MODERN CONSTRUCTION PROJECT MANAGEMENT

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BOOKS ARCADE

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Website: www.booksarcade.co.in

Year of Publication 2023

International Standard Book Number-13: 978-81-19199-38-9

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CHAPTER - 1

CONSTRUCTION PROJECT MANAGEMENT USING PRIMAVERA

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Project management is streamlined with the help of Primavera. In civil engineering, it is useful for developing plans, controlling project delays, and figuring out how to utilise resources most effectively [1],[2]. The project is finished using Primavera within the allotted budget and time. It is the application of abilities, resources, and methods to project operations in order to meet the owner's requirements [3],[4]. All sorts of projects are scheduled, managed, and estimated using the Primavera application. P6 EPPM is a fully online interface that allows the venture group to access the project data whenever and wherever they are. P6 EPPM may provide scheduling, planning, cost, and asset management software that enables organizations to make informed decisions and improve their ability to complete projects and activities on schedule and within budget [5], [6]. P6 EPPM also assists in It is a significant provider of venture administration contracts. Utilized and acknowledged broadly it can handle several duties at a centralized location. It offers the option to integrate an ERP or accounting system. Because it is electronic, the venture group may access their actions at any time and from anywhere. The whole venture management lifecycle is covered by its entirely online user interface [6].

Controlling and Monitoring

A construction project's timely completion may be ensured by monitoring and management. It may assist project management in carrying out the task as planned. The project is properly checked, and the quarries are finally removed. Controlling and monitoring allow us to keep track of our everyday development. Primavera P6 is only one of the numerous pieces of construction management software available today for regulating and managing projects. The following are the steps in monitoring and control:

- The first step in creating an EPS to build an optimal timetable for any project is to gather data that is already accessible for the project. The Primavera P6 programme may be used to carry out the following stages. Create the whole organizational structure of the business that is utilizing Primavera P6 to carry out the project, including all of its branches. The enterprise project structure is this (EPS).
- When a new project is created, it includes a variety of actions and supporting data that together represent a strategy for producing a good or service. The project is developed within the appropriate EPS divisions. Dates for the project's commencement and completion might be predetermined. A calendar is allocated to the project; it may be a global, resource, or project calendar.
- A calendar may be created and assigned to each activity using the calendar. These calendars provide the working hours for each day of the year. Include information about organizations, national holidays, project-specific workdays, resource-vocation days, and non-working days.

- Workload breakdown hierarchy: The project aspects have been identified and organized using WBS elements. The deliverables should be clearly stated, and various degrees of detail should be used to present and summaries the project's timeline and expected cost information. A construction project's WBS is a hierarchy of all the tasks that must be carried out to finish it. Every project has a unique project WBS hierarchy architecture, with the top level WBS component being identical to each project's EPS node. More specific WBS levels, occupations, or both resource constraints are included in each WBS element.

Defining activity

The basic and most important components of a project are its activities, which make up the top to bottom levels of a WBS and are the smallest division of a project. A project activity contains the following attributes, such as an activity ID, name, beginning and ending dates, calendar, activity codes, type, restrictions, costs, links between predecessors and successors, resources, roles, etc.

Constraints

Putting time restrictions on the tasks depending on the kind of job. Activities that cannot be reasonably arranged using logical relationships are subject to constraints. Occasionally, actions must be completed by specified dates rather than those set by other project activities. The need to utilise a restriction in order to start an action as late as feasible without disrupting any subsequent activities.

Level of Effort

Activities' dates and durations are derived from their predecessors and successors. Assigning a predecessor with an SS connection and a successor with an FF relationship is the most typical arrangement. Her or her effort will then be spread out across the course of the activity when resources are provided to it. Primavera's degree of effort optimises the length.

Relationship between activities

By allocating succeeding, preceding tasks that have a substantial relevance to the project's overall activities, arranging the activities may be connected to one another to create a network. FS-Art connection

Activity Length: The project duration is put throughout the original duration field during task planning. Only was project activities that have been finished may have their real duration recorded.

Dates of Activity: Primavera provides the following sorts of project activity dates: actual start, scheduled start, actual finish, and planned finish.

