UNIVERSIDAD PARA LA COOPERACION INTERNACIONAL
(UCI)

Project Management Plan for the construction and implementation of a Solar Photovoltaics (PV) and Battery Storage Microgrid Project

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FINAL GRADUATION PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE
MASTER IN PROJECT MANAGEMENT (MPM) DEGREE

Kingstown, St.Vincent & the Grenadines

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APPROVAL

UNIVERSIDAD PARA LA COOPERACION INTERNACIONAL
(UCI)

This Final Graduation Project was approved by the University as partial fulfillment of the requirements to opt for the Master in Project Management (MPM) Degree

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DEDICATION

First, I want dedicate this work to the Almighty God, thank you for the guidance, strength, power of mind, protection and skills and giving me healthy life.

Also, this study is wholeheartedly dedicated to my beloved wife, who have been the source of inspiration and gave me strength when i thought of giving up, who continually provide the moral, spiritual, emotional, and other support.

To my brothers and sisters who share their word of advice and encouragement to finish this study.

ACKNOWLEDGMENTS

I would like to thank the University for International Cooperation for affording me the un-imaginable opportunity to complete my study here, despite some minor challenges it was a very good experience. I will not forget to thank the tutors, whom for without their patience and understanding, i would not have made it this far. I also remain grateful and thankful for all my colleagues who took part in this masters program. You were all special to me.

In addition I thank the St,Vincent Electricity Services Limited for their relentless support.

Finally, and most importantly, huge thank you to my wife Ingah for her support and also the Almighty GOD, for his grace in me.

INDEX OF CONTENTS

INDEX OF FIGURES

INDEX OF CHARTS

ABBREVIATIONS AND ACRONYMS

- Alternate Current (AC)
- Ex works (EXW)
- Final Graduation Project (FGP)
- Human Resources and Administration (H&RA)
- Kilowatt (kW)
- Megga Vars (MVAR)
- Meggawatt (MW)
- Mineral Products Association (MPA)
- Nominal Power (Pnom)
- Operation and Maintenance (O & M)
- Organization Process Assests (OPA)
- Photovolataic (PV)
- Project Management Body of Knowledge (PMBoK)
- Project Management Institute (PMI)
- Project Management Office (PMO)
- Renewable Energy (RE)
- Responsibility, Accountable, Consult and Inform (RACI)
- St. Vincent Electrcity Services Limited (VINLEC)
- Suppervisory Control and Data Acquisition (Scada)
- System, Mess and Anlagentechnik (SMA)
- Value Added Tax (VAT)
- Wattage (W)
- Wattage hours (Whrs)
- Work Breakdown Structure (WBS)
- Work Package (WP)

EXECUTIVE SUMMARY (ABSTRACT)

Solar technology is fairly new in St.Vincent and the Grenadines, but it can be a very lucrative business due to the fact that the technology is a truly RE source and among other things, it can help customers reduce their electricity bills. In fact energy security is an important goal to seek to realize as an absolute requirement for economic growth and stability. There are several solar design company in St.Vincent but SolarTech design with over 10 years of experience, was approached to design and implement a Solar PV project in Mayreau.

In a highly competitive commercial industry, SolarTech focused its product on the engineering designs-implementation process as a marketing strategy to capture the market share. Also SolarTech advised customers of the different attractive finacing options for solar electric systems. Although experienced in engineering designs and project implementation, SolarTech Designs required the application of formal project management practices to sucessfully execute the project.

The company used some project management tools along with some international solar design and construction standards.

The general objective was to develop a Project Management Plan, framed with the standards of the PMI, to manage the implementation of a Solar PV system. The specific objectives were: to create a project management plan to initiate the project and ; to create a scope management plan that included all the work required to complete the project; to create a schedule management plan to ensure the project is completed within the time limits; to create a cost management plan to confirm the project was completed within the approved budget; to develop a quality management plan that identifed the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits; to create a resource management plan to manage all identified resources within the project time, cost and scope limits; to develop a communication management plan to manage SolarTech timely and effective communication of the project status and other key information; to create a risk

management plan to manage the identifed and examined risks for the successful completion of the project; to develop a procurement management plan to obtain products, services and results required by the project, and to develop a stakeholder management plan to manage the identifed and supported stakeholders of the Project ensuring effective stakeholder engagement.

The methodology used for the research was analytical or explanatory. The main sources used to gather information included A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Sixth Edition and interviews which were held with members from the client and performing organization. The information was analyzed to create each subcomponent of the subsidiary plans used to develop the Project Management Plan for a Solar PV system.

The Project Management Plan, developed using the PMBOK® Guide 6th Edition, provided a new methodology for the project team to build a more thorough project management plan for the project, in order to improve the way the company would manage the project. It also helps to ensure that the project's overall goal and its subsequent task and milestines are all align with the organization business strategy.Overall project management reduces project cost by improving effeciency, mitigating risks, and optimizing resources. Even with the added cost of investing in as project manager, the organization will stand to gain much more.

It is recommended that the project team at SolarTech Designs consider the use of the planning process and documents developed during the development of the Project Management Plan for the design and implementation of the Solar PV system as a basis for developing a methodology for similar projects in the future. Furthermore, the team at SolarTech Designs should also seek to utilize and document management and storage systems, to organize, store and create a central location for project planning documents and future Organizational Process Assets.

1. INTRODUCTION

1.1 Background

SolarTech is a fairly experienced company when it comes to the design and construction of Solar PV system in St.Vincent and the Grenadines. Building on its extensive experience of medium – large scale solar projects, the company is well positioned to meet the challenges of the rapidly growing global solar market. With a strong in-house engineering capability, global scope and unmatched responsiveness, SolarTech will design and delivers high quality solar projects for its clients world-wide.

SolarTech is experienced across the full range of solar power applications, ranging from stand-alone solar parks to complex projects with integrated energy storage. The years of experience of the SolarTech in the thermal power sector, also makes them, an ideal partner for hybrid applications, which combine the advantages of renewable energy sources with conventional power generation. Within the domain of electrical infrastructure, they have significant experience and engineering capability essential for the successful integration of solar power to the grid.

This project is on par to some of the projects that the company has acquired to date and by following the Project Management Plan created as a result of this research project, it is expected that the level of project success will improve significantly.

1.2 Statement of the problem

At SolarTech there are construction guidelines and minor project management elements, specifically management tools, in use to deliver products. However, the project management approach in use is not enough to successfully deliver a product of this magnitude. Due to the size and complexity of the project, it is of great importance to produce an extensive management tool. Each element of the Project Management Plan will be created, along with all the tools, techniques, and concepts used to justify each management decision selected for application.

1.3 Purpose

The project to develop the Management Plan for the Solar Photovoltaic (PV) and Battery Storage Microgrid project is required to effectively create the documents that will later be used by the project management team during the execution, monitoring and controlling, and closing processes. VINLEC (The only electricity power company in St.Vincent and the Grenadines) has contracted SolarTech to construct a Solar Photovoltaic (PV) and Battery Storage Microgrid System. The Solar Photovoltaic (PV) and Battery Storage Microgrid Project will be constructed to reduce the reliance on diesel for electricity generation and in the process reduce the amount of pollution from burning fossil fuel. One of the major benefits of this project is to create a green island which in turn enhance the tourism product for the island since with more solar energy being used for the generation of electricity, there will be less noise and pollution from the usage of diesel generators.

The project manger and the project management team understand the importance of the planning process and the management plan, to the successful completion of the project. During the project, the project manner will plan to develop the subsidiaries of the project management plan for the Solar Photovoltaic (PV) and Battery Storage Microgrid Project to meet scope, schedule, cost and quality constraints.

1.4 General objective

The general objective was to develop a Project Management Plan, framed with the standards of the Project Management Institute (PMI), to manage the implementation of a Solar PV system and Battery Storage Microgrid Project on the Island of Mayreau

1.5 Specific objectives

1. To create a project plan to formally authorize the project.

2. To create a scope management plan to ensure that it inludes all the work required to complete the project.
3. To create a schedule management plan to ensure that the project is completed within the schedule limits.
4. To create the cost management plan that establishes the different procedures, policies, and documentation needed to plan, manage, expand, and control the cost of the project within the approved budget.
5. To develop a quality management plan to identify the acceptable level of quality, which is typically defined by the customer, and ensure that the project results meets this expected level of quality in its deliverables and work processes.
6. To create a resource management plan for identifying and acquiring resources (both human and physical) needed to effectively complete the project.
7. To develop a communications management plan to manage the timely and effective communication of the project status and other key information.
8. To create a risk managemnt plan to identify, manage and document risk mitigation strategies.
9. To develop a procurement management plan to obtain products, services and results required by the project.
10. To develop a stakerholder management plan to identify stakeholders, their level of interests and analyses how their influence might impact the project.

2. THEORETICAL FRAMEWORK

2.1 Company/Enterprise framework

2.1.1 Company/Enterprise background

SolarTech is an engineering company that is committed to teamwork and open project leadership. Innovation, global operation, customer orientation, and quality focus are the core competencies that the company uses to excel in the market.

The company has established a good relationship with solar production facilities around the globe. The company place great emphasis on not only acquiring quality products but on implementing quality control processes to ensure product quality and reliability. SolarTech technical staff works hard to maintain the company position at the forefront of solar thermal technology.

The company was contracted to work on this project because it has the technical expertise and experience to complete the project.

2.1.2 Mission and vision statements

Mission

SolarTech is devoted to leading our clients through the design and construction process by providing an unsurpassed service, streamlined management and quality construction in a cost-effective manner.

The company hold certain values that you simply won't find anywhere. SolarTech Design is not just about making money- it's about making the right decision and providing the best services for our customer. We strive to provide the best product in the industry while also keeping you the customer well informed and knowledgeable throughout the process. SolarTech Design strives to be the best of the best, and we go great lengths to provide each one of our customers with service that exceeds their expectations.

Vision

SolarTech vision is to promote the less use of fossil fuel energy since they caused irreversible damage. The more we wait, the worse it will get. The Caribbean region receives a practically unlimited amount of sunlight- why wouldn't be harness it to do our

part to protect the environment. Together, let's choose a more responsible way to per our lives. Let's go solar.

2.1.3 Organizational structure

SolarTech is a relatively small company that is headed by a Manager and has staff of 50 full time employees. The company has three main departments that each have different functions, which when combined, allow for the supply of a quality service. The departments are Planning, Finance and H&RA. Sometimes there is another department that caters for consultants that are contracted on a need basis.

The numbers identified above can increase to include approximately thirty (30) more operational and project management team members while executing project.

Below in figure 1 the company's organization structure is depicted. The company is headed by Mr. Jonathan Baker - the managing director, lead engineer and project manager.

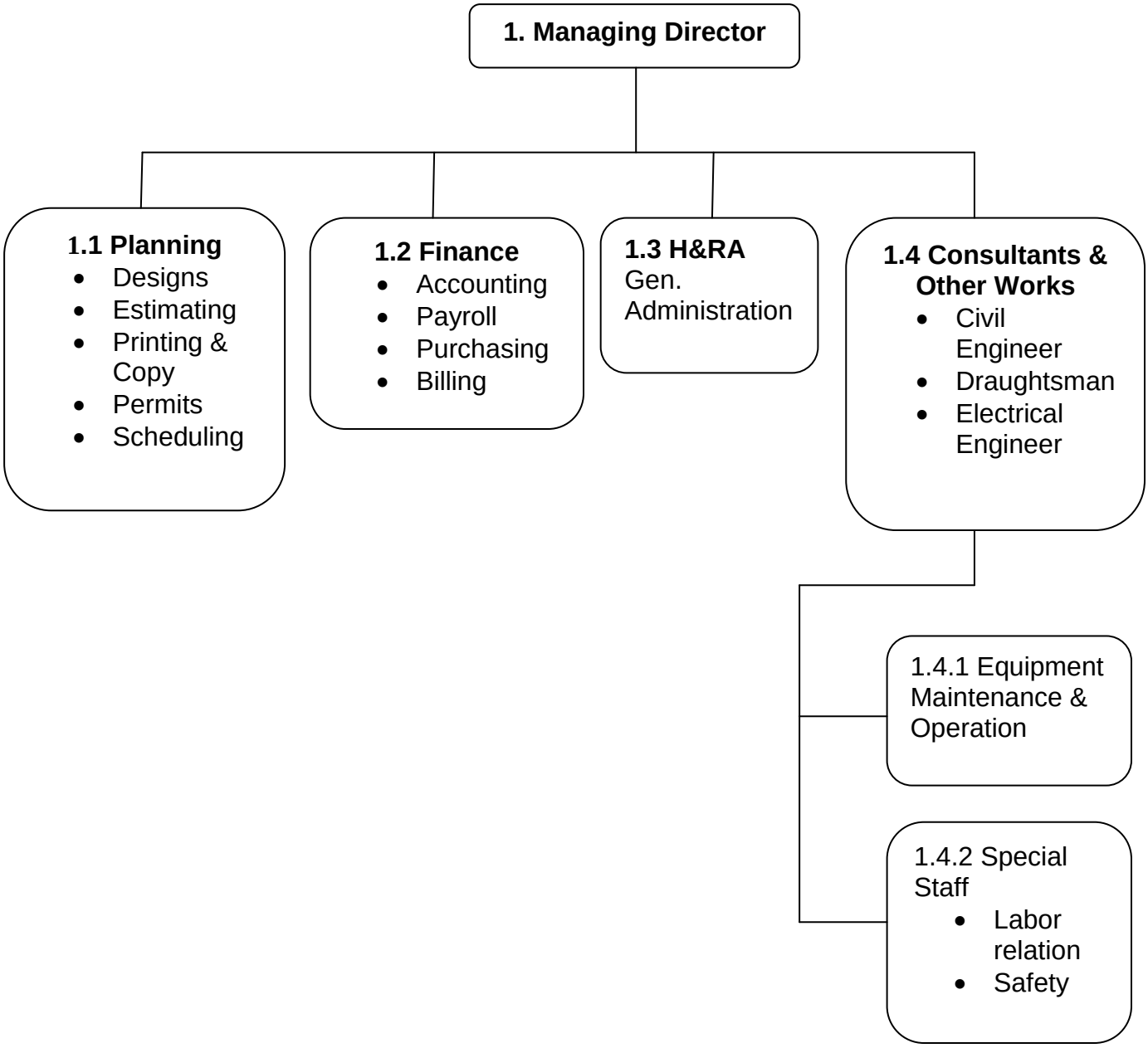

Figure 1 SolarTech organizantional structure (Source: Complied by author)

2.1.4 Products offered

SolarTech offers the following services:

1. design-build,
2. general construction,
3. architecture and engineering services,
4. project management and presentation,
5. feasibility studies, analysis

2.2 Project Management concepts

2.2.1 Project

According to Project Management Institute (PMI, 2017), a project is temporary in that it has a defined beginning and end in time, and therefore defined scope and resources. A project is unique and that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. So, a project team often includes people who don't usually work together, sometimes from different organizations and across multiple geographies.

At SolarTech, a project is twofold. One is based on the view-point of a contractor. As the company specializes in the design-build process, the owner explains both definitions of a project as follows:

As a designer, the owner defines a project as planned work that is finished to a desired result with cost, time, quality and aesthetic controls.

As a contractor, the owner defines a project as an endeavor that involves planning, executing and closing with the delivery of product that adheres to the cost, time, quality and aesthetic controls agreed upon in the contract.

2.2.2 Project management

According to Project Management Institute (PMI, 2017), Project management, then, is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

It has always been practiced informally,but began to emerge as a distinct profession in the mid-20th century. PMI's Guide to the Project Management Body of Knowledge identifies its recurring elements:

Project management processes fall into five groups:

1. Initiating
2. Planning
3. Executing
4. Monitoring and Controlling
5. Closing

The development of the Final Graduation project (FGP) will consist of the creation of the Project Management Plan for the building and implementation of a solar project. After which, the construction of the Solar project will be managed as another project with five phases. Each phase is identified below:

Phase 1: Initiating Phase

Phase 2: Planning/ Design Phase

Phase 3: Construction/Implementation

Phase 4: Post Construction

Phase 5: Project Closing

During the initiation phase of the project to develop the Project Charter and the Project Management Plan for the Solar Project. Once the charter is reviewed, accepted and formally signed by the sponsor, the formal identity of the Project Manager will be revealed, authorizing him to apply organization resources to project activities.

2.2.3 Project life cycle

The PMBOK® Guide (PMI, 2017) identifies fives process groups, they are: Initiating, Planning, Executing, Monitoring and Controlling, and Closing. These five groups represent the processes that a typical project will pass through. Project management is done by grouping project activities into groups while project work is done in phases that are usually time bound.

A project life-cycle is a series of phases that a project passes through from its initiation to its closure. The project life-cycle is a natural progression and the four main stages (phases) in a project life-cycle are concept and approval, planning and preparation, execution work activities, and closing all project activities.

As can be seen in **Figure 2** below, at SolarTech, the project life-cycle on a natural progression in that there are clearly defined phases, where one progresses into another. Moreover, at SolarTech, each of the clearly defined progressive phases has a sequence of activities that are like the process group seen in **Figure 3** below.

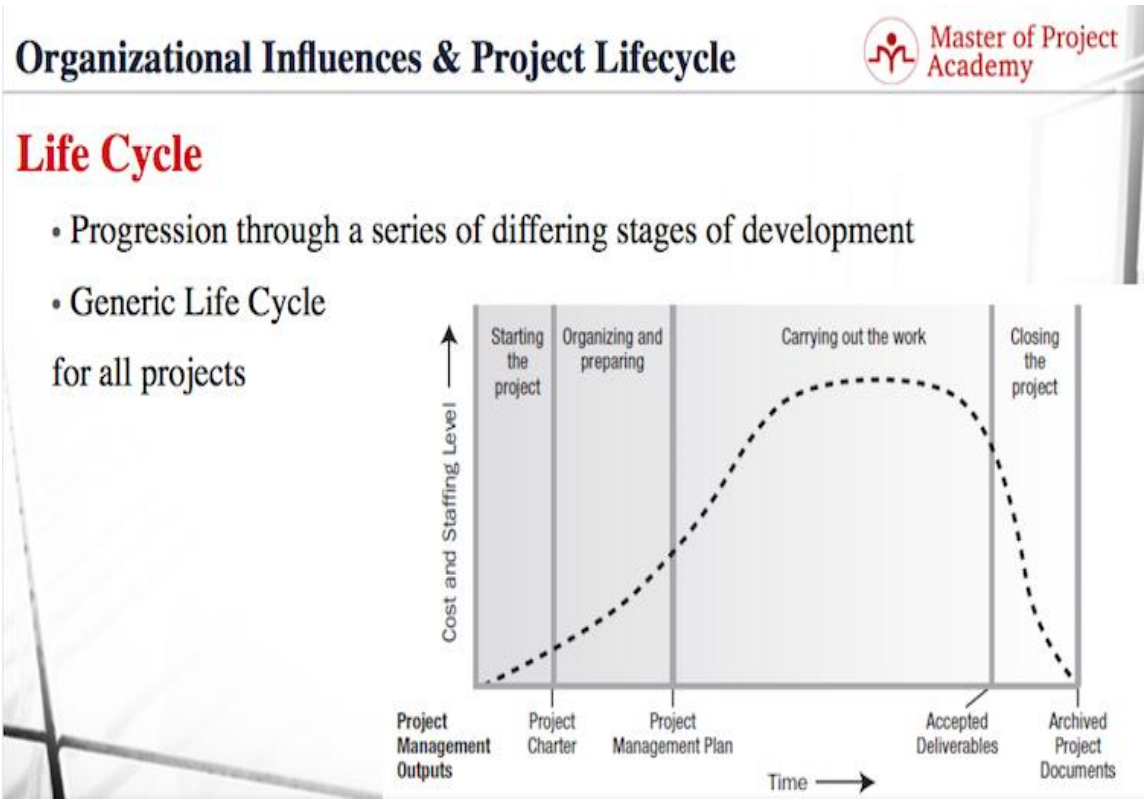

Figure 2 Project life cycle stages of progression (Source: Master of Project Academy, 2017)

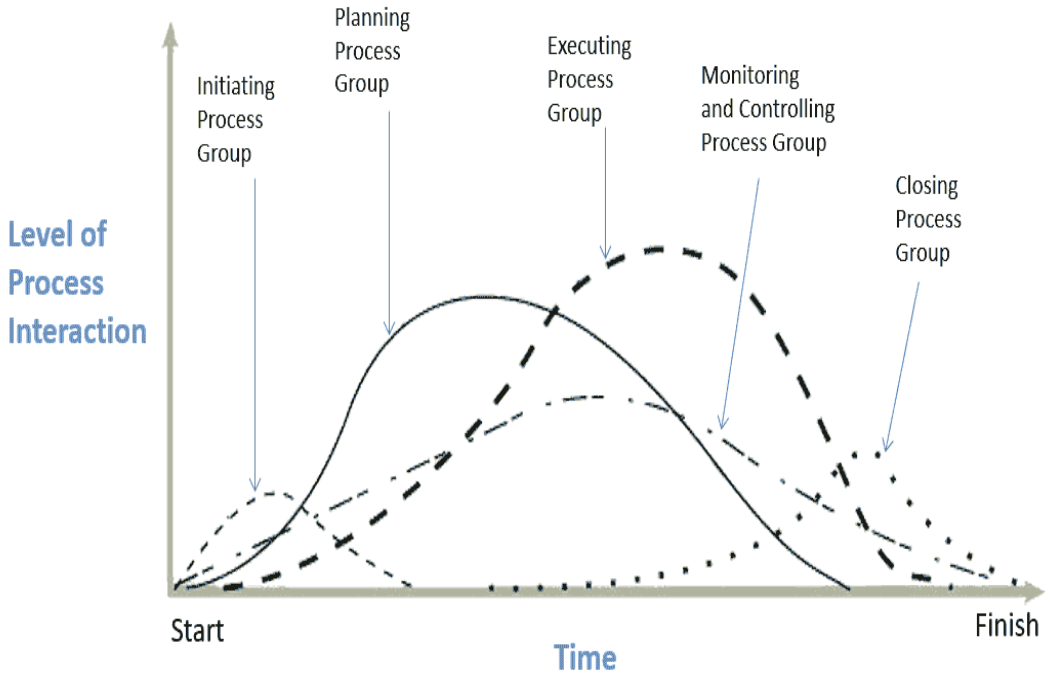

Figure 3 Process group interact in a phase or project (Source: Master of Project Academy, 2017)

2.2.4 Project management processes

Project management processes give a set of guidelines how to work effectively in a given situation in a project, though it is always up to the project manager and project team to put everything into perspective as to how these guidelines are to be followed. This allows better consistency and comparability within an organization and its projects. Though these processes do appear chronological, they are seldom only one-time events. Processes are over lapping throughout the project life cycle and depend on continuous feedback from other processes; for example, the process of Monitoring and Controlling works in unison with the process of Execution, both giving inputs and outputs to one another.

1) Initiating Process Group

The Initiating Process Group handles the processes that need to be done in order for the project to officially start. Within the initiating processes the scope of the project is defined as well as the initial budget and schedule and if not already assigned the project manager will be selected. The final product of this phase is the project charter which includes the basic information of the project, stakeholders and acts a summary for the project. The project can start once the charter is approved.

2) Planning Process Group

The planning process is a group of processes which aim to put together the project management plan. During the planning process group, the total scope of the project, definition and refinement of objectives and the action plans to achieve these objectives are put together to create the core of the project. The project management plan and project documents developed as outputs from the planning process group will explore all aspects of the scope, time, costs, quality, communication, risk and procurements. All of these aspects require constant feedback and outputs from one another throughout the project and may sometimes lead to the need to revisit and revise the project management plan. This progressive detailing of the project management plan is called rolling wave planning. The project management plan is the core of the project and it should be encouraged to receive feedback from various levels of the project organization and external stakeholders before finalizing.

3) Executing Process Group

The Executing Process Group consists of processes which need to be completed in order to achieve the objectives set in the project management plan. This means coordinating people and resources, as well as executing the processes set in the project management plan. The project execution phase is the most volatile of all project phases and as such, it needs close attention and careful planning in the project management plan. If needed, the inputs from execution processes may cause the need to alter the

project management plan. Processes in this group include: Project team acquirement, development and management. Information and stakeholder management and conduction of procurements and quality assurance.

4) Monitoring and Controlling Process Group

The Monitoring and Controlling Process Group consists of those processes required to track, review and regulate the progress and performance of the project. This system works in the fashion of the Deming cycle: Plan, Check, Do, Act. The key benefit of this group is the consistent measurement and analysis of the project performance. Monitoring and controlling a project is the act of measuring project process outputs and keeping these processes within given boundaries or alerting project management on needed changes based on changing project circumstances. Controllers keep track of project schedule, cost, quality, communications, risk, procurement and scope management and report to project management.

