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Design Standardization in Aramco: Strategic Analysis

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***Abstract*—**The construction of process plants in oil and gas-producing countries, such as Saudi Arabia, necessitates substantial investment in design and building. Each new plant, while unique, includes common building types, suggesting an opportunity for design standardization. This study investigates the adoption of standardized Issue for Construction (IFC) packages for non-process buildings in Saudi Aramco. A SWOT analysis presents the strengths, weaknesses, opportunities, and threats of this approach. The approach's benefits are illustrated using the Hawiyah Unayzah Gas Reservoir Storage Program (HUGRSP) as a case study. Standardization not only offers significant cost savings and operational efficiencies, but also expedites project timelines, reduces the potential for change orders, and fosters local economic growth by allocating building tasks to local contractors. Standardization also improves project management by easing interface constraints between different contractors and promoting adaptability to future industry changes. This research underscores the standardization of non-process buildings as a powerful strategy for cost optimization, efficiency enhancement, and local economic development in process plant construction within the oil and gas sector.

***Keywords*—**Building, construction, management, project, standardization.

I. Introduction

MAJOR oil and gas producers, such as Saudi Arabia, consistently construct numerous process plants to keep pace with the ever-growing global demand, forecasted to increase production by 50% by 2025 [1]. Among these industry players, Saudi Aramco stands out as a significant contributor to the energy sector. With each new plant, an array of common structures emerges, including administrative buildings, central control units, and substations, among others. While each plant holds unique elements in terms of process parameters and design, the associated buildings serve similar functions. The characteristic of recurring building types, coupled with the standard financial steps involving international contracts for each project's building, opens up a compelling opportunity, that is, the standardization of building designs. By issuing an IFC package that covers all buildings for future projects, Saudi Aramco can bypass stages such as Design Basis Scoping Paper (DBSP), Project Proposal, and Detailed Design leading to substantial cost savings.

A. The Problem

In the context of Saudi Aramco's operations, each project, irrespective of its similarities with previous ones, initiates an extensive design phase involving international and local contractors. Markedly, these phases, including the DBSP, Project Proposal, and Detailed Design, lead to substantial resource expenditure in terms of time, cost, and workforce. Despite serving similar functions across multiple projects, the design and construction of each building in a process plant are often treated as unique elements. The lack of standardization across building design leads to redundant design efforts and cost inefficiencies. Further, the lack of standardized design results in variability in the final structures, affecting the overall consistency of built assets across different plants. Therefore, the challenge is determining whether a standardized design approach can address these issues and provide significant benefits for the company and other stakeholders. In this regard, this study eliminates DBSP, Project Proposal, and Detailed Design stages and adopts a standardized design process by issuing an IFC package for all projects' building for future project (see Fig. 1). The introduction of a standardized IFC package for all future projects' buildings is set to streamline the Aramco project process by eliminating the redundant stages in the traditional project execution flow. As such, standardization enables earlier execution of the construction phase.

II. Background

As shown in Fig. 2, Aramco's projects are initiated through a structured process that begins with the Initiation Stage. In this stage, a business opportunity is conceptualized and elaborated, with careful consideration given to the potential benefits, risks, impacts, and synergies with other initiatives. Once a holistic view of the opportunity is attained, the project moves to the Business Case stage. In this phase, the defined opportunity is scrutinized thoroughly and juxtaposed with possible alternatives, laying a foundation for informed decision-making. Upon deciding to advance with the project, activities related to the Study Phase commence. The Study Phase stage involves an in-depth exploration of project alternatives considering various parameters, such as technical viability, site selection, commercial feasibility, risk factors, potential opportunities, and economic sensitivities. The primary aim of the Study Phase is to form a robust study estimate that supports further stages. Subsequent to the Study Phase is the DBSP stage. The primary objective during this phase is to consolidate the major scope elements and produce a budget estimate accordingly. Once the DBSP stage ends, the project enters the Project Proposal Phase. The stage's key activities centre on finalizing the Preliminary Engineering/Project Proposal, formulating an execution strategy, and refining the project estimate.

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Fig. 1 Standardized Design Phase

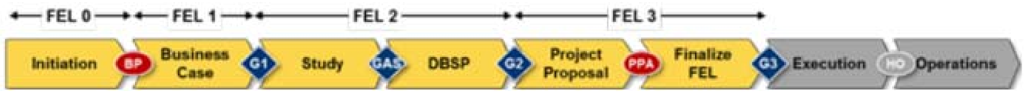

Fig. 2 Aramco Project Process [2]

III. Discussion

Implementing standardized IFC packages for non-process buildings in oil and gas projects can lead to significant cost savings, a strength the industry cannot overlook. The approach eliminates the need for a unique design process for each project, enabling companies such as Saudi Aramco to allocate their financial resources more efficiently. Data from Samsung Engineering & Construction illustrate the potential savings inherent in this model, indicating that about 7% of the total contract value, approximately 14 million USD, is devoted to the design phase of buildings [3]. Utilizing a standardized IFC package, these costs could be significantly reduced, freeing up funds for other essential aspects of the project or enabling investment in additional projects.

