

Construction of Polymerase Chain Reaction Lab



Group Number: 6015

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List of Abbreviations and Acronyms

PCR	Polymerase Chain Reaction
HIV	Human Immunodeficiency Virus
HCV	Hepatitis C Virus
HBV	Hepatitis B Virus
HAV	Hepatitis A Virus
COVID-19	Coronavirus diseases.
DNA	Deoxyribose Nucleic Acid
HESN	Health Electronic Surveillance Network
MOH	Ministry of Health
CCTV	Closed Circuit Television
LAN	Local Area Network
WAN	Wide Area Network
HVAC	Heating Ventilation Air Conditioner
WEQAYA	Public Health Authority
CAP	College of American Pathology
SCC	Saudi Construction Code
OBS	Organization Breakdown Structure
PMO	Project Management Office
EBP	Evidence Based Practice
PM	project managers
SWOT	Strength Weakness Opportunities Threats
IRMI	International Risk Management Institute
RCA	Root cause analysis
ACH	Air Change per hour

Abstract

The objective of this project is to study the viability of establishing healthcare diagnostic center and PCR testing lab services for the early detection of HIV, HCV, HBV, HAV and COVID-19. PCR is useful in the investigation and diagnosis of a growing number of diseases. PCR is also used in forensics laboratories Launching healthcare diagnostic center & PCR testing Lab finds a wide application area in healthcare services facilities.

In this project, a case study of the establishing PCR testing Lab was carried out to determine the feasibility as business. Establishing PCR testing Lab involve a number of participants and stakeholders, their participation and commitment can have a major influence on the goals of establishing PCR testing Lab.

The project research provides a basis for the establishing PCR testing Lab emphasize the necessity and significance of tailoring the establishing healthcare diagnostic Lab to the unique features of the project and its context. PCR is now a common and often indispensable technique used in medical and biological research labs for a variety of applications.

The present paper is an attempt to review basics of PCR in relation to its methods, application and use.

Keywords: Healthcare, Diagnostic center, and PCR testing Lab services.

Introduction

PCR is the abbreviation for “polymerase chain reaction”. PCR is a way used for amplifying DNA. In April 1983, Kary Mullis stumbled throughout a manner that might make limitless numbers of copies of genes now referred to as PCR. Since then, PCR has come to be famous as a diagnostic device worldwide. The name “polymerase chain reaction” is derived from the deoxyribonucleic acid (DNA) polymerase used to increase a chunk of DNA via way of means of in vitro enzymatic replication.

PCR (Polymerase chain reaction) has now become the method of choice in early and accurate diagnosis of most infectious diseases, and has become an indispensable research tool. With this revolutionary, yet relatively inexpensive, molecular genetics technology, it is possible to generate millions of DNA copies from a single strand of DNA (WHO, 2016).

PCR has significantly helped in early commencement of specific interventions for disease control, and also plays a critical role in understanding disease epidemiology, thereby unravelling the transmission dynamics of the disease.

PCR has been notably changed and is broadly utilized in molecular biology, microbiology, genetics, diagnostics, and medical, forensic and environmental laboratories, except numerous different applications. PCR methodologies have certainly developed through the years from the engineering of thermostable polymerases and production of computerized thermocyclers to more modern virtual PCR (d-PCR) methodologies and related microfluidic gadgets for dealing with excessive-throughput PCR applications.

“Real-time” PCR has earned wider popularity because of the decreased danger of carryover infection and stepped forward sensitivity, rapidity and reproducibility. It is standard as the “gold standard” for analysis of numerous viruses, and quantification of viral load in medical samples – a trademark of energetic infection, sickness development and healing reaction to antiviral drugs.

The big financial funding required for “real-time” PCR instrumentation and reagents is a prime stumbling block for its habitual use in maximum diagnostic laboratories (WHO, 2016).

1.1 Strategy

While carrying out the plan, we will hold ourselves accountable to these five corporate strategic directions or commitments.

- **Quality:** Achieving the highest level of healthcare quality is essential to the vitality of our community. We can accept nothing less than creating a culture of clinical excellence where quality is integrated in everything we do.
- **Customers:** We are committed give better care to our customers. We will provide the resources to ensure that every healthcare service we offer is focused on meeting and exceeding the expectations of patients and their families in addition to our external customers, identified in the Laboratory scope of service.
- **Community:** We all aspire to live and work in a healthier community. As the region's largest privet healthcare provider, we recognize and embrace our role in improving the health and well-being of everyone in the community serve.
- **Employees:** Efficient manpower is the cornerstone in the success of any organization. People who bring their talent, insight, and knowledge to delivering exceptional healthcare must be valued, supported and appreciated. We are building a staff that will go the extra mile to work with each other in a cooperative spirit to provide outstanding service and top-quality care.
- **Finance (Provider of cost-effective healthcare):** As a private hospital seeking financial profits, a good finance department can make this goal achieved. The balance between providing a high-quality healthcare and the cost of this care is always disturbed. We shall aim at monitoring our costs to keep our prices easily accessible to any patient without

altering the quality of service we are giving. Meanwhile, we shall invest more money in expansion of our project, which will in turn increase our income.

Business Strategy

Currently with insurance companies and MOH as our main clients, our business strategy is within economy of scale competing by lowering our prices in relation to the same category of competitor and this increases our growth revenue but decreases our profitability sharply without effect on the quality of health care. Nevertheless, when the operation becomes under pressure, the organization adapts a cost control strategy that affects the vital functions of operations.

1.1.1 Vision Statement

We strive to be the lead accredited laboratory in the region that provides the accurate result for better healthy decisions.

1.1.2 Mission Statement

To provide quality laboratory services inspection, verification, testing, and certification in timely manner with the least error percentage.

1.1.3 Objective in a SMART Model:

1. Expand the Laboratory Services Provided by the end of 2022
2. Increase the patient Served in Laboratory by 15 % by the end of Jun 2022
3. Improve the Overall Patient Satisfaction
4. Increase the profit by 15% in comparison to last 2 years by the end of 2024

5. Establish a formal Process and receiving compiling analysis and tracking of patient complaints before the end of Jun 2022 and to ensure to have it at a very minimal rate less than 5% of the total patient population per month.

1.1.4 The Performance Measurement Indicators (Lead or Lag):

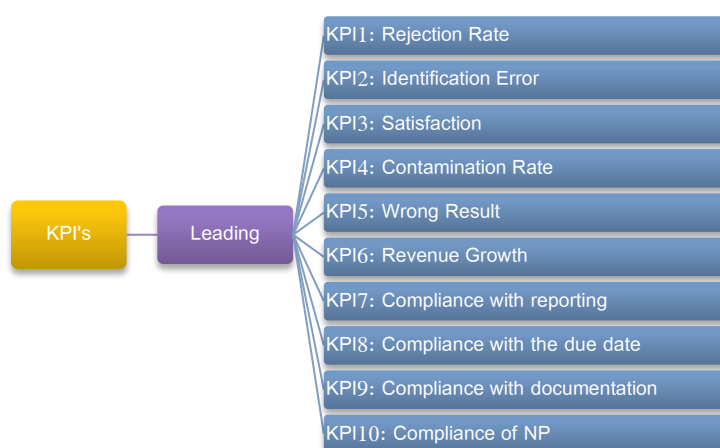


Figure 1 KPI's Lead or Lag

KPI 1: Rejection Laboratory Specimens Rate

Description: Sometimes tests cannot be performed in the laboratory if samples fall short of the quality, volume or other eligibility criteria. In these cases, the laboratory may need to reject the samples, and not carry out processing.

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	0.28 %	Negative	Monthly	1 % or less	$\frac{\text{Number of Rejection Sample}}{\text{Total Number of Request}} \times 100$

KPI 2: Patient Identification Error in Patient Laboratory Specimen Rate

Description: Identification errors involve misidentification of a patient or a specimen. Identification errors can occur during any part of the test cycle; however, most occur in the preanalytic phase.

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	6.5%	Negative	Monthly	0.5 %	$\frac{\text{Number of Identification Error}}{\text{Total Number of Request}} \times 100$

KPI 3: % Customer Satisfaction

Description: To measuring the quality in health care. Customer satisfaction affects clinical outcomes, customer retention, and medical malpractice claims.

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	85 %	Positive	Quartary	100 %	$\frac{\text{Total No of Satisfied Customer}}{\text{Total No of Customer}} \times 100$

KPI 4: Sample Contamination Rate

Description: The retrospective sample contamination rate is calculated based on certain criteria. Sample is in direct exposure to air-borne contaminants and environmental changes due to changes in humidity levels, temperature or exposure to light.

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	2 %	Negative	Monthly	2 %	$\frac{\text{Number of Contamination Sample}}{\text{Total Number of Sample}} \times 100$

KPI 5: HESN PLUS Wrong Result Entry Rate

Description: Human data entry can result in errors that ruin statistical results and conclusions as well as errors in the sample results.

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	0.5 %	Negative	Monthly	1 %	$\frac{\text{Number of Identification Error}}{\text{Total Number of Request}} \times 100$

KPI 6: Revenue Growth Rate

Description: Refers to an increase in revenue over a period of time. In accounting

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	–	Positive	Monthly	15 %	$\frac{\text{Current Period Revenue} - \text{Prior Period Revenue}}{\text{Prior Period Revenue}} \times 100$

KPI 7: % Compliance with reporting of the positive result to MOH

Description: Monitoring compliance with certification standards (MOH).

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	–	Positive	Monthly	100 %	$\frac{\text{Number of reporting}}{\text{Total Number of Compliance}} \times 100$

KPI 8: % Compliance with the Due Date of Construction

Description:

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	–	Positive	Monthly	100 %	

KPI 9: % Compliance with Documentation of Negative Pressure Checklist

Description:

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	–	Positive	Monthly	95 %	

KPI 8: % Compliance of negative pressure room with monitoring

Description: (Temperature, Humidity, Pressure, ACH)

Unit	Benchmark	Polarity	Frequent	Target	Method
Percentage	–	Positive	Monthly	100 %	

Table 1: KPIs Card

1.1.5 The Project Charter Model:

Project Title:	Establishing a new PCR Laboratory	Project Number:	
Location:	In Medina	Revision Date:	
Project Manager:	Eng. Samir Asad		
Project Objective		Project Scope	
To provide Healthcare facilities and diagnostics for the patients in and around Medina		Work to include the following:	
Project Justification		- Redesign of current structure for PCR Laboratory in the premises of Dr. Hamid Suleiman Al- Ahmadi Hospital, Medina - Approximate Site Area = 180 Sq. m - Approximate Building Area = 12000 Sq. m - All sites are to be developed by filling, compaction, and grading to the required elevation.	
Stakeholders (External and Internal)		Site is to be provided with services such as portable water supply, sewage, drainage System, Power and lighting, Telecommunication, CCTV, LAN, WAN, Public Address System, HVAC, fire detection, fire protection system	
- Project Sponsor - Project Manager - Procurement Department - IT Department - HR Department - Infection Control Department - Laboratory Department - Finance Department		Studies	
		Surveys: Existing condition as-built survey will be carried out during design task	

• Operation Department • Engineering Department • Insurance Department • Ministry of Health • Construction Company • Saudi Electrical Company • Saudi Telecom Company • National Water Company • Customers • Suppliers	Standards	
	WEQAYA, CAP, MOH & SCC	
	Project Constraints	
	Availability of infrastructure Designs	
	Project Risk Assessment	
		Timely Construction commitment of Infrastructure by Private Sector in the premises of Dr. Hamid Suleiman Al Ahmadi Hospital, Medina
		Third-Party Approvals
		As-built information of existing utilities; waterline, power lines in the area not available (delays the design)
		Safety issues during demolition and uploading of construction materials and gypsum board for the walls and floors and HVAC and electrical work during the hospital work hours.
Schedule/ Cost Estimate		
Organization Breakdown Structure (OBS)	Projectized	
Starting Design:	01 Feb 2022	
Complete Design:	28 Feb 2022	
Award:	15 March 2022	
Construction Complete:	15 June 2022	
Preliminary Cost Estimate (±15%) in SAR:	1,100,000	
Project Sponsor		Project Interfaces
Dr. Hamid Suleiman Al Ahmadi Co.		Private Sector Projects

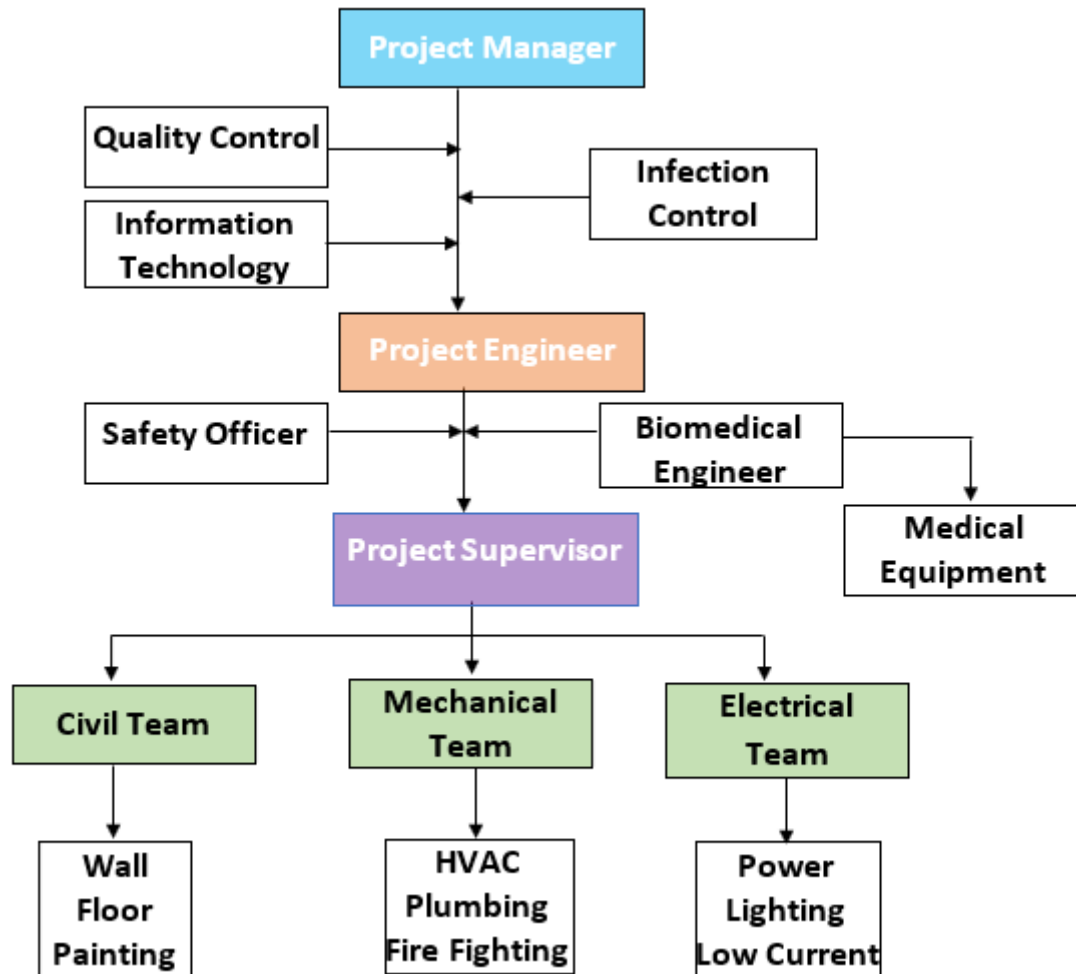


Figure 4: Organizational Structure

1.2.2 The Practical and scientific bases adopted in developing the structure.

When choosing an organizational structure, certain features should not be overlooked. The key elements that contribute to a proper organizational structure are as follows:

Degree of alignment with organizational objectives

- Accountability assignment
- Delegation of Capabilities
- Simplicity of Design
- Physical locations

In the design of an organizational structure, it is important to know the specifics of the organization before formulating the structure. Organizational structure may be centralized or decentralized. Traditionally, structures of the organization have been designed with a centralized leadership thereby having a defined chain of command. In the development of an organizational structure, the practical basis to be considered is a common purpose, coordinated effort, division of labor, and the hierarchy of authority. Its common purpose unifies members of the organization thru a common understanding of what is the vision and mission of the organization, its values, and strategies.

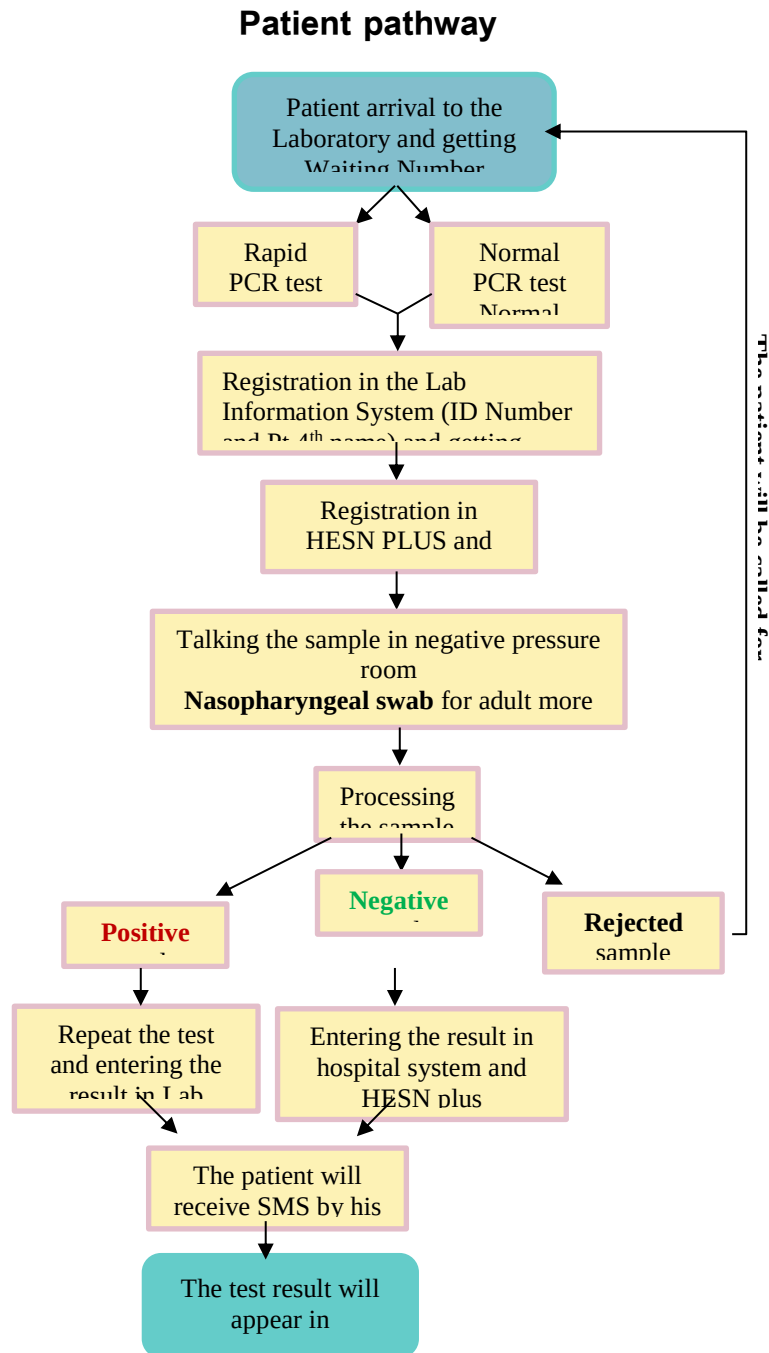


Figure 5: Patient pathway

Swab Pathway

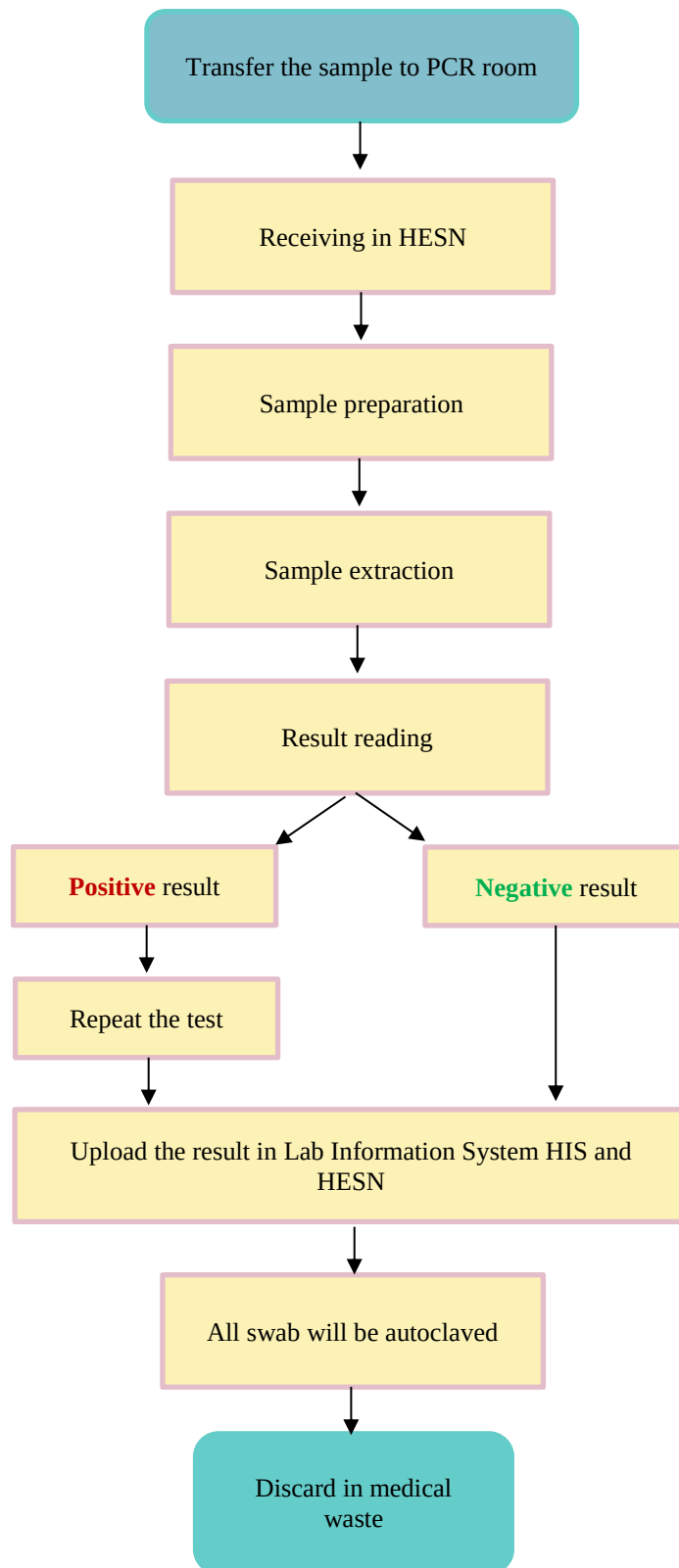
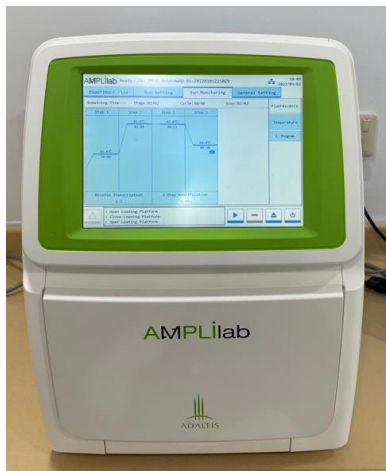


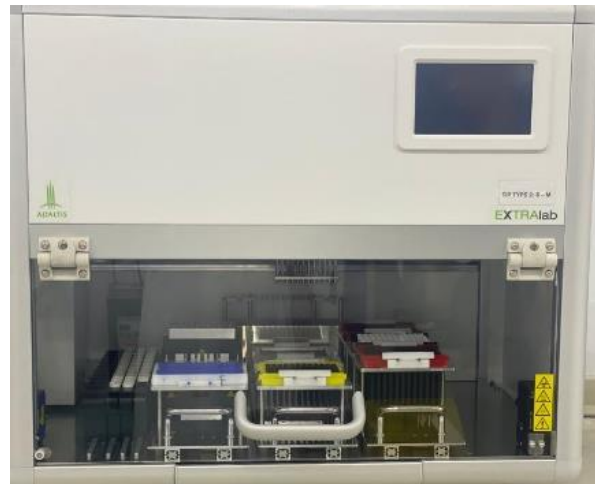
Figure 6: Swab Pathway

MACHINES USED FOR CONDUCTING MOLECULAR TEST



AMPLILAB

Figure 7: AMPILAB



EXTRALAB

Figure 8: Extra Lab

G. REAGENT PREPARATION AND ANALYZED SAMPLES

1. Preparation of serum (plasma) samples.

Plasma or serum must be placed into a separate tube within 6 hours after blood collection.

Transport and store samples:

- up to 2 hours at 18...25°C;
- up to 24 hours at 2...8°C;
- up to 1 month at minus 18...60°C.

Repeated freezing and thawing is not allowed!

Serum and blood plasma samples must be centrifuged at 13000 rpm for 5 min at room temperature 18...25°C before use.

To perform analysis 100 µL of blood serum (plasma) prepared with EDTA as anticoagulant is required.

Attention! Analysis of heparinized plasma samples is not allowed.

2. Preparation of leukocyte blood fraction.

Blood cells (leukocyte fraction of whole blood, leukocytic pellicle) should be taken after centrifugation of whole blood and removal of plasma. Using the filter tip carefully collect leukocyte cell mass from the surface of the cell sediment in the volume of 0.2 mL, and transfer to a sterile 1.5-2.0 mL test tube.

Transportation and storage of samples:

- up to 24 hours at 2...8°C;
- up to 1 month at minus 18...60°C.

Repeated freezing and thawing is not allowed!

3. Preparation cerebrospinal fluid samples.

Cerebrospinal fluid are ready for analysis.

Transportation and storage of samples:

- up to 2 hours at 18...25°C;
- up to 24 hours at 2...8°C;
- up to 2 weeks at minus 18...60°C.

4. Preparation of urine samples.

Collect the first portion of morning urine in a clean collection cup with leakproof lid. Transfer 1.5-2.0 mL of urine into a test tube, then centrifuge at 3000 rpm for 3 min. Remove the supernatant without touching the sediment. Use the resulting cell pellet for isolation of nucleic acids.

