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Project Management: Key Concepts and Basic Fundamentals

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***Abstract* - Managing projects can be difficult, especially when facing project management with little training or guidance beforehand. In addition to the actual work of project management, such as sorting out the terminology, tools, and methodologies can be discomforting. The basic primary challenge of project management is to achieve all of the project goals and objectives while honoring the pre-defined constraints which are scope, time, quality, and budget. The secondary and most critical challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives. And that will be discussed in this paper along with highlighting the importance of Project teams that play a critical part in the successful management of projects.**

Keywords: Project management, risk management, scheduling network, project plan, agile projects, project teams.

1. INTRODUCTION

Companies and organizations are very likely to face an obstacle every now and then that needs a change. Like taking in a new project, introducing a new service or product, using a different system or materials, upgrading an existing work process, moving to a new site, extending their branches, and so. All these changes require adjustments in order to meet an organization's operational or strategic objectives. And projects are used to achieve these objectives [1].

And projects are the instruments, by which this can be accomplished, for an organization or a company to reach its strategic goals [1].

Based on the nature of the business, organizations create and execute projects (internally and/or externally funded). Efficiency in project management is how the amount of real profit is increased in organizations that perform externally funded projects for a fee (of sorts) on behalf of external clients. When the organization's principal line of business is service, manufacturing, or research, the projects are most likely internally funded, and the project teams' tasks are to improve operational efficiency. Internally funded projects can contribute significantly to the profit margin [2].

Project management is a specialized career that has its own concepts, skills, and tools. Good project management is based on understanding basic project management [2,3].

2. HISTORY

Since the beginning of the 1990s writers have introduced terms such as “modern project management”, “management by projects”, projects (project management) culture” and “beyond the Gantt chart” to distinguish contemporary and future forms of project management (PM) from traditional and past forms. Such terms, in part, propose the existence of a discipline, referred to in the remainder of this paper as “emergent PM” that is characterized by Fangel [4] as being “broader in its application, concepts and methods than traditional PM”.

The common thread joining these terms together is a belief that the theory and practices of PM have fundamentally changed over the past decade. The chief concern of writers who describe these changes in the discipline is the need to ensure that PM remains a useful management tool for practitioners in today's business environments [4]. Writers suggest that to stay relevant and useful the academic discipline of PM must be updated to reflect changes in practice. For example, in reporting on a study of the effectiveness of planned and emergent PM styles of leadership, Lewis et al.[6] conclude that in the “tough, dynamic and demanding” world of new product development projects, traditional models proposing an either/or style of PM are no longer appropriate. Likewise, in outlining the inadequacies of traditional forms of PM in today's global markets, which are characterized as being “saturated, hyper-competitive and fast-moving”, Maylor [5] states that a new set of normative models of PM practice and performance are needed in place of the traditional models.

At the same time, as project-scheduling models were being developed, technology for project cost estimating, cost management and engineering economics was evolving, with

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pioneering work by Hans Lang and others. In 1956, the American Association of Cost Engineers (now AACE International; the Association for the Advancement of Cost Engineering) was formed by early practitioners of project management and the associated specialties of planning and scheduling, cost estimating, and cost/schedule control (project control). AACE continued its pioneering work and in 2006 released the first integrated process for portfolio, program and project management (total cost management framework) [5,6].

3. WHAT IS THE DEFINITION OF A PROJECT?

A project is defined as a short-term undertaking to generate a unique product, service, or outcome. According to Project Management Institute, a project is "a temporary endeavour undertaken to create a unique product, service, or result." Temporary means that a project has a clear beginning and end [7].

A project is a novel time-bound effort that entails numerous linked and/or interdependent tasks in order to generate a unique product or service with added value. Because it is a new initiative, we often lack complete knowledge and experience in planning and executing the intended project. New projects are characterized by unknown circumstances that are invariably present in different projects, delaying the development of formal scope and requirements to later phases of project planning. Any project requires the use of resources such as materials, tools, equipment, and human resources to be completed. Considering these extra aspects of a project and broadening the scope of a project, a project is a sophisticated, non-routine, one-time endeavour that is constrained by time, budget, resources, and performance standards to meet customer needs and deliver value to all key stakeholders [8,9].

4. WHAT ARE THE DIFFERENCES BETWEEN A PROJECT AND A PROCESS?

It's important to know the difference between a project and a process. A process is repeatable that has well-defined procedures and outcomes. Whether it's a product or a service, a process will provide the same result. By definition, a project, on the other hand, is unique and new.

As a result, the project's outcome will always be new, original, and unique. Project management processes and project deliverable-oriented processes, on the other hand, both are used to carry out the project [10].

Projects are always designed to meet organizational objectives and/or strategic needs, such as market demand, customer requests, technological advancements, legal requirements, social needs, crisis, etc. [10].

5. SPECIFICATIONS OF THE PROJECT

There are five important characteristics of a project:

i. It should always have specific start and end dates.
ii. They are performed and completed by a group of people.
iii. The output is the delivery ofa unique product or service.
iv. They are temporary in nature.
v. It is progressively elaborated.

"Temporary" does not apply to the project deliverable, though [11,12].

6. PROJECT MANAGEMENT

Identifying needs, setting clear and attainable targets, balancing competing demands of quality, scope, money, and time, and adapting specifications, plans, and strategy to satisfy the expectations of all key stakeholders, including the client and end-user, are all part of project management. Some describe project management as the art and science of efficiently and successfully combining experience, knowledge, skills, tools, and strategies to meet stakeholder expectations.

