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A Study on Resources Mobilization in Turnaround/Shutdown Maintenance

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ABSTRACT

Turnaround/shutdown maintenance (TAM) is a planned and periodic activity that involves the temporary shutdown of a production plant or equipment for inspection, repair, or replacement. TAM is essential for ensuring the reliability, safety, and efficiency of industrial facilities, especially in the oil and gas, petrochemical, and power sectors. However, TAM also poses significant challenges in terms of resources mobilization, scheduling, coordination, and cost management because TAM requires huge work forces including subject matter experts (SME), original equipment manufacturers (OEM), contractors, sub-contractors, and labors. Therefore, it is essential for minimizing the negative effects and maximizing the benefits of this resource's mobilization strategy. This paper aims to explore the factors that influence the resources mobilization process in TAM and propose a framework for improving performance.

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INTRODUCTION

Turnaround maintenance is a vital part of the asset management strategy for oil and gas industries. They involve completely shutting down a plant for a planned period to perform various maintenance activities, such as cleaning, inspection, repair, replacement, or modification of equipment and systems. The main purpose of turnaround maintenance is to ensure the safety, reliability, and efficiency of the plant operations, as well as to comply with the regulatory and contractual requirements. Turnaround maintenances are complex, costly, and risky, as they require a huge level of resources requirements and prominent level of coordination, integration, and communication among various stakeholders, such as the asset owner, technical experts, the contractor, and the suppliers. Since its production loss event, organizations aim to complete the Turnaround execution as soon as possible along with safety and quality standards.

The success of turnaround maintenance depends on the effective and efficient mobilization of the required resources, such as workforce, materials, tools, and equipment. However, resources mobilization is also one of the most challenging aspects of turnaround maintenance, because of the following are : Huge Manpower requirements, Resources (Manpower and Machineries) are required for shorter duration, Specialized Individuals are required, Higher Capacity Equipment is required, Requirements of latest technologies.

Resources mobilization is the process of planning, allocating, and deploying the necessary resources for maintenance activities. It involves identifying the resource requirements, sourcing, and acquiring the resources, scheduling and coordinating their delivery and utilization, and monitoring and controlling their performance and availability. For TAM, resources mobilization is a critical factor for success, as it directly affects the project preparation, execution quality, cost, and time, However, resources mobilization also faces many challenges and constraints, such as scarcity, uncertainty, variability, interdependence, and conflicts. These constraints can affect the efficiency and effectiveness of the resource's mobilization process and lead to delays, rework, waste, and increased risks. Therefore, it is essential to identify and analyze these constraints and develop strategies to overcome them.

The aim of this study is to investigate the current practices and the main issues of resources mobilization in TAM, and to propose a framework for improving the resources mobilization process and its outcomes. The study adopts a mixed-methods

approach that combines a literature review, a survey, and a case study. The literature review provides a comprehensive overview of the concepts, methods, and tools related to resources mobilization in TAM, and identifies the research gaps and the opportunities for improvement. The survey collects the opinions and the experiences of the practitioners, and the experts involved in TAM projects, and analyzes the current trends, the best practices, and the main challenges of resources mobilization in TAM. The case study examines a real-life TAM project in a petrochemical plant and evaluates the performance and the effectiveness of the resource's mobilization process and its impact on the TAM outcomes. The study then synthesizes the findings from the literature review, the survey, and the case study, and proposes a framework for enhancing the resources mobilization process and its outcomes in TAM. The framework consists of a set of guidelines, recommendations, and tools that can help the TAM stakeholders to plan, execute, and control the resources mobilization process in a more efficient, effective, and sustainable way.

LITERATURE REVIEWS

A turnaround event (Zulkipli et al., 2014) is a project that requires various resources from inside and outside our organization. Industries use their own staff and external contractors who supply many maintenance workers for the project. The workforce demand changes throughout the turnaround stages. It begins when Turnaround Management team initiates the project. It increases during the preparation and planning of the work scope and schedule. It peaks at the execution of the work activities. It then reduces until the project ends. The total resources that we need for the turnaround consist of direct staff who do the fieldwork, indirect staff who oversee the work teams and liaise with the contractors, and sub-contractors who have specialized skills that lack we internally.

