

# Integrated Simulation and Lean Approach for Production Line Improvement in a Prefabricated Homebuilding Facility

Mohammad Darwish, Osama Mohsen, Yasser Mohamed, Mohamed Al-Hussein



# Presentation Outline

- 1. Who We Are
- 2. Industrialized Building Construction
- 3. Factory Layout
- 4. Methodology
- 5. Simulation of Operations
- 6. Results and Conclusion

# 1. Who We Are

- University of Alberta
  - Edmonton, Alberta, Canada
- Department of Civil and Environmental Engineering
  - Construction Engineering and Management
- Modular Construction Team
  - Automation, Lean construction, Industrialized Construction
- Project Team:
  - Graduate Students: Mohammad Darwish (MSc), Osama Mohsen (PhD)
  - Professors: Yasser Mohamed, Mohamed Al-Hussein

## 2. Industrialized Building Construction

- ❑ Apply manufacturing principles and techniques to the construction industry leading to Lean Construction:
  - less wastes, increased productivity, higher quality, reduced costs over building life-cycle, improved safety, and timely delivery of projects
- ❑ Prefabricated panelized factory produce highly customized types of walls for residential buildings.

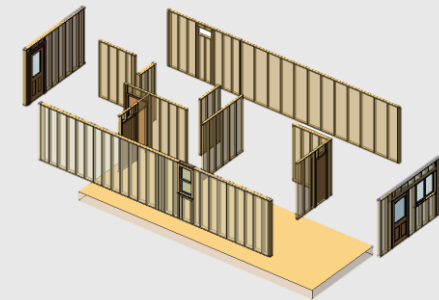
Industrialized Construction



Lightweight Timber Framing

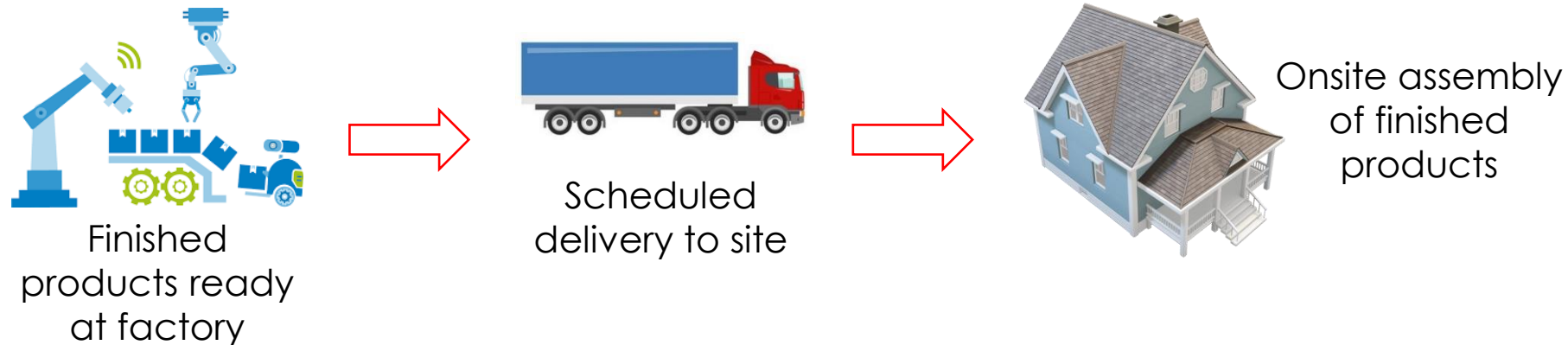


Wall Panels Fabrication



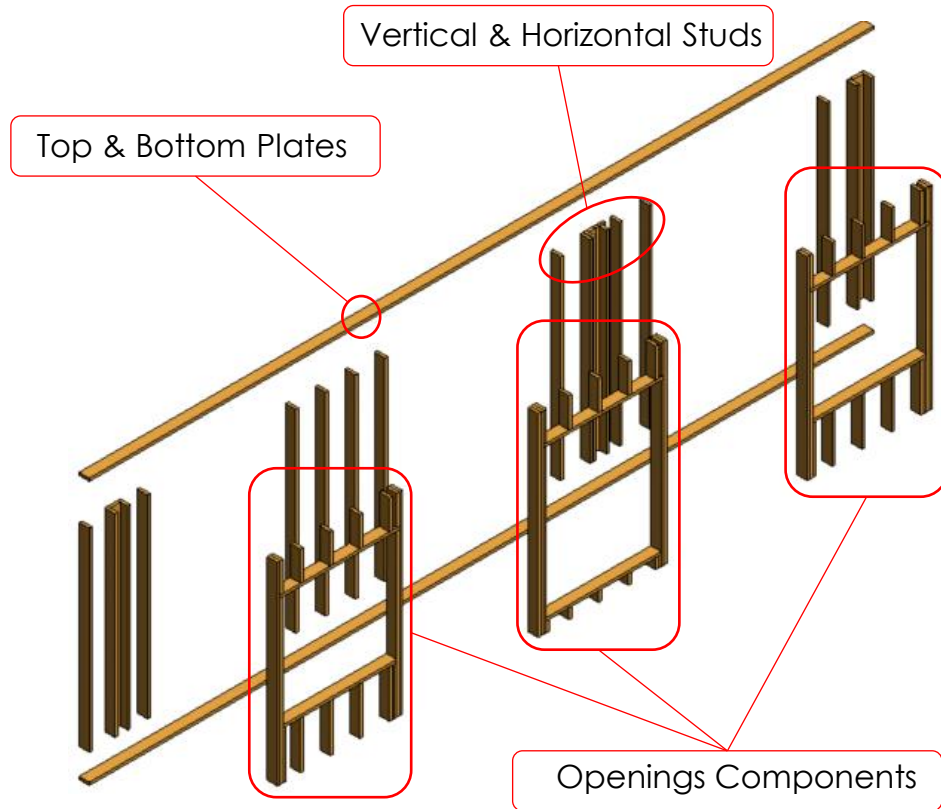
## 2. Industrialized Building Construction

- Current study focuses on operations inside the factory:

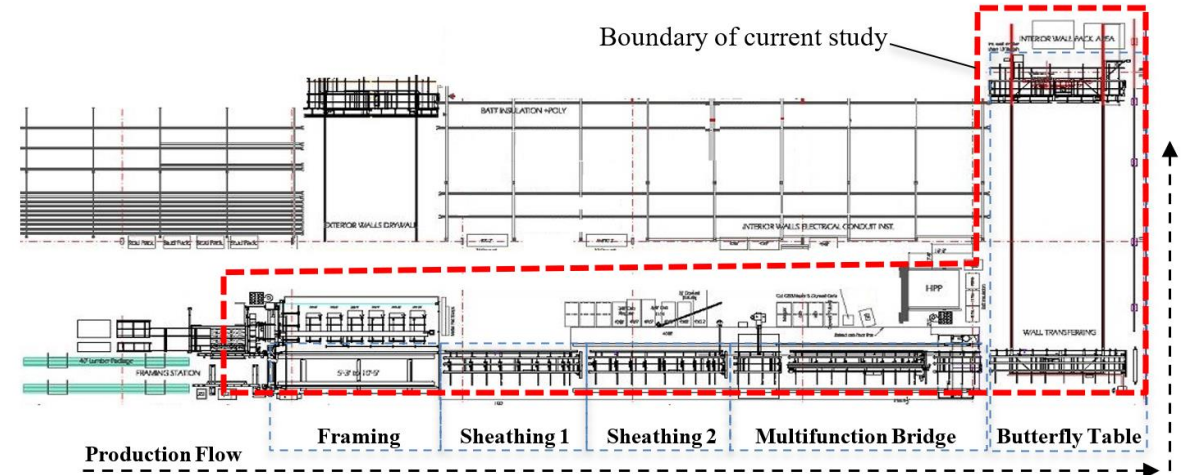


- Analyzing and simulating one phase of the production (Multiwall panel production line)
- Based on observing daily operations, and historical data