Organizations are managing multiple projects at the same time, according to current project trends.

Long-term project management success necessitates the use of proven and established project management methods and processes, as well as the replication of numerous successful projects [8,9].

Project management tools are becoming more complex and useful. Identifying needs and defining clear and attainable objectives are all parts of project management.

- Balancing the needs of time, money, scope, and quality
- Meeting all stakeholders' expectations

As a result, project management is a strategy for achieving project goals. Internal projects must be completed within organizational structure and resource constraints. Political, social, legal, and environmental constraints may need to be considered for external initiatives.

A project requires the continuous engagement of numerous functions. Integration, coordination, and responsibility are obviously more important. These integration and management functions will be aided by project management tools and techniques. Uncertainties and unknowns cause requirements to alter more often, and the project manager must meet these demands while still meeting the expectations of all project stakeholders [11,12].

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To summarize, Project management means exactly what the two terms suggest. It is effectively working to coordinate and manage individuals to work towards a common goal or objective to complete a task. Project management requires that one apply their personal knowledge, skills, tools, and techniques towards activity to meet the requirements of a project assigned. Project management involves planning, scheduling, and controlling all the combined activities in order to ensure the successful completion of project objectives. Project management is broken into 5 basic phases. (Figure 1) [13].

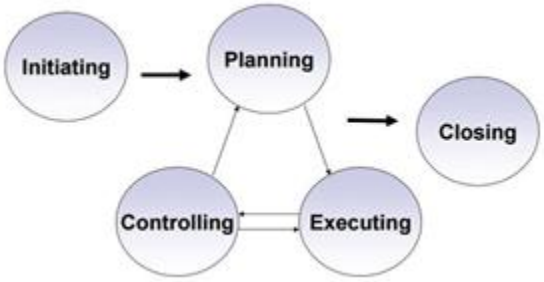

Figure 1: project management process phases

6.1 Conception and Initiation

Project conception and initiation is where the project starts. This is where someone determines if the project can be realistically completed and if the benefits of doing it make it worth the effort to move forward with the project. The concept and initiation phase are also where you determine what you are going to do to meet an objective and how you are going to do it.

For the software project, you realize this is already in the contract the customer signed, and you simply must understand it [13].

6.2 Definition and Planning

The concept and initiation phase are very broad, leaving many details unplanned. To further define it, the definition and planning phase digs into project specifics. A project team defines the tasks, calculates a budget and schedule, determines what resources are necessary, and defines acceptance and testing criteria. All this information is put into a project plan, which is reviewed and approved by the customer. The definition and planning stage ensures everybody has the same expectations, preventing unexpected and often costly mistakes.

For your software project, you realize that the definition and planning phase is where project management will add true value to the success of the contract because the overall concept in the contract is refined into a working plan that lays out, in detail, project expectations. Any concerns can be worked through at this stage before any tasks have been started [13].

6.3 Execution

The execution of the project is where tasks are assigned and completed. This is the phase where you build the product or deliver the services for the customer. In most projects, this is the phase that lasts the longest and takes up most of the project team's energy. This phase is dependent on good planning done in the previous two phases because the plans previously developed are put into action [13].

6.4 Performance and Control

While a project is in execution, performance and control ensure that the deliverables are produced as specified, at the cost estimated, and on schedule. During this phase, project managers compare 'what is' to 'what should be' and adjust the plan if needed. If the project isn't monitored, the costs could exceed profit and the company would not make money, the schedule could get off track without anyone realizing it, or the product could fail to meet agreed-upon criteria.

In looking at this phase as it relates to your software project, you realize that this is an important phase to both the customer and the company because it ensures the customer is happy with the results and the company makes a profit [13].

6.5 Closing

Closing is the phase where the customer formally accepts the project deliverables. By accepting the deliverables, the customer is saying that the product meets the criteria and expectations and that work on this project is over.

Closing isn't just for the customer. The project team should learn from the project's successes and problems, taking the time to document the lessons learned for future reference and that’s called Post Implementation Review [13].

7. PROJECT LIFE CYCLE

No matter what the specifics of the project, every project has a project life cycle. The project manager must successfully understand and navigate through each phase of the project life cycle to ensure successful project completion. There are four phases in every project life cycle. The first phase is the concept phase. This is the phase where hard evidence such as graphs, charts, statistics, and other hard data is analyzed to help with successfully completing the process. The next phase in the project life cycle is the planning phase. In this part of the project life cycle, the project team along with the project manager decides how to best complete the project and

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develops a plan for that completion. The following phase is the execution phase. This is the part of project management where the plan for completion is carried out. The final phase of the project life cycle is the closeout. In the closeout part of the phase, the project comes to an end and the project team parts ways to complete other projects waiting in the wings [13].

8. WHY HAS PROJECT MANAGEMENT BECOME A NECESSITY?

8.1 Project management is quickly becoming a typical method of carrying out business strategies.

The reasons for that:

- Knowledge economy.
- Increasing competition because of the free-market mindset.
- Cost, time, and scope (quality) restrictions.
- Client focus.
- Resource constraints.

PM (project management) allows for more effective and efficient resource utilization. PM also allows senior management to become aware of the organization's strengths and flaws.

PM requires policy, practice, and procedure adjustments in many businesses. It will influence the function of finance because project-based financial control systems are routinely implemented [14].