Creating baseline

A straightforward baseline plan is an exact replica of the original timetable that serves as a benchmark for measuring a project's success. Then create a new baseline B1 by adding and saving a copy of the existing project. Then choose B1 for the project baseline and B1 for the main baseline. Updates must be provided every day. Resource distribution: All of the resources are arranged by labor and non-labor in the resource allocation window. For rates of specific resource groupings, an approximation rate analysis was performed, taking into account the different component resources. The majority of resources are used as raw materials. Human labor is classified as labor while machine labor is excluded.

Delays

Delay is defined in a number of ways. Mubarak defines the simplest definition of construction management as a situation or an incident that causes the project to be completed later than agreed upon in the contract. To cause something to occur later than anticipated in a research. Critical and noncritical delay categories Concurrent or non-concurrent, compensable or not compensable, and excused or not excused.

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CHAPTER - 2

HISTORY OF PRIMAVERA

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Joel Koppleman and Dick Faris founded the initial business in 1983 in Philadelphia, USA, under the name Primavera Systems [1], [2]. The software system began to evolve into a server-based strategy in 1998, enabling Primavera to function as just a portfolio system [3]. This sparked the division of the programme into two versions: One represents a standalone variant of the programme that is often used by a lone power user on a single project or a constrained number of projects. The second is indeed an enterprise portfolio system that facilitates the use of Primavera for project management across businesses. In the overwhelming majority of instances, suppliers and contractors utilise the stand-alone version. They'll include it into their extensive job reporting standards. The enterprise portfolio system is used for strategic planning by a considerably smaller number of employees. The stand-alone version will be used by the providers to enter data into their systems. Primavera became the Primavera Global Business Unit when Oracle acquired it in 2008. Oracle is the industry leader in systems for enterprise finance and accounting, and Primavera P6 was created to work better in this setting [4], [5]. These innovations have strengthened Primavera P6's position among the biggest engineering suppliers, infrastructure customers, oil and gas, pharmaceutical, and refinery companies in the globe.

Primavera entered System Corporation in 1983 but was taken over by Oracle in 2008 and is now branded as Oracle Primavera. The Primavera P6 edition offers us an advanced integrated project portfolio management (PPM) solution made up of role-specific tools that must meet the requirements, responsibilities, and competencies of every team member. This solution utilizes a client/server architecture, Web-enabled technologies, stand-alone (SQL Server Express), or network-based (Oracle and Microsoft SQL-Server) databases, as well as normal Windows interfaces. Primavera gives us the necessary software component, along with a number of superior alternatives: To get us up and running, planning, and scheduling as soon as possible, Primavera P6 Professionals was created. They can start planning, scheduling, and managing our project quicker than anybody could ever imagine with extremely simple and straightforward navigation. This product, which many owners include in their project requirements, is the industry benchmark for managing projects and planning them. The weather project is a sophisticated, intricate, billion-dollar infrastructure investment or a straightforward, low-tech home or business structure.

Project Management Associates

India, where project management seminars where courses are given, is encouraging for the future of the sector. Additionally, steps must be taken to ensure proper implementation in order to prevent the scenario where information is available but not being used. It's plausible that this has happened in the past, explaining why there have been so few changes over so much time. The survey's findings show that the Indian building market is flourishing. This is a result of India's expanding

economy and demand, rising interest from international investors, continuing significant advancements in India, and the prospect of more developments. The fundamental quality triangle is preferred above the project's cost and profit considerations, which is a sign that the industry is changing in terms of standards and quality. According to the data analysis's findings, the sector is making an attempt to uphold fundamental criteria like the cost-time-quality triangle, despite continuous advancements. More factors might be added to the current list, which could gradually boost industry standards if organizations promote it and industry experts follow the philosophy of continuous development. There is evidence that certain projects have just been cost- and profit-driven, which is not unexpected given the time constraints, labor-intensive background of the Indian construction sector, and the presence of profit-driven people and organizations. Time, cost, risk, quality, communications, human resources, project procurement, and project scope are the fundamental elements of project management that seem to be well understood and taken into account while carrying out diverse projects. According to the data analysis's findings, distinct project stages are given attention as they are being carried out, and there is a widespread knowledge of their significance. Particularly compared to the building and termination stages, the two phases of idea and design are getting greater attention. The construction through termination phases could be viewed as ordinary or secondary stages once the project's idea and necessary planning are finalized, which might be one explanation for this. Other explanations include occupied schedules and the fact that the many success criteria included in the questionnaire have been chosen based on the literature research and a basic grasp of project management. Profit, effectiveness, cost, time, security, safety, client and user happiness, team member satisfaction, including structure or pattern in project execution are some of the success factors. The data analysis findings show that there is a fundamental grasp of these success criteria, but more work has to be done. When the Indian building sector is shaped into a more clearly defined structure or pattern, this will be achievable [6].

