Construction management risk and digital technology: lens of civil engineering, industrial engineering and architecture of eco wast water treatment construction

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Abstract. The sector of oil and gas, chemical and petrochemical constitute, in global perspective, are considered country’s economic investment and profits; and deemed as escalating global demand. There are challenges in handling its Waste Water Treatment (WWT) and Eco Friendly Construction (EFC). The objective of this paper is to elaborate the Construction Management Risk (CMR) and Digital Technology (DT) through the Research Methodology of Multidisciplinary Lens of Civil Engineering, Industrial Engineering and Architecture toward WWT and EFC. In this paper, the WWT refers to the case study of Sulfidic Spent Caustic (SSC). The aforementioned CMR is integrated with DT in term of Construction Management Risk System, known as CMRS. This CMRS constitutes, yet not limited to Trilogy of Client, Head Office Manager, and CEO toward Several Sites of Constructions. In this paper, the contribution of Civil Engineering constitutes the discourse and elaboration on Construction Management Risk Systems (CMRS) along with its implementation on WWT and EC. Meanwhile, the contribution of Industrial Engineering constitutes the Key Performance Indicators (KPI) and its Safety Dimensions in Construction Management. Subsequently, the Architecture contribution constitutes efficient construction implementation within the efforts to combine the balance among quality, cost, and delivery lead time.

Keywords: Construction, Management Risk System, WWT, Eco Friendly

1. Introduction
The sector of oil and gas, chemical and petrochemical constitute, in global perspective, are considered country’s economic investment and profits; and deemed as escalating global demand. There are challenges in handling its Waste Water Treatment (WWT) and Eco Friendly Construction (EFC). The objective of this paper is to elaborate the Construction Management Risk (CMR) and Digital Technology (DT) through the Multidisciplinary Lens of Civil Engineering, Industrial Engineering and Architecture toward WWT and EFC. In this paper, the WWT refers to the case study of Sulfidic Spent Caustic (SSC).
The aforementioned research on SS was performed and conducted at the Spent Caustic Oxidation Unit (Scox Unit) in one of Oil and Gas Construction Facilities. At this situation, Chemical Oxygen Demand (COD) as the indicating alerts for Scox effluent, in the maximum indicator of 900 ppm. Otherwise, if the indicator is exceeding 900 ppm, then its procedure requires it to be transferred to final Waste Water Treatment (WWT) Unit.

Incineration is deemed indispensable for handling that Scox effluent that as Chemical Oxygen Demand exceeds 100 g/L. Unfortunately, this treatment is deemed costly and resulting in hazardous chemicals [1]. Meanwhile, wet air oxidation (WAO), is in general in strictly operating procedures [2] within temperature systems of significantly level of low, medium or high [3].

Caustic (NaOH) is capitalized in the oil and gas, including petrochemical industry to remove hydrogen sulfide (H2S) from various hydrocarbon processes. The use of this caustic produces a waste product which is commonly called a sulfidic spent caustic (SSC). SSC contains high concentrations of hydrogen sulfide, alkalinity resulting from NaOH solution, and certain non-biodegradable organics, including benzene, toluene, and phenol. The caustic solution used has a high pH (pH> 12) and high salinity (Na 5-12%).

2. Construction Management Risk (CMR) and Digital Technology Systems of Civil Engineering

The construction project constitutes a complex and dynamic system. These system characteristics are due to its orchestrated among each other [4].

To some extent, the orchestrated elements within internal systems refer to the following but not limited to construction projects, cash flow, human capital and possible vested interests among developers, contractors and designers. Furthermore, the external systems refer to the country perspectives and its economy, social, regulation and green awareness. Thus, solving complex and dynamic problems constitute the successful factors for Construction Management Risk (CMR) within embedded Digital Technology (DT).

To some periphery of attention, Digital Technology (DT) constitutes parts of Trilogy Complexity of Construction Management Risk, Technological and Organizational that have augmented significantly. In recent 2018 research and findings, there are indications on the augmented construction project complexity that might jeopardize the project success probability [5]. Within the other side of the coin, there are multiple considerations in its dynamic and stable perspective [6]. Subsequently, in the old school methods are unable to comprehend the project complexity, within its critical path method and delay analysis.

To some extent, System Dynamic (SD) has been applied to accommodate the aforementioned project complexity. Since it was first coined by Forrester in 1958, SD has been applied to troubleshoot related implemented researches. Those researches are relevant to construction management and construction management risk, including its system [7 & 8].