Transportation and storage of samples of urine cell pellet:

- up to 2 hours at 18...25°C;
- up to 24 hours at 2...8°C;
- up to 2 weeks at minus 18...60°C.

5. Preparation of biopsy material and faeces samples.

Prepare biopsy material and faeces samples according the procedures described in national methodological guidelines.

1.2.3 The Project's Office Model

A PMO is a group, either an internal department or an external company that sets, maintains, and ensures project management methodology, best practices, and standards throughout an organization. It supports managing shared resources across all projects administered by the PMO and provides coaching, mentoring, training, and oversight. It keeps best practices, project direction, and project direction all from a central location. It ensures that company procedures, practices, and activities are carried out correctly on schedule, on budget, and in the same manner. A PMO exists to assure project and program success, which is crucial because projects and programs are how enterprises provide value.

In the execution of the PCR Laboratory Project as a Project Manager, the best model to be used is Supportive Project Management. I believed this type is very effective to carry out the project in a human and professional manner as the project manager oversees the team members in the project management office and takes responsibility for the quality and value of each project under its care. This involves collaboration with project managers and reporting to the executive staff of the organization .It collects all projects in an organization, supplies best practices, templates, training, but with a low degree of control. As a Project Manager, it is necessary to provide support even to the lowest member of the organization.

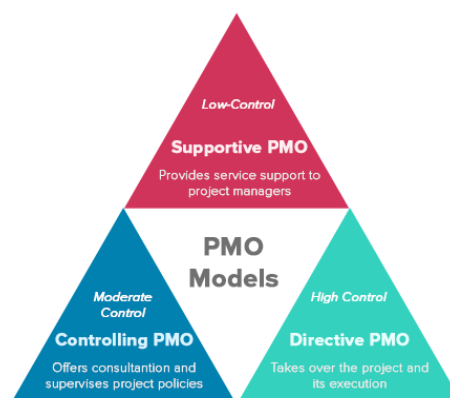


Figure 9: PMO office Model

2.1 Compliance, Standard and Regulations

2.1.1 Check Compliance Model:

The compliance model is a structured way of understanding and improving client compliance. It helps us to understand the factors that influence client behavior and to apply the most appropriate compliance strategy.

Client behavior is influenced by business, industry, technology and data, sociological, economic and psychological factors.



Figure 10: Client Behavior

The compliance model shows a continuum of client attitudes towards compliance. At the base of the continuum, clients have the desired attitude of being 'willing to do the right thing'. At the other extreme, clients have decided not to comply – choosing to evade or opt out of the tax system. The compliance model also summarizes the different sorts of support and intervention that we may need to provide to collect the required revenue. The model suggests that the ATO has the ability to influence client behavior through our response and interaction.

Compliance is attained by defining roles, assigning outcomes and cardinalities to results as well as by establishing states with conditions and activities for results categories. Roles determine individuals' rights and access. This process is set using software and is the basis of your project. Team members take on roles, carry out tasks and produce results. The project control panel gives an overview of the states of activities as well as results being produced.

Traceability is a prerequisite for compliance in a project – it enables participants to retain an overview of what happens with each result

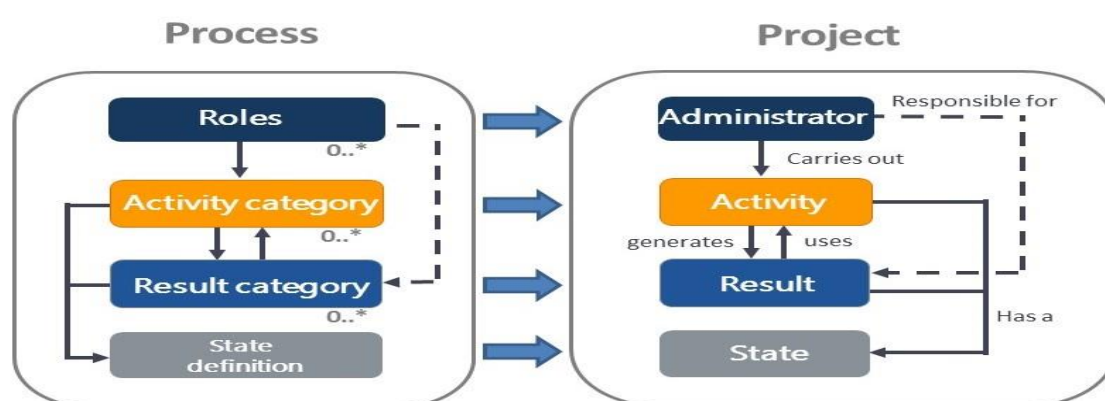


Figure 11: Process & Project

Compliance Model				
Project Name: Construction of PCR Lab		Owner: Dr. Hamid Suleiman Al Ahmadi Co.	Main Contractor:	
Date	Day	Ref.	1	
No.	Goal / Deliverable	Responsible	Compliant (Yes/No/NA)	Remarks
1	List of lessons learned	PMO	Yes	
2	Project closure document	PMO	Yes	
3	Budget Closure memo	PMO	Yes	
4	Final project status reports	PMO	Yes	
5	Supply contracts and process	PMO	Yes	
6	Engineering report	PMO	NA	
7	Summary disposal equipment and material	PMO	Yes	

Table 3 Check Compliance Model

2.1.2 Check List model for the four stages of the project (Start– Plan– Achieve– Close)

- **Start Phase**

The following checklist serves as of the start of the project and must be completed as the phase closed by the Project Manager. This document emphasizes that the output of the section will allow the project to start smoothly.

Start Phase			
Description	Yes	No	Comments
Have project objectives been defined and are they clear?			
Has a project sponsor been identified?			
Has a project customer been identified who will sign off the requirement and accept the delivery?			
Has an issues escalation mechanism been identified?			
Has an ultimate authority been identified who can make the final say on project continuation?			
Has the Project Manager been identified?			
Has a Business Analyst been identified?			
Has Core Team been identified?			
Has a Business Case been developed and approved by the authority?			
Has the project been prioritized?			
Have Business Requirements been completed and sign-off?			
Have Deliverables been defined clearly?			
Has Acceptance Criteria been established for each Deliverable?			
Has Project Management Methodology been identified?			
Has Risk been assessed?			
Have Risk Mitigation Strategies been defined?			
Has a Contingency Reserve been established?			
Have business functions been identified?			

Has the Project interface been identified/documented?			
Have business processes impacted by the project been identified?			
Has the Project Budget been approved?			
Has a Project Deadline (Completion Date) been established?			
Have interdependencies between other projects been identified?			

Table 4 Start Phase

- **Plan Phase**

The planning phase shows the road map to establish the PCR Test Lab. This includes the development of the scope, schedule, and time of the entire project. The planning team must complete this phase and make sure that all the below checklists are completed on time to allow the project to start creation.

Plan Phase			
Description	Yes	No	Comments
Have you organized a project kick-off meeting			
Does the project team need any training?			
Are you comfortable with the skill level of the project team?			
Do you need a project management plan?			
Do you have enough contingency or buffer in the budget and schedule?			
Is there a vendor contract involved in the project?			
Have all the project components been estimated?			
Do you have a detailed project schedule drafted?			
Do you need a work breakdown structure?			
Have you created a baseline for the project plan?			
Is the project team comfortable with the project schedule?			
Do you have clearly defined the milestones for the project?			
How do you plan to track project progress?			
Have the team left plans and public holidays been factored into the project plan?			

Do you have a resource plan for the duration of the project?			
Do you need to hire additional resources for the project? If yes, has the hiring process been kicked off?			
Have you factored in the resourcing costs in the plan?			
Are you aware of the SMEs required for the project?			
Is your project schedule detailed enough for the project team to understand the tasks?			
Is there a quality assurance plan for the project?			

Table 5 Plan Phase

- **Achieve phase**

This phase is where the deliverables of the project are realized by the project creating team.

The project manager will need to communicate the deliverable in a proper way to get support from the stakeholders.

Achieve Phase			
Description	Yes	No	Comments
Has the project scope been finalized by the stakeholders?			
Have the business requirements been finalized and signed off?			
Is the team aware of the project deliverables?			
Have all the hardware and infrastructure requirements been finalized and addressed?			
Does the project team need to be co-located?			
Is everyone in the team aware of roles and responsibilities for everyone, including themselves?			
Is the team aware of the benefits and business value of the project?			
Is everyone in the team fully allocated to the project?			
Is the project team comfortable with the requirements and their details?			
Have you planned the resources required for the implementation?			
Is everyone in the project team aware of the project deadlines?			
Does the project team need to be co-located?			

Is everyone aware of the defect management process?			
Are you aware of the impact of systems shut down for implementation?			
Do you have a commitment from a business for testing resources?			
Do you have a list of housekeeping tasks for the project?			
Will the system need a User Manual?			
Do you have a list of critical tasks?			
Do you have a plan to update the system documentation after the project is complete?			
Does everyone in the project team have the required hardware and software?			
Is there a mechanism to track scope creeps and change requests?			
Have you created a project change management plan? Do you have a change request log and change request template?			
Do you have a communication plan?			
Is there a set of standard templates for project artifacts available?			
How often do you review your project budget?			
Do you have a detailed project schedule where the largest task is less than 5 days?			
Do you have a defect management process in place?			
What is the frequency of status reporting?			
Do you have a project status report for weekly and/or monthly reporting?			
Do you plan to conduct a monthly project team meeting?			
How will you track resource utilization in the project?			
How do you plan to manage ongoing leave management for the team?			
Was a risk assessment conducted for the project?			
Have you created a project risk and issue register?			
What is your stakeholder management plan?			

Do you have the required tools to capture timesheets?			
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Table 6: Achieve Phase

- **Close Phase**

This phase serves as a sign of the deliverables by the stakeholders. This needs to close by the project manager and do the proper handover to the occupants' team.

Close Phase			
Description	Yes	No	Comments
Was an implementation review conducted?			
Are all the project benefits still on track?			
Will there be a closure document?			
Have all the stakeholders authorized the project closure?			
Are there any pending or open issues because of the project?			
Do you have a list of lessons learned?			
Have adequate arrangements been made for the handover of the new or updated systems/processes?			
Has the project budget been finalized?			
Are all the project resources released?			
Have all the post-project activities been complete?			
Handover is complete for all deliverables?			
All deliverables are accepted and signed off by the client?			
Final project status reports are complete?			
All financial processes and reports are complete?			
Staff performance evaluations and reports completed?			
All supply contracts and processes are terminated?			
Site operations and facilities used for the project closed down?			
Disposal of all equipment and materials is done?			
Completion of storage for all the project files?			
Communication: Announcement of completion of a project (internal, external, and public relations contacts)?			

Table 7: Close Phase

2.2 Power and Interest

The power/interest grid is a matrix used for categorizing stakeholders during a change project to allow them to be effectively managed. Stakeholders are plotted on the grid in relation to the power and interest they have in respect of the project.

2.2.1 Stakeholder Register and Form Groups for Them:

Stakeholder is: “individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion”. Stakeholders include the project manager, the customer, team members within the organization, and the project sponsor.

The Stakeholder register is the document that contains information about identified stakeholders and is the main output of the identify stakeholders’ process. Moreover, the process of identifying and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success is crucial.

This document contains information about identified stakeholders that includes but is not limited to: Identification information, Assessment information and Stakeholder classification. During this phase of the project, many tools were used, such as a brainstorming and expert that helped the team create a stakeholders register.

Stakeholders Register							
Project Name: Construction of PCR Lab				Project Reference Number: 6015			
Project Manager: Eng. Samir Asad				Project Owner/Client:.....			
Prepared By:				Date Prepared:			
Stakeholders Name	Position	Role	Group	Contact Details (Email– Mobile)	Classification	Interest	Influence

A	CEO	Project Sponsor	Owner	Ceo@pcr.com	Internal	H	H
B	PMO	Project Manager	Direct Management	Pmo@pcr.com	Internal	H	H
C	Subject Expert	Construction	Special Group	0004537899	External	H	L
D	Engineering Department	Construction	Functional Management	0003346733	Internal	H	H
E	Operation Department		Functional Management	Od@pcr.com	Internal	H	H
F	Information Technology Department	Computer systems management	Functional Management	IT@pcr.com	Internal	H	L
G	Construction Company	Lab Design	Special Interest Group	000453331	External	L	H
H	Procurements Department	Functional Management	Functional Management	Pd@pro.com	Internal	L	H
I	Saudi Telecom Company	Utility Companies	Utilities	stc@stc.com	External	L	L
G	Water National Company	Utility Companies	Utilities	Wnc@nwc.com	External	L	L

K	Saudi Electrical Company	Utility Companies	Utilities	Sec@sec.com	External	L	L
L	Suppliers	Material Suppliers	Suppliers	S@sup.com	External	H	H
M	–	Client, Customer	Customer	–	External	H	L
N	MOH	Auditor	Governments	N@moh.gov.sa	External	H	H
O	Finance Department	Provision of Funds	Functional Management	Fd@pcr.com	Internal	H	H
P	Human Resource Department	Recruitment	Functional Management	Hr@pcr.com	Internal	L	H
Q	Insurance Department	Third Party Payers	Special Interest Group	Ins@MMD.com	External	L	H
R	Infection Control Department	Internal Auditor	Special Interest Group	IC@pcr.com	Internal	L	H
S	Laboratory Department	Internal Auditor	Functional Management	Lab@pcr.com	Internal	H	H

Table 8 Stakeholders Register

2.2.2 The Two Networks: (Strength/Interest) and (Influence/ Strength):

Stakeholder analysis is used to classify and planning engagement for groups of stakeholders. It is a critical skill that help project team to ensuring that their projects succeed where others have failed.

Once you have the long list of individuals and organizations that are impacted by your work. Some of them may have the power either to block or advance. Some may be interested in what you are doing, others may not care. This is where the Power–Interest grid comes in handy in segregating/prioritizing the stakeholders. Doing this helps in identifying stakeholders based on their power and interest in the project. When you plot your stakeholders on a power/interest grid, you can determine who has high or low power to affect your project, and who has high or low interest. People with high power need to be kept satisfied, while people with high interest need to be kept informed. When a stakeholder has both, make sure you manage her expectations very closely (Bdaiwi, 2017).

- High Power – High Interest: The stakeholders are decision makers and have the biggest impact on the project success and hence you must closely manage their expectations.
- High Power – Low Interest: The stakeholder needed to be kept in loop, these stakeholders need to be kept satisfied even though they aren't interested because they yield power. These types of stakeholders should be dealt with cautiously as well since they may use their power in a not desired way in the project if they become unsatisfied.
- Low Power – High Interest: Keep these people adequately informed and talk to them to ensure that no major issues are arising. These people can often be very helpful with the detail of your project.
- Low Power – Low Interest: Monitor these people, but do not bore them with excessive communication

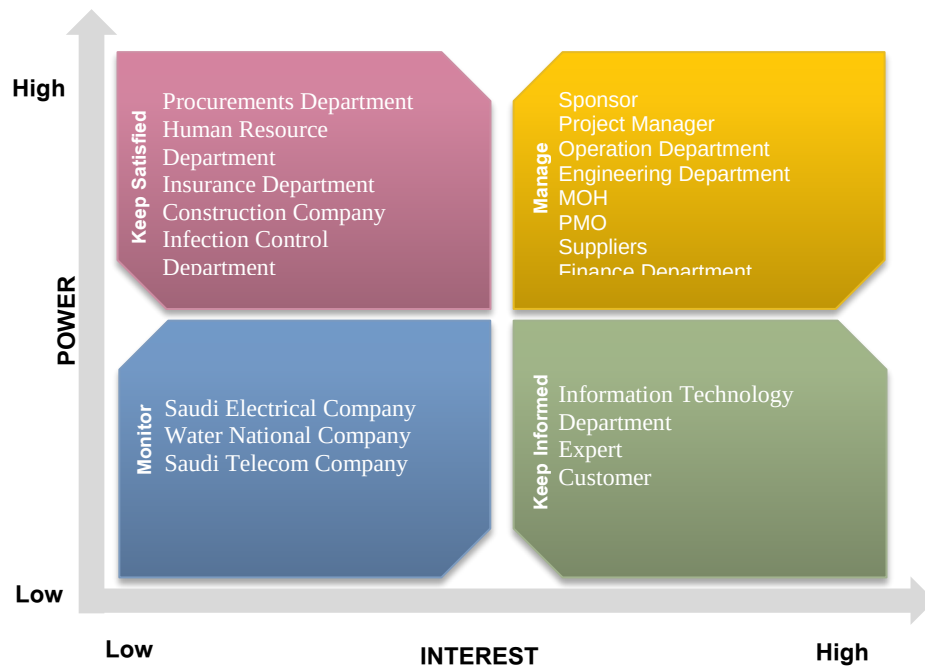


Figure 12: Power & Interest

2.2.3 The logical diagrams for the register of the stakeholder.

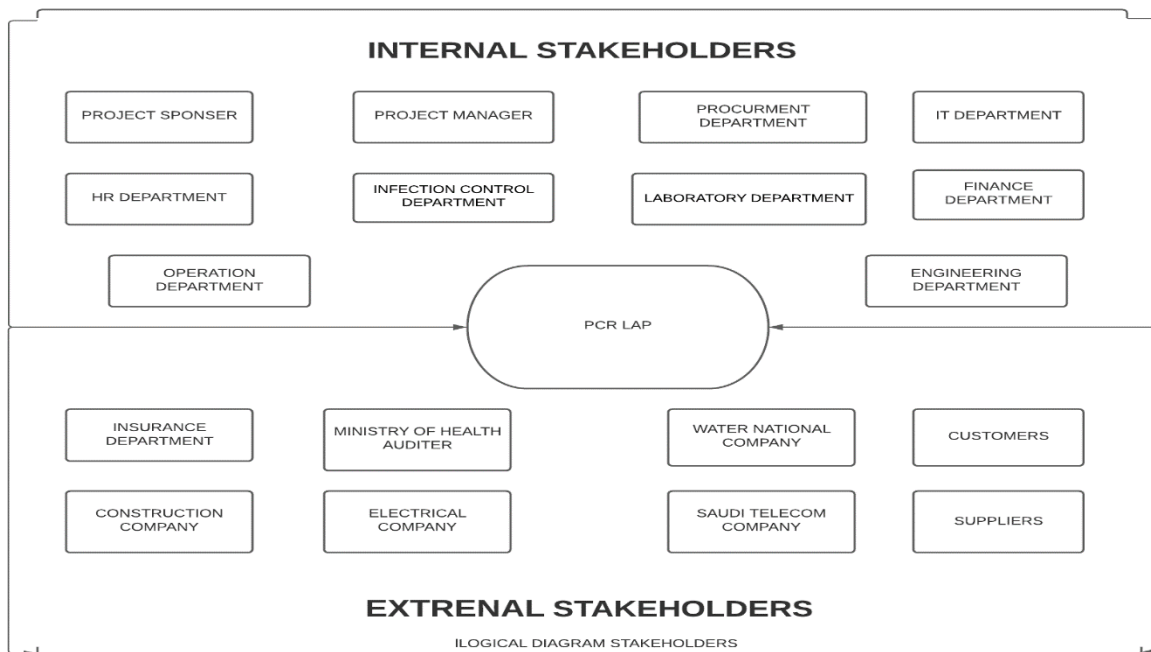


Figure 13: External Stake Holders

2.3 Culture and Values

An organization with a strong culture is one where its employees know how to respond to any situation, know how they will be rewarded when demonstrating the organization's values, and understand and know how they will be held accountable.

A highly effective organization is based on a strong culture that is rooted in deeply held and widely shared beliefs which are then strengthened by a well-developed strategy and structure (SHRM, 2021).

Epstein et al. (2014) argued that it is critical to implement sustainability in an organization that has a shared culture that is based on sustainability. According to empirical studies, sustainability-integrated firms are more likely to integrate sustainability messaging into mainstream marketing and advertising.

2.1.1 The Culture of the Organization:

Organizational culture includes an organization's expectations, experiences, philosophy, as well as the values that guide member behavior, and is expressed in member self-image, inner workings, interactions with the outside world, and future expectations

The new quality strategy represents an ambitious attempt to develop an over-arching framework for health care quality. These documents articulate a detailed set of interlocking strategies, tactics, and supporting initiatives aimed at three factors:

- defining appropriate quality standards;
- delivering health care congruent with these standards;
- Monitoring to ensure that uniformly high quality of care is achieved

Principle	Description
Customer Focus	Understanding current and future customer needs and expectations.
Leadership	Leaders establish and maintain an environment where employees can become fully involved in achieving the organization's objectives.
Involvement of People	People at all levels of the organization are fully involved in the organization. This will result in retaining competent employees, enabling their knowledge and skills, and leading to their empowerment.
Process Approach	Processes must be managed by the leaders, and related resources provided.
System approach to Management	Systems management and systems thinking leads to effectiveness and efficiency in achieving objectives.
Continuous Improvement	A continuous focus on performance improvement should be a permanent objective of the organization with all personnel contributing.
Factual Approach to Decision Making	Analysis of data and information will lead to effective Decision-making.
Mutually Beneficial Supplier Relationships	The organization and its suppliers are interdependent and a good relationship between them creates value for all.

Table 9: Principle & Description

Domains	Competencies
Quality Improvement (QI)	Use data to monitor the outcomes of care processes and use improvement methods to design and test changes to continuously improve the quality and safety of healthcare systems.
Safety	Minimize risk of harm to patients and providers through both systems effectiveness and individual performance.
Teamwork and Collaboration	Function effectively within nursing and inter-professional teams, fostering open communication, mutual respect, and shared decision-making to achieve quality patient care.

Patient-centered Care	Recognize the patient and designee as the course of control and full partner in providing compassionate and coordinated care based on respect for patient's preferences, values, and needs
Evidence Based Practice (EBP)	Integrate best current evidence with clinical expertise and patient/family preferences and values for delivery of optimal health care
Informatics	Use information and technology to communicate, manage knowledge, mitigate error, and support decision making.

Table 10: Domains & Competencies

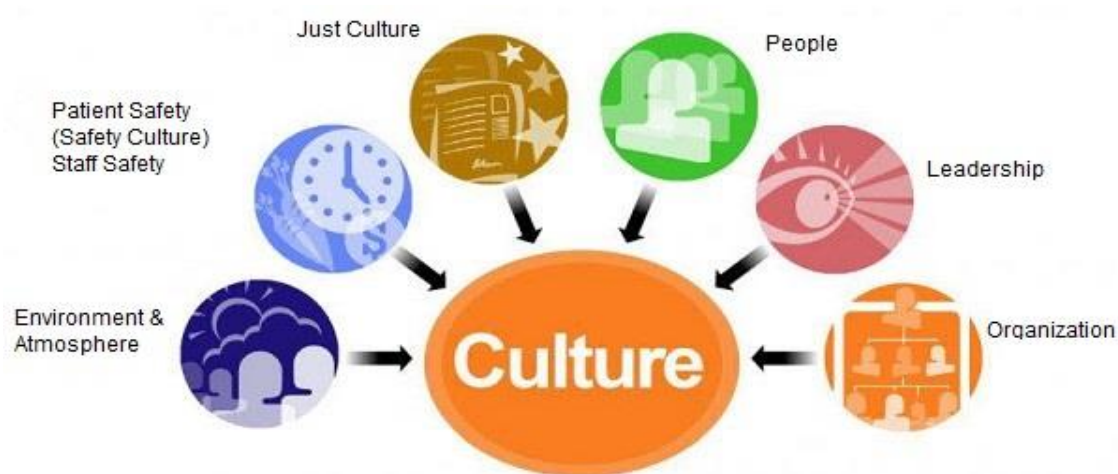


Figure 14: Culture of the organization

2.3.2 The Organization's Values

Values are the beliefs, philosophies, and principles that drive your business. They impact the employee experience you deliver as well as the relationship you develop with your customers, partners, and shareholders.

Organizational values describe the core ethics or principles the organization will abide by, they inspire employees' best efforts and also constrain their actions. Strong, clearly-articulated values should be a true reflection of your organization's aspirations for appropriate workplace behavior, and play an important role in building a positive culture at organization.

- Teamwork: to create a teamwork spirit that allows us to work calmly as there is applying of constructive collaboration and mutual trust among team's members and leaders.
- Safety: We build our capabilities and implement necessary processes to eliminate preventable harm in PCR Lab.
- Quality: We care deeply about our work, about providing excellent customer service, and we truly care about achieving results for our clients.
- Mutual Respect: Respecting the values, ideas and beliefs of others whilst not imposing our own on others.
- Honesty: Always telling the truth.

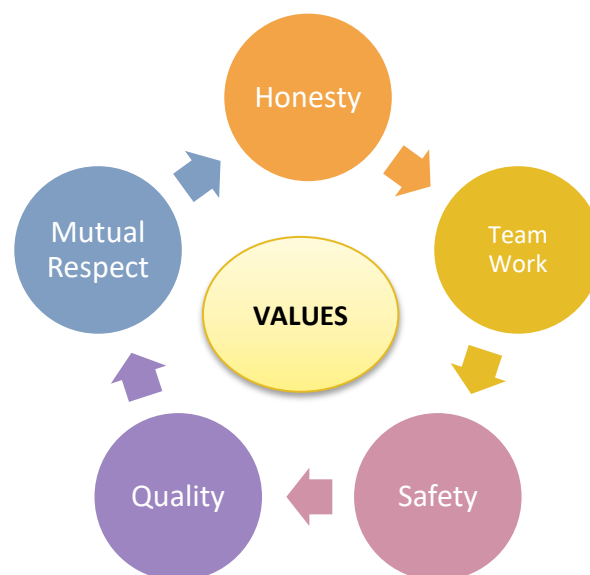


Figure 15: Values of the organization

3.1 Self-reflection and self-management

We all know that a project is considered successful if it is completed within the scope, time, cost, and quality constraints. Poor project management is expensive and difficult to deal with, especially when large projects with large sums of money are involved. Only small fractions of the many projects that are attempted around the world are truly successful. Projects are completed and closed, but they are not

always regarded as successful due to cost or schedule overruns, with the most prevalent cause of project failure being cost overrun. As a result, firms must apply improved concepts, creative approaches, and frameworks in project management.