5) Closing Process Group

The Closing Process Group consists of the processes needed to complete in order to finalize the project in a controlled manner and to ensure the proper documentation of handing over, post-project reviews and lessons learned to be archived.

These five process groups should be a part of any well thought out project and act as a guideline to successful project execution. It must be remembered though, that each project is different and has different characteristics even though it may seem similar to a past project at first. It is up to the project management and project staff to find the best way to utilize these basic principles.

2.2.5 Project management knowledge areas

There are 49 project management processes identified in the PMBOK Guide grouped into ten separate knowledge areas. A knowledge area represents a complete set of conscepts, terms, and activities that make up a professional field, project management field, or area of specialization. Most of which will be used during the lifecycle of the FGP.

The ten knowledge areas are:

1. Integration–processes that combine, unify and coordinate the various project management activities within the five process groups.
2. Scope–processes that ensure the project includes all the work required, and only the work required, to complete the project successfully
3. Schedule–processes that manage the timely completion of the project
4. Cost–processes that plan, estimate, fund, manage, and control costs so the project can be completed within the approved budget
5. Quality–processes for incorporating the organization's quality policy regarding planning, managing and controlling project and product quality requirements in order to meet stakeholders' expectations.
6. Resource–processes that identify, acquire, and manage the resources needed for the successfully completion of the project.
7. Communications–processes required to ensure the planning, creation, distribution, control and monitoring of project information
8. Risk–processes for planning risk management, the identification, analysis, and monitoring of risks on a project, and the implementation of risk responses.
9. Procurement–processes necessary to purchase or acquire products, services, or results needed from outside the project team.
10. Stakeholder–processes required to identify stakeholders, to analyze their expectations and impact on the project, and to develop management strategies for effectively engaging stakeholders in decisions that affect the project.

According to PMI (2018)‘‘The Project Integration Management Knowledge Area includes the processes and activities needed to identify, define, combine, unify, and coordinate the various processes and activities of project management within the Project Process Groups.’’ (P.69). Processes that are pertinent to this knowledge area are: Develop Project Charter, Develop Project Management Plan, Direct and Manage Project Work, Manage Project Knowledge, Monitor and Control Project Work, Perform Integrated Change Control, and Close Project or Phase. Of these processes this paper will focus on the first two: Develop Project Charter and Develop Project Management Plan.

The Project Integration Management processes are:

4.1 Develop Project Charter—The process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities.

4.2 Develop Project Management Plan—The process of defining, preparing, and coordinating all plan components and consolidating them into an integrated project management plan.

4.3 Direct and Manage Project Work—The process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project’s objectives.

4.4 Manage Project Knowledge—The process of using existing knowledge and creating new knowledge to achieve the project’s objectives and contribute to organizational learning.

4.5 Monitor and Control Project Work—The process of tracking, reviewing, and reporting overall progress to meet the performance objectives defined in the project management plan.

4.6 Perform Integrated Change Control—The process of reviewing all change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating the decisions.

4.7 Close Project or Phase—The process of finalizing all activities for the project, phase, or contract.

Figure 4 provides an overview of the Project Integration Management processes. The Project Integration Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide.

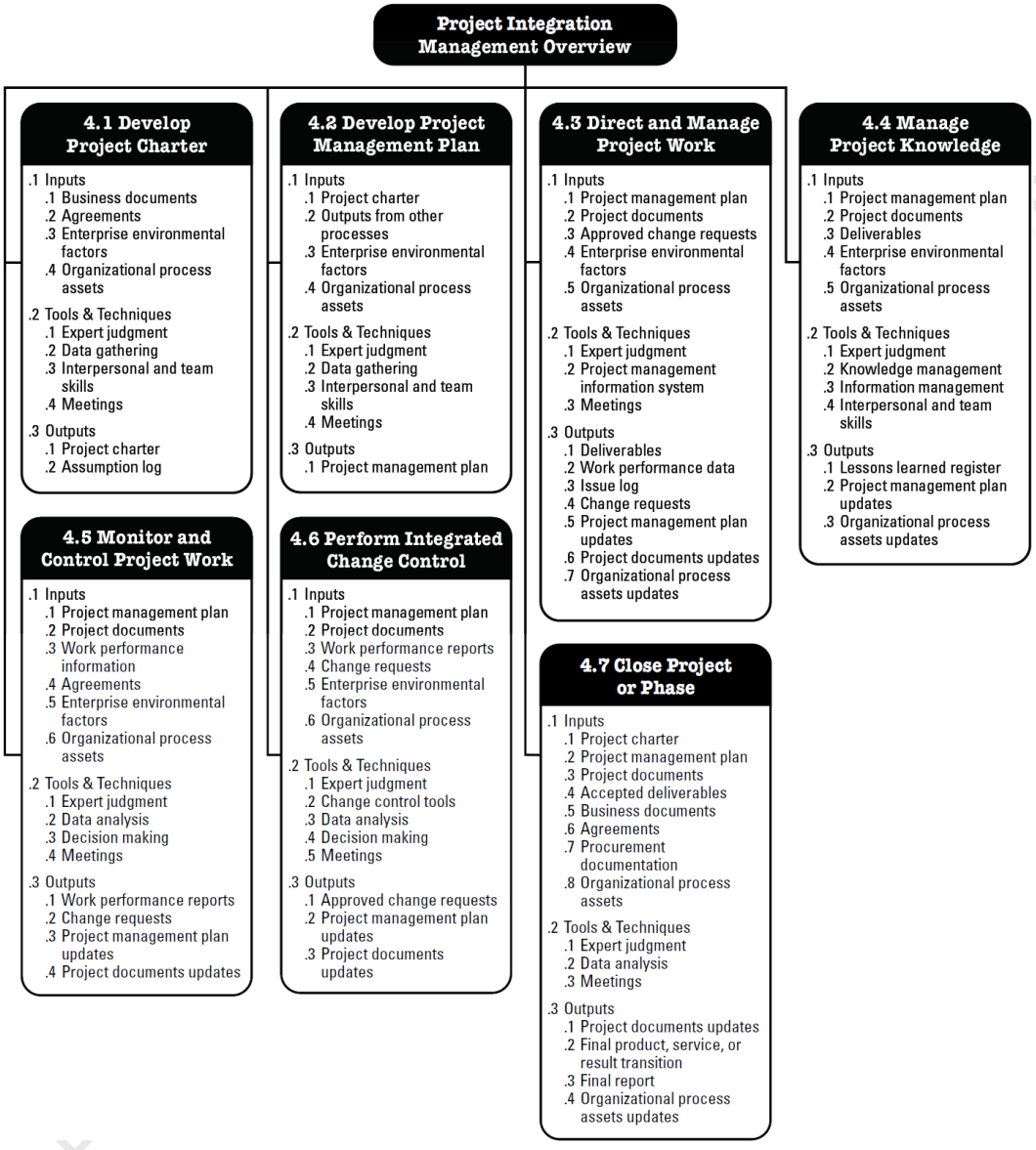

Figure 4 Project Integration Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.71, 2017)

2.3.2 Project Scope Management

Project Scope Management includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully (PMI, 2017, p.129). This means the project manager and his team must determine what is to be included or excluded from the scope. A clearly defined scope may help to prevent scope creep from taking place later during the execution phase. The following are scope management processes identified in the PMBOK® Guide by (PMI, 2017): Plan Scope Management: the process of creating a scope management plan that documents how the project scope will be defined, validated, and controlled. Collect Requirements: the process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives. Define Scope: the process of developing a detailed description of the project and product. Create WBS: the process of subdividing project deliverables and project work into smaller, more manageable components. Validate Scope: the process of formalizing acceptance of the completed project deliverables. Control Scope: the process of monitoring the status of the project and product scope and managing changes to the scope baseline. (p. 129)

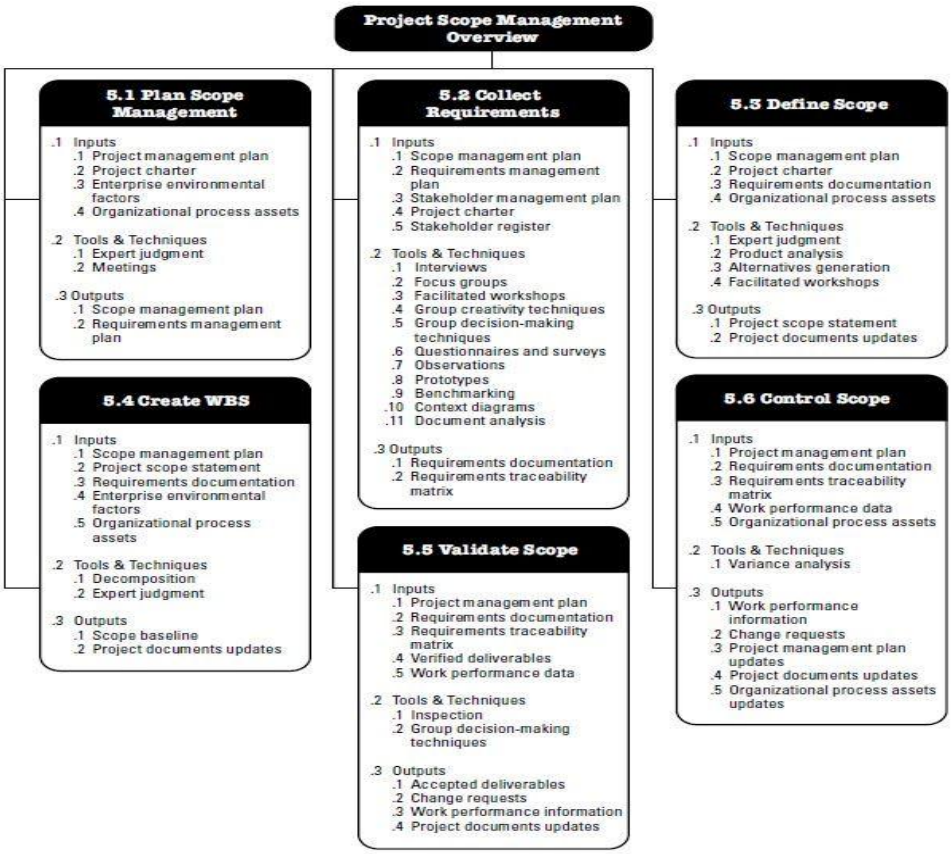

Figure 5 Project Scope Management Overview (Source: A Guide to the Project Management Body of Knowledge Guide. p.130, 2017)

2.3.3 Project Schedule Management

Project Schedule Management includes the processes required to manage the timely completion of the project. The Project Schedule Management processes are:

6.1 Plan Schedule Management—The process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

6.2 Define Activities—The process of identifying and documenting the specific actions to be performed to produce the project deliverables.

6.3 Sequence Activities—The process of identifying and documenting relationships among the project activities.

6.4 Estimate Activity Durations—The process of estimating the number of work periods needed to complete individual activities with the estimated resources.
6.5 Develop Schedule—The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model for project execution and monitoring and controlling.
6.6 Control Schedule—The process of monitoring the status of the project to update the project schedule and manage changes to the schedule baseline.

Figure 6 provides an overview of the Project Schedule Management processes. The Project Schedule Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide.

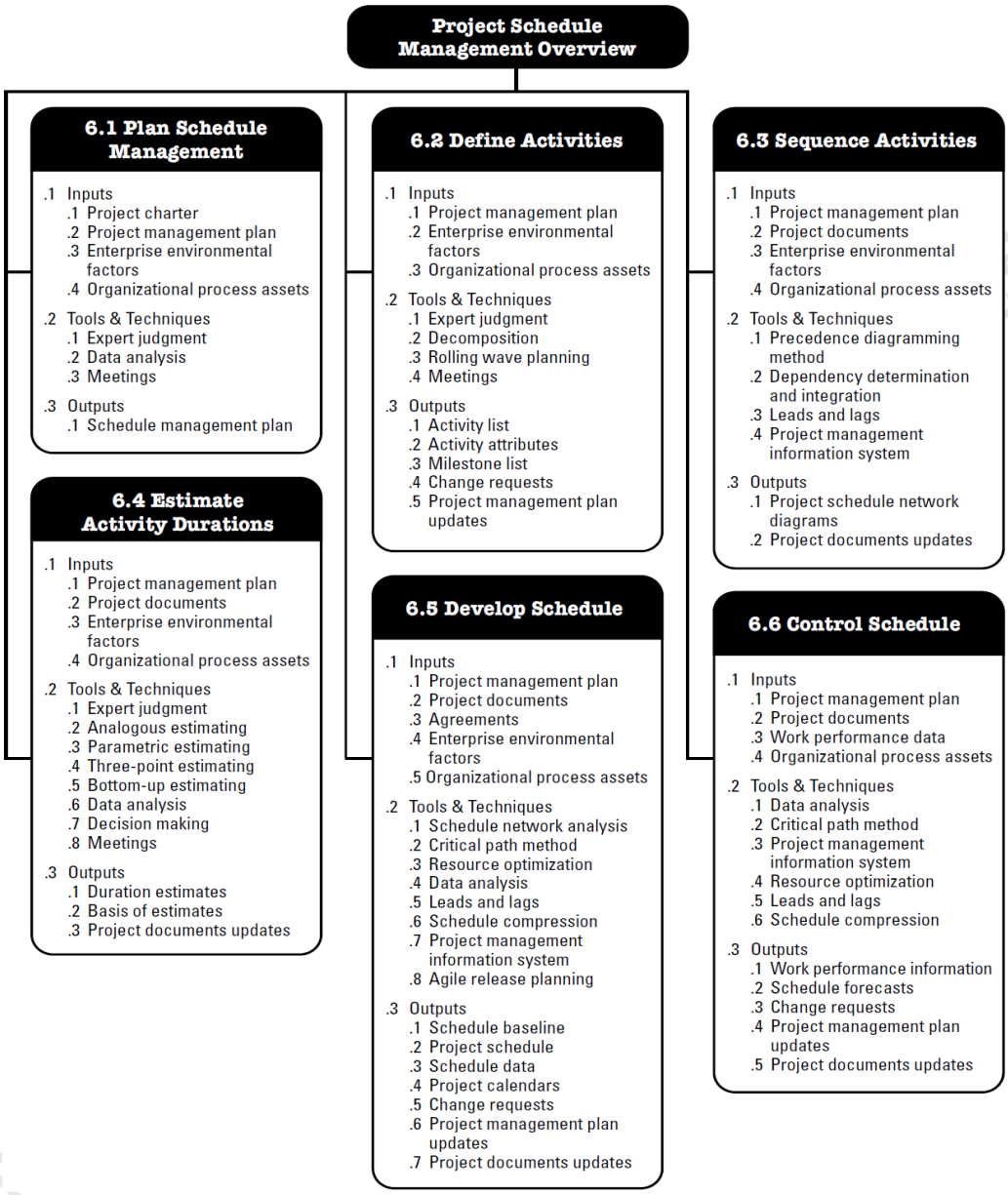

Figure 6 Project Schedule Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.174, 2017)

2.3.4 Project Cost Management

Project Cost Management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget. The Project Cost Management processes are:
7.1 Plan Cost Management—The process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled.
7.2 Estimate Costs—The process of developing an approximation of the monetary resources needed to complete project work.
7.3 Determine Budget—The process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.
7.4 Control Costs—The process of monitoring the status of the project to update the project costs and manage changes to the cost baseline.

Figure 7 provides an overview of the Project Cost Management processes. The Project Cost Management processes are presented as discrete processes with defined interfaces, while in practice they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide. These processes interact with each other and with processes in other knowledge areas.

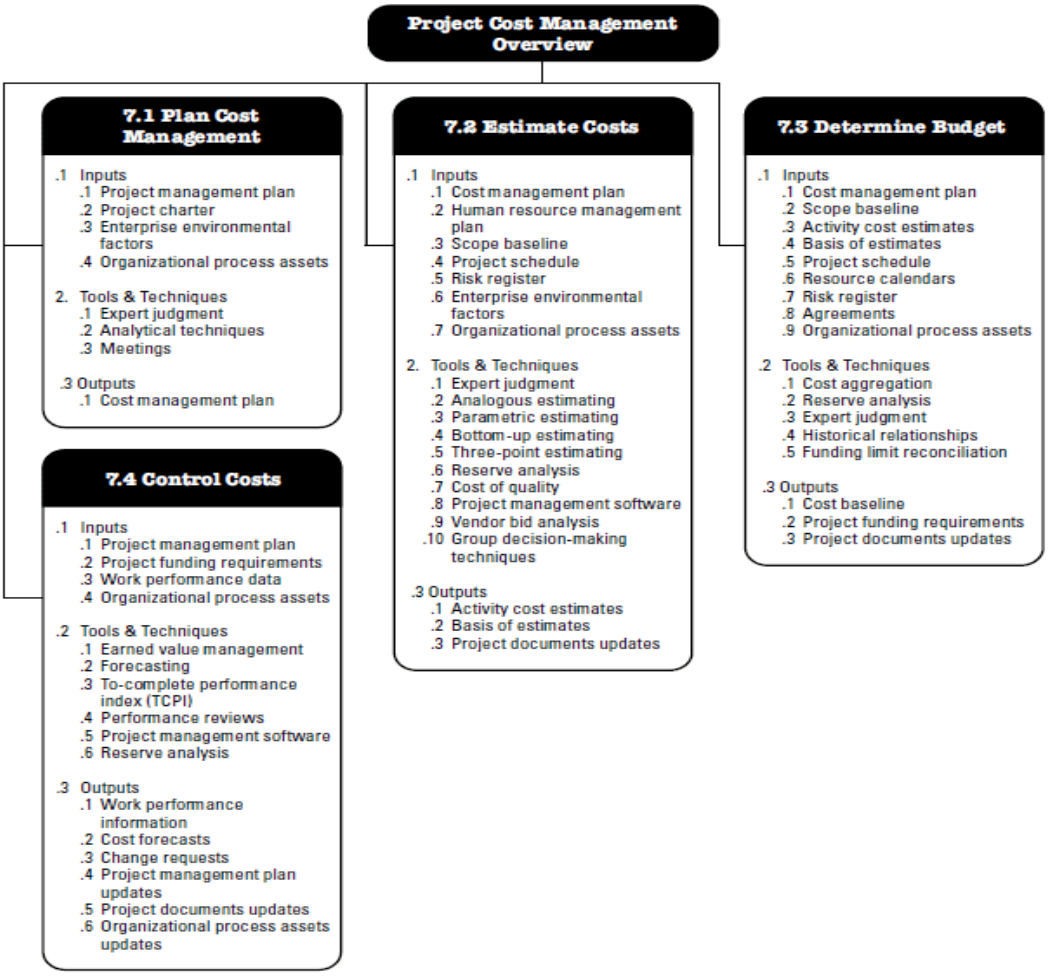

Figure 7 Project Cost Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.232, 2017)

2.3.5 Project Quality Management

Project Quality Management includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements in order to meet stakeholders' objectives. Project Quality Management also supports continuous process improvement activities as undertaken on behalf of the performing organization. The Project Quality Management processes are:

8.1 Plan Quality Management—The process of identifying quality requirements and/or standards for the project and its deliverables, and documenting how the project will demonstrate compliance with quality requirements and/ or standards.

8.2 Manage Quality—The process of translating the quality management plan into executable quality activities that incorporate the organization's quality policies into the project.

8.3 Control Quality—The process of monitoring and recording the results of executing the quality management activities to assess performance and ensure the project outputs are complete, correct, and meet customer expectations.

Figure 8 provides an overview of the Project Quality Management processes. The Project Quality Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide. In addition, these quality processes may differ within industries and companies.

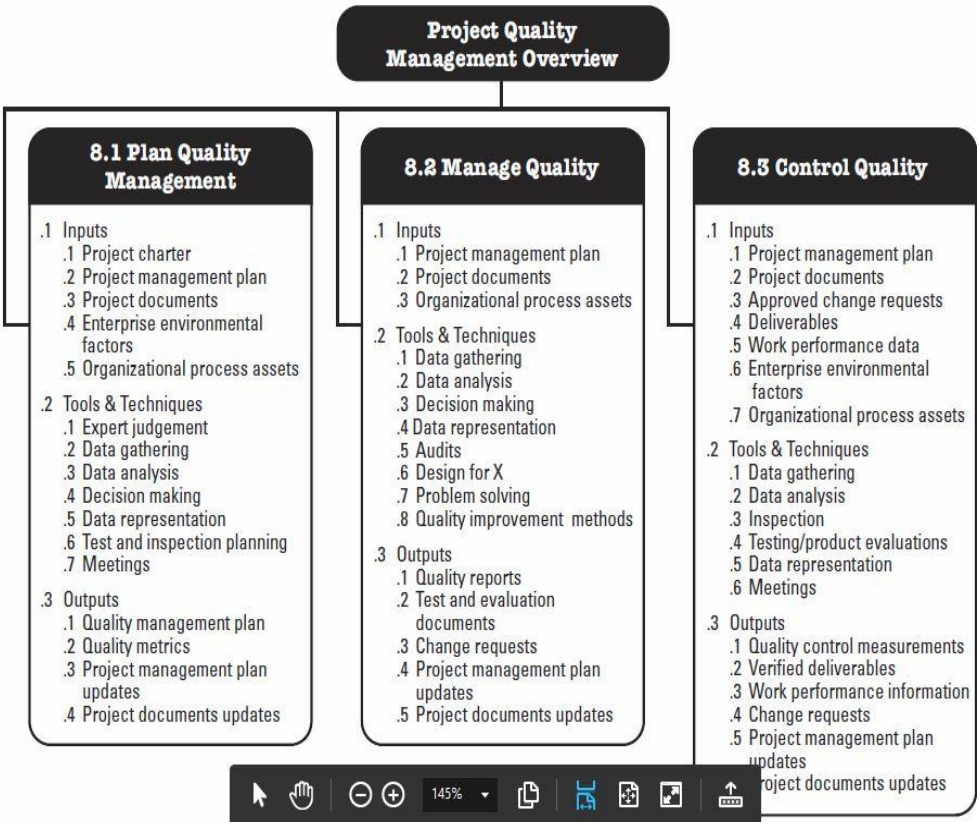

Figure 8 Project Quality Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.272, 2017)

2.3.7 Project Resource Management

Project Resource Management includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project. These processes help ensure that the right resources will be available to the project manager and project team at the right time and place. The Project Resource Management processes are:

9.1 Plan Resource Management—The process of defining how to estimate, acquire, manage, and utilize physical and team resources.

9.2 Estimate Activity Resources—The process of estimating team resources and the type and quantities of material, equipment, and supplies necessary to perform project work.

9.3 Acquire Resources—The process of obtaining team members, facilities, equipment, materials, supplies, and other resources necessary to complete project work.

9.4 Develop Team—The process of improving competencies, team member interaction, and the overall team environment to enhance project performance. 9.5 Manage Team—The process of tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance.

9.6 Control Resources—The process of ensuring that the physical resources assigned and allocated to the project are available as planned, as well as monitoring the planned versus actual use of resources, and performing corrective action as necessary.

Figure 9 provides an overview of the Project Resource Management processes. The Project Resource Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide.

