Impact of Project Management Tools and Techniques on Project Performance: Case in Oromia Water Works Design and Supervision Enterprise

Jemal Gemeda Hamda

A Thesis Submitted to

Department of Civil Engineering

College of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of

Masters in Civil Engineering

(Construction Engineering and Management)

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Office of Graduate Studies

Adama Science and Technology University

February, 2025

Adama, Ethiopia

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Advisor: Bahiru Bewket (Ph.D)

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DECLARATION

I hereby declare that this Master Thesis entitled "Impact of Project Management Tools and Techniques on Project Performance, case of Oromia Water Works Design and Supervision Enterprise" is my original work. That has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

_____ _____ _____

Name of the student Signature Date

RECOMMENDATION

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "Impact of Project Management Tools and Techniques on Project Performance – The case of Oromia Water Works Design and Supervision Enterprise" prepared under my guidance by Jemal Gemeda and submitted in partial fulfillment of the requirements for the degree of Masters of Science in Civil engineering (Construction engineering and management). Therefore, I recommend the submission of the thesis to the department following the applicable procedures.

Bahiru Bewket Mitikie, PhD		21 March 2025
Advisor	Signature	Date

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APPROVAL SHEET

I, the advisor of the thesis entitled "Impact of Project Management Tools and Techniques on Project Performance The case of Oromia Water Works Design and Supervision Enterprise" and developed by Jemal Gemeda , hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Bahiru Bewket Mitikie, PhD		21 March 2025
Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Jemal Gemeda have read and evaluated the thesis "Impact of Project Management Tools and Techniques on Project Performance – The case of Oromia Water Works Design and Supervision Enterprise" and examined the candidate during open defense.

This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Civil engineering (Construction engineering and management)

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date
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School Dean	Signature	Date
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ACKNOWLEDGEMENTS

Acknowledgement shall be to almighty God before anything else, who has kept healthy and of full of moral sprit to be on the right path of the life. God's His unparalleled support given for me so that I perform efficiently and effectively during carrying out this thesis work and giving me internal courage and strength to accomplish. Without God's grace, this would never come to the reality.

I would like to express my profound and sincere gratitude to my Advisor, Dr. Bahiru Bewket for his particular rectification, valuable support and continuous guidance in the course of conducting my study throughout the development of this study and supported me at every step to complete the thesis. He was always available to offer me guidance through face to face and through e-mail. I am also indebted to the OWWDSE technical teams and all the respondents of the company employees for their support and timely cooperation and all those who helped me throughout the duration of this thesis work and with whom I interacted during my research, for their willingness to participate in the study and for their exceptional support and coordination throughout the data collection process.

Last but not least, I would like to express my heartfelt gratitude to my family and particularly my elder son, Ramadan J., who helped me while encoding survey data into computer, without him such a work could have been boring and tiresome. Still, I am expressing my gratitude to my spouse, Nuriya A., for her continued moral built up and encouragement to pursue my study.

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LISTS OF ACRONYMS

CCPM	Critical Chain Project Management
CPM	Critical Path Methods
EEA	Ethiopian Economic Association
EVM	Earned Value Management
EPM	Extreme Project Management
GDP	Gross Domestic Production
ITTO	Input Tools and Technique Output
OWWDSE	Oromia Water Works Design & Supervision Enterprise.
PERT	Project Evaluation and Review Technique
PG	Process Group
PM	Project Management
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMM	Project Management Methodologies
PMO	Project Management Office
PMTT	Project Management Tools and Techniques
PRINCE	Project In Controlled Environment
PIM	Probability Impact Matrix
RII	Relative Importance Index
TPM	Traditional Project Management
WBS	Work Breakdown Structure

ABSTRACT

The application of project management tools and techniques under different project process groups is believed to have direct impact on project performance and research efforts has been continued to improve this knowledge area. Despite the continued evolvement of the knowledge area, there is still inconsistent application of project management techniques and project management team are still going on to apply traditional project management methodologies that has based on popularity and some contractual requirement. The project management tools and techniques practiced without predefined benefit across project management cycles going through initiation to execution and controlling might not guarantee project success. This has made project performance still to stand at discouraging rate. This study is undertaken to evaluate the actual project performance of the study area and extent impact of project management tools and techniques practiced by project managers in the water supply project construction in the Oromia water works design and supervision enterprise. The qualitative research methodology has been employed to survey two-hundred water supply projects clustered into four groups and twenty-five project management teams engaged in the management process of these category projects. statistical methodology and correlational techniques are used to analyze the results. It is found out that there is considerable project completion time over run has been noticed. there is only ten percent project could be completed within budgeted time schedule. in the similar manner, project management tools and techniques surveyed to insight the project managers perception and application of these tools. Under this survey, it is noticed that there is significant variance exists among project managers, which can lead to conclusion that there are no predefined procedures followed among project team particularly in project schedule management in planning, execution and monitoring phase. The project management tools and techniques are correlated to project performance and it has also shown strong positive correlation to exist. where there is more stronger at planning phase than execustion project management cycle.

Key words: Project, Project Management, Project performance, Project management tools and techniques

CHAPTER ONE: INTRODUCTION

1.1.Background Of The Study

According to EEA (2008) the construction industry is worthing significant national contribution amounting to 1.7 trillion US dollar. and the same report portray that the contribution of the construction industry is ranging between 5 and 7 percent of GDP in developing countries. According to this finding the construction industry has important contributions to the developing countries like Ethiopia, and as demonstrated by its share in the GDP. For instance, the share of the sector in the total GDP averaged at about 5.2 percent. In addition to contributing to national economies construction industry worldwide has great contribution in creating opportunities for considerable figures of jobs.

Though, the construction industry has significant economic contribution to national welfare, its performance as to meeting its targeted objective couldn't be constraint free. Likewise, this sector is researched in different parts of the world particularly the performance and existing challenges managing them toward contributing to national interest. As per Taddese et al, (2016) the targeted performance of the projects is measured against different measuring dimension that can be termed as internal and external factors. The internal factor has dimensions such as time, cost and quality factor. the external factor extends to client satisfaction, business performance, health and safety; The same Autor further argues that time, cost and quality are the three predominant performance evaluation dimensions.

As per the research work Ayalew et al (2017). it is found out that total cost and time overrun rates on average to be 44% and 26% respectively, further the same author identified that among other factors the average contribution of inadequate design to be 26% and 32% respectively and the extent to which inadequate design contributes, as a percentage, to cost and time overruns was 61% and 85% respectively. The case in Ethiopia is also not different with other African countries. Ayalew et (2017) went on to conclude that Ethiopia is at bottom list as far project performance is concerned which indicates that the management practice in Ethiopia is even far behind from those poor performing developing countries in Africa

Construction Project management is application of knowledge, skill, tools and techniques to activities in the project implementation process so that the project requirement can be met, (PMBOK, 2008). The application of tools and techniques by professionals on the project management has positive contributions to the success of projects (Xuan et al, 2019). As it was narrated in research paper of Miloševic & Iewwong (2004), there is Chinese proverb, "to do good work, one must first have good tools." There is Ethiopian proverb, too, "bad dug tool is not better than the bare hand." It is also true for project managers, who if they want to deliver good project results, they must first have good project management tools (Miloševic, 2004).

The project management endeavors are characterized by adoption of its management theories and basic management science deep rooted in general management philosophy. The challenges today project managers used to face while using project management tools and technique is to be analyzed from this perspective. As to research study by Kloppenborg and Opfer (2002), that was cited in Miloševic (2004), the research in the field of project management is relatively young. Theories and concepts developed in this area of science is younger in developing countries like Ethiopia and, indeed, project managers are not well equipped with project management tools and techniques that enables as effectively and efficiently improve poor project performance practices.

Dildar et al (2014) reveals that traditional project management tools and techniques are not adequate to address the key concerns of project practitioners facing today. in support to Dildar et al (2014) and Ismael (2019) determine that project management techniques and tools of worldwide recognition and suggested by the most relevant standards and methodology are not being used in construction projects. Miloševic & Iewwongcharoen (2004), disclose that project management tools and techniques (PMTT) have been commonly used by project managers have not been adequately investigated as to whether its use contributes to the success of a project. The lack of such knowledge leads to the use of PMTT because of popularity rather than any known benefits.

This research has assessed project performance as function of project management tools and techniques on the water supply projects under taken in the study area. The study result will be expected to narrow these gaps in project management tools and techniques adoptability by applying qualitative research methodology

1.2. Statement of the Problem

Oromia water works design and supervision enterprise is engaged with study and design as well construction supervision of water related infrastructure. The enterprise is dominantly undertaking engineering works in the Oromia regional state, in average undertaking forty to fifty water supply projects per annum. This project construction is costing four to five billion Ethiopian birr per annum per annum (EEA 2021). These water supply projects undertaken in the region is characterized by poor performance challenges of project over delay and continuous series of contractual time extension. The public mass expected to be benefited from the project are seen to dissatisfied with such over delayed project performance.

This project management poor has by one or the other deep rooted into poor project management methodologies as to tools and techniques applied thereof. And hence this is motive for the researcher in basic infrastructure poor project performance in general and Oromia Water Design and Supervision Enterprise Water supply project in particular.

1.3. Objective of the Study

1.3.1. General Objective of The Study

The general objective of the research is to assess the impacts of project management tools and techniques on project performance

1.3.2. Specific Objectives of the Study

1. To assess project management performance in the Oromia water works design and supervision enterprise.
2. To investigate relation of project management tools and techniques at use in project management process to project performance in the identified case study area.
3. To Customize project management tools and techniques in context of project management in Oromia water works design and supervision Enterprise.

1.4. Research Questions

This research study attempts to address the following research questions

1 What does the Project performance of water supply projects look like in the previous years? Case Oromia Water Works Design and Supervision Enterprise.

2 Which Project management tools and techniques are more commonly used by project managers and site engineers in align with project management process groups?

3 what are the relative importance indices of the project management tools and techniques in extent of its application to impacting project success.?

1.5. Scope of Study

This study has been carried out in Oromia Water Works Design and Supervision Enterprise (OWWDSE) water supply projects undertaken in the years between 2016 through 2020. In the case study, it will only evaluate the project management performance and methodological tools and techniques employed by project managers and site engineers while managing their respective projects and tools and techniques and there by impact these methodologies could impose on the project performance as well.

1.6. Significance of the Study

Project management tools and techniques is believed to contribute significantly to the project success. As poor performance has showed little improvement in the previous decades in the identified study area and project bad performance has become a common event. The project management tools and techniques that is used in the study area are inconsistent and it is unable to reverse these drawbacks and further researching the principal limitation to identify critical gaps was a motive for this research intention.

Project performance in one or the other way related to project management tools and techniques applied by project managers and site engineers. It is imperative that the use of project management tools and techniques enhance the effectiveness and efficiency of project performance. Using this project management tools and techniques efficiently and effectively has become the concern of project managers and findings of the research will have significant impact on project performance in study area.

This study is believed to narrow the cause root of poor project performance in selected areas particularly in relation to project management tools and techniques employed by project managers and site supervisors. It has attempted to identify limitation in project management tools and techniques and expected to bridge gap of skills that has challenged project management team in their day-to-day endeavors.

1.7. Limitation of Study

This study is spatially limited to the project management practice in Oromia water works design and supervision enterprise water supply projects management practice only and in relation to tools and techniques applied thereof. Other engineering works undertaken by the enterprise was not made the part of the survey.

Thematically, the study area focuses on central project management process groups (planning, executing and monitoring & evaluation). Sectoral, because of time and cost limitation, the study is solely dealing with schedule project management in water supply project only and other infrastructural project management area could not be addressed in this study.

1.8. Organization of the Research

This thesis work is organized into five chapters. The first chapter is dealing with introduction which explains about the background, statement of the problem, objectives, research questions, significance of the research work, scope the research, limitation and research report skeletal organization. In the second chapter, the theoretical overview (named as the literature review), defines project management tools and techniques and describes all prevailing project management methodologies in pertinent to tools and techniques. The third chapter outlines research design and study methodologies.

In the fourth chapter, the results from questionnaire survey are analyzed. In this regard, tables and figures are used in order to summarize data. It presents the questionnaire results from each respondent's perspective along with the analysis performed on the raw collected data to find the level of application of project management tools and techniques.

In chapter five, summary of outcomes, conclusion and recommendations is included along with some recommendations for future studies.

CHAPTER TWO: LITERATURE REVIEW

2.1. Project Performance

Ayalew et al. (2017) have research narrated as to performance of the projects against what was planned can be measured and evaluated using a large number of performance indicators that could be related to various dimensions (groups) such as time, cost, quality, client satisfaction, business performance, health and safety. This Autor further argues that time, cost and quality are, however, the predominant performance evaluation dimensions. In support to this argument as indicated by research works Kerzner (2009) cited in Alkezaz (2016) definition of a successful project is a project that is the one completed on time, within budget in accordance to an approved quality. has maximized these three factors and developed a well-defined description of a successful project.

Alias et al (2015) describe Performance as its associated with several factors such as time, cost, quality, client satisfaction, productivity and safety. There are other genuine reasons like closures, modification of drawings and changes of the design. Other grounds affecting construction projects performance are poor management and guidance; inapt participants; poor relations and coordination; lack of motivation, insufficient infrastructure, political problems, cultural problems and economic conditions. Alias et al (2015) go on to describe factors like inadequate leadership, poor site management, lack of manpower skills, lack and breakdown of equipment plays a very important part in construction delays.

As research works of Julius Ojo (2016), The Construction industry deals with large number of players include Consultants, Clients (owner) and Contractors. The roles the stakeholders play in the industry have effects on the performance of projects. As to Mamman and Omozokpia (2014) that is cited in Julius Ojo (2016) stated that construction industry is complex in nature because it involves large number of project stakeholders. Mamman and Omozokpia (2014) also argued that the overall success of a project is determined to a large extent by the proper management of the resources which are considered as an essential aspect of project implementation. These authors' went on further to disclose that if the resources are adequately used and controlled, issue that relates to cost overrun would not arise.

2.2. Project Management Theory

2.2.1. Traditional Project Management Theory

As it is narrated in journal of Project Management Theory by Prieto (2015), the roots of project management theory go very much back to the work of Taylor on scientific method and explicitly to two of the author's "students", Henry Gantt and Henry Fayol. Prieto (2015) further posit that Gantt is readily recognized for his so-called Gantt charts, which is still widely in use in project management practice. As it is portrayed Prieto (2015), Fayol's administrative theories with the author's defined five management functions represent the core of the project management body of knowledge.

