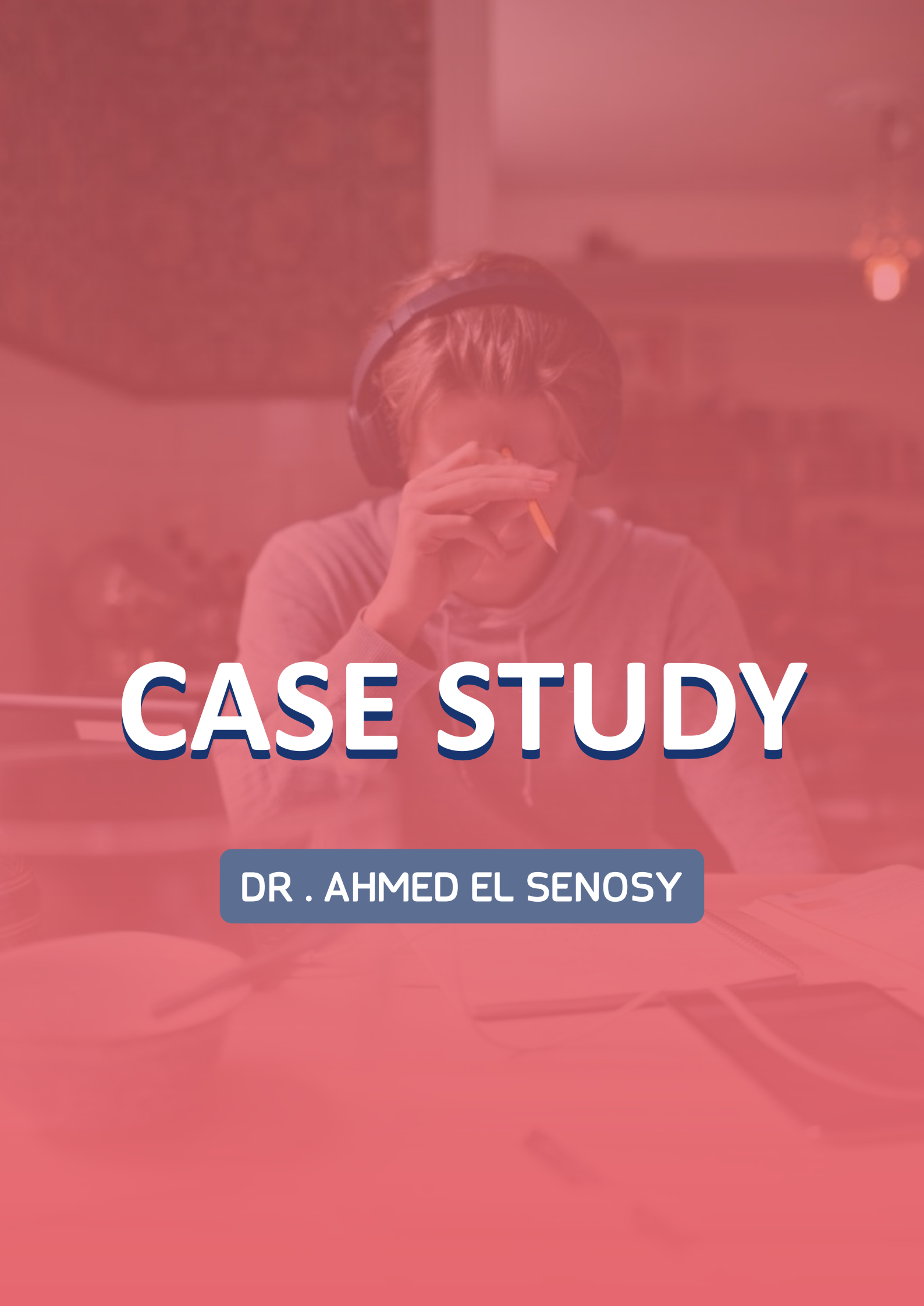


CASE STUDY

DR . AHMED EL SENOSY

TABLE OF CONTENT

Practical implementation of the project management processes is essential to ensure the achievement of a clear understanding of project management central concepts, tools, and approaches.

This chapter provides in detail a practical implementation of the project management processes in a construction project; all project management process groups are covered and considered.

By completing this chapter, the reader will be capable of applying a structured project management approach to real-life projects; the following sections are presented:


Project Description


Project Initiating


Project Planning


Project Executing


Project Monitoring and Controlling


Project Closing

Project Description

TPE is an organization that comprises real estate, development, engineering, and construction specialties.

TPE has currently agreed with a business analysis entity named PCA to study the feasibility of developing and constructing a residential compound in a new district in Riyadh city; the primary objectives of TPE is increasing the profit in addition to improving the marketplace.

PCA has conducted the feasibility study and the results show that the mentioned project, if comprises 120 residential villas in addition to infrastructure, services and amenities, and landscape works and executed within three years, could achieve the required profit and could improve the marketplace of TPE organization, thus, TPE has decided to go on and initiate the project.

Project Initiating

The real estate and development unit of TPE organization are considered the project sponsor, represented by the general manager Hany Mahmoud.

The project manager has been assigned from the engineering and the construction unit, his name is Sameh Ahmed; he has been working as a project manager in the same organization for more than ten years, and he had successfully completed three similar projects considering the defined project objectives.

It was agreed that the project would be executed in two phases; phase 1 has been planned to include 50 villas to be completed after 20 months of the project start (which has been planned

to be on March, 1st 2015); while phase 2 has been planned to include 70 villas to be completed by the project finish date, which is February, 28th 2018. The project budget has been expected

to be $120 Million.

As there are some special works related to the electromechanical system, these works have been agreed to be awarded to a nominated subcontractor MEV.

The project charter has been developed showing the high-level project information as shown in Figure 1, which includes:

 Project information

 Expected budget

 Project objectives

 Nominated subcontractors/suppliers

 Project scope

 Stakeholders

 Key deliverables

 Project success criteria

 Key milestones

 Sign off

 High-level risks

Project Information

Project: Developing Residential Compound Project in New District in Riyadh.

Sponsor: Hany Mahmoud (TPE real estate and development unit).

Project Manager: Sameh Ahmed (TPE engineering and construction unit).

Project Objectives

1. Achieve the required profit, which equals to or greater than $11 Million.
2. Improve the marketplace of TPE organization to be the leading organization in this field.

Project Scope

1. Developing the required design and shop drawings works.
2. Executing the construction works of 120 villas in addition to related infrastructure, services, and landscape works.
3. Performing the required testing and commissioning works.

Key Deliverables

1. 120 high luxury villas (turnkey).
2. The landscape is comprising external pools.
3. Services and amenities including a shopping mall, GYM, tennis courts, and football court.

Key Milestones

1. **March 1st, 2015:** Project start
2. **October 31st, 2016:** Completing phase 1 of the project (50 villas) with related networks and services.
3. **February 28th, 2018:** Completing phase 2 (70 villas) with related networks and services.

High-Level Risks

1. Running over budget.
2. Delay in completing the project.
3. Competitive projects to be carried out in the same district.
4. Observing new requirements which may affect project budget negatively.

Expected Budget

$120 Million.

Nominated Subcontractors / Suppliers

MEV (for electromechanical systems).

Stakeholders

1. Sponsor: Hany Mahmoud (TPE real estate & development unit)
2. Project manager: Sameh Ahmed (TPE engineering & construction unit).
3. CEO of nominated subcontractor (MEV): Mazen Ibrahim.
4. Customers: the residents of the developed units (project deliverables).
5. Residents nearby the project location: could be affected negatively by the construction works).
6. The municipality and governmental authorities: have an effective role in obtaining permits and licenses.

Project Success Criteria

1. Completing phase 1 and phase 2 of their defined milestones.
2. Completing the project within the defined budget.
3. Achieving customers' satisfaction regarding requirements and expectations.
4. Achieving the expected marketplace and value.

Signoff

Project Sponsor: Hany Mahmoud (TPE real estate and development unit)

Date: March 1st, 2015.

Figure 14: Project Charter

The stakeholders are initially identified considering their identification information, assessment information, and classification. This information has been recorded in the stakeholder register as shown in Figure 14.2 which presents a portion of the developed stakeholder register. This information should be updated at the start of each project phase/stage.

Name	Position in organization	Project Role	Contact Details (email / mobile)	Classification
Hany Mahmoud	PMO Manager	Sponsor	hany.m@TPE.com	External
Sameh Ahmed	Project Manager	Project Manager	sameh.a@TPE.com	Internal
Mazen Ibrahim		CEO of MEV subcontractor	m.ibrahim@MEV.com	External
Ahmed Samir		Subject Matter Expert	a.samir@hkp.com	External
Tarik Mohamed		Subject Matter Expert	tarik.m@gfh.com	External
Kamal Fadel		General manager in municipality	k.fadel@mnc.com	External
Fareed Sami		Customer (previous project)	0005859348	External
Mohamed Tawfik		Customer (looking for new villa)	0016555219	External
Adnan Saad		Resident nearby site	0015420454	External
Osama Mohamed	QA / QC Manager	Auditor	Osama.m@TPE.com	Internal

Figure 2: Stakeholder Register

Project Planning

The project manager leads the process of developing project management plan. The project management plan comprises subsidiary management plans and baselines. The project management plan is initially developed with the available information then it is progressively updated throughout the project.

The scope management plan is a subsidiary plan of the project management plan; it documents how the scope could be defined, managed, controlled, and validated. A portion of the developed scope management plan is shown in Figure 3.