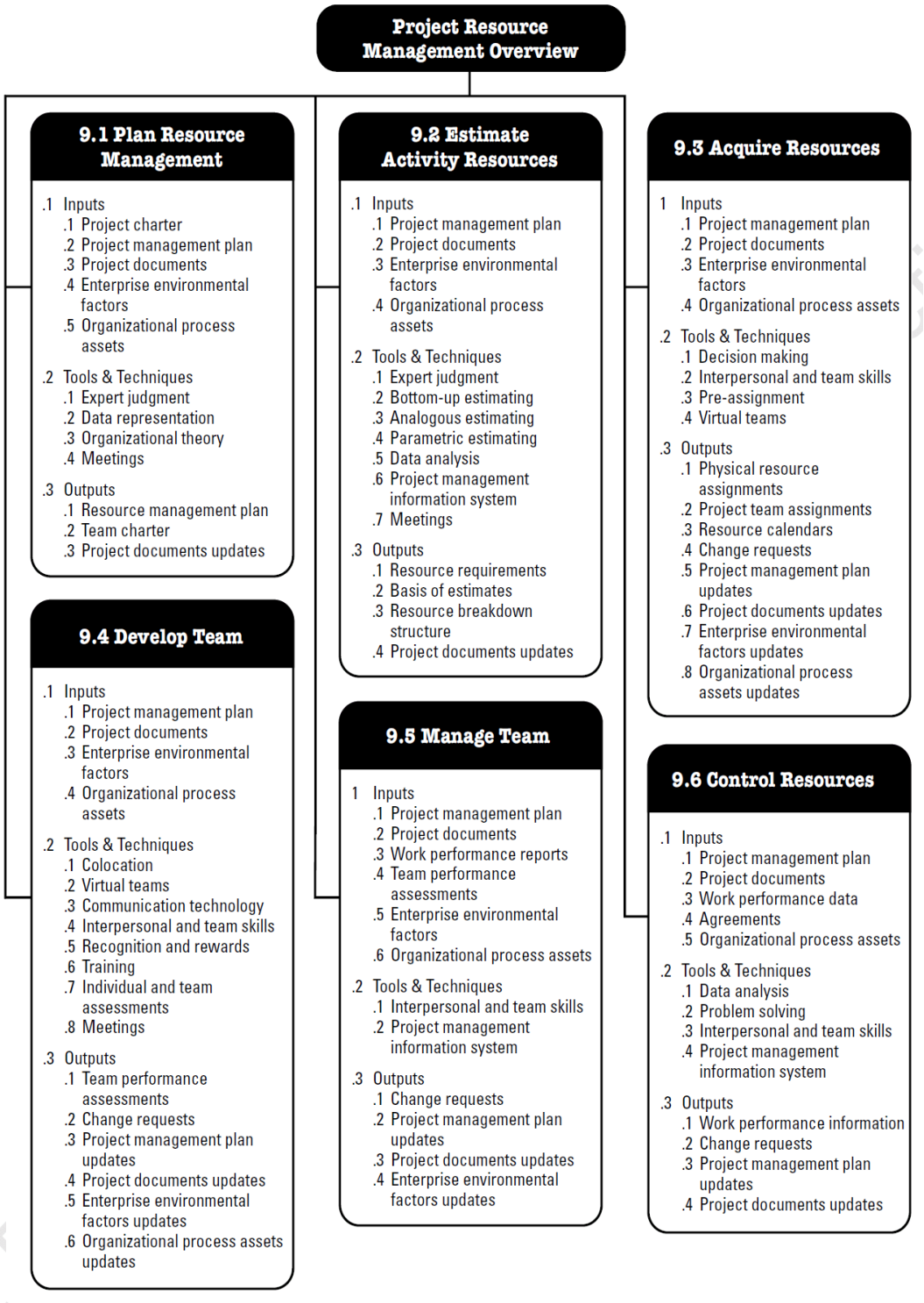

Figure 9 Project Resource Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.308, 2017)

2.3.8 Project Communication Management

Project Communications Management includes the processes that are required to ensure a timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information (PMI, 2017). As such, only process 10.1 will be referenced during project planning to develop the project's Communication Plan.

Figure 10 below outlines the Project Communications Management processes as described in the PMBOK® Guide.

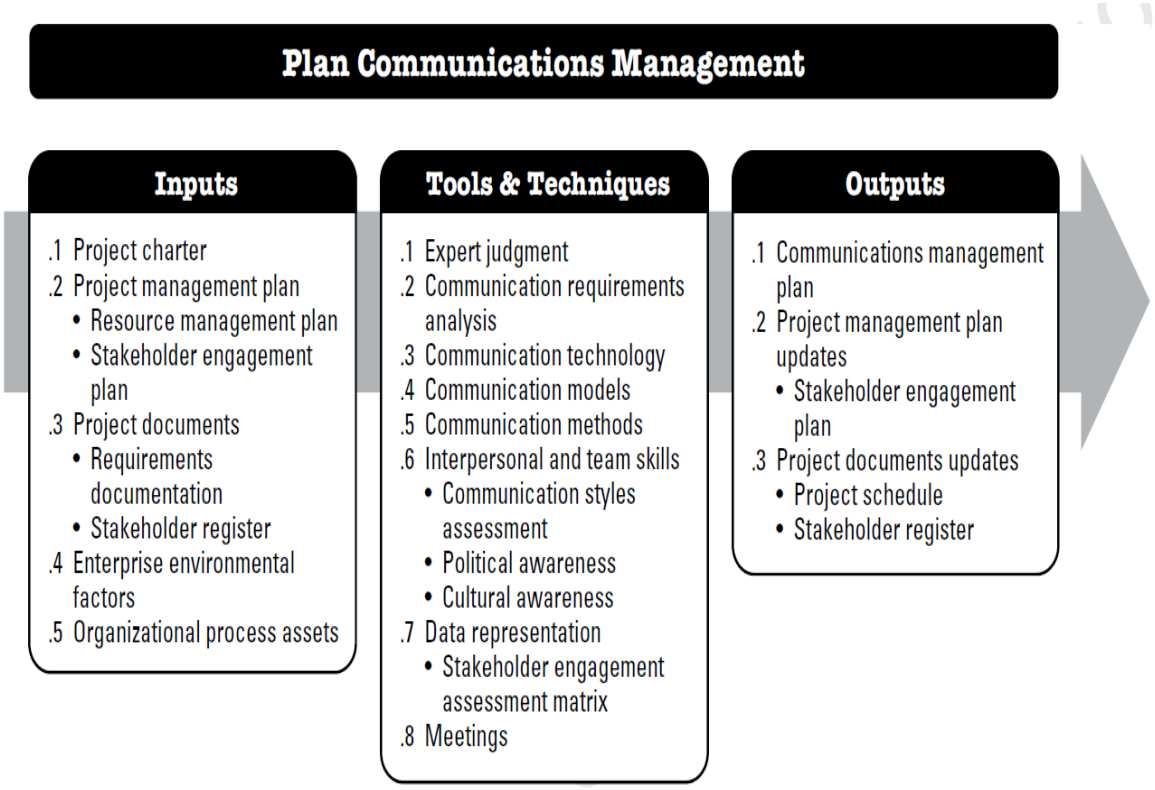

Figure 10-2. Plan Communications Management: Inputs, Tools & Techniques, and Outputs

Figure 10 Project Communication Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.360, 2017)

10.1 Plan Communication Management—The process of developing an appropriate approach and plan for project communication activities based on the information needs of each stakerholder or group, avilable organizational assests and the needs of the project.
10.1 Manage Communication—The process of ensuring timely and appropriate collection, creation, distribution, storage, retrieval, management, monitoring, and the ultimate disposition of project information.
10.2 Monitor Commuication - The process of ensuring the information needs of the project and its stakeholders are met.

2.3.9 Project Risk Management

Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. The objectives of project risk management are to increase the probability and/or impact of positive risks and to decrease the probability and/or impact of negative risks, in order to optimize the chances of project success. The Project Risk Management processes are:
11.1 Plan Risk Management—The process of defining how to conduct risk management activities for a project.
11.2 Identify Risks—The process of identifying individual project risks as well as sources of overall project risk, and documenting their characteristics.
11.3 Perform Qualitative Risk Analysis—The process of prioritizing individual project risks for further analysis or action by assessing their probability of occurrence and impact as well as other characteristics.
11.4 Perform Quantitative Risk Analysis—The process of numerically analyzing the combined effect of identified individual project risks and other sources of uncertainty on overall project objectives.

11.5 Plan Risk Responses—The process of developing options, selecting strategies, and agreeing on actions to address overall project risk exposure, as well as to treat individual project risks.
11.6 Implement Risk Responses—The process of implementing agreed-upon risk response plans.
11.7 Monitor Risks—The process of monitoring the implementation of agreed-upon risk response plans, tracking identified risks, identifying and analyzing new risks, and evaluating risk process effectiveness throughout the project.

Figure 11 provides an overview of the Project Risk Management processes. The Project Management Risk processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in this PMBOK® Guide.

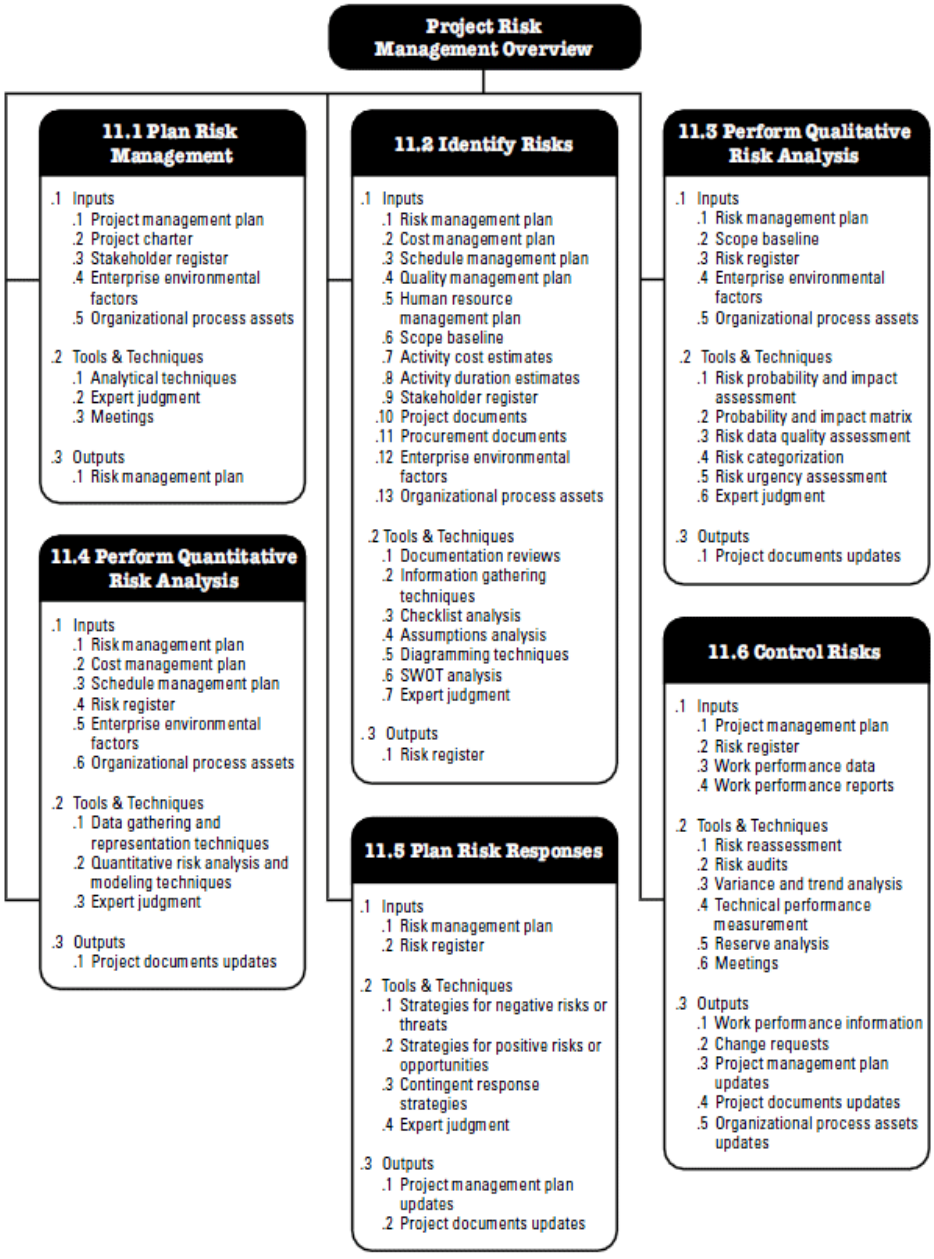

Figure 11 Project Risk Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.396, 2017)

2.3.10 Project Procurement Management

Project Procurement Management includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team. Project Procurement Management includes the management and control processes required to develop and administer agreements such as contracts, purchase orders, memoranda of agreements (MOAs), or internal service level agreements (SLAs). The personnel authorized to procure the goods and/or services required for the project may be members of the project team, management, or part of the organization's purchasing department if applicable. Project Procurement Management processes include the following:

12.1 Plan Procurement Management—The process of documenting project procurement decisions, specifying the approach, and identifying potential sellers.

12.2 Conduct Procurements—The process of obtaining seller responses, selecting a seller, and awarding a contract.

12.3 Control Procurements—The process of managing procurement relationships, monitoring contract performance, making changes and corrections as appropriate, and closing out contracts. The procurement processes are presented as discrete processes with defined interfaces. In practice, procurement processes can be complex and can interact with each other and with processes in other Knowledge Areas in ways that cannot be completely detailed in the PMBOK® Guide. The processes described in this section are written from the viewpoint where goods or services are obtained from outside of the project.

Figure 12 provides an overview of the Project Procurement Management processes. The Project Procurement Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide.

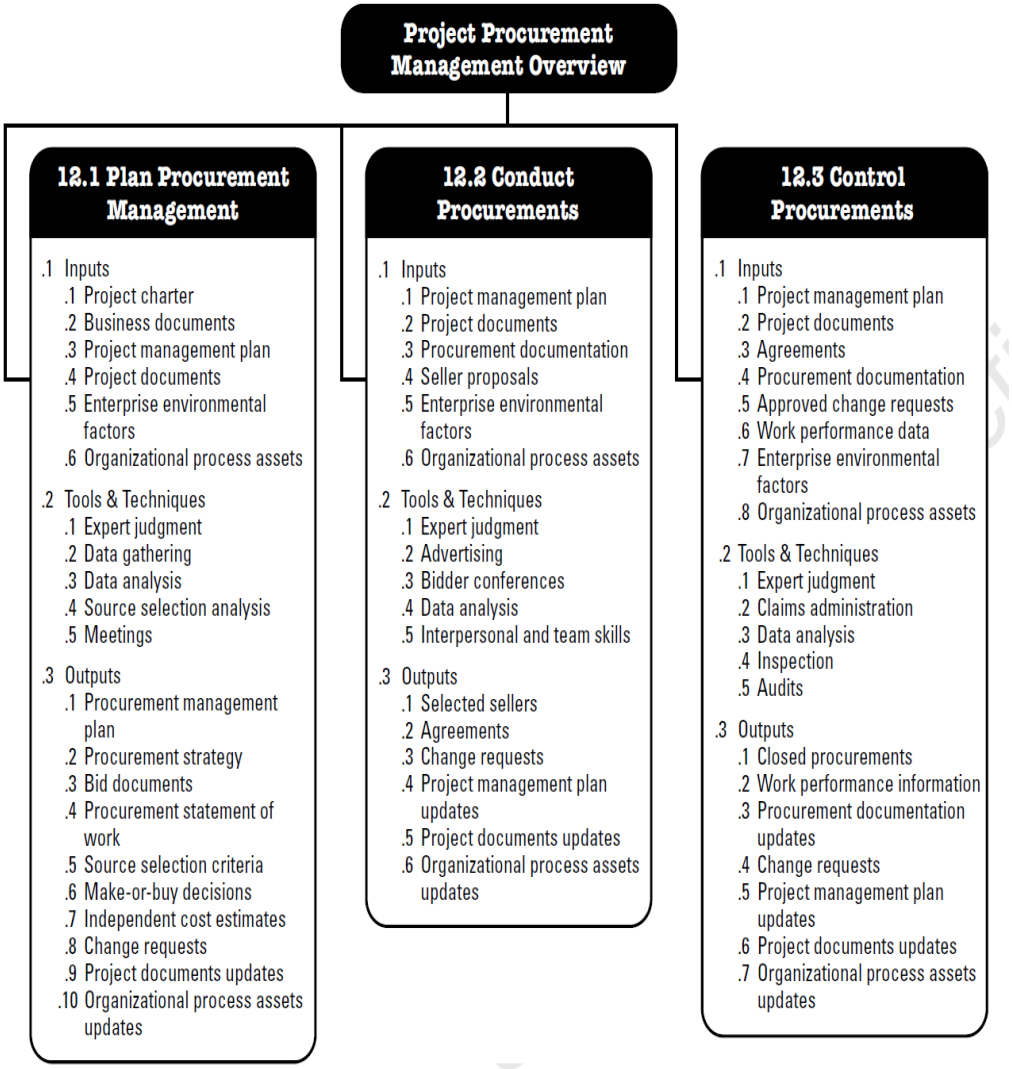

Figure 12 Project Procurement Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.460, 2017)

2.3.11 Project Stakeholder Management

Project Stakeholder Management includes the processes required to identify the people, groups, or organizations that could impact or be impacted by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution. The processes support the work of the project team to analyze stakeholder expectations, assess the degree to which they impact or are impacted by

the project, and develop strategies to effectively engage stakeholders in support of project decisions and the planning and execution of the work of the project. The Project Stakeholder Management processes are:

13.1 Identify Stakeholders—The process of identifying project stakeholders regularly and analyzing and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success.

13.2 Plan Stakeholder Engagement—The process of developing approaches to involve project stakeholders based on their needs, expectation, interests, and potential impact on the project.

13.3 Manage Stakeholder Engagement—The process of communicating and working with stakeholders to meet their needs and expectations, address issues, and foster appropriate stakeholder engagement involvement.

13.4 Monitor Stakeholder Engagement—The process of monitoring project stakeholder relationships and tailoring strategies for engaging stakeholders through the modification of engagement strategies and plans.

Figure 13 provides an overview of the Project Stakeholder Management processes. The Project Stakeholder Management processes are presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the PMBOK® Guide.

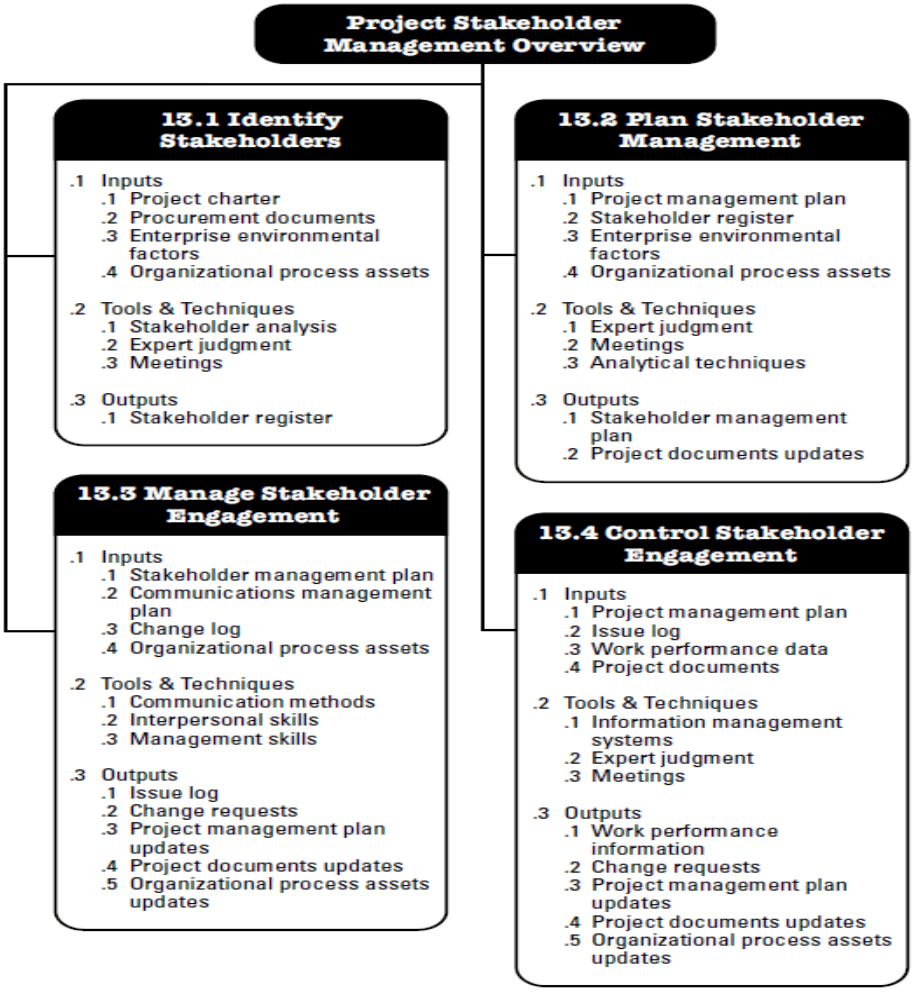

Figure 13 Project Stakeholder Management Overview (Source: A Guide to the Project Management Body of Knowledge, p.504, 2017)

2.3 Other applicable theory/concepts related to the project topic and context

2.3.1 Sustainability

Sustainability is ensuring that our present needs are met by consuming resources in a responsible way, while all the time endeavoring to avoid precluding future posterity of their ability to meet their own needs. (MPA, 2016).

2.3.2 Triple Bottom Line

Triple Bottom Line 33 The triple bottom line was coined by John Elkington in 1994. According to John an organization should not just report on or evaluate its bottom line (financial statements) but that it should also think of the social impact as well as the environmental impact. The triple bottom line allows to think of the total cost of doing business.

2.3.3 Sustainable Construction

Sustainable Construction What is Sustainability in the context of Building Construction? Sustainable Building Construction means using natural resources such as building materials, more efficiently, making processes more efficient, reducing pollution and minimizing or eliminating waste. (Mineral Products Association (MPA), 2016)

In particular sustainable construction aims:

- to promote environmentally friendly materials and the companies that use them. And therefore, greatly contribute to the well-being and "sustainability" of infrastructures;
- to highlight the concept of energy saving, particularly taking on board the typical Brussels context.

To meet the government's objectives for 2020, increased efforts need to be made to reduce CO2 emissions. That is why the cluster supports all initiatives that contribute towards this drastic reduction, such as:

- better insulation,
- rational use of energy,
- the use of renewable energies,
- better mobility,
- the use of natural or low embodied energy materials, etc.

The health and well-being of the occupants, but also of the workers on construction sites and upstream are also considered.

2.3.4 Environment and Climate Change

This environment is divided into different territories with different laws that govern manufacturing, economic, local environment, acceptable living conditions and so forth. This diversity of laws has led to an imbalance in laws that govern the activities that both negatively and positively impact the global environment. This has caused two main situations to develop; firstly, environmental conditions in most developed cities are increasingly getting worse and economic complexities seem to be shackling the hands of those who would do something to mitigate the negative impacts of people actions. This global diversity has caused stalemate at the highest levels of governance. In reference to the Parris Agreement on Climate Change, Maljean-Dubois & Wemaëre (2016, January) said that "the Agreement better takes into account diverse national circumstances, capabilities and vulnerabilities, resulting not in less but in more differentiation" (p.2). In an effort to gain consensus towards the fight on climate change which would keep "global temperatures below 2°C as compared to preindustrial levels" territories are contracted to make Nationally Determined Contributions (NDCs) every five years according to national conditions. Consensus has been achieved and now it's time for action. It's time for a new era. An era in which action takes precedence over talks.

Maljean-Dubois & (2016, January) remarked that:

The Paris Agreement marks the end-point of a long process of climate talks which actually started in Bali in 2007, but it is also a starting point of a new era of climate action at all levels: from global cooperation to local action on the ground, involving citizens and consumers, in a way that can link 35 intergovernmental decision-making and mobilisation of non-state actors to support and enhance the ambition embodied in NDCs. p.4.

O'Donnell, Pfahl, Mehling, & Gabriel, (2016) acknowledged that because this generation of young people may “endure the consequences of this change in the climate more than any generation in the past, it is fitting to inform them early of the risks that modern lifestyles entail and the challenges to bringing about a more sustainable future” (p.944). Where does this leave the Project Managers? Project Management must also walk the talk.

Like most islands in the Caribbean, St.Vincent and the Grenadines relies heavily on foreign sources of petroleum to operate its power plants. This project aims to supplement the diesel generators with renewable energy system including PV and Energy Storage on the Grenadines island of Mayreau

Apart from providing a Solar PV and battery storage system on completion.The project will aid to create jobs for the locals, reduce e,issions from fossil fuel, reduce the amount of running hours of the diesel generatos hence the amount of noise on the island, save cost and reduce the reliance on fossil fuels for electricity generation on the island.

3. METHODOLOGICAL FRAMEWORK

3.1 Information sources

According to the Concise Oxford English Dictionary, information is "the facts or knowledge provided or learned" (information, 2011, p.729) and a source is a place, person, or thing from which something originates" (Concise Oxford English Dictionary , 2011, p.1380). Therefore, it can be concluded that an information source is a place, person or thing form which fact or knowledge are provided or learned.

There are many places for information to be obtained. One can use the library sources, internet sources, organizational sources, government agencies as sources, pictorial sources, sources from bibliographies, a colleague or sometimes

even one's personal account as a source. Information sources can be printed or presented in an electronic format.

No matter where information originates from, there are only three types of inofrmation sources - primary, secondary, and tertiary (Schmidt, 2013). To develop the FGP, primary and secondary sources will be used.

3.1.1 Primary sources

Primary sources provide a first-hand account of an event or time period and are considered to be authoritative. They represent original thinking, reports on discoveries or events, or they can share new information. Often these sources are created at the time the events occurred, but they can also include sources that are created later. They are usually the first formal appearance of original research.

For the development of the FGP, the primary sources of infromation that will be used are meetings, personal interviews with members of SolarTech, interviews with subject matter experts and stakeholders, and research. Refer to **chart 1**, for the specific primary sources of information that will be used.

3.1.2 Secondary sources

Secondary sources involve analysis, synthesis, interpretation, or evaluation of primary sources. They often attempt to describe or explain primary sources.