3.1.1 Personal Behaviors Impacting the Project

One of the most important factors influencing project success is people's behavior. In the remote work environment of today, managers must understand the emotions and culture of their work team to give employees a chance at succeeding in the long run and completing projects in the manner that they should be handled. Project management revolves around people, and their actions have a direct impact on the project's success. All processes revolve around people, which is why projects cannot thrive without their input and ideas.

In this research, we will discuss three project manager personal behaviors that might have an impact on the project, as well as how project managers can manage people without jeopardizing the project's success. The following is a list of three personal behaviors of project manager that can influence the project:

- **Understanding Culture**

For humans, culture is one of the most significant and sensitive variables. To different people, the term culture can signify different things. From the standpoint of a project manager, culture could simply mean "how projects are managed here." People bring their culture along with them as luggage. Project managers must interpret and comprehend the significance of workplace culture.

At a global level, managers may find it challenging to comprehend cultural variations. While project management teams' global reach has resulted in an infusion of bright individuals, it has also resulted in

a situation where project managers aren't always in control of how their team's culture is seen and what they can do about it.

Employees are frequently required to work in environments that aren't supportive of their efforts or the job they produce. Employee morale can be harmed by a lack of acknowledgment and praise where it is due, as well as a lack of confidence to attempt new things at work. In the PCR Test Lab project, PM should encourage everyone to communicate in short clear sentences and discourage, as much as possible, the use of idiom, slang, or words with multiple meanings.

- **Engaging Team Members**

After you've figured out what culture is, the next step is to engage team members and make sure they're paying attention. Successful project management necessitates involving team members and harvesting communication between them. The level of engagement should be the same for both team members and stakeholders so that everyone is on board with the development and ready to pitch in where it's needed.

Throughout the course of a typical project's lifecycle, engagement levels should be assessed, and employees' feelings should be closely tracked. The way the project team interacts and performs as a whole can have a big impact on productivity. In the PCR Test Lab project, PM should start with setting a clear vision and specific project goals before you provide challenging but exciting assignments. Empower your team to make independent decisions and share the project's progress on an ongoing basis. Provide social and structural resources for the team and work to remove any obstacles that are hindering team success.

- **Good Communication**

People management issues aren't about the technical aspects of day-to-day interactions with people; rather, they're about a lack of communication among stakeholders. Employees will be able to communicate with one another through a variety of channels at any given time. Make sure that the communication is consistent and that it aids in the achievement of beneficial outcomes.

If project managers want to get the best results on their new initiatives, they'll have to go beyond what's written in the books. People's emotional bonds as individuals and as members of teams must be recognized to effectively manage them and reduce difficulties. In the PCR Test Lab project, PM should make good communication by focusing on the way communication is delivered and received, project management teams will see their projects run smoothly and more efficiently.

3.1.2 Behaviors reasons, and how they can be eliminated:

Team members should be acceptable communicators who advance clear, explicit data trade. It is PM work as an undertaking chief to keep many individuals educated. PM task groups must get what's generally anticipated of them, including what they should do, when they should do it, and what spending plan, time, and quality objectives they're focusing on. On the off chance that undertaking colleagues don't have the foggiest idea what their obligations are or how to finish them, the project will stop.

PM will not have the option to follow project progress in the event that PM doesn't have the foggiest idea of what the venture group is doing (or isn't doing). At last, on the off chance that PM doesn't have a clue what the client anticipates from PM, the task will not make headway. Subsequently, project correspondence can be summed up as deciding "who needs what data and when" and guaranteeing that they have it. All activities require viable communication plans, yet not all undertakings will utilize similar sorts of correspondence or spread data similarly.

The correspondence the board plan diagrams how the partners' correspondence needs will be met, including the kinds of data that will be conveyed, who will impart it, and who will get it; specialized techniques; correspondence timing and recurrence; the strategy for refreshing the arrangement as the venture advances, including the increasing system; and a glossary. The objective of the project manager is to finish things. Each association has its own arrangement of strategies, functional methodology, and hidden culture. Political traps, unique inspirations, contending interests, and force battles flourish.

A venture director should know about every one of the concealed powers at work in the association. The initiative is characterized as the capacity to spur and rouse others to accomplish explicit objectives. Pioneers impart a feeling of direction in their supporters and join them behind a shared objective. A decent venture administrator can propel and move the undertaking group to comprehend the task's vision and worth. As a pioneer, the undertaking administrator can spur the task group to discover an answer for the apparent issue.

3.1.3 Self-professional assessment using SWOT Model

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. A personal SWOT analysis is a self-introspection exercise that can help you better understand yourself and plan for future growth. It's a reliable technique for distinguishing inside and outer qualities and shortcomings, just as promising circumstances and dangers. The evaluation is remembered for any great business or promoting plan since it gives pivotal data to fostering a development system. People can profit from this significant exercise too.

An individual SWOT investigation can assist you with accomplishing your objectives, regardless of whether you're searching for a new position or attempting to progress up the professional bureaucracy.

A novel technique for self-assessment can assist you with sorting out where your profession is currently and where it may go later on.

SWOT analysis process captures information about PM internal strengths and weaknesses as well as external opportunities and threats. Key to completing your SWOT analysis is to treat your career as a business and yourself as a competitive product.

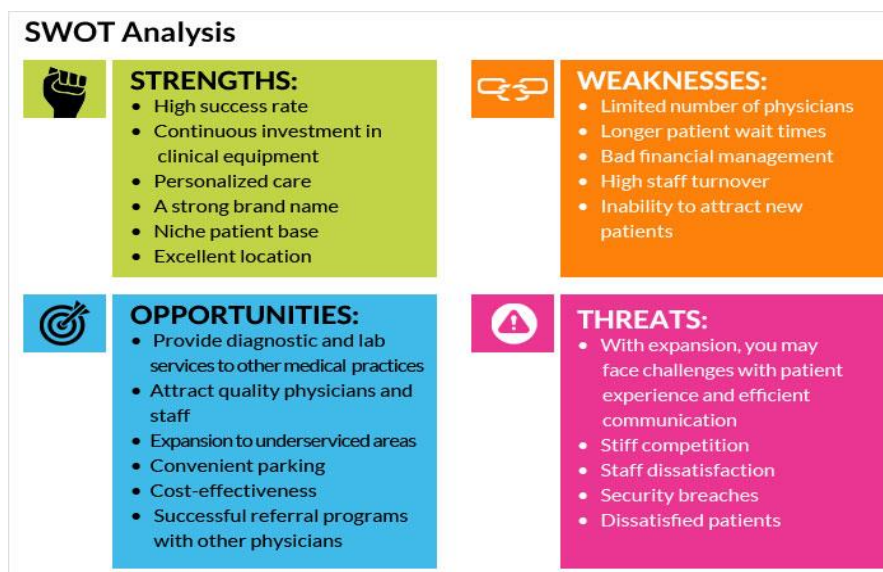


Figure 16: SWOT Analysis

• Strengths

To help you understand your strengths, picture yourself as a competitive product in the marketplace. A personal strength is an asset to you as a product and can be used as a way to differentiate PM from others when interviewing or trying to obtain your next promotion. Strengths such as strong expertise, inspiring, quality, coaching, project management skills and ability to improve processes.

• Weaknesses

A personal weakness is a liability or an area of opportunity for growth. These are characteristics PM could improve upon to increase future job opportunities. Weaknesses such as easily bored with routine work, poor typing skills, poor paper work and poor listener.

- **Opportunities & Threats**

When thinking about opportunities and threats, PM always finds it easier to begin with the “threats.” Try comparing yourself to PMs, who you will likely compete against for that next job or promotion. Then, as objectively as possible, judge your threats and determine possible ways to overcome them.

3.2 Personal Integrity and Reliability

The construction industry is a challenging and demanding business sector. Alqasmi (2019) discussed that construction projects include many stakeholders, often with varying views, and require various procedures and processes according to the context of each project. Between those procedures, gaps occur, and individuals are required to make decisions. Some of these decisions and practices may be considered unethical. The Cambridge Business English Dictionary (2013) defines ethics as “a system of accepted rules about behavior, based on what is considered right and wrong”. On the other hand, unethical practices include “acts that have harmful effects on others and are either illegal or morally unacceptable to the larger community (Jones, 1991).

Ethical practice in the building and construction industry is the vital importance in the same way to other disciplines. Scholars that the unethical practice ranks top among the most severe ills affecting the construction industry. The construction industry faces some ethical issues that are comprised of but are not restricted to: conflict of interest, inflation of bills, professional incompetence, poor work delivery, fraud, bribery, professional misconduct, intimidation and kickbacks among several other evils. The consequences of such unethical behaviors in such industry lead to confidence reduction in the profession, continuous insecure practices that risk lives and property, loss of income by clients and governments, needless and baseless expenditures.

3.2.1 “3” Behaviors that contradict moral integrity

Human integrity is crucial in business and in dealing with people as it may negatively affect others not only the individuals who breach integrity or ethics.

For example, if an individual went to a certain place looking for some laboratory results that is important to his health and family you expect the lab to be professional when dealing with patients or customers, as it is important to clearly examine the results in order to hand it to the patients.

Sometimes unethical behaviors might lead to bad results for the society not only to the individuals. If an employee is not dealing ethically with the results this might lead to misunderstanding the health situation of the patient, and it is not right.

Equally important, having ethics and good manners when dealing with all patient with equality will show that the lab cares about respecting everyone's right and turns as well, not breaching lines or ethics when people offer money for special requests or services as favors.

So, dealing with bribe or lies considered as unethical behaviors in workplace that always lead to bigger issues that affects individuals and the society itself as well.

In addition, it is important to mention that employees in such workplace should always consider dealing with people in good manners whether in delivering news to them about the results or talking to them about the right solution to deal with certain health issue that need to be taken care of.

3.2.2 Analyze the Financial, Social, and Technical Influence, if Any, of such Behaviors on the Works of the Project and the Relationships

1. Overbilling

Cash flow is critical to the construction industry. Project work packages cannot be completed without acquiring materials and manpower payments. Therefore, contractors use billings in excess to manage their expenses and reduce their reliance on credit to pay for upfront costs (Sandage, 2021). Overbilling arises when a contractor bills for contracted labor and materials before that work is being finished. For instance, during a billing cycle, a contractor completes 40% of a project but bills their customer for 50%. That extra 10% is the overbilled amount.

Overbilling leads to situations where the estimated cash required to complete the project exceeds the amount that can still be billed before completion. Such practices lead to a negative cash flow for the remaining activities. Also, it results in an inaccurate monthly income (or profit-and-loss) statement. In other words, over-billing will reflect too much profit in the profit and loss financial statement for the contractor.

2. Late Payments or Unpaid Work

Nowadays, finances are a major issue facing the construction industry in 2020. It is significant to have a positive cash flow for the company with a responsibility to ensure the livelihood of the employees and their families. Latham (1994) stated that “the cascade system of payment starts from the financial institution to the main contractor to subcontractor and so on down the chain”. The insolvency of one party in the payment chain could cause severe impacts to parties down the contractual chain.

It is found in the construction of PCR Test Lab the subcontractor is not receiving payment for its completed work in several instances. Consequently, subcontractor typically files claim against the general contractor and owners in several major projects. Also, subcontractors are front-loading costs on many projects and paying their suppliers and employees. However, they are patiently awaiting payment from the general contractor or owner who may be disputing the payments, although the work is completed.

The impact of late payments or non-payment leads to:

1. Delay in project's progress
2. Extension of time for project
3. Low quality works due to contractor's uncertain financial condition
4. Abandonment of the project
5. Creates negative relationship among parties
6. Creates financial hardship for the company
7. Subcontractors refuse to continue works on the project

3. Corruption

The construction industry has an international reputation for corruption and bribery. Corrupt practices can be found at every phase in construction projects, such as the planning stage and the awarding of construction contracts (Rodriguez, Waite & Wolfe, 2005). Examples of corruption include bribes, fraud, and kickbacks. Examples of corruption in the design stage of the project cycle include but are not limited to the following:

- Corrupt selection of consultants for feasibility studies, preparation of specifications/bid documents.
- Over-designed and overpriced projects.

The global infrastructure Anti-corruption Center (n.d) states that such corrupt practices cause loss and damage including financial loss and property damage. For instance, financial loss may arise from inflation of project price, increased maintenance and repair costs, damage to reputation, and legal fees. Project

funds may be wasted where there is corruption in project selection or project design resulting in non-viable projects or projects which are unsuitable for the intended purpose.

3.3 Personal communication

Communication is the process of exchanging information, intended or involuntary, between project team and stakeholders. In this project we use different methods to exchange information between stakeholders such as; private letters, memos, emails, personal interviews or telephone conversations.

3.3.1 The Register of Stakeholders

See Table 8 Stakeholders Register.

3.3.2 The Personal Communication and the Effective Communication

Communication is one of the most basic functions of management. Communication is essential for achieving managerial and organizational effectiveness. Good communication helps employees become more involved in their work and helps them develop a better understanding of their jobs. Clear, precise and timely communication of information also prevents the occurrence of organizational problems. Without communication, employees will not be aware of what their coworkers are doing, will not have any idea about what their goals are, and will not be able to assess their performance. Managers will not be able to give instructions to their subordinates and management will not receive the information it requires to develop plans and take decisions, hence communication acts as nervous system for any organization.

Communication refers to a process of conveying information, ideas, feelings, opinion, messages or facts between two or more persons either verbally or non-verbally using a medium.

Organizational Communication can be broadly classified into formal and informal communication.

Formal communications are those that are official, that are a part of the recognized communication system which is involved in the operation of the organization. These communications may be oral or written. A formal communication can be from a superior to a subordinate, from a subordinate to a superior, intra administrative, or external. Formal communications take place externally to the organization i.e., with outside groups, such as suppliers, clients, unions, government agencies and community groups. Formal communications may be mandatory, indicative or explanatory. Mandatory communication implies an order or command to be followed and goes by various euphemistic names such as instructions, briefing, etc., this kind of communication is mostly vertical and usually one way from top to downward. The indicative or explanatory communication may exist between any levels and may be vertical as well as horizontal.

Informal communications grow out of the social interactions among people who work together. These are not bound by any chart on the wall but are bound by conventions, customs and culture. Such communication provides useful information for events to come, in the form of grapevine.

Effective communication occurs when there is shared meaning. The message that is sent is the same message that is received. There must be a mutual understanding between the sender and the receiver for the transmission of ideas or information to be successful.

Characteristics of effective communication are:

1. **Clarity of Purpose:** The message to be delivered must be clear in the mind of sender. The person to whom it is targeted and the aim of the message should be clear.
2. **Completeness:** The message delivered should be complete. It should be supported by facts and observations. It should be well planned and organized. No assumptions should be made by the receiver.

3. **Conciseness:** The message should be concise. It should not include any unnecessary details. It should be short and complete.
4. **Feedback:** Whether the message sent by the sender is understood in same terms by the receiver or not can be judged by the feedback received. The feedback should be timely and in person. It should be specific rather than general.
5. **Empathy:** Empathy with the listeners is essential for effective verbal communication. The speaker should step into the shoes of the listener and be sensitive to their needs and emotions. This way he can understand things from their perspective and make communication more effective.
6. **Modify the message according to the audience:** The information requirement by different people in the organization differs according to their needs. What is relevant to the middle level management might not be relevant to the top level of management. Use of jargons should be minimized because it might lead to misunderstanding and misinterpretations. The message should be modified according to the needs and requirements of the targeted audience.
7. **Multiple Channels of communication:** For effective communication multiple channels should be used as it increases the chances of clarity of message. The message is reinforced by using different channels and there are less chances of deformation of message.
8. **Make effective use of Grapevine (informal channel of communication):** The employees and managers should not always discourage grapevine. They should make effective use of grapevine. The managers can use grapevine to deliver formal messages and for identification of issues which are significant for the employees. The managers can get to know the problems faced by the employees and can work upon it.

3.3.3 The Shapes, Models, and Channels of Personal Communication:

Communication is a complex process, and it is difficult to determine where or with whom a communication encounter starts and ends. Communication is the process of exchanging information, intended or involuntary, between project team and stakeholders. Communications describes the means by which information can be sent or received, either through activities, such as meetings and presentations, or artifacts, such as emails, social media, project reports, or project documentation (PMBOK, 2017).

This paper will explain some important models of communication, specific concepts and steps within the process of communication, obstacles in communication and how to overcome these obstacles by communicating together.

Models of communication simplify the process by providing a visual representation of the various aspects of a communication encounter. They can represent the communication process in its most basic linear form (sender and receiver) or a more interactive form that encompasses the additional element of feedback, or human elements such as the sender and recipient. Although these models of communication differ, they contain some common elements (PMBOK, 2017).

Basic sender/receiver communication model: This model describes communication as a process and consists of two parties, defined as the sender and receiver. This model is concerned with ensuring that the message is delivered, rather than understood.

Interactive communication model: This model also describes communication as a process consisting of two parties, the sender and receiver, but recognizes the need to ensure that the message has been understood.

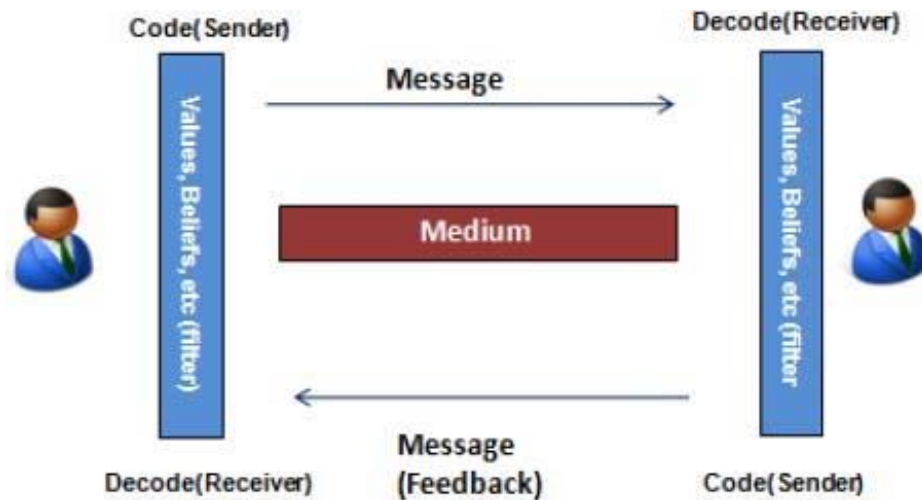


Figure 17: Interactive communication model

The sender is responsible for the transmission of the message, ensuring the information being communicated is clear and complete, and confirming the message is correctly interpreted. The receiver is responsible for ensuring that the information is received in its entirety, interpreted correctly, and acknowledged or responded to appropriately. These components take place in an environment where there will likely be noise and other barriers to effective communication (PMBOK, 2017).

3.3.4 The Communication Matrix:

Communication is, essentially, the effective sending and receiving of information. In order to share the right information about the project with the right people in an effective and timely manner. The following table identifies the communication requirement for constructing this project.

Type	Objective	Medium	Frequency	Audience	Owner	Deliverables	Format
Kick-off meeting	Create a shared understanding of the project background.	Face to Face	Once	Project Sponsor Project Team	PM	Agenda Meeting minutes	Soft copy in the archive Hard copy

	Introduce the project team. Review project objective and management approach.			Stakeholders			distribution
Project Team Meeting	Review the status of the project with the team	Face to Face Conference call	Weekly	Project Team	PM	Agenda Meeting minutes Project schedule	Soft copy in the archive Hard copy distribution
Technical Design Meeting	Discuss and develop the technical design for the project	Face to Face	As needed	Project design team	Design lead	Agenda Meeting minutes	Soft copy in the archive Hard copy distribution

Monthly Project Status Meeting	Report the status of the project to management	Conference call	Monthly	PMO	PM	Slide templates Project schedule	Soft copy in the archive Hard copy distribution
Project Status Report	Report the status of the project including activities progress and cost	Email	Monthly	Sponsor Project Team PMO	PM	Project Status report Project schedule	Soft copy in the archive Hard copy distribution

Table 9: Communication Matrix

3.3.5 3 Wrong Scenarios of Communication

- Assuming You Know the Message before the Person Finishes Talking:** When we are listening to someone speak, we already assume that we know what is going to be said before he/she finishes his/her full sentence. When we assume know what the person going to say, we will miss what is actually being said.

- **Letting Your Emotions Dictate Your Response:** We are more inclined to say things we do not mean when we are emotionally charged. A good communicator allows emotions to sit for a while and then chooses to carefully respond rather than react.
- **Workplace Intimidation:** Intimidation methods are a type of negative communication that may swiftly turn a workplace into a toxic and fear-filled one. High turnover is likely for a supervisor who pressures his people into getting things done. Coworkers competing for the same promotion can likewise be intimidated. This unsettling behavior is frequently expressed through direct verbal language or physically threatening actions. Loud shouting, physically taking over the workspace, or standing in close physical proximity to inflict discomfort are examples of intimidation.

3.3.6 Stakeholder's Assessment Matrix

When creating the stakeholder engagement assessment matrix, e.g., in the process 'plan stakeholder engagement', a project manager should refer to the stakeholder engagement plan for the desired level of engagement. The desired level ("D") of engagement is then incorporated into the stakeholder engagement matrix. When monitoring the actual stakeholder engagement, the project manager adds the observed current level ("C") of engagement for each stakeholder

Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
Sponsor				D C	
Project Manager					D
Project Management Team					D C
Project Department				D	
Engineering Department				D	
Procurements Department				D	
O&M Departments				D C	
Health Department			D		

Medina Community			D C		
Transportation Department				D	
Construction Contractors					D
Saudi Electrical Company				D	
Saudi Telecom Company				D	
Childcare Facilities				D	
Material Suppliers				D	
Local residents				D	

Table 10: Stockholder Assessment Matrix

4.1 Leadership

4.1.1 The leadership model, which is preferred to the project leadership:

“Leadership is not about titles, positions or flowcharts. It is about one life influencing another” (John C. Maxwell)

From this phrase we can understand that leadership is about people and the way of dealing with those people towards productivity. Thus, every individual has a preferred way to be dealt with as well as teams. Eng. Samuel A Malachowsky the author of (Project Team Leader and Communication –2018) has classified the leadership styles into seven styles. Those styles were classified according to the nature of people and the situations. Considering the type of our project and the team members, we have studied all seven styles, and we’ve found that the most appropriate leadership style to be used in managing this project is the “Democratic” as primary, and we’ve chosen the “Transformational/Visionary” leadership style as secondary.

4.1.2 Specify the reasons for which such a model is preferred:

The Democratic leadership style was chosen in discussion the different parts of the project because the team has different experiences, and this kind of leadership style can harness the advantages of this variations which brings a high quality of work.

The reasons that guide us to use Transformational/Visionary style are the project itself and the complexity of it. Also, at the early start of this project, the project idea was rejected by the instructor of this course, resulting a need by the team to be inspired that the effort that was done will be rewarded.

4.1.3 “5” proposals for the motivation methods that are compatible with the nature of the project.

Motivators are different among individuals; someone motivator shouldn't be another motivator. So, in our project we will use 5 different types of motivators:

1. Purpose: since the project is serving a greater purpose to society.
2. Money/Power: The most common motivator and mostly the force that bring people to work.
3. Autonomy/ Interesting work: Both architects and engineers of the project would be motivated by new and exciting work.
4. Recognition: The project is complex and has many team members, we know that some of the team would prefer recognition for their work.
5. Mastery/Exploration: The team has many creative individuals who are motivated by finding solutions and overcoming challenges.

4.2 Teamwork

4.2.1 RACI Model for 3 Administrative Measures of the Project:

One of the essential parts of project manager roles is delegation, therefore, early identification of roles and responsibilities early in a project is extremely essential. As a project manager, it is necessary to set the expectations of people involved in a project from outset. Projects are recognized by the involvement of many people, yet, how a situation where people are struggling against one another to do a task is avoided.

The same goes for dealing with a situation in which no one is taking responsibility and making a decision. How can people differentiate between their level of responsibility, when they should consult their project manager, or when they should exercise their own judgment? Applying the RACI matrix can help. The RACI matrix is a straightforward tool utilized for identifying and assigning roles and responsibilities and avoiding confusion over those roles and responsibilities during a project. (Santos, 2021).

RACI Matrix Model						
Project Deliverable or Activity	Roles					
	Executive Sponsor	Project Sponsor	Project Manager	Functional Lead	Subject Matter Expert	Project Team Members
Initiate Phase Activities						
Submit Project Request	A,C	A,C	R	I	I	
Request Review By PMO		A	R			
Research Solution	I	I	R,A	C	I	
Develop Business Case	C	A,C	R	I	I	I
Plan Phase Activities						
Create Project Charter	A	A	R,A	C	C	
Create Schedule	I	I	R,A	C	C	C
Review Plans	R	R	C	I		
Create additional plan if required	I	I	R,A			I
Execute Phase Activities						
Build Deliverables	C,I	C,I	A,I	R,A	R	R
Create Status Report	I	I	R,A	R,A	R	
Monitor/Control Phase Activities						
Perform Change Management	I	C	R,A	A	A	A
Close Phase Activities						
Create Lessons Learned	C	C	R,A	C	C	C
Estimate Budget	I	A	R	R	I	
Final Review	R	R	A	C	I	

Create Project Closure Report	I	I	R,A	I	I	I
R: Responsible person or role for ensuring that the item is completed. A: Accountable person or role responsible for actually doing or completing the item. C: Consulted person or role whose subject matter expertise is required in order to complete the item. I: Informed person or role that needs to be kept informed of the status of item completion.						

Table 11: RACI Matrix Model

4.3 Conflict and Crisis

Construction projects nowadays have become more complex in nature. McManamy (1994) stated that the complex, relational and lengthy process of designing and executing makes construction a process wherein arguments and conflicts are virtually ensured. Moreover, Whitfield (1994) argued that the participation of multidisciplinary in construction projects may lead to conflicts among different parties. In other words, conflict and disputes are inevitable to the construction industry particularly when most of the construction projects are surrounded by many uncertainties.

Kumaraswamy & Yogeshwar (1998) agreed that contractual matters, including variation, time extension, payment, quality of the technical specification, availability of information, administration and management, unrealistic client expectations and determination are common causes of construction conflicts.

Conflict in the PCR Test Lab project may hinder the achievement of one of the parties nevertheless, it has many advantages that may improve the performance of the project as cited by Rauzana (2016). First, it provides information and generates ideas that improve the quality of decision-making. Second, it influences different parties to consider others' views. Third, it helps the project manager/leader to in finding the best solutions for matters that had been buried and become open. Finally, it provides mutual understanding and respect for others' opinions.