Constraints in Resources Mobilization

High demand with short duration

As Turnaround Maintenances are short duration projects, it demands more workforce to complete the activities in a short duration of time. Resources requirements vary based on scope of work. [7] [5] [10] Normally it ranges from 1000+ to 5000+. [16] Highlighting that inadequate resources are one of the major causes of scheduled slippage. [17] Malaysian petrochemical industrial experts confirmed that contractors mobilize Insufficient resources to perform job and unskilled workers to meet the high demand requirements which causes TAM delay. Additionally, higher resources requirements are only shorter duration. TAMs are planned only for 31 to 21 days [6] [1] to reduce the production loss due to the short duration Resources are not interested to join projects. [2] TAM is conducted in O&G refineries usually every 4 years and lasts 1.5 months on average, requiring approximately 300,000+ labor hours. [2] confirms that requirement of high labor hours is one of the major constraints in Turnaround maintenance.

Limited availability

Skilled and experienced workers, especially in remote or hazardous locations, is another challenge in resource mobilizations. [3] A petrochemical plant consists of various high-powered machines such as compressors, pumps, motors, and gearboxes. These machines are susceptible to various kinds of problems that can affect their performance and functionality. To resolve these problems and restore the machines to their optimal condition, we require the assistance of experts from the service centers that are authorized by the original equipment manufacturers. [9] highlighting that it is crucial to have sufficient resources for the peak need with the right technical skill and shed them as soon as they are required. In addition, the turnaround duration is compressed. For this reason, the availability of the right resources of the right quantity at the right time and the right place is vital. [2] Confirming that labor skills are one of the top five factors affecting TAM performance. Moreover, TAM professionals and workers might be assigned tasks they have never executed before or trained and are rotated frequently before gaining experience in a specific task, therefore shortage of skilled workforce is always there.

Uncertainty and variability

TAMs are known for discovery scopes, resulting in frequent changes and adjustments in the resources plan. (Z. Ghazali & M. Halib, 2015) Confirming that TAM are known for uncertainty works. Uncertainties are certain as it involves plants that are worn or damaged. Chances of emergency work cannot be underestimated and at times the impact can be significant to the turnaround overall schedule and cost. [14] Resources are planned and hired on a contract basis, several months before the execution start date. However, discovery scope occurs at execution stage, which will create additional requirements for resources.

Regulatory challenges

A Turnaround maintenance is a complex and temporary undertaking that involves huge [7] [5] [10] workers range from 1000 to 5000 with diverse skills and expertise. Some of the skill sets required for this type of project are scaffolding, mechanical, electrical, inspection, planning, painting, and others. The workers include laborers, supervisors, and managers who are hired for a limited duration. Contractor source these workers from countries where they can find a large and affordable pool of workforce. Worker's mobilization from India to UAE is a widespread practice in many sectors such as construction, oil and gas, hospitality, and IT. According to a report by the Ministry of External Affairs, India, there were about 3.42 million Indian workers in UAE as of December 2018, making it the largest destination for Indian migrants in the Gulf region. [16] Discussed various internal and external forces that affect resources mobilizations. Internal factors such as strategy of the organization, its financial concerns, structural context, and human capital knowledge and experience. External stakeholders include among others the customers, government authorities, and the local community.

Recommendations for Resources Mobilization issues

Utilize the technologies

Primarily, constraints in resources mobilization for TAM due to huge workforce requirements, this can be solved by scope optimization, such as lean management, modularization, prefabrication, digitalization, and automation. (Z. Ghazali & M. Halib, 2015) Answering that scope optimization can reduce the resource requirement which will solve mobilization issues. [6] Implemented proactive maintenance application at Sarir refinery and optimize the Turnaround duration based on the risks associated with the equipment, removing items which can be implemented as a routine maintenance from turnaround work scope and application of on-line maintenance. [12] suggesting utilization of multi-skill workers, even for tasks that require lower skill levels, would reduce shutdown time, and solve the resource mobilization issues. [8] suggesting various innovative maintenance technologies. One, A Subsea Robot Arm Called Eleme for underwater inspection and repair operations have been conducted by Remote Operating Vehicles (ROVs). Second, The Development of the Industrial Internet which will transform industry through intelligent, interconnected objects that dramatically improve performance, lower operating costs, and increase reliability. Third Eddyfi Inspection Tool for Corrosion Under Insulation (CUI) helps to predict the failures to effectively prepare complex maintenance tasks where insulated equipment is vulnerable to CUI.