Scholarly journals, although generally considered to be secondary sources, often contain articles on very specific subjects and may be the primary source of information on new developments.

For the development of the FGP, the secondary sources of information that will be used are the PMBoK Guide, library databases, and the PMI database will be used. Refer to **chart 1**, for the specific primary sources of information that will be used.

Chart 1 Information Sources

Objectives	Information sources	
	Primary	**Secondary**
1. To create a project management plan to initiate the project	Meetings,interviews with lead project experts	PMBOK Guide and PMI database
2. create a scope management plan that included all the work required to complete the project.	Meetings, Interviews, communications via email	PMBOK Guide and PMI database
3. To create a schedule management plan to ensure the project is completed within the time limits.	Interviews, communications via email	PMBOK Guide and PMI database
4. to create a cost management plan to confirm the project was completed within the approved budget.	Interviews with project experts	PMBOK Guide and PMI database
5. To develop a quality management plan that identifed the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits.	Meetings, Interviews, communications via email	PMBOK Guide and PMI database
6. To create a resource management plan to manage all identified resources within the project time, cost and scope limits.	Meetings, Interviews, communications via email	PMBOK Guide and PMI database
7.To develop a communication management plan to manage SolarTech	Meetings, Interviews, communications via email	PMBOK Guide and PMI

Objectives	Information sources	
	Primary	**Secondary**
timely and effective communication of the project status and other key information.		database
8. To create a risk management plan to manage the identifed and examined risks for the successful completion of the project	Meetings, Interviews, communications via email	PMBOK Guide and PMI database
9. To develop a procurement management plan to obtain products, services and results required by the project	Purchasing institutions, Meetings, Interviews, communications via email	PMBOK Guide and PMI database
10. To develop a stakeholder management plan to manage the identified and supported stakeholders of the Project ensuring effective stakeholder engagement	Interviews,	PMBOK Guide and PMI database

(Source: Complied by author)

3.2 Research methods

Research is defined as a careful consideration of study regarding a particular concern or a problem using scientific methods. According to the American sociologist Earl Robert Babbie, “Research is a systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods.”

Source: Adi Bhat.(2010, May 3). Retrieved April 25, 2019 from https://www.questionpro.com/blog/what-is-research/

3.2.1 Analytical method

In Analytical Research, the researcher has to use facts or information already available, and analyze them to make a critical evaluation of the material. It involves the in-depth study and evaluation of available information to explain complex phenomenon. With this research method, information from multiple sources will be examined and used to develop the deliverables found in **chart 2.** The research method for each specific objective is indicated in chart 2 below.

Chart 2 Research Methods

Objectives	Analytical Research Method
1. To create a project management plan to initiate the project	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 1 above, to drive decision making when creating the project charter.
2. create a scope management plan that included all the work required to complete the project.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 2 above, to drive decision making when creating the documents which comprise the scope management plan.
3. To create a schedule management plan to ensure the project is completed within the time limits.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 3 above, to drive decision making when

Objectives	Analytical Research Method
	creating the documents which comprise the schedule management plan.
4. to create a cost management plan to confirm the project was completed within the approved budget.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 4 above, to drive decision making when creating the documents which comprise the cost management plan.
5. To develop a quality management plan that identifed the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 5 above, to drive decision making when creating the documents which comprise the quality management plan.
6. To create a resource management plan to manage all identified resources within the project time, cost and scope limits.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 6 above, to drive decision making when creating the documents which comprise the resource management plan.
7.To develop a communication management plan to manage	The analytical method will be employed by using facts or

Objectives	Analytical Research Method
SolarTech timely and effective communication of the project status and other key information.	information from the sources identified in chart 1 objective 7 above, to drive decision making when creating the documents which comprise the communication management plan.
8. To create a risk management plan to manage the identified and examined risks for the successful completion of the project.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 8 above, to drive decision making when creating the documents which comprise the risk management plan.
9. To develop a procurement management plan to obtain products, services and results required by the project.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 9 above, to drive decision making when creating the documents which comprise the procurement management plan.
10. To develop a stakeholder management plan to manage the identified and supported stakeholders of the Project ensuring effective stakeholder engagement.	The analytical method will be employed by using facts or information from the sources identified in chart 1 objective 10 above, to drive decision making when creating the documents which comprise the stakeholder

Objectives	Analytical Research Method
	management plan.

(Source: Complied by author)

3.3 Tools

The PMBOK® Guide (PMI, 2013) defines tools as something “tangible, such as a template or software program, used in performing an activity to produce a product or result.

Chart 3 Tools

Objectives	Tools
1. To create a project management plan to initiate the project	Project Charter template and Project Management Plan template.
2. create a scope management plan that included all the work required to complete the project.	• Interviews • Focus groups • Facilitated workshops • Group creativity techniques • Group decision-making techniques • Questionnaires and surveys • Observations
3. To create a schedule management plan to to ensure that the project is completed within the schedule limits.	• Gantt Chart • PERT • Critical Path Method • Critical Chain Method
4. to create a cost management plan to confirm the project was completed within the approved budget.	• Expert judgment • Analogous estimating • Parametric estimating • Bottom-up estimating • Three-point estimating • Reserve analysis • Cost of quality • Project management • Software • Vendor bid analysis • Group decision-making techniques

5. To develop a quality management plan that identified the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits.	• Cost-benefit analysis • Cost of quality • Seven basic quality tools • Benchmarking • Design of experiments
6. To create a resource management plan to manage all identified resources within the project time, cost and scope limits.	• Pre-assignment • Negotiation • Acquisition • Virtual teams • Multi-criteria
7.To develop a communication management plan to manage SolarTech timely and effective communication of the project status and other key information..	• Communication technology • Communication models • Communication methods • Information management systems • Performance reporting
8. To create a risk management plan to manage the identified and examined risks for the successful completion of the project.	• Risk Management Planning • Risk Identification • Qualitative Risk Analysis • Quantitative Risk Analysis • Risk Response Planning • Risk Monitoring and Control • Expert judgment • Documentation reviews
9. To develop a procurement management plan to obtain products, services and results required by the project.	• Make-or-buy analysis • Expert judgment • Market research • Meetings
10. To develop a stakeholder management plan to manage the identified and supported stakeholders of	• Power and interest • Power and influence

the Project ensuring effective stakeholder engagement.	• Influence and impact • Power, urgency and legitimacy

(Source: Complied by author)

3.4 Assumptions and constraints

According to Study Circle (2016) "An assumption is a belief of what you assume to be true in the future. You make assumptions based on your knowledge, experience or the information available on hand. These are anticipated events or circumstances that are expected to occur during your project's life cycle".

Assumptions are supposed to be true but do not necessarily end up being true. Sometimes they may turn out to be false, which can affect your project significantly. They add risks to the project because they may or may not be true.

"Constraints are limitations imposed on the project, such as the limitation of cost, schedule, or resources, and you have to work within the boundaries restricted by these constraints. All projects have constraints, which are defined and identified at the beginning of the project".

The PMBOK Guide (PMI, 2017) recognizes six project constraints: scope, quality, schedule, budget, resource, and risk. Out of these six, scope, schedule, and budget are collectively known as the triple constraints.

Chart 4 Assumptions and constraints

Objectives	Assumptions	Constraints
1. To create a project management plan to initiate the project	The project charter will be created within the allotted time.	There are only three (3) days allocated to create the

		project charter.
2. create a scope management plan that included all the work required to complete the project.	The project scope will be clearly understood by the executing team.	The scope may change as the project progresses. Therefore, making changes to one part of the scope will have an impact on aonother part of the project.
3. To create a schedule management plan to ensure the project is completed within the time limits.	The time allocated for the develoment of the schedule management plan will be sufficient.	The time allocated for the develoment of the schedule management plan must not exceed three (3) months.
4. to create a cost management plan to confirm the project was completed within the approved budget.	A detail budget will be developed and enough to cater for the project expensives.	The budget allocated for the project must not exceed two (2)

		million dollars.
5. To develop a quality management plan that identified the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits.	The quality of material used in the project will meet the required standard.	The structure is able to withstand a category 5 hurricane.
6. To create a resource management plan to manage all identified resources within the project time, cost and scope limits.	Some particular equipment will be made available for use whenever needed.	Some resources may not be available locally, therefore will have to be hired externally.
7.To develop a communication management plan to manage SolarTech timely and effective communication of the project status and other key information.	The organization has the technology required to suffice the communication needs of all stakeholders.	Language differences and the difficulty in understanding unfamilar accents.
8. To create a risk management plan to manage the identified and examined risks for the successful completion of the project.	The counterparty such as acontractor will not fail to deliver on their contractual obligations.	Only some of the certain amount of monies to finish the project will be availiable.

		Negotiation is needed to get more monies.
9. To develop a procurement management plan to obtain products, services and results required by the project.	All good and services will be procured locally.	All goods and services for the project must be purchase from one supplier.
10. To develop a stakeholder management plan to manage the identified and supported stakeholders of the Project ensuring effective stakeholder engagement.	All good and services will be procured locally.	Some of the required good are not available locally.

(Source: Complied by author)

3.5 Deliverables

According to investopedia.com "deliverables is a project management term for the quantifiable goods or services that will be provided upon the completion of a project. Deliverables can be tangible or intangible parts of the development process, and they often are specified functions or characteristics of the project".

Chart 5 Deliverables

Objectives	Deliverables

1. To create a project management plan to initiate the project	Project Charter
2. To create a scope management plan to ensures that it includes all the work required to successfully complete the project.	Scope Management Plan and Requirements Management Plan
3. To create a schedule management plan to ensure the project is completed within the time limits.	Schedule Management Plan
4. to create a cost management plan to confirm the project was completed within the approved budget.	Cost Management Plan
5. To develop a quality management plan that identified the quality requirements for the project to ensure the results meet expectations for approval within the time, cost and scope limits.	Quality Management Plan and Qulaity Metrics
6. To create a resource management plan to manage all identified resources within the project time, cost and scope limits.	Resource Management Plan and Team Charter
7.To develop a communication management plan to manage SolarTech timely and effective communication of the project status and other key information.	Communication Management Plan and Communication Matrix
8. To create a risk management plan to manage the identified and examined risks for the successful completion of the project.	Risk Management Plan
9. To develop a procurement management plan to obtain products, services and	Procurement Management Plan, Procurement Strategy, Bid documents,

results required by the project.	Procurement Statement of Work, Source Selection Criteria, Make- Or- Buy Decisions and Independent Cost Estimate.
10. To develop a stakeholder management plan to manage the identified and supported stakeholders of the Project ensuring effective stakeholder engagement.	Stakeholder Management Plan

(Source : Compiled by author)

4. RESULTS

4.1 Project Integration Management

In developing the Project Management Plan for the construction of a Solar Photovoltaic and Battery Storage System, a Project Charter, specific objective one (1), was the first process use in the Project Integration Knowledge area. As per *the* PMBOK® Guide*,* the Project Charter was accomplished using tools and techniques such as expert judgment, data gathering and meetings. Also, a template from the PMI database was used as a tool to develop the Project Charter that formally authorized the project manager to start the approved project and allow him to use organizational resources to accomplish the objectives of the project.

The Project Charter consisted of high level planning information (scope, deliverables, a summary milestone schedule, assumptions and constraints, high level risks, stakeholder list, overall project budget, criteria necessary for approval and the sponsor's authorization) about the project. The specific of the project activities are developed later.

The development of the Project Management Plan is the second process in the Project Integration Management Knowledge area comprises of the subsidiary plans developed during the Final graduation Project. A template was used to guide the compilation of the plan.

According to the PMBOK® Guide, to develop the Project Charter the following inputs, tools and techniques were required. See figure 14 below. (project Management Institute, 2017, p.75).

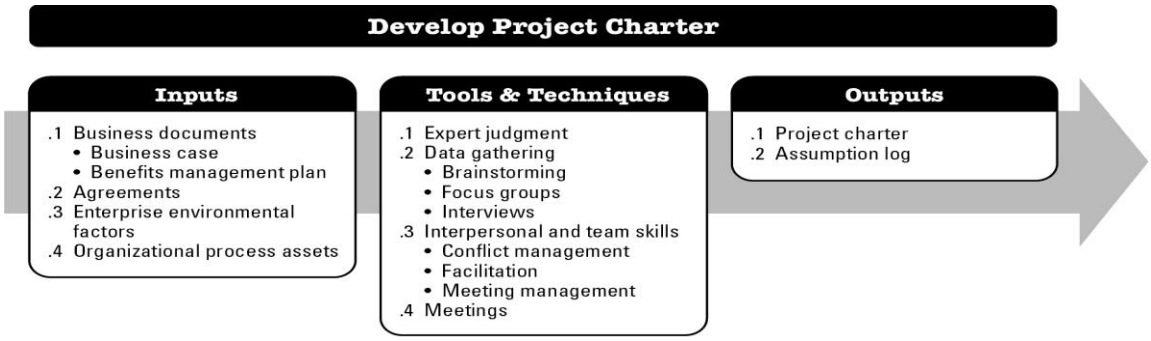

Figure 4-2 (Guide). Develop Project Charter: Inputs, Tools & Techniques, and Outputs

Figure 14 Develop Project Charter: Inputs, Tools & Techniques, and Outputs (Source: A Guide to the Project Management Body of Knowledge, p.75, 2017)

Project Charter

Construction of a PV Solar System

Project Purpose/Justification

Business Need/Case

The construction of the Solar Photovoltaic and Battery Storage System on the island of Mayreau arises from the fact that, Mayreau being the smallest of the Grenadine Island territories of Saint Vincent and the Grenadines. The generation capacity on the island is approximately 308kW, which is supplied only by diesel engines. This project will see approximately 46 percent of the energy generated from Solar Energy and Battery Storage. Therefore, there will be a significant reduction in the use of diesel engine; hence a reduction in the importation of fossil fuel, less pollution and noise, because the engines will be required to run less. This will make the island of Mayreau a green island and more open to tourism.

Business Objective

The following are the main business objectives of the project:

1. To significantly reduce the amount of money spent on the purchasing of fossil fuel.

2. The implementation of Solar Photovoltaic and Battery Storage System on the island of Mayreau will improve the island's electrical system reliability.

3. To reduce the amount noise from the diesel engines and carbon pollution in the air.

4. To make the island of Mayreau a green island and in the process boost tourism on the island.

Project Description

Stakeholders/Sponsor

- The government and people of St.Vincent and the Grenadines
- St.Vincent Electricity Services Limited (VINLEC)

SolarTech

- Draftsman
- Engineers (Civil and Electrical)
- Project Manager
- Contractors

Subcontractors

- Electricians
- contractors
- Foreman

Suppliers

- SMA
- Suntech

Consultant

- Rocky Mountain Institute

Measurable Project Objective and Success Criteria

Requirements

The Solar Photovoltaic and Battery Storage System must be constructed out of material that are structurally sound and are able to withstand a category 5 hurricane. Also the system will be installed next to the sea therefore the materials must be able to withstand a high degree of salt air conditions.

Constraints

- The project had limited budget and could not exceed and estimated US$600,000.00 to be completed. Since the project had limited funds the project schedule was limited as well and must be completed within 3.5 months.
- The transportation of goods and service to the island is fully dependable on the ferry service.
- All material need to be imported, so any miscalculation can lead to delays.

Assumptions

- The time of the year the project was schedule to be executed it was assumed that it would not rain much.
- St.Vincent and the grenadines geographic location make it prone to hurricanes; therefore concessions have been made to purchase solar panel made of material capable of withstanding a category 5 hurricane. Also, other materials and civil designs was done bearing in mind the possibility of a island experiencing very strong storm winds.
- The local workers on the island would have sufficient skill to be able to do labourer work.

- The internet speed on the island would be good enough in order to teleconference (Audio and video).
- There is to restriction where some of the proposed infratstures are to be located.

Preliminary Scope

The project includes civil works, the construction of 100kW Solar Photovoltaic and 216kWhrs Battery Storage, which is to be integrated into the island existing electrical grid. The solar panels will be mounted on a racking system which will be concrete in to the ground. Also, the inverters for the Solar Panels, Inverters for the Batteries and the Batteries will be storage in two 20ft containers close to where the panels will be installed.

This project will consist of :

- 12 Sunny Island 8.0H-11 (Battery Inverters)
- 32 BMZ ESS7.0 (Batteries)
- 4 Sunny Tripower 25000TL-30 (solar inverters)
- 313 Suntech STP320 - 24/vfw (Solar Modules)
- 2 - 20ft container
- Racking systems for the Solar Modules

Risk

The following are some possible risks identified prior to the start of the project.

1. Financial

- The cost of material increases during the project.
- Damage to material during shipping and when on site
- Accident on site
- Underestimation of the project cost.

2. Scheduling delays

- Shipping delays
- Travel delays for workers working on the project
- Designs delays
- Severe weather condition causing delays
- Production and fabrication delays
- Materials not accounted for after packages/boxes arrived on site
- Equipment defect

3. Accommodation

- Not enough accommodations(rooms) located on the island to cater for all the workers working on the project.

<u>Project Deliverables</u>

- Project Charter
- Site Plan
- Engineering drawings
- Structural drawings
- Environmental Studies
- Tender documents
- Electrical Installation
- Completion of structures
- Civil works
- Progress Reports
- Test Reports
- Certificate of completion

Chart 6 Summary Milestones Schedule

Milestones	Dates
Project Kick-off meeting	Mon 03-06-19
Approval of final design drawings	Thu 18-07-19
Arrival of all equipment on site	Mon 07-10-19
Completion of all civil works	Fri 30-08-19
Completion of PV Solar Panels installation	Fri 20-09-19
Completion of the installation of batteries and inverters (batteries and PV) installation	Tues 17-09-19
Final Testing and commissioning	Fri 04- 10-19
Completion of staff training	Fri 11-10-19
End of Project	Fri 18-10-19

(Source: Complied by Author)

Chart 7 Summary Budget

Items	Project cost ($ USD)
Construction & Administration	$497,000.00
Value added Tax 17%	$8,702.70
Contingency (3%)	$14,910.00

Grand Total	**$598,935.00**

(Source: Complied by Author)

4.2 Project Scope Management

The Project Scope Management was the first of the planning process group used, following the development of the project charter, stakeholder register and procurement management plan respectively.

The scope management plan included the scope definition, project scope statement, the work breakdown structure (WBS), WBS dictionary, validate scope and control scope. These will be used to guide the project team throughout the life of the project.

The scope management plan provides the scope framework for this project. This plan documents the scope management approach; roles and responsibilities as they pertain to the project scope.

Scope Management Approach

For this project, the scope management wil be the sole responsibility of the Project Manager. The Project Manager, Sponsor and Stakeholders will establish and approve documentation for measuring project scope which includes deliverables quality checklists and work performance measurements. A request for a change in scope may be initiated by the Project Manger, Stakeholders or any member of the project team. All change request will be submitted as change orders to the Project Manager who will then evaluate the requested scope change. Upon acceptance of the scope change request, the Project Manger will submit the scope change request to the Sponsor, Stakeholder, Sub Consultants and/or Subcontractor. The Project Manger is responsible for the approval of scope changes that are strictly technical in nature. Whereas, the Project

Sponsor is responsible for the approval of scope changes affecting time and cost parameters of the project. Upon approval of scope changes, the Project Manager will update all the necessary project documents and communication all changes to the Stakeholders.

Roles and Responsibilities

The Project Manager, Sponsor and Team will all play key roles in managing the scope of this project. As such, the project sponsor, manager, and team members must be aware of their responsibilities in order to ensure that work performed on the project is within the established scope throughout the duration of the project. The table below defines the roles and responsibilities for the scope management of this project.

Chart 8 Scope Management Roles and Responsibilies

Name	Role	Responsibilities
Government of St. Vincent and the Grenadines VINLEC	Project Sponsor	a. Approve or deny scope change request as appropriate b. Evaluate need for scope change request c. Accept project deliverables
Earlan Myers	Project Manager	a. Measure and verify project scope b. Facilitate scope change requests c. Facilitate impact assessments of scope change requests d. Organize and facilitate scheduled change control meetings e. Communicate outcomes of scope change requests f. Update project documents upon approval of all scope changes
		a. Participate in defining change

Name	Role	Responsibilities
Project Team	Team Members	resolutions b. Evaluate the need for scope changes and communicate them to the project manager as necessary
Stakeholders/SolarTech	Contractor/Consultants/Subcontractors/Site Workers	a. Can propose scope changes b. Will execute change directives issued by Project Manager

(Source: Complied by author)

Scope Definition

The scope for this project was defined through a comprehensive requirements collection process. First, a thorough analysis of similar project, existing project contract, was revised meeting minutes, owners' requirements and documentation relative to industry standards were completed. From this information, the project manager along with key team members developed the requirements management plan, requirements documentation and the requirements traceability matrix for the Photovoltaic Solar System specifications.

Project Scope Statement

The project scope statement provides a detailed description of the project, deliverables, constraints, exclusions, assumptions, and acceptance criteria. Additionally, the scope statement includes what work should not be performed in order to eliminate any implied but unnecessary work which falls outside the project's scope.

Scope Description:

The project includes the construction of a 100kW Solar Photovoltaics (PV) and 216kWhrs Battery Storage. The following details includes:

1. Electrical Work

Electrical design

The contractor will do the design of the electrical system on the DC side and will work together with VINLEC to set connections at the AC side at 400V volts. The primary components of the electrical system are the solar modules (panels), Batteries and Inverters.

The design must outlay the main solar electric system parameters:

- System type - Grid-Connected
- PV Field Orientation
- PV modules Model and W_p
- Battery Model and Whrs
- PV Array: Number of modules, and total kW_p
- Inverter Model, AC output (Pnom) and total kW ac
- Inverter pack Number of units, Pnom and total kW ac

Photovoltaic Modelling Software known as PvSyst will be utilized for system simulation and results shared:

- The System Production or Produced Energy per year
- Specific production per kilowatt of peak capacity per year (kWh/kW_p/year)
  A guarantee on the system Performance Ratio PR (%)Solar Modules

The Project will consist of crystalline solar modules. The selected modules will consist of the following information:

- Total capacity:
- Nameplate capacity (AC):
- PV module Type:

- Manufacturer:
- Number of PV modules in series or parallel:
- Total number of PV modules:
- Unit Nom. Power: (Wp)
- At operating conditions: kWp (°C)
- Array operating characteristics: (°C), Maximum Power Point (MPP) Voltage (V) and Current (I)
- Total Module Area (m^2)

Battery Systems

There will be housing provided for the selected battery system to be installed. The battery systems was selected based on their lifetime, costs and application to the capacity determined for the photovoltaic system. The Batteries will be stored in cool, dry locations away from direct sunlight. This will be inside of a 20ft shipping container.

Utility Interconnection

The Solar and Battery Systems will work as distributed power for VINLEC. The solar system will attach to the substation feeder using an underground bored conduit to the Project Site. This will require 400V extension for the Project Site. The opportunity exists for metering equipment and fiber to provide communication and controls of the breakers and other essential equipments.

Switchgear specified for this project will be determined based on the design and should be designed to fully incorporate the latest developments in medium voltage circuit breaker technology. These switchgears must meet or exceed the latest requirements of ANSI, IEEE, and NEMA standards.

Solar PV Modules

The Project will have a total of approximately 100,000 watt (W) solar PV modules, each weighing approximately 25.8kg, with dimensions of 1956mm long by 992mm wide by 40mm thick. The modules will be mounted on the racking system by installers with the help of a small mobile crane.

Inverters Installation

The Project will have a total of 100kW AC inverters. The inverters will convert the DC power collected by the solar PV modules into AC power. Each Inverters will be stored in a 20ft container to protect the equipment from the weather and to reduce noise emissions. The containers will be trucked to the site and installed on cast-in-place concrete pad by means of a crane.

Electrical Cable Installation

Electrical cabling, including DC cables from the solar PV modules to the inverters and AC cables from the inverters to the switchgear room, will be run underground in trenches excavated for this purpose. Trenches will typically be 3 ft deep by 2ft wide and will be excavated using a ‘ditchwitch’ plough, backhoe or similar equipment. The cabling will be buried to a minimum depth of 3 ft and caution tape will be buried in the trench above the cables to warn of the presence of the underground cables. Once the cabling is laid, the trenches will be backfilled and leveled to match the existing grade. For the directional bore, high density polyethylene (HDPE) conduits will be installed and in areas of shallow bedrock to house and protect the cables.

2. Construction

Site Preparation

Site preparation refers to all necessary activities prior to the construction of the support foundations and installation of the PV modules and electrical equipment. It includes site clearing, surface grading, construction a access road and drainage systems

- Site Plan and Staking

A Site Plan will be completed and stake the exact location of the site perimeter for possible fencing, access road layout, foundations and the Inverters and Battery housing. As part of this work, any buried utilities, infrastructure and their associated easements as well as any designated environmental features (e.g. wetlands, woodlands, etc.) and their associated setbacks will be demarcated and protected by means of staking, flagging, fencing or signage to prevent any intrusion into these areas by construction vehicles. The key construction locations for the solar power modules and electrical equipment will also be staked for identification.