Scope Management approach

- Scope management is a main responsibility of the project manager.
- The scope should be defined considering the requirements collected from the project stakeholders in order to produce a project scope statement; a WBS has to be performed, and a scope baseline should be established.
- No scope changes are allowed without an approved change request; any approved change should be updated in the project management plan and communicated to relevant stakeholders.
- The scope should be validated to obtain a formalized acceptance which could be utilized effectively in the project closure phase.

Scope Definition

The scope should be defined considering the following:

- Project charter;
- Requirements documentation;
- Organizational culture, and structure; and
- Industry requirements.

The scope definition produces a project scope statement which includes:

- A detailed description of scope;
- Project deliverables;
- Acceptance criteria; and
- Project boundaries and exclusion.

Figure 3: Portion of Scope Management Plan

The requirements management plan defines how the requirements could be collected, analyzed, managed, and traced. A portion of the developed requirements management plan is shown in Figure 4

Requirements Management approach

- Requirements should be collected by interviewing and conducting questionnaires with identified stakeholders, especially customers and end users.
- The collected requirements should be presented in requirements documentation and should be linked to their origin and business objectives in a requirements traceability matrix in order to be monitored effectively.

Requirements Classification and Prioritization

- Requirements could be classified using affinity diagrams.
- In case of applying voting, plurality should be achieved.

The schedule management plan documents the established criteria and activities for developing, monitoring, and controlling the schedule; it includes the scheduling methodology and tools, accuracy level, measuring units, and control thresholds. A portion of the developed schedule management plan is shown in Figure 5.

Units of Measure

Duration units: Days.

Staff / Labour units: Hours.

Equipment units: Hours.

Intervals for Schedule Updating

The project schedule should be updated Monthly (end of each calendar month).

Control Thresholds

If Schedule Performance Index (SPI) is less than 0.7, then the schedule needs to be adjusted to consider the current progress status and plan how to recover the delays.

Figure 5: Portion of Schedule Management Plan

The cost management plan describes how the project costs will be estimated, structure, managed, and controlled; it includes the reporting formats, accuracy level, measuring units, and control thresholds. A portion of the developed cost management plan is shown in Figure 6.

Units of Measure and Level of Precision

Cost: Dollars $.

Level of Precision: Round up to the nearest integer ($1566.678 round to $1567)

Process Description

- Costs should be estimated using bottom-up estimating, or parametric estimating techniques.
- The budget should be determined, and cost baseline should be established considering the developed project schedule to obtain time-phased budget.
- Costs should be monitored and controlled effectively by applying earned value management; the reporting period should be monthly (at the end of each calendar month).

Control Thresholds

If Cost Performance Index (CPI) is less than 0.88, then the budget should be re-evaluated, and more control actions should be applied on site.

Figure 6: Portion of Cost Management Plan

The quality management plan defines the quality standards and documents how the quality will be managed and controlled. A portion of the developed quality management plan is shown in Figure 7.

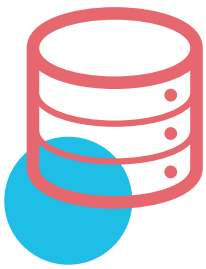
Quality Assurance Standard for Schedule Management

- The schedule is developed and maintained following the approaches defined in the schedule management plan.
- Meetings are conducted to develop and periodically review the project schedule.
- Actions recorded in schedule review meetings are documented and tracked.
- Changes to the project schedule are following a structured approach as defined in the change management plan.

Quality Control Standard for Schedule Management

- All task dependent activities should be loaded with resources.
- Resources should be leveled and do not exceed a predefined limit.
- Activity ID length should be consistent in all activities.
- All activities should have activity codes to facilitate reporting.
- The schedule planned dates should match the agreed dates.

Figure 7: Portion of Quality Management Plan



The resource management plan describes methods for identifying and acquiring resources; it defines roles, responsibilities, authority, and competences. It presents the organization charts, the required training, and methods for developing the team and controlling resources. A portion of the developed resource management plan is shown in Figure 8.

Methods for Team Development

- Establishing monthly offsite events.
- Awarding the best employee at the end of each calendar month.

Required Training

- Project Management Professional (PMP) preparation course.
- Building Information Modelling courses.
- Communication and leadership training.

Figure 8: Portion of Resource Management Plan

The communication management plan includes the communication requirements of stakeholders, the information needed and the methods and responsibilities of sending and receiving, and communication methods and technologies. A portion of the developed communication management plan is shown in Figure 9.

Information Needed (Responsibility and Frequency of Distribution)

- Schedule performance: needed by project sponsor; distributed by the project manager (Monthly).
- Cost performance: needed by project sponsor; distributed by the project manager (Monthly).
- Daily progress for each discipline: needed by project manager; distributed by each discipline senior/manager (Daily).

Communication Technologies

- Emails: pushing memos, and reports.
- Meetings: progress review, resolving issues and conflicts, and managing stakeholders' expectations and needs.
- Schedules' Databases: illustrating day-by-day progress, the percentage of completion, actual start and finish dates, etc.

Figure 9: Portion of Communications Management Plan

The risk management plan comprises methodology, roles and responsibilities, budget, and timing of conducting risk management activities; it also contains definitions of probability and impact, probability impact matrix, stakeholder risk tolerances; and reporting formats. A portion of the developed risk management plan is shown in Figure 10.

Risk Management Methodology

- Engaging project stakeholders and project team should identify risks effectively in order to obtain a comprehensive risk register.
- Risks should be prioritized by using qualitative approaches considering the probability and impact of risks.
- Quantitative analysis should only be performed if needed.
- Risk response planning should be conducted.
- Unconditional responses should be updated in the project management plan.
- Trigger conditions should be defined for conditional responses.
- Responses should be implemented as planned.
- Risks should be monitored, assessed for validity, and new risks should be identified and analyzed.

Probability and Impact Definitions

Scale	Probability	Impact on Cost	Impact on Time
Very High	>70%	>$5M	>8 months
High	51-70%	$3M-$5M	5-8 months
Medium	31-50%	$1M-<$3M	3-<5 months
Low	11-30%	$0.05M-<$1M	1-<3 months
Very Low	<10%	<$0.5M	<1 month

Probability and Impact Matrix

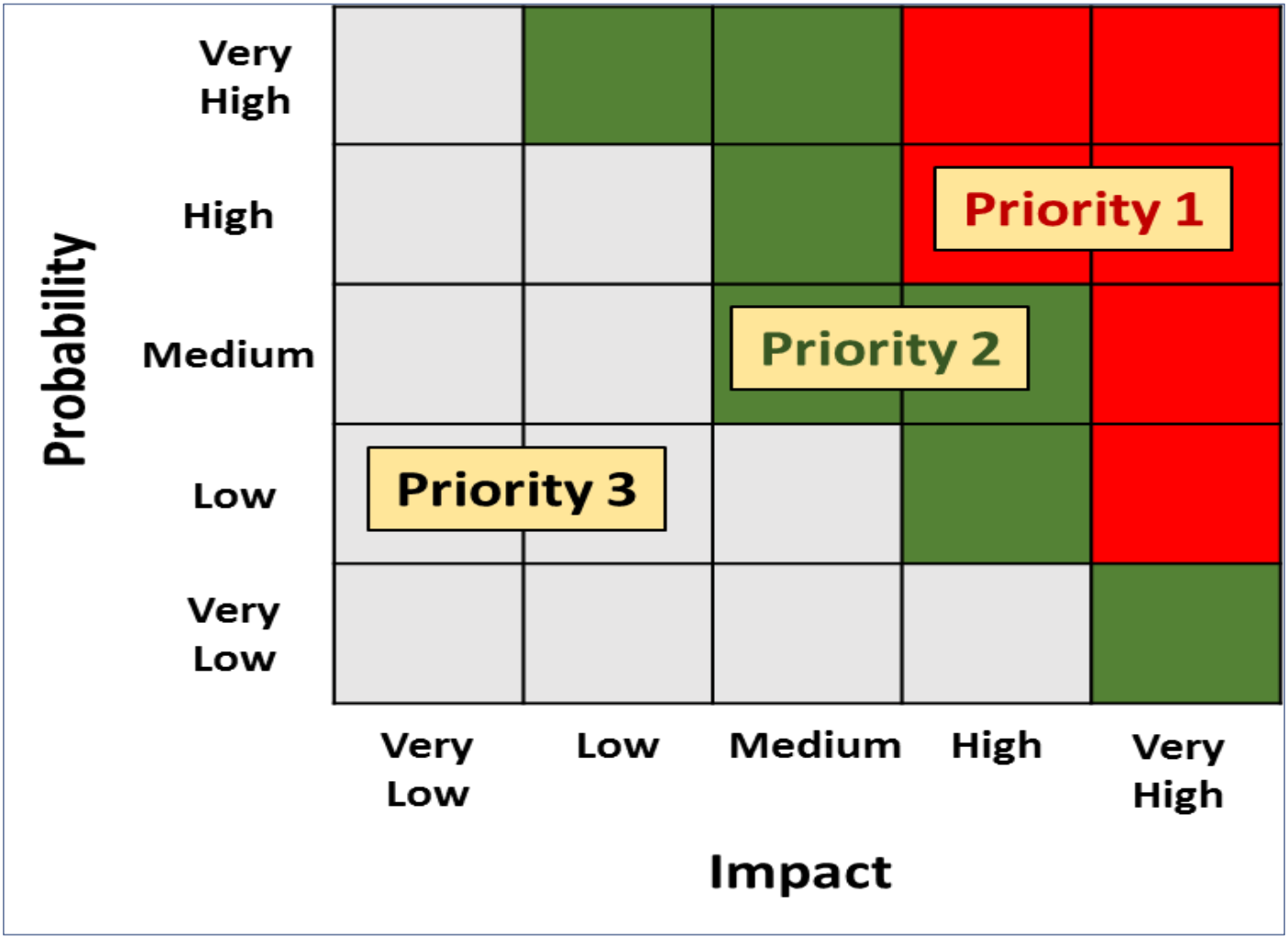


Figure 10 : Portion of Risk Management Plan

The procurement management plan defines the activities needed to complete the procurement process effectively; it presents the responsibilities related to procurement and a list of prequalified sellers. A portion of the developed procurement management plan is shown in Figure 11

Nominated Subcontractors

- **MEV:** for electromechanical systems.