It is possible to precisely point out the underlying theoretical foundation of project management as advocated in the PMBOK by PMI and mostly applied in practice. Koskela and Howell (2002) further portrayed the theory of project management is provided by the transformation view on operations. In the transformation view, a project is conceptualized as a transformation of inputs to outputs. There are a number of principles, by means of which a project is managed. These principles suggest, for example, decomposing the total transformation hierarchically into smaller transformations, tasks, and minimizing the cost of each task independently. The understanding of management is based on three theories: management-as-planning, the dispatching model and the thermostat model. In management-as-planning, management at the operations level is seen to consist of the creation, revision and implementation of plans. This approach to management views a strong causal connection between the actions of management and outcomes of the organization. The dispatching model assumes that planned tasks can be executed by a notification of the start of the task to the executor. The thermostat model is of management control that consists of the following elements: there is a standard of performance; performance is measured at the output; the possible variance between the standard and the measured value is used for correcting the process so that the standard can be reached (Koskela and Howell 2002).

Koskela et al (2005) has reiterated the study of Koskela & Howell (2002) on the same subject matter and reviewed the theoretical basis of the conventional doctrine of project management (Koskela & Howell 2002). On same matter these authors pointed out that production was a

transformation of inputs to outputs as the theory of project. The theory of management consists of particular theories for planning, execution and control. Regarding planning, the conventional theory, management-as-planning, implies that planning is the core task of management. Execution is conceptualized as one-way communication or orders as it was indicated in classical communication theory

Table 2.1 underlying theory of Traditional project management

Subject of theory		Theory
Project		Transformation
Management	Planning	Management-as-planning
	Execution	Classical communication theory
	Control	Thermostat model

Source: Koskela and Howell (2002).

Prieto (2015) explains as project management make advances through the introduction of CPM, with its deterministic activity periods and PERT, a modernization of Gantt's work, with the previously mentioned stochastic activity times. This traditional project management approach is codified with the 1969 issuance of PMBO K, the Project Management Body of Knowledge, which was intended to provide a management framework for most projects (Bob Prieto, 2015). As Yung (2012), Project management theory, there existed two main theoretical traditions in project management research, namely, the Task Perspective and the Organizational Perspective. The Task Perspective of project management is known as "hard" perspective, while the Organizational Perspective is generally known as "soft" perspective. Yung (2012) further elaborated that the task perspective of project management theory focused on the planning and control mechanisms in project. It has its intellectual roots in the engineering science and applied mathematics. As to this author's study work, during the 1950s, network analysis and planning techniques, such as program evaluation and review technique (PERT) and critical path methods (CPM) formed the focus of development in project management and later on, the increasing use of computers given rise to a "second generation" of operations research devoted to computer applications and expert systems for project planning, control and risk analysis.

Yung (2012) further went on to elaborate that the task perspective of project management theory generally divides a project into 3 distinct stages, namely, development, implementation and termination. The development phase is usually subdivided into conceptualization and planning

stages. These phases were always assumed to be sequential, and therefore the Task Perspective of project management theory can be described in terms of a theory of planning, a theory of execution and a theory of evaluation (Koskela and Howell, 2002).

Cicmi and Hodgson (2006) explained as around the closing decade of the 20th century, project management was challenged more seriously than in any previous period, despite the levels of research founded on the presumptions of instrumental rationality in decision-making and control, it is increasingly apparent that accepting and applying such traditional project management belief couldn't eliminate project management challenges.

In agreement with research findings of Hodgson (2006) and Yung (2012) went on to explain the traditional task perspective of project management theory had been critiqued like several authors such Koskela and Howell. The major reason was that accepting and applying such convention did not eliminate project failures, nor did it guarantee project success.

In parallel to this second organizational Perspectum to project management theory dealt with the process, governance, behavioral, cultural and political aspects in the project. The underlying assumption is that these aspects will affect project performance. There was, however, no consolidated or widely agreed theory on the organization perspective of project management (Yung, 2012).

Prieto (2015) in his journal of project management theory categorizes management theory in to Traditional project management (TPM) and Agile project Management theory. As to Traditional project management it has narrated as management procedure of step-by-step workflow, rigid timelines, and strict requirements have a hard time adapting to the need for change partway through a project.

The other traditional project management theories discussed in research work of Prieto (2015) Critical Chain Project Management philosophy. Critical Chain Project Management (CCPM) addresses uncertainty and resource constraints. Critical chain project management is based on methods and algorithms derived from Theory of Constraints and include resource leveling and use of buffers.

2.2.2. Agile Project Management Theory

Extreme project management (EPM) is short and flexible where traditional project management is not. EPM allows you to alter your project plan, your budget, and your final outcome to fit changing needs, no matter what stage the project is in, and usually involves projects that last only a few weeks or even just days.

The emergence of extreme project management moves project management theory into the world of dynamic, non-deterministic systems. The control point is focused on how you respond to the reality that you have no control.

Table 2.2 Comparison of Classes of PM Theories

Class	Industerial	Human	Biological	Evolution
Theories	Traditional pproch PRINCE2 Process	Agile PM	CCPM Theory	Extreme Project Mangement Theory

Source: Prieto (2015)

2.3. Project Management Tools & Techniques and Process Group

PMBOK (2008) and Martinelli and Milosevic (2016) define project management tools and techniques as enabling devices that assist a project manager in reaching an objective and project deliverable which provides greater opportunity and value to an organization and its project team. According to Joslin and Muller (2015), a tool is tangible, such as templates or software programs, used in performing an activity to produce a product or result. Which includes scheduling tools, project management information systems, surveys, project estimating tools, time controlling and reporting systems. In the similar work it is narrated that a technique is applied to a particular endeavor and requires skill and experience so as to affect a desired result. Such as communication techniques, expert judgment, three-point estimates, conflict management and quantitative risk analysis.

As it is narrated in research paper of Miloševic & Charoen (2004) one has to own first a good tool so that it can perform a good job as well. It is also true for project managers, who if they want to deliver good project results, must first have good project management tools. In support

to the previous author, Xuan et al (2019) posit that Project management tools and techniques provide the efficiency and effectiveness in managing and handling the projects.

Dildar et. al (2014) postulate that in today's highly competitive environment, project management (PM) is subject to appropriate usage of project management tools and techniques (PMTT). The study of this author reveals that traditional project management tools and techniques are not adequate enough to address the key concerns of project practitioners facing today because they are working in an environment where uncertainty, technological advances and corporate re-engineering are taking place. Moreover, customer satisfaction, complexity management, accelerating schedule, contract management and risk management are among the key issues. Dildar et. al (2014) further elaborate that working effectively in this environment necessitating employing and improving use of PMTT along with enhanced skill levels of project managers to continue in survive or thrive environment.

Like other researcher, Ismael (2019) presented research work on an analysis of project management tools and techniques usage and its practical application in the construction sector. And he elaborated fact that techniques and tools of worldwide recognition and suggested by the most relevant standards and methodology are not being used in construction projects. In his work the deficiencies and strengths of the companies were shown when applying the project management techniques and tools.

As research work of Abdulla (2019) elaborate that Project Management Methodologies (PMM) reduces the risk, cuts the costs and improves the success rates. That's why different PMM have been employed by different organizations in order to increase the efficiency and effectiveness of their projects. Joslin and Muller (2015) as cited in Abdulla (2019) showed that PMMs contribute 22.3% to project success which has supportive argument by Berssaneti and Carvalho (2015) as in citation of the same research work.

As per PMBOK 6the edition, the project management has classified the project endeavors in five process groups and ten knowledge areas. The five project management process groups as per (PMBOK 6th edition) is: Initiating, Planning, Executing, Controlling and Closing. The figure below is to illustrate the overall and the central (core) project management process group that is thematic area for this specific study.

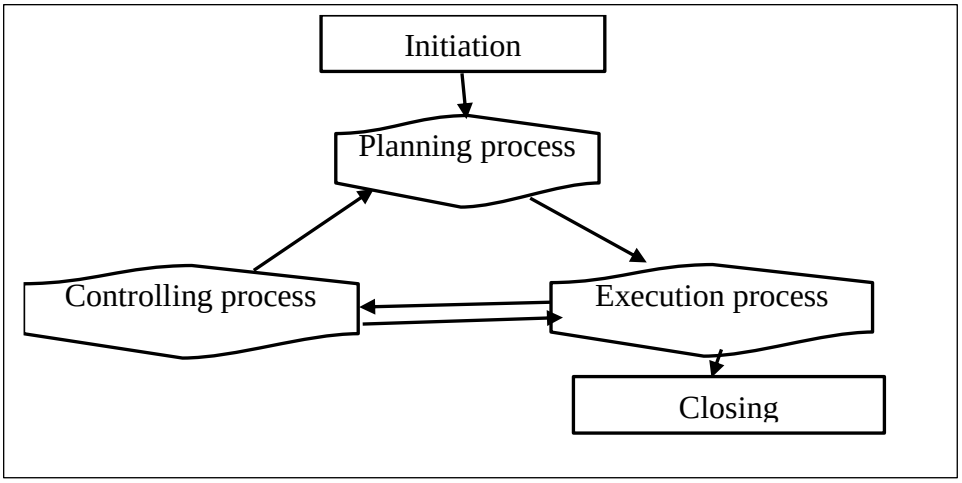


Figure 2.1 Project Management Process Group Model

Source: (PMI 2008)

Table 2.3 PMTT In Different Phases of a Project Life Cycle

	Conceptual	Planning	Execution	Termination
Activities	Project selection	Scheduling	Change management	Postmortem analysis
	Team Member selection	Cost estimating		
PMTT	Scoring model	Critical path method	Change request	Performance report
	Decision tree	Program evaluation & review technique	Risk log	Postmortem review
	Analytical hierarchal process	Scope statement	Scope change control	
	Project charter	WBS	Earned value management	
	Scope statement	Guant charts	Performance report	
	Work breakdown structure	Critical chain		
		Schedule crushing		
		Stake holder analysis		

Source: (Milosevic 2004).

A Knowledge Area is an identified area of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques.

Although the Knowledge Areas are interrelated, they are defined separately from the project management perspective. The ten Knowledge Areas identified in this guide PMBOK (2008)

are used in most projects most of the time. The ten Knowledge Areas described in this guide are: Project Integration Management. Includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups. Project Scope Management. Includes the processes required to ensure the project includes all the work required, and only the work required, to complete the project successfully. Project Schedule Management. Includes the processes required to manage the timely completion of the project. Project Cost Management. Includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so the project can be completed within the approved budget. 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' expectations. Project Resource Management. Includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project. Project Communications Management. Includes the processes required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition of project information. Project Risk Management. Includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. Project Procurement Management. Includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team. Project Stakeholder Management. Includes the processes required to identify the people,

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.

As PMBOK, (2017), these project management knowledge areas have link to specific project management process and tools and techniques assigned to them as summarized in Table 2.4.

Table 2.4 Knowledge Area Versus Process Group Matrix

Knowledge area	Initiating	Planning
Integration Management.	Develop Project Charter	Develop Project Management Plan
Project Scope Management.		Plan Scope Management Collect Requirements Define Scope Create WBS
Project Schedule Management.		Plan Schedule Management Define Activities Sequence Activities Estimate Activity Durations Develop Schedule
Project Cost Management.		Plan Cost Management Estimate Costs Determine Budget
Project Quality Management.		Plan Quality Management

(a) *Initiating and Planning* phase

Knowledge area	Executing,	Controlling and monitoring
Integration Management.	Direct and Manage Project Work Manage Project Knowledge	Monitor and Control Project Work Perform Integrated Change Control
Project Scope Management.		Validate Scope Control Scope
Project Schedule Management.		Control Schedule
Project Cost Management.		Control Costs
Project Quality Management.	Manage Quality	Control Quality

(b) Execution and controlling phase

Source: (PMBOK,2017)

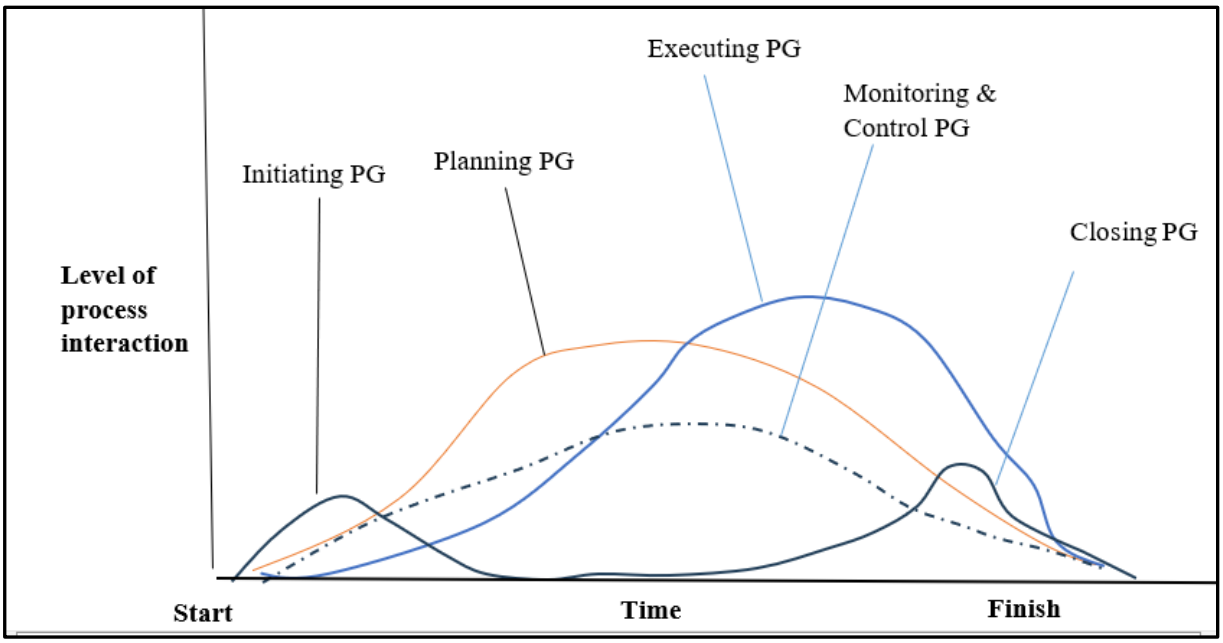


Figure 2.2 Project Management Process Group Interaction

Source: (PMI 2008)

As per PMBOK (2017), the Initiating Process Group consists of those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase and the purpose of the Initiating Process Group is to align the stakeholders' expectations and the project purpose, inform stakeholders of the scope and objectives, and discuss how their participation in the project and its associated phases can help to ensure their expectations are met.