The potential to expedite the project timeline significantly underscores the strength of a standardized design approach. In the conventional project cycle, the DBSP, Project Proposal, and Detailed Design phases form an extensive preliminary part of the project. Each of these stages involves substantial time investments, ranging from discussions, drafting, and revisions to final approvals. However, a standardized IFC package could transform this lengthy preliminary process. By pre-establishing the designs for common buildings within a process plant, projects could bypass these preliminary phases and transition directly to the construction phase; this acceleration results in an earlier start for construction activities and a potential reduction of the overall project duration. For instance, considering the data from Samsung Engineering & Construction, a significant portion of man-hours is devoted to these preliminary phases. By eliminating this necessity, a streamlined project timeline could lead to further cost savings.

The substantial reduction in the potential for change orders is a significant strength of implementing standardized designs. Change orders are a common cause of disruptions in project timelines, leading to delays and unexpected cost overruns [4]. The issue arises particularly when unanticipated scenarios during the construction phase necessitate alterations in the initially-approved designs. However, the likelihood of requiring substantial modifications during the construction phase diminishes by employing standardized designs that have been previously executed, tested, and refined across various plants. Markedly, these designs have proven their integrity and functionality in real-world settings, thereby reducing uncertainties; this approach, therefore, offers an opportunity to enhance project predictability, ensuring that projects adhere more closely to their planned schedules and budgets. In such a highly competitive and cost-sensitive industry, this reliability can be a crucial factor in a project’s overall success and profitability.

Standardizing building designs introduces an advantageous reallocation of project responsibilities, improving project execution and fostering local economic growth which will result in supporting achieving the targeted Gross Domestic Product from 40% to 65% [5]. Markedly, this approach allows international contractors to concentrate their expertise on the complex process and semi-process scope of projects. By focusing their resources and efforts on these critical aspects, international contractors can enhance their efficiency, resulting in smoother project execution and potentially fewer technical issues. On the other hand, design standardization permits the de-scoping of building constructions, enabling these tasks to be awarded to local contractors; this strategy not only fosters the growth of local businesses but also provides an avenue for potential cost savings. Local contractors, familiar with the local regulations, resources, and labour market, may offer more competitive bids than their international counterparts. Thus, through strategic task reallocation, standardization of building designs could simultaneously enhance project execution, support local industry, and drive cost-effectiveness.

A critical strength of the standardization approach involves how it addresses the potential constraints that can arise due to the interface between different contractors. Particularly, when buildings are awarded to another contractor separate from the LSTK one, coordination between these different parties can present challenges. By implementing a standardized design and providing an IFC package, an effective interface management plan can be established, enhancing communication, coordination, and cooperation between all involved parties. The approach mitigates the risk of discrepancies, misunderstandings, and inefficiencies, which can lead to project delays and increased costs. The approach also allows for the possibility of progressively transitioning the building awards to competitive bidders while ensuring proper evaluation of the first projects. Therefore, standardization can facilitate smoother project execution by minimizing the complications that often arise when multiple contractors are engaged in various components of a complex project.

Despite the numerous advantages, the standardization approach is not without its challenges. The key concern lies in managing interfaces between the international contractor handling the process and semi-process scope and the local contractor responsible for the buildings; this interface requires careful management to avoid miscommunication and coordination problems that could negatively impact the project timeline or quality. Despite this challenge, standardization opens up significant opportunities. The approach provides a platform for local contractors to participate in large projects, thereby promoting their growth and adding value to the local economy. Standardization also leads to enhanced project management, as resources can be focused on the critical aspects of the project.

While the standardization of building designs promises a wide range of benefits, it is crucial to acknowledge the potential threats that may arise through its application. Some stakeholders might resist such a uniform approach, driven by a preference for bespoke designs tailored to each project's unique requirements. Notably, this resistance can stem from an understanding that each project possesses distinct characteristics and that a 'one-size-fits-all' design might not optimally cater to all these variables. Additionally, there may be concerns regarding the adaptability and future-proofing of standardized designs. As the oil and gas industry continually evolves, adopting new technologies and practices, there may be apprehensions about whether these pre-determined designs can accommodate such advancements or site-specific needs. Consequently, the flexibility and adaptability of standardized designs may be questioned, necessitating a balance between the convenience of standardization and the flexibility to adapt to evolving industry dynamics.

IV. Practical Resolution of the Problem

The solution to the problems identified in Aramco's process design lies in the implementation of standardized IFC packages for all non-process buildings involved in future projects. The IFC approach focuses on creating a standardized design package that can be replicated in multiple projects, eliminating the need for reiterative designing and, thereby, saving substantial time and cost.

The first step in implementing the standardization solution is the adoption of an exhaustive IFC package. The package entails all necessary specifications, blueprints, layouts, material requirements, and every detail that defines the construction and functionality of each building. The IFC package is comprehensive and clear, leaving no room for ambiguity that could lead to change orders during the construction phase. The IFC package includes provision for adequate testing and validation processes to ensure that the design is not only fit-for-purpose but also meets all necessary safety, regulatory, and operational standards. Moreover, the IFC package is flexible enough to accommodate any project-specific requirements or adapt to emerging industry trends and technological advancements.