In today's globalized world, negative events are the cause of the crisis, which affects construction companies gradually. In most cases, these events may occur suddenly or over a period of time. When a crisis arises in an organization, a disruption to the organization's normal routine procedure makes this

impossible. Environmental causes of the crisis are beyond the control of companies. In general, these are related to economic, political, legal, natural, and rivalry conditions, clients' expectations, and technological developments.

Crisis occurs across different industries such as the construction industry, much of the information on crises and their responses tend to be general. Nevertheless, certain things appear common to industrial crises conceptualization. Hällgren & Wilson (2007) claimed that progress in construction projects can be interrupted by many incidents. Nurul Islam & Hamidul Islam (2020) conducted a study and concluded that fourteen major variables influencing crisis management implementation in construction projects. Those are poor initial estimation, financial issues, too many changes, lacking the contractor's experience, worker strikes issues, inadequate knowledge of workers, workers unavailability, conflicts between parties, target cost, technical issues, political issues, natural issues, schedule variance issues, compressing schedule. Also, Nurul Islam & Hamidul Islam (2020) found that the crisis in construction projects occurred due to inadequate funds, inflation rate, and political stability.

4.3.1 The Conflict and Crisis

1. Project Life Cycle and Conflict

Conflict is defined, as cited by Meredith & Mantel (2012), as “the process which begins when one party perceives that the other has frustrated, or is about to frustrate, some concern of his”. To understand how conflict affects the performance in the construction industry, it is necessary to relate the project life cycle with the primary conflict groups and determine how certain patterns of conflict are associated with the various periods/phases in the project life. Therefore, the project manager can diagnose the nature of the conflict quickly and accurately.

Project life cycle stages such as PCR Test Lab projects have been differently classified by scholars. For example, Adams et al. (1983) break the project life cycle into four stages: conceptualization, planning,

execution, and termination. Meredith & Mantel (2012) cited that all project life cycle stages appear to be typified by conflict. Conflicts are rooted in matters such as schedules, priorities, staff and labor requirements, technical factors, administrative procedures, cost estimates, and, certainly, personality conflicts.

2. Areas of Conflicts between Project Owner and Construction Contractor

Conflict in the construction of PCR Test Lab leads to dysfunction, which is detrimental to the project's outcome and stakeholders. Conflicts that are ignored can transform a simple issue into one that may become insuperable afterward. Addressing conflict once it arises is the most efficient way to avoid future discord. According to the International Risk Management Institute (IRMI) (n.d.), conflict arises for several reasons, and the most common ones are conflicts of interest, poor communication, and limited resources.

3. Conflicts associated with the Construction of PCR Test Lab are listed below:

Areas of Conflicts between Project Owner and Contractor in the Construction of PCR LAB		
S/N	Area of Conflict	Reasons for Conflict
1	Communication	Different communication styles. Unclear roles and responsibilities of project parties.
2	Scope of Work	Poor preparation. Developing the scope by a non-specialized team.
3	Schedule	Unrealistic schedules (being overly optimistic). Unclear listing of project activities.
4	Resources Allocation	Running multiple projects at a time. Non-availability of required tools and materials. Insufficient budget.
5	Re-assignment of Project Team Members	Overlapping with other projects. Projects priority not set properly. Unqualified manpower.
6	Conflict of Interest	Fighting for Personal Goal Transferring Risk

Figure 18: Area & Reason for conflict

4.3.2 Expected scenarios of the conflict's events in the project

Scenario 1: Communication Conflict

It is found that the contractor is submitting the status report to different people once requested without concerning the main concerned party. Therefore, such behavior leads to misunderstanding and discord among people working together on construction projects. Also, lack of information, partial information, untimely information, and inaccurate information all can lead to work being done that does not meet expectations and sets the stage for conflict and animosity.

Resolution Strategies:

Standardize the channels of communication in the project to fasten and ease the communication process.

To establish a clear chain of command on a construction site that standardizes communication, creates efficiency and accountability, and eliminates confusion. The hierarchy for a work site should be laid out in the initial contract documents and include:

- Project owner
- General contractors
- Subcontractors
- Members of individual crews like engineers, architects, plumbers, and electricians.

Outline relationships in the contract documents and share them among concerned project parties.

Scenario 2: Schedule Overrun

Construction schedule overrun is common on construction projects over the world and the Saudi Arabia construction industry has not escaped the challenges of failing to deliver projects on time. According to Alkhathami (2004), schedule overrun is defined as “extra time required to finish a given construction project beyond its original planned duration, whether compensated for or not”.

Ali, Smith, Pitt, and Choon (2012) emphasized that four factors that cause schedule overruns: contractor-related factors, consultant-related factors, client-related factors, and external factors. Scenarios of schedule overrun caused by external factors involve unforeseen site conditions, bad weather, and updated government's regulation. For example, some products/ materials are behind scheduled delivery.

Resolution Strategies:

- Evaluate alternative products or vendors
- Determine product slack
- Seek alternative vendors
- Use a 10% budget cushion to expedite delivery
- Update budget

Scenario 3: Conflicts of Interest

Individuals fighting for personal goals may lose sight of the project or organizational goals meaning that a person or party has concerns that do not coincide with an overall goal. It is in the owner's best interest that a project is completed at the highest quality for the lowest cost. In contrast, a contractor would prefer to expend the least number of resources necessary to complete a project to maximize their profits. Each side is attempting to transfer risk to the other party (IRMI, n.d.).

For instance, the owner may attempt to take project management into their own hands and fail to adequately manage duties. Alternatively, a general contractor may attempt to delegate most of the work to a subcontractor. Often an owner will insist on a lump sum contract that places an increased amount of risk on a contractor. In this scenario, a poorly estimated project scope can result in a contractor footing the bill (Contney Attorneys & Consultant, n.d.). Another example is that the contractor is transferring manpower among other projects.

4.3.3 The Strategies to Deal with Each Conflict, and Specify the Reason for Preference:

One tactic may be continually reminding owners, partners, employees, and the contractor how their personal goals and efforts "fit" into the project's strategic goals and outcome expectation. Being able to recognize and openly address conflicts of interest is crucial to a project's success. Nevertheless, the only way to be sure that everyone's interests are protected is to get it in writing.

Having a well-written contract and a well-defined scope of work is the only way to mitigate these kinds of disputes. Deciding where risks lie in advance will go a long way towards securing project completion regardless of the varying interests of biased parties involved.

Other Scenarios:

Another scenario for conflict may arise from the limited resources. Many situations on projects when resources are limited and have to be managed effectively. Conflict may arise over the use of equipment, space, material, time, manpower, etc. Such conflicts must be dealt with effectively to maintain harmony on-site. An optimal strategy is to include employees and partners in the resource allocation process. This will provide them with a better understanding of how allocation decisions are made in the best interest of the project.

4.3.4 Root Cause Analysis

Root Cause Analysis (RCA) is defined as "the process of discovering the root causes of problems to identify appropriate solutions" (Aventis Learning, n.d.). RCA assumes that it is much more effective to systematically avoid and resolve underlying issues. RCA can be performed with a collection of principles, techniques, and methodologies that can all be leveraged to identify the root causes of an event or trend.

Approaches of RCA include:

1. Events and causal factor analysis
2. Change analysis
3. Barrier analysis
4. Management oversight and risk tree analysis
5. 5-why's technique

The 5-why's technique is used to analyze the root cause for the above-stated conflicts. It is a simple and effective tool for solving problems. Its main goal is to find the exact reason that causes a given problem by asking a sequence of "Why" questions. This technique helps the team to focus on finding the root cause of any problem. Also, it encourages each team member to share ideas for continuous improvement, rather than blaming others. In addition, it gives the team the confidence that it can eliminate any problem and prevent the process from recurring failures.

Below is the root cause analysis for the above three conflicts:

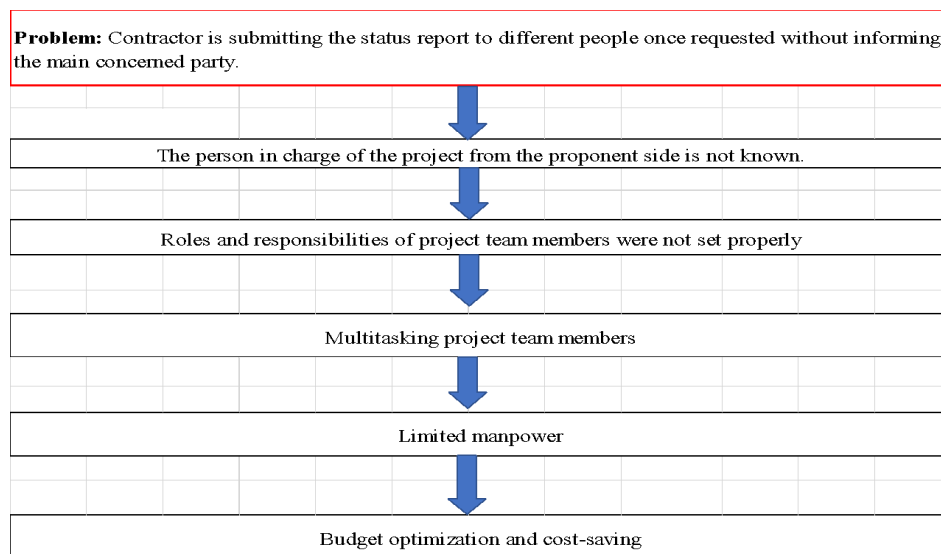


Figure 19: Communication conflict root cause analysis

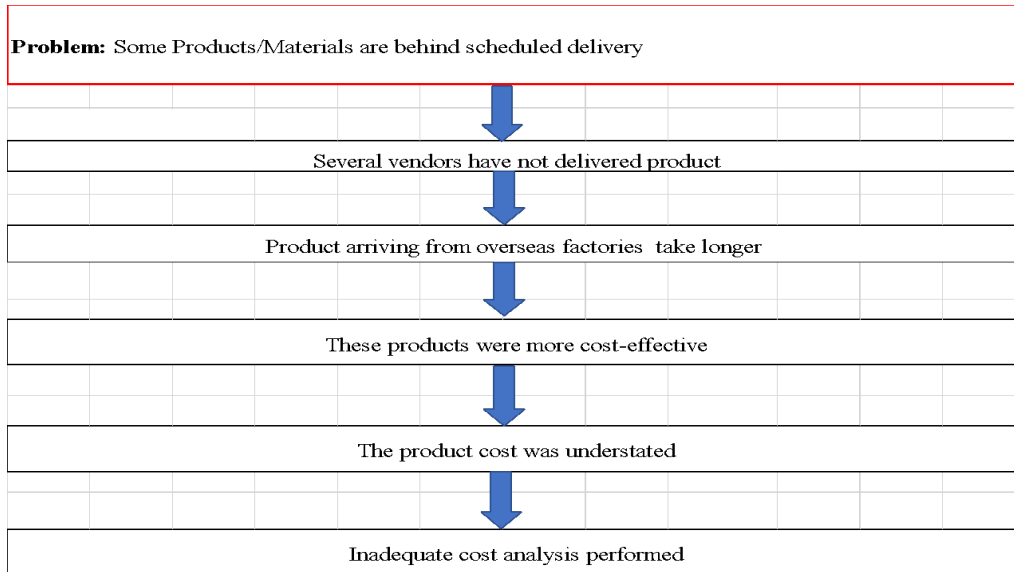


Figure 20: Product/Materials conflict root cause analysis

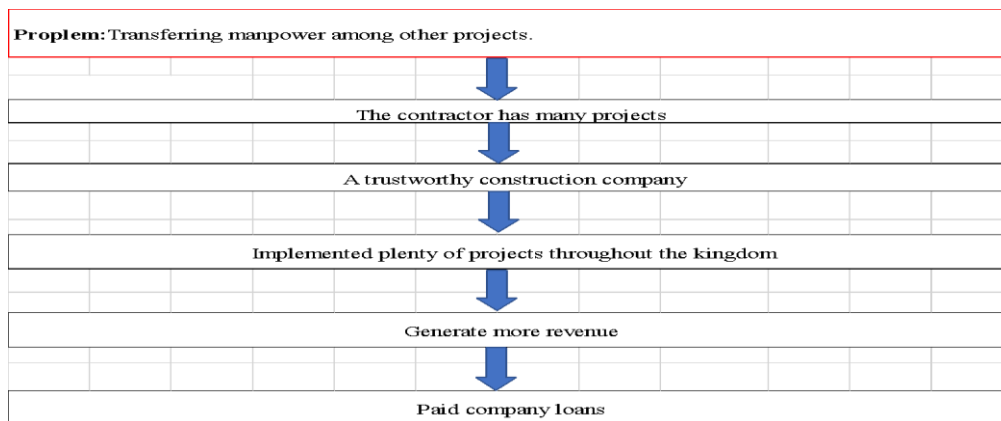


Figure 21: Transferring Manpower root cause analysis

5.1 Resourcefulness

5.1.1 Distribute the human resource on the Functions:

5.1.2 Conducting Crashing and Fast-Tracking Process:

Fast-tracking in project management is a technique where activities are performed in parallel, instead of being carried out sequentially using the original schedule.

Crashing in project management is when you shorten the duration of a project by reducing the time of one or more tasks. Crashing is done by increasing the resources to the project, which helps make tasks take less time than what they were planned for.

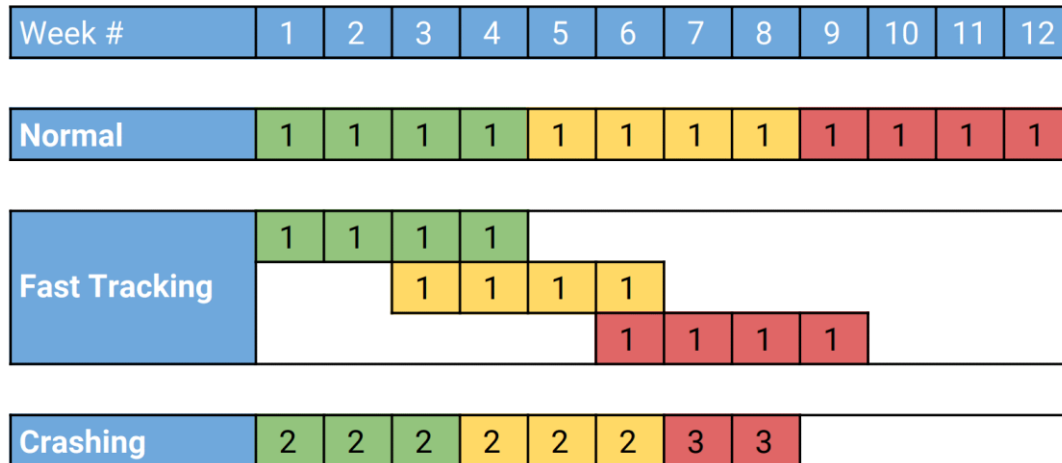


Figure 22: Crashing Vs Fast Tracking

Normal table in our Project

Week / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A																									
B																									
C																									
D																									
E																									

Figure 23: Normal Table

Fast-Tracking:

Week / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A																									
B																									
C																									
D																									
E																									

Figure 24: Fast-tracking

Crashing:

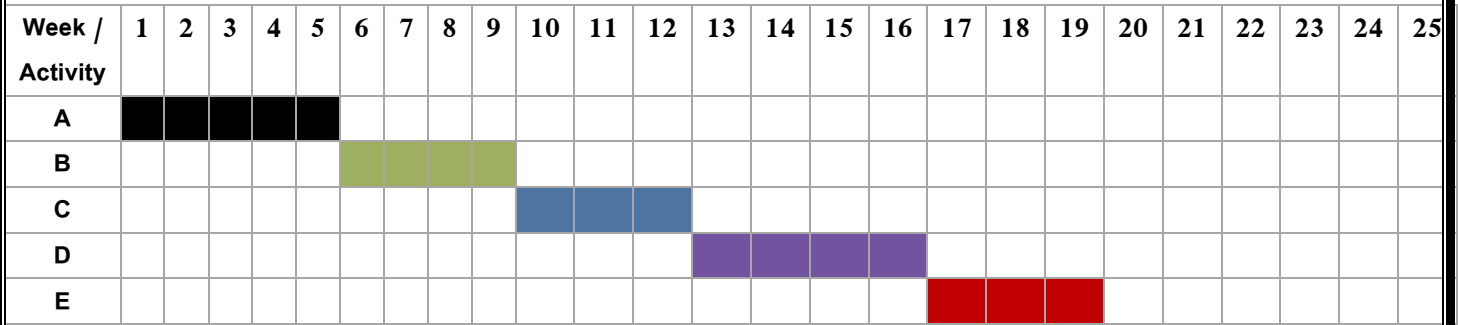


Figure 25: Crashing

5.2 Negotiations

Negotiation is a strategic discussion to resolve issues in a way that both parties find acceptable. In a negotiation, each side tries to convince the other to share their views. Through negotiations, the parties try to avoid disputes but agree to some form of compromise. (Kenton, 2021)

The gist is a defined plan for all the requirements of the project to be created Negotiated agreements that avoid internal and external conflicts of interest. Also, we will successfully guide the matching principle of both parties. Internal negotiations are part of introducing all departmental requirements and discussing values Use our project and do it by solving all the problems. Starting with external negation, requires the participation of other entities and our relationship Values and project strategies give us the space to discuss and match potential needs Benefit to a perfect negation.

5.2.1 General rules for the Negotiation process.

Model presented below identifies the five stages of each negotiation in a simplified framework that will help you analyze, assimilate, and apply Best Negotiation Practices. (Watershed, 2018).



Figure 26: Five Stages of Negotiation

Five Stages of a Negotiation:

Stage 1: Prepare

Which is includes:

- Identify potential value.
- Begin to understand interests.
- Develop Fact base.

Stage 2: Information Exchange and Validation

Which is includes:

- Discovering and creating value.
- Assess interests.
- Build rapport and trust.

Stage 3: Bargain

Which is includes:

- Create and distribute value.
- Address interests.
- Make and manage concessions.

Stage 4: Conclude

Which is includes:

- Capture value.
- Confirm interests have been met.

- Thank them.

Stage 5: Execute

Which is includes:

- Expand value.
- Addressing changing interests.
- Strengthen relationships.

5.2.2 Negotiation Plans:

In many projects, the balance of power has dramatically shifted from buyers to suppliers. Whatever the reason, the project manager needs to negotiate the situation strategically. Neither experience, bargaining skills, nor persuasion on the part of the negotiator can compensate for the absence of preparation. The following are two examples of negotiation plans:

Negotiation plan 1 for Sellers

This plan consists of strategies that help determine how the seller will manage negotiation strategies with the preferred responder prior to finalizing the contract award. The negotiation team should concentrate on the following points:

- Recognize the requirements of the other party.
- Identify the buyers: User, Technical, Strategic, Coach
- Determine the other party positions and interests
- Identify BATNA (Best Alternative to a Negotiated Agreement) and the other party BATNA
- Determine each side's sources of power and leverage: time, information, standards, expert and title power.
- Determine the best, most likely, and least likely outcomes.

- Find out what our killer arguments are.
- Determine our most important discriminators.
- Find out what our ghosting discriminators are.
- Determine the return on investment that we will provide to the prospect.
- Identify team members: leaders, experts, spokesperson, numbers person, experts, and observer.
- Determine the roles of third-parties.
- Develop opening statement for relationship building
- Develop questioning strategies
- Develop an opening proposal
- Develop pricing strategies
- Develop concession strategies
- Develop bargaining strategies
- Ready for unethical negotiating techniques

Negotiation plan 2 for Procurement

Planning for negotiation is critical to achieving a successful result in the construction of Lab procurement stage (CIPS, 2020). Areas that the negotiation team needs to concentrate on include:

- Deciding on the nature of the contractor's relationship with the supplier and how to establish that.
- Identifying all the points to be negotiated.
- Prioritizing the contractor's needs and wants and the supplier's needs and wants.
- Identifying alternative positions and the point at which the contractor will exit negotiations.
- Deciding on the approach to achieving the contractor's most desired outcome.
- Anticipating the supplier's moves and how to counter them.
- Working with the supplier to establish a realistic contract delivery or implementation plan.

- Addressing transitional arrangements from the current supply arrangement.
- Establishing what sustainability will look like.
- Identifying what best public value will look like.
- A negotiation plan should be completed and approved before initiating negotiations with the recommended supplier. The following approvals are needed:
 - Procurement manager confirms that the plan meets the requirements.
 - Project sponsor gives authority to proceed to negotiations with a contract view.

6.1 Project Design

In this project, Design is a process of creating a description of a new facility, usually represented by detailed plans and specifications. The design process needs to be planned and controlled. Problems may occur where there is missing information, poorly communicated information, inconsistencies between documentation, poor resource allocation, poor decision making due to inadequate information, and so on.

A PCR Test Lab building to be constructed and the users of the new building will be for internal and external customers.

PCR Test Lab Design

Health Care provided to public in their early diagnose is critical for building the foundation for health character formation. In the environment carefully designed for PCR Test Lab, public should be encouraged to have various experiences while spending time mostly. Providing healthcare at PCR Test Lab should be comprehensive and yet be tailored to public individual needs. PCR Test Lab design is generally based on the following considerations:

- Designing environments for diverse life experiences.

- Improving facilities such that they strengthen the health care benefits.
- Aiming for smooth transition from PCR Test Lab.
- Making spaces for patient experience improvement.
- Considering promotion of special needs for patients.
- Considering sustainability in terms of the environment.
- Considering safety.

The PCR Test Lab is organized as follows:

Laboratory spaces, social spaces, administrative unit, service areas and outside activities. The multipurpose space are located on the one side, on the other side there are administration units, services and corridor.

Some general requirements for the design are the following elements:

- Finalization of program for the new PCR Test Lab, based on the municipal needs.
- Surveys and investigations of the site of the building to be constructed.
- Conceptual design of the new building and of its surrounding.
- Detailed design of the new building and of its surrounding and making of technical specifications, the Bill of Quantities (BOQ) and drawings in accordance with the relevant international construction and safety standards.
- Assistance to the construction manager during the works execution phase.
- To identify the Triple constraint of the project.

6.1.1 The Triple Constraint of the Project:

A project manager needs to be highly aware of all the constraints affecting their project and how to find the optimum balance and keeping those constraints in mind and also communicate the design department so the design activities which might affect the project constraints can be avoided by the alternative solution as a triple constraint is about balancing each constraint to reach a successful conclusion. As the project

progresses, the project manager may find that any changes in design at execution phase may have an impact on any of the constraints (Westland, 2022).

For example, if you are up against a hard deadline, de-scoping project tasks can cut time and costs as well. When you de-scope project tasks that are less critical in the short term, you can meet your next project milestone while also cutting costs and time. Conversely, the triple constraints say that a negative impact on one of these constraints yields a domino effect. For instance, if you underestimate the time spent on a project, the iron triangle (triple constraint) implies that this will also hurt your project's cost, scope, or both (LaPrad, 2018) (Maffeo, 2018).

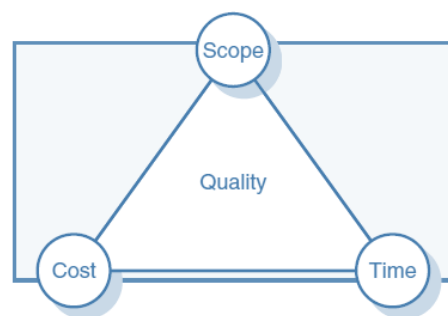


Figure 27: Triple constraint Triangle

Current Project variables which need to be monitored are

	Time	Performance	Cost
Constraint	X		
Enhance		X	
Accept			X

Table 12: Project Priority Matrix

Time	• Delivery Time: 93 Days • Due date: 15TH JUNE 2022
Scope	Construction of PCR Test Lab
Budget	1,100,000 SAR

Table 13 Project constraint

Time:

The Time constraint talks about how to manage a project in a way that it meets the set deadlines and allocates all the resources effectively. The time constraint limits a project in two ways – deadlines and resources. First, a project has a set timeline and a date when it has to be completed. You will rarely encounter a project that can last indefinitely and thus you have to keep to a certain schedule. Secondly, each project has a certain amount of people and those people have a limited amount of available work hours. Once again, the project is constrained to this amount and has to be completed within it. Each constraint forms the vertices, with quality as the central theme.

Scope:

The Scope constraint is all about the goals and deliverables of the project. It defines priorities and the most important parts of the project, specifying what has to be done. If there are any changes to the scope it will invariably cause changes to the timeline and cost, or at least, it should maintain a fair balance for the client and the project team.

The scope is generally outlined in a document, which lays out all of the goals and requirements of the project. This ensures that everyone involved in the project knows what's expected of them and can execute it. It helps the client to see what you will and won't complete for them within the project and makes sure that the team is aware of everything necessary to execute the project properly for the client.

Cost:

The cost constraint refers to handling the project to stay within a given budget. This includes not only the materials but labor, vendors, and all other costs of a project.

A project's budget includes both fixed and variable costs, including materials, permits, labor, and the financial impact of team members working on the project.

A few of the ways to estimate the cost of a project include:

- **Historical data:** Looking at what similar projects cost in the recent past.
- **Resources:** Estimating the rate of cost for goods and labor.
- **Parametric:** Comparing historical data with updated, relevant variables.
- **Vendor bid:** Averaging the total charge of several solid vendor bids.

6.1.2 A List of the Project Success Factors:

Time	i. Change in Specification. ii. Lack of project financing. iii. Scope change. iv. Planning and building regulations restrictions. v. Lack of Human recourses.
Scope	i. Communication Barrier ii. Scope creep iii. Political Interference. iv. Poor Planning. v. Change in Design.
Budget	i. Change in scope. ii. Delay in deadline. iii. Price fluctuation. iv. Risks v. Poor monitoring & controlling, vi. Force Majuro.

Table 14: Triple Constrain Table

Project manager can measure both project success and estimating accuracy with the help of triple constraint. According to PRINCE2's definition, critical success factors (CSFs) are "elements in a project that are critical to the project achieving its mission or goal."

The success criteria for a construction project are not only evaluate the cost, time and quality as a success factor but also including the successful of project management, organizational success and the customer satisfaction. Another perspective was stated were the importance of organizational' s planning effort, project manger's commitment and safety precaution in order to complete the construction project complete by meeting cost, meeting on time, follow the schedule accurately and meeting the quality needed to ensure the project success (Pandey, 2022).