Contract Type

The contract should be **fixed price contract.**

Procurement Statement of Works (SOW)

- Providing the required works for the following systems for 120 villas:
  - Fire alarm system;
  - Telephone and data system; and
  - CCTV system.
- The subcontractor is responsible for:
  - Providing shop drawings for approval;
  - Providing samples for materials to be used for approval;
  - Delivering required materials;
  - Installing first fix (conduits);
  - Installing second fix (wires and cables);
  - Installing third fix (final system fixture);
  - Testing the systems;
  - Handing over the system; and
  - Providing one-year warranty for fixing systems' failures.

Figure 11 : Portion of Procurement Management Plan

The stakeholder engagement plan documents the appropriate approaches for involving stakeholders in decision making and execution. It shows the current and desired levels of project stakeholders. A portion of the developed stakeholder engagement plan is shown in Figure 12.

Stakeholders Engagement Strategy

- Customers/end user should be involved early in the project, especially in the collect requirements process, so that their needs and expectations are met in the final output of the project (product).
- The sponsor should be involved at the end of the phase to ensure the alignment of the project with the high-level strategies and to increase the chance of the final project acceptance.
- The sponsor should be involved when there is a need to utilize management reserves, or when there is a problem regarding completing the project with the current budget, or in case if it is observed that project will not achieve its objectives if completed.
- Informal meetings should be conducted with residents nearby the site to change them from negative stakeholders to neutral or supportive stakeholders; they should be convinced that the presence of such project in the district will improve the market value of all residential areas in the same district.

Current and Desired Levels of Stakeholders

- **Sponsor:**
  - **Current Level:** Supportive.
  - **Desired Level:** Supportive.
  - **Actions to recover gap:** no action needed.
- **Residents nearby site:**
  - **Current level:** Resistant.
  - **Desired level:** Neutral or supportive.
  - **Actions to cover gap:** informal meetings; discussing the effect of the project on the market value of the whole district; and conducting friendly activities and events with them.

Figure 12 : Portion of Stakeholder Engagement Plan

In order to achieve the project objectives and meet stakeholders' needs and expectations, requirements have to be collected; the stakeholder register is a main document that has been considered to collect requirements. Interviews have been conducted with customers/end users to determine their requirements in order to be considered if appropriate in the project scope. The results of the conducted interviews produce requirements documentation, which is shown in Figure 13 .

Business Requirements

- The project has been taken to achieve a specific profit (greater than or equals to $11 Million)
- The project has also been taken to improve the marketplace of the organization.

Stakeholders Requirements

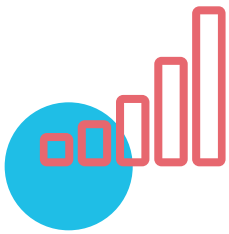
The customers/end users defined the following requirements:

- There should be a large green landscape area.
- A shopping mall should comprise all the residents' needs such as market, stationary, and pharmacy.
- There should be enough sports centers and courts.
- Kids' area should be available.

Project Requirements

- The required permits should be obtained from relevant authorities before starting construction works.
- A time-buffer should be considered between the delivery of materials and starting installation to allow proper testing and recording of all materials.

Figure 13 : Portion of Requirements Documentation



Requirements traceability matrix has been developed to track requirements and ensure their alignment with the project objectives. Figure 14 shows the developed requirements traceability matrix.

ID	Requirement Description	Business Goals	Project Objectives	Design	Development
REQ 001	Large green landscape area.	Stakeholder satisfaction leading to the better marketplace	More profit as marketing will be easier	Considered	Will be considered
REQ 002	Shopping mall is comprising all the residents' needs.	Stakeholder satisfaction leading to the better marketplace	More profit as marketing will be easier	Considered	Will be considered
REQ 003	Sports centers and courts.	Stakeholder satisfaction leading to the better marketplace	More profit as marketing will be easier	Will be considered	Will be considered
REQ 004	Kids' area.	Stakeholder satisfaction leading to the better marketplace	More profit as marketing will be easier	Will be considered	Will be considered
REQ 005	Obtaining building permit		Complete project on time and within budget	Considered	Considered

Figure 13 : Portion of Requirements Traceability Matrix

After determining the requirements, the scope has been defined in detail; the define scope process produces the project scope statement which includes a detailed description of the scope of work, this could include the detailed design drawings and the corresponding bill of quantities (BOQ); Figure 14 shows a portion of project scope statement.

Project Description

The project the development of residential compound project by TPE organization. The project comprises 120 villas and the related infrastructure networks and landscape. The electromechanical systems should be executed by a nominated subcontractor MEV.

More details are presented in design drawings (Appendix A), and Bill of Quantities (Appendix B).

Constraints

- **October, 31st 2016**: Completing phase 1 of the project (50 villas) with related networks and services.
- **February, 28th 2018**: Completing phase 2 (70 villas) with related networks and services.
- **Limited budget of $120 Million.**

Project Deliverables

- 120 high luxury villas (turnkey).
- Landscape comprising external pools.
- Services and amenities including shopping mall, GYM, tennis courts, and football court.

Project Exclusions

- The project does not include preparing special roads for entering the compound directly from the district entrance (internal existing roads of district should be used).

Item	Description	Quantity	Unit
	SECTION C - CONCRETE WORK		
	Concrete		
	Plain poured insitu concrete using sulphate resisting cement type V; Grade 20/25		
B	70mm thick blinding	9	m3
	Reinforced poured insitu concrete using ordinary portland cement (OPC) type II or Moderate sulphate resisting cement (MSRC); Grade 35/45		
C	300mm thick basement suspended slab ; To unit	38	m3

Figure 14 : Project Scope Statement

After the scope has been defined; the Work Breakdown Structure (WBS) has been created. The created WBS is shown in Figure 15 which shows the representation of the created WBS in the scheduling tool for further decomposition.

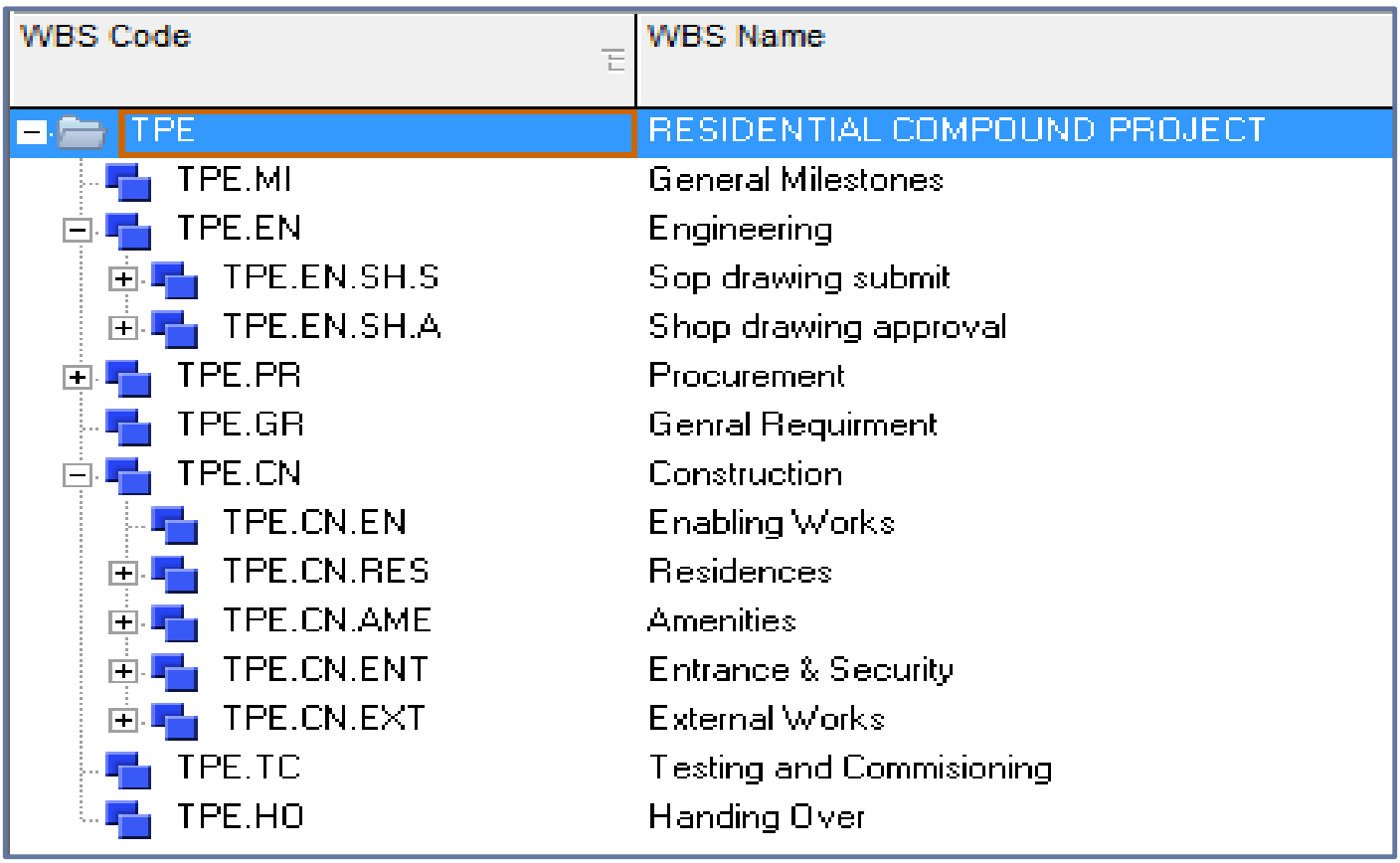
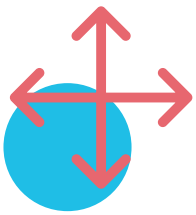


Figure 15 : WBS Representation in Scheduling Tool

After creating the WBS, the next step is defining the project activities. Each work package of the created WBS has been decomposed into activities which represent the required efforts and actions to complete this work package; this produces a complete activity list. Figure 17 shows a portion of the defined activity list in a scheduling tool/software.