This conceptual process group is steered by project management tools and techniques supposed to effective and efficient, some of this as of Milosevic et al (2010) analogous estimate and communication plan were found to be the only two positive contributors to project success measures; however, several PMTT are used in this phase. It is typical that at the early stage of the project life cycle, a detailed definition of the project is not yet clear. Milosevic (2003) argued that to be successful in the later phases, the project manager needs to gather more project information and that is why the use of communication plan may very well serve this purpose and therefore contribute to the overall project success.

The key benefits of this Process Group are that only projects that are aligned with the organization's strategic objectives are authorized and that the business case, benefits, and

stakeholders are considered from the start of the project (PMBOK 2017). In some organizations, the project manager is involved in developing the business case and defining the benefits. In those organizations, the project manager generally helps write the project charter; in other organizations, the pre-project work is done by the project sponsor, project management office (PMO), portfolio steering committee, or another stakeholder group. This standard assumes the project has been approved by the sponsor or other governing body and they have reviewed the business documents prior to authorizing the project.

The project charter, business documents, and success criteria are verified. The influence, drivers, expectations, and objectives of the project stakeholders are reviewed. Involving the sponsors, customers, and other stakeholders during initiation creates a shared understanding of success criteria. It also increases the likelihood of deliverable acceptance when the project is complete, and stakeholder satisfaction throughout the project. (PMBOK 2017).

In support to (PMBOK 2017) and Ismael (2019) suggested proposes tools &techniques is to starting the Project charter and defines it as the document that formally authorizes the existence of a project and gives the project manager authority to assign the organization's resources to project activities.

In project management practice planning is the second process group. Planning is supposed to be the heart of the project management as it encompasses and reflects the best efforts of a project team to create the documentation and approve project important parameters before proceeding to development stage (Ismael 2019). In support of the argument is posited in (PMBOK 2017) that the Planning Process Group consists of those processes that establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives. The processes in the Planning Process Group develop the components of the project management plan and the project documents used to carry out the project.

The key aim of this Process Group is to define the course of action to successfully complete the project or phase. The project management team seeks input and encourages involvement from relevant stakeholders while planning the project and developing the project management plan and project documents. When the initial planning effort is completed, the approved version of the project management plan is considered a baseline (PMBOK 2017).

Develop Project Management Plan is the process of defining, preparing, and coordinating all plan components and consolidating them into an integrated project management plan (PMBOK 2017). The key benefit of this process is the production of a comprehensive document that defines the basis of all project work and how the work will be performed. This process is performed once or at predefined points in the project. The inputs and outputs of this process and tools and techniques that are used to gear the process are depicted in Figure 2-3

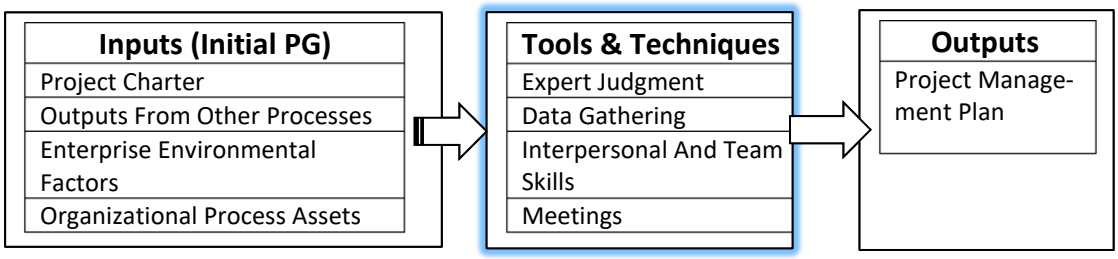


Figure 2.3 Project Management Plan PG: ITTO

Source: (PMBOK, 2017)

As to Milosevic (2010), in the planning phase, PMTT that significantly contribute to project success measures are those that serve the purposes of developing detailed scopes, schedules or budgets. CPM and hierarchical schedule seem to be the significant contributors to project success. CPM contributes toward the internal dimension of project success while hierarchical schedule contributes toward the customer dimension and overall project success. Typically, CPM is a PMTT for time management, which is also a basis for cost management. It is therefore not surprising that CPM contributes to the time and cost success dimensions. The authors also agree that the use of hierarchical schedule could lead to success with respect to the customer dimension. Hierarchical schedule suggests different levels of project schedule with different uses. The high-level schedule is typically used for communication with the customers while the lower levels are used within the project team. If the high-level schedule is developed based on the deliverable-oriented WBS, it tends to be more customer-focused. This may provide a reason why hierarchical schedule contributes to customer satisfaction.

Plan Scope Management is the process of creating a scope management plan that documents how the project and product scope will be defined, validated, and controlled (PMBOK, 2017). This process is performed once or at predefined points in the project.

Martinelli, and Milosevic (2016) argue that Scope planning involves identifying goals, objectives, tasks, resources, budget, and timeline. The concept includes a number of high-impact tools that can be added to a project manager's PM Toolbox to assist with the process of scope planning. Used in conjunction with tools for schedule, budget, resource, and risk planning, project scope planning tools eventually lead to project plan development. Later, during project implementation, the scope baseline will be a vital foundation for disciplined scope control and change management, creating a barrier to unnecessary scope creep (Martinelli, and Milosevic, 2016).

Define Scope is the process of developing a detailed description of the project and product. . This process is performed once or at predefined points in the project (PMBOK, 2017).

Martinelli, and Milosevic (2016) has defined project work breakdown structure as an outcome-oriented grouping of project elements that organized and defined the total scope and the project work not in the WBS is outside the scope of the project.

The project WBS provides the project manager the means to divide a project into manageable increments, helping to ensure the completeness of all work that is required for successful completion of a project. Projects are planned, organized, and controlled around the lowest level of the WBS or work packages that are assigned to a project team member for responsibility of completion (Martinelli and Milosevic 2016).

In agreement to Martinelli and Milosevic (2016), PMBOK (2017) posit Work Breakdown Structure (WBS) as the process of subdividing project deliverables and project work into smaller, more manageable components.

Estimate Activity Durations is the process of estimating the number of work periods needed to complete individual activities with estimated resources. The key benefit of this process is that it provides the amount of time each activity will take to complete. This process does have the following PM tools and techniques, namely Expert Judgment, Analogous Estimating, Parametric Estimating, Three-Point Estimating, Bottom-Up Estimating and Data Analysis.

Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create a schedule model for project execution and

monitoring and controlling. The key benefit of this process is that it generates a schedule model with planned dates for completing project activities. And tools and techniques used is listed as Schedule Network Analysis, Critical Path Method, Resource Optimization, Data Analysis, Leads and Lags, Schedule Compression, Project Management information System, and Agile Release Planning

Plan Cost Management is the process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled. The key benefit of this process is that it provides guidance and direction on how the project costs will be managed throughout the project. This process is performed once or at predefined points in the project.

Estimate Costs is the process of developing and approximation of the monetary resources needed to complete project work. This process is performed periodically throughout the project as needed. The inputs and outputs of this process are depicted in Figure 2-4.

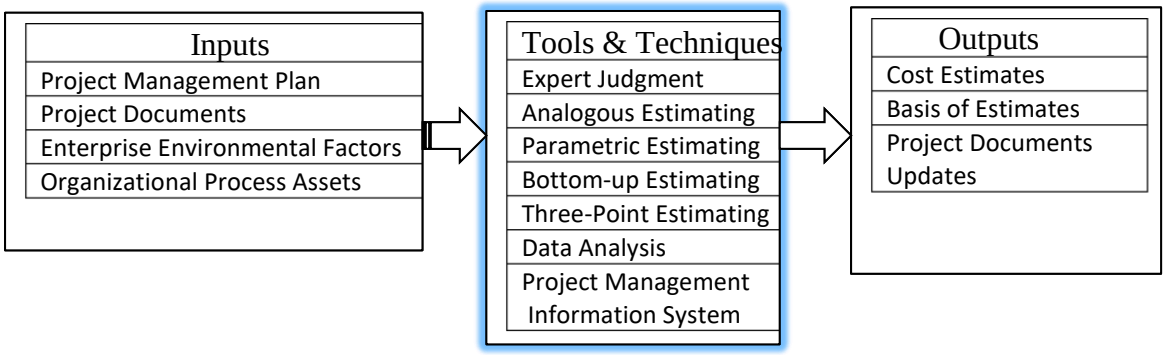


Figure 2.4 Tools & Techniques in Estimate Costs

Source: (PMBOK, 2017)

Direct and Manage Project Work is the process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives. The key benefit of this process is that it provides overall management of the project work and deliverables, thus improving the probability of project success. This process is performed throughout the project. The inputs and outputs of this process are depicted in Figure 2-5.

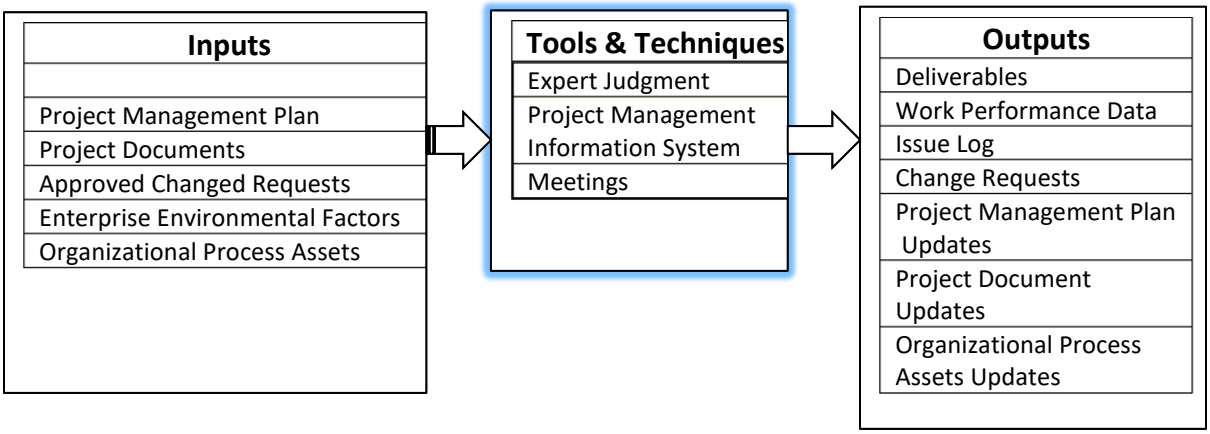


Figure 2.5 Tools & Techniques in Direct and Manage Project Work:

Source: Martinelli and Milosevic (2016),

Manage Project Knowledge is the process of using existing knowledge and creating new knowledge to achieve the project's objectives and contribute to organizational learning. The key benefits of this process are that prior organizational knowledge is leveraged to produce or improve the project outcomes and that knowledge created by the project is available to support organizational operations and future projects or phases. This process is performed throughout the project.

The Monitoring and Controlling Process Group consists of those processes required to track, review and regulate the progress and performance of the project; identify any areas in which changes to the plan are required and initiate the corresponding changes. Monitoring is collecting project performance data, producing performance measures and reporting and disseminating performance information. Controlling is comparing actual performance with planned performance, analyzing variances, assessing trends to effect process improvements, evaluating possible alternatives and recommending appropriate corrective action as needed. The key benefit of this Process Group is that project performance is measured and analyzed at regular intervals, appropriate events, or when exception conditions occur in order to identify and correct variances from the project management plan. The Monitoring and Controlling Process Group also involves:

1. Evaluating change requests and deciding on the appropriate response;

2. Recommending corrective or preventive action in anticipation of possible problems;
3. Monitoring the ongoing project activities against the project management plan and project
4. Influencing the factors that could avoid the change control process so only approved changes are implemented.

Continuous monitoring provides the project team and other stakeholders with insight into the status of the project and identifies any areas that require additional attention. The Monitoring and Controlling Process Group monitors and controls the work being done within each knowledge area, each process group, each life cycle phase and the project as a whole.

Monitor and control project work is the process of tracking, reviewing and reporting the overall progress to meet the performance objectives defined in the project management plan. The key benefit of this process is that it allows stakeholders to understand the current state of the project to recognize the actions taken to address any performance issues, and to have visibility into the future project status with cost and schedule forecasts. This process is performed throughout the project. The inputs and outputs for this process are depicted in Figure 2-6

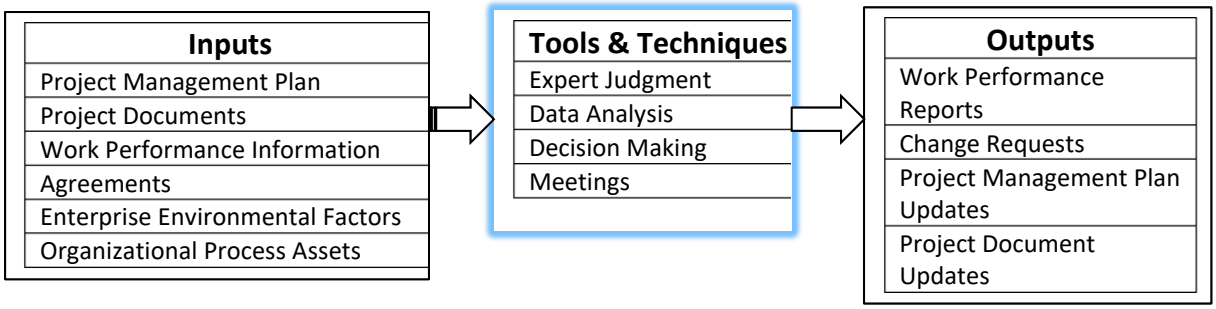


Figure 2.6 Tools & Techniques in Monitor and Control Project Work:

Source: (PMBOK, 2017)

Control Schedule is the process of monitoring the status of the project to update the project schedule and manage changes to the schedule baseline. The key benefit of this process is that the schedule baseline is maintained throughout the project. This process is performed throughout the project. The inputs and outputs of this process are depicted in Figure 2-7.