Similar to how customer happiness was one of the factors highlighted in the success criterion, it seems that the Indian construction sector pays some attention to this factor. It is acknowledged that the usage of tools like project management would be valued by customers, end users, and stakeholders. The absence of structure and openness in the sector, which may theoretically be accomplished through proper project management implementation, may be the primary reason why this has not yet happened. The results of the data analysis indicated that the industry needed a pattern or structure (where pattern is defined as an organized and planned model or structure to carry out various and interconnected phases of any project), and it is interesting to see how much respondents believe project management can do this. Although there is consensus across the professions that the industry lacks the framework required for project execution, there is still disagreement on whether project management can fill this gap. This difference is said to be caused by the lack of clarity around the industry's overall shift and the challenges experts are encountering when putting project management principles into effect. In the data analysis, it was found that the Indian construction sector has challenges when applying tools like project management, and that organizations should promote and support the use of such tools and methods more. The degree of variation in project management application between both the public and the private sectors of the Indian construction industry is one of the most salient problems. Government regulations, bureaucracy, corruption, and a lack of methodological and operational flexibility are a few of the often cited causes by respondents. Growing competitiveness, rising productivity and efficiency, giving the industry structure and pattern, promoting transparency and a better perception of the sector, modernization, and meeting rising needs are the main forces behind the growth of the Indian

construction industry. The data analysis leads to the conclusion that the industry is aware of these problems and is motivated to alter the way items have been seen in the past. Taking into account the existing level of work in the sector. It is true that people are aware of the shortcomings of the practices and procedures now in use, and they are also conscious of the obstacles and milestones that the sector will face in the future.

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CHAPTER - 3

CONSTRUCTION PROJECT MANAGEMENT OF RESIDENTIAL BUILDING

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Project management with a specific focus on construction. Simply said, residential construction administration is construction project management with an emphasis on residential buildings where people live rather than on community, professional, industrial, or heavy civil building or repair projects. Residential construction management has been defined as "a professional service that offers a project's owner(s) and effective management of a project's scheduling, cost, cleanliness, safety, scope, and function," similar to other aspects of construction project management [1], [2]. Residential construction managers (CMs) are responsible for supervising all aspect of residential construction projects, from the planning stages through the delivery of the completed single-family house or complex [3]. They support owners in selecting teams, including architects, contractors, and insurers, by assisting in the definition of goals, examining budget and feasibility, establishing performance criteria, and determining timetables. The human element is crucial while creating residential structures [4], [5]. In addition to meeting the necessary technical and budgetary requirements, homes should appropriately represent their owners' interests, tastes, and personalities. Good home construction managers are able to transform this into genuine, cohesive projects with realistic limitations and achievable objectives because they are aware that they are leaving a legacy.

Additionally, they prepare for and accept unexpected and adjustments. The process of managing construction projects is known as construction management. The primary difference between managing construction projects and other kinds of projects is that construction projects are mission-based. In other words, once the project construction is finished, the project's organization is finished. When operating in the construction sector, your perspective must be wider. While broadly speaking, project management is described as managing resources across the project's entire life cycle using different tools and processes to regulate scope, cost, time, and quality, etc. A larger range of restrictions that are unique to the design and implementation of construction projects are often taken into account in construction management. During the course of a project, construction project management may also interact with a number of other disciplines, including architecture, engineering, public works, and city planning.