Realistic assessment of the resources needs and availability

A secondary way of managing the resources mobilization issue is to increase the accuracy of resources calculation based on the historical data, the current condition equipment.[9] suggesting timing and sequence of the resource mobilization is essential to minimize congestion of skilled resources mobilization issues. [13] suggesting the following way of estimating resources accurately. One, use expert judgment. This means consulting with experts who have experience in similar projects and asking for their opinions. Second, Alternative analysis is a process of comparing different options for achieving a goal and choosing the best one. Third, use sources such as articles, books, journals, and periodicals that gather, examine, and report data from other researchers' projects. Fourth, Project management software such as Microsoft Project will often have features designed to help project managers estimate resource needs and constraints and find the best combination of assignments for the project. Last, Bottom-up estimating, breaking down complex activities into pieces and working out the resource assignments for each piece.

Managing contingency and risk management strategies

Another way of managing the resources mobilization issues is using risk management strategies by developing detailed and flexible resources plans, clear roles and responsibilities, milestones and deliverables, and performance and quality indicators.[14] Suggesting two options one is postponing some of the activities to future Turnarounds or available opportunities. Second is multi-stage stochastic programming approach.

Figure 1 shows the effect of uncertainty on scheduling decisions and workforce requirements. Part (1) shows not affecting schedule and resources requirement. part (2) shows uncertainty creating potential delay. Part (3) shows traditional ways of solving the issues by shifting all the activities. Part (4) suggests completing noncritical activity as soon possible instead of waiting for schedule and reserve resources of uncertainty. [14] Inspect early and thoroughly is one of the Keys for successful turnaround execution because the earlier inspections can be performed within a reasonable time frame before the turnaround, of course—the more work can be identified, specified and resources can be arranged accordingly and the lower the risk of finding anything unexpected that would jeopardize

turnaround schedule and budget. And even after the turnaround is kicked off, inspections need to be on the front of all work, and it helps to have all inspection work planned as detailed as the repair and maintenance work.

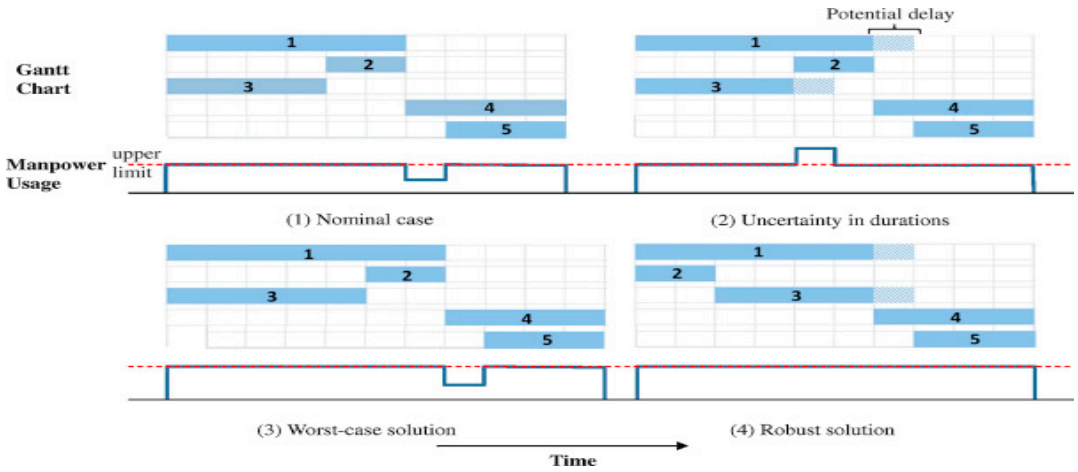


Figure 1 The effect of the manner of consideration of uncertainty on scheduling decisions and workforce requirement. Picture courtesy from Reference[14].

Ensure regular and effective communication and feedback

A final way to address the issue of resource mobilization is to build a solid and cooperative partnership with the stakeholders, founded on trust, transparency, and mutual benefit. For project management to succeed, effective communication is essential, especially in turnaround maintenance projects where huge resources are required in a shorter period. This way, all stakeholders stay updated, delays are minimized, and costly mistakes are avoided. [15] suggesting some communication strategies that can improve the mobilization processes of construction sites. 1. Establish a Communication Plan which is essential for managing site mobilization. This document explains the communication methods and expectations among the project stakeholders and helps them align their vision and goals. 2. Utilize Project Management Software. Such a software offers various features like Real-time communication, Document sharing, task tracking and notifications and reminders. 3. Implement Regular Meetings. This fosters a sense of unity, keeps everyone informed, and enables effective problem-solving, leading to more efficient mobilization. 4. Maintain Open and Transparent Communication. This will lead to Trust and collaboration, Early issue detection, Effective conflict resolution and enhanced problem-solving.