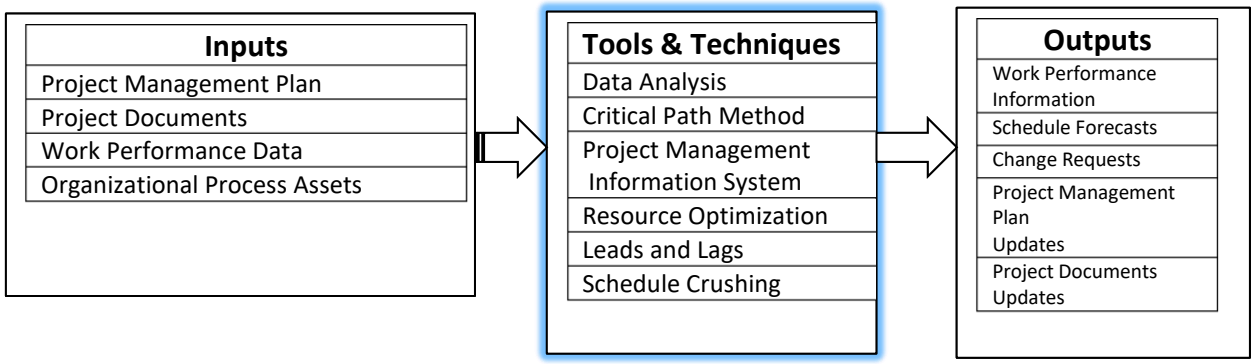


Figure 2.7 Tools & Techniques in Control Schedule:

Source: (PMBOK, 2008)

5.6 CONTROL COSTS

Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline. The key benefit of this process is that the cost baseline is maintained throughout the project.

This process is performed throughout the project. The inputs and outputs of this process are depicted in Figure 2-8.

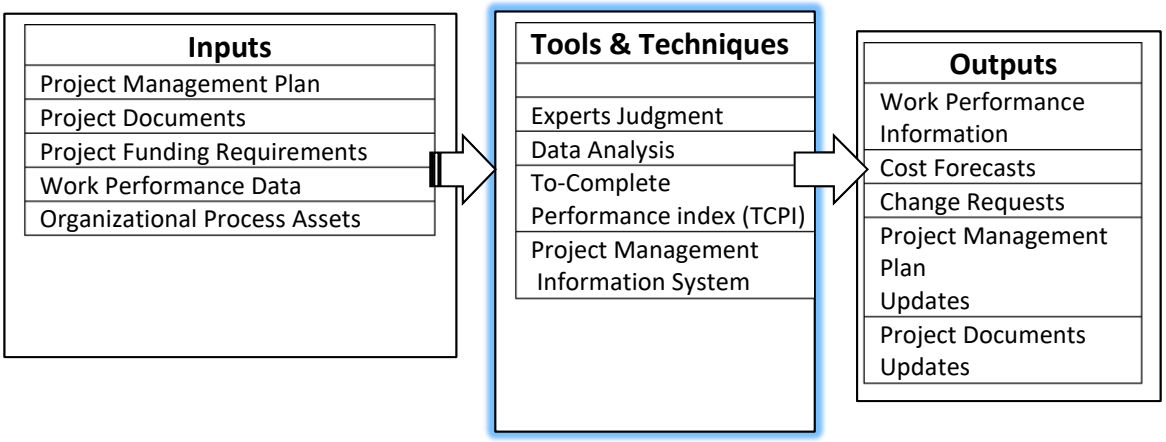


Figure 2.8 Tools & Techniques in Control Costs:

Source: (PMBOK, 2008)

2.4. Literature review summary

Most theorists who have been developing Project management theories has been emphasizing the importance of Gantt Chart and PERT as project management tools particularly in project

time scheduling. The project time scheduling, which is based on work breakdown structure and assigned time for each activity is assumed to be traditional project management practice is very deterministic which strictly stick to process related activities step-by-step workflow, rigid timelines, and its requirement to hard time adapting to the need for change partway through a project is criticized by recent researchers (Prieto, 2015) and supposed to be a gap in handling modern features of project management system. The only task-process based project management philosophy in traditional project management (TPM) system was striving to improve limitation by including human related dimension which is indication for inclusion of stakeholder involvement as project management tools and techniques. The traditional project management (TPM) realizes Lean as some improvement has gap in handling uncertainty that is often happening in in the project management process and further improvement is made to handle risk related issues (as in Critical Chain Project Management philosophy (CCPM)). Here the risk management has become complementing project management tool toward project success.

In codification of the project management practice as to project management body of knowledge (PMBOK) in 1969 by Project Management Institute (PMI) of America, the area has got momentum and researches have been continued to be undertaken since then. In this regard, Agile Project Management theory developed which focus on iterative human interactions as project management success factor, (Bob Prieto 2015). Agile project management methodology's key to successful is use of active client involvement and real-time decision making is one of best project management tools and techniques towards project success. Extreme project management (EPM) is improved version of agile project management philosophy in which flexibility play avital role where traditional project management is not. EPM allows to alter your project plan, budget, and final outcome to fit changing needs, no matter what stage the project is.

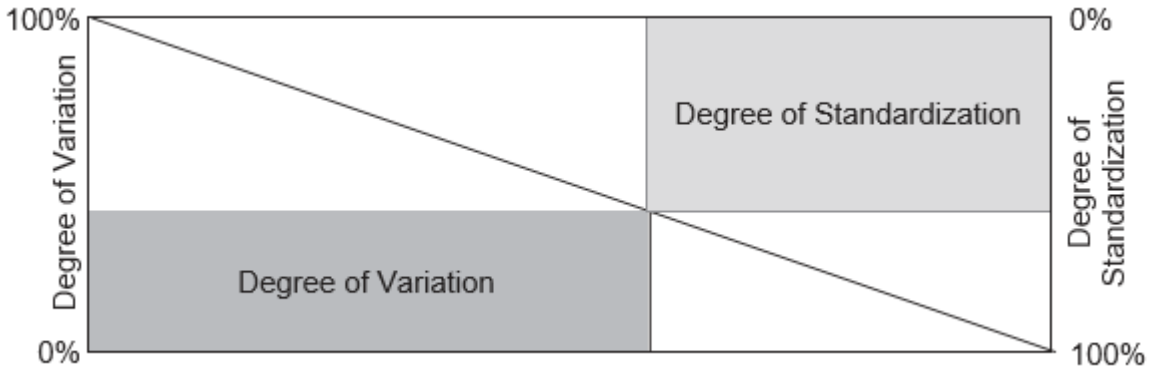
In this due course, different researchers in their theory have advised different project management tools and techniques and most of these authors on the subject matter (Miloševic, et al, (2004), Xuan et al (2019), Dildar et. al (2014), Ismael (2019), Abdulla (2019) agree the importance of project management tools and techniques towards effective and successful project performance, but the place in the project cycle where these tools could be more effectively applied is

inconsistently described. This has become a gap to the project managers in selecting and using tools and techniques and in what situation to apply them as well.

As to Martinelli and Milosevic (2016) when organization grows and becomes more mature in its practices, the need for standardization of methodologies and processes invariably arises. This is due to increased need for repeatability and consistency of project outcomes.

At one extreme, there may be a complete variation in the project management methods and processes. Literally, every time a process is performed, it is performed in a different way. Obviously, 100 percent variation means that standardization is equal to zero. This is often referred to as an ad-hoc approach. At the other extreme, methods and processes may be 100 percent standardized, meaning a process is performed in the same way every time. In this case, variation is zero percent. Between the two extremes lies a continuum of methodologies and processes with different ratios of standardization and variation and it is indicated in Table 2.5.

Table 2.5 Measure of Degree of Variation and Standardization



Source: Russ J Martinelli and Milosevic (2016)

2.5. Literature Gaps

Though considerable research is underway on the subject matter, there considerable in consistency among these scholars, there is no predefined most beneficial recommendation made to the project managers which and where these tools are more effective and efficient to apply and the Table 2.6 is presented to show how these tools and techniques are recommended by different scholars.

Table 2.6 PM Tools and Techniques summary versus application phase

Authors name	PM Tools and Techniques (PMTT)	Tools & Techniques Phase of application
Xuan et al (2019)	✓ Work Breakdown Structure (WBS) ✓ Feasibility Study (FS) ✓ Stakeholder Power Interest Matrix (SPIM) ✓ Risk Register (RR) ✓ Gantt Chart (GC)	Generic
Dildar et. al (2014)	✓ Work breakdown structure ✓ Hierarchical Schedule and ✓ Analogous Budget Estimation	Planning phase
Dildar et. al (2014)	✓ Earned value management, ✓ Cost baseline, ✓ Schedule crashing	Execution phase
Miloševic (2004)	✓ Critical path method ✓ Program evaluation and review technique ✓ Scope statement ✓ Work breakdown structure ✓ Gant chart ✓ Cortical chain ✓ Schedule crashing ✓ Stake holders' analysis	Planning phase
Miloševic (2004)	✓ Change request ✓ Risk log ✓ Scope change control ✓ Earned value management ✓ Performance report	Execution phase

PMBOK (2017)	✓ Earned value analysis, ✓ Interpretation & contextualization of data, ✓ Duration and costs, Trend analysis, ✓ Industry and focus area of the project, ✓ Risk management, and ✓ Contract management.	Monitor and Control Project

Source: Self summary compilation

Martinelli and Milosevic (2016) further elaborate that different project sizes require different processes and tools, and has classified projects by size in relation to application of tools and techniques. As Martinelli and Milosevic (2016), the project with cost less than 2 million US dollar is assumed small size and the project with cost 2-10 million US dollar medium size project and those cost greater than 10 million US dollar is classified as large size as well. Table 2.7 is presented to show project type across different implementation phase.

Table 2.7 project Size Versus PM Tools And Techniques Application

	Project Phases			
Project Size	Initiation	Planning	Execution	Closure
Small	Project charter	Scope statement WBS Responsibility matrix Milestone chart	Progress report	Final report
Medium	Project charter Skill inventory	Scope statement WBS or PWBS Responsibility matrix Cost estimate Gantt chart Risk plan	Progress report Change process Change log Gantt chart Cost breaks down Risk register	Final report Change log Postmortem report

Large	Project charter Stakeholder matrix Stakeholder strategy	Scope statement WBS and PWBS Responsibility matrix Cost estimate	Progress report Project indicators Change process and log Time-scaled arrow diagram	Final report Postmortem report

Source: Martinelli and Milosevic (2016)

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1. Study Area

The research is under taken in construction industry based public enterprise. The subject area of the study is water projects under construction in Oromia region water works design and construction enterprise as case study and descriptive research which is used to survey water supply projects undertaken in Oromia regional. This study area is clustered into four main clusters namely, western, central, eastern and southern clusters. Each amin clutters do have subclusters based on the number of water supply projects under taken in the specified region.

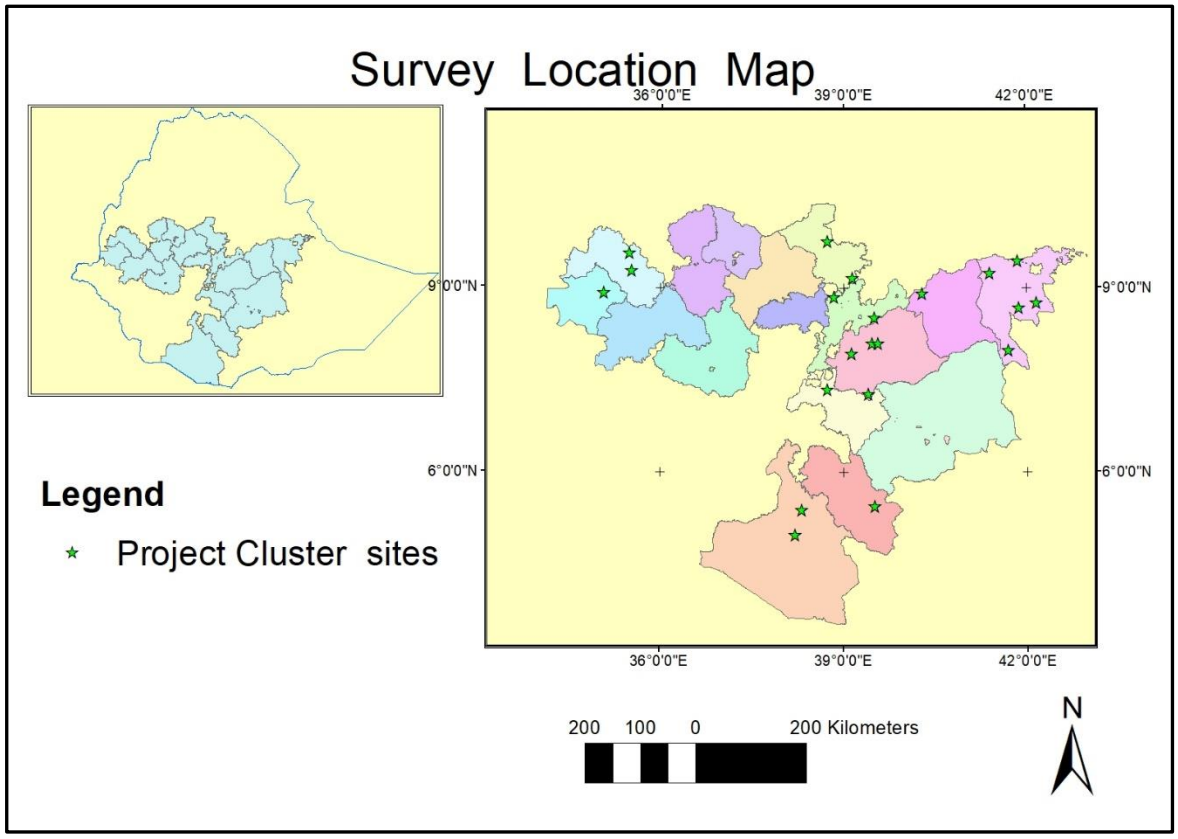


Figure 3.1 Map of Study Area

Source: Self Compilation

3.2. Research Design

This research is case study and descriptive research combination type which is used to survey the management methodologies of construction projects. The research has been designed and undertaken in two sections having logical interconnection. As response to research question stipulated in the objective part, the first section of the research has been intended to address the question of the project performance in the study area. The case study, Oromia water works design and supervision enterprise water supply projects under taken in the previous years has been focused. The project performance reports that have been produced at end of each physical year is obtained from archive of the planning section of enterprise. These data are coded using excel spread sheet and systematically categorized in different level of physical performance. The results of the analysis and the findings are tabulated as fresh baseline that could later be correlated to project management tools and techniques exercised in the selected enterprise.