The Project Life Cycle

No matter who owns a physical facility a commercial enterprise, a governmental agency, or an individual buying it often requires making a substantial capital investment. Since market needs or fictitious requirements are what motivate such an outlay of resources, the facility was anticipated to achieve certain objectives within the constraints set by the owner and the scope of the law. With the noteworthy exception of the speculative real estate market, where the residential units may

very well be sold as constructed by the real estate developer, the bulk of newly produced facilities are made to order in collaboration with the owners. In the same way that a government agency might sponsor a public project before turning it over to another government organization when it is done, building projects may be thought of as being sponsored by a real estate developer. From the standpoint of project management, the terms "owner" and "sponsor" are equivalent since both have the last word in all important decisions. Because they are essentially purchasing a facility on the basis of a promise made under some sort of agreement, owners would be wise to have a thorough understanding of the acquisition process throughout in order to maintain strong control over the quality, timeline, and cost of the finished facility (Figure 1).

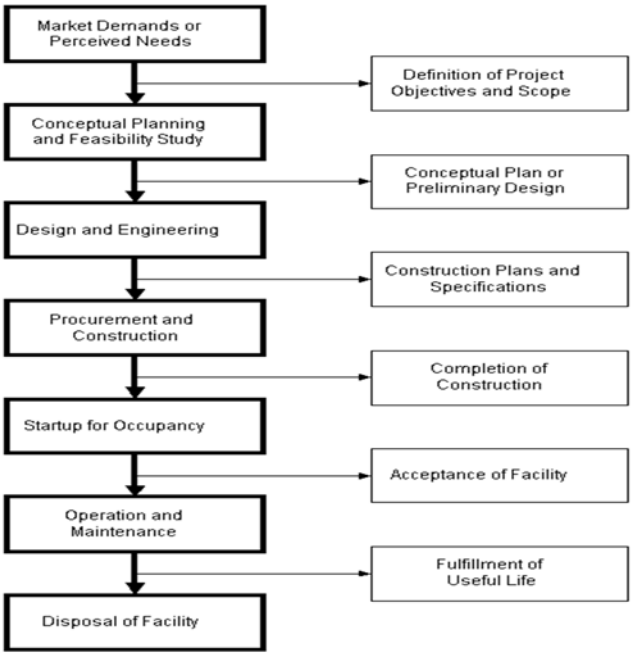

Figure 1: Illustrates a project is conceived to meet market demands or needs in a timely fashion [6]**.**

From the owner's perspective, Figure 1 depicts a schematic illustration of the project life cycle for a single constructed facility. In essence, a project is developed to quickly meet the demands of the market. Several possibilities might be considered during the conceptual planning stage. The technical and financial feasibility of each alternative will be analyzed and contrasted in order to choose the optimal project. The project's timeline would take into account the estimated completion date, the flow of available cash, and the financing strategies for the offered alternatives. After the project's scope has been carefully identified, a thorough engineering design will provide the construction's blueprint, and the final cost estimate will serve as the beginning point for cost control. Throughout the construction and procurement phases, the supply of materials and the construction of the project on site should be carefully planned and controlled. There is often a brief interval after construction is complete known as start-up or shake-down before a facility is first occupied. The owner is granted control of the management of the property when the facility approaches the end of its useful life and is planned for demolition or conversion.

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CHAPTER - 4

COMPENSABLE VS NON COMPENSABLE DELAYS

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Excusable delays are divided into two categories in certain studies: excusable delays that can be compensated for and excused delays that cannot be compensated. Both the designer as well as the owner are responsible for compensable delays [1], [2]. Usually, the contractor is entitled to a reimbursement and a delay in payment of the expenses associated with the delays. Changes in the project work, accessibility to the site, and various site circumstances are examples of factors that might impact the project and create delays [3]. Delays that, although being excused, do not entitled the contractor to receive remuneration are known as non-compensable delays. Excusable delays that are not compensable are outside of the control of the owner or contractor [4].

Concurrent Delay

The combination of two or more separate delays from distinct sources that take place at the same time is known as a concurrent delay. The author claims that both excusable and inexcusable delays may occur concurrently. "More than one delay which would be contributed towards project delay, not that the delays must happen at the same time," according to Callahan et al. (1992), is another description provided [5]. Following are the primary delays identified in this study: - Delays brought on by important activities: Getting work permits from the municipal late, mobilizing slowly, having issues with the foundation's excavation, and late start of construction in Figure 1 are all examples of late starts.