RESEARCH METHOD

The paper adopts a mixed-methods approach that combines a literature review, a questionnaire survey, and a case study analysis. The literature review identifies the key resources required for TAM, such as manpower, materials, tools, equipment, and external services. The questionnaire survey collects data from 42 TAM experts who have more than 15 years of experience in maintenance fields in gulf countries to assess the current practices and challenges of resources mobilization in TAM. The case study analysis examines three TAM projects in the oil and gas sector to illustrate the application and benefits of the proposed framework.

The paper finds that the resources mobilization process in TAM is influenced by several factors, such as the scope, duration, and complexity of the TAM project, the availability and accessibility of the resources, the quality and reliability of the resources, the communication and collaboration among the stakeholders, and the risk and uncertainty of the TAM environment. The paper also proposes a framework that consists of four phases: planning, preparation, execution, and evaluation. The framework provides a systematic and comprehensive approach for identifying, acquiring, allocating, and managing the resources in TAM. The framework also incorporates the use of digital technologies, such as enterprise resource planning (ERP), radio-frequency identification (RFID), remote operated Vehicle (ROV) and works management system (WMS) to enhance the efficiency and effectiveness of the resources mobilization process.

The paper contributes to the existing literature on TAM by providing a holistic and integrated perspective on the resource's mobilization process. The paper also offers practical implications for TAM practitioners by suggesting a framework that

can help them to optimize the resources utilization and minimize the costs and risks of TAM. The paper concludes with some limitations and directions for future research.

DATA AND METHODS

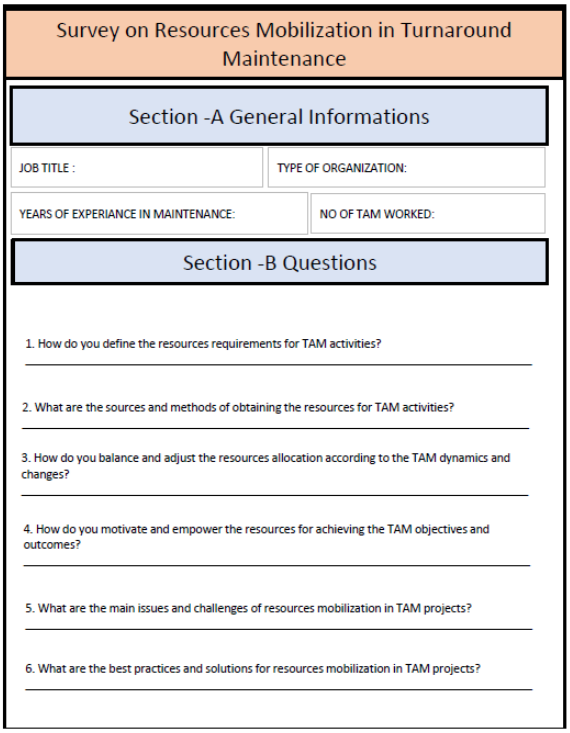
Data

For this analysis, data collected at both induvial levels and organization levels. Individual experts provide information on their project's resources mobilization, issues they faced, way of handling the issues and usage of latest technologies to support workplace health and safety and optimize the requirements. For organizations, a project manager or HR representative, who handles the resources recruitment and mobilization, provides information on the general characteristics of the mobilization, internal strategies for selection, recruitment, and mobilization.
Data collected from 42 field exports individuals and 7 project organizations who are involved in Turnaround projects every year. Their feedback has been collected about every project they were involved in between 2019 and 2023. During this period resources were mobilized for 14 turnaround projects. Each project mobilized around 1500+ manpower from various countries. Table 1 presents the manpower were mobilized for various TAR projects during the study period and participating expert's positions.

Table 1: Total number of manpower mobilized and expert's positions.

Turnaround Years	Resources Mobilized	Position	No of Person Interacted
Year 2019	4500+	Project Manager	7
Year 2020	1200+	HR Administrators	7
Year 2021	2200+	Planning Leader	7
Year 2022	3500+	Logistic Coordinator	7
Year 2023	4500+	HSE Lead	7
		Execution Lead	7

Figure 2 below shows the list of questions asked to participants. The survey questions are divided into two sections: A) General Information, B) Resources Mobilization questions. Participants were asked to answer questions based on their TAM experiences.