- Construction Staging / Laydown Area

Part of the Project Site will be graded and fenced for security and used as a construction staging/laydown areas. The staging area will include temporary construction office trailer, first aid station, worker parking, construction equipment, material laydown area, storage shed, truck unloading/loading area, and a waste disposal/pick-up area. Portable toilets will also be on-site and maintained weekly during the construction phases.

Establishment of the staging area will involve the removal of vegetation and the stripping and stockpiling of topsoil. An adequate road base for construction vehicles, heavy equipment and material laydown is required. The staging area will be decommissioned and all temporary facilities removed when construction is completed.

Tree-Cutting and Vegetation Removal

In order to enable installation of the solar PV models during construction and to avoid shadows during operation, some minor vegetation removal may be necessary to ensure the minimum extent of shadowing to the solar modules. Vegetation will be left in place to the extent possible. Tree cutting, if necessary, will be conducted using chainsaws. Stumps, roots and brush vegetation will be removed using an excavator or small bulldozer. During the clearing activities, merchantable timber, non-merchantable timber

(e.g. firewood) and other cleared vegetation will be temporarily stockpiled adjacent to the access road. This material will be loaded on trucks and taken away by the buyer (i.e., merchantable timber), chipped for off-site composting or disposal, or used on-site as biodegradable erosion protection matting for exposed soil areas.

- Excavations, Fill Placement and Surface Grading

The Site Plan and grading permits will determine if the project requires any major excavation work, fill placement or significant alteration of the existing landscape. As such, the primary excavation work will be limited to any soil removal for access road construction, pad mount foundations and digging of trenches to run electrical cables. The utilization of driven piles or screw piles to support the solar PV modules does not require soil excavation. Sediment and erosion control measures will be implemented for areas with exposed soils to control soil erosion caused by wind or runoff.

Once completed, pad mount excavations and cable trenches will be backfilled and leveled to match the existing grade. Any excess subsoil will be used to infill low lying areas followed by general surface grading, including redistribution of topsoil; overall, the Project is not expected to result in any excess fill material. Following this, the entire Project Location, with the exception of new access roads, parking lots and the pad mounted electrical equipment will be covered with low maintenance vegetation. Native plant species from local sources will be used.

- Access Roads

In the instance that selected sites must construct access roads, the size will allow space for construction sized vehicles. The culvert required will be installed beneath the access road at locations where conveyance of surface drainage is required according to the approved Site Plan. Erosion and sedimentation control measures (e.g., silt fence barriers, rock flow check dams, etc.) will be installed in accordance with the approved Site Plan.

Construction and Installation

Construction and installation of the solar facility consists of building pad mount foundations, foundation for 20ft containers for the PV and Battery inverters ,trenches for electrical cabling, structural supports for the solar PV module racks, installation of the solar PV modules on the racks, and installation of the inverters and transformers and associated electrical equipment. This includes the underground cabling installations within the Project Site and the underground electrical distribution line.

Inverter Container and Electrical Equipment Foundations

Support foundations for the inverter containers will be cast-in-place concrete pads. Cast-in-place concrete foundations will be constructed on-site by means of excavation and removal of in-situ material using a backhoe or excavator, placement of granular material using a front-end loader, formwork construction, installation of reinforcing steel (rebar), installation of electrical grounding grid, and placement of concrete into the forms. Ready-mix concrete will be delivered to the Project Site by transit mixer truck from a local supplier. Foundations will require a minimum number days to cure to allow for concrete to reach its specified compressive strength prior to erection of structural support and equipment installation.

PV Module Mounting System, Supports and Foundations

The solar PV modules will be mounted on a fixed tilt, ground mounted racking system comprised of an aluminum lattice structure. Each lattice structure will be assembled on site and can typically hold 313 individual PV modules. An estimated racks will be required for the Project. The racking system will be supported by steel uprights mounted on either driven steel piles based on the results of the geo-technical survey and the soil conditions within the site.

Driven piles, will be installed using mechanical, hydraulic or vibratory pile hammer equipment mounted on a specialized “Bobcat” or equivalent machine.

Interconnection to Substations

Connecting to the existing substation may require electrical distribution cable between the Project switch gear and the point of interconnection (POI). This may require metering equipment and installation of fiber optic cable to provide trip control of the intertie breaker.
Inverters must be to a standard to allow anti-islanding capabilities along with necessary supply feeder circuit breaker.

SCADA requirements will be determined for remote control and monitor of data such as:

- Real time MW
- Real time MVAR
- Real time amperes
- Real time voltage

Testing and Commissioning

Testing and commissioning will be performed on the installation prior to start up and connection to the power grid. The solar modules, inverters, batteries and electrical cables will be checked for system continuity, reliability, and performance tested. If problems or issues are identified, modifications will be made prior to start up.

Site Restoration

Site restoration will be applicable for the entire Project Location. The main objective will be to reinstate the area to the original pre-construction condition to the extent possible. All construction material, equipment, temporary facilities, and waste will be removed

from the site. Topsoil will be redistributed where required, followed by finished grading and landscaping to achieve proper drainage. Re-vegetation will include planting of native plants and hydro-seeding where required.

Project Constraints

- The project sponsor has requested that the project should not exceed $600,000.00, and the duration should not exceed three (3) months to completed.

Project Assumptions

- The time of the year the project was schedule to be executed it was assume that it would not rain much.
- St.Vincent and the grenadines geographical location make it prone to hurricanes; therefore concessions have been made to purchase solar panel made of material capable of withstanding a category 5 hurricane. Also, other materials and civil designs was done bearing in mind the possibility of a island experiencing very strong storm winds.
- The local workers on the island would have sufficient skill to be able to do labourer work.
- The internet speed on the island would be good enough in order to teleconference (Audio and video).
- There is to restriction where some of the proposed infrastructures are to be located.

Work Breakdown Structure

In order to effectively manage the work required to complete this project, it will be subdivided into individual work packages. This will allow the Project Manager to more

effectively manage the project's scope as the project team works on the tasks necessary for project completion. The project is broken down into three phases: engineering, procurement and delivery and construction and closing. Each of these phases is then subdivided further down to work packages (see WBS below).

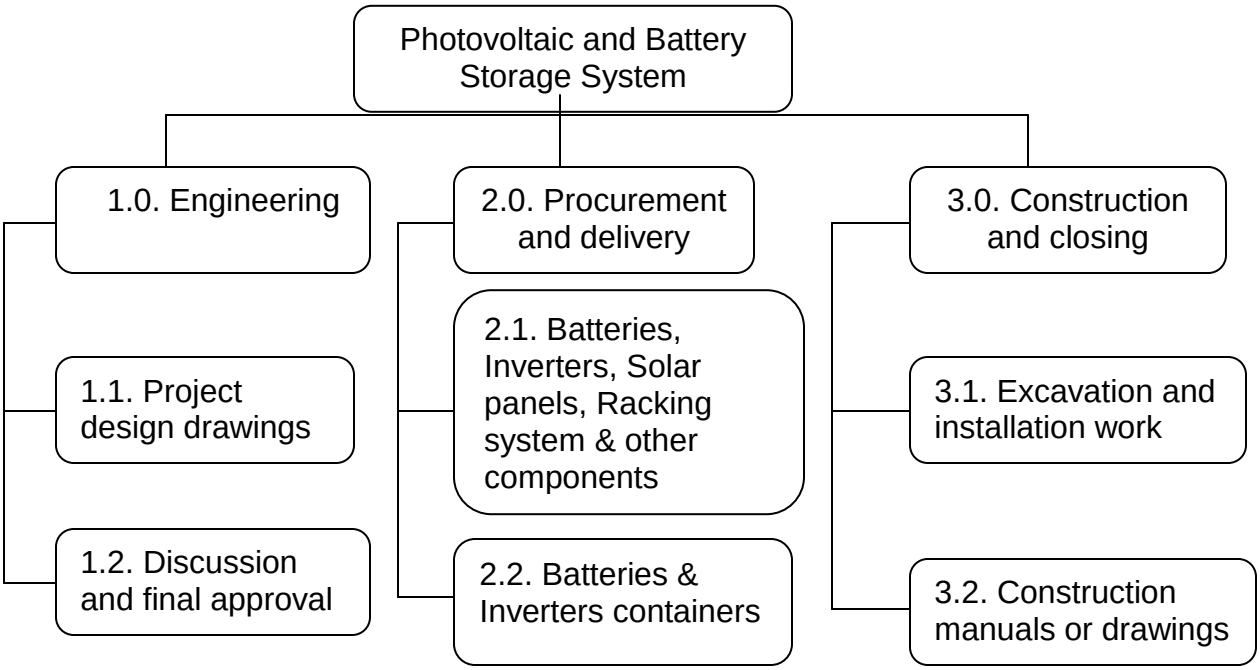

Figure 15 Work Breakdown Structure Source (Compiled by Author)

In order to more clearly define the work necessary for project completion, the WBS Dictionary is used. The WBS Dictionary includes an entry for each WBS element. The WBS Dictionary includes a detailed description of work for each element and the deliverables. The project team will use the WBS Dictionary as a statement of work for each WBS element.

Chart 9 WBS Dictionary

Level	WBS Code	Element Name	Description of Work	Deliverables	Resources
1	1.0	Engineering	The global and Conceptual scope of engineering the project	Engineering drawings and the type of technology and equipment specifications to be used.	Consultants (Photovoltaic system experts) electrical and civil engineers
1	2.0	Procurement and delivery	Phase where product are ordered on time for producing the deliverables	Agreements, selected sellers	Contractor and Electrical engineers
1	3.0	Construction and closing	Phase where project execution occurs, signifies the completion of project and the handing over of completed deliverables	Civil and Electrical Work.	Contractor, engineers, consultants
2	1.1	Project design drawings	Electrical and civil design/drawing for all electrical and structural	Engineering drawings including container	

Level	WBS Code	Element Name	Description of Work	Deliverables	Resources
			components on the project that instructs the contractors how the infrastructures will be built	layout, cabling location and size	
2	2.1	Batteries, Inverters, Solar panels, Racking system & other components	A set of documentation and purchase orders with a list of items to be delivered and the expected delivery dates	Delivery of items	Procurement officers
2	3.1	Excavation and Installation work	Preparing the work area and the digging of trenches	Holes, trenches and pull boxes	Trackers or backhoe
3	1.2	Discussion and final approval	Revision of drawings and permission to proceed with work	Submissio n of final approved drawing	Engineers
3	2.2	Batteries and Inverters Containers	A set of documentation and purchase orders with a list of items to be delivered and	Delivery of items	Procurement officers

Level	WBS Code	Element Name	Description of Work	Deliverables	Resources
			the expected delivery dates		
3	3.2	Construction manuals and drawings	Preparing of all updated drawing and operation manuals for the project	Final project documents	Contractor, consultants and engineers

(Source: Complied by author)

As this project progresses, the Project Manager will verify interim project deliverables against the original scope as defined in the scope statement, WBS and WBS Dictionary. Once the Project Manager verifies that the scope meets the requirements defined in the project plan, the Project Manager and Sponsor will meet for formal acceptance of the deliverable.

The Project Manager and the project team will work together to control the scope of the project. The project team will leverage the WBS Dictionary by using it as a statement of work for each WBS element. The project team will ensure that they perform only the work described in the WBS dictionary and generate the defined deliverables for each WBS element. The Project Manager will oversee the project team and the progression of the project to ensure that the scope control process is followed.

If a change to the project scope is needed, the process for recommending changes to the scope of the project must be carried out. Any project team member or sponsor can request changes to the project scope. All change requests must be submitted to the Project Manager in the form of a project change order. The Project Manager will then

review the suggested change to the scope of the project. The Project Manager will then either deny the change request if it does not apply to the intent of the project or convene a change control meeting between the project team and Sponsor to review the change request further and perform an impact assessment of the change. If the change request receives approval by the Project Manager and Sponsor, the Project Manager will then formally submit the change request to the Project Sponsor who will then formally accept the change by signing the change order. Upon acceptance of the scope change by the Project Manager and Project Sponsor, the Project Manager will update all project documents and communicate the scope directive to all project team members and stakeholders.

4.3 Project Schedule Management

The first process in project time management involved developing the Schedule Management Plan that would be used to guide the lifecycle of the project's schedule. The Project Charter and the Scope Management Plan were used as inputs to this process to gather information regarding the Scope Baseline and the summary milestone schedule. The tools and techniques used were expert judgement, analytical techniques, and meetings in order to create the Schedule Management Plan. Since there were no OPA's, a Schedule Management Plan template was derived from another source and modified for this purpose (Project Management Institute, 2017, p. 173).

Project schedules will be created using MS Project 2016 starting with the deliverables identified in the project's Work Breakdown Structure (WBS). Activity definition will identify the specific work packages which must be performed to complete each deliverable. Activity sequencing will be used to determine the order of work packages and assign relationships between project activities. Activity duration estimating will be used to calculate the number of work periods required to complete work packages. Resource estimating will be used to assign resources to work packages in order to complete schedule development.

Once a preliminary schedule has been developed, it will be reviewed by the project team and any resources tentatively assigned to project tasks. The project team and resources must agree to the proposed work package assignments, durations, and schedule. Once this is achieved the project sponsor will review and approve the schedule and it will then be baselined.

The following will be designates as milestones for the project schedule:

1. Project Kick-off meeting
2. Approval of final design drawings
3. Arrival of all equipments on site
4. Completion of all civil works
5. Completion of the installation of Batteries and Inverters (Batteries and PV) installation
6. Final Testing and Commissioning
7. Completion of staff training
8. End of project

Roles and responsibilities for schedule development are as follows:

The project manager will be responsible for facilitating the breakdown of work packages into activities that provide a basis for sequencing, and estimating duration and resources with the project team. The project manager will also create the project schedule using MS Project 2016 and validate the schedule with the project team, and stakeholders. The project manager will obtain schedule approval from the stakeholders and baseline the schedule.

The project team is responsible for participating in work, and duration and resource estimating. The project team will also review and validate the proposed schedule and perform assigned activities once the schedule is approved.
The project stakeholders will participate in reviews of the proposed schedule, assist in its validation and approve the final schedule before it is baselined.

The project schedule will be reviewed and updated as deem necessary with actual start, actual finish, and completion percentages which will be provided by task owners.

The project manager is responsible for holding bi-weekly schedule updates/reviews; determining impacts of schedule variances; submitting schedule change requests; and reporting schedule status in accordance with the project's communications plan.

The project team is responsible for participating in bi-weekly schedule updates/reviews; communicating any changes to actual start/finish dates to the project manager; and participating in schedule variance resolution activities as needed.

The project sponsor will maintain awareness of the project schedule status and review/approve any schedule change requests submitted by the project manager.

Any changes in the project scope, which have been approved by the project sponsor, will require the project team to evaluate the effect of the scope change on the current schedule. If the project manager determines that the scope change will significantly affect the current project schedule, he/she may requested that the schedule be re-baseline in consideration of any changes which need to be made as part of the new project scope. The project sponsor must review and approved this request before the schedule can be re-baselined.

The second process in planning project schedule management, following the development of the Schedule Management Plan, was Activity Definition. The define activity process produces the activity list. this list represents all of the schedule activities that will need to take place for the project to be completed. This is primarily accomplished by taking the WBS and decomposing the work packages even further

until they represent schedule activities. The activity list is used as the basis for the next four schedule management processes: Sequence activities, estimate activity durations, develop schedule, and control schedule.

The table below outlined the human resources assigned to each activity.

Chart 10 Sequence Activities

ID	WBS	Activities	Duration	Start	Finish	Resources
		Kick-off meeting	0 days			Project Manager, Engineers, Consultants
1	**1**	**Engineering**	**35 days**	**Mon 03-06-19**	**Fri 19-07-19**	
2	1.1	Project drawings	10 days	Mon 03-06-19	Fri 14-06-19	Draughtsman, Engineers, VINLEC, SolarTech
3	1.1.1	Detail Civil drawing	21 days	Mon 03-06-19	Mon 01-07-19	Draughtsman, Civil Engineers
4	1.1.2	Detail Electrical drawings	21 days	Mon 03-06-19	Mon 01-07-19	Draughtsman, Electrical Engineers
5	1.1.3	Layout of Containers drawing	10 days	Mon 10-06-19	Fri 21-06-19	Draughtsman, Civil Engineers
6	1.1.4	PV farm layout drawings	14 days	Mon 17-06-19	Thu 04-07-19	Draughtsman, Electrical Engineers
7	1.1.5	Battery system layout	14 days	Mon 17-06-19	Thu 04-07-19	Draughtsman, Electrical Engineers
8	1.1.6	Cables		Mon 24-	Tu 03-07-19	Draughtsman, Electrical

ID	WBS	Activities	Duration	Start	Finish	Resources
		trenches layout	8 days	06-19		Engineers
9	1.2	Discussion and final approval of drawings	10 days	Fri 05-07-19	Thu 18-07-19	VINLEC, SolarTech
10	1.2.1	Submission of final design	1 day	Mon 08-07-19	Mon 08-07-19	VINLEC, Solar Tech
11	1.2.2	Review of final design	5 days	Tues 09-07-19	Mon 15-07-19	VINLEC, SolarTech
12		**Approval of final design drawings**	0 days	Wed 17-07-19	Wed 17-07-19	VINLEC
13	**2.0**	**Procurement and delivery**	**76 days**	**Mon 24-06-19**	**Mon 07-10-19**	Suppliers
14	**2.1**	**Batteries inverters & other components**	**50 days**	**Mon 24-06-19**	**Fri 30-08-19**	Suppliers
15	2.1.1	P.O placement and confirmation	7 days	Mon 24-06-19	Fri 02-07-19	VINLEC
16	2.1.2	Production	25 days	Mon 01-07-19	Fri 02-08-19	Suppliers

ID	WBS	Activities	Duration	Start	Finish	Resources
17	2.1.3	EXW delivery	0 days	Fri 26-07-19	Fri 26-07-19	
18	2.1.4	Export and Transport	25 days	Mon 29-07-19	Fri 30-08-19	Suppliers
19	2.1.5	CIF delivery	1 days	Fri 30-08-19	Fri 30-08-19	Suppliers
20	**2.2**	**Containers for Batteries & Inverters**	**70 days**	**Mon 24-06-19**	**Fri 27-09-19**	Suppliers
21	2.2.1	P.O placement and confirmation	7 days	Mon 24-06-19	Fri 02-07-19	VINLEC
22	2.2.2	Production	35 days	Mon 24-06-19	Fri 09-08-19	Suppliers
23	2.2.3	EXW delivery	1 days	Fri 09-08-19	Fri 09-08-19	
24	2.2.4	Export and Transport	35 days	Mon 12-08-19	Fri 27-09-19	Suppliers
25	2.2.5	CIF delivery	1 days	Fri 27-09-19	Fri 27-09-19	
26		**Arrival of all equipment on**	0 days	**Mon 10-**	**Mon 10- 07-19**	

ID	WBS	Activities	Duration	Start	Finish	Resources
		site		**07-19**		
27	**3.0**	**Construction and closing**	**55 days**	**Mon 05-08-19**	**Fri 18-10-19**	SolarTech, Subcontractor, VINLEC, Consultant
28	**3.1**	**Excavation and installation**	**50 days**	**Mon 05-08-19**	**Fri 11-10-19**	SolarTech, Subcontractor, VINLEC, Consultant
29	3.1.1	Ground clearing and grading for PV panels	7 days	Mon 05-08-19	Tues 13-08-19	SolarTech, Subcontractor, VINLEC, Consultant
30	3.1.2	Digging of trenches and pull boxes	2 days	Mon 05-08-19	Tues 06-08-19	SolarTech, Subcontractor,
31	3.1.3	Preparation of foundation for PV panel racking system	10 days	Mon 05-08-19	Fri 16-08-19	SolarTech, Subcontractor,
32	3.1.4	Laying of racking system for PV panels	10 days	Mon 26-08-19	Fri 06-09-19	SolarTech, Subcontractor,

ID	WBS	Activities	Duration	Start	Finish	Resources
33	3.1.5	Mounting of PV panels	10 days	Mon 09-09-19	Fri 20-09-19	SolarTech, Subcontractor,
34		**Completion of PV panel installation**	**0 days**		**Fri 20-09-19**	
35	3.1.6	Installation of cable trays	5 days	Mon 09-09-19	Fri 13-09-19	SolarTech, Subcontractor,
36	3.1.7	Preparation of concrete footing for containers	20 days	Mon 05-08-19	Fri 30-08-19	SolarTech, Subcontractor,
37	3.1.8	Place containers on footing	2 days	Mon 02-09-19	Tues 03-09-19	SolarTech, Subcontractor,
38		**Completion of civil works**	**0 days**		**Fri 30-08-19**	
39	3.1.9	Installation of batteries and inverters	10 days	Wed 04-09-19	Tues 17-09-19	SolarTech, Subcontractor
40		**Completion of batteries and inverters**	**0 days**		**Tues 17-09-19**	

ID	WBS	Activities	Duration	Start	Finish	Resources
		(batteries and PV) installation				
41	3.2.0	Installation of AC and DC cables	10 days	Wed 18-09-19	Tues 01-10-19	SolarTech, Subcontractor
42	3.2.1	Installation of communication cables	5 days	Wed 18-09-19	Tues 24-09-19	SolarTech, Subcontractor
43	3.2.3	Testing and commissioning of the system	9 days	Wed 25 -09-19	Fri 04-10-19	SolarTech, Subcontractor
44		**Final testing and commissioning**	0 days		**Fri 04-10-19**	SolarTech, Subcontractor
45	3.2.4	Staff training	5 days	Mon 07-10-19	Fri 11-10-19	SolarTech, Subcontractor, Suppliers
46		**Completion of staff training**	0 days		**Fri 11-10-19**	
47		**End of project**	0 days		**Fri 18-10-19**	

(Source : Complied by author)

4.4 Project Cost Management

The Project Manager will be responsible for managing and reporting on the project's cost throughout the duration of the project. The Project Manager will send out a monthly financial report by E-mail to the Project Sponsor. During the monthly project progress meeting, the Project Manager and key team members will meet with Project Sponsors to present and review the project's cost performance for the previous month. Performance will be measured using earned value management or metrics. The Project Manager is responsible for preparing the Cost Management Plan and the Cost Baseline. The Project Manager is also responsible for accounting for cost deviations and presenting the Project Sponsor with options for getting the project back on budget. The Project Sponsor has the authority to make changes to the project to bring it back within budget.

Cost Management Approach Costs for this project will be managed at the first level of the Work Breakdown Structure (WBS). Control Accounts (CA) will be created at this level to track costs. Earned Value calculations for the CA's will measure and manage the financial performance of the project. Although activity cost estimates are detailed in the work packages, the level of accuracy for cost management is at the first level of the WBS.

Cost variances of +/- 0.2 in the cost and schedule performance indexes will change the status of the cost to cautionary; as such, those values will be changed to yellow in the project status reports. Cost variances of +/- 0.3 in the cost and schedule performance indexes will change the status of the cost to an alert stage; as such, those values will be changed to red in the project status reports. This will require corrective action from the Project Manager in order to bring the cost and/or schedule performance indexes below the alert level. Corrective actions will require a project change request and be must approved by the Project Sponsor before it can become within the scope of the project.

Performance of the project will be measured using Earned Value Management. The following four Earned Value metrics will be used to measure to projects cost performance:

- Schedule Variance (SV)
- Cost Variance (CV)
- Schedule Performance Index (SPI)
- Cost Performance Index (CPI)

If the Schedule Performance Index or Cost Performance Index has a variance of between 0.2 and 0.3 the Project Manager must report the reason for the exception. If the SPI or CPI has a variance of greater than 0.3 the Project Manager must report the reason for the exception and provide management a detailed corrective plan to bring the projects performance back to acceptable levels.

Chart 11 Performance Measurement

Performance Measure	**Yellow**	**Red**
Schedule Performance Index (SPI)	Between 0.8 and 0.7 or Between 1.2 and 1.3	Less Than 0.7 or Greater than 1.3
Cost Performance Index (CPI)	Between 0.8 and 0.7 or Between 1.2 and 1.3	Less Than 0.7 or Greater than 1.3

(Source: complied by author)

The cost change control process will follow the established project change request process. Approvals for project budget/cost changes must be approved by the project sponsor.

The budget for this project is detailed below.