8.2 Strategic alignment: Organizations use projects to achieve their strategic objectives and aims.

Accountancy, sciences, economics, finance, and management are just a few of the academic areas that make up project management. It integrates various disciplines using a systems approach. Because it is how business is done in the current global economy, PM will continue to increase in relevance [14].

The business strategy plan and investment strategies should guide project selection.

As a result, each project must have a business goal that is in line with the strategic plan; this will serve as the basis for the project investment proposal.

Moreover, a project must serve a larger purpose than a set of internally determined goals. To be effective, the project manager and teams must have a thorough understanding of their client's vision and goal; this understanding will increase the likelihood of delivering products and services that fulfill stringent customer requirements, resulting in customer satisfaction [14].

9. PROJECT PERFORMANCE DRIVERS

Projects are new by definition and learning something new is linked to a change in behavior. As a result, project teams must be capable of working in groups, integrating, learning, and cooperating. As a result, excellent communication is critical to the company's success. The larger the project sizes get; the more difficult communication will be [14].

The following have been recognized as significant determinants of project performance and are also termed success factors. It's the responsibility of the project manager to:

1. Knowledge of technology in relation to project products.
2. Understanding Management concepts.
3. Interpersonal skills for clear communications that help get things done.
4. Ability to see the project as an open system and understand the external-internal interactions.
5. Define project processes and roles.
6. Generate trust.
7. Manage outcomes.
8. Convey objectives and outcomes to all stakeholders.

However, keep in mind that project success criteria fluctuate depending on the stakeholders. A project, for example, maybe regarded as successful by the client despite time and expense overruns [14,15].

10. PROJECT SUCCESS AND PROJECT MANAGEMENT SUCCESS

It's important to understand the difference between project success and project management success. Project success is determined by accomplishing the overall project objectives, whereas project management success is determined by keeping the project on track in terms of time, money, and scope [14].

Project success is a multi-dimensional construct that can mean different things to different people. It is best expressed at the beginning of a project in terms of key and measurable criteria upon which the relative success or failure of the project may be judged. For example, some generally used success criteria include:

- Meeting key project objectives such as the business objectives of the sponsoring organization, owner, or user

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- Eliciting satisfaction with the project management process, i.e., the deliverable is complete, up to standard, is on time and within budget
- Reflecting general acceptance and satisfaction with the project's deliverable on the part of the project's customer and most of the project's community at some time in the future [14].

11. MANAGEMENT OF THE PROJECT'S SCOPE

The scope of the project must cover all the work that is needed [8].Scope management is the process of defining and controlling the scope of a project. It takes precedence over all other aspects of project management knowledge. The scope should specify what should and should not be planned, budgeted, staffed, and performed for the project. The boundaries separating omitted activities or resources from those that must be included for project execution are also defined by the project scope [8].

The project's scope changes frequently throughout the duration of the project as a result of the unknown circumstances that are unpredictable.

All these changes will have an impact on the scope and management of the project.

A clearly defined scope is critical for producing a project plan, which serves as a foundation for controlling the project's schedule, budget, and detailed work. Progress can't be tracked unless without having a clearly defined scope.

The project manager and an early-stage project team begin scope management by generating a preliminary scope statement based on the project charter once the project has been started. The preliminary scope statement formalizes a contract between the project and its customer, quantifying project/product goals and defining precise deliverables [8].

While the preliminary scope statement establishes goals at a higher level of abstraction, these goals must be stated as precisely as feasible before clear timetables, budgets, and work plans can be produced during the project management life cycle's planning phase [16].

At this stage, only historical data and expert opinion are available are used to generate a set of requirements that will guide project execution within the restrictions and assumptions of the current project. This set of criteria serves as the foundation for scope definition, which breaks down the project's primary deliverables into smaller, more manageable chunks. It's critical to turn the client's objectives into specifications, which indicate finality and a clear definition of project results with specified quality metrics and measures.

This preliminary scope statement document establishes numerous product performance objectives, defines the first project organization, boundaries, assumptions, and limitations, and includes a high-level work breakdown structure (WBS) and cost estimates in order of magnitude [2,10].Figure 2 shows an example of a deliverable-oriented WBS (work breakdown structure).

As the project continues through the planning phase, this preliminary will be modified into a formal scope declaration. WBS is the result of this refinement. It serves as the foundation for the scope management plan, which outlines how objectives and deliverables will be managed, as well as how scope changes will be included in the project [17].

12. WHAT IS EXACTLY THE WORK BREAKDOWN STRUCTURE (WBS)?

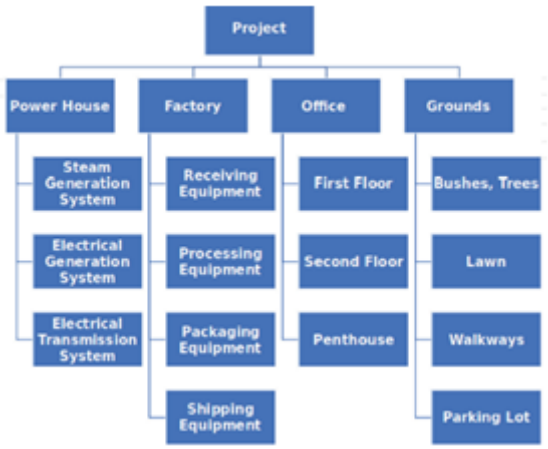

Figure 2: WBS (work breakdown structure)

The work breakdown structure (WBS) is a tree structure that shows a subdivision of the activities required to achieve an objective – for example a portfolio, program, project, and contract. The WBS may be hardware-, product-, service-, or process-oriented. Besides WBS for project scope management, there is an organizational breakdown structure (chart), cost breakdown structure and risk breakdown structure.