Survey on Resources Mobilization in Turnaround Maintenance

Section -A General Informations

JOB TITLE : TYPE OF ORGANIZATION:

YEARS OF EXPERIANCE IN MAINTENANCE: NO OF TAM WORKED:

Section -B Questions

1. How do you define the resources requirements for TAM activities?

2. What are the sources and methods of obtaining the resources for TAM activities?

3. How do you balance and adjust the resources allocation according to the TAM dynamics and changes?

4. How do you motivate and empower the resources for achieving the TAM objectives and outcomes?

5. What are the main issues and challenges of resources mobilization in TAM projects?

6. What are the best practices and solutions for resources mobilization in TAM projects?

Figure 2: Survey Questions

Case Studies

Our case study focused on how an oil and gas company mobilized resources for a major TAM project at one of its refineries and petrochemical plant in the Middle East. Interacted with Turnaround management team and read their close-out reports which helped to understand various resources mobilizations concepts. TAM included shutdown of 21 plants including the crude distillation unit, the hydrocracker unit, Olefins unit, Polyolefins, utilities & off site, and recovery unit. Table 2 below shows the case studies plant TAM information.

Table 2 : Case Study TAM Information

TA Name	Production Loss Per Day	No of Manpower Mobilized	Execution Duration (Days)	No of Main Contractor Involved	No of Subcontractor Involved	No of OEM/Vendors Involved	No of Units Involved
TA2019	5 MUSD	6000+	45	3	17	18	8
TA2020	4 MUSD	4500+	50	1	15	21	5
TA2022	3 MUSD	5000+	37	2	12	15	5
TA2023	4 MUSD	5200+	40	3	14	17	6

TAM had the following objectives:

- To comply with American Petroleum Institute (API) standards for static equipment such as exchangers, pressure vessels, filters, and tank and sumps and To Test Safety critical equipment such as pressure safety valves (PSV), functionalities.
- To improve the reliability and availability of rotating equipment such as turbines, extruders, gear boxes, compressors, and pumps.
- Implementation of plant modification projects to enhance the efficiency and performance of the units by upgrading the existing equipment or installing new equipment and systems.

Mobilization strategies were followed:

- Early contract award to secure the resources on time.
- Agreed Resources requirement and Mobilization plan to confirm the quantity requirements.
- Client participation in resources selection process to confirm the Quality of the resources.
- Effective and transparent communication and coordination between contractor, sub-contractor, and client by having weekly, by-weekly progress review meetings to monitoring and improvement.

Tools used to Plan, Allocate and Manage the resources:

- Used the computerized maintenance management system (CMMS) to do the detailed planning which is helping them to use the previous TAM data like work order, task list, bill of materials, and resource requirements.
- Previous TAM actuals were referred from primavera(P6) software and resources plan were developed accordingly.
- Resources mainly were mainly arranged by TAM main contractor, OEM, Vendor and Local Manpower supplier.
- Used works management system mobile device to optimize resources requirements during TAM execution time.
- Used drones and remote operated vehicles in confined spaced entries while inspecting the tanks, sumps, flare tips and underwater inspections.
- Used radio-frequency identification (RFID) for valves movement and spare parts movement tracking.
- Various training courses were given to contractor people to educate them in safety, quality and maintenance related. Training includes lifesaving rules, safety awareness programs, flange management programs and equipment awareness programs.

Resources mobilization challenges were encountered:

- High demand of labor work during 2022 TAM time because there were many TAMs in nearby countries at the same time.

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- Late award of contract resulted in shorter time to recruit and mobilize the resources.
- During TA2022 resources were interviewed using MS team due to pandemic travel restrictions resulted us to poor quality of manpower.
- Employment visa issuance was stopped for regions in a specific country resulted to have short of manpower.
- Company introduced fatigue management during TA2023 TAM resulted shortage of manpower.
- Quarter four of the year OEM/Vendors availability from European countries are always challenges due to holiday sessions.
- TA2019 Tank cleaning activity resources were estimated lower than requirements resulted problem during the TAM executions.
- TA2020 mid of the TAM execution all the resources were stopped due to covid pandemic lockdown.