As an overview in this paper, the contribution of Civil Engineering constitutes the discourse and elaboration on Construction Management Risk Systems (CMRS) along with its implementation on WWT and EC. Meanwhile, the contribution of Industrial Engineering constitutes the Key Performance Indicators (KPI) and its Safety Dimensions in Construction Management. Subsequently, the Architecture contribution constitutes efficient construction implementation within the efforts to combine the balance among quality, cost, and delivery lead time.
| ONGOING RESEARCH DOMAIN | RESEARCH TOPICS | FUTURE RESEARCH DIRECTIONS |
|--------------------------|----------------|---------------------------|
| RM -1. Construction Risk Management | Risk Allocation | |
| RM-2. Schedule Risk | Cost Risk | |
| WM-1. Waste reduction and recycling | Waste incineration | |
| WM-2. Economic Feasibility | Waste facility and its Economic feasibility | |
| EM -1. Commercial Energy Consumption Variables | Lighting | |
| EM-2. Nation wide Energy Consumption Life Cycle | Energy Consumption Variables | |
| CMP -1. Head count Productivity | Technology Driven Productivity | |
| CMP-2. Revamp Contract | Cost Risk on Natural Productivity | |

**Figure 1.** Past, Present and Future Research on Construction Management in term of System Dynamic [8]
Figure 2. Construction Management Risk Systems and its Trilogy Perspectives [9]

The Construction Management Risk System, known as CMRS, is performing inputs risk occurrence information and its status into the server.

By doing so, as CMRS intertwines with SD, it is enabling systematical risk management identification within construction management, with the alignment of Digital Technology, known as DT.

As illustrated in Figure 2, This CMRS constitutes, yet not limited to Trilogy of Client, Head Office Manager, and CEO toward Several Sites of Constructions. Eventually, the aforementioned systematical risk management identification serves as guidelines for strategic decision making through corporate’s knowledge management perspectives in the construction management risk systems [9]. The monitoring results of the Sulfidic Spent Caustic (SSC) on Water Waste Treatment (WWT) can be sent to CMRS server and the management can make decision based on the data.
3. Industrial Engineering Perspective
As an overview in this paper, posterior to contribution of Civil Engineering, then, the contribution of Industrial Engineering constitutes the Key Performance Indicators (KPI) and its Safety Dimensions in Construction Management [10].

To begin with, this session of Industrial Engineering conveys the perspectives of Key Performance Indicators [11]. These scholars define KPI as the measurement of both quantitative and qualitative data. Both data is intended to convey information on safety concern, within construction management on sites. Ultimately, both data is guarding the performance quality in Construction Management [12].

As overview, the aforementioned KPIs constitute several clusters. The first cluster constitutes KPIs for Planning, Design and Procurement in Construction Management. The second cluster constitutes the Safety Dimensions in Construction Management.

The cluster of Planning, Design and Procurement in Construction Management cover several indicators. Those indicators refer to a. Design Firm Engagement, b. Contractor Selection, c. Contractual Agreement.

Meanwhile, the cluster of Safety Dimensions covers several segregated indicators in sub Safety Dimensions of: I. Maintenance and Safety Behaviour, and Communication of Safety Behaviour. II. Construction Safety Policy; and III. Construction Safety Workers.

Integrated data of WWT obtained by CMRS server can be used by management to do the risk allocation and reduce the cost. CMRS server can enhance the overview of the systems within the whole process of WWT. Thus, despite the usage of IT Enhancement in Digital Transformation Era, then, the human as the brain behind the system can be a great combination toward management of risk allocation and cost reduction.

4. Architecture Perspective
As an overview in this paper, posterior to contribution of Civil Engineering and Industrial Engineering, then, the contribution of Architecture constitutes efficient construction implementation within the efforts to combine the balance among quality, cost, and delivery lead time.

To some extent, the periphery of attention toward those balances is the Architect Critical Challenges, in his or her capacity as Project Manager, known as APM. Engineer in his or her career that is involving in construction professionals, have important roles in the construction management process. Among those engineers, architects are frequently having responsibility as the project manager (APM) in which his or her role is to ensure the success factor for projects implementation. Thus, it is indeed Critical Challenges [13].

There are several categories that refer to those Critical Challenges, which are: Category 1: Technical; Category 2: Managerial; Category 3: Personal Skills; Category 4: Contractual; Category 5: Psychological; and Category 6: Financial. The amount of Sulfidic Spent Caustic (SSC) on Water Waste Treatment (WWT) can be used to do the engineering judgement in determining the most efficient of WWT design.

