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SIMULATION-BASED CAPITAL INVESTMENT DECISION-MAKING IN STEELWORKS

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ABSTRACT

We have created a simulator to analyze material logistics within and outside the steelworks, aiding decision-making in capital investment. To ensure profitability, we are consolidating and migrating facilities and production processes. However, introducing new equipment or making significant process changes across multiple sites requires substantial investment and careful consideration. By using the simulator, we assessed logistics process changes before investing in facilities. Additionally, by validating the impact in case of breakdowns or failure, we confirmed the potential to avoid excessive facility investments costing millions of dollars.

1 INTRODUCTION

In steelmaking that requires heat for processing, it is crucial to avoid production stoppages and reductions caused by material shortages, ensuring continuous operation, improved energy efficiency, and reduced costs. Therefore, it is important to assess the impact of problems when introducing new facilities or changing operating methods (Seiringer et al. 2021). We present case studies that we used a simulator to consider capital investment in non-steady-state situations.

2 STRUCTURAL REFORM OF STEEL SUPPLY

In line with the current carbon-neutral trends, there has been consideration of moving away from blast furnace processes that emit high levels of CO2. As part of this structural reform, we have implemented a system where certain steelworks halt their upstream processes, such as smelting iron from ore, and instead receive processed semi-finished products through maritime transport from other sites. During the preparation period for this system change, we had to consider the operations management, taking into account competition with conventional product transportation. To guarantee the effectiveness of the reform proposal, we used dynamic simulation to confirm the logistics after the reform and validate its feasibility.

The post-reform logistics line is implemented as follows: (Figure 1)

1. Ship semi-finished products from other works.
2. Unload from ships at the berth in target works.
3. Store in a temporary yard (newly established).
4. Load onto trucks and transport them to the factory entrance.
5. Transport the processed products from the factory to the berth, and load them onto ships.

First, we created scenarios for semi-finished product supply and product transportation. We simulated to determine if the supply in each factory would meet the production demand, and confirmed it was feasible. However, the construction of a temporary yard in Step 3 was expensive. To reduce costs, we considered skipping the step and directly transporting them. It was crucial to ensure operations wouldn't collapse even if shipping and receiving were halted due to severe weather. Therefore, we simulated under more stringent conditions than the actual frequency of severe weather events. The results showed that the inventory was able to be restored to a steady state within 11 days after a week of bad weather. Based on this simulation, we concluded that investing in the temporary yard construction was unnecessary.

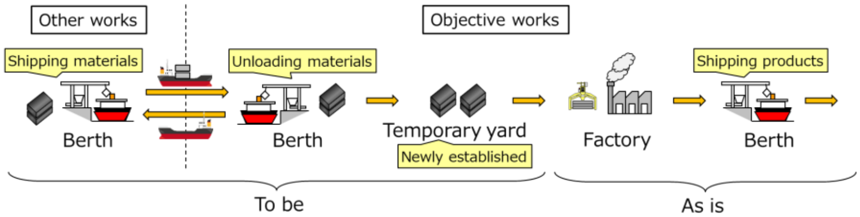

Figure 1: Logistic flow after structural reform.

3 TRANSITION OF IRON ORE HANDLING METHODS

We conducted a case study on capital investment considerations in internal logistics within the steelworks.

In steel production, different types of iron ores and raw coal are blended to achieve desired grades and qualities. There are two blending methods: bed blending and bin blending (Figure 2). The bed blending method we currently adopt allows for efficient logistics as materials can be transported in bulk, but it suffers from variation in blending ratios and quality deterioration due to outdoor exposure. On the other hand, the bin blending method ensures stable quality but incurs higher logistics costs due to smaller tank capacities and more frequent transportation.

To stabilize iron ore quality, we considered transitioning from the bed blending method to the bin blending method. However, we were concerned about potential cost increases due to bottlenecks. Therefore, we developed a simulator to calculate logistics costs and assess the operating method before investing in blending bins. The simulator considered the process layout after implementing blending bins, where stored materials were consumed based on production volume and blending ratios. By running the simulator with randomly generated breakdown data for a month, we confirmed that the inventory level of the blending bins remained above the lower limit, validating the feasibility of operation after implementing the blending bins. Additionally, by verifying the processing capacity of the blending bins, we avoided excessive investment.

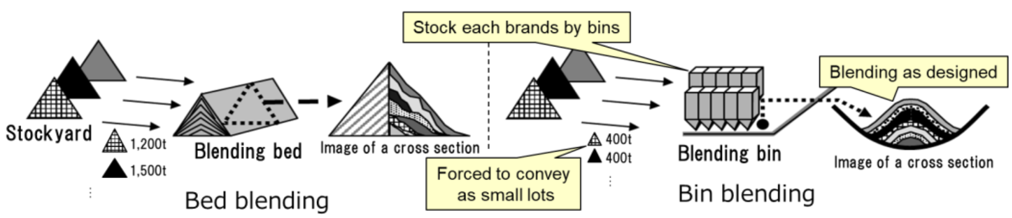

Figure 2: Comparison of blending methods.

4 CONCLUSION

Our simulator has been instrumental in analyzing material logistics and aiding our decision-making in capital investment. It allows us to assess the impact of trouble and validate the feasibility of investments. The case studies showed its effectiveness in considering steel supply reform and internal logistics. Overall, the simulator helps optimize our decision-making process and minimize unnecessary costs.

REFERENCES

Seiringer, W., K. Altendorfer, J. Castaneda, J. Panadero, and A.A. Juan. 2021. "Applying Simheuristics for Safety Stock and Planned Lead Time Optimization in a Rolling Horizon MRP System under Uncertainty". In *2021 Winter Simulation Conference (WSC)*. https://doi.org/10.1109/WSC52266.2021.9715294.