Activity ID	Activity Name
Construction	
Enabling Works	
GNRL.ENBL.GN.02.1001	Site Preparation, Clearance, & Demolishing Works
GNRL.ENBL.GN.02.1000	Excavation & Leveling Works
GNRL.ENBL.GN.02.1015	Backfilling Works
Residences	
PHASE A	
Zone 01	
Civill Works	
Substructure & Basement	
MZ01.GNRL.BS.02.1000	Excavation Works
MZ01.GNRL.BS.02.1005	Anti-Termite Works
MZ01.GNRL.BS.03.1040	Plain Concrete Works
MZ01.GNRL.BS.03.1050	RC Raft Foundation Works
MZ01.GNRL.BS.03.1075	RC Column Works
MZ01.GNRL.BS.03.1080	RC Concrete Walls
MZ01.GNRL.BS.07.1285	Waterproofing for foundations & RC walls & columns
MZ01.GNRL.BS.02.1015	Backfilling around foundation & RC walls & columns
MZ01.GNRL.BS.03.1085	Concrete Slab Works

Figure 17 : Portion of Defined Activity List



The defined activities are then linked together with logical relationships in order to sequence activities and create the schedule network diagram. Figure 18 shows an example linking and sequencing activities.

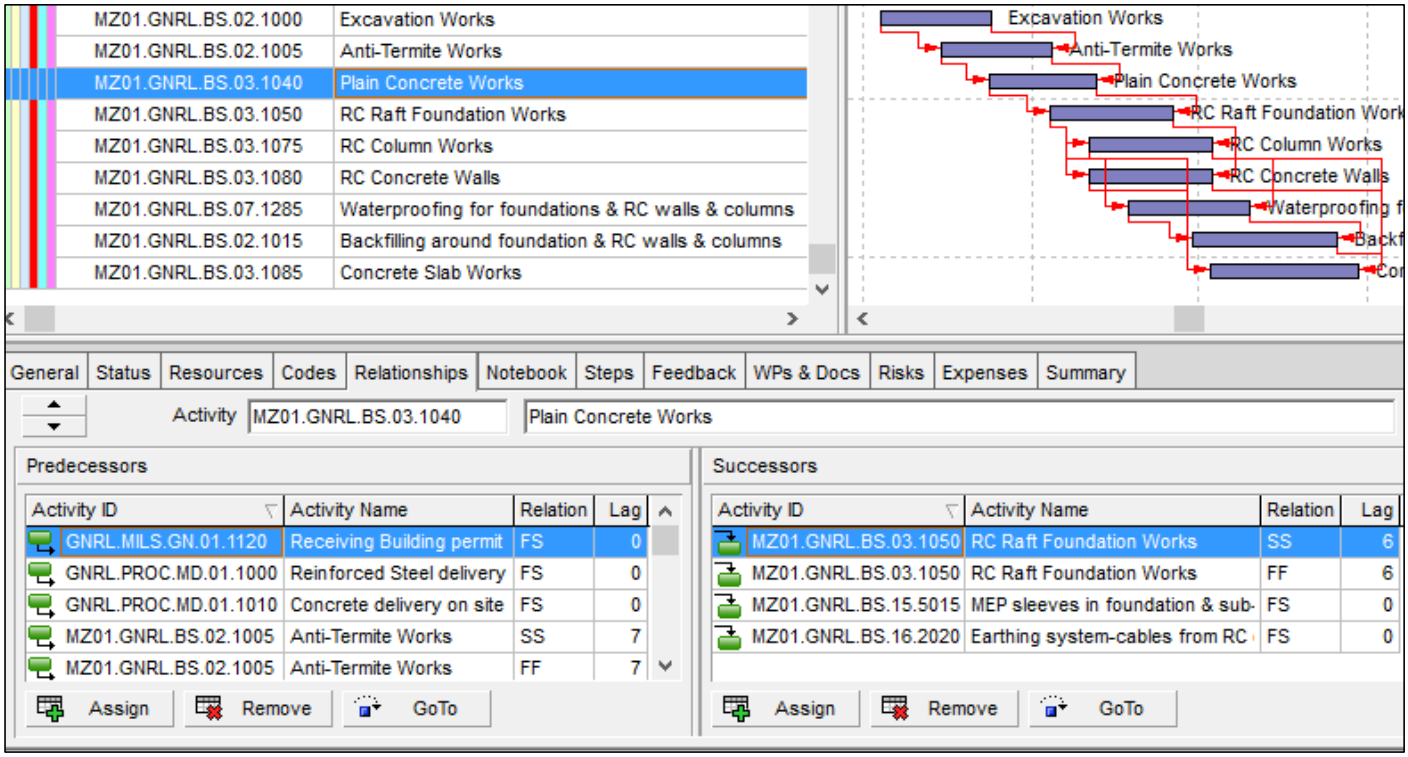
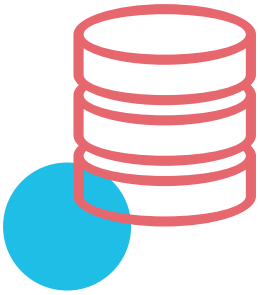


Figure 18 : Sequencing Activities



Resources are then estimated by defining the type, and amount of the resources need to complete each activity; this is usually performed considering the physical quantity produced by this activity; for example, 1 hour of mason's effort produces 1.4 square meters of masonry works, thus, if the physical quantity of a masonry works activity is 14 square meters, then the required man-hours (effort) to perform this activity equals to 10 hours of masons' work. Figure 19 shows an example of resource requirements assigned to activities.

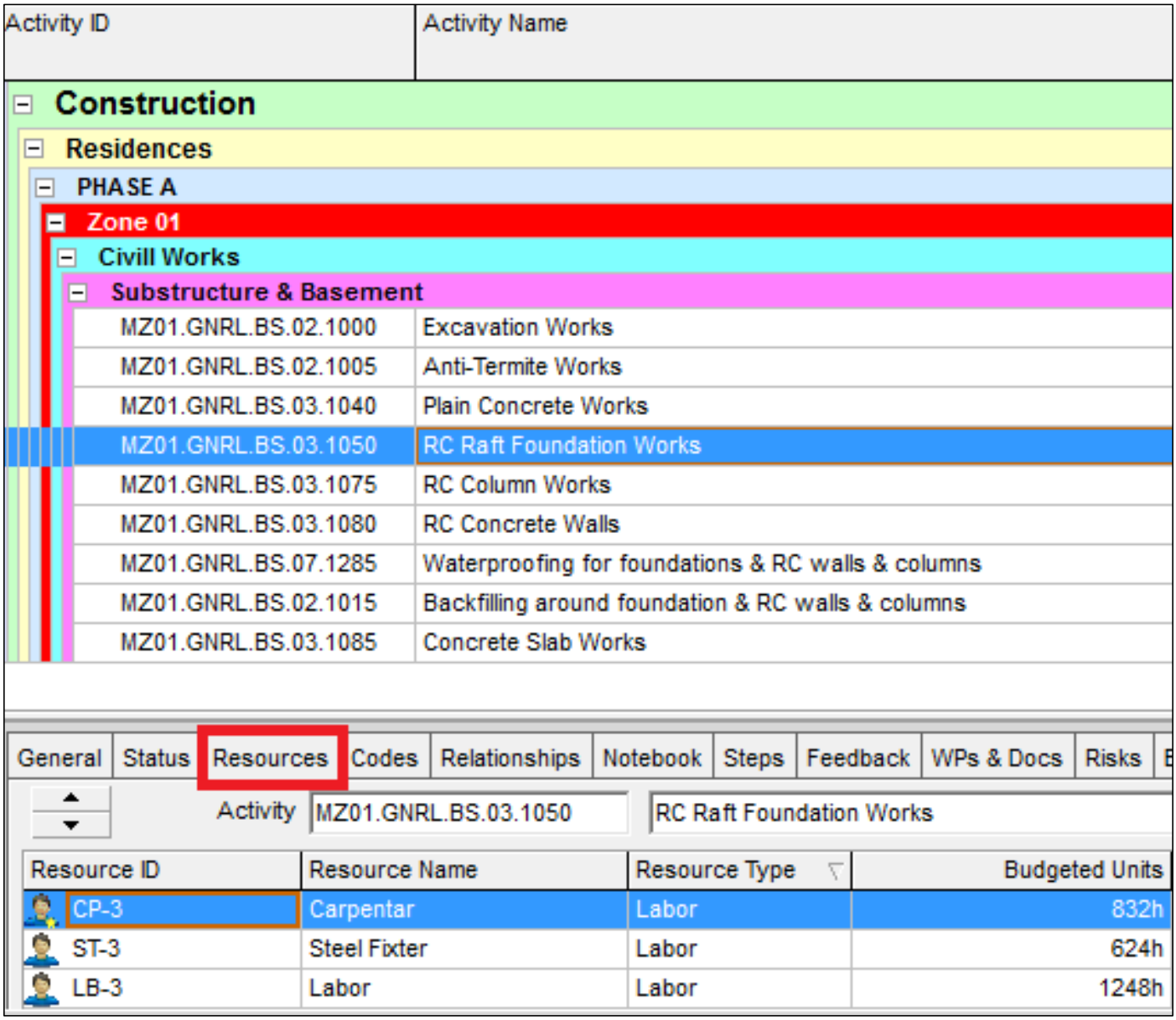
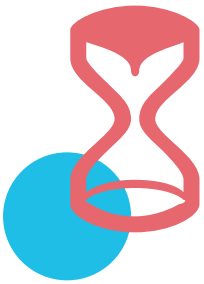


Figure 19: Sequencing Activities

Based on the estimated resource requirements and resources availability; durations of activities are estimated; for example, if masonry works activity requires 40 hours of mason work, and only one Mason is available with eight working hours per day, then the activity duration equals 40 divided by 8 equals five working days. Figure 20 shows a portion of estimated durations assigned to activities.