Below is the list of critical factors that can make this construction project successful:

1. **Iron Triangle:** Basically, the Triple Constraint states that the success of the project is impacted by its budget, deadlines, and features. As a manager of that project, you can trade between these three constraints.
 - Within Budgeted cost.
 - Within the allocated time period.
 - As per define scope.
2. **Goals & Objectives:** of Project are clearly defined. It can play an important role in the success of project. Commitment of PM & all project team towards the project goals & objectives. Make sure there is agreement with management, project sponsors, and other stakeholders on the purpose and goals of the project.
3. **Project Manager:** Experience and executive records of the project manager plays a critical role in the success of project. Ability of on-time decision making. Decisions drive projects. There is a decision to

proceed that makes a project a project. There are decisions regarding requirements, the choice of resources, design approach, and various other issues. Decision making is a critical success factor.

4. **Project Requirements and Scope:** Project requirement should be cleared & Scope would be clearly defined. The project scope is defined in the goal setting, and planning stages of a project. It would be nice if the scope never changed, but this is the real world! The project manager must always be on the alert for changes to the scope and effectively manage those changes.
5. **Project Strategic Planning:** Proper project management plan that will document all the necessary stuff related to the project. Create and share a project management plan that will document how the project will be managed. This should be agreed upon with the resources and management.
 - Document how changes will be handled, especially those that impact the scope, dates, budget, or resources.
 - Document how issues will be managed and escalated.
 - State how the schedule will be managed.
 - Include all methods of communications that will be used for the project.
6. **Monitoring and Controlling:** Monitoring and control keep projects on track. The right controls can play a major part in completing projects on time. The data gathered also lets project managers make informed decisions. They can take advantage of opportunities, make changes, and avoid crisis management issues. Put simply, monitoring and control ensures the seamless execution of tasks & success of project by improving productivity and efficiency. Quality data and reporting play a major role in monitoring & controlling.
7. **Management Commitment, Stakeholders:** As top management support is considered one of the critical success factors in project management, effective executive involvement can significantly improve project success. Top management support is significantly correlated with project success. The more

you engage and involve stakeholders, the more you will reduce and uncover risks on your project. Uncovering risks and then discussing a plan to mitigate them before issues arise will dramatically increase the success of your project.

8. **Communication:** Is one of the key items recognized as leading to a successful project. Not only does the project team need to know why they are focusing on the project, who owns which task, with whom they should interact and collaborate in order to be successful, and to whom they should hand-off as the next critical path task, but they need to communicate with all related parties frequently. These should include the project sponsor, managers who need to support their efforts with resources and in communications etc. Effective consultation with all stockholders plays a critical role in the success of project.
9. **Risk:** Every project – big and small – needs risk management. Upfront risk planning and identification and ongoing risk monitoring, mitigation and avoidance should be practiced no matter what. The project manager and team who choose to ignore this critical practice are setting their project up for failure. For this reason, risk management also one of the key factors for the success of the project.
10. **Top Management Support:** Since the budget is not constraints in this project, we need the top management support to direct finance department to cooperate in funding the project and any other department to provide any kind of recourse.
11. **Minutes of Meeting:** It is usually underestimated, but in big project you would realize its importance. A project with different departments and stakeholders and big number of tasks would need a record for all agreements raised on meetings.

6.1.3 Work Breakdown Structure (WBS)

The work breakdown structure (WBS) is used to decompose all the work of the project. It begins at the project level and is successively broken down into finer levels of detail. The lowest level, a work package, represents a discrete deliverable that can be decomposed into activities to produce the deliverable (PMI, 2020).

The WBS should have a method of identifying the hierarchy, such as a numeric structure. The WBS can be shown as a hierarchical chart or as an outline.

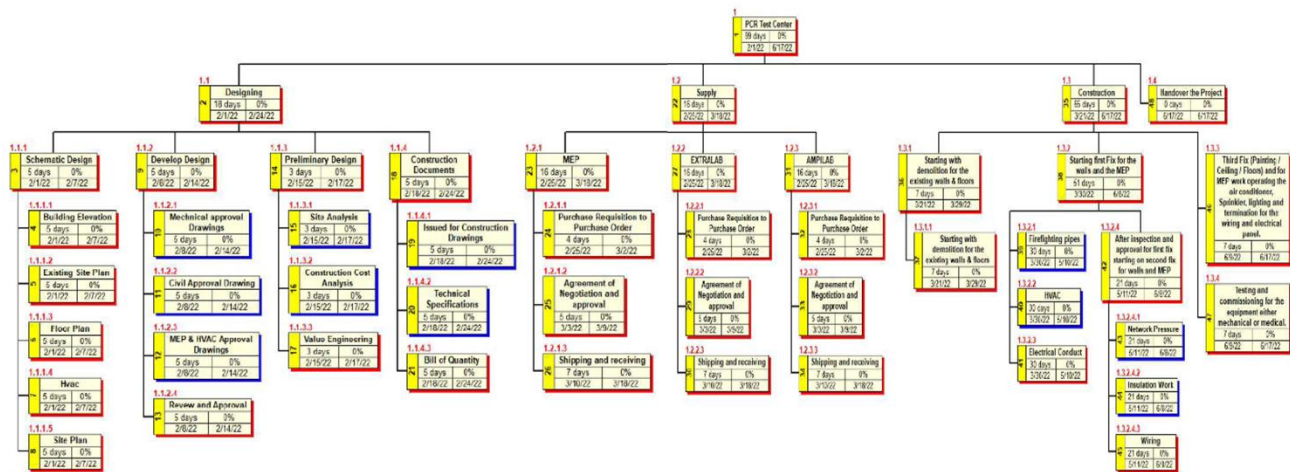


Figure 28 Project Work Breakdown Structure

6.2 Requirements and Objectives:

6.2.1 Identify Requirement Traceability Matrix:

A requirements traceability matrix is used to track the various attributes of requirements throughout the project life cycle. It uses information from the requirements documentation and traces how those requirements are addressed through other aspects of the project. The following form shows how requirements would be traced to project objectives, WBS deliverables, the metrics they will be measured to, and how they will be validated (Dionisio, 2017).

Requirement Traceability Matrix					
Project: PCR Lab Construction			Date Prepared:		
Requirement Information			Relationship Traceability		
ID	Requirement	Source	Priority	Category	Deliverable
1.1	Schematic Design				
1.1.1	Building elevation	Engineering Dept.	L1	Functional	A drafted view of the exterior of the building
1.1.2	Existing site plan	Engineering Dept.	L1	Functional	A map of the proposed area of construction
1.1.3	Floor plan	Engineering Dept.	L2	Functional	A drafted view of the building floor plan or layout
1.1.4	HVAC	Engineering Dept.	L2	Functional	Heating, ventilating, and air conditioning
1.1.5	Site plan	Engineering Dept.	L2	Functional	A drafted view of the location of the `proposed project
1.2	Develop Design				
1.2.1	Mechanical approval drawings	PM	L1	Non–Functional	Approved project work plan
1.2.2	Civil approval drawings	PM	L1	Non–Functional	
1.2.3	MEP & HVAC approval drawings	PM	L1	Non–Functional	
1.2.4	Review and approvals	PM	L2	Non–Functional	
1.3	Preliminary Design				
1.3.1	Site Analysis	Project Team	L1	Functional	Lab site selection
1.3.2	Construction Cost Analysis	Finance Dept.	L1	Functional	Construction budget
1.3.3	Value Engineering	Engineering Dept.	L2	Functional	Pre–design phase scrutinizes
1.4	Construction Documents				
1.4.1	Issued for construction drawings	Project Team	L1	Non–Functional	IFC Drawings

1.4.2	Technical specifications	Project Team	L2	Non-Functional	Technical specification. document
1.4.3	Bill of Material	Project Team	L2	Non-Functional	Material list for procurement
2.1	Extra lab				
2.1.1	Purchase requisition to purchase order	PM Procurement Dept.	L2	Functional	–
2.1.2	Agreement of negotiation and approval	PM Procurement Dept.	L2	Non-Functional	Select seller and agreement document
2.1.3	Shipping and receiving	Procurement Dept.	L2	Functional	Receive Molecular diagnostics instrument
2.2	Ampi lab				
2.2.1	Purchase requisition to purchase order	PM Procurement Dept.	L2	Functional	–
2.2.2	Agreement of negotiation and approval	PM Procurement Dept.	L2	Non-Functional	Select seller and agreement document
2.2.3	Shipping and receiving	Procurement Dept.	L2	Functional	Receive Molecular diagnostics instrument
3.1	Starting with demolition for the existing walls and floors	Project Team	L1	Functional	–
3.2	Starting first fix for the walls and the MEP				
3.2.1	Firefighting pipes	Project Team	L2	Functional	Firefighting pipes, HVAC, Electrical installed on site
3.2.2	HVAC	Project Team	L2	Functional	
3.2.3	Electrical conduct	Project Team	L2	Functional	
3.3	After inspection and approval for first fix starting	PM	L1	Non-Functional	

	on second fix for walls and MEP				
3.3.1	Network pressure	Engineering Dept.	L2	Functional	Network pressure, Wiring, installed on site
3.3.2	Insulation work	Engineering Dept.	L2	Functional	
3.3.3	Wiring	Engineering Dept.	L2	Functional	
3.4	Third fix (Painting/ Ceiling/ Floors) and for MEP work. Operating the air conditioner, sprinkler, lighting, and termination for the wiring and electrical panel.	Project Team	L2	Functional	Lab site completed
3.5	Testing and commissioning for the equipment either mechanical or medical	PM Engineering Dept.	L2	Non-Functional	
3.6	Handover the Project	PM	L1	Functional	Lab ready for operation

Table 1.5 Requirement Traceable Matrix

6.2.2 The Methods used in Requirement Collection:

1. Brainstorming: Also called as group thinking or group creativity. It involves exchanging ideas with project stakeholders and taking the views.

2. Interview: The key feature of this process is that it helps the project manager interview experienced project participants, sponsors, stakeholders, and other executives, as well as subject matter experts who can help identify and define project characteristics and roles. Desired product deliverables.
3. Study analogous system: It involves studying available systems related to Lab construction project.
4. Examining Reports: This would be a research based on internet or journals. These reports should be related to the project scope.
5. Questionnaires and Surveys: The project manager is asked to prepare a questionnaire and conduct surveys to collect stakeholders list of requirements.

6.2.3 The Hierarchical Structure of the Objective of the Project:

The methodology was developed as a means of clarifying project objectives, both for planning purposes and for post-project evaluation. The hierarchy of objectives serves a number of purposes; namely it can be used to:

1. Clarify the need or demand for the project.
2. Clarify the requirements for meeting the need.
3. Communicate the project objectives to everyone involved in the project.
4. Promote appropriate project design by encouraging feedback from the people who are involved in, or affected by, the project.
5. Enable the post-project evaluators to measure the project's success in attaining its objectives. The hierarchy provides guidance to the evaluators and helps direct their inquiry.
6. Demonstrate that the project has different levels of objectives, and clarify how the objectives relate to one another in the hierarchy.
7. Visibly link a project to the enterprise's business strategy.

Levels of Objectives:

The hierarchy of objectives is a tool that helps analyze and communicate a project's objectives. The hierarchy of objectives organizes the objectives of a project into different levels of a hierarchy or tree.

Different organizations use different names for the various levels and the types of objectives at each level.

Otherwise, there is a great deal of similarity in approach. Our approach organizes objectives into three broad levels: policy, strategic, and operational. In general, these levels correspond to the top, middle, and working levels of management in an organization.

They are grouped into three levels: policy, strategic, and operational.

Policy Objective: The overall policy objective is to increase industrial production. We then ask: How is this to be accomplished? That brings us to the next lower objective, the strategic objective.

Strategic Objective: the organization adapts a cost control strategy that affects the vital functions of operations.

Project Objective: The project objective in most cases is the same as the deliverable for the project. In this case, it is to build a PCR Center.

The next lower level of objective in the hierarchy, the input objective.

Input Objective: The input objectives relate primarily to the resources and conditions that are required to accomplish the project



Figure 29: A hierarchy of objectives.

This feature of the hierarchy of objectives is called the Why–How framework. The Why–How Framework is based on the Means–End Chain developed by March and Simon in 1958. When you ask why something is to be done you are asking about ends—what is the purpose or objective of the activity. When you ask how something is to be done, you are asking about the means—the strategy that will be used.



Figure 30: Why-How framework.

7.1 Project Scope

Project scope is the work required to output a project’s deliverable. Change happens, and project scope management includes the process to manage scope changes and make sure the project will still come in on time and within budget. The scope document also states the objectives and output of a certain project. It must include the key deliverables and how you propose to accomplish them with a set of milestones.

Additional information or modifications to the project scope and objectives should be included in the Project Summary Section of the Project Plan. Project managers, appointed at the time a project is chartered, will conduct a review and analysis of the project scope and objectives as part of the project plan development (PMBOK, 2017).

A. General Information: Basic information that identifies the **project**.

- Project Title: Construction of PCR Test Lab
- Project Working Title Design & construction of PCR Test Lab
- Project Sponsor: Dr. Hamid Suleiman Al Ahmadi Co
- Project Manager: Eng. Samir Asad
- Date/ Control Number The date the plan is finalized and the change or configuration item control

number assigned.

B. Project Scope

Deliverables

For this project the deliverables are.

- The Engineering reports
- Design drawings
- Project report
- Building of PCR Test Lab
- Design review report

C. Project Business Objectives

To provide high quality health care for people and a secure foundation for learning in an encouraging and nurturing environment, where there is an equality of opportunity and support for all and where staff and parents or careers work in close partnership.

7.1.1 Project Scope Statement

The Project Scope Statement provides the documented basis for making all project decisions and is used to direct the project effort and communicate the project scope to the project team and other project stakeholders. Projects that do not have a Project Scope Statement are plagued with scope creep issues. When a project team creates a Project Scope Statement early in the project lifecycle, they define the boundaries of the project (Burek, 2006).

According to the Project Management Institute, a strong project scope statement has several key characteristics i.e.

- Define the boundaries of the project.

- Define the business need and the expected outcome of the project.
- Identify constraints that limit a project team's option for developing a solution.
- List assumptions regarding decisions the project team's control.
- Identify business processes impacted by the project.
- Identify internal and external entities with which the project team will interface.

The Scope Statement for Constructing A PCR Test Lab			
Project Title	Establishing a new PCR Laboratory	Project Manger	Eng. Samir Asad
Project No	XXX-CXX	Project Sponsor	Dr. Hamid Suleiman Al Ahmadi Co
Purpose	The main purpose of the document is to list all the requirements for the PCR Test Lab that will provide a quality health care facility for all patients.		
Scope	Build a new PCR Test Lab that provide a quality health care facility with state-of-the-art facilities for up to 100 people. The PCR Test Lab includes two front offices, one people lounge,		
Deliverables	Complete building of PCR Test Lab		
Constraint	<u>Time:</u> Delivery Time: 93 DAYS Due date: 15 June 2022 <u>Scope:</u> Construction of PCR Test Lab <u>Budget:</u> 1,100,000 SAR		
Assumptions	Budget and schedule have already been determined in the PCR Test Lab Project Charter. PCR Test Lab will be located in Private Sector in the premises of Dr. Hamid Suleiman Al Ahmadi Hospital, Medina therefore, the sector parking area has been assessed to have adequate parking spaces for the people. Land for the PCR Test Lab is already owned by the project sponsor and not included in project costs.		
Exclusion	Operations Manual, Guidelines, or any component relating to how PCR Test Lab will operate on a daily basis is out of scope for this project.		

	Lab will not be equipped to handle and therefore will not accept patients with special needs. Transportation to and from PCR Test Lab is not provided. Designated smoking area anywhere on the property.
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Table 16 Project Scope Statement

7.1.2 Scope Creep

The definition of scope creep is when a project's scope changes, the project work starts to extend, or "creep", beyond what was originally agreed. With just about any project, change is inevitable, but it's the uncontrolled changes that delay projects and cause scope creep. Requested changes that are documented and implemented as part of the updated scope of a project are controlled (PMQ, 2019).

The problem comes with any unauthorized changes which can affect productivity, deliverables not being achieved, budgets being exceeded. The completed project can potentially look very different from what was originally envisioned. There are a number of reasons why scope creep occurs that are fairly common with most projects, including (PMQ, 2019):

- **Unclear Project Scope:** Vague project goals and requirements can steer project team in different directions. Each team member will assume the scope from their own perspective and start working in isolation. Hence, it is crucial to define the project scope from the beginning clearly. The best way is to document the project scope. Be clear with the minute aspects of project requirements.
- **Not Involving Client throughout the Project:** There is a need to communicate with client at different stages of project completion. In doing so, Project manager can understand their pulse, their change in opinion, and so on. Also, they can anticipate changes at their end. On the contrary, if a project is directly delivered in one go, it may even end up redoing the entire project by spending more resources.

- **Ineffective Team Communication:** Team communication decides the quality of any project outcome. With effective communication, Project Manager can efficiently collaborate on the tasks. When communication channels break down, each team member completes an assignment with incomplete information and support, leading to project scope creep.
- **Project Complexity:** A complex project involves numerous stakeholders and takes a lot of time for completion. With more inputs, opinions, negotiations, etc., it becomes difficult to arrive at a proper consensus. Hence, a scope creep can occur during different instances like scope creep in software development, scope creep in agile projects, scope creep during final vetting phase and so on.
- **Lack of Pro-activeness:** The project manager and the team need to be proactive from the beginning of the project planning. Be bold and ask more and more questions. If the client requirement is vague and uncertain, ask them to simplify it. If not, the requirements tend to pile up and catch you unaware.
- **Direct Contact between Client and Team Members:** Sometimes, when a new requirement crops up at the last minute, the team members directly coordinate with the client without keeping the project manager in the loop. This bypass of authority leads to chaos and non-clarity of exact requirements. In fact, managers are trained to allocate the tasks in the best way possible at the nth moment.
- **Absence of Client Agreement:** Before start working on a project, it is necessary to identify the exact client requirements. In many cases, the failure to put forth multiple questions to understand the real requirements lead to project scope creep. Make sure that client agreement seals it in the form of a written to avoid future confusions.

- **Differing Stakeholder Opinions:** There are numerous stakeholders involved in project completion: clients, different teams, customers, etc. Each stakeholder has its own requirements and expectations as to how a project needs to be delivered. Disagreements crop up on what to prioritize, what tools to use when to make the project live, and so on. These crucial stakeholder factors finally add up to the creation of project scope creep.
- **Ineffective Leadership:** Effective leadership involves deciding with far sight and conviction. The art of saying “No” also forms a significant part of leadership. In many cases, project managers are reluctant to say “No” to a last-minute project requirement, even though it may seem impossible to deliver. This leads to last-minute hiccups in the form of project scope creep.

7.1.3 Product Analysis Management

Product analysis can be used to define products and services. It includes asking questions about a product or service and forming answers to describe the use, characteristics, and other relevant aspects of what is going to be delivered. Each application area has one or more generally accepted methods for translating high-level product or service descriptions into meaningful deliverables. Requirements are captured at a high level and decomposed to the level of detail needed to design the final product (PMBOK, 2017). Examples of product analysis techniques include but are not limited to:

- **Product Breakdown Structure (PBS):** is a tool for analyzing, documenting and communicating the outcomes of a project, and forms part of the product-based planning technique. The PBS provides “an exhaustive hierarchical tree structure of deliverables (physical, functional, or conceptual) that make up the project, arranged in a whole part relationship”. This diagrammatic representation of project outputs provides a clear and unambiguous statement of what the project is to deliver.

- **Requirements Analysis:** Closely tied to requirements gathering and elicitation is Requirements Analysis. The purpose of Requirements Analysis is to discover unknown requirements, i.e., to turn unknown requirements into known requirements. Users' needs that were not expressed during requirements gathering and elicitation can be uncovered through Requirements Analysis. It is beneficial for the project if unknown or missed requirements are discovered as early as possible in the project life cycle. This will minimize the cost impact of requirement changes.
- **Systems Analysis:** System analysis is the process of studying a procedure or business to identify its goals and purposes and create systems and procedures that will achieve them in an efficient way". Another view sees system analysis as a problem-solving technique that breaks down a system into its component pieces for studying how well those component parts work and interact to accomplish their purpose. System analysis relates closely to requirements analysis or to operations research. It is also "an explicit formal inquiry carried out to help a decision maker identify a better course of action and make a better decision than he might otherwise have made.
- **Value Analysis & Value Engineering:** also known as Value Analysis as function analysis of a product or job in order to increase the value. He argued further that value projects involve three basic units: the value, the function and the life cycle cost. Thus:

$$\text{Value (V)} = \text{Function (F)} / \text{Cost (C)}.$$

Some authors argue that Value Engineering is a process that can be applied all through the product development phases or project lifecycle (Yan, 2012).

According to Kelly et al. (2004), VM is the process in which function benefits of a project are made explicit and appraised consistent with a value system determined by the Client. The Client is required to explicitly and implicitly establish a value system for the project.

7.2 Time:

A project schedule is a timetable that shows the start and end date of all project tasks, how the tasks relate to each other and usually which team members or other resources are responsible for delivery. It is a dynamic document that is created during initial planning stage. The approved project schedule acts as a baseline to work to, but it is maintained and updated throughout the project as things change.

7.2.1 The Functions List or the Activities Included in Each Work Package in WBS:

To develop that common understanding of the project work, another key project deliverable should be created: the Work Breakdown Structure (WBS). The WBS is defined in the PMBOK® Guide as a deliverable-oriented hierarchical decomposition of the work to be executed by the project team to accomplish the project objectives and create the required deliverables. It organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of the project work (PMBOK, 2017). A WBS contain at least three levels, but can contain more depending on the complexity and size of a project.

- First level: Project title of final deliverable
- Second level: Major deliverables or controls account
- Third level: Work packages that are deliverable to the customer
- Fourth level: Activities assigned to team members to complete work packages

The Work Package is the lowest level of detail within the WBS. There are normally several work packages required in order to fulfill a single WBS element. Work packages must be structured so that all work can be allocated to complete the WBS element. The work package description is key to understanding the work to be accomplished within the quadruple constraints of Scope, Quality, Time,

and Cost. Normally earned value data is captured at this level of detail to ensure that the proper health of the project is being tracked (PMI, 2020).

Activity: Activities or tasks are a further breakdown of the work packages. An activity typically comprises of multiple tasks and upon completion, the entire activity is completed. Many activities can be combined leading to the summary activity. The duration of an activity can be figured out considering the effort it takes to complete the designated tasks. The beginning and end of activity are also determined by limitations commonly known as dependencies. These dependencies between activities and other planning factors are visualized and estimated in a Gantt diagram.

In this project the team used MS project to build the project schedule. The table below shows the activities for Work Packages of the project with duration and the relationships between the activities.

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
..			PCR Test Center	99 days	Tue 2/1/22	Fri 6/17/22	
1.			Designing	18 days	Tue 2/1/22	Thu 2/24/22	
1.1			Schematic Design	5 days	Tue 2/1/22	Mon 2/7/22	
1.1.1			Building Elevation	5 days	Tue 2/1/22	Mon 2/7/22	
1.1.2			Existing Site Plan	5 days	Tue 2/1/22	Mon 2/7/22	
1.1.3			Floor Plan	5 days	Tue 2/1/22	Mon 2/7/22	
1.1.4			Hvac	5 days	Tue 2/1/22	Mon 2/7/22	
1.1.5			Site Plan	5 days	Tue 2/1/22	Mon 2/7/22	
1.2			Develop Design	5 days	Tue 2/8/22	Mon 2/14/22	4,5,6,7,8
1.2.1			Mechanical approval Drawings	5 days	Tue 2/8/22	Mon 2/14/22	8
1.2.2			Civil Approval Drawing	5 days	Tue 2/8/22	Mon 2/14/22	8
1.2.3			MEP & HVAC Approval Drawings	5 days	Tue 2/8/22	Mon 2/14/22	8
1.2.4			Review and Approval	5 days	Tue 2/8/22	Mon 2/14/22	8
1.3			Preliminary Design	3 days	Tue 2/15/22	Thu 2/17/22	13
1.3.1			Site Analysis	3 days	Tue 2/15/22	Thu 2/17/22	13
1.3.2			Construction Cost Analysis	3 days	Tue 2/15/22	Thu 2/17/22	13
1.3.3			Value Engineering	3 days	Tue 2/15/22	Thu 2/17/22	13
1.4			Construction Documents	5 days	Fri 2/18/22	Thu 2/24/22	17
1.4.1			Issued for Construction Drawings	5 days	Fri 2/18/22	Thu 2/24/22	17
1.4.2			Technical Specifications	5 days	Fri 2/18/22	Thu 2/24/22	17
1.4.3			Bill of Quantity	5 days	Fri 2/18/22	Thu 2/24/22	17
2.			Supply	16 days	Fri 2/25/22	Fri 3/18/22	21

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
2.1			MEP	16 days	Fri 2/25/22	Fri 3/18/22	21
2.1.1			Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21
2.1.2			Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	24
2.1.3			Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	25
2.2			EXTRALAB	16 days	Fri 2/25/22	Fri 3/18/22	21
2.2.1			Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21
2.2.2			Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	28
2.2.3			Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	29
2.3			AMPILAB	16 days	Fri 2/25/22	Fri 3/18/22	21
2.3.1			Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21
2.3.2			Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	32
2.3.3			Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	33
3.			Construction	65 days	Mon 3/21/22	Fri 6/17/22	34,26,30
3.1			Starting with demolition for the existing walls & floors	7 days	Mon 3/21/22	Tue 3/29/22	34,26,30
.			Starting with demolition for the existing walls & floors	7 days	Mon 3/21/22	Tue 3/29/22	34

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
3.2			Starting first Fix for the walls and the MEP	51 days	Wed 3/30/22	Wed 6/8/22	36
3.2.1			Firefighting pipes	30 days	Wed 3/30/22	Tue 5/10/22	36
3.2.2			HVAC	30 days	Wed 3/30/22	Tue 5/10/22	36
3.2.3			Electrical Conduct	30 days	Wed 3/30/22	Tue 5/10/22	36
3.3			After inspection and approval for first fix starting on second fix for walls and MEP	21 days	Wed 5/11/22	Wed 6/8/22	41
3.3.1			Network Pressure	21 days	Wed 5/11/22	Wed 6/8/22	41
3.3.2			Insulation Work	21 days	Wed 5/11/22	Wed 6/8/22	41
3.3.3			Wiring	21 days	Wed 5/11/22	Wed 6/8/22	41
3.4			Third Fix (Painting / Ceiling / Floors) and for MEP work operating the air conditioner, Sprinkler, lighting and termination for the wiring and electrical panel.	7 days	Thu 6/9/22	Fri 6/17/22	45
3.5			Testing and commissioning for the equipment either mechanical or medical.	7 days	Thu 6/9/22	Fri 6/17/22	45
3.6			Handover the Project	0 days	Fri 6/17/22	Fri 6/17/22	47

Figure 31 Activity list of PCR Test Lab construction project

7.2.2 The Relationships between the Activities:

The precedence diagramming method (PDM) is a technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed. PDM includes four types of dependencies or logical relationships. A predecessor activity is an activity that logically comes before a dependent activity in a schedule. A successor activity is a dependent activity that logically comes after another activity in a schedule (PMBOK, 2017).

