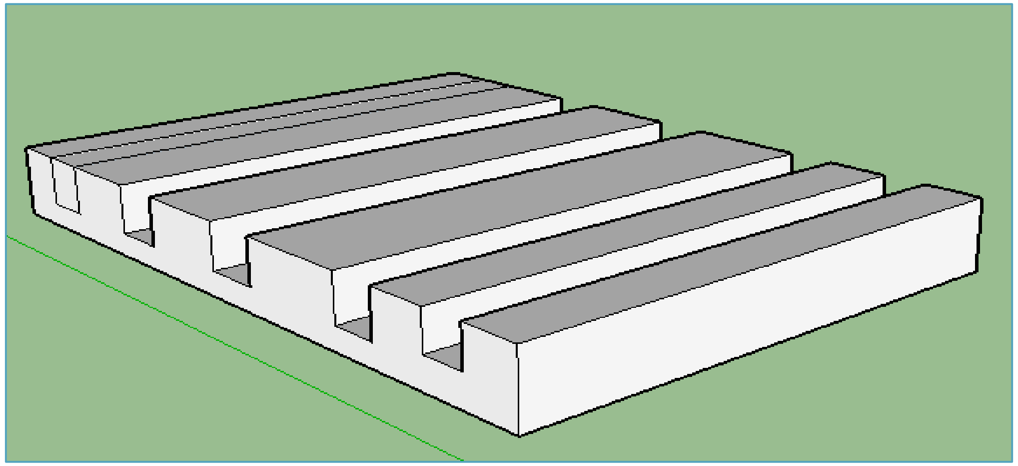


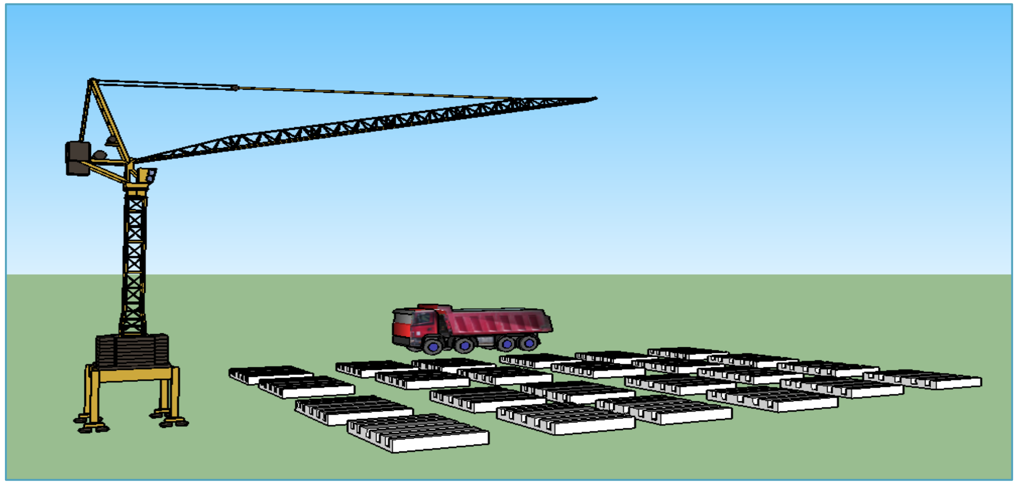
Conceptual Model



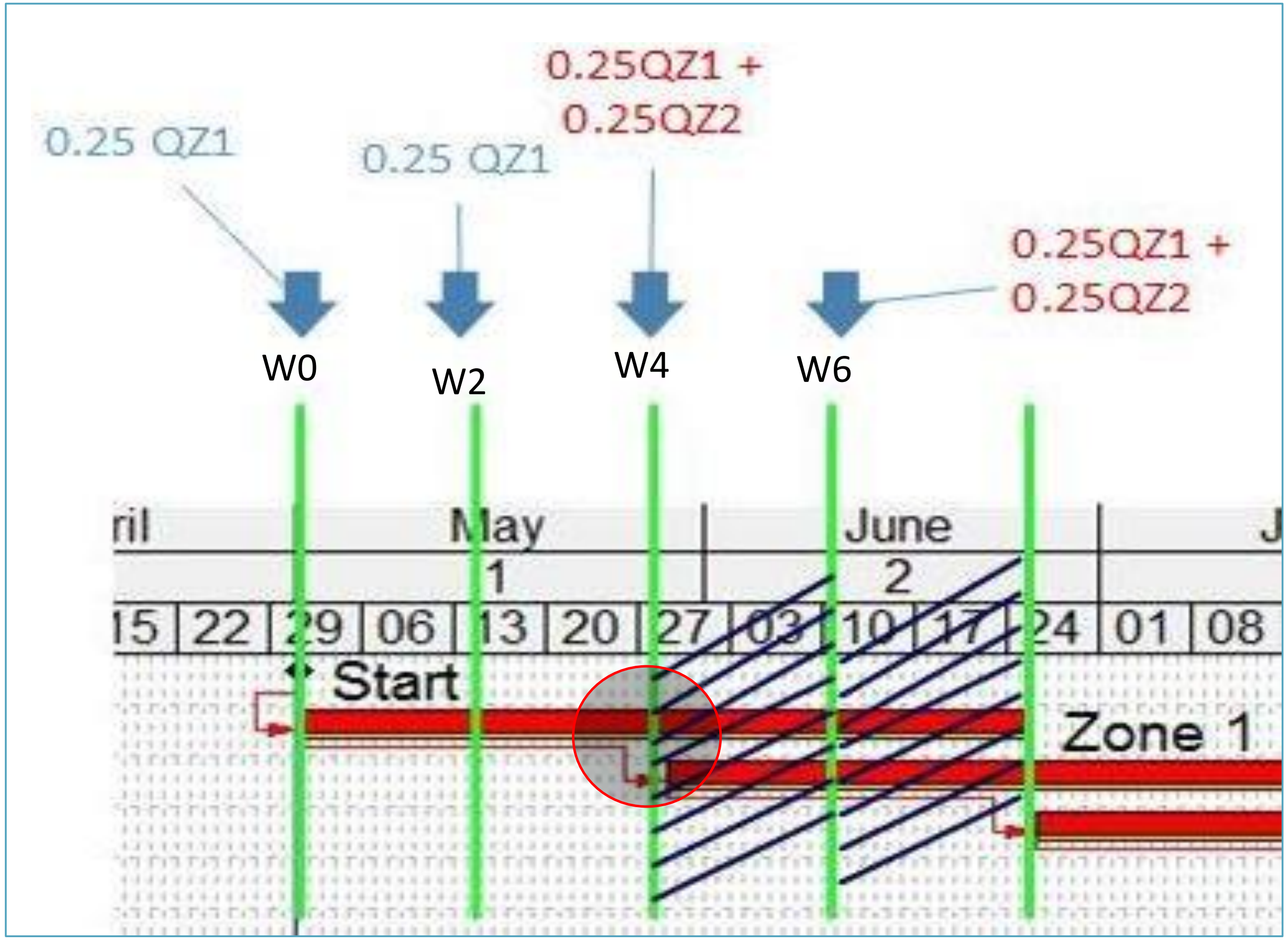
Conceptual Model



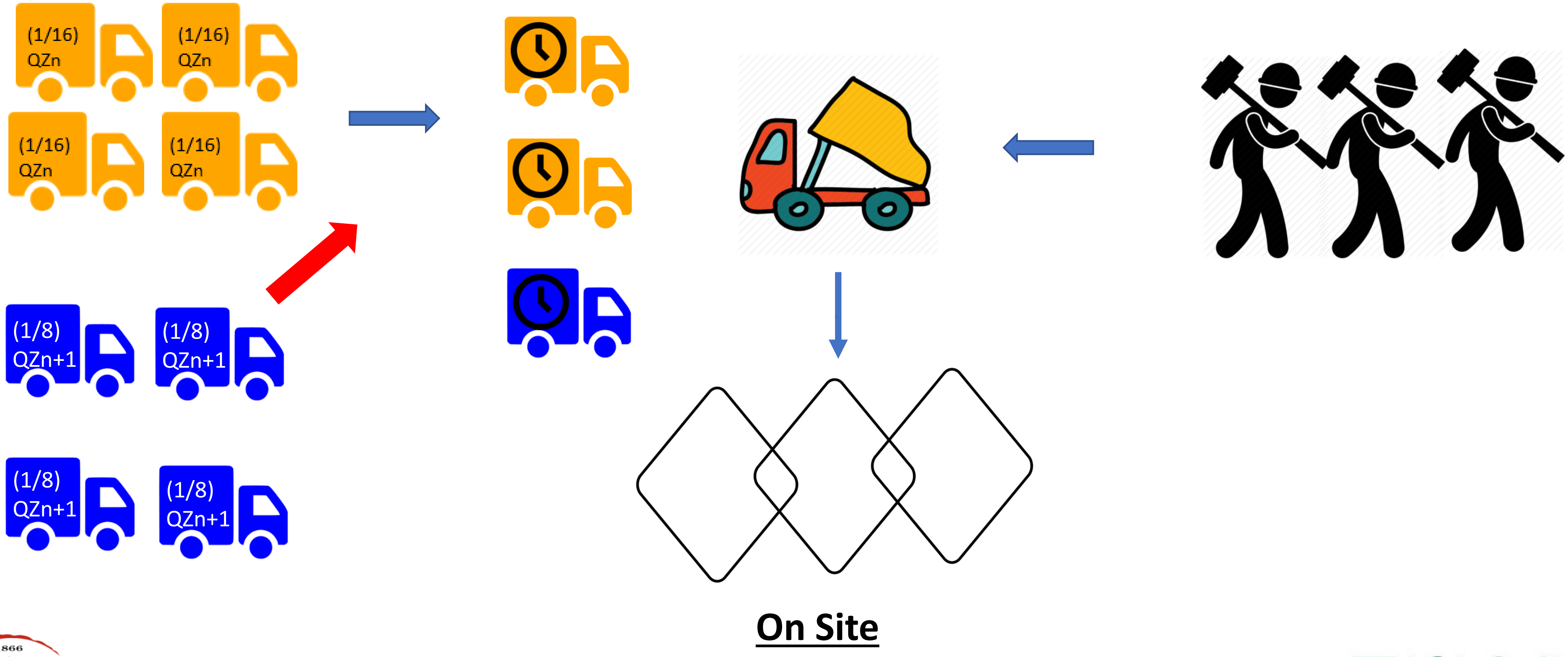