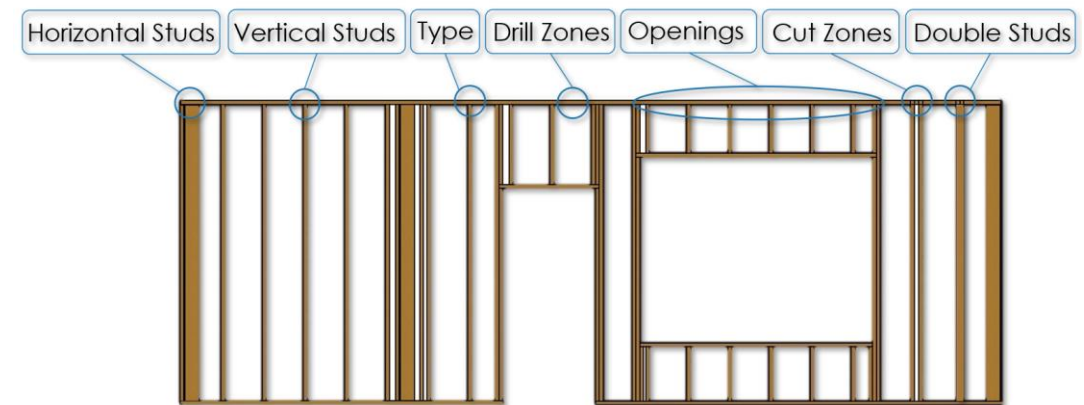
# 3. Factory Layout



Wall Panels' Attributes



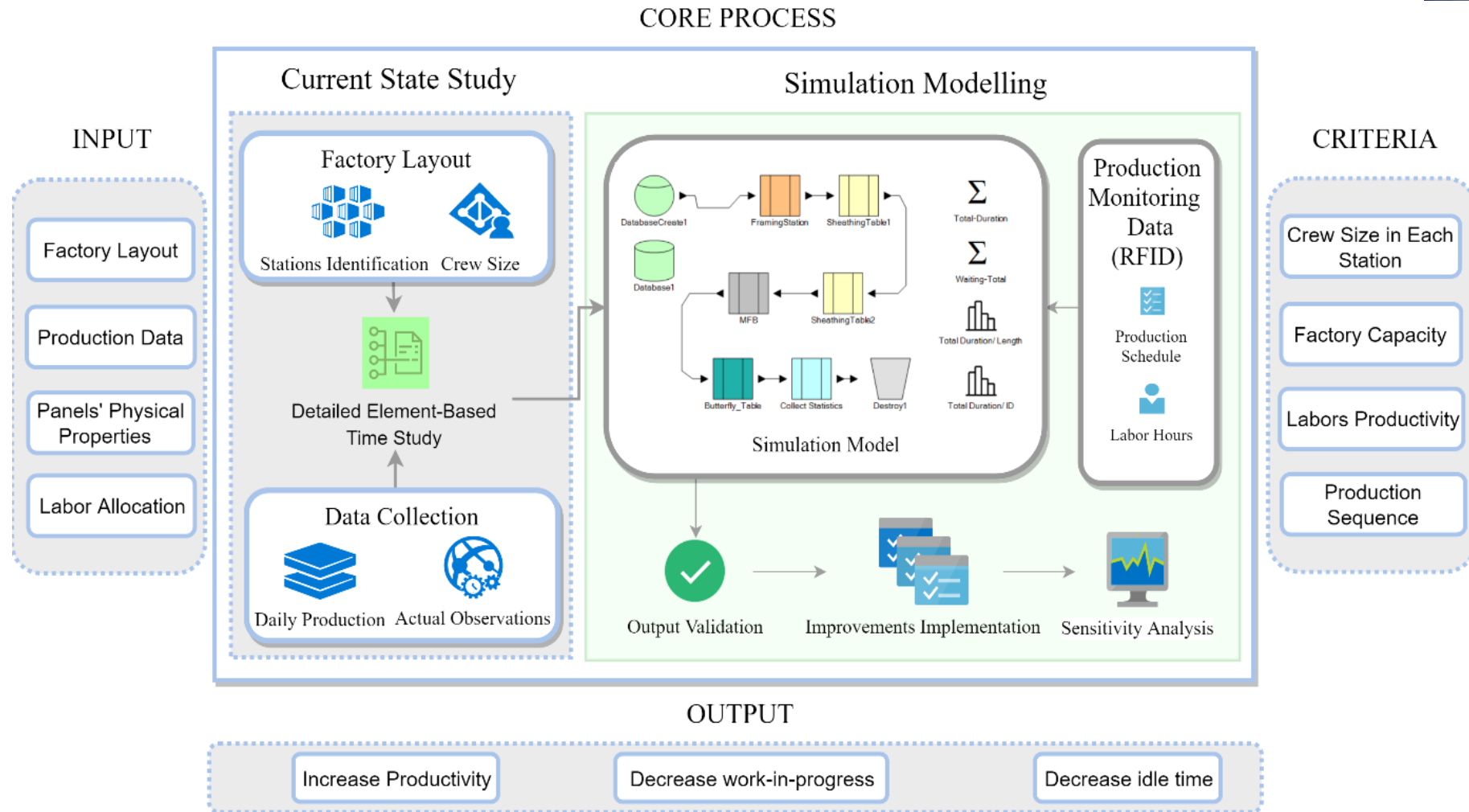
Factory Layout and the Boundary of the Current Study