In this project we use different technique for constructing a schedule model:

The Finish-to-Start (FS) logic type simply states that the succeeding activity cannot begin until the preceding activity has completed. An example of the FS constraint is that the Purchase Requisition to Purchase Order must be finished before the Shipping and receiving Supply.

MEP	16 days	Fri 2/25/22	Fri 3/18/22	21
Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21
Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	24
Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	25

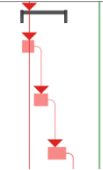


Figure 32 Finish to Start Activity

The Finish-to-Finish (FF) logic type is used to identify that a successor activity cannot finish until the predecessor activity is finish. This is normally used when both activities can be performed for the most part in parallel; however, some piece of work must be accomplished before the other piece can be accomplished.

Starting first Fix for the walls and the MEP	30d	03/30/22	05/10/22	36	
Firefighting pipes	30d	03/30/22	05/10/22	36	Project Team
HVAC	30d	03/30/22	05/10/22	38SS, 38FF	Project Team
Electrical conduct	30d	03/30/22	05/10/22	38SS, 39FF	Project Team

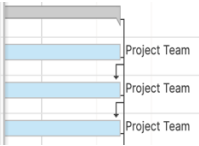


Figure 33 Finish to Finish Activity

The Start-to-Start (SS) logic type is used to signify that for a succeeding activity to begin, a preceding activity must first begin. This is normally accomplished when both activities can be performed for the most part in parallel; however, some work must begin before work can begin on the other activity. An example of the SS all activities in Develop Design milestone will start parallel in same date.

Develop Design	5 days	Tue 2/8/22	Mon 2/14/22 4,5,6,7,8	
Mechanical approval Drawings	5 days	Tue 2/8/22	Mon 2/14/22 8	
Civil Approval Drawing	5 days	Tue 2/8/22	Mon 2/14/22 8	
MEP & HVAC Approval Drawings	5 days	Tue 2/8/22	Mon 2/14/22 8	
Review and Approval	5 days	Tue 2/8/22	Mon 2/14/22 8	

Figure 34 Start to Start Activity

Start-to-Finish (SF) logical relationship in which a successor activity cannot finish until a predecessor activity has started. For example, a new accounts payable system (successor) must start before the old accounts payable system can be shut down (predecessor). The SF relationship is very rarely used.

7.2.3 The Logical Diagram of the Project Activities, and the Critical Path:

The critical path is defined as “Longest path through the project”, which means that there may or may not be slack in the schedule, but that the schedule's longest path to completion is through the critical path. With this in mind we must analyze the schedule to ensure that our proposed critical path actually makes sense to us from a programmatic view. Does it line up with the thinking of our SME’s that this is really the “longest pole in the tent?” There may be tuning to the resources required, the durations, or even the logic, as we go through the analysis of the critical path. There may even be places where constraints may be required in order to ensure that the critical path is planned correctly (Jones, 2009).

One thing to remember is that most of the tools use zero (0) as the definition of the critical path for slack. This is adjustable and, in many cases, should be adjusted to ensure the critical path is meaningful. Of course, changing this value may provide for a multimodal (more than one) critical

path. There is nothing wrong with this, just more to manage, and this normally provides a strong point of review and management of the plan.

In our project the team used Microsoft project to display a network diagram of project schedule and to understand the relationships between tasks. The critical path for our project is displayed in RED Stacked Bar in Project Schedule Figure 33.

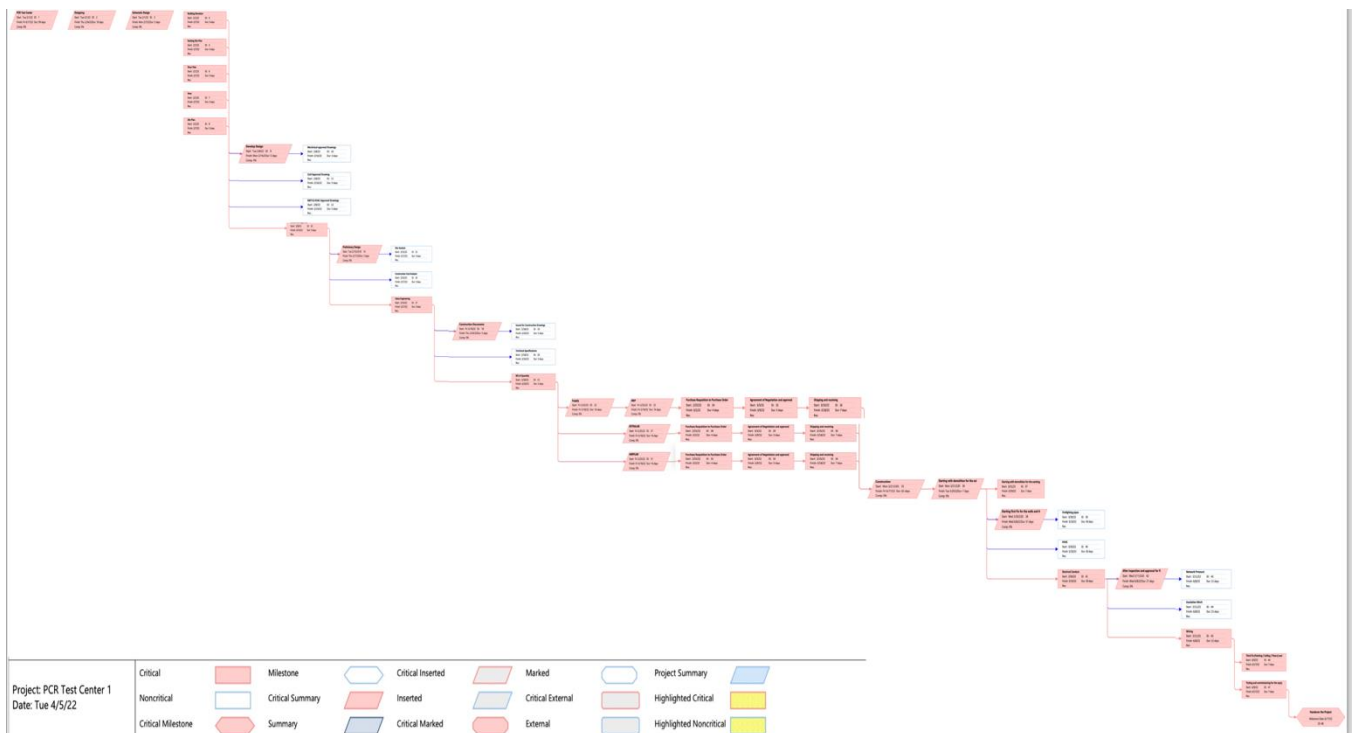


Figure 35: The Network Diagram for PCR Lab Project

7.2.4 Gantt Chart and Milestones Model

Bar charts. Also known as Gantt charts, bar charts represent schedule information where activities are listed on the vertical axis, dates are shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates. Gantt charts are relatively easy to read and are commonly used. Depending on the audience, float can be depicted or not. For control and management communications, the broader, more comprehensive summary activity is used between milestones or across multiple interdependent work packages and is displayed in bar

chart reports. On large projects it is necessary to draw the bar chart in a summary form (PMBOK, 2017). Here is the clear explanation about the Gantt chart:

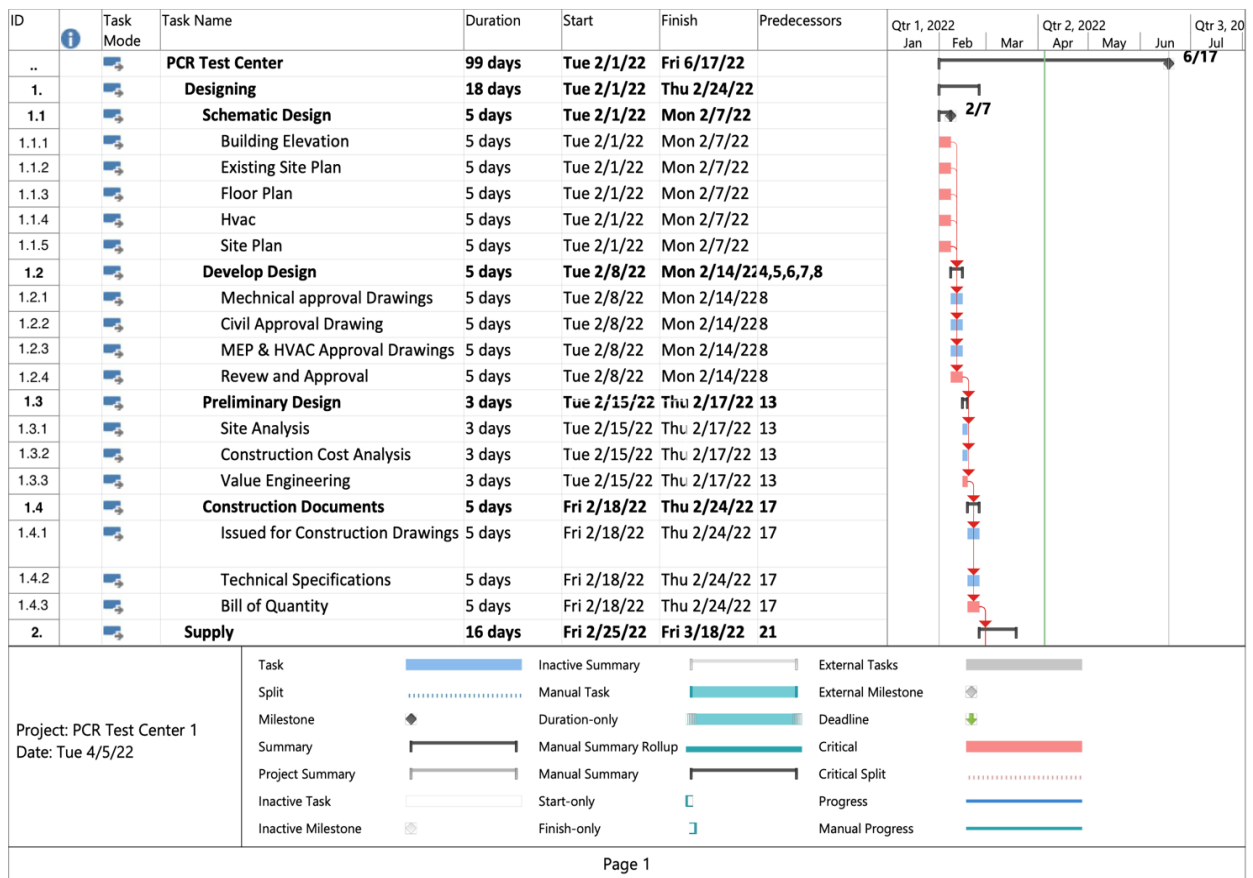
- A Gantt chart is the Visual representation of the Project Schedules. Also, Project activities are shown in the Stacked Bar Chart to represent Completion Tasks, Tasks in Progress and Tasks Pending. And each stack in the chart is highlighted with a different color to differentiate % of tasks to represent the status.
- Advanced Gantt Charts will have scroll bars to scroll the items in Charts. And scrollbars helps the user to navigate and display required items on Chart.
- And we can also show the additional metrics. For example, Project and Milestone separators on the Gantt Charts. And we can also show the overall aggregates by Milestones, Phases and Projects.
- Similarly, we can add dependencies and predecessors in the Gantt Charts to relate with other tasks. And we can also group all sub task under a main task. And this grouping helps to expand and collapse all sub tasks under a main task.

In this project, we used the most accurate scheduling model auto-scheduling of tasks in Microsoft Project. The milestones are shown as a grey diamond “◊”, the blue bar “

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Milestones	Description	Duration
1. Designing	The design milestone includes all activities related to laboratory design as well as approvals for construction	18 days
2. Supply	This milestone includes the requisition for the supply of laboratory equipment and contracts for the supply	16 days
3. Construction	This milestone includes building the laboratory from walls, floors, electrical wiring and fire pipes, as well as handing over the laboratory to the owner to operate the lab.	65 days

Table 17: Milestones Model



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Qtr 1, 2022	Qtr 2, 2022	Qtr 3, 2022
Jan	Feb	Mar	Apr	May	Jun	Jul			
2.1		MEP	16 days	Fri 2/25/22	Fri 3/18/22	21			
2.1.1		Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21			
2.1.2		Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	24			
2.1.3		Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	25			
2.2		EXTRALAB	16 days	Fri 2/25/22	Fri 3/18/22	21			
2.2.1		Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21			
2.2.2		Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	28			
2.2.3		Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	29			
2.3		AMPILAB	16 days	Fri 2/25/22	Fri 3/18/22	21			
2.3.1		Purchase Requisition to Purchase Order	4 days	Fri 2/25/22	Wed 3/2/22	21			
2.3.2		Agreement of Negotiation and approval	5 days	Thu 3/3/22	Wed 3/9/22	32			
2.3.3		Shipping and receiving	7 days	Thu 3/10/22	Fri 3/18/22	33			
3.		Construction	65 days	Mon 3/21/22	Fri 6/17/22	34,26,30			
3.1		Starting with demolition for the existing walls & floors	7 days	Mon 3/21/22	Tue 3/29/22	34,26,30			
.		Starting with demolition for the existing walls & floors	7 days	Mon 3/21/22	Tue 3/29/22	34			

Project: PCR Test Center 1 Date: Tue 4/5/22	Task	Inactive Summary	External Tasks
	Split	Manual Task	External Milestone
	Milestone	Duration-only	Deadline
	Summary	Manual Summary Rollup	Critical
	Project Summary	Manual Summary	Critical Split
	Inactive Task	Start-only	Progress
	Inactive Milestone	Finish-only	Manual Progress

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ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Qtr 1, 2022	Qtr 2, 2022	Qtr 3, 2022
Jan	Feb	Mar	Apr	May	Jun	Jul			
3.2		Starting first Fix for the walls and the MEP	51 days	Wed 3/30/22	Wed 6/8/22	36			
3.2.1		Firefighting pipes	30 days	Wed 3/30/22	Tue 5/10/22	36			
3.2.2		HVAC	30 days	Wed 3/30/22	Tue 5/10/22	36			
3.2.3		Electrical Conduct	30 days	Wed 3/30/22	Tue 5/10/22	36			
3.3		After inspection and approval for first fix starting on second fix for walls and MEP	21 days	Wed 5/11/22	Wed 6/8/22	41			
3.3.1		Network Pressure	21 days	Wed 5/11/22	Wed 6/8/22	41			
3.3.2		Insulation Work	21 days	Wed 5/11/22	Wed 6/8/22	41			
3.3.3		Wiring	21 days	Wed 5/11/22	Wed 6/8/22	41			
3.4		Third Fix (Painting / Ceiling / Floors) and for MEP work operating the air conditioner, Sprinkler, lighting and termination for the wiring and electrical panel.	7 days	Thu 6/9/22	Fri 6/17/22	45			
3.5		Testing and commissioning for the equipment either mechanical or medical.	7 days	Thu 6/9/22	Fri 6/17/22	45			
3.6		Handover the Project	0 days	Fri 6/17/22	Fri 6/17/22	47			

Project: PCR Test Center 1 Date: Tue 4/5/22	Task	Inactive Summary	External Tasks
	Split	Manual Task	External Milestone
	Milestone	Duration-only	Deadline
	Summary	Manual Summary Rollup	Critical
	Project Summary	Manual Summary	Critical Split
	Inactive Task	Start-only	Progress
	Inactive Milestone	Finish-only	Manual Progress

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Figure 36 Project Schedule

7.3 Quality:

Quality Management (QM) is a key element of Project Management. It is a simple concept. It involves carrying out a project through its four phases (concept, development, execution, and finish) with zero deviations from the project specifications. The environment necessary to support this effort must focus on quality policies, plans, procedures, programs, and specifications. This report identifies the key components that should be used to manage quality throughout the life of a project (Dixon, 1987).

The Quality Management Function is the process of ensuring that all aspects of a project and its results fully meet the needs and expectations of the project's client, participants and shareholders both internal (relating to the project's system of development), and external (relating to the project's performance or service) (Dixon, 1987). The primary components of the quality management function are:

- **Overall Quality Philosophy:** The involvement of all project participants in ensuring that project goals, requirements and performance standards are in compliance with the expectations of both the client and the project team.
- **Quality Assurance:** The managerial processes that determine the organization, design, objectives and resources, and that provide the project team, client and shareholders with performance standards and feedback on the project's performance.
- **Quality Control:** The technical processes that examine, analyze and report the project's progress and conformance with performance requirements

7.3.1 Deming Model for Quality

The Deming cycle is a continuous quality improvement model which consists of a logical sequence of four key stages: Plan, Do, Study, and Act. The model is divided into four phases that form a

circular, repetitive process. This methodology, originally called the Shewhart cycle, was developed by Walter A. Shewhart. It was renamed the Deming cycle by the Japanese in 1950. W. Edwards Deming suggested that this procedure should be followed for the improvement of any stage of production and as a procedure for finding a special cause of variation indicated by statistical signals (Henshall, 2020).

Plan: One of the most important projects within any business is to identify key business processes that will produce a desired outcome. Having an understanding of key business processes required to run the business and increase performance sets the foundation for process improvement. Once the foundation is set and key processes are in place, it should be easy to understand and identify problems within a process and create a suitable process plan to deal with it.

Do: Key business processes require constant evaluation in order to eliminate deficiencies and maximize performance. It is necessary for business organizations to understand the problem and analyze the root cause in order to develop a process plan of action to resolve systemic issues and improve the process. Testing is part of the “Do” phase in order to find effective solutions to process issue.

Check: The effectiveness of key processes depends on the effectiveness of the process plans put in place to improve. Without following-up on the effectiveness of corrective actions and results, it will be nearly impossible to determine process capabilities and improvements. Measuring, monitoring, and evaluating process results will help decision makers establish the best possible solution for improvement.

Act: Adjust the process by incorporating corrective actions. This step allows business organizations to share best practice, share lessons learned, and re-deploy new processes with the workforce.



Figure 37 Deming Model

7.3.2 The SIPOC Model and Ishikawa for One of the Issues of the Project Outputs:

The acronym SIPOC stands for Suppliers, Inputs, Process, Outputs and Customer. Using information from these five areas creates a process map that gives a high-level overview of a Six Sigma project. It is a simple, yet effective tool to align the project team and all stakeholders as to the core process within the scope of the project (Bridges, 2022).

- The general approach to the SIPOC process identification includes the following steps:
- Start with a simple definition of the in-scope process
- Identify key steps of the process (expand these at the bottom of the SIPOC diagram)
- Have the team identify the major inputs and outputs of the process
- Have the team identify key suppliers of the inputs, and customer for each output

SIPOC is actually an acronym with letters that indicate each process component being evaluated:

Supplier: The supplier is the person or entity that provides resources needed to create value for the customer. They could be the supplier of raw materials, manufactured items, or information. These suppliers could be vendors, employees, or manufacturing facilities.

Input: This is what's being provided by the supplier and will help create the value or solve the problem for the customer. It may be materials or information or both?

Process: The series of steps taken to convert the input to an output that gives the product or service.

At this point it is staying at very high-level. Full process flow diagram is not drawing out. Instead, simply want high-level steps are involved in the discussion.

Output: The resource or service produced by the process. It could also include any by-products that are not used by anyone. For example, if a process produces waste products that must be disposed of, consider that also.

Customer: This is the receiver of the product or service. This could be a customer internal to a company or an external customer.

Supplier	Inputs	Process	Outputs	Customers
Civil Construction Material Supplier	• Birks • Stone • Concrete • CS rods • Mixing material	Make a design ↔ Procure material ↔ Build PCR Test Lab Building Structure ↔ Complete MEP Work & Decoration work ↔ Final Inspection & Acceptance	PCR Test Lab Building	Project Sponsor
Wood & Carpentry material supplier	• Tables • Chairs • Wooden Pallets			
MEP material Supplier	• Electrical systems and equipment • Plumbing Material			
Framing & Surface finishing material	• HVAC • Sanitary material Paint • Doors • Windows			

Table 18: SIPOC Model for PCR Test Lab Construction Project

Ishikawa Diagram: A fishbone diagram is a cause-and-effect discovery tool that helps figure out the reason(s) for defects, variations or failures within a process. In other words, it helps break down, in successive layers, root causes that potentially contribute to an effect. Sometimes called an Ishikawa diagram or cause-and-effect analysis, a fishbone diagram is one of the main tools used in a root cause analysis (Trout, 2020). There are some feasible category or combination of categories that might cause the above problem, as follows:

Plant: Equipment or space which involved in material procurement and delivery.

Policies: the Company's higher level decision rules.

Procedures: The Company's steps in material procurement and delivery.

People: all parties involved in this process, i.e. engineer, purchaser, vendor, logistic/transporter, etc.

Measurement: Calibration and data collection related to the procurement and delivery process.

Environment: Building, logistic, space and physical things related to procurement and delivery process.

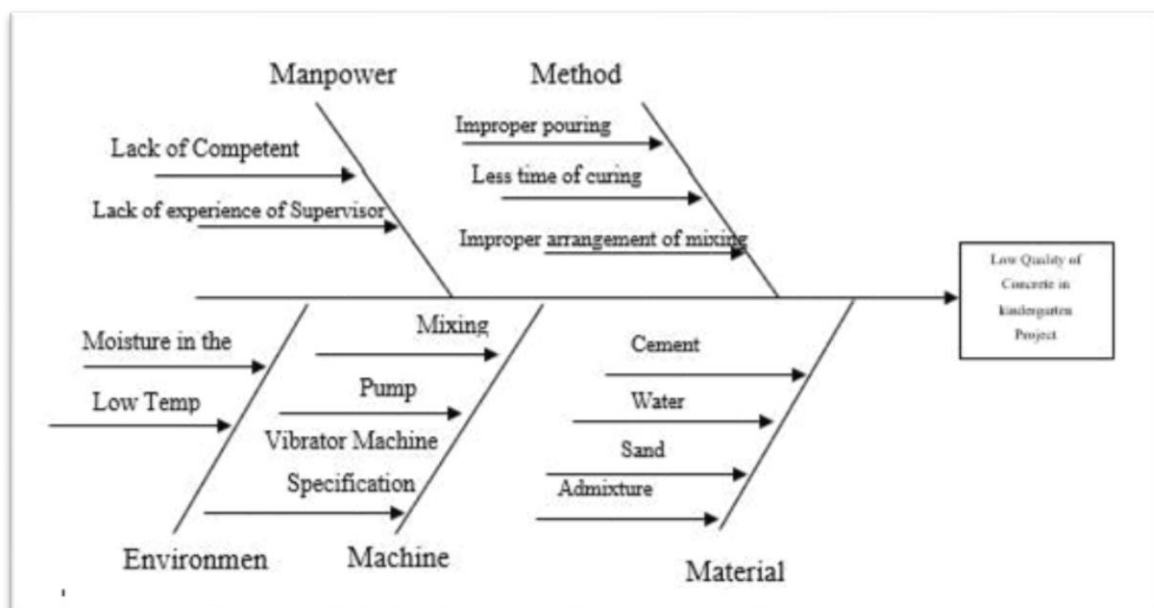


Figure 38: Ishikawa Diagram example for PCR Test Lab Project

Project Issue: Beside equipment and workers, materials are one of the three major components of the resources of the project. Late in materials delivery, will create significant impact to the project objective. From the above categories, the following are the three categories that has identified, causes the most significant effect to late material's delivery to project site, where the other three are relatively easier to manage:

- **Policies:** The company policy that all materials procurement has to be procured under centralized Procurement Department. This needs to be evaluated as the centralized procurement (project and maintenance procurement) will bring excessive load to this department.
- **Procedures:** Shipping prioritization still not clear and depend on whether end user "push" logistic to prioritize their material. There should be a prioritization system that consistently follow and working automatically.
- **People:** Engineer (material requester) incomplete or wrong or not understandable specification has caused long delivery of vendor quotation. Purchaser work overload, lack of vendor data base and lack of experience/creativity of purchaser has also cause long delivery of "correct/appropriate" vendor quotation.

8.1 Finance

Financing the project is to guarantee that the amount of money needed is available. This means that the project management sponsor, in order to know how much money is needed, needs to be able to calculate the amount of the cost, benefits and investment (Pinto, 2009).

Once it is known how much money is needed for the project, it is the sponsor's responsibility to assure that the money is ready when it's needed. The sponsor may have direct funding or may establish debt or get

other sponsor's to fund the project, but its indispensable that he or she have full knowledge of the project money implications (Pinto, 2009).

8.1.1 Cost Breakdown Structure and the project balance in accordance with WBS

A Cost Breakdown Structure (CBS) is a breakdown or hierarchical representation of the various costs in a project. The Cost Breakdown Structure represents the costs of the components in the Work Breakdown Structure (WBS). The CBS is a critical tool in managing the project lifecycle, especially the financial aspects of any project by creating a structure for applying measurable cost controls (ADEACA, 2020).

In project estimation methods, project cost breakdown can be used for providing more accurate estimates of the final figures.

- Expert judgement: experts' opinion used to make up for the lack of clarity in existing cost breakdown can influence cost drivers where more predictability is required. While this method is used to come up with more accurate estimates, significant difference between the planned and the final figure is still possible.
- Analogous estimation: comparing estimates based on cost breakdown for previous projects with new similar ones helps improve estimation technique and get more accurate assessment of project costs, profitability, and general outcome.
- Bottom-up analysis: planned project costs are structured on the basis of the costs of small tasks, services, and product parts. High accuracy is achieved by taking into account all cost drivers, including costs of routine works, overhead, and possible additional costs.
- Top-down analysis: a top-down cost structure can be used for coming up with a ballpark estimate of the final figure. When using it, it's essential to factor in various additional costs not included in the initial estimate.

