Construction materials flow investigation – delay evaluation in a sand supply chain with simulation

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INTRODUCTION

• The increasing competition in today's market;
• Need for more significant investment in planning and control, leading to studies to find solutions that reduce waste and losses in the sector;
• The principles of Lean thinking meet the demands of the current context and have as their starting point the elimination of waste;
• Integration allows better synchronization between supply and demand, bringing material to the workplace.
The purpose of this study is to evaluate the effects of using a delay generation system on the construction order time and delivery interval in a sand supply chain, measuring the impacts from supplies chain model simulations.
RESEARCH METHOD

• In the model presented in this article, the sand flow was evaluated in a case study of the construction of a 300m² single-family residential building.

• The development of the simulation model of this study was based on the works of Ruiz, Fontanini and Corrêa (2019) and Ruiz and Fontanini (2014).

• The period between the first and last request for sand delivery was 300 days. Shipments were weekly, made in a 6m³ truck. The ordering interval for sand work was, on average, two days, and the delivery time was three days.
• The model was developed in the Stella® software;

• Within the model was inserted a delay system, that influenced the order and delivery intervals and an accountant.

• The delays during the simulation varied randomly.

• As for the delay in the work order interval, a maximum tolerance of 1.5 days in a month was considered.

• The delay in the restoration interval, the tolerance was two days late in one month, which resulted in a 0 to 6.66% variation.
RESEARCH METHOD

- A total of 100 simulations were performed on the model. The generated data were evaluated for the mean, median, standard deviation, coefficient of variation, amplitude, maximum, and minimum values;

- Based on this assessment, the impact of delays was measured on both the expected total Lead Time and the costs relative to the waiting teams.
Figure 1: Macro Model of Sand Supply Chain Value Flow Map with a Delay and Loss Accounting System
DELAY IMPACTS

Table 1: Impact of cost delays (loss)

<table>
<thead>
<tr>
<th>Average (μ)</th>
<th>Standard deviation (s)</th>
<th>Median</th>
<th>Coefficient of variation</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$ 1,993,78</td>
<td>US$ 51,08</td>
<td>US$ 1,994,06</td>
<td>% 2,5621</td>
<td>US$ 2,140,37</td>
<td>US$ 1,872,45</td>
<td>US$ 267,91</td>
</tr>
</tbody>
</table>

Figure 2: Loss frequency graph
Figure 3: Graph of the scope of results for losses
CONCLUSION

- Through the statistical analyses carried out in this study, it was possible to evaluate the effectiveness and precision of the model elaborated with a close approximation to reality;

- In the case study, the average loss generated by delays within the sand supply chain for the single-family residential project was R$ 6251.39 (US$ 1742.30). The model considered only the costs related to labor. The impact of material delays was not assessed in this study.
CONCLUSION

• Due to the absence of a control system over orders and delays, it would be necessary to consider an additional cost in the work of approximately R$ 6543.00 (US$ 1823.58) in addition to the price initially foreseen, to cover 95% of possible losses.

• Through the analyses performed, it was observed that the range of results regarding the loss at the end of the simulations was approximately R$ 840.00 (US$ 234.11), almost equivalent to hiring another mason’s assistant.
CONCLUSION

• The importance of having an inventory control system;
• Stay within the cost initially provided for in the project;
• With these delays, there will be a consequent decrease in the profit margins previously stipulated;
• The model structure used in this study has potential for implementation in other construction supply chains;
• A proposal for future studies would be to implement this model in other flows, assessing the impacts of delays in the monetary sphere.
We would like to thank the State University of Campinas for the support and provision of the necessary infrastructure to conduct this research.
Thank you!

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