A WBS can be developed by starting with the end objective and successively subdividing it into manageable components in terms of size, duration, and responsibility (e.g., systems, subsystems, components, tasks, sub-tasks, and work packages), which include all steps necessary to achieve the objective [18].

The work breakdown structure provides a common framework for the natural development of the overall planning and control of a contract and is the basis for dividing work into definable increments from which the statement of work

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can be developed and technical, schedule, cost, and labor hour reporting can be established. The work breakdown structure can be displayed in two forms, as a table with a subdivision of tasks or as an organizational chart whose lowest nodes are referred to as "work packages".

It is an essential element in assessing the quality of a plan, and an initial element used during the planning of the project. For example, a WBS is used when the project is scheduled so that the use of work packages can be recorded and tracked.

Similarly, to Work Breakdown Structure WBS, other decomposition techniques and tools are Organization Breakdown Structure OBS, Product Breakdown Structure PBS, Cost Breakdown Structure CBS, Risk Breakdown Structure RBS and Resource Breakdown Structure ResBS[18].

13. MANAGEMENT OF EXPENDITURES

WBS lists all project activities that must be completed, but it does not include time, resources, or cost estimates. WBSs should be created at a higher level at first, and then expanded to include more specifications as the project's requirements change. The next step is to create the first two or WBS, which lists all project tasks to be completed but does not contain time, resource, or cost estimates. WBSs should be created at a higher level at first, and then expanded to include more specifications as the project's requirements change. The first two or three levels of the WBS, which effectively comprise deliverables, will be developed as a future phase. These higher-level work aspects are divided into four categories The list of job packages is both comprehensive and exhaustive [10].

The WBS is divided into three levels, each of which contains deliverables. These higher-level concepts work is divided down into smaller and smaller work packages so that you may focus on what you do best [2].

At any point in the project, you can have manageable tasks to complete. The list of job packages is both comprehensive and exhaustive. These responsibilities should, ideally, be completed in a timely manner be at or below level 3 Remember that a solid WBS promotes a systematic planning process, lowers the likelihood of critical project task aspects being overlooked, and divides the job into digestible sections, making it easier to handle [2, 10].

14. COST MANAGEMENT

As the project continues through the planning phase, this preliminary will be modified into a formal scope declaration. WBS is the result of this refinement. It serves as the foundation for the scope management plan, which outlines how objectives and deliverables will be managed, as well as how scope changes will be included in the project [17].

15. ESTIMATING COSTS

We'll need the following information to estimate the cost of a work element:

- Required resources (people, equipment, tools, and materials)
- Timeframe for use (time unit)
- Time unit's cost rate

The duration of materials absorbed for the completion of the work may not be relevant. The cost of each resource is estimated by multiplying the number of resources by its duration and the rate. You may estimate the activity cost by adding all the resource costs together. To calculate the entire projected project cost, we add all the project's activity costs together [17].

During the project execution phase, these costs must be managed and controlled along with the timetable [2, 17].When all the elements of the WBS have been recognized with a fair degree of certainty and the resource breakdown structure (RBS) has been specified with the appropriate degree of certainty, the most accurate and trustworthy estimate for a project can be created. This estimate is known as a bottom-up estimate since it is produced from detailed information in the WBS and RBS at the time of the estimate. The Resource Breakdown Structure (RBS) is related to the Work Breakdown Structure (WBS).

By resources, we mean anything that will cost money to get and is required for the project's completion (labour, materials, equipment, etc.). The RBS hierarchy is based on the WBS, and we can categorize resources into broad categories such as:

- Individuals
- Tools, machinery, and fees and licenses
- Materials and installed equipment

RBS must be accurate and dependable to be valuable; hence it must be updated on a regular basis. The following is an example of RBS (Figure 3) estimates that are detailed and reliable and require a lot of definitive information about the project. Furthermore, the estimating work necessitates a significant amount of time and effort. As a result, a balance must be struck between the time spent estimating, the accuracy of the results, and the level of accuracy expected by the stakeholders at the project's current stage. Various

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methods and tactics for project cost estimation are recognized by project management approaches.

	Unit of Measure	Cost/Price (Dollars)
R100 Development Staff		
R110 Server Development Personnel		
R111 Systems Analyst	Staff Hour	$70
R112 Application Analyst	Staff Hour	$60
R113 Systems Programmer	Staff Hour	$50
R120 Database Development Personnel		
R121 Data Base Administrator	Staff Hour	$75
R122 Sr. Data Design Specialist	Staff Hour	$65
R123 Data Design Specialist	Staff Hour	$60
R130 Client Development Personnel		
R131 PC Systems Analyst	Staff Hour	$65
R132 PC Systems Programmer	Staff Hour	$55
R140 Network Development Personnel		
R141 Infrastructure Analyst	Staff Hour	$85
R142 Infrastructure Engineer	Staff Hour	$80
R143 Network Engineer	Staff Hour	$70
R200 Product Assurance Staff		
R210 Quality Assurance Personnel		
R211 Sr. QA Specialist	Staff Hour	$65
R212 QA Specialist	Staff Hour	$45
R220 Requirements Management Personnel		
R221 Requirements Manager	Staff Hour	$65
R222 Requirements Specialist	Staff Hour	$45

Figure 3: RBS example

Analogous estimating is a top-down strategy in which managers make estimates based on expert judgment, data from previous projects, industry benchmarks, and published or own research sources. This method is usually less precise than bottom-up estimations, but it may be developed faster and for less money [17].