Chart 12 The project budget

Expense	Quantity	Unit Cost	Total Cost	Purpose
Construction/ Subcontracts				
In-house				
Engineers	3		$15,000.00	Labour only
Technician	5		$8,000.00	
Skill Workers	5		$5,000.00	
Contractors/Sub Contracts				
Ground Clearing/ Excavation of Trenches	7	$1000.00	$7,000.00	Labour and material
Preparation of foundation for PV panel racking system	10	$800.00	$8,000.00	Labour and material
Laying of racking system for PV panels	10	$200.00	$2,000.00	Labour and material
Mounting of PV panels	10	$200.00	$2,000.00	Labour and

Expense	Quantity	Unit Cost	Total Cost	Purpose
				material
Installation of cable trays	5	$200.00	$1,000.00	Labour and material
Preparation of concrete footing of containers	20	$900.00	$18,000.00	Labour and material
Place containers on footing	2	$3,000.00	$6,000.00	Labour and equipment
Installation of batteries and inverters	10	$500.00	$5,000.00	Labour and material
Installation of AC and DC cables	10	$600.00	$6,000.00	Labour and equipment
Installation of communication cables	5	$600.00	$3,000.00	Labour only
Supervision work	50	$500.00	$25,000.00	Labour only
Testing and commissioning of system	9	$3000.00	$27,000.00	Labour only
Suppliers/Vendors				
Batteries inverters &	12	$5000.00	$60,000.00	Equipm

Expense	Quantity	Unit Cost	Total Cost	Purpose
other components				ent
Containers for Batteries & Inverters	2	$20,000.00	$40,000.00	Equipment
Solar Panels	313	$25.00	$7,825.00	Equipment
Solar Panel racking system	1	$8000.00	$8,000.00	Material
Cables and accessories	1	$1000.00	$10,000.00	Material
Heavy Machines (backhoe/ excavator and Crane)	3	$500.00	$1,500.00	Equipment
Administrative/Professional				
Draughtsman	2		$8,000.00	Labour only
Accountant	1		$6,000.00	
Project Manager	1		$50,000.00	
Project Clerk	1		$20,000.00	
Office Operations	4		$15,000.00	
Construction & Administration			$491,825.00	
Contingency 3%			$147,54.75	
VAT 17%			$86,118.56	
Grand Total			$592,698.31	

(Source: Complied by author)

4.5 Project Quality Management

The Quality Management Plan is an integral part of any project management plan. The purpose of the Quality Management Plan in this project is to describe how

quality will be managed throughout the lifecycle of the project. It also includes the processes and procedures for ensuring quality planning, assurance, and control are all conducted. All stakeholders in the project should be familiar with how quality will be planned, assured, and controlled.

The quality management approach for the project will ensure quality is planned for both the product and processes. In order to be successful, this project will meet its quality objectives by utilizing an integrated quality approach to define quality standards, measure quality and continuously improve quality.

The Project Quality Management Plan documents the necessary information required to effectively manage project quality from project planning to delivery. It defines a project's quality policies, procedures, criteria for and areas of application, and roles, responsibilities and authorities.

The Project Quality Management Plan is created during the Planning Phase of the project. Its intended audience is the project manager, project team, project sponsor and any senior leaders whose support is needed to carry out the plan.

Project Quality Management Overview:

Chart 4 Organization, Responsibilities, amd Interfaces

Name	Role	Quality Responsibility
Project Manager	Manage all work on the project	Quality monitoring & Control
Engineers	Superivor installations	Quality Audit

(Source: Complied by author)

The Project Manager/Engineers and the project team will perform assessments at planned intervals throughout the project to ensure all processes are being correctly

implemented and executed. The table below provides the key quality assurance metrics for the Project.

Chart 14 Key quality assurance metrics for the project

Tools/Method	Description
Seaward PV150	PV installation tester. PV150 performs open circuit voltage, short circuit current and insulation resistance tests.
Fuke VT04	Compact and intuitive, the VT04A and VT04 Visual IR Thermometers blend a visual image with a heat map overlay, to help quickly identify the location of issues
Concrete Slump test	Required amount of PSI strength

(Source: Complied by author)

The Project Manager and the project team will provide day-to-day quality management and conduct process audits on a weekly basis, monitor process performance metrics, and assure all processes comply with project standards. If discrepancies are found, the Project Manager will meet with the Foreman and review the identified discrepancies.

To assure Quality product Contractor used qualified and certified products through the project. For example al PV panels specified for the project will be Suntech panels. All panels complies the highest international standards: ISO 9001: 2008, ISO 14001: 2004 and ISO17025: 2005. Also, the inverters are manufactured by SMA who is a lead global specialist in photovoltaic system technology with more than 37 years experience. Safety and quality are non-negotiable for SMA because

in the end, exactly these factors guarantee maximum and sustainable efficiency of PV systems in all application areas and sizes for years.

SMA Inverters are certified to comply with mostly all quality, performance and grid Standards. Hereby some are the standards: BDEW 2008, C10/11:2012, CE, CEI 0-16, CEI 0-21, DEWA 2.0, EN 50438:2013, G59/3, IEC 60068-2-x, IEC 61727, IEC 62109-1/2, IEC 62116, MEA 2013, NBR 16149, NEN EN 50438, VDE 0126-1-1, VDE-AR-N 4105, VFR 2014

BMZ (Lithium-ion) is a leading European battery expert and global player. Process-oriented quality management and product quality have been taking centre stage at BMZ since the company was established. The requirements of DIN EN ISO 9001:2008 are part and parcel of our management system, which is the same for all of BMZ's facilities around the world. It is the basis for outstanding products and business excellence. BMZ is recommended Lithium Ion brand by SMA. Electrical Products To ensure to have a good project that has longer lifetime is critical to have all other devices, connections, cabinets with certification. This certification differs according to purpose of the material or device. All electrical cable, connection are certified to a minimum VDE, TUV, UL, KEMA, IEC, EN.

To ensure to have a long lasting products it is critical to have all other devices, connections, cabinets with certification. This certification differs according to purpose of the material or device. All electrical cable, connection are certified to a minimum VDE, TUV, UL, KEMA, IEC, EN.

In order to control the quality on the project contractor will check every components in order to ensure that was the item or equipment that was ordered. Every replacement need to have the same certification or better.

Independent testing company will a perform a pre-shipment solar panel quality testing on-site at the PV-factory and this test will contain visual and thermal

inspections. In the same way an independent testing company will perform a pre-shipment inverter quality testing on-site at the inverter factory.
Also during commissioning the contractor will test and measure all the strings and record the information so as to compare with the test results at the factory. Additional the contractor will use a thermal IR meter to verify that when the system is on all equipment/connections are at the desire temperature. This is to prevent permanent damaged on the system.

All bolted or screwed connection are fastened and torque according the manufacturer recommendation. For control, the connections will be torque by two persons. The ones that are already torque will be marked as a means of signifying that they are already torque.

4.6 Project Resource Management

Human resources management is an important part of the Building of the Convention Center. The human resources management plan is a tool which will aid in the management of this project's human resource activities throughout the project until closure. The human resources management plan includes:

- Roles and responsibilities of team members throughout the project
- Project organization charts
- Staffing management plan to include:
  a. How resources will be acquired
  b. Timeline for resources/skill sets
  c. Training required to develop skills
  d. How performance reviews will be conducted
  e. Recognition and rewards system The purpose of the human resources management plan is to achieve project success by ensuring that the appropriate human resources are acquired with the necessary skills,

resources are trained if any gaps in skills are identified, team building strategies are clearly defined, and team activities are effectively managed.

The purpose of the human resources management plan is to achieve project success by ensuring that the appropriate human resources are acquired with the necessary skills, resources are trained if any gaps in skills are identified, team building strategies are clearly defined, and team activities are effectively managed.

Roles and Responsibilities The roles and responsibilities for the project team of the construction of the Solar and Battery Storage Project are essential to project success. All team members must clearly understand their roles and responsibilities in order to successfully perform their portion of the project. For the construction of the Solar and Battery Storage Project the following project team roles and responsibilities have been established:

Draughtsman/Designer (A), (1 position): responsible for ensuring the project area are properly laid out, and use of space are adhered to

Project Manager (PM), (1 position): responsible for the overall success of the Project. The PM must authorize and approve all project expenditures. The PM is also responsible for ensuring that work activities meet established acceptability criteria and fall within acceptable variances. The PM will be responsible for reporting project status in accordance with the communications management plan. The PM will evaluate the performance of all project team members. The PM is also responsible for acquiring human resources for the project by skill set. The PM must possess the following skills: leadership/management, budgeting, scheduling, and effective communication.

Electrical Engineer (EE), (1 position): responsible for ensuring that the installation work are at optimum level and the system function in an efficient and

effective matter. The EE is responsible for producing an electrical system layout for the entire project to be issued to the Draughtsman.

Civil Engineer (CE), (1 position): responsible for the structural integrity of the foundations, other civil works on the site and produces structural calculations and drawings to be issued to the Draughtsman.

Foreman (F), (1 position): responsible for the technical requirements as per the specifications and drawings. The Foreman ensures that each skilled worker carries out the work per the specifications.

Electrical Subcontractor (ES), (1 position): responsible for reading and calculating electrical drawings and ensuring system are installed as per the design. In addition, the ES is responsible for installing all site cabling and lighting as per electrical and site layouts and schedules.

Accountant: responsible for all financial transactions and financial reporting pertaining to the project.

Project Organizational Charts

The following RACI chart shows the relationship between project tasks and team members. Any proposed changes to project responsibilities must be reviewed and approved by the project manager. Changes will be proposed in accordance with the project's change control process. As changes are made all project documents will be updated and redistributed accordingly.

Chart 5 Chart 15 RACI chart for the project

	Project Manger	Engineers	Sub contractors	Foreman	Site Workers	Accountant	Supplier
Project drawing/design	A	R	I	I	I		
Procurement	A					I	R
Project Scope	R	I	I	I	I		I
Change Request	R	I	I	I	I		
Project Communication	R		I	I	I		
Stakeholder Management	R			I	I		
Project Quality	R						
Site Management	A	C	C	R			
Manage site workers	A		C	R			
Accounting	A					R	

	Project Manger	Engineers	Sub contractors	Foreman	Site Workers	Accountant	Supplier
Staff development	R			A	I		

(Source: Complied by author)

Key:

R – Responsible for completing the work

A – Accountable for ensuring task completion/sign off

C – Consulted before any decisions are made

I – Informed of when an action/decision has been made

For the construction of the Solar and Battery storage project, the project staff will consist of a some internal resources. However, few of the work will be subcontracted to external resources. There will be outsourcing/contracting performed within the scope of this project. The Project Manager will negotiate with various companies in order to identify and assign 20 resources for the project. All resources must sign a contract/agreement with the performing organization before the resource may begin any project work. The managerial staff and office workers will work at the office of SolarTech and be required to visit the site daily. The subcontractors and site workers will work on site until contract completion.

The construction of the Solar and Battery storage project will last for a total of 20 weeks. Most of the resources are required before the project begins. However, few of the resources are source after the project starts. The resource histograms below illustrate the number of days required to complete the project management, design

and construction works for the Solar and Battery storage project. Therefore, it gives an idea how days the different resources will be involved in the project.

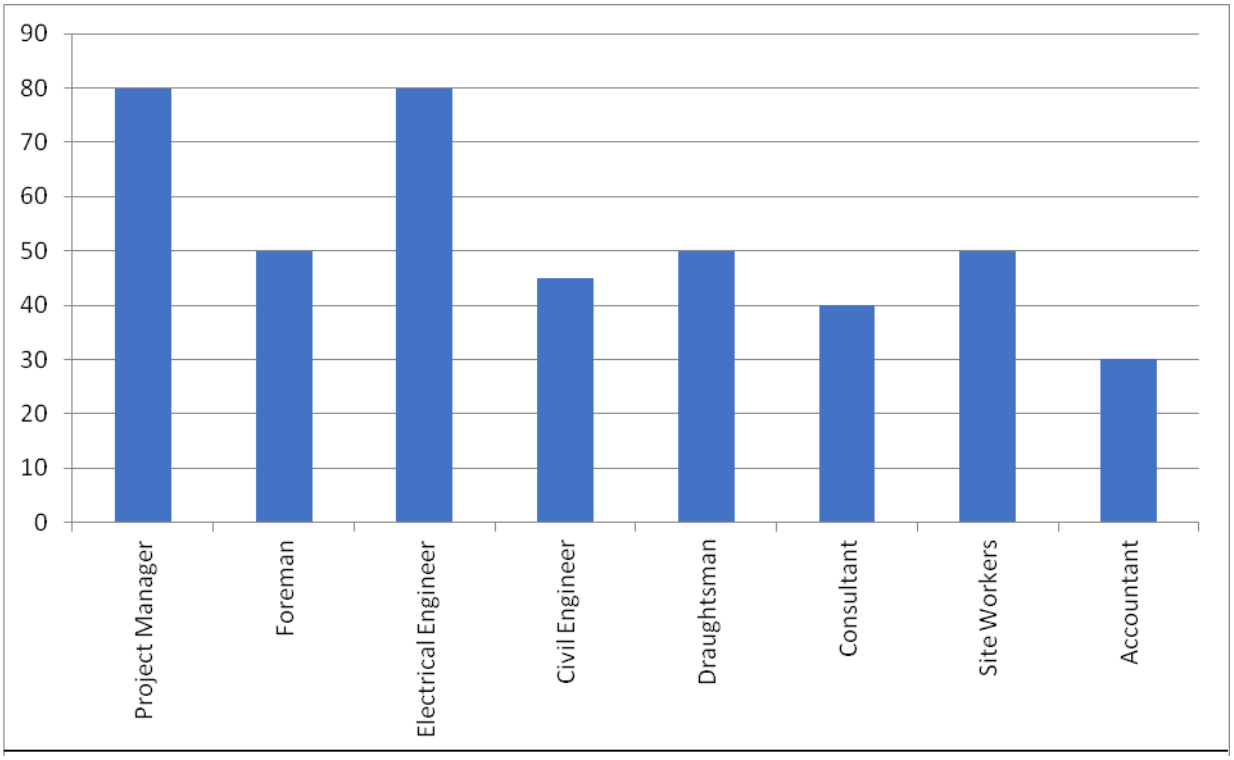

Figure 16 Solar and Battery storage project histogram (Source: Complied by author)

4.7 Project Communication Management

In this the Project Manager will take a proactive role in ensuring effective communications is carried out. The communications requirements will be documented in the Communications Matrix presented in this document. The Communications Matrix will be used as the guide for what information to communicate, who is to do the communicating, when to communicate it and to whom to communicate. It is an easy way to keep key players in the loop.

Chart 16 Communication matrix

Communication	Purpose	Medium	Frequency	Audience	Owner	Deliverable
Kickoff Meeting	Introduce project. Review objectives and goals	In person / Face-to-face	Once	Project team Project sponsor Stakeholders	Project Manager	Agenda
Project Team Meetings	Review status of project	Face-to-face or Conference call	Weekly	Project team	Project Manager	Agenda, Project Schedule
Technical & Design Meeting	Discuss, review technical & design problems and solutions	In person / Face-to-face	As needed	Technical team	Technical lead	Agenda
Monthly Project Status meeting	Update leadership on project status	Face-to-face or Conference call	Monthly	Project manager, Shareholders	Project Manager	Slide presentation, Project Schedule

Communication	Purpose	Medium	Frequency	Audience	Owner	Deliverable
Project Status Report Meetings	Detailed report on project status including progress, costs, and problem	Email	Monthly	Project manager, Shareholders	Project Manager	Project status report, Project Schedule

Source: Complied by author

As with most project plans, updates or changes may be required as the project progresses or changes are approved. Changes or updates may be required due to changes in personnel, scope, budget, or other reasons. Additionally, updates may be required as the project matures and additional requirements are needed. The project manager is responsible for managing all proposed and approved changes to the communications management plan. Once the change is approved, the project manager will update the plan and supporting documentation and will distribute the updates to the project team and all stakeholders. This will ensure that all project stakeholders remain aware and informed of any changes to communications management.

4.8 Project Risk Management

The first step in applying any risk management process is understanding what a risk is. *A Guide to the Project Management Body of Knowledge (PMBOK®)*, 2000 Edition defines a risk as an uncertain event or condition, that if it occurs, has a positive or negative effect on a project objective. Thus a risk is not an event or occurrence which has already befallen a project. It is an event that might happen. Secondly, a risk can have a positive impact or a negative impact. Many tend to only focus on risks that will have a negative impact. A project manager should seek to identify the positive and the negative.

Risks are composed of three elements: the risk event itself, the consequence or the impact of a risk event occurring, and the likelihood or probability of a risk event occurring. Lacking a clearly defined risk event, it is impossible to completely understand the concern. A clearly defined consequence is vital to ensure all understand the ‘so what' of a risk. Only by understanding the likelihood of a risk to some degree can a team know how important the risk is to the overall project outcome.

The main objective of the project team members is to increase the chance of the project success. Therefore, in order to achieve success the team intend to progressively elaborate and assess the potential of risk occurrence and the severity of impacts whether negative or positive.

To ensure that the project team captures and analyzes as many risks as possible that is realistic to the project, information gathering techniques such as brainstorming, Delphi Techniques, interviews and root cause analysis will be used. SWOT analysis will be used to explore treats as well as opportunities. Once all risks have been identified to a reasonable extent a risk register will be created. All risk is then quantified to determine their likelihood of occurrence and the impact they might have on project objectives. A risk response strategy is then developed

to eliminate or reduce the impact of risk. Then each risk is assigned to a person or team on the project who will be responsible for managing the category of risk.

The risks for the project will be identified under the following risk categories:

1. Technical
2. Energy Resource
3. Severe Weather Event
4. Cost Forecast
5. Construction
6. Financial
7. Political Risks/Others
8. Environment and Social

Based on the probability of each risk occurring and its impact on the project different colour code was used. The red represents high risks, the yellow moderate risks and the green represents low risks.

Chart 17 Risk severity and frequency numerical values

Risk Severity and Frequency numerical Values	
Description	**Metric**
High	Red
Medium	Yellow
Low	Green

Source: Complied by author

Risk Control Strategies

The following are the risk control strategies for the project:

1. Avoid

Change the project plan to eliminate the risk or to protect the project objectives (schedule, cost, scope, quality) from its impact. This can be achieved by modifying scope, adding contingency to the project plan either as additional time for critical path activities, or adding resources. Some threats that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

2. Mitigate

Reduce the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than trying to repair the damage after the risk has occurred. Risk mitigation may take resources or time and hence may represent a trade off. However, the overall result may reduce risk to the overall project objectives

3. Transfer/Share

Shift the negative impact of a threat to a third party through: insurance, performance bonds, warranties, guarantees, incentive/disincentive clauses.
Transference reduces the risk only if the person to whom the risk is transferred (such as the contractor) is better able to take steps to reduce the risk and does so. Risk transference nearly always involves payment of a risk premium to the party taking on the risk.

4. Acceptance

Adopted if is either not possible to eliminate that risk from a project or the cost in time or money of the response is not warranted by the potential impact of the risk. The most common active acceptance strategy is to establish a contingency

reserve, including amounts of time, money, or resources to handle the threat or opportunity.

Chart 18 Risk Matrix

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
1. Technical								
Performance of technology	Lower yield = lower revenues	Continued	High	Low	Proven technology Quality components correctly dimensioned. Manufacturer/supplier warranties and performance gurantities and terms	Transfer	Manufacturer, Contractor	Technology to be provided by Manufacturer
Technical Availability	Lower yield = lower revenues	Low	High	Low	Proven technology Quality components correctly dimensioned. Manufacturer/supplier warranties and performance gurantities and terms	Transfer	Manufacturer, Contractor	Technology to be provided by Manufacturer
Equipment defect / decreasing yield	Lower yield = lower revenues	Low	Medium	Low	Manufacturer warranties and performance guarantees and	Transfer	Manufacturer, Contractor	Degradation rate guaranteed by the

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
(degradation)					terms O&M guarantees			manufacturer
2. Energy Resource								
Variability of irradiation data	Uncertain yield	Medium	High	Low	Use of different data bases, on-site irradiation measurements	Mitigate	VINLEC/ Consultants	A number of irradiation data and models to be used by the developer, using reputable consultants to perform the feasibility studies. Theoretical data to be combined with on site measurements.
Quality of irradiation data	Overestimation of yield	Medium	High	Low	Use of proven databases with well correlated theoretical and	Mitigate	VINLEC/ Consultants	A number of irradiation data and models to be

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
					empirical data. Use of on-site measurements.			used by the developer, using reputable consultants to perform the feasibility studies. Theoretical data to be combined with on site measurements.
3.Severe Weather Event								
Lightning Strike	Damage of installation	High	High	Low	Use of technical protection measures	Transfer, Mitigate, Accept	Designer/EPC contractor	Appropriate measures to be incorporated in the installation's design, Insurance
Extreme wind	Damage of	High	High	Medium	Use of technical protection	Transfer, Mitigate,	Designer/EPC	Appropriate measures to

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
conditions	installation				measures	Accept	contractor	be incorporated in the installation's design, Insurance
Flood	Damage of installation	Low	Medium	Medium	Site selection	Transfer, Mitigate, Accept	Designer/EPC contractor	Appropriate measures to be incorporated in the installation's design, Insurance
Sand storm	Damage of installation	High	High	High	Use of technical protection measures	Transfer, Mitigate, Accept	Designer/EPC contractor	Appropriate measures to be incorporated in the installation's design, Insurance
Earthquake	Damage of installation	Low	High	Low	Site selection	Mitigate, Accept	Designer/EPC contractor	Appropriate measures to be incorporated in the installation's

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
								design, Insurance
4. Cost Forecast								
CAPEX	Underesti mates	Medium	High	Low	The cost estimates to be based on recent quotes from the manufacturer/su ppliers.	Transfer	Sponsor	The budget will be based on fixed price contract
Maintenance Reserve Account (inverter replacement)	Underesti mates can lead to reduced cashflow	Medium	High	Low	The cost of replacement to be build- in in to the financial model, sufficient MRA to be envisaged in the budget	Transfer	Sponsor	The model will consider the replacement needs based on the technical characteristic s provided by the manufacturer. Strong performance guarantees to be requested.
5. Constructio								

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
n Risks								
Cost overrun / adjustments	Can lead to lack of funds to complete the project	Medium	Medium	Low	Engineering Procurement and Construction Contract, Completion Guarantees, Monitoring reports, Performance reports, Penalty clauses, Project's budgeted costs will include cost contingency funds	Avoid, Transfer, Mitigate	Manufacturer, Contractor	
Equipment Delivery Delays	Delay in completion, loss of revenue, penalty for late completion	Medium	Medium	Low	Engineering Procurement and Construction Contract, Completion Guarantees, Monitoring reports, Performance reports, Penalty clauses,	Avoid, Transfer, Mitigate	Manufacturer, Contractor	

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
					Project's budgeted costs will include cost contingency funds			
Transportation Price	Cost overrun	Medium	Medium	Low	Engineering Procurement and Construction Contract, Completion Guarantees, Monitoring reports, Performance reports, Penalty clauses, Project's budgeted costs will include cost contingency funds	Transfer, Mitigate	Manufacturer, Contractor	Transportation rate to be included in contract.
6. Financing risks								
Currency	Devaluation of currency in a foreign	High	High	High	Hedging Financial Covenants Market Flex	Transfer	Borrower, Lender	A hedging must be arranged to protect from currency

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
	currency loan will result in reduction of the ability to repay the loan							devaluation. If the currency value changes between term sheet and loan agreement, the loan terms can be changed (market flex). A provision can stipulate a tariff correlated to the currency of the loan.
Inflation	High inflation can result in increase to increase of the	High	Medium	Low	Fixed O&M Hedging	Transfer	Contractor	

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
	O&M costs							
7. Political Risks/other								
Region Stability	Delay in completion	High	High	High	Political guarantee	Accept, Mitigate	Sponsor/Insurer	Political insurance to be arranged with the necessary parties
Theft, Vandalism	Delay in completion, loss of revenue	Medium	Low	Low	Use of stringent security protection measures. Contribution to local economy	Mitigate	Sponsor/Contractor	The project will contribute to local social programme. Local people will have vest interest in the project success.
8. Environmental and Social								
Unacceptable environmental impacts	Protected territory, endangered species,	Medium	Low	Low	Full Environmental and Social Impact Assessment will	Avoid, Mitigate	Sponsor/contractor	Stringent environmental procedures to be followed at

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
	pollution etc.				be performed. Use of stringent safety protection measures. Environmental Action Plan agreed and prepared.			construction and operations in accordance to agreed Environmental Action Plan
Environmental impact during construction	Pollution to the construction area and surroundings. Destruction of local habitat.	Medium	Low	Low	Full Environmental and Social Impact Assessment will be performed. Use of stringent safety protection measures. Environmental Action Plan agreed and prepared.	Avoid, Mitigate	Sponsor/contractor	Sponsor will make its best endeavours to select land for the projects that shows no agricultural use and also where no resettlement is required. In the event that the selected land displays such impacts, appropriate mitigation measures will be

Events	Potential effect	Frequency (event/ year)	Severity	Estimated risk	Mitigation/ Strategy	Risk Control Strategy	Risk taker	Notes
								established.
Opposition by the local community	Delay in completion, loss of revenue.	High	High	Medium	Social Programme contribution from the project	Avoid, Mitigate	Sponsor	The Sponsor will make its best endeavours to select land for the projects that shows no agricultural use and also where little, or no resettlement is required and land owners/users are fairly compensated.