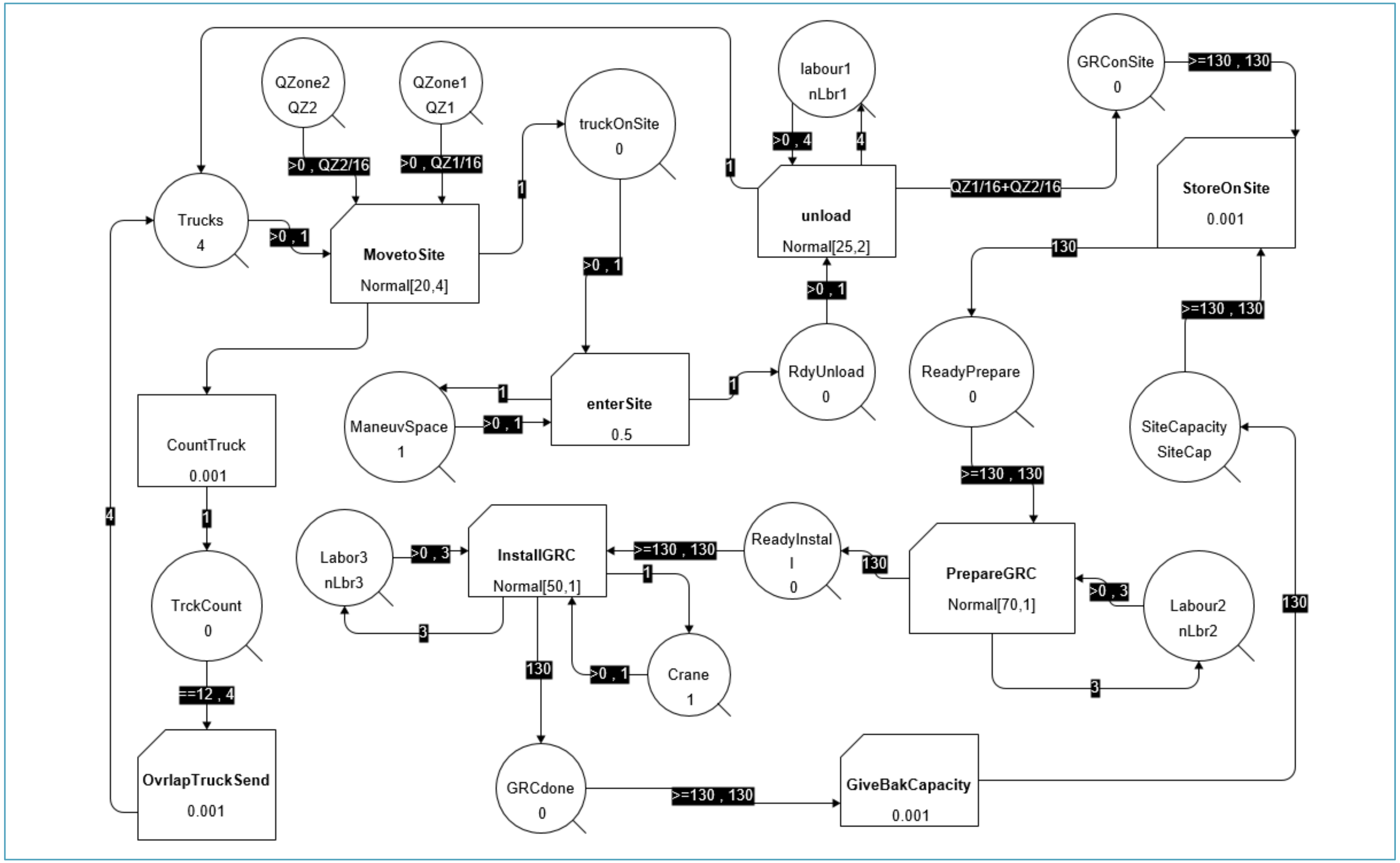
Conceptual Model



Conceptual Model



Base Model


QZone2
QZ2
QZone1
QZ1
truckOnSite
0
labour1
nLbr1
GRConSite
0
>=130 , 130
>0 , QZ2/16
>0 , QZ1/16
1
>0 , 4
4
1
Trucks
4
>0 , 1
MovetoSite
Normal[20,4]
unload
Normal[25,2]
QZ1/16+QZ2/16
StoreOnSite
0.001
>0 , 1
130
>0 , 1
>=130 , 130
CountTruck
0.001
ManeuvSpace
1
1
>0 , 1
enterSite
0.5
1
RdyUnload
0
ReadyPrepare
0
SiteCapacity
SiteCap
>=130 , 130
4
1
Labor3
nLbr3
>0 , 3
InstallGRC
Normal[50,1]
>=130 , 130
ReadyInstall
0
130
PrepareGRC
Normal[70,1]
>0 , 3
Labour2
nLbr2
130
TrckCount
0
3
1
Crane
1
130
>0 , 1
3
==12 , 4
OvrlapTruckSend
0.001
GRCdone
0
>=130 , 130
GiveBakCapacity
0.001