Wall Panels' Framing Operations

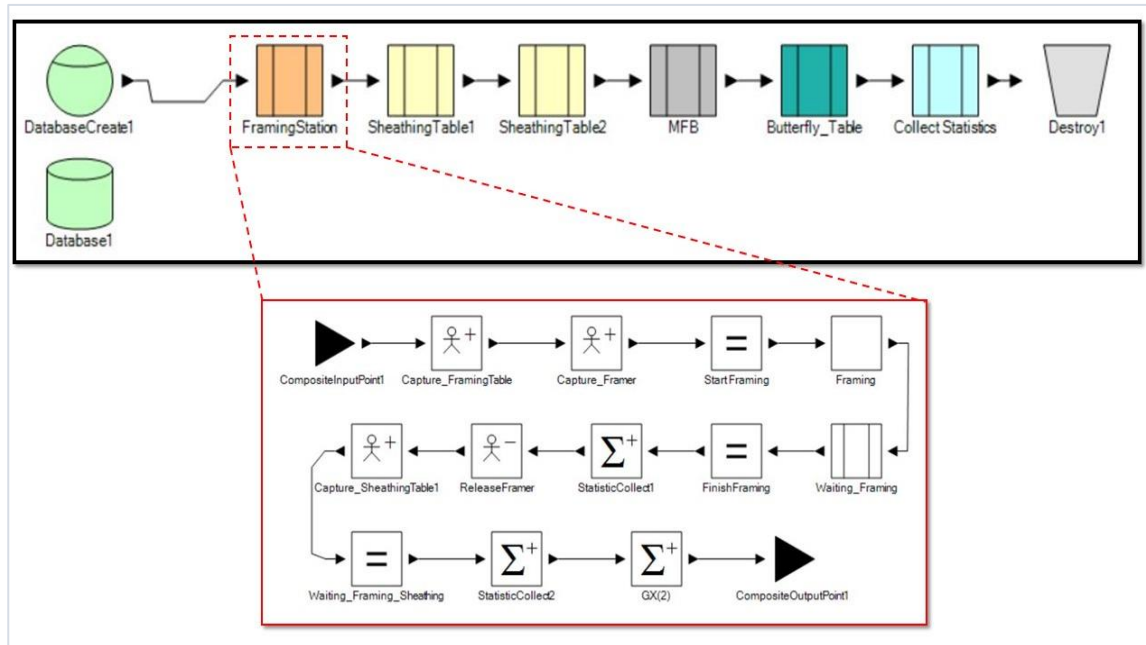


# 4. Methodology



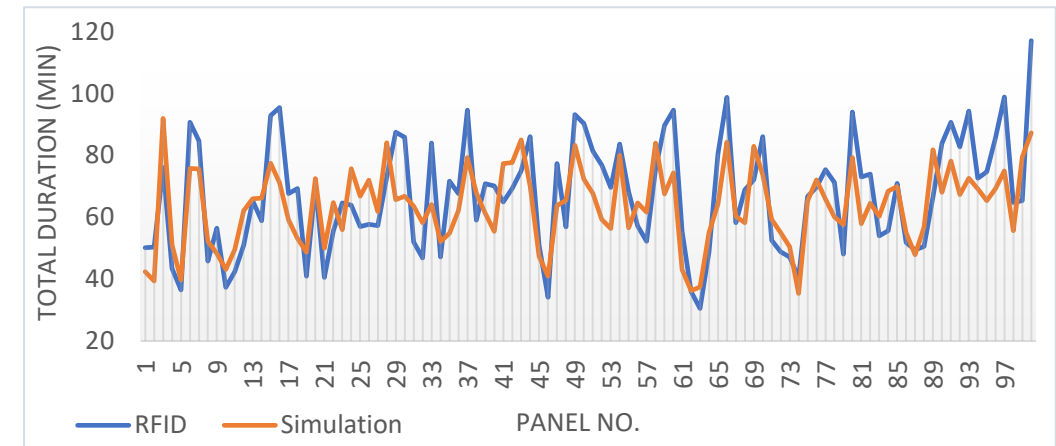
Research Methodology

## 5. Simulation of Operations



Simulation Model of the Multiwall Panel  
Manufacturing using Symphony.NET

Simulation of current state of operations is  
validated using historical performance data  
obtained from RFID system.