Activity ID	Activity Name	Original Duration
Ground Floor		417
Finishes Works		326
Wall & Ceiling Finishes		280
Z012.TA01.GF.04.1160	Masonary works	15
Z012.TA01.GF.09.1390	Internal Plaster works	12
Z012.TA01.GF.09.1405	Putty Coat Works	14
Z012.TA01.GF.09.1425	Gypsum Board / Plaster Board Suspended Ceiling	20
Z012.TA01.GF.09.1410	First painting coats	20
Z012.TA01.GF.09.1415	Final painting coat	20
Flooring		62
Z012.TA01.GF.03.1145	Screed Works	10
Z012.TA01.GF.09.1445	Ceramic tiles for Flooring works	12
Z012.TA01.GF.09.1465	Ceramic Skirting works	6
Z012.TA01.GF.09.1470	Porcelain tiles for Flooring	20
Z012.TA01.GF.09.6000	Floor finishes for balcony / terrace (including waterproofi	20
Z012.TA01.GF.09.1475	Porcelain skrting works	20
Wet Areas		60
Z012.TA01.GF.07.1290	Damp proofing for wet areas	20
Z012.TA01.GF.09.1460	Tiles works (ceramic / porcelain) for Wet Areas Walls	20
Z012.TA01.GF.09.1455	Tiles works (ceramic / porcelain) for Wet Areas Flooring	20
Doors & Windows		40
Z012.TA01.GF.08.1360	Wooden Doors installation	20
Z012.TA01.GF.08.1355	Windows installation	27
Z012.TA01.GF.08.1375	Aluminum Doors installation	20

Figure 20 : Assigning Durations to Activities



Based on the developed activity list, the sequencing of activities, assigned resources and assigned durations, the project schedule has been developed considering the required project dates and constraints. A portion of the developed schedule is shown in Figure 21

Activity ID	Activity Name	Original Duration	Planned Start	Planned Finish
First Floor		240	03-Oct-16	12-Jul-17
Finishes Works		195	23-Nov-16	12-Jul-17
Wall & Ceiling Finishes		187	23-Nov-16	03-Jul-17
Z062.VIL1.FF.04.1160	Masonary works	12	23-Nov-16	07-Dec-16
Z062.VIL1.FF.09.1390	Internal Plaster works	15	21-Dec-16	08-Jan-17
Z062.VIL1.FF.09.1405	Putty Coat Works	15	08-Feb-17	26-Feb-17
Z062.VIL1.FF.09.1425	Gypsum Board / Plaster Board Suspended Ceiling	16	17-Apr-17	06-May-17
Z062.VIL1.FF.09.1410	First painting coats	15	06-May-17	23-May-17
Z062.VIL1.FF.09.1415	Final painting coat	12	15-Jun-17	03-Jul-17
Flooring		51	26-Feb-17	26-Apr-17
Z062.VIL1.FF.03.1145	Screed Works	12	26-Feb-17	12-Mar-17
Z062.VIL1.FF.09.1445	Ceramic tiles for Flooring works	16	12-Mar-17	30-Mar-17
Z062.VIL1.FF.09.1465	Ceramic Skirting works	8	30-Mar-17	09-Apr-17
Z062.VIL1.FF.09.1470	Porcelain tiles for Flooring	15	30-Mar-17	17-Apr-17
Z062.VIL1.FF.09.6000	Floor finishes for balcony / terrace (including waterproof	4	17-Apr-17	22-Apr-17
Z062.VIL1.FF.09.1475	Porcelain skrting works	8	17-Apr-17	26-Apr-17
Wet Areas		35	12-Mar-17	22-Apr-17
Z062.VIL1.FF.07.1290	Damp proofing for wet areas	7	12-Mar-17	20-Mar-17
Z062.VIL1.FF.09.1460	Tiles works (ceramic / porcelain) for Wet Areas Walls	14	20-Mar-17	05-Apr-17
Z062.VIL1.FF.09.1455	Tiles works (ceramic / porcelain) for Wet Areas Flooring	14	05-Apr-17	22-Apr-17
Doors & Windows		20	23-May-17	15-Jun-17
Z062.VIL1.FF.08.1360	Wooden Doors installation	10	23-May-17	04-Jun-17

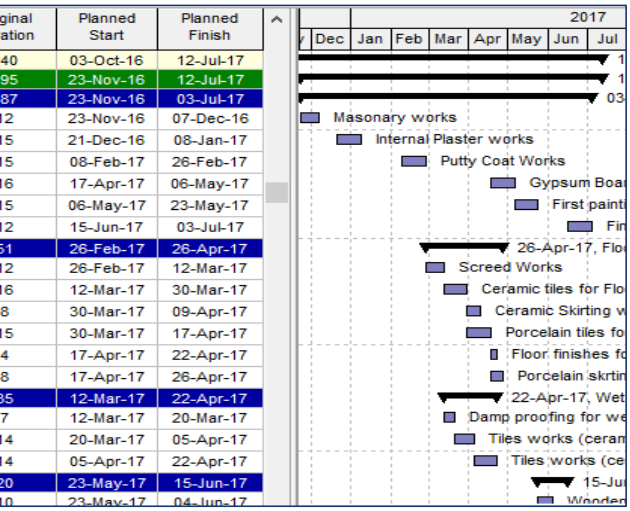
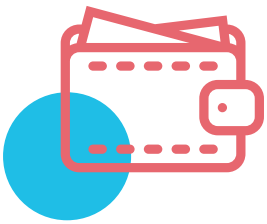


Figure 21 : Developed Project Schedule



Concurrently, project costs have been estimated considering bottom-up estimating by breaking each item into more detailed components and requirements to obtain accurate estimates. Figure 22 shows a portion of the cost estimation.

Item Description	Unit	Material				LABOUR					Miscellaneous			
		Unit	Qty	Rate	Amount ($)	PROD.	MDAY (Duration)	MANDAY-RATE	RATE / UNIT	Amount ($)	Unit	Qty	Rate	Amount ($)
Concrete Slab Works	**m3**	**m3**	**68.51**	**836.93**	**57,338**		**145.96**			**16,351**	**m3**	**68.51**	**10.00**	**685**
Concrete (C30)		m3	72	265	19,063									
Reinforcement steel		Ton	14	2,650	36,220									
Formwork		L.S	69	30	2,055									
Miscellaneous											L.S	69	10	685
Carpenter						1.5	46	128	85	5,846				
Steel Fixer						2.5	27	128	51	3,508				
Labor						0.9	73	96	102	6,997				
Concrete Beam Works	**m3**	**m3**	**9.43**	**687.80**	**6,486**		**8.17**			**946**	**m3**	**9.43**	**10.00**	**94**
Concrete (C30)		m3	10	265	2,624									
Reinforcement steel		Ton	1	2,650	3,673									
Formwork		m3	9	20	189									
Miscellaneous											m3	9	10	94
Carpenter						3.0	3	128	43	402				
Steel Fixer						5.0	2	128	26	241				
Labor						3.0	3	96	32	302				

Figure 22 : Estimating Costs

After estimating costs and developing the project schedule, the estimated costs are assigned to their corresponding activities in the project schedule in order to obtain a time-phased budget; the output of this process is the cost baseline, which could be represented by S-curve as shown in Figure 23.