RESULTS

High demand with short duration

For the fourth quarter of 2022, the plant we examined had a major maintenance project planned. This project required more than 3860 workers to work for 35 days. Figure-2 shows the workforce and equipment mobilization plan of Turnaround maintenance projects. Our study confirmed that each turnaround maintenance project requires more than five thousand people, including direct workforce who are mostly laborers working in the fields for short periods, indirect workforce who are officers managing the overall projects, and subcontractors who manage specialized activities in turnaround maintenance. The short-term projects with high resource needs are causing issues like the lack of qualified staff. To cope with this demand, the Turnaround contractor is hiring people from Asian countries where they can get a large and low-cost workforce.

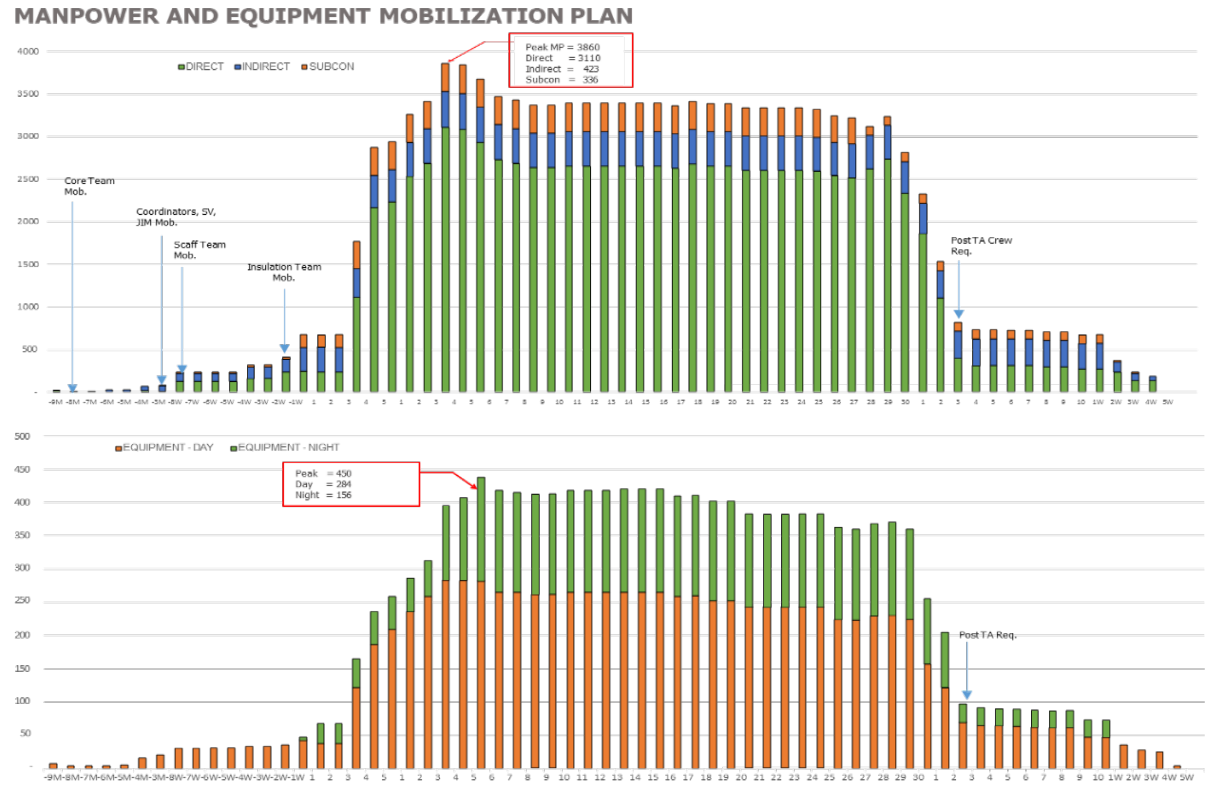

Figure 3 Resource Mobilization plan.

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Limited availability

The experts also explained that Turnaround maintenance needs not only labor work forces, but also technical experts to manage high critical equipment in Mechanical, electrical and instrumentation fields. This equipment can only be overhauled by technicians recommended by original equipment manufacturers (OEMs) such as ABB, Siemens, MHI, etc. Figure-3 shows list of critical resources that were used for major 2022 TAR projects. These manufacturers have limited-service engineers, which creates a shortage of resources. For the Q4-2022 shutdown, they had to mobilize twelve vendors from different OEMs. It was a challenge to secure these vendors because of their limited availability and other turnarounds happening in nearby plants. Another factor to consider is that the last quarter of the year coincides with the holiday season in many western countries, such as Europe. This reduces the availability of resources from those regions.