The second section of the research is assessment of application of project management tools and techniques and their level of influence towards project performance. This has been started by assessing the exiting theoretical knowledge and pervious research endeavors in the identified subject matter. Here, the theoretical findings and continuous research development to evolve the subject matter has been insighted. In this due course, the project management body of knowledge (PMBOK) conceptual finds and drawn project management models has been referred and used as basic milestone.

As descriptive research type, qualitative data are acquired through structured questionnaires from project managers, resident engineers and site supervisors. To handle the perception of project managers, resident engineers and site supervisors, 5-point Likert scale is used as data acquiring tool. The acquired data is analyzed through descriptive statics tools, in which statistical parameters such as mean, variance, percentage and relative importance indices were analyzed for further stages.

3.3. Population and Sample Size

3.3.1. Population Size

The population size of the research is projects undertaken under Oromia Works and Design and supervision Enterprise in the last five years and project managers and site supervisors directly

involved in the project management. As to this data exists, there is 200 water supply projects in four clusters under taken by Oromia water works design and supervision enterprise in the year between 2016 and 2020.

3.3.2. Sample Size

Regarding sample size, Yamane (1967) provides a simplified formula to calculate sample sizes. As indicated in the previous section there has been about 200 projects(population) and 151 samples have been analyzed. In the similar manner twenty-five project management team involved in the direct managements of these projects were studied as to their level of application of project management tools and techniques. This formula was used to calculate the sample sizes in equation (3.1) as shown below.

Taro Yamane (1967) formula:

$$n = \frac{N}{1 + N(e)^2} \qquad \text{--------Equation (3.1)}$$

Where n = Desired sample size

N = Population of the study

e = precision of sampling error (0.05)

3.4. Data Collection Tools

Data for the study were derived from both primary and secondary sources. The primary data were obtained from structured questionnaire designed in Likert Scale in rating Scale of 1to5. The secondary for the first section of research survey was obtained from archrival data of the planning section of the Oromia Water Works and Supervision Enterprise. And also, the supporting and research enriching secondary data were obtained from various publications such as relevant journals, text books and conference proceedings to further restrengthen the research survey. The structure questionnaires were designed to obtain Perceptual information on the attitude of professionals towards the factors influencing the performance of construction projects in the study area particularly in pertinent to PM tools and techniques use. A total of 25 copies of questionnaire were distributed and completed by professionals working on different public water supply projects in the study area.

3.4.1. Sampling Techniques

Pandey and Mishra P. (2015) posit that reliable sampling method need be applied to obtain accurate and reliable information about the universe with minimum of cost, time and energy and to set out the limits of accuracy of such estimates. It makes exhaustive and intensive study possible with much less time, money and material. In this manner purposive sampling techniques is employed to acquire data for the survey.

3.4.2. Questionnaire Method

The primary data has been obtained by developed structured questionaries to targeted respondents of project managers and resident engineers involved in the active project management system so that their perception in project management tools and techniques application and to find out if there is limitation in using the application knowledge thereof.

First, the respondents were asked to provide their personal information, such as educational back ground, years of experience, the organization in which they were serving and so on. Then respondents were asked to think about some of projects that were under progress or recently completed on which the respondents were engaged on in the last five years. The questions were designed to be answered in the following way. The was the information regarding the frequency of use of each PMTT in each process groups and particularly the core or central process group, namely planning process group, Execution process groups and controlling & monitoring process groups and rated by a 5-point Likert scale (Weight: Always: 5. Often 4. Sometimes 3. Rarely 2. Never 1.). In other words, for each PMTT, respondents were asked to rate how often they used PMTT in each specific process group. An example of the questions includes: 'How often do you use an analogous cost estimate in (1) the planning phase (2) execution, controlling and monitoring phase.

3.4.3. Case Study Method

As to Creswell (2003) cited in Williams (2007), case study is defined as "research explores in depth a program, an event, an activity, a process, or one or more individuals". The case study can be either a single case or a case bounded by time and place (Creswell, 2003). Leedy and Ormrod (2001) provide several examples from different disciplines such as medical research studying a rare illness (event) or political science research on a presidential campaign (activity).

Leedy and Ormrod (2001) state, case studies attempt to learn "more about a little known or poorly understood situation" Creswell (2003) suggests the structure of a case study should be the problem, the context, the issues, and the lessons learned. The data collection for a case study is extensive and draws from multiple sources such as direct or participant observations, interviews, archival records or documents, physical artifacts, and audiovisual materials.

As case study, the water supply projects undertaken in Oromia water works and design enterprise, between the year 2016 through 2020 is taken. These water supply projects are categorized in two four categories to cover the entire area of the region. The archival data that complied at the end of each physical year is obtained as secondary data. The performance plan at the beginning of the physical year and the achievement at the end of each year is tabulated. The difference between plan and performance is evaluated as well.

3.5. Data Analysis Method

3.5.1. Descriptive Data Analysis

As to data analysis techniques, descriptive statistics was used in this study. The descriptive data analysis involved frequency, percentage, variance and relative importance index. The relative importance index method (RII) was used to determine the to measure the project managers, site engineers and supervisors' perceptions of the relative importance of the identified project management tools and techniques. The index was adopted from Milosevic (2010); Abdulla and Al-Hashimi (2019); Ismael (2019),) Where W is the weight given to each factor by the respondents and ranges from 1 to 5.

According to Aibinu & Jagboro (2002) sited in A. Kassem (2020), the Relative Importance Index (RII) approach is preferred to describe the relative importance of the specific causes and effects based on the likelihood of occurrence and effect on the project using the Likert scale of five scales. In addition, the higher value of the index of relative importance (RII) is the critical cause or impact component and is determined by Equation (3.2)

$$RII = \frac{\sum W}{A*N} \qquad \text{Equation----------(3.2)}$$

Where :

- W is the weight given to each factor by the respondents and ranges from 1 to 5,
- A is the highest weight, which is 5 and
- N, is the total number of respondents.

In allaying the existence of correlational among the variable application of project management tools and techniques and the project performance, Pearson's correlation coefficient is preferably used as proposed by Richard Fellow (2008). The approach is adopted because respondents interpret the scorings differently in terms of the score categories (Likert 1–5). The coefficient of correlation is a measure of the association between two variables which is determined from the observations of the variables. It is calculated using Pearson's coefficient of correlation, R:

$$R = \frac{\sum XY}{\sqrt{\sum X^2}\sqrt{Y^2}} \qquad \text{Equation----------(3.3)}$$

Where :

- R Coefficient of Pearson's Correlation,
- Y=Y- $\bar{Y}$ and X=X-$\bar{X}$
- $\bar{X}$ -Mean value independent variable
- $\bar{Y}$ -Mean value dependent variable

3.6. Reliability and Validation

3.6.1. Reliability

According to Fellows and Liu (2008), reliability referred to the extent to which a scale produces consistent results if repeated measurements are made and is assessed by determining the proposition of systematic variation in a scale. Approaches for assessing reliability include the internal consistency, alternative forms and test–re-test methods. Internal consistency reliability is used to assess the reliability of a summated scale where several items are summed to form a total score. Each item measures some aspect of the construct measured by the entire scale and

the items should be consistent in what they indicate about the construct. This measure of reliability focuses on the internal consistency of the set of items forming the scale

According to Dessalegn (2021), Cronbach's alpha is commonly used to assess the internal consistency of variables in the research instrument. And hence, Cronbach's Alpha test was used to check internal consistency. Cronbach's Alpha value that has a range between 0 (no consistency) and 1 (complete consistency). A scale is said to have a very good reliability if Alpha is between 0.80 and 0.95, and a good reliability in the range of 0.7 and 0.8, and a fair reliability if Alpha is between 0.6 and 0.7. If Cronbach Alpha is below 0.6, the scale is said to have a poor reliability. Equation (3.4) is used to calculate the reliability of the data as well.

$$\alpha=\frac{K}{K-1}\left(1-\frac{\sum Q}{Q^2}\right) \qquad \text{Equation----------(3.4)}$$

Where:

α -Cronchbach alpha coffient

K- the number of questionaries resipondent

Q- the resipondent values variance

3.6.2. Validity

Validity is the extent to which difference found with measuring instrument while data acquiring reflecting true differences among those being tested. In order to ensure the quality of the research design content and construct validity of the research is checked (John,2007).

According to (Dessalegn, 2021) internal validity used to assure the research validity. To treat the internal validity of this research, a questionnaire was distributed within the same period and collected within a week and reasonable sample was taken from the population and questionnaire randomly and distributed to participants. The pilot test was made on the questionnaire way of preparation, wording, coherence and any other valuable comment and to incorporate any important comments and while finalizing the questionnaire.

Data validity was also tested using published scales as bench mark. Scale from Milosevic (2010) was adopted for the management tools and techniques whereas the measurement survey for the project success was used from archived report which is formally documented.

3.7. Ethical consideration

ASTU Research Guideline (2021) posits ethics as the morals of the investigation or intervention as regards the minimal abuse, disregard, safety, social and psychological well-being of the person, community and /or animals i.e., how the principles of consent, beneficence and justice are handled in the study. To this end, the objective of the research is clearly informed to the respondents about the purpose of the study and it has been vividly and boldly indicated at the heading of the questionnaire distributed for the purpose of data acquisition, i.e., purely for academic. And the introduction of the purpose study in the introductory part of the questionnaire to the respondents confirmed that subject's confidentiality was protected. In addition, the study was based on the consents of the respondent and no sort any intimidation and lobby. The researcher was attempting not personalizing any of the response of the respondents during data collection by excluding names and any finger Prentis that help identify the identity of the respondent. Furthermore, all the materials used for this research were duly acknowledged. The research will respect the following ethical principles: Sufficient informed consent is provided; Privacy is respected; Integrity is fundamental. Records is kept confidential and anonymity is guaranteed during and after this paper is compiled.

CHAPTER FOUR: RESULT AND DISCUSSION

4.1. Introduction

This chapter is designed to deal with the findings while research is undertaken on project management tools and techniques in identified research area of Oromia Water Works Design and Supervision Enterprise. As the research is designed under three thematic sections. This section starts in portraying the general demographic profile of the sampled survey respondents and has further elaborated their educational settings. It would also map the experiences project management team those have direct engagement in the project management endeavors.

4.2. Demographic Profile of Respondents

As it has been presented in the Table 4-1, the 25-questionnaire distributed to project managers, resident engineers and site supervisor and 18 response (72 %) returned. As the precent returned is satisfactory and analysis is made on the data obtained. Table (4.1) has summarized the demographic profile of the respondents.

Table 4.1 Demographic Profile of Respondents

Ser no	Description,	Number/Value
1	Questionnaires Distributed	25
2	Questionnaires Used in survey	18
3	Percentage of Survey Response rate	72.00
4	Experience 1-5 years	1
5	Experience 5-10 years	8
6	above10 years	9

4.3. Academic and Responsibility Profile of Respondents

As to responsibility of the respondents, all experts are directly involved into project management endeavors, the project manager, resident engineer and office engineer who make up to 94 % of respondents portray that the nucleus of project management team is noticeably included.

Table 4.2 Academic and Responsibility Profile of Respondents

Ser no	Description	Number /Value
1	Academic profile	
	Diploma	-
	First Degree	7
	Master's	11
	PHD	-
2	Responsibility profile	
	site supervisor	1
	Resident Engineer	5
	Office Engineer	6
	Project Manager	6

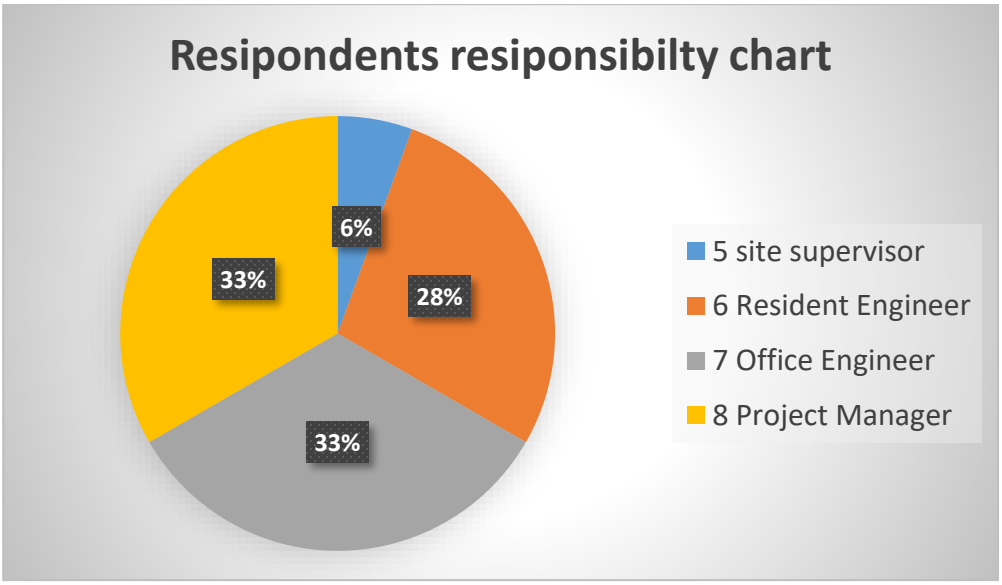


Figure 4.1 Respondents Responsibility Map

4.4. Result of project physical performance

The second part is dealing with the project physical performance. In this section, the research has archived 200 water supply projects and randomly selected 151 projects that were performed in the year between 2016 and 2020. while evaluating these projects physical performance during these times, project reports documented and archived were collected from Oromia water works design and supervision enterprise planning department.

