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Industrial Production of the Saudi Future Dwelling: A Saudi Volumetric Solution for Single Family Homes, Leveraging Industry 4.0 with Scalable Automation, Hybrid Structural Insulated Panels Technology and Local Materials

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Abstract : The King Abdulaziz City for Science and Technology (KACST) created the Saudi Future Dwelling (SFD) initiative to identify, localize and commercialize a scalable home manufacturing technology suited to deployment across the Kingdom of Saudi Arabia (KSA). This paper outlines the journey, the creation of the international project delivery team, the product design, the selection of the process technologies, and the outcomes. A target was set to remove 85% of the construction and finishing processes from the building site as these activities could be more efficiently completed in a factory environment. Therefore, integral to the SFD initiative is the successful industrialization of the home building process using appropriate technologies, automation, robotics, and manufacturing logistics. The technologies proposed for the SFD housing system are designed to be energy efficient, economical, fit for purpose from a Saudi cultural perspective, and will minimize the use of concrete, relying mainly on locally available Saudi natural materials derived from the local resource industries. To this end, the building structure is comprised of a hybrid system of structural insulated panels (SIP), combined with a light gauge steel framework manufactured in a large format panel system. The paper traces the investigative process and steps completed by the project team during the selection process. As part of the SFD Project, a pathway was mapped out to include a proof-of-concept prototype housing module and the set-up and commissioning of a lab-factory complete with all production machinery and equipment necessary to simulate a full-scale production environment. The prototype housing module was used to validate and inform current and future product design as well as manufacturing process decisions. A description of the prototype design and manufacture is outlined along with valuable learning derived from the build and how these results were used to enhance the SFD project. The industrial engineering concepts and lab-factory detailed design and layout are described in the paper, along with the shop floor I.T. management strategy. Special attention was paid to showcase all technologies within the lab-factory as part of the engagement strategy with private investors to leverage the SFD project with large scale factories throughout the Kingdom. A detailed analysis is included in the process surrounding the design, specification, and procurement of the manufacturing machinery, equipment, and logistical manipulators required to produce the SFD housing modules. The manufacturing machinery was comprised of a combination of standardized and bespoke equipment from a wide range of international suppliers. The paper describes the selection process, pre-ordering trials and studies, and, in some cases, the requirement for additional research and development by the equipment suppliers in order to achieve the SFD objectives. A set of conclusions is drawn describing the results achieved thus far, along with a list of recommended ongoing operational tests, enhancements, research, and development aimed at achieving full-scale engagement with private sector investment and roll-out of the SFD project across the Kingdom.

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