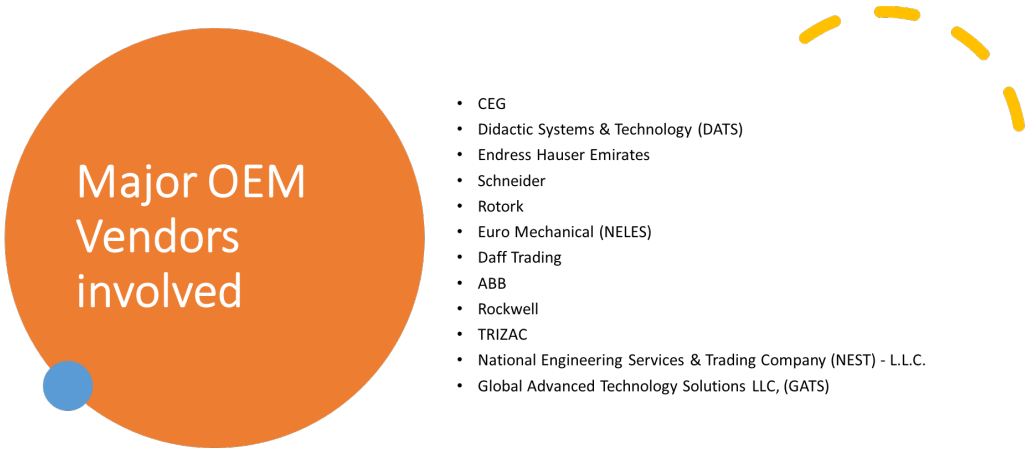

Figure 4 Vendor Involved in Q4-2022 TAR project.

Uncertainty and variability: Turnaround maintenance involves a lot of uncertainty and variability. These factors lead to extra scopes that need more resources to complete. Some scopes are added after the turnaround scope freeze, which happens 12 months before the TAR execution date, because the plants need more maintenance work while they are operating. Some scopes are discovered when the equipment is opened, and its internal condition is revealed. In both cases, more resources are needed to manage these scopes which were not planned well before. In addition, Uncertainty extent project duration and overruns the project cost. Therefore, it is critical to manage the Uncertainty and variability in scope of works in Turnaround maintenance project.

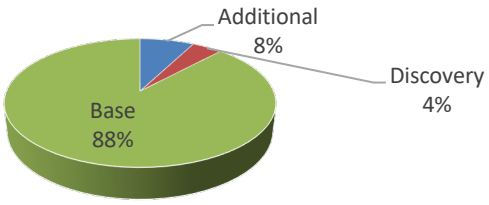

Figure 5: Uncertainty and Variability in Q4-2022 TAR Project

Figure-4 obtained from our study plant had these results. Variation accounted for 8% of the total resource need and unpredictability added 4% to the total resource need. According to previous experience of TAR exports, uncertainty, and variability of scope of works cause an extra 15% of total resources to be generated on average.

Regulatory challenges: our study reveals that every project faced problems because of new rules. Most of the resources came from Asian countries for turnaround project. But during the deployment, the government changed the medical procedures which added more cost to contractor and disqualified some resources due to health reasons. The project team and the contractor did not know this before, and it delayed the resource deployment. In addition, our study

finds out that project which were executed after year 2020, had additional regulations COVID-19, companies introduced new rules related to health and safety of human resources, such as number of occupancies in a room, premedical check-up and added safety trainings.

Solutions

Realistic assessment of the resources needs and availability.

As per our study, planning team is responsible to calculate the resource requirements and They are also sought some advice from subject matter experts who have experience in similar turnaround projects, to ensure the accuracy of their resource estimations. Furthermore, all the TAR projects are using primavera software to create a detailed schedule for each activity, which will help them determine the exact resources needed. To do this, they are breaking down complex activities into smaller tasks and assigning resources to each task. Critical and limited resources such as original equipment manufacturer (OEM) vendors requirements are combined and arranging for a single vendor to execute the activities for all the plants, with proper scheduling arrangements. This reduces the time for each plant requirement and allows them to use a smaller overall buffer time.