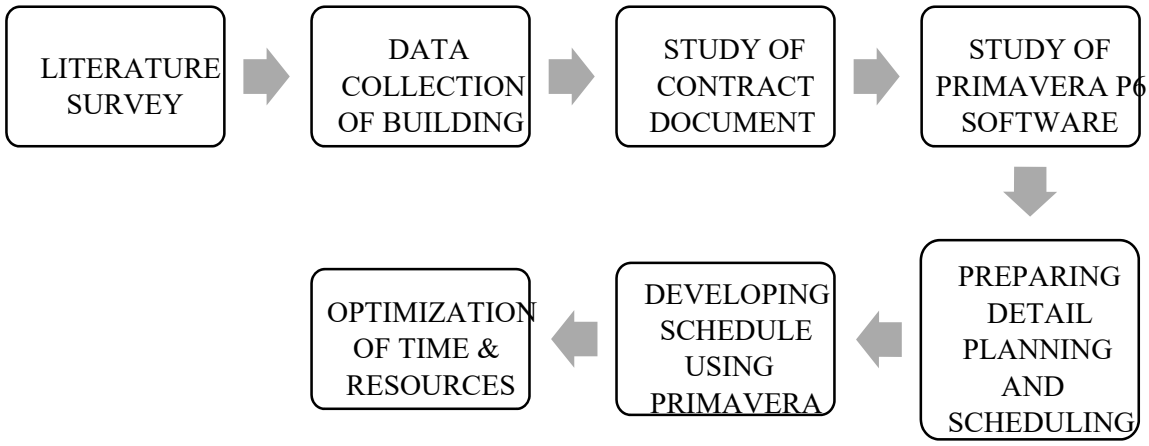

Figure 1: Illustrates the flow chart of shows the process of primavera software.

To address these problems, steps are now being taken. The survey and data analysis have produced this significant and encouraging finding. The Indian construction sector is expanding, and it's feasible that successful project management may help it achieve new heights of achievement and

greater standards. Project management, its techniques, advantages (transparency, higher productivity, overall efficiency with both the modernization of the industry), and how project management may raise standards are already somewhat known and understood. The Indian construction sector is developing, and there is a healthy balance of circulation and interaction among many professions because of the expanding economy and demand, interest of international investors in India, and continuing big advancements in India with more to come. Transparency, flexibility, and modernity are attributes that project management delivers, and they should transform how the industry is seen by customers, stakeholders, and end users alike. Growing recognition of the shortcomings of present approaches and procedures coexists with an understanding of the industry's future obstacles and turning points. Despite the efforts of a younger generation of professionals, the conventional and labor-intensive character of the sector makes it difficult to put project management actual effect. Construction businesses must promote and support project management adoption by providing resources like training for current employees and new hires based on their project management expertise. 10 Additionally, care should be made to ensure that project cost and profit considerations do not unduly impact the significance of the performance triangle or the industry's reputation. While the individual project stages get a lot of attention, the whole process has to be reviewed and the proper improvements must be implemented. The enormous differences in how project management is employed in the public and private sectors of an Indian construction industry should also be mentioned. Government actions including excessive bureaucracy, poor project execution, quality and standard concessions, personal interests, and insufficient transparency are to blame for this.

Enterprise Project Structure (EPS)

The hierarchy of the organization's projects is shown by the enterprise project structure. Depending on the requirements and operational procedures of your firm, higher level EPS nodes may represent project stages, site locations, corporate divisions, or other significant groups. It can be simpler to picture the folder structure within your computer's hard drive as the EPS. Projects are equivalent to the individual files, whereas EPS nodes are equivalent to the folders. An EPS node must contain every project throughout the organization. Separate P6 schedules may be combined under one EPS to symbolize a single project. Before separating a project into various P6 schedules, it is important to understand the problems involved, such as having different data dates, not being able to determine the longest route, and default project. The contractor, P3, and MS Project (MSP) schedules from subcontractors or even other project stakeholders may also be combined using EPS. Project Link, a Microsoft Project Plug-in, enables users to utilise MSP as their primary tool for tracking projects on a daily basis while also enabling the data to display in P6. Users of P6 can see projects managed by MSP but not implement modifications to them. Prior to uploading a project to P6, it must be locally stored in MPP format. The user needs access to both the EPS Node that project is under and the ability to import global data. A project may only be checked in or checked out by one person at a time. The majority of things will only be read in Project Manager [6].

