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Modular construction system simulation incorporating off-shore fabrication and multi-mode transportation

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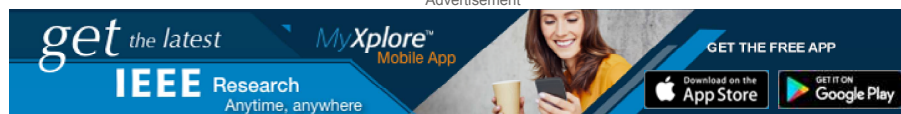
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Abstract:

The global material supply chain for modular construction, consisting of assemblies prefabrication, material delivery and handling, module assembly, and site installation, can be regarded as a "Big Site" problem. With a combination of various transportation modes (i.e., trucks, ships, and rails), insufficient logistic planning on the capacity and time availability of unloading bays and transportation resources potentially delays material arrival dates on an industrial construction site and field installation schedules. Previous related research in construction engineering and project management domain largely focused on matching material supply with site demand without emphasis on logistics and supply chain management. A special purpose simulation template is developed based on the Symphony platform to facilitate the simulation modeling of module fabrication, transportation, assembly, and installation processes. System performance indicators are adapted from port management literature in order to assess different scenarios of modular construction planning. A case study representing modular construction practice is presented.

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1 Introduction

Modular construction involves off-shore prefabrication, multi-mode transportation, and on-site installation of modules in the formation of the industrial engineering facilities. Generally, fabrication shops, modular shops and construction fields are adjacently located in a local region, which can be integrally viewed as the "site". However, the practice of globally sourcing materials, off-shore fabrication and then transshipment to local module shops for assembly and eventually installed in field, is observed in current industrial projects. Thus, the scope of the site is no longer just within the local area; it extends into the global domain. As per Figure 1, raw materials such as pipe and steel are prefabricated at the fabrication shop offshore. The prefabricated materials are loosely packed in a sea container bounded for a particular module shop for assembly operations. The container is delivered from the fabrication shop to the port of loading (POL) by trucks. Then, it is transferred from POL to the port of destination (POD) by ship. The container is further transported from POD to the module shop. In this case, there are two feasible routes for transferring the container from POD to Module Shop A or B. The selection of a particular shipment route is dependent on the container's specified destination and the truck's availability. At the module shop, steel and pipe components in the container are assembled into modules by bolting, welding, and coupling connections. Then, the module is transported to the construction site by truck for field

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