Base Model Concerns

Improved Model

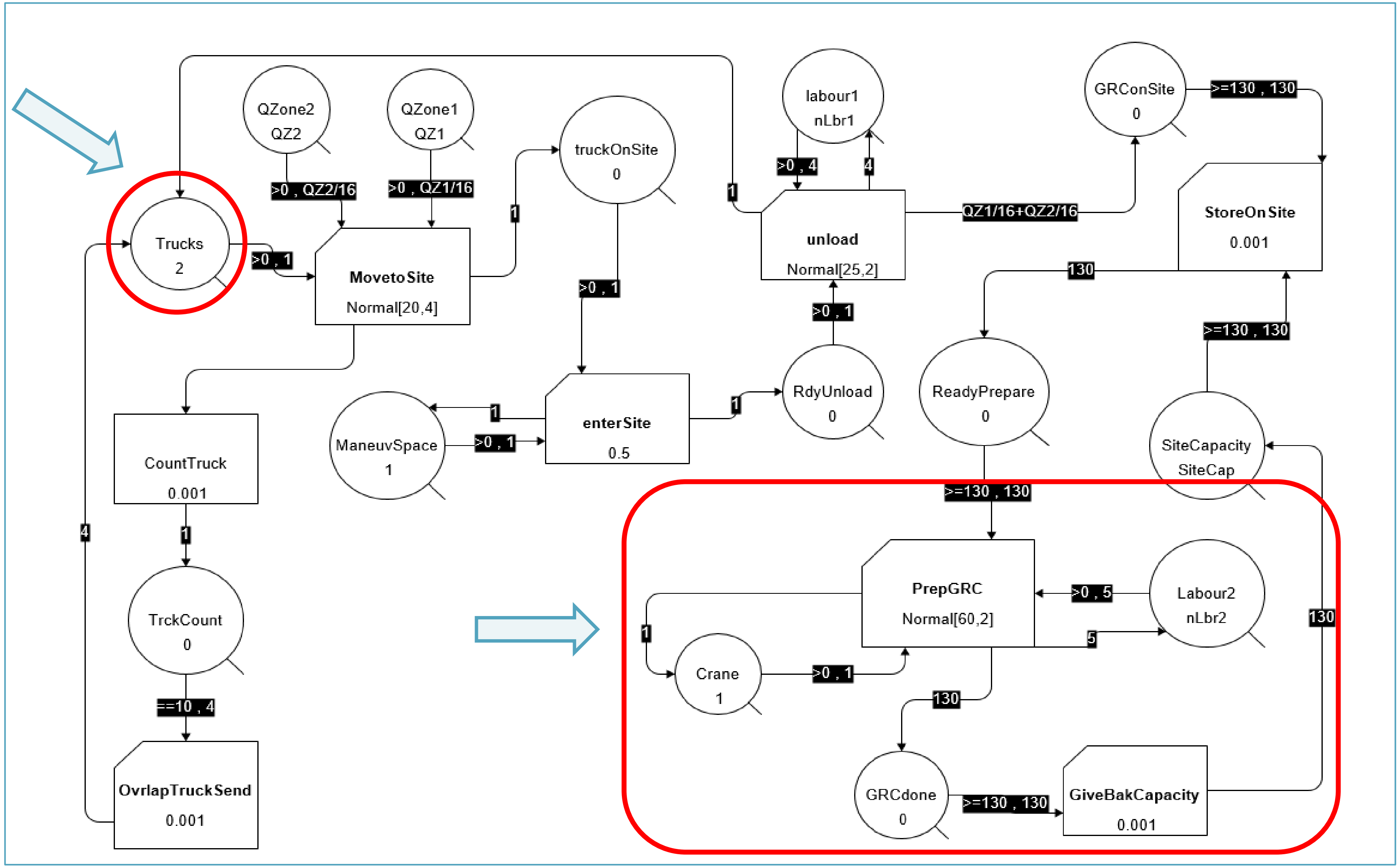
Pull System
Decrease Lead Time of Trucks on Site

Merging Activities
Combine the activities "Clean GRC" and "Install GRC" into one

- Decrease the # of trucks from 4 to 2
- Make deliveries weekly instead of biweekly

- Crane moves a GRC rack (10 units) instead of moving one unit
- Labors of both activities should work at the same time
- Requires less time than if the activities were separated (less movement)

Improved Model



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Developed Models

Models Developed

Model A

- Reduced L.T. = 1 Week (pull system)