Codes and Work Products/Docs are the only objects in P6 that may be modified. It is possible to move the EPS through one database to another even if there are no tools for doing so by taking a backup of the source database's EPS structure and restoring it on the target environment. You may manage projects individually while maintaining the flexibility to roll up and summaries data to higher levels thanks to several layers. For each node in the EPS, for instance, you may summaries the data. For cost management, on the other hand, companies may apply top-down budgeting

through higher-level EPS nodes down through their lower-level projects. A global organizational breakdown structure (OBS), which symbolizes the management accountable for the projects in the EPS, is used to implement access permissions and privileges to networks within the hierarchy of the EPS. Each supervisor in the OBS is linked to a section of the EPS via a node or a project, as well as the WBS for that specific level in the hierarchy. You may configure the EPS and assign an accountable manager (an OBS element) to each level after you've added users and linked them to OBS elements with project profiles. Each EPS node needs a designated manager, who you must name.

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CHAPTER - 5

ORGANIZATIONAL BREAKDOWN STRUCTURE (OBS)

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The organizational framework for project planning, resource management, time and expenditure monitoring, cost distribution, revenue/profit reporting, and task management is described in a hierarchical model called the Organization Breakdown Structure, or OBS [1],[2]. The Work Breakdown Structure (WBS) organizes and encapsulates all project components. A better foundation for planning and managing ongoing projects is provided by breaking big, complicated projects into smaller project parts [3], [4]. The organizational framework for planning phase, resource management, time and expenditure monitoring, cost distribution, revenue/profit reporting, and task management is described in a hierarchical model called the Organization Breakdown Structure, or OBS. The Work Breakdown Structure (WBS) organizes and encapsulates all project components [5].

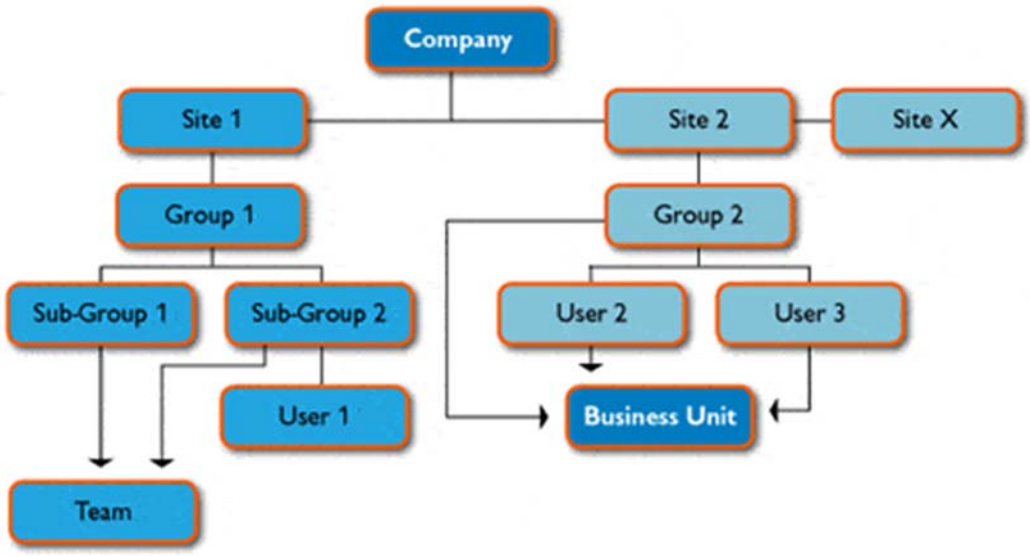

Figure 1: Illustrates the sample of develop an Organizational breakdown structure [6]**.**

Large, complicated projects may be divided into smaller project components to better organize and manage ongoing and upcoming tasks. WBS makes it easier to allocate resources, assign tasks, monitor and manage project costs, and generate invoices. The WBS is used at the beginning of the task to specify scope, pinpoint cost centers, and serve as the foundation for creating project plans and Gantt charts. The Organization Breakdown Structure classifies and links related project activities into "work packages" that are representative of the organization. Project management, budget management, billing, budgeting, and project control are all roles that are outlined in an organizational breakdown structure, or OBS. The OBS offers an organizational view on the project

as opposed to a task-based one. The OBS's hierarchical structure enables the rollup (aggregate) of project data to higher levels. The OBS and WBS are connected because once project responsibilities are established and work is assigned, enabling the use of powerful analytics to assess project and workforce achievement at very high levels (for example, business unit performance) or in minute detail (for instance, user work on the task) in Figure 1.