Expanding the implementation of thoroughly prepared and vetted IFC packages is a strategic move towards standardizing building designs in the oil and gas sector. The IFC package is not merely a blueprint but represents an exhaustive collection of comprehensive specifications, layouts, and material requirements; these designs are vetted meticulously, ensuring that every single detail adheres to the safety, functionality, adaptability, and cost-effectiveness parameters required in the construction of each building. The exhaustive preparation process transforms the IFC package into an adaptable, resilient, and future-proof resource. The validation process demands meticulous attention to ensure that the designs are robust enough to withstand future technological shifts, comply with evolving regulatory changes, and meet ever-advancing industry standards. Therefore, the successful adoption and implementation of these packages not only streamline construction procedures but also bolster the long-term resilience of the projects, reinforcing their ability to adapt and thrive amidst an evolving industry landscape.

The potential benefits of this standardization process can be evidenced by the HUGRSP case study. HUGRSP successfully implemented this concept on eight critical buildings. By utilizing previous project-building packages and capitalizing on them, the outcomes were satisfactory to the project sponsor in terms of meeting the stated objectives. The outcomes indicate the feasibility and potential benefits of design standardization. Based on the HUGRSP experience, standardization could result in substantial cost savings. For instance, we consider that 7% of the HUGRSP contract value was dedicated to building design, equating to approximately $14 million (Samsung Engineering & Construction). Therefore, standardizing the design could save approximately $14 million per project, not accounting for potential savings in the HVAC and plumbing areas. The financial implications of implementing standardized IFC can be seen when analysing the deliverable list for the detailed design phase. The list, which comes from Samsung Engineering & Construction, shows the number of man-hours needed to complete the detail design of the buildings in a project and is used as a reference point.

A. Mathematical Expression of the Solution

We consider that the total number of man-hours required for the detailed design phase is represented by 'H.' As per the data from Samsung Engineering & Construction, 1 man-hour costs approximately $107. Hence, the total cost for the detailed design phase, denoted as 'Costdetailed,' can be calculated as:

$$\text{Costdetailed} = H * 107 \tag{1}$$

H = the total number of man-hours.

This cost, as experienced in HUGRSP, was equivalent to approximately $14 million. Therefore, implementing the standardized IFC packages could avoid this substantial cost for each project. However, the savings do not stop at the detailed design phase; this $14 million saving excludes the savings that would be generated from the DBSP and Project Proposal phases. The total saving, 'Totalsaving,' if standardized in building design for all phases, including DBSP, Project Proposal, and Detailed Design can be expressed as:

$$\text{Totalsaving} = \text{CostDBSP} + \text{CostPP} + \text{Costdetailed} \tag{2}$$

CostDBSP = Design Basis Scoping Paper; CostPP = Project Proposal.

By eliminating these costs through standardization, the total savings across all project phases would be substantial. Adopting a standardized IFC package for non-process buildings in projects not only promises substantial cost savings but also enhances operational efficiency and allows for better project management, as seen in the HUGRSP case study. The mathematical representation underscores the financial benefits, making the case for standardization even stronger.

V. Implications and Future Directions

Implementing standardized IFC packages in Saudi Aramco's projects presents far-reaching implications. Operational efficiency stands to benefit remarkably from this standardization process. The efficiency stems from the elimination of repetitive design processes, quick transitions to construction phases, and enhanced management of resources. Notably, the localized economy could witness substantial ripple effects from these changes. The transfer of building design tasks to local contractors aids in fostering the growth of the local construction sector. The growth could lead to job creation and enhanced skill sets and contribute significantly to the economic diversification goals of Saudi Arabia's Vision 2030.

While beneficial for building design, the concept of standardization also has broad applications across other aspects of project operations.

Considering the future direction, the standardization process should remain adaptable to evolving industry practices and emerging technologies. Saudi Aramco can ensure the ongoing relevance of standardized designs by setting up periodic reviews and updates of IFC packages. It is, thus, crucial to stay updated with advancements in building technologies, materials, and design practices and incorporate them into standardized designs. The constant refinement of IFC packages will be instrumental in maintaining their applicability and maximizing the benefits of standardization. Additionally, Saudi Aramco must also consider the growing emphasis on sustainability in construction practices. As such, future revisions of IFC packages should incorporate eco-friendly materials and energy-efficient design principles wherever possible.

VI. Conclusion

The standardization of building designs in oil and gas projects can introduce significant cost and time efficiencies while promoting local contractor growth and improving project management. Hence, this paper highlights how a carefully crafted IFC package can eliminate the need for repetitive design processes in DBSP, Project Proposal, and Detail Design phases, providing substantial savings. The analysis reveals that integrating standardized designs can make project timelines be expedited and focus be directed toward the crucial process and semi-process scopes. Furthermore, the strategy reduces change orders, limits interface constraints, and stimulates the local economy by awarding contracts to local entities. However, the success of this approach hinges on the rigorous preparation and validation of the IFC packages, ensuring their robustness and adaptability to future industry changes. Markedly, this model presents a promising avenue for improving project outcomes, reinforcing industry standards, and fostering local participation.

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