- Parametric estimation: this estimation method can be used with cost structures where cost drivers are predictable and measurable. On the basis of existing data, different parameters can be estimated with a high accuracy degree.

Cost Break down Structure of PCR Test Lab

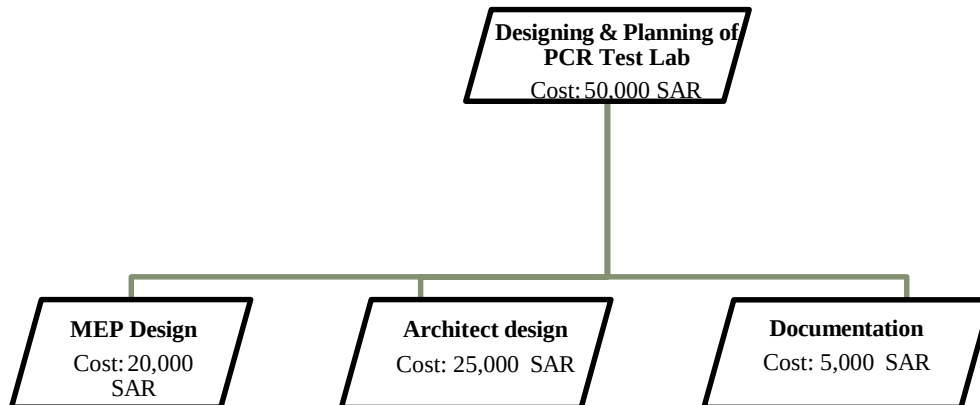


Figure 39: Cost Break down Structure Design

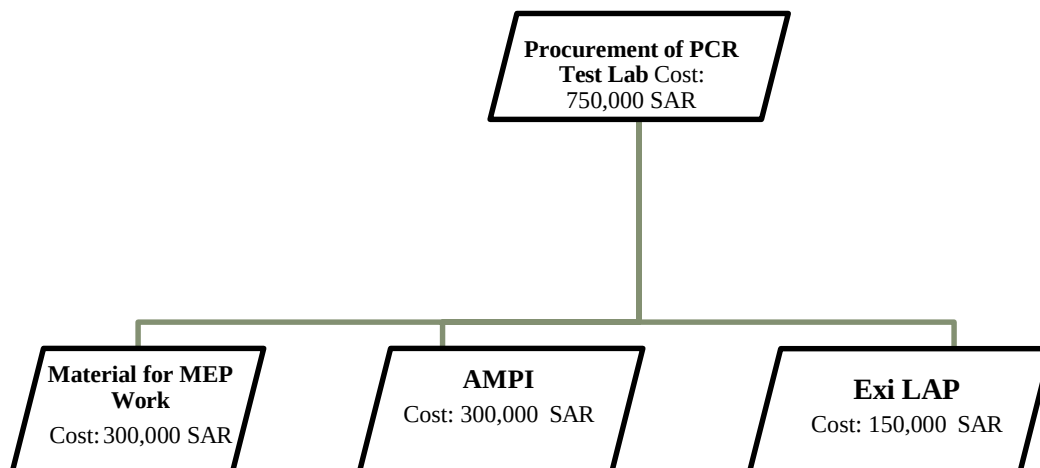


Figure 40: Cost Breakdown Structure Procurement

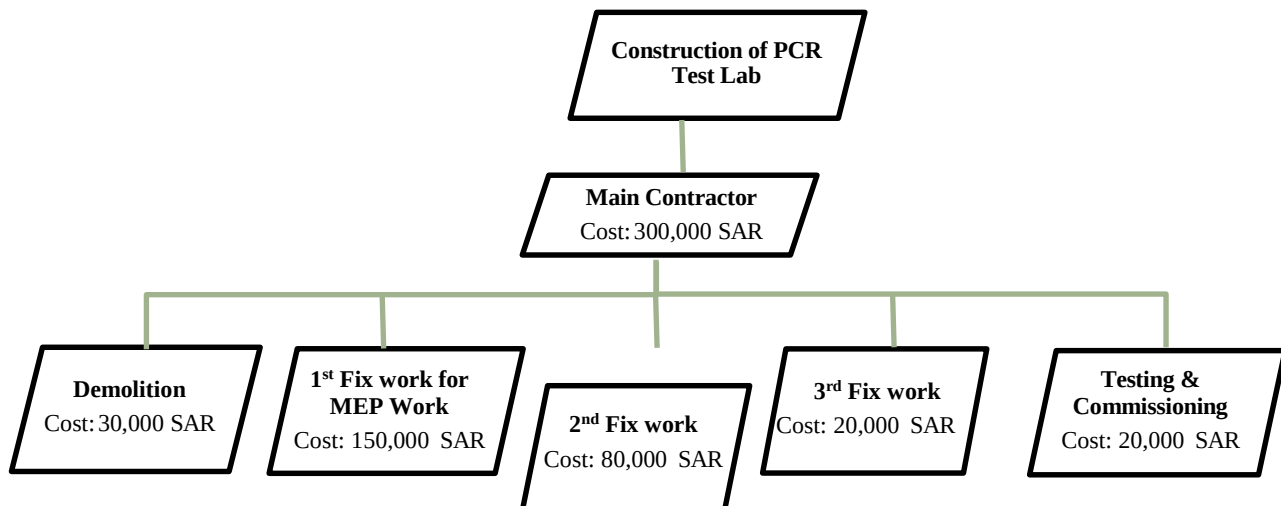


Figure 41: Cost Breakdown Structure

Earned Value Calculation of the project after ending of 20% of its period and completion of 50% of the outputs case-by-case basis

Project Management presents many tools and techniques for the management of the successful project. One of the most regarded of these tools would be Earned Value Analysis

Earned Value Analysis (EVA) is a method that allows the project manager to measure the amount of work performed on a project beyond the basic review of cost and schedule reports. EVA provides a method that permits the project to be measured by progress achieved. The project manager is then able, using the progress measured to forecast a project's total cost and date completion based on trend analysis and application of the project's "burn rate". This method relies on a key measure known as the project's earned value (Reichel, 2006).

Oftentimes the term "earned value" is defined as the "budgeted cost of worked performed" or BCWP. This budgeted cost of work performed measure enables the project manager to compute performance indices or burn rates for cost and schedule performance, which provides information on how well the project is doing or performing relative to its original plans. These indices, when applied to future work,

allow for to project manager to forecast how the project will do in the future, assuming the burn rates will not fluctuate, which oftentimes is a large assumption (Reichel, 2006).

Earned value analysis uses three key pieces of project information: the planned value, actual cost, and earned value. The first two terms are not new, they are the plan spend curve and the actual cost expenditures curve many project teams have been using for years (Lukas, 2012).

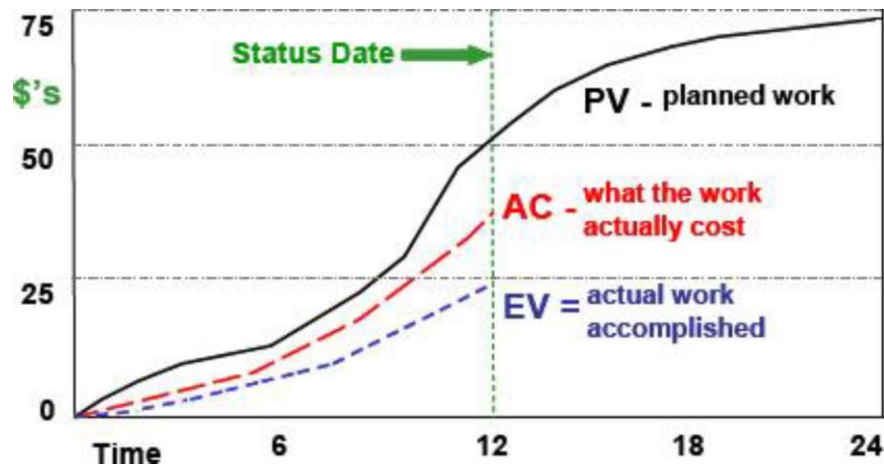


Figure 42: Earned Value analysis

- **Planned Value (PV)** is the budgeted cost for the work scheduled to be done. This is the portion of the project budget planned to be spent at any given point in time. This is also known as the budgeted cost of work scheduled (BCWS).
- **Actual Costs (AC)** is simply the money spent for the work accomplished. This is also known as the actual cost of work performed (ACWP).
- **Earned Value (EV)** is the percent of the total actual budget completed at a point in time. This is also known as the budgeted cost of work performed (BCWP). EV is calculated by multiplying the budget for an activity or work package by the percentage progress.

Earned Value Management Calculation of PCR Test Center Project

Budget at completion (BAC)	1,100,000
Project Duration	4 months

Total Period Passed	20% of Project Duration
Planned Work Completed	20%

Table 19: Earned Value Management Calculation

Planned Value

Planned Value 20% x 1,100,000 = 220,000 SAR

Table 20: Planned Value

EV = % complete x budget

Actual Cost	200,0000
Work Package progress	30%
Budget	1,100,000
Earned value	1,100,000 x 30% = 330,000

Table 21: Earned Value

Earned Value Calculations

With the terms PV, EV, and AC defined, along with how to determine progress, some key calculations can easily be done, which provide important information on how the project is doing.

Cost Variance: $CV = EV - AC$	330,000-200,000	130,000
Cost Performance Index: $CPI = EV/AC$	330,000/200,000	1.65
Schedule Variance: $SV = EV - PV$	330,000-220,000	(110,000)
Schedule Performance Index: $SPI = EV/PV$	330,000/220,000	1.5

Table 22: Earned Value Calculations

Forecasting Using Earned Value

The Cost Performance Index is an excellent indicator of the cost efficiency for completed work. One main use of CPI is forecasting the final project cost. Before listing the common formulas used, a few terms need to be defined (Lukas, 2012).

- **Estimate to Complete (ETC)** – the expected additional cost needed to complete the project.
- **Estimate at Completion (EAC)** – The expected total cost of the project when the defined scope

of work is completed.

- **Budget at Completion (BAC)** – The total approved budget when the scope of the project is completed (including any project contingencies).

$EAC = AC + (BAC - EV)$	$200,000 + (1,100,000 - 330,000)$	970,000 SAR
-------------------------	-----------------------------------	-------------

Table 23: Forecasting

To Complete Performance Index

Another useful evaluation tool is the ‘To Complete Performance Index’ (TCPI), which provides a forecast of the required performance level, expressed as the CPI, which must be achieved on the remaining work to meet the project financial goal. The TCPI calculation can look at either the current authorized budget or the current estimate at completion. TCPI provides a “sanity check” for the project manager on whether the required CPI for the rest of the project is realistically obtainable. Of the two formulas, looking at the CPI required to complete the project based on the estimate at completion is probably more meaningful (Scott, 2012). The two TCPI formulas are:

$TCPI_{(BAC)}$	=Work Remaining /Fund Remaining	$(BAC - EV) / (BAC - AC)$
$TCPI_{(EAC)}$	=Work Remaining /Fund Remaining	$(BAC - EV) / (EAC - AC)$

Table 24: TCPI

9.1 Resources:

A resource can be a person, a team, a tool, finances, and time. Resources should be assessed and allocated before a project begins. Resources are the largest contributor to successful project delivery, and project managers spend significant time planning and managing their activities. Once deployed, the project manager ensures that the assigned resources perform at their maximum potential and complete the delivery (Negi & Palit, 2021).

Effective project resource planning provides a clear picture of who is doing what and how long they need to accomplish the same. It helps to visualize underutilized resources or those getting rolled off from tasks and re-allocate them to suitable project vacancies.

On an enterprise level, project resources can be human and non-human, which includes but not limited to: On an enterprise level, project resources can be human and non-human, which includes but not limited to:

- **Labor:** or human resource forms the backbone of any project and comprises employees (part-time or full-time) and contingent staff with various skill sets required for delivery.
- **Consumables & Materials:** These are the consumables needed to generate the final product. The materials for a road construction project are soil, rock aggregates, binders like lime, bituminous materials, cement, etc.
- **Equipment & Tools:** It covers all the tangible assets (machinery, plant, equipment, etc.) and intangible assets (software, process, methods, and even ideas). These assets might change depending upon the type and nature of the organization.
- **Facilities:** Resources need an environment for project execution, such as land, conference room, office space, accommodation, and more.
- **Finance:** The most significant resource is the money required to procure the resources and carry out the necessary work.

9.1.1 The Concept of Resource Leveling and Smoothing:

Resource optimization is needed when resources have been over allocated, such as when a resource has been assigned to two or more activities during the same time. It may also be needed when certain resources (e.g., equipment or machinery) are available in limited quantities, while the CPM schedule demands more than the available quantities. Two techniques of resource optimization techniques are:

1. **Resource leveling:** is a technique in which start, and finish dates are adjusted based on resource limitation with the goal of balancing the demand for resources with the available supply. When performing project planning activities, the manager will attempt to schedule certain tasks simultaneously. When more resources such as machines or people are needed than are available, or perhaps a specific person is needed in both tasks, the tasks will have to be rescheduled sequentially to manage the constraint. Resource leveling during project planning is the process of resolving these conflicts. It can also be used to balance the workload of primary resources over the course of the project, usually at the expense of one of the traditional triple constraints (time, cost, scope) (Branco, 2019).

Resource Leveling evaluates all the resources to see if the network diagram or the critical path needs to change. This is done to accommodate resource assignment dependencies and ensuring resources were booked. Resource leveling may result in change of the total project duration. Resource leveling is used to examine unbalanced use of resources (usually people or equipment) over time and for resolving over-allocations or conflicts.

2. **Resource smoothing** is a technique that adjusts the activities of a schedule model such that the requirements for resources on the project do not exceed certain predefined resource limits. Once resource leveling is done, there is a possibility that the float or slack values have changed. It is also possible that there are days when resources aren't utilized as much as other days. Resource smoothing is done to ensure that resource utilization is more or less similar across the project. Resource smoothing will not change the total project duration (Bansal, 2019).

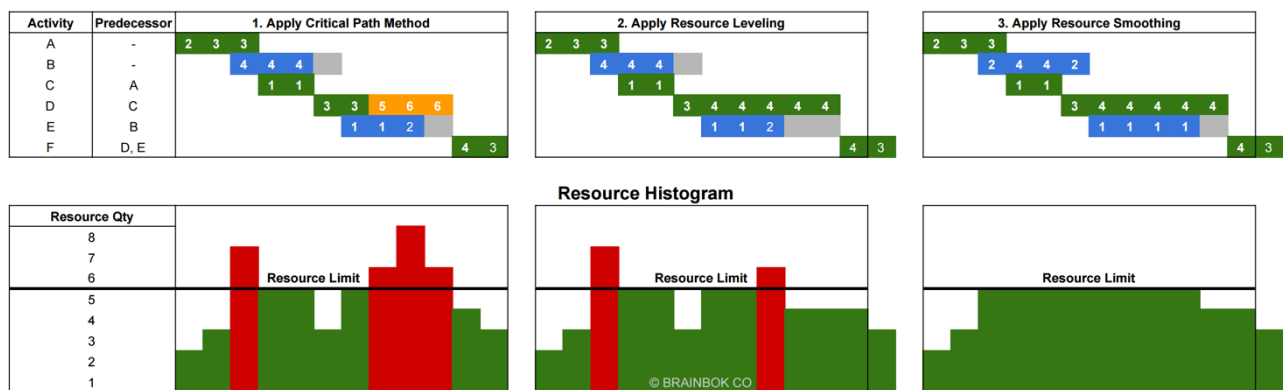


Figure 43 Resource Leveling vs Resource Smoothing

Distributing the Project Resources of Equipment and Tools:

Resource allocation is the process of assigning and scheduling available resources in the most effective and economical way possible. Projects will always need resources, but they can often be scarce. The task, therefore, lies with the project manager to determine the proper timing and allocation of those resources within the project schedule. In project management, resource allocation or resource management is the scheduling of activities and the resources required by those activities while taking into consideration both the resource availability and the project time. In order to save costs and maximize project efficiency, project managers must ensure that resources are assigned in a controlled and pragmatic manner. Here are some important things for allocating resources to projects (Negi & Palit, 2021).

Understand the Project Scope & Timeline

To make the best use of the resources, better understanding of project scope is required so that resources are not over extended. Second, estimate how long each phase will last and set clear milestones at the end of each phase.

Identify Resources: With a detailed task timeline ready. It's time to identify the resources required to complete each task. Past team knowledge and experience come in handy for this.

Find Available Resources: After identified the task and resources, it's now time to check the resource

pool. This is the key to mitigating the resource allocation challenges we covered earlier on. Remember to look out for resources that:

- Aren't on other assignments.
- Aren't on an absence such as a holiday
- And meet any time zone restrictions the project may have

Allocate Resources: is the process of assigning assets in a manner that's supports project goal.

Monitor project schedule: Any changes in project schedule can and will impact the resources allocation plan. That's why needed to keep a close eye on any changes to the project schedule.

- Delayed tasks that cause a significant delay in dependent tasks.
- Unplanned off days
- Over-worked team members.
- Changes in business goals and objectives that may adversely affect resource availability.

9.2 Procurement:

Companies are seriously exploring the potential of supply chain management (SCM) (Gunasekaran et al., 2008). The procurement process is an area of interest to organizations responsible for project delivery for better performance in product quality, cost, cycle time, and responsiveness (Sanderson & Cox, 2008).

The procurement process is composed of different stages (pre-acquisition phase, tender process and contract award, contract and supplier management), each one requiring a specific and careful design capable of guaranteeing the best possible results (Baldi et al., 2016).

In case of a project requiring buying goods or services, the procurement department comes into action.

A project manager is expected to understand what procurement experts will need from them, provide

the experts with that information, and then work with the procurement department throughout the life of the procurements.

Post the decision of procuring goods or services, the procurement manager should:

- Facilitate to create a Procurement Management Plan
- Create Procurement Statement of Work (SOW)
- Determine type of contract
- Determine procurement document
- Request for Proposal (RFP)
- Invitation for Bid (IFB)
- Request for Quotation (RFQ)
- Send the documents to the seller then, Seller Reviews the documents, seeks additional information (if needed), and sends required documents
- Negotiations take place with the seller and contract is signed with right seller
- Procurement administration is the next step.
- Monitoring and Control of Procurement administration is done.
- Procurement closure involves procurement audit and lessons learned
- Final Payment is made

9.2.1 Develop the Procurement Execution Process, and Contractor Selection:

Execution/Conduct Procurements is the process of obtaining seller responses, selecting a seller, and awarding a contract. The key benefit of this process is that it provides alignment of internal and external stakeholder expectations through established agreements.

During the Conduct Procurements process, the team will receive bids or proposals and will apply previously defined selection criteria to select one or more sellers who are qualified to perform the work and acceptable as a seller.

On major procurement items, the overall process of requesting responses from sellers and evaluating those responses can be repeated. A short list of qualified sellers can be established based on a preliminary proposal. A more detailed evaluation can then be conducted based on a more specific and comprehensive requirements document requested from the sellers on the short list. In addition, tools and techniques described here may be used alone or in combination with select sellers. A weighting system can be used to:

- Select a single seller that will be asked to sign a standard contract
- Establish a negotiating Sequence by ranking all proposals by the weighted evaluation scores assigned to each proposal.

Tool & Technique

- Bidder Conferences
- Proposal Evaluation Techniques
- Independent Estimates
- Expert Judgment
- Advertising

- Analytical Techniques
- Procurement Negotiations

Selected Sellers

The selected sellers are those who have been judged to be in a competitive range based upon the outcome of the proposal or bid evaluation, and who have negotiated a draft contract that will become the actual contract when an award is made. Final approval of all complex, high-value, high-risk procurements will generally require organizational senior management approval prior to award.

Agreements

A procurement agreement includes terms and conditions and may incorporate other items that the buyers specifies regarding what the seller is to perform or provide. It is the project management team's responsibility to make certain that all agreements meet the specific needs of the project while adhering to organizational procurement policies. Depending upon the application area, an agreement can also be called an understanding, a contract, a subcontract, or a purchase order. Regardless of the document's complexity, a contract is a mutually binding legal agreement that obligates the seller to provide the specified products, services, or results, and obligates the buyer to compensate the seller.

A contract is a legal relationship subject to remedy in the courts.

[\(https://sites.google.com/site/kodebryanhossac/project-execution-and-control/procurement-execution/\)](https://sites.google.com/site/kodebryanhossac/project-execution-and-control/procurement-execution/)

The procurement execution process:

Our organization has its own process that govern the activity of procurement process as follow:

1. The team of which the purchase request serves with the project manager prepare the (RFP), then start entering the request with attaching the (RFP) in procurement system.

2. The budget control team makes the first approval in the system for the purchase request after checking the availability of the requested amount.
3. The procurement team then approve the request in the system after checking the items.
4. Then upload the (RFP) in procurement platform so corporates can submit their financial and technical proposals within 10 days, and they can ask for more information using the platform.
The answer will be shared with all submitted corporates.
5. After 10 days, the submission stops and the procurement committee will review these proposals and the legal documents of those corporates.
6. A technical assessment then will be conducted using scoring model to choose the supplier.
7. Procurement team issues the purchase order or contract for the winning bidder and announce the winner in the platform.

The selection of a supplier is one of the main activities of the procurement area. Without an adequate and precise method to select the most appropriate supplier, the performance of the whole project may be affected (Cheng & Li, 2004). This task is difficult and challenging, replete with many uncertainties. It is a complex process, which requires individuals to make judgments and decisions and trade-offs between competing goals and limited resources. The selection of one supplier over another depends largely on the company's preferences in terms of evaluation criteria and weights used and the commitments the supplier is willing to make (Watt et al., 2009).

Supplier Scoring Model

A Supplier scoring model, also known as a decision matrix, is an analysis tool that provides a systematic, structured process for selecting options based on multiple criteria. It allows us to decide based on several important factors. It simplifies, and quantifies, what regularly starts out as a complicated question in order to arrive at an objective answer.

To create a supplier scoring model, the following steps are applied:

- Identify the criteria important to the decision process.
- Assign a weight to each criterion based on its relative importance in the decision (ideally, so they all add up to 100%).
- Assign numerical scores to each criterion for all of the options being considered.
- Calculate the weighted scores by multiplying the weight for each criterion by its score and adding the resulting values.

Below is the example of scoring model in PCR Lab supplier's evaluation

Criteria of evaluation with example:

SR #	Criteria	Weight
1	Ability to deliver in below target price. (Price)	30%
2	Reputation on the basis of past projects (Reputation)	35%
3	Ability to deliver the material on given timelines. (Timeline)	35%

Table 25: Criteria of Evaluation

The scores for each vendor are shown below.

Criteria	Vendor A	Vendor B	Vendor C
Price	10	10	8
Reputation	10	6	7.5
Timeline	5	10	9

Table 26: Scores for each Vendor

Weightage of each supplier is calculated in below table.

Criteria		Vendor A	Vendor B	Vendor C
Price	30%	3	3	2.4
Reputation	35%	3.5	2.1	2.625
Timeline	35%	1.75	3.5	3.15
	Total	8.25	8.6	8.175

Table 27: Weightage of each supplier

Supplier Comparison Form

A Supplier Comparison Form help the project managers to understand comparative advantages among suppliers. They help you compare their performance and understand what features are important to your supply

CS Reference: 0				Comparative Statement								
Date: Project # XXX-XXZ Chargable : Delivery at:				XXX China				XXY England				
Specification:												
Sr.No.	Description	Unit	Qty	Brand/Origin	Unit Price (USD)	Total (USD)	Brand/Origin	Unit Price (USD)	Total (USD)	Brand/Origin	Unit Price (USD)	Total (USD)
1	Ceiling Lights	Nos	150		32.06	4,809.00		40.00	6,000.00		60.00	9,000.00
2	Air Conditioning System	Nos	1		20,000.00	20,000.00		23,000.00	#####		27,000.00	27,000.00
3	IB's	Nos	5		800.00	4,000.00		1,200.00	6,000.00		13,000.00	65,000.00
4	Projectors	Nos	7		500.00	3,500.00		600.00	4,200.00		750.00	5,250.00

Figure44 : Supplier Comparison Form

9.3 Plan and Control:

Project planning as a process is output oriented. It is concerned with deciding in advance what, when, how, and who will take the necessary actions to accomplish established objectives. In this context planning is a pervasive management function which is accomplished by all levels in the project hierarchy, the difference being scope, detail, and the magnitude of the effort. Planning forms the foundation for future actions, using the past as a guide.

For the technical definition, there's the project management Institute's project management bible, Project Management body of knowledge (PMBOK). Which states project's controls are the data gathering management and analytical processes used to predict, understand and constructively influence the time and cost outcomes of a project or program; through the communication of information in formats that assist effective management and decision making

Think of project controls as the mechanism that keeps a project on schedule when planning and executing, keeping costs within budget. In fact, it works throughout the entire life cycle of a project.

In project management, project controls address the following:

- Project strategy
- Methodology
- Schedule
- Cost estimates
- Risk management
- Project documentation
- General oversight
- Quality
- Resources

It's all about collecting and managing data, finding trends in that information, reporting on progress, and then putting into practice

9.3.1 Agenda– Invitation and Virtual Record of a Virtual Meeting.

A Virtual Meeting is when individuals in various locations connect at the same time using technology to accomplish a shared goal, but they should not be confused for virtual events or webinars. Virtual meetings tend to be somewhat simpler to plan and do not need as much prep time as a virtual event. As with any in– person meeting, it is important for a virtual meeting to have a detailed agenda, as well as plan to effectively follow that agenda (Linthicum, 2021). In this project, Microsoft Teams is used for virtual meeting.

A meeting agenda is a chronological list of topics, tasks, and activities to be addressed or tackled

upon during a meeting. A virtual meeting agenda allows attendees to have an outline of what will be discussed in the meeting so they can prepare ahead of time to ensure the most productive and effective meeting possible (lifesize, 2019).

