A discrete event simulation approach to define the operating strategies and assumptions in an iron ore port

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Abstract. The best scenario for an iron ore port is to operate with the least amount of resources, the lowest cost and ensuring all aspects of operational safety. In the field of logistics and supply chain management simulation-based decision support systems provide solutions to a wide range of issues at both a strategic, operational and tactical level [1]. The discrete event simulation is relevant for the provision of operating resources, expenses and as reference for the maintenance contracts, vessels, equipment and materials.

The planning of operating strategies and assumptions is the key factor in achieving the best system productivity. However, the complexity of the system with the interaction of large equipment from the unloading iron ore wagons, the stockyard to ship loading and its restrictions is a challenge to determine the best way to operate with the correct equipment allocation, maintenance priorities, stockpiles and conveyor belts routes in each scenario. A simulation model can represent complex and important characteristics of real systems, which allows its representation of the behavior that such systems would present when subjected to the same conditions [2]. From this perspective, operational research aims to planning the operating strategies and reduces the operational costs.

The simulation involves risks and uncertainties in parameters from the type and quality of iron ore, through the physical availability of the equipment used, mine production demand, unloading and loading rates, to climatic operating conditions. Furthermore, in recent years the handling of iron ore has presented challenges in operational and navigation safety. Another important issue considered is the thousands of routes possibilities and operational restriction in interaction of the unloading process, stockyard management and ship loading. After modeling and validation, a simulation model has the potential to support decision making in situations that are difficult to test in practice [3,4].

Before reaching a cargo ship, the iron ore traverse stockyards with well-planned operations to avoid impairments in ship delivery [5]. Therefore, knowing the best route, the proportion of iron ore handled in each stockyard and interactions between each equipment is crucial to minimizing these problems. The operational efficiency of the stockyard–port requires that the flow of ore in each process is carried out quickly and without interruption, at the same time as the ships are loaded with the quantity and quality of ore requested by customers [5]. Furthermore, any stock is considered as loss in a productivity system, because besides being idle capital, the stock is subjected to two basics factors: obsolescence and deterioration [6].

Considering a production demand below the port capacity, the opportunity to attend this demand with the best productivity was identified. To achieve this, simulation was used to evaluate asset hibernation, aiming to optimize resource allocation and reduce costs. The modeling approach consider the 3 main processes: the unloading of the iron ore wagons, the stockyards and the loading of ships. In this way, there is the arrival rate of the wagons to the car dumpers, the routes for stacking and reclaiming of iron ore in the stockyards, the arrival rate of ships for the loading of specified ore.

The discrete event is applied to model and to simulate three different scenarios of a real iron ore port, analyze and propose the planning strategy for the highest productivity scenario, as well as proposing improvements. Three different scenarios were simulated.

The first scenario, the current state of the port, absorbed the demand from the mine and the demand from customers, presenting excess capacity operating with all equipment. The second scenario, considering the operation with one less berth operating, despite having annual capacity greater than production demand, occasionally in some months it was not possible to attend the demand. With the simulation it was possible to identify that in the months with lower capacity, the other berths were unable to attend the demand. In this scenario, considering a period of one year, the estimated potential cost reduction was U$17.5MM. The third scenario, considering the operation with one less stacker equipment, presented capacity greater than demand in all months of the year, without compromising the port performance. Through the simulation results, it was possible to evaluate the percentage of all routes and resources available with the hibernation of an asset. In this scenario, the estimated potential cost reduction with the asset hibernation was U$7.6MM.

Therefore, scenario 3 was chosen to build the operational strategy and with simulation it was possible to identify which routes, assets and resources were most important, making it possible to define more robust maintenance and operating strategies, especially in the case of key assets.

Keywords: discrete-event simulation; operational research; iron ore port, operating strategies.

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