(Source: Complied by author)

4.9 Project Procurement Management

This Procurement Management Plan sets the procurement framework for this project. It will serve as a guide for managing procurement throughout the life of the project and will be updated as acquisition needs change. This plan identifies and defines the items to be procured, the types of contracts to be used in support of this project, the contract approval process, and decision criteria. The importance of coordinating procurement activities, establishing firm contract deliverables, and metrics in measuring procurement activities is included. Other items included in the procurement management plan include: procurement risks and procurement risk management considerations; how costs will be determined; how standard procurement documentation will be used; and procurement constraints.

The Project Manager will provide oversight and management for all procurement activities under this project. The Project Manager will work with the project team to identify all items to be procured for the successful completion of the project. The PMO will then review the procurement list prior to submitting it to the contracts and purchasing department. The contracts and purchasing department will review the procurement items, determine whether it is advantageous to make or buy the items, and begin the vendor selection, purchasing and the contracting process.

The purpose of procurement is to describe, in specific terms, what items will be procured and under what conditions. Sometimes items which must be procured for a project can be made internally by an organization. Additionally, procurement deadlines are usually affected by the project schedule and are needed by certain times to ensure timely project completion. This section is where these items must be listed, justified, and the conditions must be set. Any important technical information should also be included. Individuals may also be listed with authority to approve purchases in addition to or in the absence of the project manager.

The following procurement items and/or services have been determined to be essential for project completion and success. The following list of items/services, justification, and timeline are pending the project manager review for submission to the purhasing office in the finance/purchasing department for purchasing.

Chart 19 Procurement date for items and services

Item/Services	Justification	Needed by
Steel	Used to reinforced all concrete component	05/08/19
Concrete	Mixture of sand, cement, water and aggregate	05/08/19
Timber	Used to form formwork structure.	05/08/19
Plywood	Used to form formwork structure.	05/08/19
Screws and nail	Fasteners	05/08/19
Cable Trays	Used to running both the AC and DC cables on	05/08/19
Cable ties and markers	Used to tie and mark the cables	04/09/19
Solar panels	Use to generate DC power to the inverters	05/08/19
The mount stands for the Solar Panel	Use to mount the Solar panels	05/08/19
Batteries	Use to store energy	04/09/19
Inverters	Use to convert DC current	04/09/19

Item/Services	Justification	Needed by
	to AC current	
Mount racks for the Batteries and Inverters	Use to mount the Batteries and inverters.	04/09/19
20ft Containers	For housing the batterries and inverters	05/08/19
AC and DC Cables	For providing power to the system	04/09/19
Telephone and Equipment	Used to provide telephone communications on site	18/09/19

(Source: Complied by author)

Make or buy decision

The project manager will determine the strategic choice when it comes to procuring items from suppliers. The make-or-buy decisions are often items or source for external suppliers. If the decision of the project management team is to make the item, then the procurement plan then decides the processes and agreements that are necessary for making the item.

However, the project is being executed on small island where there are limited resources therefore all of the items acquired for the project will have to be purchased.

Contract used for the project

All items and services to be procured for this project will be solicited under firm-fixed price contracts. The project team will work with the contracts and purchasing department to define the item types, quantities, services and required delivery

dates. The contracts and purchasing department will then solicit bids from various vendors in order to procure the items within the required time frame and at a reasonable cost under the firm fixed price contract once the vendor is selected.

For this project we will issue a Request for Proposal (RFP) in order to solicit proposals from different vendors which describe how they will meet our requirements and the cost of doing so. The vendors will outline how the work will be accomplished, who will perform the work, vendors' experience in providing these goods, customer testimonials, backgrounds and resumes of employees performing the work, and a line-item breakdown of all costs involved. Additionally, the vendors will be required to submit work breakdown structures (WBSs) and work schedules to show their understanding of the work to be performed and their ability to meet the project schedule.

All information must be included in each proposal as the proposals will be used as the foundation of our selection criteria. Proposals which omit solicited information or contain incomplete information will be discarded from consideration.

VINLEC maintains a repository on the company's shared drive which contains standard project management and procurement documentation that will be used for projects. The following standard documents will be used for this project procurement activities:

Standard Request for Proposal Template to include

- Background
- Proposal process and timelines
- Proposal guidelines
- Proposal formats and media
- Source selection criteria
- Pricing forms
- Statement of work

- Terms and Conditions
- Internal source selection evaluation forms
- Non-disclosure agreement
- Letter of intent
- Firm fixed price contract
- Procurement audit form
- Procurement performance evaluation form
- Lessons learned form

4.10 Stakeholder Management

Stakeholder management focuses on identifying the relevant project Stakerholders, creating a pln, executing the plan and monitoring and controlling. The idea that drives this is to work to manage the expectations that drive stakeholder satifaction.

As desribe previously in this document, the Stakeholder Management Plan includes several sections:

- Identify Stakeholders – identify by name and title of the people, groups, and organizations that have significant influence on project direction and its success or who are significantly impacted by the project.
- Plan Stakeholder Management – identify the strategies and mechanisms that will be used to achieve the greatest support of stakeholders and minimize resistance.
- Manage Stakeholder Engagement – outlines the processes and steps that will be undertaken to carry out the planned strategies.
- Control Stakeholder Engagement – describes the methods that will be used to monitor stakeholder engagement and alert the project team if problems are surfacing.

In order to develop an effective plan for managing stakeholders, they first need to be clearly identified and assessed. Stakeholders will be identified by performing a stakeholder analysis in which potential stakeholders and relevant information (interests, involvement, influence, and potential impact on project success) are gathered, documented and analysed. To assist with stakeholder identification and analysis, the team has created a Stakeholder Analysis Register categorized by Stakeholder Group. The Stakeholder Analysis Register captures the following information:

Name
Functional Area
Role-Responsibilities
Main Expectations
Major Requirements
Influence/Impact (Low- Medium-High)
Additional Comments

Chart 20 Strakeholder register matrix

ID	Name	Functional Area	Main Expectations	Major Requirements	Influence/ Impact(Low-Medium-High)	Additional Comments
MJ	Marcus James	CEO/VINLEC	The solar PV and battery storage project is an effective way to achieve an overall Energy Management goal and provide significant benefits for the the compnay and the community. The signiccantly reduce the reliance on the purchase of fossil fuel.	For the project can stand on it own in providing for significant long-term cost savings and an energy strategy not subject to fuel price volatility. For the elctricity grid to become more reliable since diesel engines required alot of maintenance work and normally fail from time to time	H/H	Since they are the sponsors of the project they will make available the necesary resources to ensure that the project meets the intended deliverables
JB	Jimmy Bachhus	Government Ministry	The solar PV and battery	For the project can stand on it	H/H	Since they are the sponsors of

ID	Name	Functional Area	Main Expectations	Major Requirements	Influence/ Impact(Low-Medium-High)	Additional Comments
			storage project is an effective way to achieve an overall Energy Management goal and provide significant benefits for the community. This includes serving as a model to residents, businesses and neighboring towns and cities in environmental stewardship, enhancing economic development, and contributing to	own in providing for significant long-term cost savings and an energy strategy not subject to fuel price volatility, at a time when many community is required to become more efficient in managing it limited operating resources.		the project they will make available the necesary resources to ensure that the project meets the intended deliverables

ID	Name	Functional Area	Main Expectations	Major Requirements	Influence/ Impact(Low-Medium-High)	Additional Comments
			workforce development for renewable energy business in the new economy.			
		Electrical & Civil Engineer/Subcontractors	To ensure that the project design are executed in a manner as to completed the deliverables within schedule, scope and cost	To have the necessary resources to execute the project within the schedule timeline.	H/H	These are the people who will execute the design of the project, thus they will have power to choose the most appropriate materials which will impact the budget as well as timeline.
CW	Carl Williams	Draughtsman	Given his role as designer he can have main expectation to see that his design plans are effective in	The design decision will not have a negative impact on prject's budget.	L/H	Given his role as designer he can have major influence on design decision and his decisions will

ID	Name	Functional Area	Main Expectations	Major Requirements	Influence/ Impact(Low-Medium-High)	Additional Comments
			meeting the project's expectations			impact the budget of the project
SS	Suzan Small	Accountant	To analyzed and report on the project status including income statement variances, communicating financial results to the management, budget preparation and analysis.	The monies are spent on what the monies were being disburse for.	H/H	The account has high inflence and high impact because if the necessary documentation are not recieved the customers and other big suppliers would not be paid.
	The people of Mayreau	The comunity of Mayreau	The project will provide benefits to the community.	For a reduction in cost of electricity, more reliable source of energy and for the project to provide jobs	H/H	These stakeholders have high influence and high impact on the project. Therefore, they are very

ID	Name	Functional Area	Main Expectations	Major Requirements	Influence/ Impact(Low-Medium-High)	Additional Comments
				for the locals in the community		relevant to the government and must be manage closely due to the fact that they can positively or negatively affect the implementation of the project activities.

(Source: Complied by author)

CONCLUSIONS

1. The project will result in a reduction in the use to diesel generation on the Grenadine island of Mayreau.
2. The project will help to sell the island as a green island which will play a role in enhancing the tourism product on the island.
3. The implementation of the project will reduce the regular need for maintenance to the diesel generators since with the use of solar generation the diesel engines will be required to run less hours.
4. The use of the project management process was important to this project because it ensures not only the risks are properly managed and mitigated against to avoid issues. However, to ensure what is being delivered to the people of Mayreau and St.Vincent and the Grenadines is right, and will deliver value against the business opportunity.

RECOMMENDATIONS

Although it is a relatively small project in term of timeline. The sponsor should ensure that formal Project Management methods are implement at all times to ensure that the project yield the expected results and benefits to the people of the island of Mayreau.

1. The project should have employed as part of the project team an experience global energy consultant which the drive to create clean, prosperous, and secure low carbon future. This would have help create the Islands Energy Partnership. This partnership will have guide the government of St.Vincent and other surrounding islands to develop energy transition strategies, scale renewable projects, and support the capacity of islands to achieve their sustainable energy goals. It will do this by delivering technical expertise, engaging with governments, utilities and island stakeholders, and providing communications support.
2. Also, this Partnership will have bring experience gained from engagements with island and continental governments and utilities to solve the toughest energy challenges. It harnesses a diverse skillset in integrated resource planning, project identification, project development, construction management, and a range of business advisory services. Additionally, the Partnership leverages an array of consulting services from leading engineering and consulting firms in the power generation and transportation sectors.

The government should have promoted the project more regionally and internationally as green island project so as to attract investment and boost tourism on the island of Mayreau.

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APPENDICES

Appendix 1: FGP Charter

PROJECT CHARTER	
Date	**Project Name:**
11 November 2018	Project Management Plan for the construction and implementation of a Solar Photovoltaics (PV) and Battery Storage Microgrid Project
Knowledge Areas / Processes	**Applicacion Area (Sector / Activity)**
Knowledge areas: Project Integration Management, Project Scope Management, Project Schedule Management, Project Cost Management, Quality Mangement, Project Resources Mangement, Project Risk Management, Project Procurement Management, Project Communications Management, Project Stakeholder Management **Process groups**: Initiating, Planning, Monitoring and Controlling	Planning/Constrcution.
Start date	**Finish date**
11 November 2018	9 December 2018

Project Objectives (general and specific)

General Objective:

To create a Project Management Plan, framed within the standards of the Project Management Institaute, to manage the construction of a Solar Photovoltaics (PV) and Battery Storage Microgrid Project on the Island of Mayreau

Specific objectives:

1. To create a project charter to formally authorize the project and provide the project manager with the mandate to apply organizational resources to the project and to produce the project management plan.
2. To create a scope management plan to ensure that it inludes all the work required to successfully complete the project.
3. To create a schedule management plan to support the development and managemnt of a project schedule to ensure that project is completed within the schedule contraints.
4. To create the cost management plan that establishes the different procedures, policies, and documentation needed to plan, manage, expand, and control the cost of the project within the budget constraints.
5. To develop a quality management plan to identify the acceptable level of quality, which is typically defined by the customer, and ensure that project results meets this expected level of quality in its deliverables and work processes.
6. To create a resource management plan for identifying and acquiring resources (both human and physical) needed to effective complete the project within schedule, cost and scope constraint.
7. To develop a communications management plan to ensure the timely and effective communication of the

project status and other key information.

8. To create a risk managemnt plan to identify, manage and document risk mitigation strategies to reduce the impact of risk on scope, cost and schedule inorder to sucessfully complete the project.
11. To develop a procurement management plan to be used to obtain product, services and results required by the project.
12. To develop a stakerholder that identifies stakeholders, their level of interests and analyses how their influence might impact the project.

Project purpose or justification (merit and expected results)

The project to develop the project Management Plan for The Solar Photovoltaics (PV) and Battery Storage Microgrid Project is required to effectively create the documents that will later be used by the Project Management Team during the execution, monitoring and controliing, and clsoing processes. VINLEC has contracted XYZ Design to consturtuct a Solar Photovoltaics (PV) and Battery Storage Microgrid System. The Solar Photovoltaics (PV) and Battery Storage Microgrid Project will be consturcted to reduce the reliance on diesel for electricity generation and in the process reduce the amount of pollution from burning fossil fuel.

The project manager and the project management team understand the importance of the planning process and the project management plan, to the sucessful completion of the project. During the project, the project mangaer will plan to develop the subidiaries of the project management plan for the Solar Photovoltaics (PV) and Battery Storage Microgrid Project to meet scope, schedule, cost and quality constraints.

Description of Product or Service to be generated by the Project – Project final deliverables

The Project Management Plan for the Planning and Construction of a solar photovoltaic (PV) and energy storage microgrid Systems will be generated by this project. This Plan will consist of all the subsidiary documents of a Project Management Plan. The subsidiary documents are: Project Scope Management, Project Schedule Management, Project Cost Management, Quality Mangement, Project Resources Mangement, Project Risk Management, Project Procurement Management, Project Communications Management, Project Stakeholder Management.

Assumptions

1. Review and feedback of the project deliverables will be done in a timely manner.
2. There will be expert judgment to guide the project.

Constraints

1. Five weeks to complete the first parts of the FGP.
2. The FGP document must follow the format provided.

Preliminary risks

Cause	Effect	Impact
Failing to identify all Project requirements.	Delay in submitting Deliverables	Scope and schedule
Communication	Inadequate time to honor change request to meet planned deadlines	Scope and schedule
Under estimating the complexity of the project scope and requirements	Incomplete Project Deliveries	Scope and schedule
Inadequate approval of deliveries	Incomplete changes	Scope, time, quality
Inadequate access to information	Referencing unapproved sources	scope, time, cost, quality

Budget

$600,000.00 USD (break down specific project deliveries are not yet available)

Milestones and dates

Milestone	Start date	End date
Submission of Charter	9 November 2018	9 November 2018
Submission of WBS	9 November 2018	9 November 2018
Submission of Chapter	16 November 2018	16 November 2018
Submission of FGP Schedule	16 November 2018	16 November 2018
Submission of Therorectical Frame work	23 November 2018	23 November 2018
Submission of Bibliography, Indexes	7 December 2018	7 December 2018
Formualtion of the project management Plans	15 March 2019	15 March 2019
Final Project Submission	3 May 2019	3 May 2019
Presentation to board of directors	21 March 2019	21 March 2019

Relevant historical information

Stakeholders

Direct stakeholders:
VINLEC
The community of Mayreau
Earlan Myers- Project Manager
The Contrator

Indirect stakeholders:
Government of St.Vincent and the Grenadines

Project Manager: Earlan Myers	Signature: E. Myers.

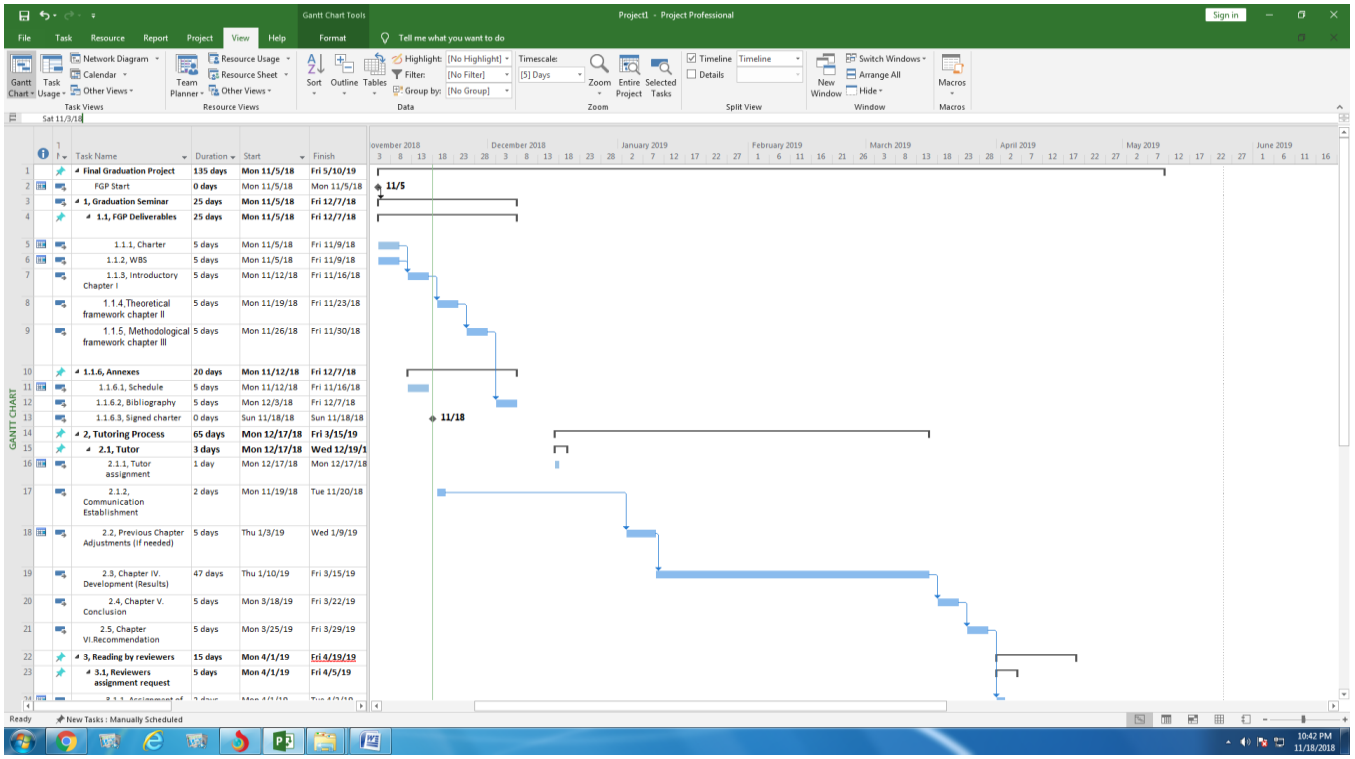
Authorized by: Mr. Carlos Brenes Signature:

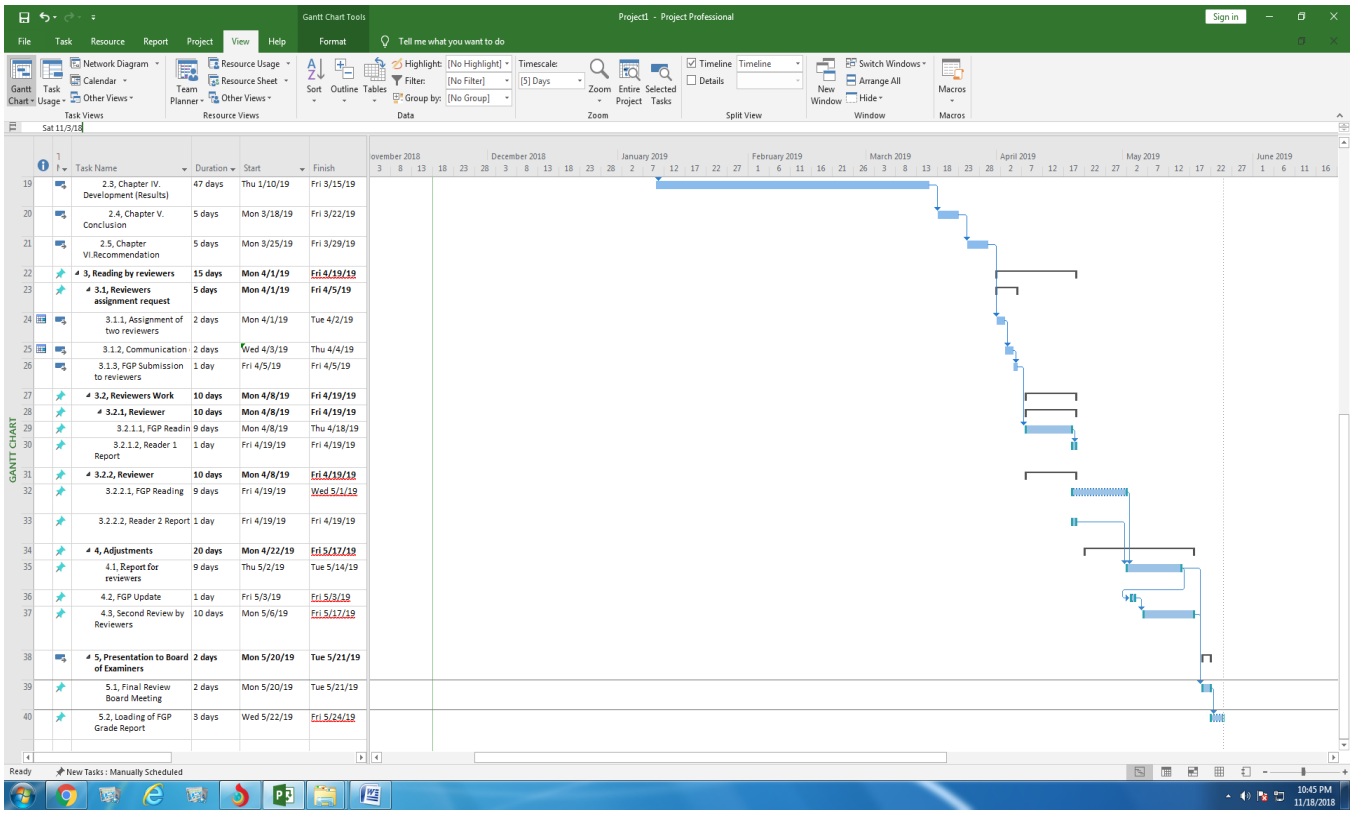
Appendix 2: FGP WBS

No.	*Task*
	Final Graduation Project
1	**Final Graduation Seminar**
1.1	FGP Deliverables
1.1.1	Charter
1.1.2	WBS
1.1.3	Introductory chapter I
1.1.4	Theoretical framework chapter II
1.1.5	Methodological framework chapter **III**
1.1.6	**Annexes**
1.1.6.1	Schedule
1.1.6.2	Bibliography
1.1.6.3	Signed charter
1.2	Graduation Seminar approval
2	**Tutoring Process**
2.1	Tutor
2.1.1	Tutor Assignment
2.1.2	Communication Establishment
2.2	Previous Chapter Adjustments (If needed)
2.2.1	Adjust Charter
2.2.2	Adjust Chapter 1
2.2.3	Adjust Chapter 2
2.2.4	Adjust Chapter 3
2.3	Chapter 4. Development (Results)
2.4	Chapter 5. Conclusion
2.5	Chapter 6. Recommendation
3	**Reading by Reviewers**
3.1	Reviewers assignment Request
3.1.1	Assignment of two reviewers
3.1.2	Communication establishment
3.1.3	FGP Submission to reviewers
3.2	**Reviewers Work**
3.2.1	Reviewer
3.2.1.1	FGP Reading
3.2.1.2	Reader 1 Report
3.2.2	**Reviewer**
3.2.2.1	FGP Reading
3.2.2.2	Reader 2 Report
4	**Adjustments**
4.1	Report for reviewers
4.2	FGP Update