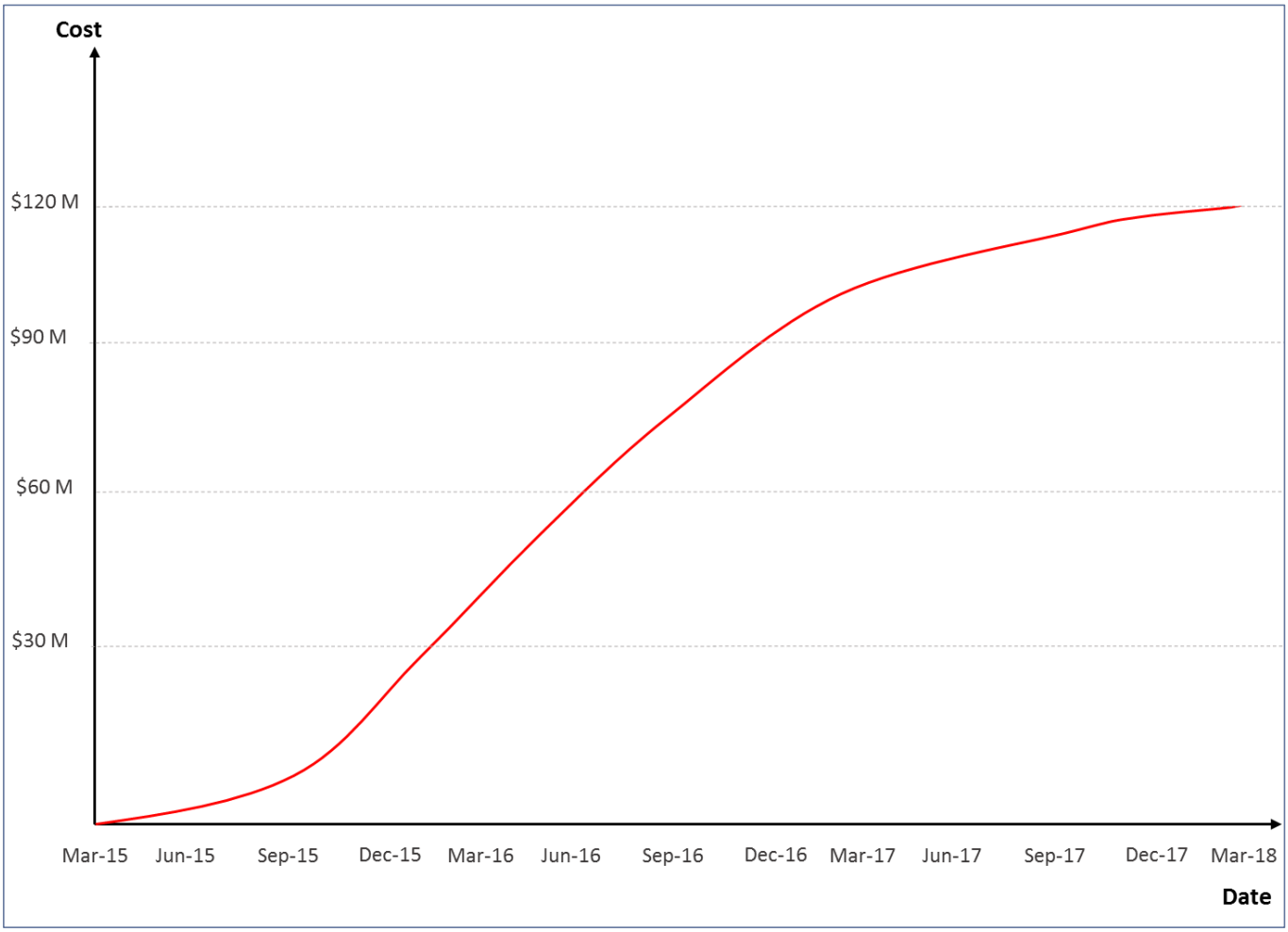


Figure 23 : Cost Baseline

Risk management processes are then performed; risks are identified by involving several stakeholders in order to produce a risk register, this has been done via interviews, and brainstorming considering the available and extensive experience of the involved stakeholders; each identified risk has been prioritized through qualitative risk analysis process considering the probability of occurrence and the impact; the results identified priority group of risks where responses and actions should be focused on. Figure 24 shows the risk register after being updated with the qualitative risk analysis process.

Risk ID	Risk Description (Cause – Risk – Effect)	Risk Owner	Probability	Impact	Priority
R001	Incomplete definition of requirements **may cause** many changes to the scope **which may affect** the project planned dates and budget	Project Manager	Medium	Very High	**Priority 1**
R002	Using only one source of electricity **may cause** power failure **which may affect** construction progress	Project Manager	Medium	Medium	**Priority 2**
R003	Utilizing a nominated subcontractor **may cause some** difficulties in coordination **which may affect** the quality of deliverables and the completion date of the project	Project Manager	Medium	High	**Priority 2**

Figure 24 : Risk Register after Qualitative Risk Analysis

Quantitative risk analysis is then performed to evaluate the combined effect of individual risks and the overall risks on the project objectives; probability distributions have been defined to represent the impact of risks; for example, the risk "Delay in obtaining required permits from related authorities" could follow triangular distribution to represent its expected duration as follows: 8 days (optimistic), 13 days (most likely), and 16 days (pessimistic).

Other risks are represented considering the same concept in a simulation tool/software that utilizes Monte Carlo simulation to perform its function; the results show the project finish date plotted against the corresponding level of confidence as shown in Figure 25; while Figure 26 shows sorting of project risks (Tornado diagram / Sensitivity analysis) considering their influence on the project objective being studied (time).

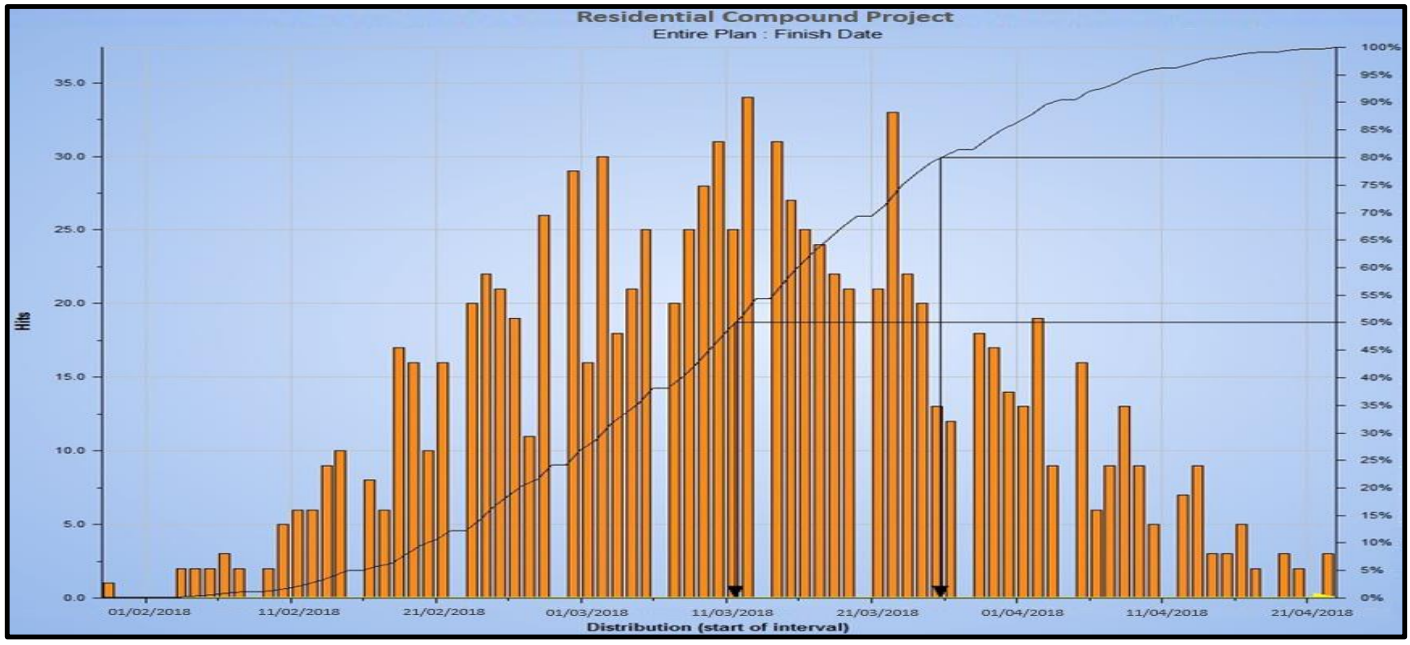


Figure 25 : Project Finish Date and Confidence Levels

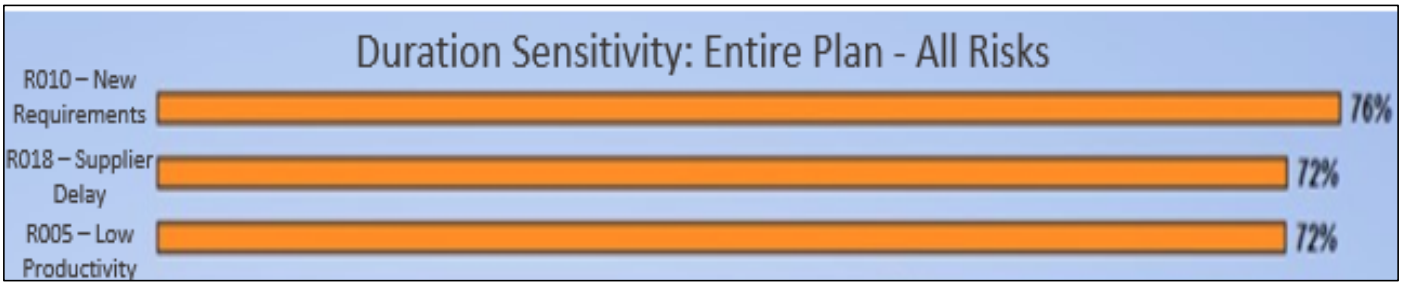


Figure 26 : Portion of Tornado Diagram / Sensitivity Analysis

After finalizing the risk analysis process, risk responses have been defined as shown in Figure 27.