To predict costs, parametric estimating uses mathematical models. Specialized computerized estimating tools may be used as part of these strategies. Specific measures, such as cost per line of code and building cost per square foot, may be applicable to a specific industry sector.

Bottom-up estimating is a process in which the cost and schedule estimates are created by the people and other resources assigned to the task. This technique gets the most out of the performing team, and it works best when the team has the right subject matter expertise (domain-specific knowledge) and enough experience to forecast duration estimations properly. This method is the most accurate of all the estimates. Below is an example of a bottom-up estimate (Figure 4) [2, 17].

	Unit	Intensity	Duration (Days)	Total (Staff Hours)	Unit Cost	Extension
000 System						$2,426,780
100 System Code						$966,400
110 Server Code						$373,100
111 Server Source Code						$345,600
R121 Data Base Administrator	Staff Hour	1	100	800	$75	$60,000
R122 Sr. Data Design Specialist	Staff Hour	1	125	1000	$65	$65,000
R123 Data Design Specialist	Staff Hour	3	125	3000	$60	$180,000
R241 Test Manager	Staff Hour	1	10	80	$70	$5,600
R242 Sr. Test Engineer	Staff Hour	1	25	200	$65	$13,000
R243 Test Engineer	Staff Hour	1	50	400	$55	$22,000
112 Server Object Code						$27,500
R121 Data Base Administrator	Staff Hour	1	6	48	$75	$3,600
R122 Sr. Data Design Specialist	Staff Hour	1	12	96	$65	$6,240
R123 Data Design Specialist	Staff Hour	1	24	192	$60	$11,520
R231 Sr. CM Specialist	Staff Hour	1	5	40	$65	$2,600
R232 CM Specialist	Staff Hour	1	10	80	$45	$3,600
120 Client Code						$139,200
121 Client Source Code						$124,500
R131 PC Systems Analyst	Staff Hour	1	75	600	$65	$39,000
R132 PC Systems Programmer	Staff Hour	2	75	1200	$55	$66,000
R241 Test Manager	Staff Hour	1	5	40	$70	$2,800
R242 Sr. Test Engineer	Staff Hour	1	12	96	$65	$6,240
R243 Test Engineer	Staff Hour	1	24	192	$55	$10,560
122 Client Object Code						$14,600
R131 PC Systems Analyst	Staff Hour	1	6	48	$65	$3,120
R132 PC Systems Programmer	Staff Hour	1	12	96	$55	$5,280
R231 Sr. CM Specialist	Staff Hour	1	5	40	$65	$2,600
R232 CM Specialist	Staff Hour	1	10	80	$45	$3,600

Figure 4: Bottom-up estimate

After all work packages' costs have been calculated, supplemental information documented, and cost accounts assigned, the costs are rolled up to the highest level of the WBS to establish the project cost. This is a method of gradually adding up the work package estimates until they reach higher levels of detail [17].

16. TIME MANAGEMENT

Time management is essential to ensure that the project is completed on time, and it is divided into six components, five of which occur during the planning phase of project lifecycles:

- Activity Defined: Identify and document actions that result in WBS items
- Activity Resource Estimating: determine what and when resources quantities are needed
- Activity Duration Estimating: develop activity durations from scope and resource information
- Schedule Development: determine the start and finish dates for activities
- Schedule Control: manage and control changes to the schedule

The following are examples of scheduling tools in general:

- Flowcharts.
- Bar (Gantt) Charts.
- Network Diagrams.
- Milestone Charts.

The network diagram, which shows the interdependencies of all jobs and illustrates the project's process, is the most important of these [17,20].

17. DIAGRAM OF A NETWORK

Because of their emphasis on activity dependencies, network diagrams have become the de facto norm for developing project schedules. They display entire projects, or subprojects, as visual maps that depict tasks in the order in which they must be completed. These diagrams can be created in any of the following two ways:

- Activity-on-Arrow (AOA), also known as Activity-on-Line (AOL) or
- Activity-on-Node (AON) also called Precedence Diagram Method (PDM).

Due to the increased memory required to program the fake activities, AOA diagramming is almost never found in today's popular software products [17, 19].

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18. DIAGRAMMING OF ACTIVITY ON THE NODE (AON)

AON, or precedent diagramming, was developed particularly to "do away" with the dummy activity. The arrow represents "precedence" in this diagramming; it simply defines which action must be finished before the next can begin, with the arrowhead signifying the flow direction through the network. In previous diagramming, the arrow does not reflect completed work.

Work is instead expressed on the network's node - in this case, the node is represented by a rectangle with the name of the activity within it. Other data, such as early start, early finish, late start, late finish, duration, cost, and so on, can be inserted into the rectangle node. Precedent diagramming has become popular in the IT industry its predominant form of network diagramming.

Accepted practices and rules

Network diagramming is a key scheduling tool for any programmer.

Manager of the project: There are a few universally applicable rules, or recognized practices [17 -19].

