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

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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.
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

Top & Bottom Plates

Vertical & Horizontal Studs

Openings Components

Wall Panels’ Attributes

Wall Panels’ Framing Operations

Boundary of current study

Factory Layout and the Boundary of the Current Study
4. Methodology

CORE PROCESS

Current State Study

Factory Layout
- Stations Identification
- Crew Size

Detailed Element-Based Time Study

Data Collection
- Daily Production
- Actual Observations

Simulation MODELLING

Simulation Model
- Output Validation
- Improvements Implementation
- Sensitivity Analysis

Production Monitoring Data (RFID)
- Total Duration
- Memory Foot
- Total Queue Length
- Total Execution ID
- Labor Hours

Research Methodology

INPUT

Factory Layout
Production Data
Panels’ Physical Properties
Labor Allocation

CRITERIA

Crew Size in Each Station
Factory Capacity
Labors Productivity
Production Sequence

OUTPUT

Increase Productivity
Decrease work-in-progress
Decrease idle time
5. Simulation of Operations

Simulation Model of the Multiwall Panel Manufacturing using Simphony.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
6. Results and Conclusion – Results Comparison

<table>
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<tr>
<th></th>
<th>TD (min)</th>
<th>IT (min)</th>
<th>Average Utilization Rates %</th>
<th>TP reduction (hr)</th>
<th>MH reduction (hr)</th>
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<td></td>
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<td>ST2</td>
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</table>
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!