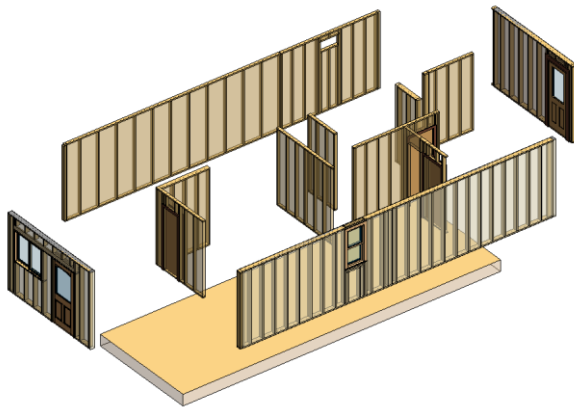


Simulation Validation Results

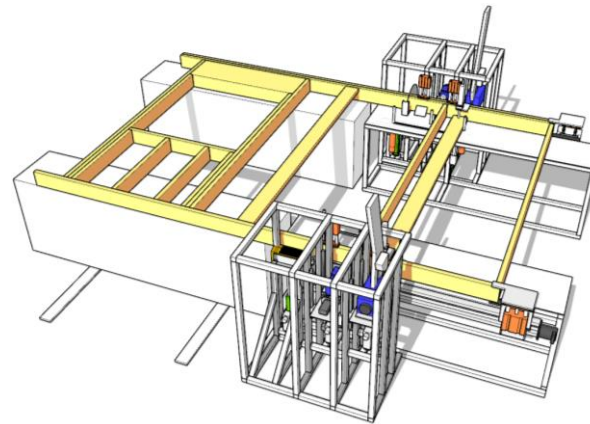


## 6. Results and Conclusion – Model Validation

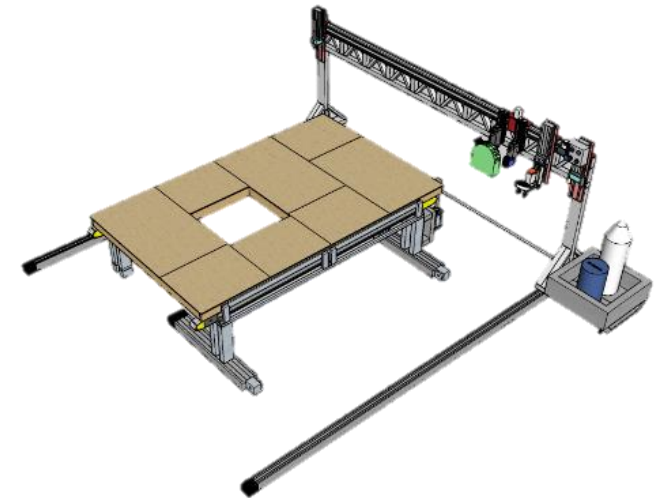
- Three different improvement scenarios are simulated and compared against the current state of operations:
  1. Rerouting Interior Walls
  2. Enhanced Automated Nailing Machine
  3. Combination of the First Two Scenarios



Wall Panels



Automated Wall Framing



Automated Sheathing Installation

## 6. Results and Conclusion – Results Comparison

	TD (min)	IT (min)	Average Utilization Rates %					TP reduction (hr)	MH reduction (hr)
			FS	ST1	ST2	MFB	BT		
Current State	64	20	95%	77%	56%	71%	44%	-	-
Scenario 1	45	12	95%	72%	44%	51%	10.8%	27	189
Scenario 2	62	26	95%	55%	66%	77%	49%	22	154
Scenario 3	37	13	95%	40%	48%	54%	12%	58	406

## 6. Results and Conclusion

- DES is used to explore potential improvements in the production flow in a panelized manufacturing facility.
  - ✓ Scenario 1: 40% reduction in IT and 30% reduction in TD
  - ✓ Scenario 2: 30% increased IT and 4% reduction in TD
  - ✓ Scenario 3: 35% reduction in IT and 42% reduction in TD
- By implementing scenario 3, we obtain improved daily production from:  
**36 panels/day** to **42 panels/day**, on average.

# Thank You!