5. Waste Water Treatment (WWT) and Sulfidic Spent Caustic (SSC)
This paper elaborates the discussion on the infrastructure of oil and gas construction. To some extent, this discussion is inseparable with the discussion on Waste Water Treatment and Sulfidic Spent Caustic (SSC). Furthermore, the discussion continues on the question on the construction management that relates to the aforementioned WWT and SSC.

WWT and SSC constitute integral part of treatment for oil and gas construction infrastructure that result in sulfidic soda with high concentration and disturbing smell. Furthermore, the challenges continue in term of the treatment and transportation cost [14].

Sulfidic Spent Caustic (SSC) belongs into the Spent Caustic (SC) Categories. In this bigger classification, SC is categories into the following identifications. The first identification refers to Sulfidic Scent Caustic, known as Su (SSC). The second identification refers to Spent Caustic Cresylic (SCC). Ultimately, the third identification refers to Spent Naphthenic Caustic (SNC).
6. Research Methodology

In this paper, the WWT refers to the case study of Sulfidic Spent Caustic (SSC). The research on SS was performed and conducted at the Spent Caustic Oxidation Unit (Scox Unit) in one of Oil and Gas Construction Facilities. By using the quantitative research approach and combining theoretical and empirical perspectives, the design of WWT can be obtained. The integration multi perspectives of wide array of engineering multidisciplinary of Civil engineering, Industrial Engineering and architecture can result the enhancement of the design.

7. Results and Discussions

As it was stated in prior paragraphs, in recent 2018 research and findings, there are indications on the augmented construction project complexity that might jeopardize the project success probability. On the other side of the coin, there are multiple considerations in its dynamic and stable perspective. Subsequently, in the old school methods are unable to comprehend the project complexity, within its critical path method and delay analysis.

Thus, It is important to ensure the success factors for construction project implementation, by also considering the results and discussions that relate to Waste Water Treatment (WWT) and treatment for Sulfidic Spent Caustic (SSC). Research on SS was conducted at the Spent Caustic Oxidation Unit (Scox Unit) in one of Oil and Gas Construction Facilities.

Spent Caustic (SC) solutions, including Sulfidic Spent Caustic (SSC), are identified by its pH level that exceeds 12 [15]. In addition to that, High sodium concentration level constitutes another identification, in which it is within the range level of 2%–15% (w/w). In some researches, the spent sulfidic caustics are identified by its component of both hydrosulfides (HS) and sulfides Thus, they refer to the range above 2%–3% (w/w) [16].

The results and discussions in this paper refers to some chemical equations that relate to not only SC, but also SSC and its variants. To begin with, the equation (1) refers to the formation of sodium Mercaptan Oxidation, known as MEROX process, to produce disulfides for SC and SSC.

$$RSH + NaOH \rightarrow RSNa + H_2O$$  \hspace{1cm} (1)

Furthermore, MEROX to form disulfides by addition of NaOH to yield the following equation:

$$RSNa + \frac{1}{4}O_2 + \frac{1}{2} H_2O \rightarrow RSSR + NaOH$$ \hspace{1cm} (2)

SSC waste is very foul smelling, poisonous, and very alkaline. This waste contains high levels of COD, total organic carbon (TOC), and Total Dissolve Solid (TDS). These characteristics make it difficult to process with conventional systems.

The ethylene plant will always have a Scox unit, which uses a Wet Air Oxidation (WAO) system to treat SSC waste by oxidizing sulfides, Mercaptans, and the majority of COD. This allows the SSC to be oxidized and its waste water can be sent to the biological waste water treatment before discharge. Chemical Oxygen Demand (COD) is used as the indicating alerts for Scox effluent, in the maximum indicator of 900 ppm. If the indicator is exceeding 900 ppm, the procedure requires it to be transferred to final Waste Water Treatment (WWT) Unit.
Figure 3. Spent Caustic Oxidation (Scox) Unit for Waste Water Treatment in Construction Management for Oil and Gas Sector Based on Empirical Aspect of Qatar Chemical Company, and theoretical Aspect of Sabri et al [16]

8. Conclusions
The aforementioned research on SS was performed conducted at the Spent Caustic Oxidation Unit (Scox Unit) in one of Oil and Gas Construction Facilities. At this situation, Chemical Oxygen Demand (COD) as the indicating alerts for Scox effluent, in the maximum indicator of 900 ppm. Otherwise, if the indicator is exceeding 900 ppm, then its procedure requires it to be transferred to final Waste Water Treatment (WWT) Unit.

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