Risk ID	Risk Description (Cause – Risk – Effect)	Risk Owner	Probability	Impact	Priority	Planned Response
R001	Incomplete definition of requirements **may cause** many changes to the scope **which may affect** the project planned dates and budget	Project Manager	Medium	Very High	**Priority 1**	Conducting sessions for brainstorming and finalizing requirements collection
R002	Using only one source of electricity **may cause** power failure **which may affect** construction progress	Project Manager	Medium	Medium	**Priority 2**	providing two electrical generators to be utilized during construction if power failure occurred
R003	Utilizing a nominated subcontractor **may cause some** difficulties in coordination **which may affect** the quality of deliverables and the completion date of the project	Project Manager	Medium	High	**Priority 2**	Conduct coordination meetings continuously

Figure 27 : Risk Register after Plan Risk Responses

" The results of risk management planning processes are used to update / re-planning the project management plan and baselines to consider the risk effect on the project objectives and to incorporate the corresponding actions in order to control the risks and prevent/mitigate their effect on the project objectives. "

Project Executing

It is worth to mention that the project management processes of executing process group are performed without considering a specific order.

Concurrently, while the planning process is being performed, the project team has been started to be formed and acquired progressively via acquiring resources process.

The project manager applied and considered the following techniques while acquiring resources

Negotiation: the project manager has negotiated with the functional manager and other project managers in the same organizations for specific team members; the project manager has applied his interpersonal skills to acquire these members as he believes that they could contribute to the success of the project.

Pre-assignment: there is one nominated subcontractor (MEV) for the electromechanical system. The project manager has applied conduct procurement process to consider this pre-assignment, and he has built an agreement between TPE Organization and MEV Company as shown in Figure 28.

Date of Contract

March 15th, 2015

Contract Parties

- TPE Organization represented by Engineer Sameh Ahmed (Buyer).
- MEV Company represented by Mr. Mazen Ibrahim (Subcontractor).

Contract Background

TPE organization is in the process of developing the residential compound project. Thus, TPE has entered into this contract with MEV company to complete the works of electromechanical systems as per the contract documents.

Contract Price

$22 Million

Contract Duration

30 Months starting from the agreement date

Order of precedence

1. Contract Agreement.
2. Contract Particular Conditions.
3. Contract General Conditions.
4. Design Drawings.
5. Bill of Quantities.
6. Specifications.

Figure 28: Portion of Agreement between TPE and MEV

Direct and Manage project work process is achieved continuously throughout the project, and it is considered the umbrella for all the executing processes. The project manager in this project has performed the following:

- Leading the execution of the construction work at the site by directing and managing the responsible team members to deliver the required materials and assign the needed resources to several work disciplines, such as concrete work, finishing work, etc.
- Managing the nominated subcontractor by coordinating the civil works and the electromechanical system works to minimize clashes and conflicts and save time.
- Producing deliverables which are consistent with the project management plan; these deliverables include completed villas, completed phase, completed networks, etc.
- Implementing all the approved change requests.
- Collecting work performance data, which shows the progress percentage and the actual dates of activities, as shown in Figure 28.

Activity ID	Activity Name	Activity % Complete	Actual Start	Actual Finish	Remaining Duration
A1150	Excavation works for Zone 1	100%	02-Apr-15	20-Apr-15	0
A1160	Excavation works for Zone 2	60%	28-Apr-15		8
A1170	Excavation works for Zone 3	20%	28-Apr-15		16
A1180	Excavation works for Amenities	0%			45

Figure 29: Work Performance Data

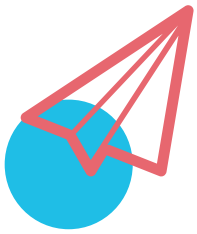
Implementing risk responses that have been planned is also performed while directing and managing project work. From these responses, one unconditional response which is "providing two electrical generators to be utilized during construction if a power failure occurred."

Quality has been managed via manage quality process by ensuring that all the work performed is executed as per specific procedures, standards, and guidelines; for example, before delivering and pouring concrete, the project manager ensures that the following processes have been defined and considered:

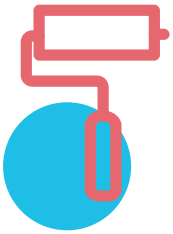
- Standards and specifications for concrete mix design have been defined;
- The concrete batch plant is complied with standards and specifications;
- Concrete has been checked via slump test before pouring; and
- Workforce experienced with concrete pouring are available.

Manage project knowledge has been achieved by the project manager by reviewing the lessons learned of previous similar projects; the main item that has been considered is the importance of continuously involve stakeholders throughout the project phases to increase the chance of final acceptance and for achieving stakeholders satisfaction, and thus, achieve project objectives.

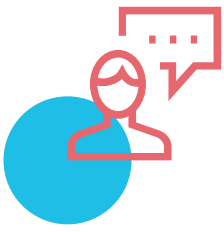
Manage stakeholder engagement has been performed as follows:



At the start of construction works, and throughout performing the excavation and the concrete works have resulted in noise and traffic issues nearby the site; at this stage, the project manager focused on meeting with the surrounding residents to discuss that the project adds value to the whole district. He also conducted many friendly events with these residents to maintain effective relationship with them and decrease their resistance to the project.



Throughout the construction works, the project manager focused on involving the customers/end users to know their preferences regarding the decoration, final finishes, and fixtures; this was achieved by providing a prototype which comprises several options which are within the project budget; several end users showed their preferences which helped the project manager to produce deliverables that achieve customer satisfaction.



The project manager has involved the project sponsor in decisions related to project budget when the contingency reserve has been inadequate. The sponsor had the authority to apply management reserves.

It is important to mention that the main important factor in achieving a successful stakeholder engagement is the application of effective communication management via manage communication process as follows

- Interactive communication has been considered between the project manager and the residents nearby the site; this method created an effective relationship between the project manager and those residents and changed them from resistant stakeholders to neutral and supportive stakeholders.
- Push communication method has been applied to distribute project reports, and memos as per defined in the communication management plan.
- Formal written communication has been considered in the contractual issues when dealing with the nominated subcontractors; this type of communication helped to preserve the rights of all parts.

Throughout the project, manage team process has been applied effectively by the project manager; a major conflict has occurred between the technical office manager and the construction manager regarding a connection detail that was ambiguous in the shop drawings, the construction manager claimed that this details should have been more clear while the technical office manager stated that the current level of detail is enough for experienced construction manager to deduce any minor missing details; the project manager applied collaborative/problem solving technique by conducting a separate meeting with each of the conflict parties and emphasising the importance and the value of each of them in the project; he conducted them a meeting including both parties and stated that they are all one team and he proposed a procedure for clarifying such ambiguous issues in the future so that no conflicts will occur; both parties were very satisfied with the project manager action.

In addition to managing the team, the project manager has applied develop team process by defining a monthly team building event, which sometimes was hanging out with the team, traveling to a resort, etc. This activities improved the cohesion between team members and results in increased productivity. Team performance has also been evaluated and assessed producing team performance assessments (example shown in Figure 30 that have been utilized in determining rewards, required training and improvement, etc.

Item	Very Low	Low	Medium	High	Very High
The team is focused on results					✓
The team is optimistic most of time				✓	
Conflicts are solved internally				✓	
Different points of view are valued					✓

Figure 30: Team Performance Assessment

Project Monitoring and Controlling

Monitoring and controlling processes are carried throughout the project; they are not performed in series with executing processes, but they are performed in parallel with all project management processes.

Control scope has been effectively performed by the project manager by ensuring that the work carried out is only the work defined in the scope; he did not consider for application a verbal proposal by the technical office manager to increase the grade of the granite in some facades as he considered this gold plating that is not matching with the project defined scope.

The project manager has controlled schedule by utilizing the work performance data produced via executing processes and analyzing this data to produce work performance information. The work performance data used in controlling schedule includes actual start dates of activities, actual finish dates of activities, the percentage of completion of activities, and remaining durations of activities. This information has been analyzed to produce work performance information such as Schedule Performance Index (SPI) and Schedule Variance (SV). The project finish date on the updated schedule represented the forecasted finish date; this date has been checked continuously to maintain the project schedule and protect it from slippage.

Costs have been controlled by applying earned value management (EVM). The collected work performance data mainly included incurred actual costs. This information has been analyzed

by allocating this costs to their corresponding control accounts and comparing actual costs to earned values by using Cost Performance Index (CPI) and Cost Variance (CV). The forecasted cost at the end of the project (estimate at completion EAC) has been also evaluated continuously to ensure that the project will be completed within the defined budget.

Monitoring and controlling project works has involved representing the work performance information through work performance reports as shown in Figure 31.