The screenshot shows a virtual meeting invitation form. The title is "Delay in Delivery of wood stock." The required attendees are "Pro@rcjubail.gov.sa; project@rcjubail.gov.sa team@rcjubail.gov.sa" and the optional attendee is "ceo@rcjubail.com". The start time is "Tue 3/1/2022" at "3:00 PM" and the end time is "Tue 3/1/2022" at "5:00 PM". There are checkboxes for "All day" and "Time zones", and a "Make Recurring" link. The location is "Microsoft Teams. Meeting ID: 001122005" with a "Room Finder" link. Below the form is an "Agenda:" section with two bullet points: "To review the situation that arises after delay in the delivery of your order." and "To Discuss the strategy to minimize the impact of this situation." Below the agenda is a link to "microsoft.com/feedback/forum/ad198462-1c1c-ec11-b6e7-0022481f8472". Below the link is a header section with "From: Pro@rcjubail.gov.sa", "Sent: Sunday, November 14, 2021 7:06 PM", "To: Pro@rcjubail.gov.sa", "Cc: ceo@rcjubail.com", and "Subject: Delay in Delivery". Below the header is a "Dear Sir," salutation, followed by a paragraph explaining the delay in the delivery of the order due to the COVID-19 situation. The email ends with "Best Regards," and the signature "Procurement Manger, Procurement Department".

Title Delay in Delivery of wood stock.

Required Pro@rcjubail.gov.sa; project@rcjubail.gov.sa team@rcjubail.gov.sa

Optional ceo@rcjubail.com

Start time Tue 3/1/2022 3:00 PM ☐ All day ☐ Time zones

End time Tue 3/1/2022 5:00 PM [Make Recurring](#)

Location Microsoft Teams. Meeting ID: 001122005 [Room Finder](#)

Agenda:

- To review the situation that arises after delay in the delivery of your order.
- To Discuss the strategy to minimize the impact of this situation.

Please click the link below to add in the meeting.

microsoft.com/feedback/forum/ad198462-1c1c-ec11-b6e7-0022481f8472

From: Pro@rcjubail.gov.sa
Sent: Sunday, November 14, 2021 7:06 PM
To: Pro@rcjubail.gov.sa
Cc: ceo@rcjubail.com
Subject: Delay in Delivery

Dear Sir,

I am writing this email to inform you that there has been a delay in the delivery of your order. The shipment that we were supposed to receive yesterday has not arrived yet due to covid situation. The wood stock that you ordered has stalled and we are doing our very best to make sure that it will be here as soon as possible.

Best Regards,
 Procurement Manger
 Procurement Department

Figure 45: Virtual Meeting Invitation & Agenda

Minutes of Meetings: A well-executed meeting ends with prompt and clearly documented meeting minutes. A skilled and successful Project Manager always has meeting minutes prepared and distributed within 24 hours of having a meeting. Project meeting minutes not only summarize what was discussed and agreed upon during the meeting but also includes a list of action items. It is important that the action items are documented and distributed quickly so the assignees have enough time to follow up on their action items or ask for clarification. Below is the example of PCR Test lab minutes of meetings.

Minutes of Meetings					
Subject	Procurement Status		Prepared by:	-----	
Venue	Conference Room	Held On	1 st Mar, 2022	Ref No.	XXXX
Participants				Distribution	
Project Manger Procurement Manger Project Engineer CEO Purchase Officer				PMO Procurement Office CEO Project Team	
Agenda of Meeting: To discuss the Procurement Status					
Meeting Duration		60 Mins		Issue Date	2 nd Mar, 2021
Sr.#	Discussion Points		Action Items		Timelines
1.	Delay in the delivery of Wood stock		Air lift the material from China to minimize the effect of delay.		End of March
2.	Other		It has been learnt that projects schedule suffer initially due to the wrong estimations during the bidding stage and later at procurement stage.		

Table 28: Minutes of Meeting

9.3.2 Identify Performance Measurement:

Project performance measurement is the creation of regular reports against the project's constraints (schedule, resources, and budget) to project governance, team members, and stakeholders. The reports provide visibility into progress/performance of the project in a summarized, concise format.

Regular project status reporting is one of the most important sources of information for project governance and team members. Appropriate status reports enable informed decision making and risk management for the project and can be used as a tool to keep stakeholders (including team members) engaged and informed. Project status reports are usually created by the Project Manager, after gathering updated information from the project team. The status reports should be shared with the sponsor, governance, the project team, and other stakeholders, where required. The format and details within the status report may vary, depending on the audience (PMO, 2018).

Project status reporting is an iterative process throughout project execution and should be done on a regular basis (no less than monthly).

Project Status Report

Project: PCR Lab Construction
Project Manager: Samir Asad

Project Phase: **Initiation/Planning/Execution/Closure**
Status date: April 10, 2022
Project timeline: 2/1/22 – 6/17/22

Project Performance

Indicate overall project status (red, yellow, green) and resource capacity status (red, yellow, green) and trends (status direction compared to the last status report). List major project milestones and status of the milestones (red, yellow, green) using the legend at the bottom of the table. Projected End Dates is the most recent end date. Original end date is the original target date for the milestone. Use the Progress values as indicated in the table.

Overall Project Status:	Green	Trend:	Resource Capacity Status:	Yellow	Trend:
Milestone	Status	Progress NS – Not Started HF – About Halfway AC – Almost Complete C – Complete	Projected End Date 17/06/2022	Original End Date 10/04/2022	Comments/Actions to Return to Green <i>If status is other than green indicate reason for status color and what actions (change in constraints of either scope, resources, and/or timeline) will be taken to trend it back towards yellow or green.</i>
Designing	G				
Supply	R				
Construction	Y				
Legend: Project/Milestone Status: Green – No major issues (Driving on the road) Yellow – Risk towards meeting targets (Swerving on shoulder) Red – Can't meet targets; one or more constraints must change (In the ditch) Resource Capacity: Green – All key resources fully committed Yellow – Key Resources partially committed Red – Some or all key resources not available Trend: Improve ☐ Steady ☐ Decline ☐					

Items for Governance/Team Attention

Key Project Notes (information on major project elements including decisions, risks, issues, etc.) *(Highlight key issues being experienced and if Mgmt needs to assist; Link to RAID log)*

Project Status

Accomplishments this period: <i>(Summarize the deliverables/activities that were completed this reporting period that the recipients of this report should be made aware of)</i>
Planned but not completed: <i>(Summarize the deliverables/activities that were planned but not completed for this reporting period that the recipients of this report should be made aware of)</i>
Planned for next period: <i>(Summarize the deliverables/activities that are planned for the next reporting period that the recipients of this report should be made aware of)</i>

Figure 46 Project Status Reporting

9.3.3 Change Request Model:

A change request is a proposal to alter some aspect of a given project. Change requests can originate either internally or externally. For example, the client may request a change to the agreed-upon deliverables, or change request received from a team member who's actively working on the project. Either way, without a formal change request process in place, these proposals can easily get lost, buried, or simply overlooked (McAbee, 2020).

A typical change request can request a change to several project areas including requests to expand or reduce the scope of the project, requests to modify policies, procedures, plans, or processes, requests to modify expenditures, and requests to update or modify schedules. One constant throughout

most change request processes is that change request must be made formally, via a written proposal or request form typically, and that changes are not to be implemented until they are formally approved. The following figure provides an overview of a change request through different PMBOK Guide's process.

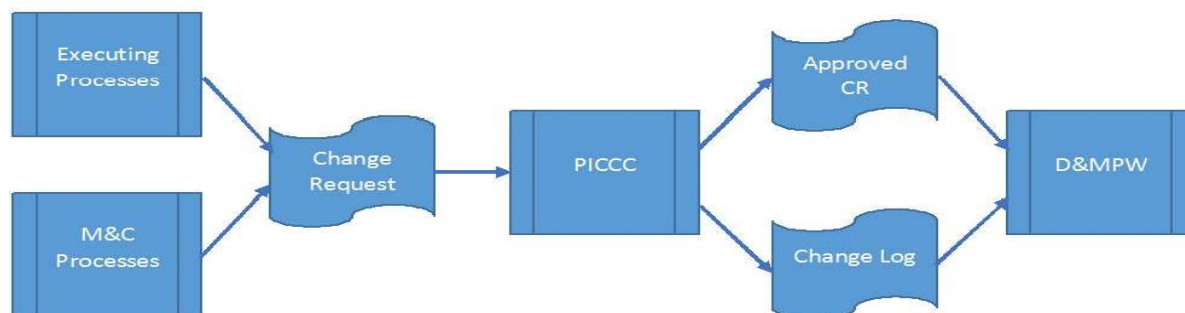


Figure 47: Change Request Process

Change request ID	PCR-01: Changing HEPA filter machine to negative pressure	
Requested by	Eng. Samir	
Reason for the Request	The type of filters should change according to the requirements and standards of the Ministry of Health and Weqaya because the swab room must be always operated at negative pressure.	
Impacts of Change	The change will increase the duration of project 2 weeks, Cost will increase by 100,000 SR, the project quality will be conforming to Weqaya standards.	
Recommendation	The laboratory room must be maintained at negative pressure supported by a pressure cascade through the entrance rooms and anterooms. There must be a dedicated system with alarms and monitoring covering all critical system and operating conditions.	
Received by	Project Sponsor Dr. Hamid Al Ahmadi	
Status	Approved	Reject
Date of CR status	09 April 2022	

Table 29 Change request model

10.1 Risk and Opportunities:

Risk is the recognized possible loss, usually measured as the probability of the unfavorable event. The uncertainty shows the events that exits and activity results are nondeterministic and the degree of impact of those events can be both positive and negative. While the probability of favorable outcomes may be viewed as opportunity. So, used opportunities carry with them associated risks and the greater opportunity, the greater is the degree of uncertainty and the consequent associated risk. Hence, opportunity and risk are tied together and, indeed, one can be seen as the result of the other. The constant goal of project management should be moving uncertainty away from risk and toward Opportunity. The authors from “project Management institute – PMI” (2004) indicate that “project risk is an uncertain event or condition that if it occurs, has a positive or negative effect on at least one objective”.

Cooper et. el. (2005) marks that risk thus has two elements: the likelihood or probability of something happening, and the consequences or impacts if it does. Positive consequences or impacts describe opportunity (positive risk) a risk that will have a positive impact on project objectives, or a possibility of positive changes “negative consequences or impacts describe threat (negative risk) a risk that will have a negative impact on project objective if it occurs, or a possibility for negative changes”

10.1.1 Identify Risks (threats) and opportunities and give examples:

Describing risks as “uncertainty that matter” allows for different types of consequences, and leading standards and guidelines define the concept of risk to include both upside as well as downside impacts. This means that the word risk can be used to describe uncertainties which if they occurred would have a negative or harmful effect, and the same word can also describe uncertainties which if they occurred would be helpful. In short, there are two types of risk: threats and opportunities. The

first step is to be clear about what we are looking for: uncertainties which might or might not occur, but which if they did happen would help us to achieve our objectives, for example allowing us to work smarter, faster, or cheaper

There are at least four distinct ways of finding them:

- Some opportunities arise from the absence of threats. If the bad thing does not happen, we might be able to take advantage of something good instead. For example, if poor industrial relations do not lead to a strike, we might be able to introduce an incentive scheme and turn the situation round from negative to positive.
- Other opportunities are the inverse of threats. Where a variable exists on a continuous scale and there is uncertainty over the eventual outcome, instead of just defining the risk as the downside it might also be possible to consider upside potential. For example, where the productivity rate on a new task is unknown, it might be lower than expected (a threat), or it might be higher (an opportunity).
- We should also remember secondary risks, which are introduced by implementing a response to another risk. Sometimes by addressing one risk we can make things worse (the response creates a new threat), but it is also possible for our action to create a new opportunity. Avoiding potential delays to my car journey by taking the train might also allow me to do some useful work during the journey.
- Lastly, we must not neglect 'pure opportunities' which are unrelated to threats. These are simply unplanned good things which might happen. For example, a new design method might be released which we can apply to benefit our project. Or a recruit to the team may unexpectedly possess a skill needed to solve a problem. This type of opportunity needs to be actively sought out, requiring fresh thinking and awareness of how potential additional benefits might be created.

Types of Risks:

1. Cost Risk	Cost risk is probably the most common project risk of the bunch, which comes as a result of poor or inaccurate planning, cost estimation, and scope creep. When this happens, project managers end up spending more money than they actually have on a project, which may hurt the business in other places or cause the project to go unfinished if funds and resources can't be replenished.
2. Schedule Risk	The result of poor planning, schedule risk is the risk that project tasks and activities will take longer to complete than estimated. Schedule risk is closely related to cost risk because any slips in schedule often increase costs, slow down project benefits, and throw off timelines, which lose any competitive advantage you might've had at the start.
3. Performance Risk	This project risk is not the fault of any one party, which makes it especially daunting. Performance risk is simply the risk that the project won't produce the results and benefits outlined in the project specifications. Even if you keep costs within budget and stick to the schedule, performance risk can mean that you've lost time and money on a project that ultimately did not deliver.
4. Operational Risk	Operational risk stems from poor implementation and process problems, including but not limited to: procurement, production, and distribution. In short, this project risk is part of performance risk because the expected outcome doesn't happen at all or in the way that project managers had planned.
Market Risk	Market risk includes risks posed from competition, commodity markets, interest rates, foreign exchange, and liquidity and credit risks. This project risk is more unpredictable and difficult to plan for, but there are ways in which project managers can protect their business.
6. Governance risk	Governance risk is connected to the performance of the board and management in regard to the community, ethics, company reputation,

	and community stewardship. This risk should be easier to mitigate because it depends largely on the behavior of executives in business. Of course, this risk is still real and should be taken seriously.
7. Legal risk	Legal risk can be unpredictable and may arise from legal and regulatory duties. These include contract risks, litigation brought against the business or organization, and internal legal issues.
External Hazard Risks	These risks are the most unpredictable of all and come from entirely external sources: nature, other people, government, and society. External hazard risks include storms, floods, earthquakes, and other natural disasters; vandalism, sabotage, and terrorism; and civil unrest and labor strikes.

Table 30: Risk

10.1.2 Prepare Risk Register:

Risk Register is a document that contains the information about identified risks, results of Risk Analysis (impact, probability, effects), as well as Risk Response Plans. Risk Register also use to monitor and control risks during the whole project life cycle. The purpose of a project management risk register is to identify, log, and track potential project risks. A risk in project management is anything unexpected that could happen that would positively or negatively affect project.

Risk registers may vary depending on the organization and the project. However, most risk register templates share these commonly used elements:

- **Risk identification ID:** A name or ID number to identify the risk.
- **Risk description:** A brief explanation of the risk.
- **Risk breakdown structure:** A risk breakdown structure is a chart that allows to identify all project risks and categorize them.
- **Risk categories:** There are many risk categories that can impact a project such as schedule, budget, technical and external risks.
- **Risk analysis:** The purpose of risk analysis is to determine the probability and impact of a

risk. Qualitative risk analysis or a quantitative risk analysis both can be used.

- **Risk probability:** project manager will need to estimate the likelihood of each risk and assign a qualitative or quantitative value.
- **Risk priority:** The risk priority is determined by assigning a risk score to each risk, which is obtained by multiplying the risk impact and probability values. If qualitative measurements are used, risk needs to be prioritized with the highest impact and highest probability.
- **Risk response:** Each risk needs a risk response to mitigate its effect on project. Those risk responses are also documented in a risk response plan.
- **Risk Ownership:** Each risk needs to be assigned to a team member who becomes a risk owner. The risk owner is responsible for deploying the appropriate response and supervising it.

Below is the figure of Risk register for PCR Lab Project:

Risk ID	Date Raised	Risk Description	Likelihood of Risk Accruing	Impact of Risk	Severity	Risk Owner	Response
01	16-03-2022	Project Scope is not well defined	Medium	High	High	Project Sponsor	Make sure that Scope of project is well defined in. Define scope phase
02	16-03-2022	Material delivery is delayed	Medium	High	High	Procurement Manger	Keep in contact with vendor with continuous follow ups. Have an alternative supplier on retainer

03		Project schedule is not clearly defined or understood	Low	Medium	Medium	Project Manager	Hold scheduling workshops with the project team, so they understand the plan and likelihood of missed tasks is reduced.
04		Project design & Deliverables definition is incomplete	Low	High	High	Project Sponsor	Define scope in detail via design workshops with inputs from subject experts.
05		Lack of communication, causing lack of clarity and confusion	Medium	Medium	Medium	Project Manager	Write a communication plan which includes: the frequency, goal, and audience of each communication. Identify stakeholders early and make sure they are considered in the communication plan. Use most appropriate channel of communication for audience e.g. don't send 3 paragraph email to Developers, have a call instead.

Table 31: Risk Register

10.1.3 Qualitative Risk Analysis:

Qualitative risk analysis is simply the process of prioritizing the risk based on probability of occurrence and impact, as well as some other characteristic if they are relevant it's what must of us it recognizes as an important step in project risk management – the part where we decide which are the risks we are going to focus on because we don't have time to spend effort on all of them.

The point of doing it is to priorities individual risks by looking at how likely they are to happen

(probability of occurrence) and how bad they would be for the project if they did happen (impact).

As with risk identification, it has to happen throughout the project because risks come and go and also change in severity. Something that has a low probability of occurrence today could have a dramatically different likelihood of occurring tomorrow if something else happens to make it so.

A qualitative risk analysis ranks the recognized project risks using a pre-defined rating scale. The risks will be recorded based on their probability of taking place and the impact on project objectives should they happen. A qualitative risk analysis tends to be more subjective, hence it focuses on recognizing risks to measure both the probability of a precise risk of events happening during the project and the impact it will have on the general plan should it happen. The results are then recorded in a Risk Assessment Matrix to communicate outstanding hazards to stakeholders.

The qualitative risk matrix in Figure 46 shows high-priority risks in red and the lowest in green.



Figure 48: Qualitative Risk Analysis

Generic Likelihood Scales

Level	Probability of Occurrence	Intervention Difficulty
1	You would be surprised if this happened.	Your normal management processes should easily ensure an acceptable outcome.
2	Less likely to happen than not.	Careful oversight of your normal management processes will probably bring about an acceptable outcome.
3	Just as likely to happen as not.	Additional time and effort will be required to move toward an acceptable outcome.
4	More likely to happen than not.	Your resources and authority are sufficient to permit only a minor effect on the outcome.
5	You would be surprised if this did not happen.	Your ability to affect the outcome is effectively zero.

Figure 49: Generic Likelihood Scales

Precision Definitions

Low	Estimates of risk effects and likelihood are merely guesses.
Medium	Enough information is available to provide provisional estimates of risk effects and likelihood.
High	Knowledge of risk effects and likelihood is adequate for all practical purposes.

Figure 50: Precision Definitions

Qualitative Risk Analysis Techniques/Methods

There are a few techniques used when carrying out a qualitative risk analysis to determine the likelihood and impact of risk. Here are the most common techniques:

- A risk assessment matrix (RAM): This is a technique used to determine which risks need project manager to develop a risk response for. The first step in developing a RAM is to define

the rating scales for probability and impact.

- Strength, Weakness, Opportunities, and Threats (SWOT) analysis: This is a tactical planning technique used to help an organization recognize strengths, weaknesses, opportunities, and threats linked to project planning.
- Improvements, Challenges, Opportunities, and Risks (ICOR) analysis: This technique blends risk management practices with the SWOT analysis. A SWOT template with ICOR information puts in plain view the improvements expected, the challenges to be faced, opportunities to be realized elsewhere, and any risks involved with the event.
- Delphi technique also known as Estimate Talk Estimate (ETE): This technique makes use of expert judgment to identify, analyze and evaluate risks on an individual and unidentified basis.
- Decision Tree Analysis: This method is often used to help determine the best course of action wherever there is ambiguity in the consequence of possible events or projected plans.
- Bow tie Analysis: This method helps to recognize and implement barriers to each of the roots and consequences disjointedly, effectively mitigating both the likelihood of risk occurrence and the following impacts, should the risk still happen.
- These techniques are used based on based on the situation at hand and what to achieve. Sometimes, it needs to perform a SWOT analysis and with that project manager can make necessary plans to make a turn around.

Generic Impact Scales

	1 Very Low	2 Low	3 Medium	4 High	5 Very High
Cost	Insignificant cost increase	<5% cost increase	5–10% cost increase	10–20% cost increase	>20% cost increase
Schedule	Insignificant schedule slippage	Overall project slippage <5%	Overall project slippage 5–10%	Overall project slippage 10–20%	Overall project slippage >20%
Functionality	Functionality decrease barely noticeable	Minor areas of functionality are affected	Major areas of functionality are affected	Functionality reduction unacceptable to the client	Project end item is effectively useless
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires client approval	Quality reduction unacceptable to the client	Project end item is effectively unusable

Figure 51: Generic Impact Scales

10.1.3 Risk Response Strategies:

The priorities, which are created for opportunities in the analysis and evaluation process could be interpreted in the same way as risk priorities, with the focus on capturing and exploiting the opportunities rather than avoiding or mitigating the possible problems

- **Extreme opportunity:** a detailed planning is performed at senior levels to prepare and capture the opportunity.
- **High opportunity:** senior executive's attention is needed, and management responsibility should be specified.
- **Medium opportunity:** is managed by specific monitoring or response procedures.
- **Low opportunity:** is managed by procedures that do not need the specific application of resources.

The actions for risks, which have positive or negative results are defined in PMBOK project risk management process Risk response planning phase. After opportunities have been changed or shared, there may be residual opportunities that are formed with no immediate action

In a strategy or scenario risks are described and needed response actions are considering. It is a way to define processes in a broader way and used tools and techniques to minimize or share. Strategies are useful by creating response actions for negative impact or possible problems where managers have low knowledge or expertise. They include managers actions related with positive risks for objectives of the project. There can be only one or a set of strategies, which are the effective for each selected risk. Here are response strategies for risk.

Negative Risk response		Positive Risk response	
Avoid	Risk avoidance is a risk response strategy whereby the project team acts to overcome the threat or protect the project from its impact.	Exploit	The aim of this strategy is to eliminate the uncertainty associated with a particular upside risk. The strategy may be selected for risk where the organization needs to ensure that the opportunity is realized. Directly related response actions include assigning more resources to the project to reduce the time to completion or provide better quality than originally planned.
Mitigate	Risk mitigation is a risk response strategy whereby the project team acts to reduce the probability of occurrence or impact of a risk.	Enhance	The strategy changes the size of the opportunity by increasing probability and / or positive 108 impacts to the project and maximizing key drivers of these positive impact risks.
Transfer	In the risk transference response strategy, the project team transfers the impact of a risk to a third party, together with possession of the response. Transfer strategy does not remove the risk. It just transfers the responsibility of managing risk.	Share	This strategy includes allocating ownership to a third party who is best able to capture the opportunity. The risk-sharing partnerships, teams, special-purpose companies, or joint ventures could be established on purpose of managing opportunities.

Accept	In the risk acceptance strategy, the project team decides to recognize the risk and not take any action if the risk does not arise.	Accept	Strategy for both Threats and Opportunities acceptance is adopted because it is seldom possible to eliminate all risks from a project. The strategy shows how the project team has decided not to change the project management plan in order to deal with risk, or it is unable to identify any suitable response strategy. This strategy can be used both for threats and opportunities and be either passive or active.
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Table 32: Risk Response Strategies

10.2 Stakeholder:

The term stakeholder is used as a general term to describe individuals, groups, or organizations that have an interest in the project and can mobilize resources to affect its outcome in some way. A formal of a stakeholder is: “individuals and organization who are actively involved in the project, or whose definition interests may be positively or negatively affected as a result of project execution or successful project completion” (project management institute). Project stakeholders usually include the project manager, the customer, team members within the performing organization, and the project sponsor. However, there are more than just these few.

10.2.1 Stakeholder Engagement Assessment Matrix:

Stakeholder engagement assessment matrix is a way of analyzing and portraying the level and direction of stakeholder engagement. The matrix is one of the analytical techniques that are the tools

and techniques listed for the PMI process of plan stakeholder management.

The engagement classifications recommended in the PMBOK are:

- **Unaware** – does not know about the project or its benefits and other impacts
- **Resistant** – aware of the project and its impacts, but resistance to the change
- **Neutral** – aware of the project, not resistant or supportive
- **Supportive** – aware of the project, and supports the change and potential impacts
- **Leading** – aware of the project and potential impacts, and actively ensuring its success.

Following the PMIS taxonomy, the current level of engagement is documented with a “C”. The desired level is represented with a “D”. A populated stakeholder engagement assessment matrix looks like the following example.

Stakeholders	Unaware	Resistant	Neutral	Supportive	Leading
Sponsor				D C	
Project Manager					D
Project Management Team					D C
Project Department				D	
Engineering Department				D	
Procurements Department				D	
O&M Departments				D C	
Health Department			D		
Transportation Department				D	
Construction Contractors					D
Saudi Electrical Company				D	
Saudi Telecom Company				D	
Material Suppliers				D	
Local residents				D	
workers			D		

Table 33: Stakeholder Engagement Assessment Matrix:

Summary

In this project, we study the project management of construction projects in healthcare facilities for the PCR Test Center Program. Project management finds a wide application area in construction healthcare facilities. A case study of the construction of a PCR Test Center was carried out to determine the importance of project management success using The Project Excellence Baseline (IPMA PEB®), and to find out how to manage design and construction throughout the life cycle of the project. As construction projects involve a number of participants and stakeholders, their participation and commitment can have a major influence on the goals of construction development. The project report provides a basis for the construction of a PCR Test Center based on project management best practices that emphasize the necessity and significance of tailoring the project management approach to the unique characteristics of the project and its context.

Lessons Learned and Recommendations

Lessons Learned

The construction team made trips to observe not only newly constructed facilities but other PCR Test Centers as well. Many PCR Test Centers were facing problems regarding water and electric power supply. It was recommended that when installing water and electric power supply systems for the same type of project, training in day-to-day maintenance and immediate repair in an emergency, etc. should be included.

Recommendations

The Project Kickoff meeting is when you assemble all your team members with stakeholders in attendance watching you layout how you are going to run the project. Think of the stakeholders as parents that want the project team members to succeed. Whether you are teaching PCR Test Centers or running a project you need to set the ground rules and expectations from the beginning and develop

and refine it along the way. Setting up expectation and ground rules will avoid any assumptions and make everyone's job easier by knowing what is expected of you.

Application of project management tools, like WBS and responsibility matrix, along with careful project planning lead to successful project completion, and can be recommended for use in small to medium design projects.

High attention to details and collaborative team work is recommended for future design projects. Owner, architect, consultant, designer, construction company representative should be involved during the design stage. Civil design is a complex process and required knowledge in different spheres.

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