OBS as a function of Project Management

Project management may be summed up as a technique that employs knowledge, skills, and talents to accomplish a work or project from beginning to conclusion should people be new with the idea. Project management is applied in a variety of occupations and sectors. Project management, for instance, may be used to plan the construction of a building or even the coaching and training of players on a football team who play various roles. A work breakdown structure is yet another essential project management tool that collaborates with OBS. A work breakdown structure (WBS), in contrast to the OBS, aids in identifying which personnel or departments are in charge of particular activities. It does this by breaking down any project into smaller, more manageable components.

OBS Design Basics

Graphs or charts are often used to graphically depict organizational breakdown structures. Under the project manager (or general manager), a number of divisions, such as those for product development, designing, materials management, and manufacturing, may be established. There may be multiple subcategories or individual names listed immediately beneath the more extensive divisions under these divisions. Consider the OBS as a tree, with each branch denoting a functioning connection and lateral communication duty. An individual is more likely to have larger duties the closer they are to the OBS'stop.

Identifying OBS Responsibilities

When used in combination with a project workflow schedule, the OBS performs effectively. This document outlines the tasks that each individual named in the OBS is responsible for carrying out to achieve the project's goals. People should ideally be given jobs that complement their talents and areas of interest. This encourages a feeling of ownership in the project and makes the assumption that employees will be in charge of creating and finishing their own tasks. In smaller firms, project participants could be required to do various tasks. In these circumstances, the OBS and workflow plan are even more crucial for keeping employees on task, assisting them in setting objectives, and disseminating information on their specific direct project tasks.

Breaking down Project Resources

The resource breakdown is yet another crucial component of the OBS. A resource breakdown is indeed a list of all the money, material resources, and labor they will need to finish a project. In the past, this section of the OBS was approached by constructing another tree with different branches to show where resources should be directed. Another strategy is to survey team members to determine what they need in order to effectively perform a job once they have been given it. This second strategy may be preferable if finance isn't a concern for your company since it offers team members a feeling of control over their individual project tasks and puts budget and resource management in the hands of people who will be utilizing the supplies.

Reducing Confusion and Miscommunications

The more specific an OBS is, along with its associated workflow schedule and resource division, the better aware your team members are likely to be of the project's aims and objectives. Having said that, keeping things simple is often the greatest method for project management. Have the specifics planned out and available for inspection, but avoid communicating in a too technical manner. Goal-setting for each person should be specific and achievable, and output should really be effective and efficient. Reiterating to your staff over and time again that a project is running behind schedule or over budget is not motivating and may even reduce their output.

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CHAPTER - 6

WORK BREAKDOWN STRUCTURE (WBS)

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The Work Breakdown Structure (WBS) is a tool or essential project deliverable that divides a team's work into easier-to-handle sections or tasks [1]. These are just hierarchical breakdowns of deliverables that must be completed by the project team. WBS is often created by the project team by selecting the most important functional deliverables and then breaking each of these variables down into smaller systems and sub-deliverables [2]. WBS creation is often predicated and influenced by company culture, customer choice, budgetary restraints, and a number of other difficult-to-define project-specific characteristics [3]. In the WBS, larger activities are separated and divided into digestible pieces of labor. Deliverable-Based Approach & Phase-Based Approach are the two main forms of WBS. It only offers different information architectures. A straightforward job decomposition for assigning diverse duties, an essential supporting framework for scheduling, budgeting, and expense monitoring, and a description of all critical and important work are a few examples of these information structures [4].

Conventional WBS issues

Conventional WBSs are often prematurely deconstructed or organized, planned, and budgeted with either too little or not enough information around product design [5], [6]. The traditional WBS often has three major faults:

Premature structured or decomposition around product design

It will observe that traditional WBS has been first broken down or organised principally into every one of its product architecture's subsystems. They are further broken down into the parts of every subsystem. After all of this, a firm basis for planning is usually established that is exceedingly difficult to modify and quite expensive to do so.