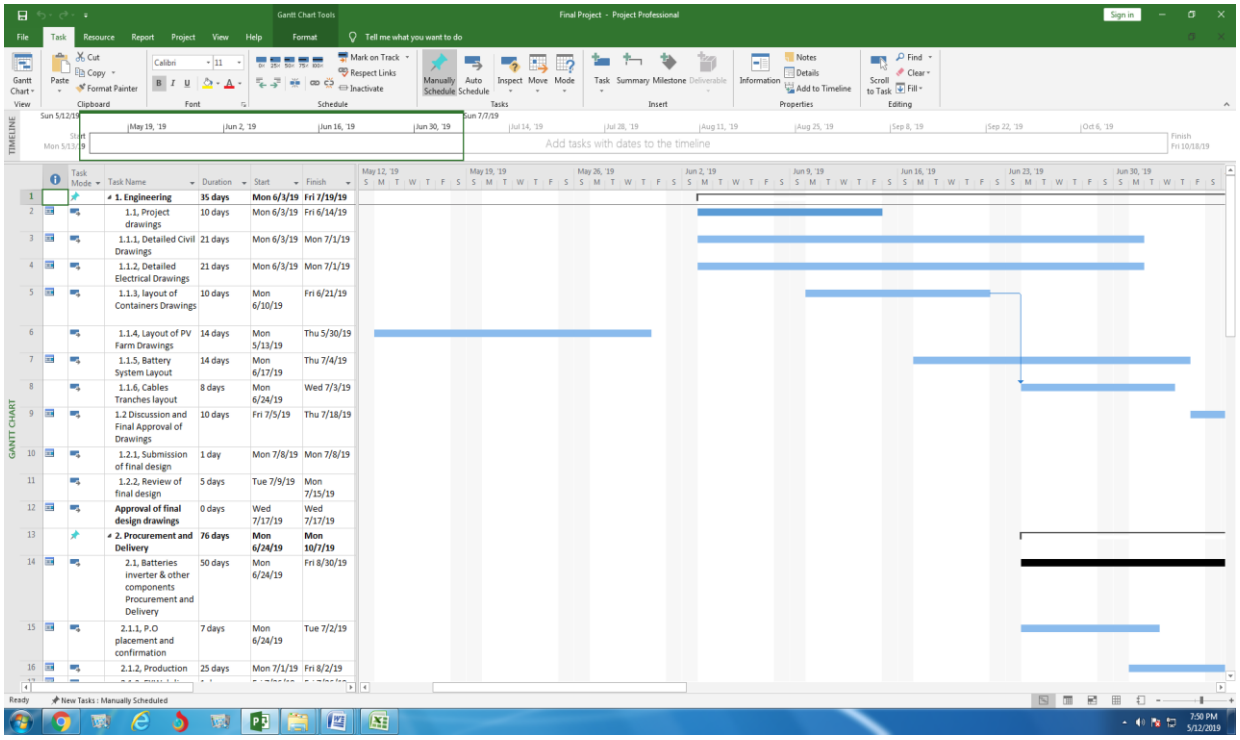
4.3	Second Review by Reviewers
5	**Presentation to Board of Examiners**
5.1	Final Review Board Meeting
5.2	Loading of FGP Grade Report
	FGP End

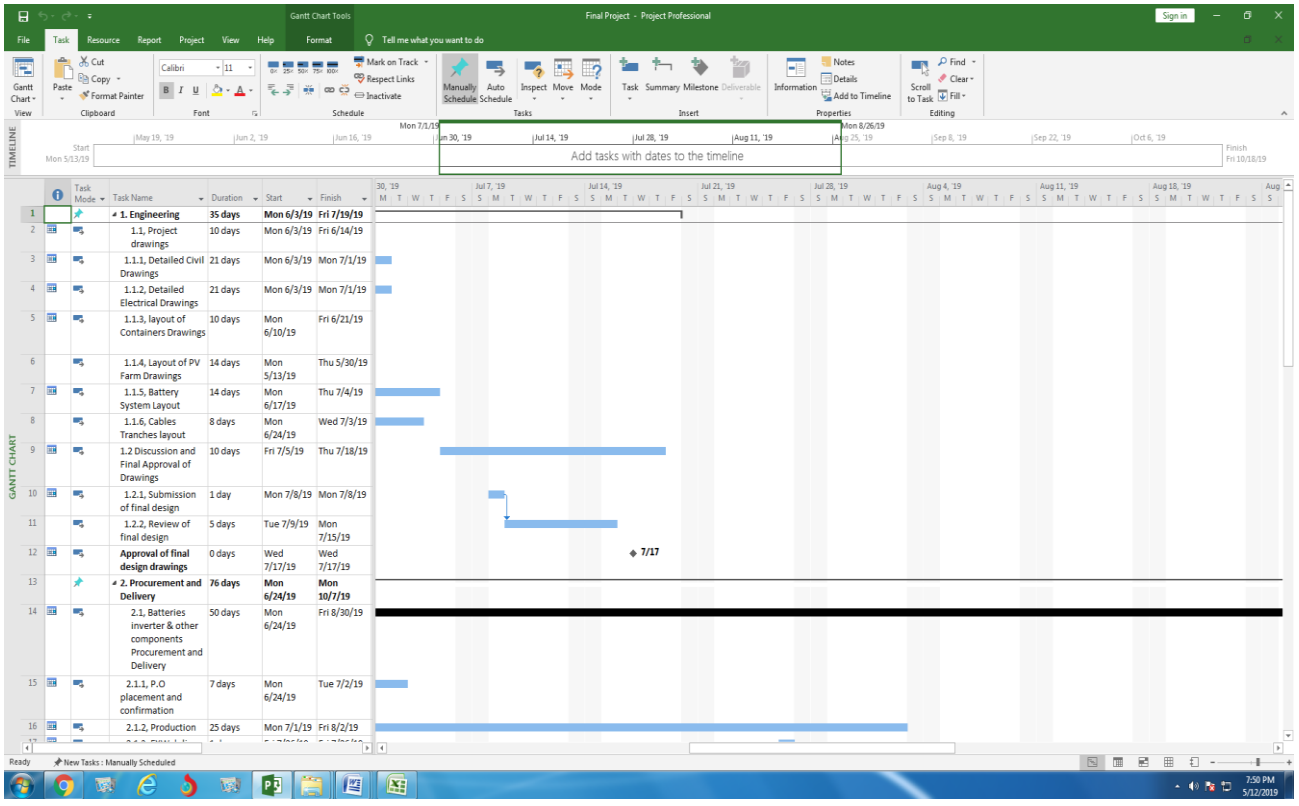
Appendix 3: FGP Schedule

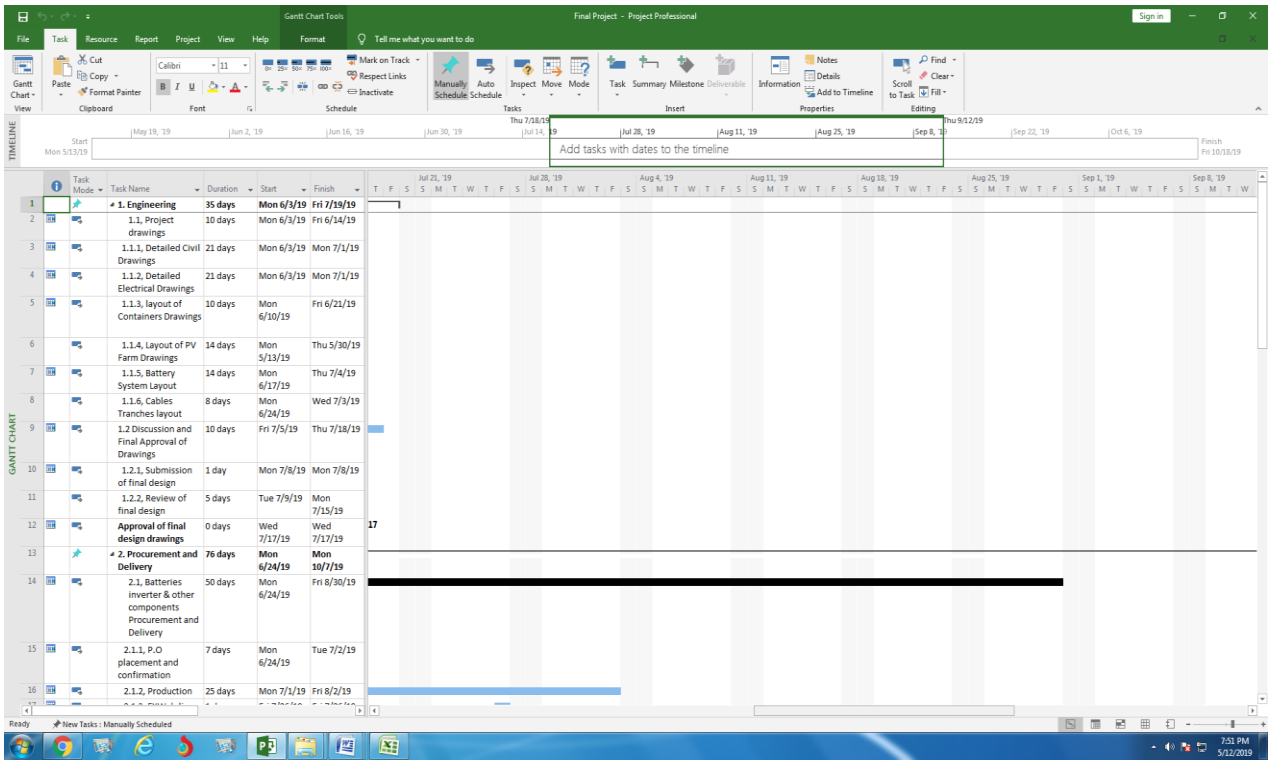


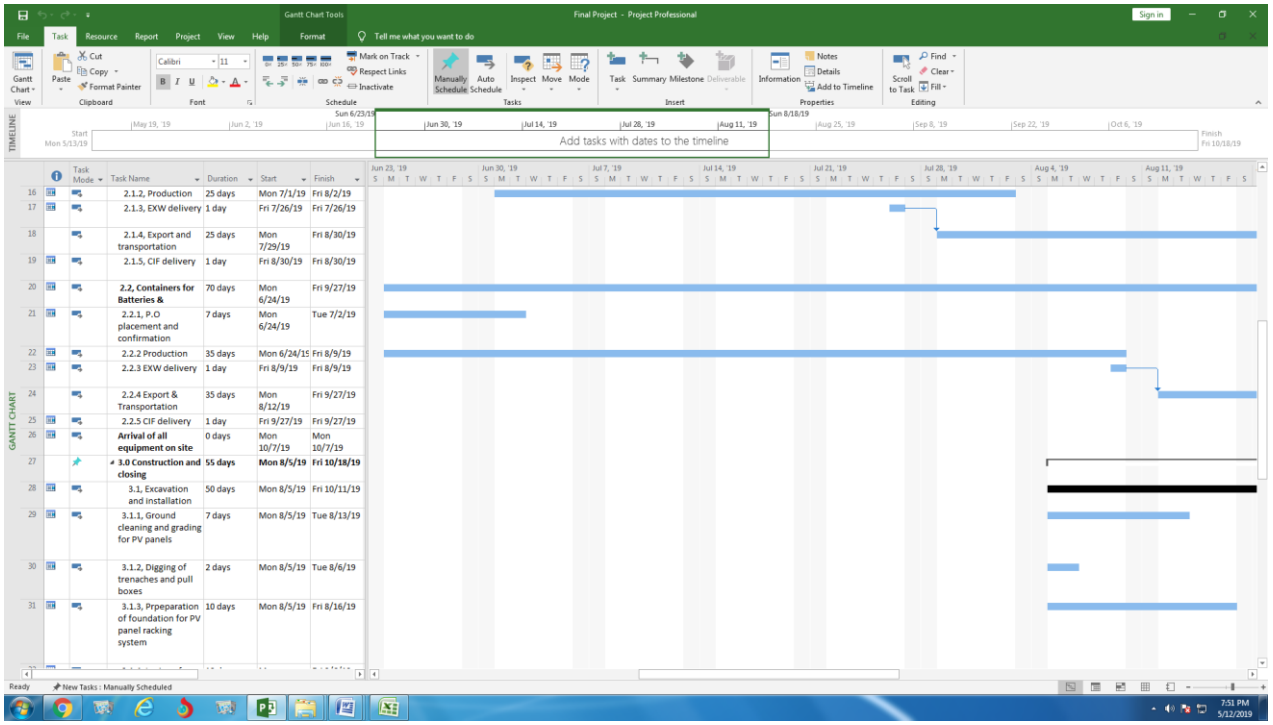


Appendix 4: Project Result Schedule






Final Project - Project Professional
Gantt Chart Tools
Add tasks with dates to the timeline
GANTT CHART
TIMELINE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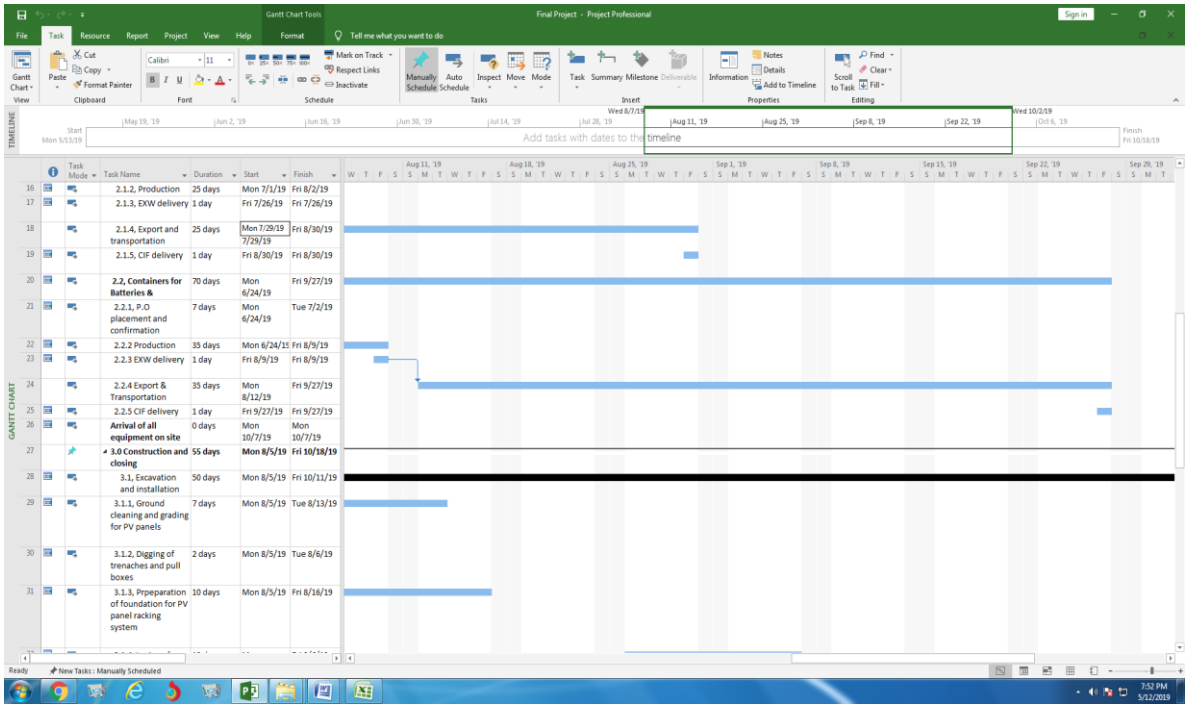
GANTT CHART
TIMELINE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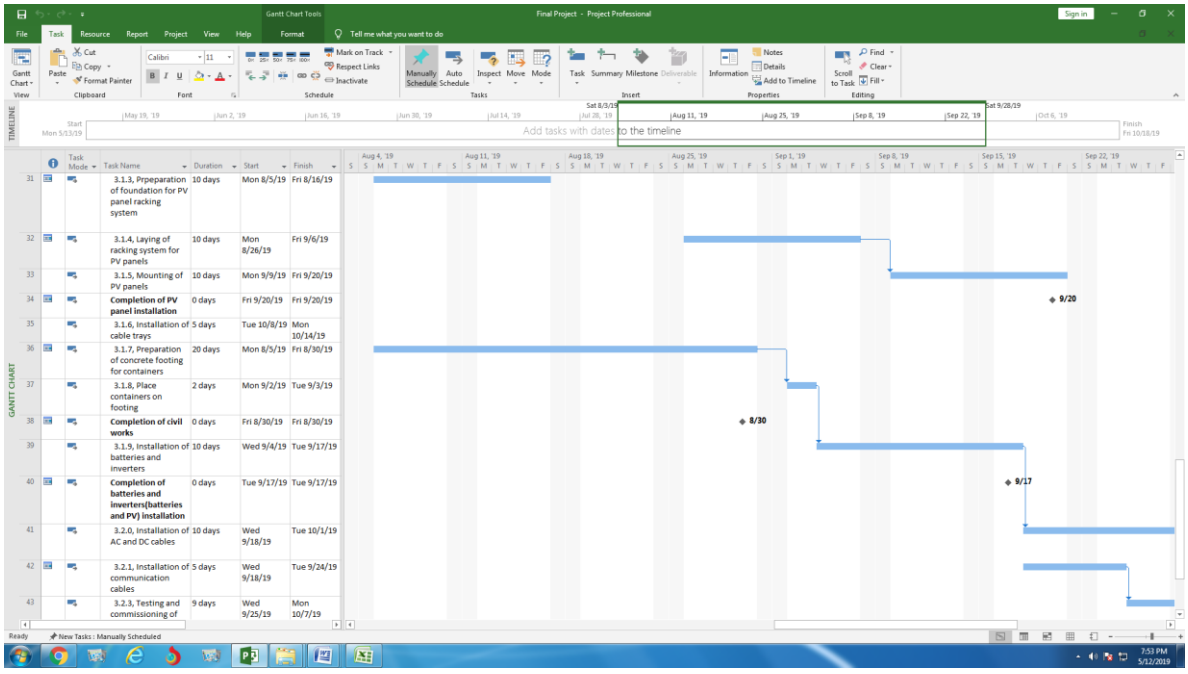
Gantt Chart Tools
Add tasks with dates to the timeline
GANTT CHART
TIMELINE


Final Project - Project Professional
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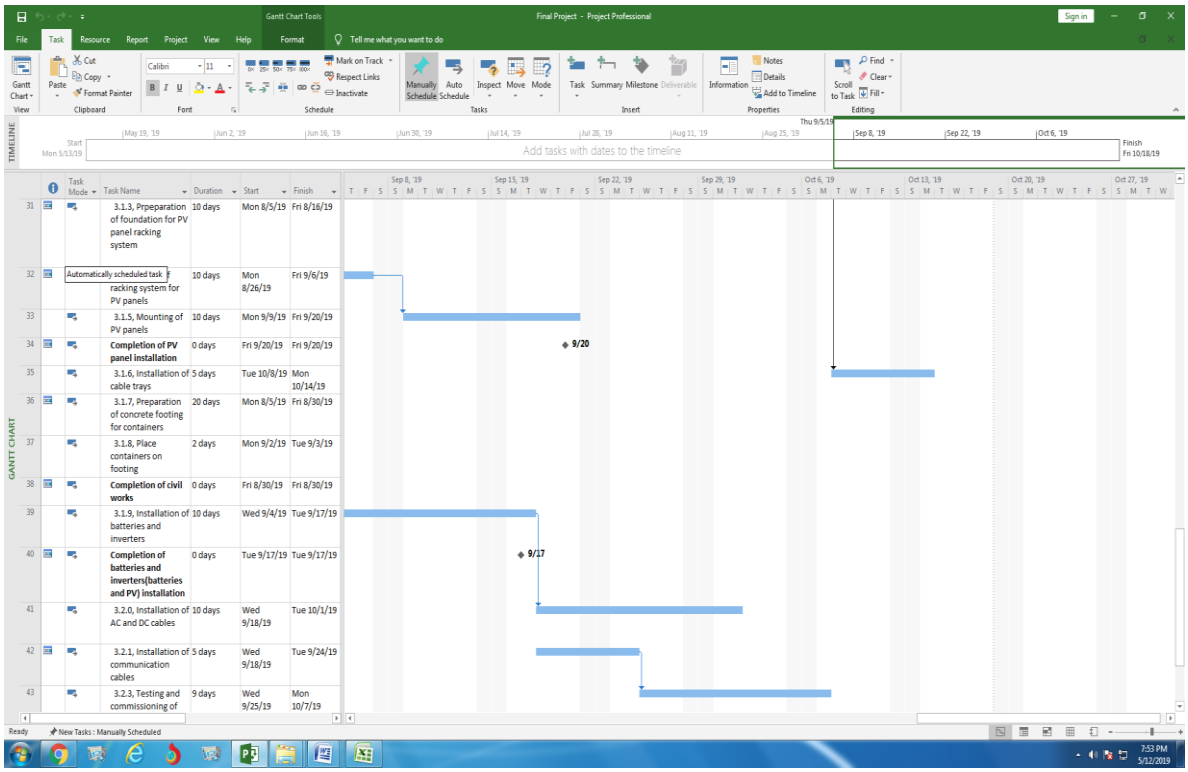
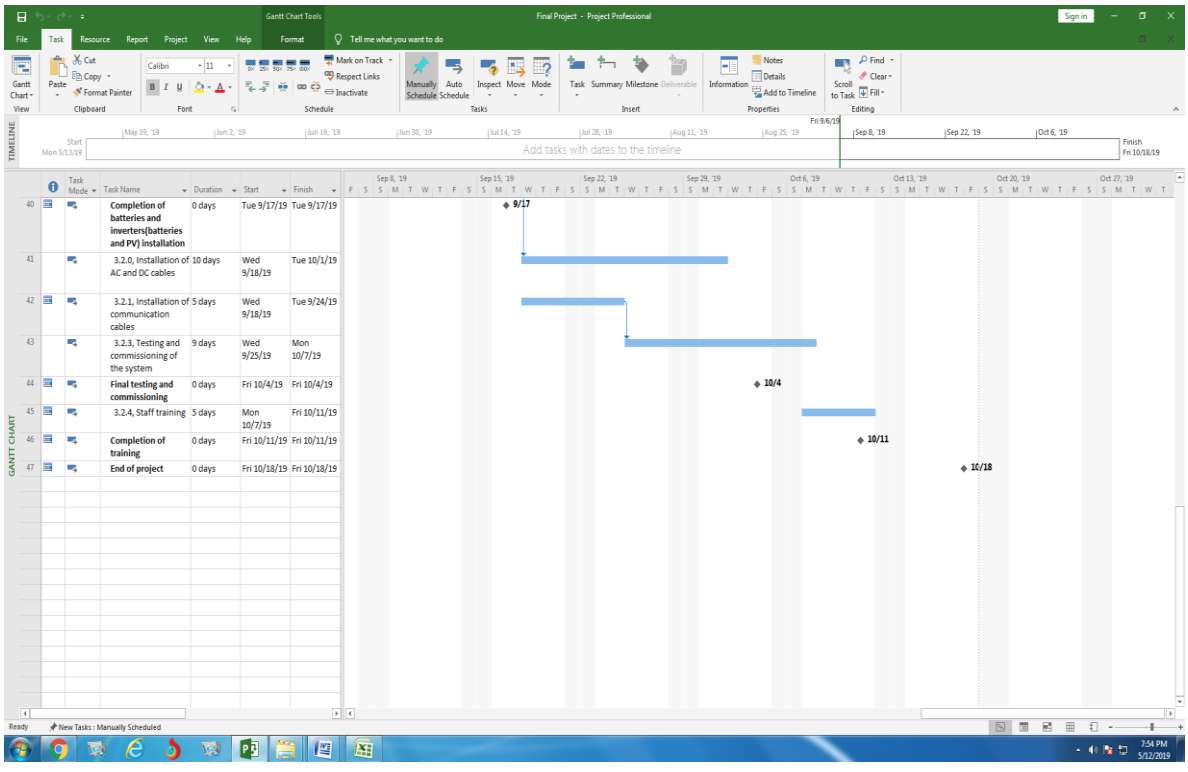
Add tasks with dates to the timeline
GANTT CHART
TIMELINE
9/20
8/30
9/17


Final Project - Project Professional
Gantt Chart Tools
Add tasks with dates to the timeline
3.1.3, Prpeparation of foundation for PV panel racking system
3.1.4, Installation of racking system for PV panels
3.1.5, Mounting of PV panels
Completion of PV panel installation
3.1.6, Installation of cable trays
3.1.7, Preparation of concrete footing for containers
3.1.8, Place containers on footing
Completion of civil works
3.1.9, Installation of batteries and inverters
Completion of batteries and inverters(batteries and PV) installation
3.2.0, Installation of AC and DC cables
3.2.1, Installation of communication cables
3.2.3, Testing and commissioning of
9/20
9/17
Ready
New Tasks : Manually Scheduled


Final Project - Project Professional
Gantt Chart Tools
Add tasks with dates to the timeline
Completion of batteries and inverters(batteries and PV) installation
3.2.0, Installation of AC and DC cables
3.2.1, Installation of communication cables
3.2.3, Testing and commissioning of the system
Final testing and commissioning
3.2.4, Staff training
Completion of training
End of project
9/17
10/4
10/11
10/18
Ready
New Tasks : Manually Scheduled