19. DIAGRAMS OF NETWORKS, HOW TO?

1. An arrow is a straight line, and the precedence arrows may have right angles. They have angles incorporated into them. All such bent arrows must be bent according to good technique. At right angles, and only at right angles, so that we can plainly see what the problem is the bending was deliberate.
2. An arrow is always pointing in one direction, with the arrowhead indicating the direction. Each arrow must have an arrowhead to show its direction.
3. The arrows commonly cross one other, but with good practice, they may be avoided. Arrows will cross in front of each other at right angles. The purpose of this is to help us follow the arrows without getting side-tracked onto another arrow.
4. Arrows in well-formatted network diagrams can be drawn from left to right, up, or down on the paper. If there are no arrows, it's safe to assume that the actions are carried out from left to right.

Every project has a single, and only one, starting point, as well as a single, and only one, finishing point. This is simple in the AOA format, but it is a common practice in AON networks that is frequently broken. In AON formats, this mistake can be fixed by adding two more nodes, one named "start" and the other labeled "end." Then, from the start node, all of your initial activities will be started, and all of your hanging activities will be linked to the end node. Of course, the duration of both the start and end nodes will be zero.

PERT (Program Evaluation Review Technique) focuses on meeting activity time estimates.

Schedules with cost flexibility can only be drawn on an AOA diagram, and as a result, dummies are possible [17, 20-21].

20. ACTIVITY DURATION ESTIMATING

1. Each activity has three different estimates: optimistic (O), pessimistic (P), and most likely (M) (M)
2. PERT uses the following equation to compute an anticipated time:

   (P + 4 M + O)

3. A Beta Distribution can be described using these estimates. You're most likelyare you familiar with the Normal Distribution (which looks like a bell and is used in statistics)?

Quality Management (Six Sigma). The form of a Beta Distribution differs from that of a Normal Distribution.

This distribution has a long tail, which differs from a normal distribution in which the m is an equal distance between the a and the b and represents the 50/50 mark of the distribution (50 percent of sample times falls to the left of m and 50 percent of sample times falls to the right of m) [17, 20].

21. METHOD OF THE CRITICAL PATH (CPM)

Although the term "critical path" is used in this technique, it does not apply to the process of discovering the critical path. It is a method of estimating based on a single time estimate for each task.

- The critical path is the network diagram's longest path, and there may be more than one critical path.
- Allows you to detect potential "off-schedule" spots in the project as well as slack or "float time" that allows you to postpone some tasks that are not vital [17, 20, 21].

22. SIMULATION WITH MONTE CARLO

This method produces a project duration that is more accurate than CPM or PERT. This method, which does not employ the PERT formula, uses computers to simulate the outcome of a project based on PERT estimates and the network diagram.

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Simulation can give you the likelihood of finishing the project on a specific day, for a specific cost, the likelihood of any work being on the critical path, and the overall project risk [17].

The network diagram depicts the order in which workpieces must be completed for the project to be completed. It's worth noting that the first stage of network diagramming doesn't necessitate time or expense estimates. We just find the most logical and technically feasible strategy to complete the project and display it using the network format. You should keep in mind that the logic of the initial network diagram is driven solely by work-related restrictions; you should not incorporate resource or time constraints at that moment (17).

You can assign resources to each activity and produce first task time estimates once the network exhibiting a logical flow of work items in the project is developed. The critical path and slack periods are calculated using these estimates, which are then aggregated across the network these estimates are then aggregated across the network to calculate its critical path, and the slack times associated with each activity.

These calculations use a forward pass to determine the earliest start and end times. Times for each activity, followed by a backward pass to establish the most recent start and finish times.

The activity's end times. Then there's the time discrepancy between the first and last times.

All activities with zero-length slack times represent the project's crucial path(s) [18-20].

23. QUALITY MANAGEMENT

The practices required to guarantee that projects meet the needs for which they are undertaken are referred to as quality management. These procedures should ensure that the project adheres to the agreed-upon standards. During both project planning and implementation, quality management necessitates an accurate assessment of stakeholder needs and requirements. It's crucial to remember that rather than being inspected in, quality must be planned. Without proper quality control, projects run the danger of incurring additional expenditures while also jeopardizing project team morale and client satisfaction.

Some quality management tools and techniques are used to project outputs (products and tangible deliverables) and project management procedures in quality planning. This is a critical distinction to grasp [16].

- During the planning phase, when requirements and specifications are developed, the quality of project outcomes (deliverables or services) is determined.

During the project execution phase, we apply quality assurance and control methods as we generate these project deliverables. The project manager and the project team are largely responsible for this aspect of quality.

- The organization's knowledge and maturity in managing projects have an impact on project management process quality. The project manager and the project team, on the other hand, are responsible for ensuring that quality assurance is implemented properly.

When planning quality, one of the most critical responsibilities a project manager must focus on is defining quality and how it will be monitored (i.e., what determines Project Success?). Remember to incorporate both quantitative (benchmark specifications, experiments, and financial/cost metrics) and qualitative (subjective judgment) metrics while constructing these measures.

Non-conformance or failure costs are included in the cost of quality, as are conformance costs (both preventive and appraisal) (both internal and external). Nonconformance expenses are typically higher [16].

Quality Assurance is the process of regularly evaluating overall project performance to ensure that the project will meet the applicable system of quality standards.

Quality Control is keeping track of individual project outcomes to see if they meet certain quality criteria and figuring out how to fix any problems that arise. Quantitative analysis is used for specific processes and project protocols during Quality Control.