Model B

- Merging activities
- Longer L.T. = 2 Weeks

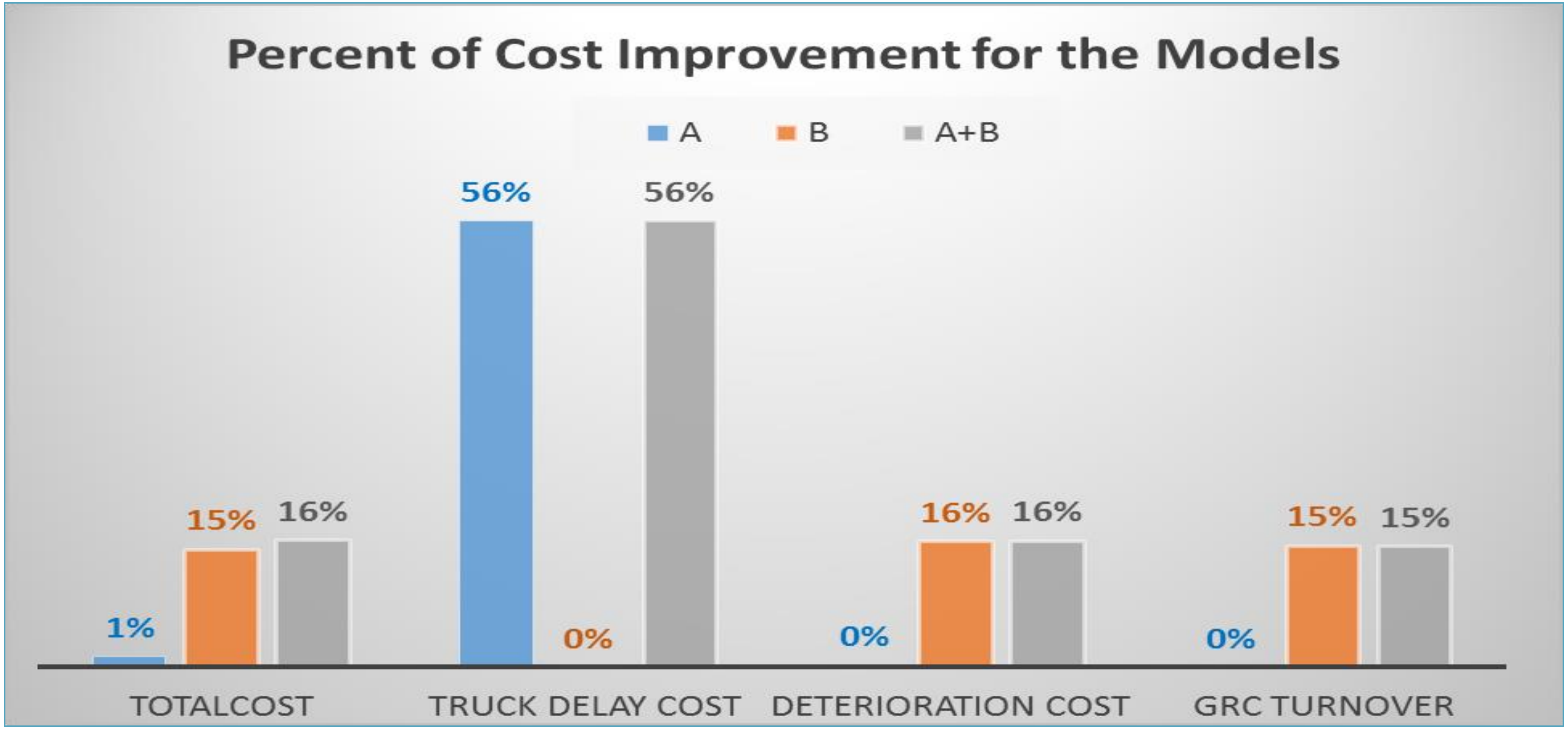
Model AB

- Merging activities
- Reduced L.T. = 1 Week

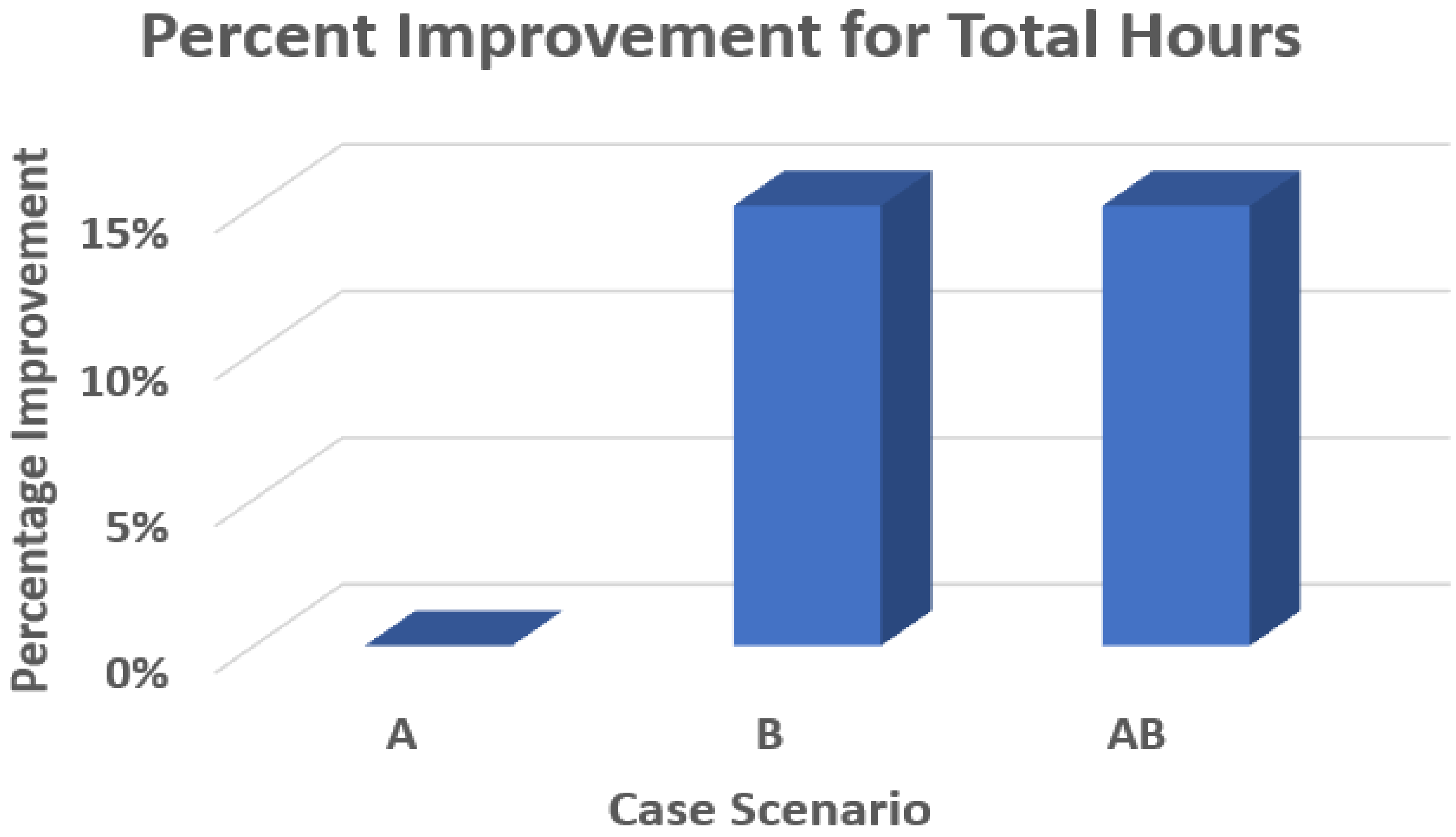
Assessment Criteria

Total hours	Model simulation time
The Truck Delay Cost ($)	Cost incurred by trucks waiting to be unloaded instead of performing another delivery
Deterioration Cost ($)	Cost of the total time a GRC unit spends on site before its final installation
Turnover Rate (hours/occurrence)	Time needed for the storage space on site to be replenished by a new GRC rack.
Total Cost ($)	Cost of the trucks, labour, crane, the GRC units' deterioration cost, and truck delay cost.

Simulation Results & Analysis



Simulation Results & Analysis



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Simulation Results & Analysis

Reducing Lead Time Effect

- Decreased transportation delay cost
- Satisfy site and schedule demand
- Reduced site congestion

Combining Activity Effect

- Decease unneeded movement
- Decreased total material handling cost
- Increased space utilization

Conclusions & Future Work

Incorporating lean tools along with the proper supply chain

---> Reduced the material related costs on site by 15-16%
---> Reduced the process time by 15%

Future work aims at improving the existing model to better reflect the actual site conditions regarding labour productivity and truck capacity of the site.

Thank you for your time!