Data Date	31-Jul-15

Phase	Zone	Planned Value	Earned Value	Actual Cost	SPI	CPI
Phase 1	1	123,520	126,350	120,415	1.02	1.05
	2	118,426	119,423	118,965	1.01	1.00
	3	95,648	93,413	96,532	0.98	0.97
	4	23,111	25,269	26,610	1.09	0.95
Phase 2	5	20,198	18,650	19,120	0.92	0.98
	6	18,560	16,123	12,553	0.87	1.28
	7	17,960	14,625	12,111	0.81	1.21
	8	10,456				
	9					
Whole Project		**427,879**	**413,853**	**406,306**	**0.97**	**1.02**

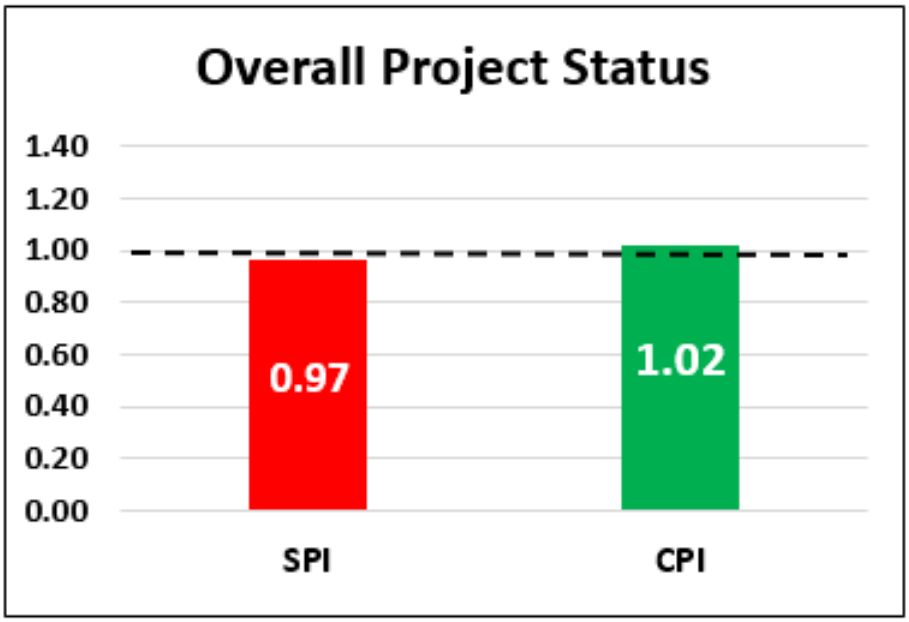


Figure 31: Work Performance Report Example

Resources have been controlled in the project by ensuring the availability of the needed resource to carry out the planned work. The actual number, amounts, or time units of project resources have been documented and compared to the planned number, amounts, or time units at the same time point to identify if any gaps existed and to proceed through recovery actions. Figure 32 shows the actual number of excavators at site compared to the planned number of excavators at the same time, which indicates that more excavators should be acquired to follow the plan effectively.

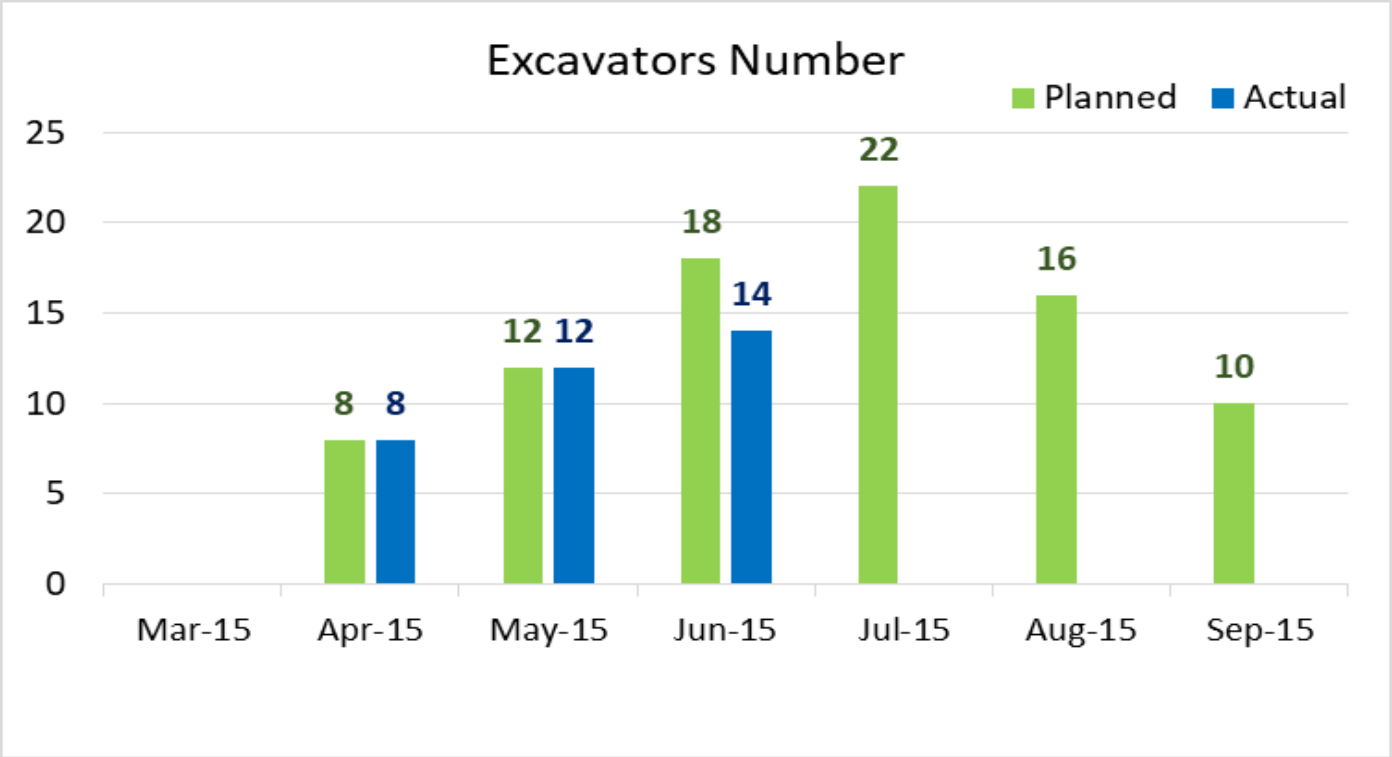


Figure 32 : Actual versus Planned Excavators

Risks have been monitored to check their validity and the adequacy of contingency reserves, and to identify any new risks that could impact the project. The project manager continuously ensured that the risk management processes had been done as defined in the risk management plan. A new major risk has been identified during performing the construction works, which is "the main supplier responsible for

delivering the porcelain tiles is facing financial problems that may prevent him from providing the required amount of porcelain on the required time"; the analysis showed that this risk is a high priority risk and response action has been defined as follows "obtain other quotations from other suppliers to be ready for instant delivery if the main supplier fails to fulfil the requirements", the defined response action has been implemented effectively.

Stakeholders engagement has been monitored throughout the project by the project manager by ensuring that they are involved in the required times and phases as defined in the stakeholder engagement plan; also communications has been controlled by ensuring that all reports are delivered at the required intervals as defined in the communication management plan; and that the communication methods are applied effectively as planned (interactive communication/meetings with sponsor, formal written communication with subcontractor, etc.).

One of the challenges that faced the project manager was dealing with changes and performing integrated change control; by involving the customers/end user throughout the project, a new requirement has evolved, where many customers are preferring to have an indoor basketball court while keeping only one open tennis court instead of having two tennis courts. The project manager has raised a change request to the change control board (CCB) which contains the project sponsor and other subject matter experts; the CCB evaluated the impact of the change request and approved it. The approved change has been updated in the change log and communicated to the project team for updating project plans and baselines, and to be considered for implementation. Figure 33 shows a portion of the submitted change request.

Change Request Main Information

Subject: Adding one basketball court and omitting one tennis court.

Date: October 15th, 2015.

Requester: Sameh Ahmed.

Requester Role: Project Manager.

Change Request Description

By involving the customers/end users, it was observed that most of them prefer to have one basketball court while keeping one tennis court instead of having two tennis courts. Complying with their expectations and requirements is essential for achieving the marketing objectives.

Impact on Project

- There will be no impact on the project schedule finish date as the activities related to implement the change request are not critical activities (analysis attached in Appendix A).
- There will be an extra cost of $60,000 (analysis attached in Appendix B).

Change Control Board Decision

Approved

Required Updates

- Change log.
- Project management plan.

Communicate to

- Project manager (will distribute to all responsible parties).
- Customers/end users.

To increase the chance of final project acceptance, validate scope has been applied by the project manager to obtain formal acceptance for project deliverables; the project manager has been obtaining formal acceptance for each zone/subzone in each project phase to facilitate obtaining the final acceptance at the end of each phase. The formal acceptance obtained via validate scope has been used then in the project closing process.

Project Closing

The project manager performed close project or phase process twice; once after completing phase 1, and the other after finalizing phase 2 and all remaining works. The project manager has performed the following tasks:

- Ensured that the lessons learned are collected and archived to be used in future projects.
- Ensured that all issues have been resolved.
- All payments and issues related to the nominated subcontractor MEV have been finalized and settled and no open claims.
- Completed and ensured the transition of the final product (the villas in addition to related landscape and networks) to the organization and the customers.
- The prepared final report that presents the project objectives and how they have been met.
- Released the project resources.

The project manager performed close project or phase process twice; once after completing phase 1, and the other after finalizing phase 2 and all remaining works. The project manager has performed the following tasks:

Ensured that the lessons learned are collected and archived to be used in future projects.

Ensured that all issues have been resolved.

All payments and issues related to the nominated subcontractor MEV have been finalized and settled and no open claims.

Completed and ensured the transition of the final product (the villas in addition to related landscape and networks) to the organization and the customers.

The prepared final report that presents the project objectives and how they have been met.

Released the project resources.

Figure 34 shows a portion of the developed final report.

Project Objectives Performance

- Objective 1: Achieve the required profit, which equals to or greater than $11 Million.
- Performance: This objective has been achieved.
- Objective 2: Improve the marketplace of TPE organization to be the leading organization in this field.
- Performance: The marketplace of TPE organization has been improved, but still it is not the sole leading organization in the field; more projects are required to achieve this strategic objective.

Milestones Performance

Phase 1 has been completed before the required date; while phase 2 has been completed exactly on the required time.

Lessons Learned

- Customers/end users should be involved extensively to achieve their satisfaction with the final product.
- It is important to track to minimize the interval for tracking and monitoring the subcontractors to avoid and reduce delays and conflicts.
- Some standard productivity rates defined in the organizational process assets are not reliable and should be updated with the actual rates attached in the report appendix.

Figure 34 : Portion of the Final Report

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