When processes deviate from predefined parameters, changes must be made quickly to bring the operations back into compliance with project-defined quality requirements. The following are examples of quality control tools:

- Process stability is determined by control charts.
- Cause and Effect Diagrams: Shows how different factors can lead to problems or effects.
- Pareto diagrams: Shows the number of flaws by category and cause.
- Statistical sampling: This method reduces a study's population to a representative sample.
- Run Charts: Display the variation's history and pattern.
- Trend analysis: Determines the extent of non-conformance over time.

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It is critical that you comprehend how these technologies work. Most of these tools are not project-specific. They were created and used in continuous manufacturing environments to improve goods and processes [16].

24. RISK ASSESSMENT

Risk refers to being exposed to a scenario that is likely to result in a negative outcome. A project risk is an unforeseen event or set of circumstances that, if realized, has a positive or negative impact on at least one of the project's goals. A risk could result in either a loss or gain. If left handled or neglected, the negative risk could obstruct the project's effective completion, resulting in time and expense overruns, as well as a reduction in the product or service's quality. A project's risk is inherent because it is a new endeavor with unknowns and uncertainties. In general, taking a risk when trying something new is unavoidable.

It's critical to distinguish between a risk and a problem. A problem has been detected and is currently known, and it is a specific event. As a result, an instant remedy is required [15,16].

A risk is an event that is likely to happen in the future. Even if a risky event occurs, the consequences remain unknown. A risk is an incident that is either known or unknown. Problems that have not yet occurred are referred to as risks. If a risk is not prepared for or managed properly, it might become a problem. The occurrence and evaluation of project risk is a combination of an unplanned or unwelcome event, its likelihood of occurrence, and its influence on project execution. The basic parts of risk planning include identifying, assessing, and responding [14, 15].

25. RISK MANAGEMENT

Project risk management is unavoidable and critical to project success. Throughout the course of a project, risk management is the art and science of identifying, analyzing, and responding to risk factors in the best interests of project objectives and metrics for project success. The goal of risk management is to take a systematic approach to address project hazards. Risks can lead to project failure in terms of cost, scope, and project deliverables if they are not addressed comprehensively and properly. The purpose of risk management is to maximize the positive outcomes of favorable events while minimizing the negative outcomes. The sources of a project's risk can be deduced from the risk breakdown structure (Figure 5) [14, 15, 17].

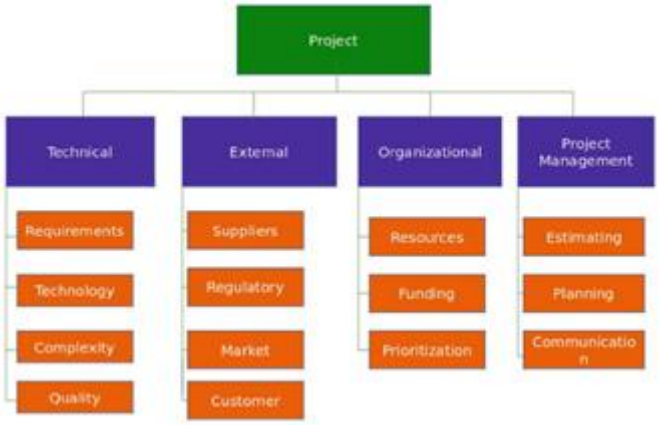

Figure 5: risk breakdown structure

The influence of risks on project objectives such as financial targets, timely and successful completion of the project determines whether a formal or informal strategy to planning and managing risks within a project is used. It is, nonetheless, important that we do recognize the risk management method that has been defined. Taking a more formal approach.

The PMBOK defines risk management as "the process of identifying, assessing, and managing risks."

1. Make a risk management strategy.
2. Recognize dangers.
3. Conduct a qualitative risk assessment.
4. Conduct quantitative risk analysis.
5. Devise risk mitigation strategies, and
6. Maintain control.

Hazards. The first five of these processes will be the subject of this learning lesson [14,17].

Various approaches to Risk management entail:

- Accept: take on the risk of potential harm.
- Mitigate: devise countermeasures.
- Transfer: reassign the risk to another person.
- Don't do it: choose a completely different strategy.

The risk management strategy is a complicated process that is influenced substantially by the organizational and project environment, the performing organizations' cultural and operational styles, as well as management and other project stakeholders' individual perspectives and risk tolerances. It's vital to understand management and stakeholder risk tolerances: customers, sponsors, and senior management are all likely to have different ideas about what constitutes acceptable risk.

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Each of the concerns should be addressed in a way that is appropriate to the individual project and its unique environment in the risk management plan [14, 15, 17].

26. PROJECT TEAMS AND THEIR IMPORTANCE

Projects are carried out in groups. Projects are typically handled by teams in a complicated work environment for two reasons: first, each project is unique, and second, team selection and motivation circumstances are frequently far from ideal [22].

Unfamiliarity is frequently defined as one of the qualities of projects, in addition to distinctiveness and complexity, and as a result, projects are frequently connected with change. Hence effective project management necessitates strong leadership with vision and the flexibility to adapt to change [22].

Projects are one-of-a-kind and are frequently accompanied by unknowns and uncertainties. It's acceptable to presume that in project management, the question isn't whether the plans will change, but when, what will change, and how much will change. Change is the one thing that is constant throughout a project. When a project undergoes substantial changes, as is frequently the case, the leadership role becomes even more important. Leadership efforts are focused on persuading individuals to change, aligning them with a new direction, and motivating people to collaborate to achieve project objectives in difficult and demanding work conditions [16].

