Proceedings of the 2023 Winter Simulation Conference
C. G. Corlu, S. R. Hunter, H. Lam, B. S. Onggo, J. Shortle, and B. Biller, eds.

LNG CCS (CARGO CONTAINMENT SYSTEM) MANUFACTURING SYSTEM USING IOT DATA AND SCHEDULE SIMULATION

Yonghee Kim
Eunsun Jeong

HD Korea Shipbuilding & Offshore Engineering
HDHyundai Group
Seongnam, Bundang 13553, KOREA

ABSTRACT

Compared to other manufacturing industries, the shipbuilding industry has high uncertainties and volatility in resources such as manpower, space, and equipment. The labor-intensive, expansive yard spaces, and enclosed working areas of the shipbuilding industry make it difficult to aggregate and analyze data. The research effort presented in this extended abstract focuses on gathering production data using IoT technology and schedule simulation for the intent of reduction in uncertainty of project management. The gathered data from automated equipment can be employed to monitor production performance and conduct data-driven production management. It is possible to prevent from decreasing production performance and excluding input of batch production performance unrelated to actual work information. In addition, we use simulation to find the optimal solution for the purpose of load leveling in the process of establishing an LNG CCS manufacturing plan.

1 INTRODUCTION

The field of process-related data utilization and management in the shipbuilding industry mainly focuses on research that monitors and analyzes about daily work performance data. However, in shipbuilding industry, production site managers input a significant portion of the production performance data directly in an office. This practice is necessitated by challenges in setting up effective communication channel across expansive yard spaces and dealing with communication difficulty caused by numerous enclosed areas and shaded zones. In this study, we developed a system that calculates work information based on real-time equipment operation data and monitors work status in a LNG CCS which enclosed space by using LoRa communication-based IoT technology(Alireza Zourmand, 2019). In the production planning, a rescheduling algorithm was developed that minimizes the deviation of daily work volume by simulating the buffer from the completion of the preceding work to the start schedule of the following work by utilizing the harmony search algorithm (Z.W.Geem, 2001). The proposed system and technology can improve the accuracy of process management based on real-time data and provide better schedules to work managers by automatically establishing production plans that minimize LNG CCS production load deviations.

2 APPROACH

Our approach is based on rescheduling technology that applies a harmony search algorithm that improves the degree of load leveling and automation of performance collection linked to automated equipment operation data. Figure 1 shows a system configuration for project management for LNG CCS. We developed a LoRaWAN-based data collection device that is specialized for IoT networks and has high radio wave diffraction, which is convenient for shipbuilding industry environments such as enclosed areas or inside cargo holds. Based on the collected real-time performance data, it is possible to predict delays in the

cargo hold manufacturing process and to check the remaining quantity for each process in real time. The simulation model generates a new schedule, taking load leveling into account, by making adjustments to the buffer between the completion of the preceding task and the commencement of the subsequent process.

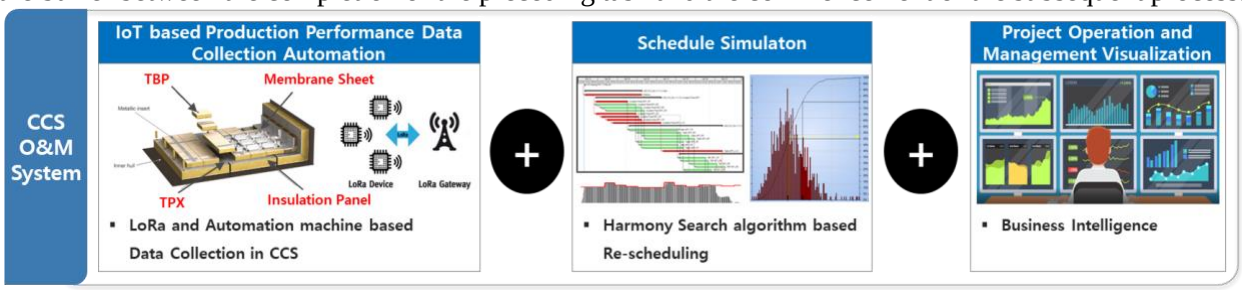

Figure 1: System Configuration for project management and construction of LNG CCS.

3 RE-SCHEDULING (SIMULATION) RESULT

We conducted a simulation experiment to optimize schedule by adjusting buffer and load balancing in LNG cargo hold production. To begin with, an initial solution (referred to as Harmony Memory) is created by utilizing the standard schedule provided as input data along with a randomly generated buffer period. The following steps are performed to create a new schedule based on the initial solution. First, we find a better solution configuration by combining the buffer period of the initial solutions. Second, a better configuration is found by adjusting the buffer value step by step up or down based on the parameter value set by the planner. Third, buffer values are randomly generated to find completely new combinations. As a result of confirming the new schedule through the above three adjustment steps, a new manufacturing schedule was derived with an improvement of about 12% in the standard deviation value of the number of manufactured cargo holds per day, which evaluates the degree of load leveling.

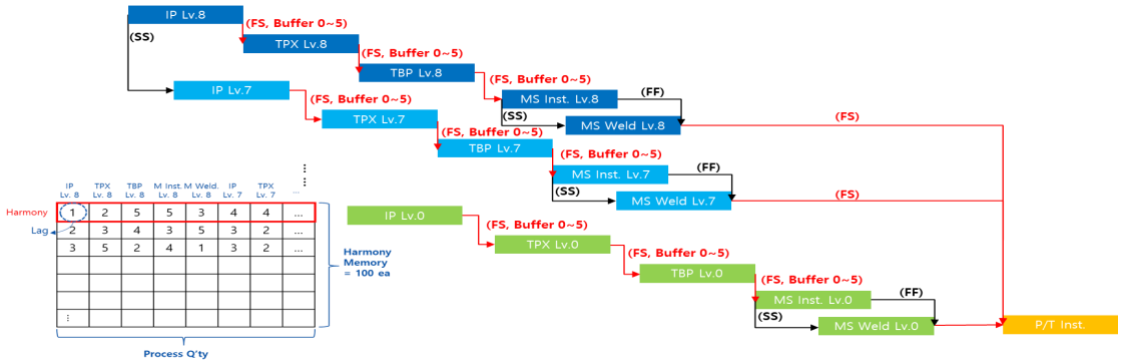

Figure 2: Initial solution configuration and schedule simulation points based on LNG CCS manufacturing.

4 FUTURE DIRECTIONS

Currently, production forecasting plans are established without incorporating performance-based schedule adjustment simulations or rescheduling using actual daily working data. In the future, a completion schedule prediction simulation and digital twin system based on the results of daily construction performance data analysis will be established.

REFERENCES

Geem, Z. W., J. H. Kim, and G. V. Loganathan. 2001. "A New Heurisitc Optimization Algorithm; Harmony Search". *Simulation*. 76(2), 60-68

Zourmand, A., and A. L. K. Hing. 2019. “Internet of Things using LoRa Technology”. *2019 IEEE International Conference on Automatic Control and Intelligent Systems*