The survey result is under taken by categorizing the physical performance each sets into ductile percentages from 100 % to 10 %. From table 4-3 it can be sighted that 25.17 % (38 projects) were completed 90 to 100% physically when plan versus execution is evaluated. And on the another extreme 19.87 % (30 projects) had registered to stand on less 10 % of its physical achievement. When the middle value of the percent performance of the project by the surveyed enterprise is evaluated, it is seen that only 84 projects (55.63%) have performance about 50% physical achievement. These project performances have been summarized and illustrated in Table (4.3) and Figure (4.2) as well.

Table 4.3 Project Physical Performance

Year	Less than 10%	10 to 20%	20 to 30%	30 to 40%	40 to 50%	50 to 60%	60 to 70%	70 to 80%	80 to 90%	90 to 100%
2016	12	9	5	3	2	2	1	3	2	3
2017	2	1	2	0	1	0	4	6	2	9
2018	1	1	1	1	1	1	1	1	4	7
2019	12	6	1	2	1	2	1	0	1	11
2020	3	2	1	2	1	3	2	2	2	8
Project Complete	30	19	10	8	6	8	9	12	11	38
% Complete	19.87	12.58	6.62	5.30	3.97	5.30	5.96	7.95	7.28	25.17
Cum. % Complete	100.00	80.13	67.55	60.93	55.63	51.66	46.36	40.40	32.45	25.17

The result in the next table and graph disclose that the physical performance of the study output shows that declining towards left that indicate that 10% of the projects has hit 100% targeted plan, 50% of the projects hit 55.63% and 100% of the project can be physically achieve 25.17% progress, this is to mean that 74.83 % (seven project from ten are failed to achieve schedule target). This has got supporting finding with research advices (Ayalew,2017) which outline that the failure in project by schedule slippage is from 61-80%.

Table 4.4 Project Percent Completion Probability

Ser. No	Cumulative % Complete	Target % Complete	Number of projects Complete
1	25.17	100	38
2	32.45	90	49
3	40.40	80	61
4	46.36	70	70
5	51.66	60	78
6	55.63	50	84
7	60.93	40	92
8	67.55	30	102
9	80.13	20	121
10	100.00	10	151

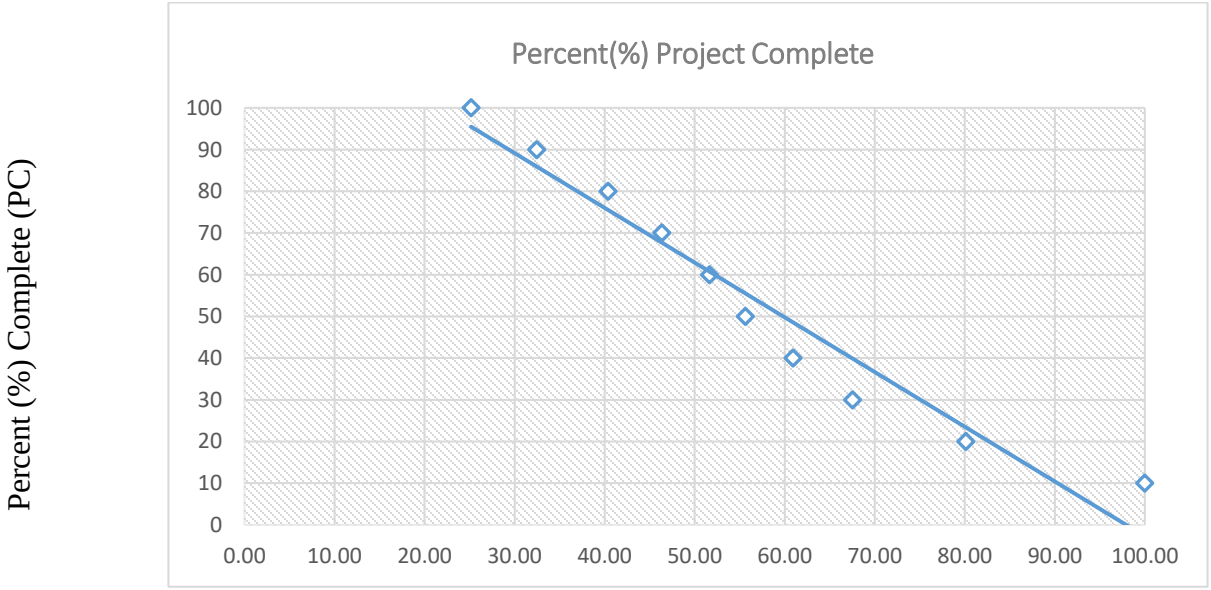


Figure 4.2 Project completion Percentile

The next table and graph are showing project physical performance measured less 50% as per predefined target plan and its trend with time. As to this, the result indicates the first year and second year there are 31 to 32 % of the projects are physically stand at less than 50%. In the third year 23%, in the fourth year 9% and in fifth year 4 %.

Table 4.5 Project Performance Time Trend

Ser no	YEAR	Performance Percentage Less than 50%
1	2016	31
2	2017	32
3	2018	23
4	2019	9
5	2020	4

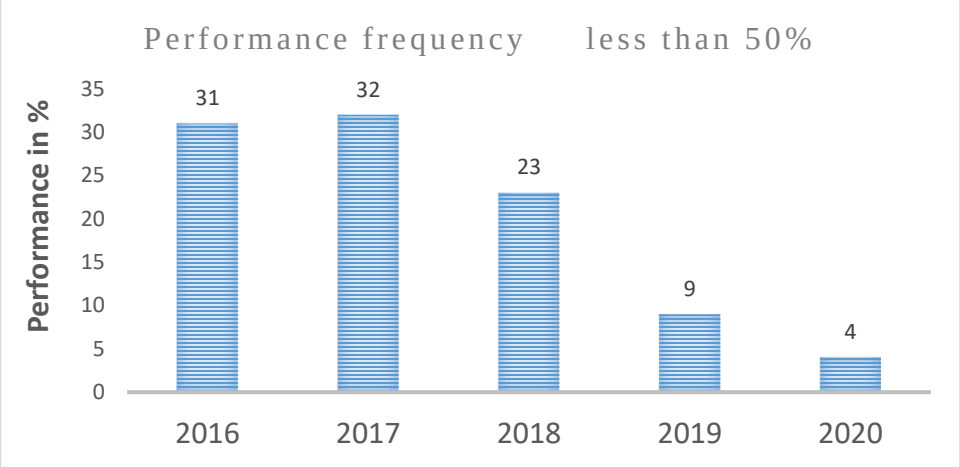


Figure 4.3 Performance Trend with Times

4.5. Application of Project Management Tools and Techniques

The third part of this chapter is designed to deal with application of project management tools and techniques and its impact on project performance. The survey went on to find the relation that might exist between the project performance and application of project management tools and techniques. The project performance as to plan targated and performance dicussed in the pprevios section is traced and documented in in section, too, and survey is under gone. The project management tools and techniques commonly used are idetified and top ten of them are listed for both planning and execution and controling phase of project management life cycle.

The commonly used and simplest methods used to determine criteria weights according to the priority of criteria, a certain number of points is given to each criterion (Odu G. O,2019). The points criterion receives the greater value as to its relative importance.

The physical performance discussed in the previous section are assigned in the respective column.

Table 4.6 PMTT Scoring Planning Process Group

Planning Process Group				
PMTT	Weight	Score By Survey	Weight Score PMTT	Project Physical Performance
Milestone prediction chart	1	2.7500	2.750	25.17
Time-scaled arrow diagram	1.1	3.6923	4.062	32.45
Analogous cost estimate	1.2	3.3571	4.029	40.40
Cost baseline	1.3	3.4615	4.500	46.36
Critical Path Method (CPM)	1.4	3.2308	4.523	51.66
Milestone chart	1.5	3.0833	4.625	55.63
Contingency plan	1.6	2.8571	4.571	60.93
Brainstorming	1.7	2.8462	4.838	67.55
Work Breakdown Structure	1.8	3.9231	7.062	80.13
Scope statement	1.9	3.3333	6.333	100.00

4.6. Correlation of Project Performance and PM Tools & Techniques

Using Mark Romanelli (2008) and Odu, G.O. (2019), Weighting Methods for Multi-Criteria Decision-Making model, these project management tools and techniques are scored. Thus the variables, project performnce as dependent and project management tools and techniques as independent variable are correlated during project management planning phase.

For project managemnrt practices at planning phase, the weighted score of project management tools and techniques perception by survey is further analysed in to Multi-Criteria Decision-Making model chart by in with project performance results analyed in preceeding section.

The result in the table 4-4 and subsquent graph indicate that the least weighted score (2.75) is percevied in the survey is assigned for tools and techniuques of mile stone prediction in the project planning and the highest weighted score(7.06) evaluted for work breakdown structure during planning project cycle.

There is slightly equal weighted score analysed (4.06, 4.03) for analoges cost estimate and diagramed arrow methodolgy for schedule planning. The rests project plaaning technical tools are having weighted scores in the order of (4.5-4.8).

Table 4.7 PMTT Vs Project Performance in Planning Process Group

Survey Points	Tools & Technique Score (TT)	Performance Score (PR)	TT-Tav	PR-Pav	(TT-Tav) *(PP-Pav)	(TT-Tav)^2	(PR-PRav)^2
1	2.750	25.17	-1.98	-30.86	61.08	3.92	952.40
2	4.062	32.45	-0.67	-23.58	15.74	0.45	555.84
3	4.029	40.40	-0.70	-15.63	10.95	0.49	244.27
4	4.500	46.36	-0.23	-9.67	2.22	0.05	93.49
5	4.523	51.66	-0.21	-4.37	0.90	0.04	19.10
6	4.625	55.63	-0.10	-0.40	0.04	0.01	0.16
7	4.571	60.93	-0.16	4.90	-0.77	0.02	24.02
8	4.838	67.55	0.11	11.52	1.26	0.01	132.78
9	7.062	80.13	2.33	24.11	56.22	5.44	581.10
10	6.333	100.00	1.60	43.97	70.54	2.57	1933.67
Sum	47.29	560.26	0.00	0.00	218.18	13.01	4536.82
Average	4.73	56.03					

R^2=0.8065

The project management tools and techniques scale of application is correlated to performances analysed. To test the relational strength existing among these variables, Sprearman's ranking correlation is used as it has been recommended for such qualitative data analysis techniques. And the result indicates that there exists computed value of (R^2) 0.8065 strong postive correction. It is also possible to deduce from graph (4.4) that one unit increase in application of project management tools and technique will have 16.77 % increase project performance during planning phase. Likewise, the survey result in planning and controlling phase indicate that (Graph 4.5) that one unit increase in application of project management tools and technique will have 12.33 % increase project success rate.

The litrature indicate that (Abdulla and Al-Hashimi, 2019), one unit change in the application of relevant PMM elements throughout the project life cycle has 32.3% impact on project success whereas one unit change in the application of comprehensive PMM elements has 27% impact on project success.

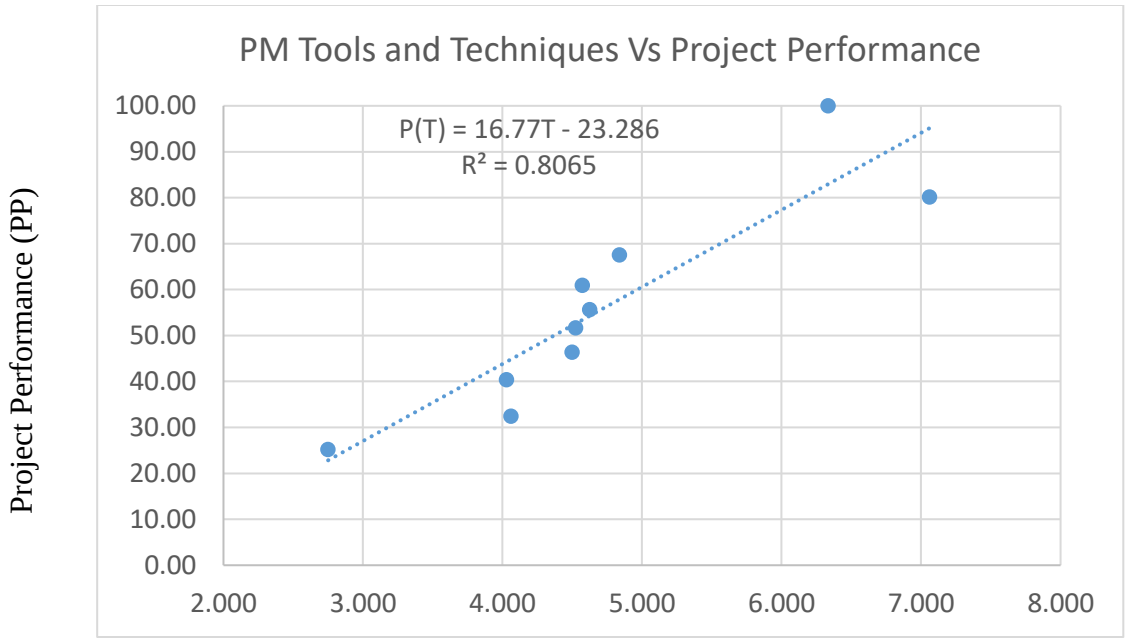


Figure 4.4 PMTT Vs Project Performance IN Planning PG

For project managemnrt practices at execution and monitoring phase, the weighted score of project management tools and techniques perception by surveyed project management team is analysed as well in to Multi-Criteria Decision-Making model chart produced by Odu, G.O. (2019), along with project performance results noted in preceeding section.

The result in the table 4-8 indicate that the least weighted score (4.07 and 4,08) is percevied in the survey is assigned for tools and techniuques of schedule crushing teqhniques and performance base line analysis in the project execution and monitoring life cycle. The highest weighted score(7.87 and 7.65) evaluted for check listing technique and performance reporting widely percieved by project managemnt team during execution and monitoring project cycle.

There are also midle value weighted score analysed (5.20, 6.04, 6.62) for bar charting technique for schedule managent, project change request during monitoring, work breaking down techniques in project progess contoling and reviewing where ever deviations has happened from pre set base line.