Managing a contingency and risk management strategies

Project which held on quarter four 2022 had 5% contingency plan on the resource's estimation means they are arranged additional 5% of total resources well in advance with additional cost. Contractor was using those resources to support base activities until discovery jobs requested. The company's internal maintenance resources, who have more experience than contractors, are kept standby to take care of any critical discovery activities as part of managing contingency. Additionally, Turnaround planning team setting the risk categories for each work orders like priority 1 (P1) Must be done, priority (P2) Safety and Reliability issues, priority 3 (P3) Economically better to do it TAR and priority 4 (P4) Low risk activities. This helped them to reduce the scope and execute the additional scope with planned resources.

Ensure regular and effective communication and feedback.

The study reveals that biweekly meetings, organized by the project team to review the progress of the mobilization plan and compare it with the actual mobilization status and issues, were very effective and helped them to identify issues on time. Weekly reports submitted by contractors helped the management to closely monitor mobilization progress and intervene if needed. The Turnaround Management team had been assigned a dedicated logistic coordinator who is responsible for overseeing the mobilization of resources and reporting the variances.

Utilization of technologies.

The study finds that all the management were very much interested in implementing new technologies and digital technologies because of two reasons. One is workplace health and safety of people and second is optimized resources requirements. TAR project happened in 2019 and used bar code technology to track the valve movements. Project 2022 and 2023 used remote operated vehicle (ROV) to inspect the underwater pipeline and the hazardous tank, which eliminated the need for human intervention and exposure to risks which resulted to achieve optimized critical manpower and improved workplace safety. In addition, the project which happened last year 2023 was using drones to inspect the flare tips at elevated levels, which saved 10 hours of work. They also employed multi-skilled rope access technicians who could perform electrical, mechanical and instrument tasks on the flare structure, which saved 12 hours of work and reduced the number of technicians required from three to one and reduced the exposure to risk of falling from higher elevations.
Currently with the support of management companies have started utilizing the new technologies for projects. However, our study found that the number of activities utilizing the new technologies are very limited compared to overall project scopes. Our study suggests exploring and implementing more new digital technologies on TAR projects on various such as planning, progress reporting, safety & quality control, documentation, and approvals.

Newly Industrialized Constraints

Our study reveals that a new constraint emerged recently after the COVID-19 pandemic. Project conducted in 2023 faced the challenge due to a change in the medical procedure for workplace health and safety, which affected the resource mobilization process. Before, contractor could mobilize resources from Asian countries based on the medical reports they got in their home countries. But now, the company only accepts the medical reports from the local hospitals in the plant location. This means that the individuals must travel to the site and take the medical test there, and sometimes, they are found to be medically unfit and rejected. This leads to increased resources mobilization and overall project cost.

CONCLUSION

One of the key factors that determine the success of turnaround/shutdown maintenance projects is the effective mobilization of resources. This aspect has a significant impact on the project cost, schedule, and quality. However, there are many challenges and constraints that affect the availability and allocation of resources in such complex maintenance projects. Some of the key issues are the high demand for resources within a fleeting period, the limited supply of critical resources, the uncertainty and variability of the project scope and conditions, and the changes in the regulatory environment. This paper explores these issues in detail and proposes some best practices and solutions based on literature reviews and from our studies. The paper suggests the following solutions: using technologies to reduce the resource needs, estimating the resources accurately and avoiding unnecessary buffers, managing the contingency with risk management strategies, and maintaining regular and effective communication and feedback.

Further studies

This study focused on the challenges and solutions of mobilizing resources for Turnaround Maintenances in Gulf Countries oil & gas and petrochemical companies. Resource mobilization also impacts plant modification projects that are done outside turnarounds. Therefore, future studies should investigate plant modification projects in Gulf Countries oil & gas and petrochemical companies. The findings can be integrated into overall project management systems.

Limitation

Resources mobilization studies in TAM offer important and practical insights into how to optimize the resources mobilization process and results in various settings and sectors. However, our studies only cover Oil & gas and petrochemical plants with TAM experience, mainly in UAE, Qatar, Saudi Arabia which affect the generalizability to other industries and countries. By overcoming these limitations and exploiting the opportunities, resources mobilization studies can improve their role in advancing the theory and practice of resources mobilization.

ETHICS STATEMENT

Research uses secondary data that is anonymized with no individuals identifiable. Participation in data collection was all voluntarily.

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