Motivating the project team entails convincing team members to complete duties not because they must, but because they see the importance of their contributions to the project's overall success and want to do so. If people desire to do what we need them to do, their dedication will almost certainly be higher, and the job will almost certainly be completed far more efficiently than if they are forced to do the work [16].

Project managers must be aware of and supportive of project team members' personal goals. The project manager's leadership abilities are critical in encouraging and guiding the project team to achieve project goals while growing as professionals, in essence, project managers must ensure that both personal and project objectives are met, as well as that the dispute is resolved. The distance between these two objectives is kept to a minimum [16].

The project manager's role is to persuade people to perform what he or she requires. They should do it because they want to, not because they are obligated to. Empowerment means giving individuals the freedom (not the control) to do what they choose.

What it is that they wish to do? This is not the same as forcing people to do what you desire them to complete [16].

On projects, empowerment makes sense. Most projects make use of a comprehensive approach necessitating the participation of subject matter specialists from several functional areas Each person brings to the project their own set of skills and experience.

Team allowing members of the project team to make decisions and define goals [17].

Traditional or plan-driven project management takes a transformational approach. It is founded on the following principles: conducting the project as planned, utilizing the execution, monitoring, and control strategy Measures are included in the proposal to keep track of progress and completion [22]. The traditional or plan-driven approach is appropriate when the scope and deliverables can be explicitly defined. In this case, Uncertainties and unknowns may still exist, but they are unlikely to provide a challenge or derail the project's deliverable. If a project is complex and time-sensitive, however, the classic or plan-driven project management technique may be challenged. There have been significant changes [22].

When a project's deliverables aren't fully understood, or when a project's deliverables aren't fully understood, when a project is linked to rapid technical developments, or when a project is associated with fast-paced technological advancements, how much, and by how much Change is the one thing that is constant throughout a project. When a project undergoes substantial changes, as is frequently the case, the leadership role becomes even more important. Leadership efforts are focused on persuading individuals to change, aligning them with a new direction, and pushing people to collaborate to meet project objectives in difficult and demanding work conditions [18,22].

27. CONCLUSION

The key to matching project objectives to customer satisfaction is the proper application and measurement of project management. If the fundamentals of project management are to be perfectly understood, applied, and encouraged, it will be a great success tool for any project. It will prove and amplify the uniqueness of the chosen project.

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REFERENCES

[1] Rad P, Anantatmula V. Successful Project Management Practices. Bingley, UK: Emerald Group Publishing; 2010.
[2] Rad P, Anantatmula V. Integrated Project Planning. Berkeley Heights, NJ: Project Management Excellence; 2009.
[3] Anantatmula V. Project Teams: AStructured Development Approach. New York, NY: Business Expert Press; 2016.
[4] Fangel, M. (1993), "The broadening of project management", International Journal of Project Management, Vol. 11 No. 2, p. 72.
[5] Maylor, H. (2001), "Beyond the Gantt chart: project management moving on", European Management Journal, Vol. 19 No. 2, pp. 92-100.
[6] Lewis, M.L., Welsh, M.A., Dehler, G.E. and Green, S.G. (2002), "Product development tensions: exploring contrasting styles of project management", Academy of Management Journal, Vol. 45 No. 3, pp. 546-64.
[7] PMP Project Management Professional Study Guide. McGraw-Hill Professional, 2003.
[8] Project Management Institute. A Guide to the Project Management Body of Knowledge (PMBOK®). 6th ed. Project Management Institute; 2017.
[9] Anantatmula V, Rad P. Attributes of Project-Friendly Enterprises. New York, NY: Business Expert Press; 2016.
[10] Rad P, Anantatmula V. Project Planning Techniques. Vol. 2005. Vienna, VA: Management Concepts; 2005.
[11] Dennis Lock (2007) Project Management (9th ed.) Gower Publishing, Ltd., 2007
[12] Anantatmula, V. S., 2020, 'Project Management Concepts', in A. Petrillo et al. (eds.), Operations Management - Emerging Trend in the Digital Era, IntechOpen, London.
[13] Steffey WR, Anantatmula V. International projects proposal analysis: Risk assessment using radial maps. Project Management Journal 2011.
[14] Anantatmula V. Role of technology in project manager performance model. Project Management Journal. 2008.
[15] Anantatmula VS, Rad PF. Role of organizational maturity factors on project success. Engineering Management Journal. 2018.
[16] Kloppenborg T, Anantatmula V, Wells K. Contemporary Project Management. 4th ed. Boston, MA: Cengage Learning; 2017.
[17] Anantatmula V. Project manager leadership role in improving project performance. Engineering Management Journal 2010a.
[18] Morcov, S. (2021). Managing Positive and Negative Complexity: Design and Validation of an IT Project Complexity Management Framework. KU Leuven University.
[19] Anantatmula V, Fan Y. Risk management instruments, strategies and their impact on project success. International Journal of Risk and Contingency Management (IJRCM) 2013.
[20] PMI (2010). A Guide to the Project Management Body of Knowledge.
[21] Anantatmula V. Project Teams: A Structured Development Approach. New York, NY: Business Expert Press; 2016
[22] Anantatmula V, Kloppenborg T. Being Agile and Then Doing Agile. New York, NY: Business Expert Press; 2020.

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