Table 4.8 PMTT Scoring Execution and Controlling Process Group

Execution and controlling process group				
Execution and controlling process group	Weight	Score By Survey	Weighted Score PMTT	Project Physical Performance
Schedule crashing technique	1	4.071	4.071	25.17
Performance Baseline Measurement	1.1	3.714	4.086	32.45
Milestone analysis	1.2	3.083	3.700	40.40
Critical Path Method (CPM)	1.3	3.385	4.400	46.36
Bar charting techniques	1.4	3.714	5.200	51.66
Milestone prediction chart	1.5	2.923	4.385	55.63
Work Breakdown Structure (WBS)	1.6	4.143	6.629	60.93
Performance report	1.7	4.500	7.650	67.55
Project change request	1.8	3.357	6.043	80.13
Check listing technique	1.9	4.143	7.871	100.00

The project management tools and techniques scale of application is correlated to performances analysed. To test the relational strength among these variables, Sprearman's ranking correlation is used as it has been recommended for such qualitative data analysis techniques. And the result indicates that there exists computed value of (R^2) 0.7218 strong postive correction.

Table 4.9 PMTT Vs Project Performance at Execution and Monitoring Process Group

Survey	Tools & Technique Score (TT)	Performance Score (PR)	TT-Tav	PR-Pav	(TT-Tav)(PP-Pav)	$(TT-Tav)^2$	$(PR-PRav)^2$
1	4.07	25.17	-1.33	-30.86	41.12	1.78	952.22
2	4.09	32.45	-1.32	-23.58	31.06	1.74	555.92
3	3.70	40.40	-1.70	-15.63	26.62	2.90	244.23
4	4.40	46.36	-1.00	-9.67	9.70	1.01	93.47
5	5.20	51.66	-0.20	-4.37	0.89	0.04	19.08
6	4.39	55.63	-1.02	-0.40	0.41	1.04	0.16
7	6.63	60.93	1.23	4.90	6.01	1.50	24.03
8	7.65	67.55	2.25	11.52	25.88	5.05	132.76
9	6.04	80.13	0.64	24.10	15.41	0.41	580.91
10	7.87	100.00	2.47	43.97	108.50	6.09	1933.54
Sum	54.04	560.28	0.00	0.00	265.61	21.55	4536.31
Average	5.40	56.03					

R^2=0.7218

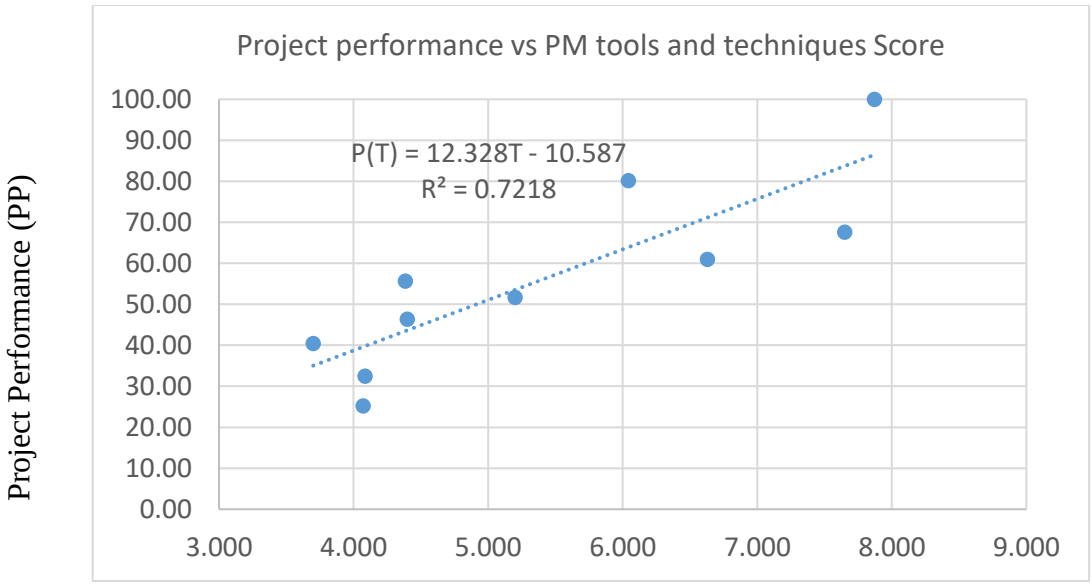


Figure 4.5 PMTT Vs Project Performance in Execution & Controlling Process

4.7. Relative Importance Index of Project Management Tools and Techniques

The Relative Importance Index (RII) is a statistical tool used to rank different factors by their level of importance or impact. Research commonly uses it to prioritize items based on respondents' ratings. A relative index analysis was used to estimate the relative significance of Project management practices among different project management tools and techniques. Table 4-10 shows the rankings for each appliciabilty perception of tools and teccniques during project management by project management team.

Table 4.10 RII Tools And Techniques in Project Planning Process

Tools And Techniques	Never	Rarely	Some-times	Often	Always:	Total	Score	RII
Weight	1	2	3	4	5			
Analogous cost estimate	2	2	1	10	2	17	3.47	0.6941
Brainstorming	3	2	4	5	1	15	2.93	0.5867
Contingency plan	2	4	7	3	1	17	2.82	0.5647
Cost baseline	1	2	3	5	5	16	3.69	0.7375
Critical Path Method (CPM)	3	1	3	3	6	16	3.50	0.7000
Milestone chart	0	6	3	5	1	15	3.07	0.6133
Milestone prediction chart	2	4	3	6	0	15	2.87	0.5733
Scope statement	2	1	4	5	3	15	3.40	0.6800
Time-scaled arrow diagram	0	2	4	4	6	16	3.88	0.7750
Work Breakdown Structure (WBS)	0	0	5	5	6	16	4.06	0.8125

The analysis of the Relative Importance Index (RII) has provided valuable insights into the extent and frequency of applicability of tools and techniques. The findings indicated that the most of project management team has applied most frequently work breakdown techniques in their day-to-day project management endeavors, and as to this survey the WBS has the highest relative important index of (0.8125) during project planning.

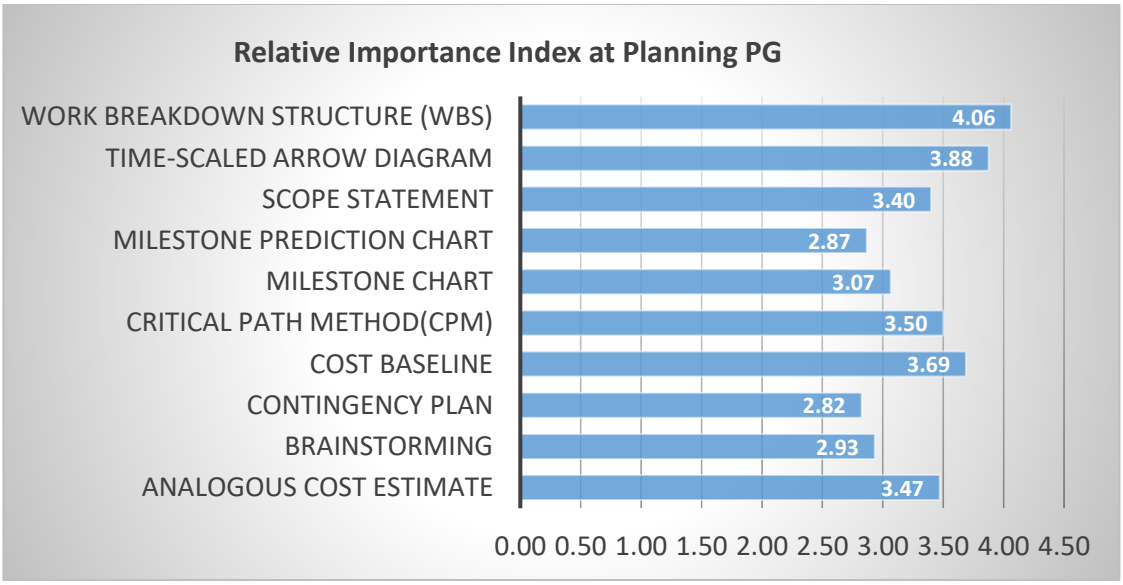


Figure 4.6 RII PMTT Tools in Project Planning Process Group

In the similar manner, during project execution and monitoring, as indicated in table 4-11 The findings indicated that the most of project management team has frequently apply performance reporting technique, check listing technique, work break down structure and schedule crushing. The relative importances index of these tools are scored from 0.9167 to 0.8353. the tools and techniques that have scored less relative importance are mile stone prediction technique, miles stone analysis and project change request. In the middle there are project management tools and techniques such as bar chart technique, performance base line measurement and critical path method commonly perceived in this specific survey while project execution and monitoring is underway.

Table 4.11 RII PMTT in Project Execution, Controlling and Monitoring Process

	Never	Rarely	Some-times	Often	Always:	TOTAL	SCORE	RII
Performance reporting	0	1	1	2	13	17	4.59	0.9176
Checklist Techniques	0	0	5	3	9	17	4.24	0.8471
Work Breakdown Structure (WBS)	0	2	1	5	9	17	4.24	0.8471
Schedule crashing	0	0	4	6	7	17	4.18	0.8353
Bar chart technique	1	2	3	7	4	17	3.65	0.7294
Performance Baseline Measurement	1	0	5	5	6	17	3.88	0.7765
Critical Path Method (CPM)	2	2	2	4	6	16	3.63	0.7250
Project change request	1	3	3	7	3	17	3.47	0.6941
Milestone analysis	1	4	4	2	4	15	3.27	0.6533
Milestone prediction chart	2	5	3	3	3	16	3.00	0.6000

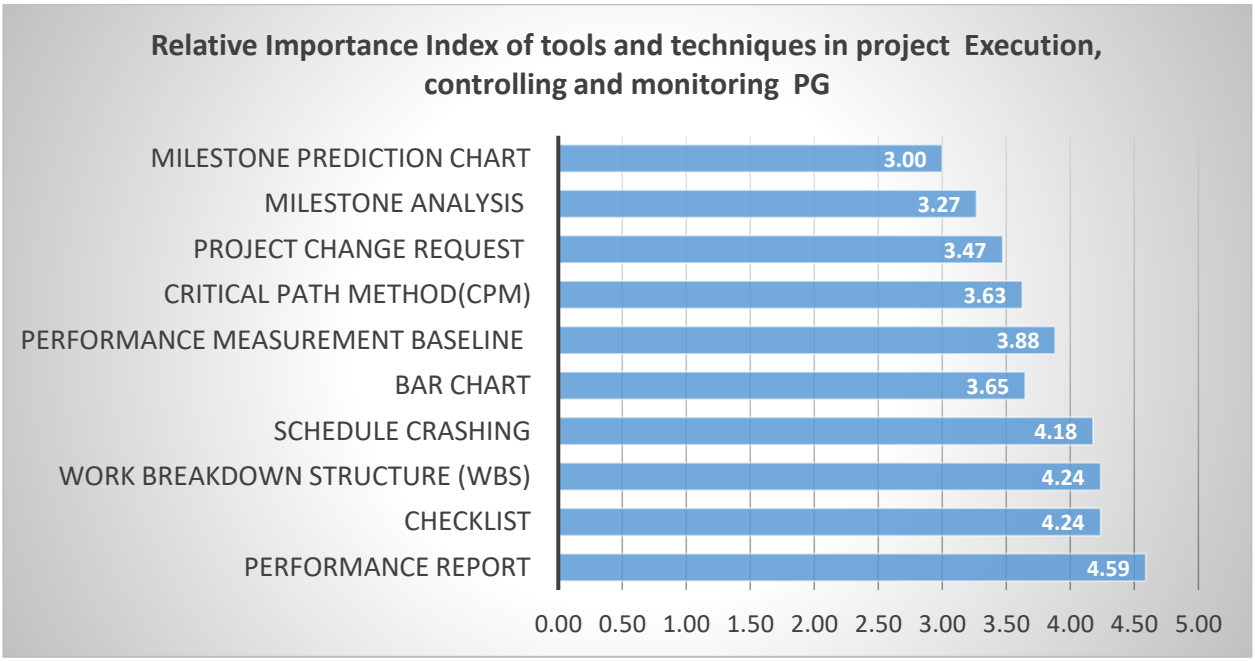


Figure 4.7 RII PMTT at Execution and Controlling PG

Further to elaborate the third specific objective, it is to customize and develop project management tools and techniques in context of project management in Oromia water works design and supervision Enterprise. This is based on survey results and literatures recommendations on the subject matter. There have been procedures recommended by

conceptual theories in literature while adopting the best methodology Bob Prieto (2015). In this case existing project management tools and techniques from survey result and conceptual frame work selection from literature has been applied.

Three categories are used to customize project management tools and techniques. In this customization procedure project management toolbox model (Martinelli and Milosevic 2016) has been used as guideline and three project categories, namely project size, project family and project type has been summarized.

The studied enterprise has been managing projects having varying sizes. The assumption is that larger projects are more complex than smaller ones, or that size drives differences in project management methodology complexity. The reasoning here is that as the project size increases, so does the number of activities and resulting project deliverables associated with a project, as well as the number of interactions among project management tools.

Since different project sizes require different processes and tools, the researcher first needed a way to classify projects by size and then customize the corresponding Tools and techniques.

Table 4.12 Project Management Tools and Technique Customization

	Project Phases	
Project Size	Planning	Execution and Monitoring
Small	Scope statement	Progress report
	WBS	
	Responsibility matrix	
	Milestone chart	
Medium	Scope statement	Progress report
	WBS	Change process
	Responsibility matrix	Change log
	Cost estimate	Gantt chart
	Gantt chart	Cost breaks down
	Risk plan	Risk register
Large	Scope statement	Progress report
	WBS	Change process and log
	Responsibility matrix	Time-scaled arrow diagram
	Cost estimate	EVM
	Risk plan	Risk register

Source: Customized from Project Management Toolbox (Martinelli and Milosevic ,2016)

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1. Conclusion

As to the first section of the survey there was crtical poor project performance noticed in the surveyed enterprice department in year between 2016 and 2020. The performance indicate that only 10% of projects are performed physically as planed and in average there has been doubled project completion duration which is to mean that the project competion time has consumed as double as the budgeted and scheduled base line project compeletion period.

The survey went on to find the relation that exist between the project performance and application of project management tools and techniques. The project performance as to plan targated and performance registered is thoroughly analysed and documented in research survey. The projcet management tools and techniques are similally surveyed as the perception of project management team. Thus the variables, project performnce as dependent and project management tools and techniques as independent variable are correlated and found that there exists strong postive correlation between these variables with sprearman's correlation factor of (R =0.8980 and R =0.8496) for planning and execution process group recipectively.

5.2. Recommendation

This Research has prioritized the main project management tools and techniques as to their relative importance. The surveyed enterprise is noticed to have considerable incosisteny in application of project management tools and tequniques and clealy laks predefined project management procedure.

Based on the finding survey and recommendations from literatures project management tools need not applied just randomly as the case in the noticed in a survey of this case study. Few tools and management methodologies can yield better result than the other if properly applied to specific process group and some are not.

As a result of this research, it has been idetified what and when to use each technique or tool. A total of 10 project mamangement tools were chosen that are considered the most commonly used. Some of these tools are not well known and it has to be practiced in the enterprise since their applicability internationally has shown efficiency in project performance . it is also

recommended to be cost effective if it is alliended with project siz and project management process group,

Project size small and planning phase:

- Work Breakdown Structure, Scope statement, Responsibility matrix and Milestone chart are recommended to be used for small and routine projects at planning process group.

At projectexecution and monitoring phase: for medium and large project size

- Scope statement, Performance report, Work Breakdown Structure (WBS), Checklist, Schedule crashing, Performance Measurement Baseline, Bar chart, Critical Path Method (CPM), Project change request, Milestone analysis, Milestone prediction chart are recommended to be used at Execution and controlling process as well.

This research has dealt with project phyical performance and project management tools and techniques applied in the oromia water works degin and supervision enterprise and recommendation made in the preceeding section is as to this specfic tools to project schedule management that is belived to improve the impact of the project performance thereof. The researcher is further recommeding the other performance dimensions such as cost and quality that would make the internal project performance evalution more comperhended. There is also an other importatnat performance indicator such as client satisfaction that is also the recommendation of the paper for those researcher to deal about it any further.

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APPENDICES

APPENDIX A

Adama Science & Technology University

School Civil Engineering and Architecture

Department of Construction Engineering and Management

Survey Questionnaire

The purpose of this survey questionnaire is to collect data to my thesis entitled as "Impact of Project Management Tools and Techniques on Project Performance: Case in Oromia Water Works Design and Supervision Enterprise" to fulfill the requirement for Master Degree program in Construction Engineering and Management at the Adama Science and Technology University. I can assure you that the research data will be used solely for the research purpose and will be treated with strict confidentiality. Particular mentioning will not be required anywhere.

Jemal Gemeda Hamda

Phone No: +251913633391

Email: jgemeda2@gmail.com

Your open and prompt response is highly appreciated.

Thank you in advance for your support and cooperation!

PART ONE: General Profile (Please put "✓" mark in the box that best describes you)

1. Gender:

□ Female □Male

2. Age group

□ 18 - 27 □ 28- 37 □ 38 - 49 □ 50 and above

3. Type of Organization:

□ Consultant □ Contractor

□Client/Employer □Professional Institution

4. Type of firm ownership

□ Private □Public □Other

5. Educational Background

□ Diploma / Level IV □ First Degree

□Master's □Other

6. How long have you worked at the company or elsewhere?

□ Less than (1) year □5- 10 years

□ 1 -5 years □Above 10 years

7. Position/role in the company you represent:

□ Site Supervisor □Resident Engineer

□ Project Manager □ Office Engineer

8. Name of the organization (Optional) _____

9. Have you had any project management trainings in the last five years?

□Yes □ No

PART TWO: General Questions application of Project Management Tools & Techniques

1. Which of the following Project Management Tools & Techniques, you think, are often applied in project planning phase?

□ Scope Statement □ Feasibility Study Report

□ Work Breakdown Structure □ Risk Mitigations Plan

□Analogous Cost Estimate □ Stakeholder Analysis

□ Gantt Chart Scheduling □ Others

2. Which of the following Project Management Tools & Techniques, you think, are mostly applied in project execution phase?

□ Project Management Information System □ Earned Value Management

□ Interpersonal And Team Skill Management □ Performance Report

□Change Management Project □ Risk Registering

□ Scope Change Control □ Others

3. Which of the following Project Management Tools & Techniques, you think, are often applied in project controlling and monitoring phase?

□ Project Management Information System □ Earned value analysis

□ Schedule Crushing □ Duration and cost trend analysis

□ Testing and Inspection □ Contract administration and supervision

□ Meetings(3C) and decision making □ Others

4.Do you think that Project Management Tools & Techniques program be beneficial to your organization?

. □ Yes □ No

5 Which of the following project management methodology you use while managing the project progress in your organization?

. □ CPM /PERT- Critical Path Method □ Agile project management

□ PRICE2 Project in controlled Environment □ Others

6.How do you measure project performance success?

□ In Project Time Dimension □ Customer Satisfaction

□ By Project Cost □ Other Methods

"PART THREE: Effect of Project Management Tools & Techniques implementation in construction industry on project performance: the case of Oromia Water bureau
Please indicate the degree of your agreement/disagreement with the following statements associated with the performance measures in water supply projects in Oromia: - Please put " ✓ "sign according to your perception on statement given in the table below.

Weight: Always: 5. Often 4. Sometimes 3. Rarely 2. Never 1.

How often do you use the following tools and techniques in project management planning process		1	2	3	4	5
1	Analogous cost estimate					
2	Brainstorming					
3	Contingency plan					
4	Cost baseline					
5	Critical Path Method (CPM)					
6	Milestone chart					
7	Milestone prediction chart					
8	Scope statement					
9	Time-scaled arrow diagram					
10	Work Breakdown Structure (WBS)					

Always: 5. Often 4. Sometimes 3. Rarely 2. Never 1.

How often do you use the following tools and techniques in project management Execution, controlling and monitoring process		1	2	3	4	5
1	Bar chart					
2	Checklist					
3	Critical Path Method (CPM)					
4	Milestone analysis					
5	Milestone prediction chart					
6	Performance Measurement Baseline					
7	Progress Performance report					
8	Project change request					
9	Schedule crashing					
10	Work Breakdown Structure (WBS)					

If you have any comment about Project Management Tools & Techniques in construction projects you are kindly welcome

_____

_____

_____

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_____

Thank You for your Response!

APPENDIX B-1 Reliability Test Using Cronbach's alpha Value

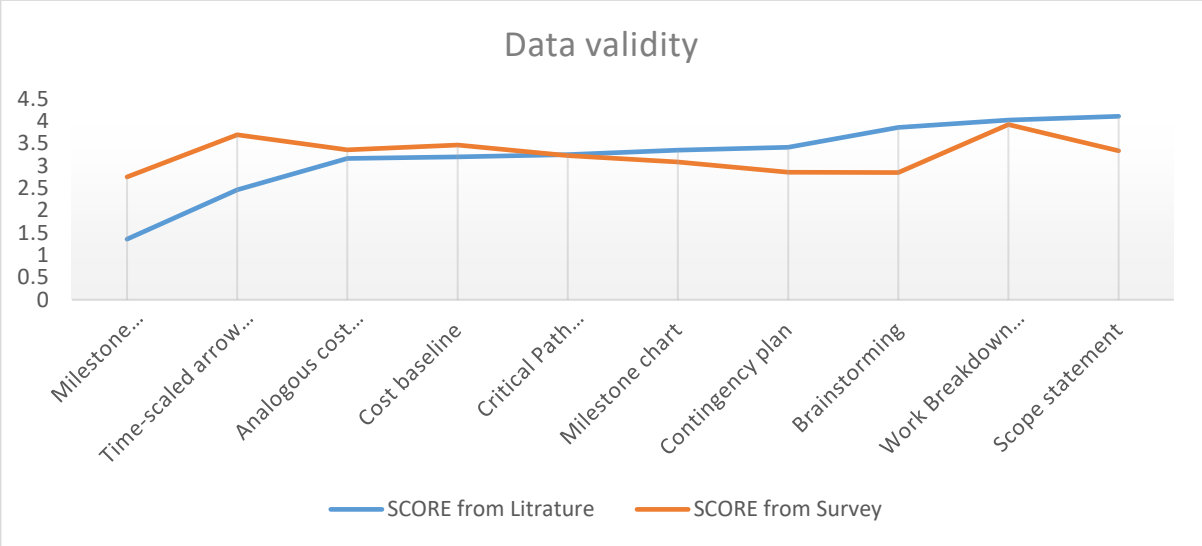
PMTT	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo
Analogous cost estimate	1	4	4	4	4		4	2	4	4
Brainstorming	2	4	1	4	4		3	1	4	3
Contingency plan	2	3	1	4	4		3	1	3	3
Cost baseline	2	3	5	4	5	5		1	3	4
Critical Path Method (CPM)	1	1	1	5	5	3		3	4	5
Milestone chart	2		2	4	4		4	2	4	3
Milestone prediction chart	2		1	4	4		4	1	4	3
Scope statement	3		1	4	5		5	1	3	5
Time-scaled arrow diagram	3	3	5	4	4		5	2	3	5
Work Breakdown Structure (WBS)	3	3	5		5		5	4	3	5
TOTAL	21	21	26	37	44		33	18	35	40

PMTT	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Resipo	Var s
Analogous cost estimate	1	3	4	4	4	5	5	2	1.51
Brainstorming	1	2		5	3	4		3	1.64
Contingency plan	2	2	3	5	4	3	3	2	1.15
Cost baseline	2	4		4	3	5	5	4	1.56
Critical Path Method (CPM)	5	3		2	4	5	5	4	2.40
Milestone chart	5	2	2		3	4	3	2	1.07
Milestone prediction chart	3	2	2		3	4	4	2	1.27
Scope statement	3	2	4		4	4	4	3	1.69
Time-scaled arrow diagram	4	2		3	5	5	5	4	1.18
Work Breakdown Structure (WBS)	4	4	4	3	3	5	5	4	0.73
TOTAL	30	26	19	26	36	44	39	30	72.11

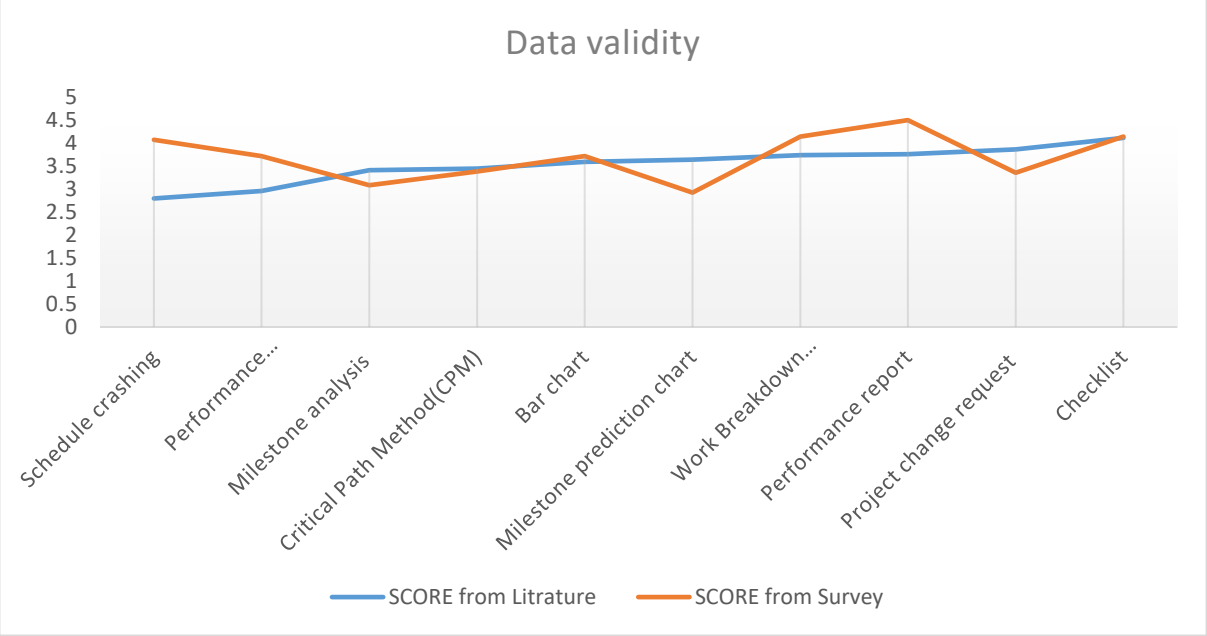
$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum Q}{Q^2}\right)$$

APPENDIX B-2 Validity Test Using previous research Value

PLANNING PROCESS GROUP		
PMTT	SCORE from Litrature	SCORE from Survey
Milestone prediction chart	1.357	2.7500
Time-scaled arrow diagram	2.462	3.6923
Analogous cost estimate	3.165	3.3571
Cost baseline	3.198	3.4615
Critical Path Method(CPM)	3.252	3.2308
Milestone chart	3.35	3.0833
Contingency plan	3.418	2.8571
Brainstorming	3.861	2.8462
Work Breakdown Structure (WBS)	4.025	3.9231
Scope statement	4.108	3.3333



EXECUTIOPN CONTROLING PROCESS GROUP		
	SCORE from Litrature	SCORE from Survey
Schedule crashing	2.796	4.071
Performance Measurement Baseline	2.96	3.714
Milestone analysis	3.408	3.083
Critical Path Method(CPM)	3.446	3.385
Bar chart	3.589	3.714
Milestone prediction chart	3.643	2.923
Work Breakdown Structure (WBS)	3.737	4.143
Performance report	3.762	4.500
Project change request	3.864	3.357
Checklist	4.114	4.143



APPENDIX C-1 Physical Performance of the Project

Year	Less than 10	10 % to 20%	20 % to 30 %	30 % to 40 %	40 % to 50 %
2016	12	9	5	3	2
2017	2	1	2	0	1
2018	1	1	1	1	1
2019	12	6	1	2	1
2020	3	2	1	2	1
Total	30	19	10	8	6
cumulative	151	121	102	92	84
%	19.87	12.58	6.62	5.30	3.97
% Cumulative	100.00	80.13	67.55	60.93	55.63

Year	50% to 60%	60% to 70%	70% to 80%	80% to 90%	90% to 100%
2016	2	1	3	2	3
2017	0	4	6	2	9
2018	1	1	1	4	7
2019	2	1	0	1	11
2020	3	2	2	2	8
Total	8	9	12	11	38
cumulative	78	70	61	49	38
%	5.30	5.96	7.95	7.28	25.17
% Cumulative	51.66	46.36	40.40	32.45	25.17