Premature decomposition, planned, and budgeted in either too less or too much

Large-scale systems can easily implement the WBS as it is shown. These often have six or more tiers of WBS in place. In contrast, WBS is only expanded to one level in modest or internal developments and without any further information. However, WBS is often simply expanded upon and described on two or three levels. So may conclude that small-scale projects tend to be under planned whereas large-scale developments are often over planned.

Difficult or impossible comparison of project-specific and cross-project

Some firms are only permitted and given the go-ahead to customize their project structures in accordance with the project managers' management methods, the wants or requests of consumers, etc. Without a WBS framework, comparing plans, finances, schedules, organizational data, and many other things would be exceedingly challenging.

Evolutionary Work Breakdown Structures

All planning components are simply arranged using evolutionary work breakdown structures within process framework rather than product framework. In WBS, hierarchy should be organised as follows: At the first level of the WBS, it is important to specify elements including workflows, which include management, environments, requirements, design, implementation, evaluation, and deployment. At the second level of the WBS, elements for various lifecycle stages like genesis, elaboration, construction, and transition should be described. At the third level of the WBS, elements for tasks that produce artefacts from different stages should be specified. The WBS essentially organizes a project's elements and associates them with its lifecycle, budget, and manpower. Simple key indications that are significant for management strategy, priorities, and worries are provided by WBS and related budgets that are distributed across components. It is quite simple to plan, arrange, and manage a project using WBS. Additionally, it increases the efficiency of the project and aids in the estimation of necessary resources like money, time, and employees.

Key Characteristics and Components of the WBS

The 100% rule is a crucial part of a work breakdown structure. As a result, the WBS includes not only the person or team in charge of each component, but also every facet of the project. The levelling structure of WBS is another important feature. Level 1 of a WBS will represent the whole of the project when the 100% rule is applied. In certain WBSs, if a project isn't self-explanatory, an explanation or summary is included at the top level. The project is then broken down further at each level below it, using the 100% rule through each level. For example, Level 1 of a WBS for just a new website would be "Website supporting New Brand." The deliverables required to complete the project are broken down into level 2 parts, such as secure website URL, design and layout, and content development. The components are further broken down into depth at each level that follows.

WBS Is Helpful for Project Management

For several reasons, the work breakdown structure is indeed a useful project management tool. In the beginning, it divides the endeavor into digestible, bite-sized pieces, making it less intimidating. Second, it offers a road map for the many people and teams engaged in the project. Many projects need many teams to work simultaneously, and for the project to be completed, they must all communicate and work together. The many people and teams may concentrate on their unique duties and deliverables even while understanding how their part fits into the project in its entirety by adopting a WBS. Lastly, a WBS is a great tool for budget resource allocation, milestone identification, and project completion measurement. Project managers may be certain that the project is adequately funded and that they won't encounter any obstacles as a result of a "surprise" delivery by using the 100% rule.

Determining activities

Activities are a project's primary working components and its smallest component. An activity's primary attributes include its ID, name, start and end dates, calendar, type, codes, limitations, costs, linkages between predecessors and successors, resources, responsibilities, etc.

Relations between activities

The activities must be connected to one another in a network, which is accomplished by assigning preceding and following activities that have a strong connection to the activities. Relationships may be finished to start (FS), finished to finish (FF), started to start (SS), or started to finish (SF).

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CHAPTER - 7

CONVENTIONAL AND MODERN METHODOLOGIES CONSTRUCTION METHODS

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A traditional approach is one that is currently being used for construction. The use of traditional materials and processes is typically or frequently included [1],[2]. Most conventionally constructed buildings are based on simple measurements and simple design ideas. Ways in addition to the common floor plans. While the prefabricated approach is much quicker, the work produced using the conventional method has extraordinary beauty and authenticity [3],[4]. It doesn't always yield the same consistency that traditional procedures do. However, high rise buildings like skyscrapers are now being constructed using current construction techniques. Mechanization is being used in every industry in the western part of the globe. Because traditional methods have numerous downsides, such as the high labour demands (manpower) and the lengthy formwork construction process. Etc. Increased automation is the process of using machines to do the bulk of the labour that had previously been done entirely by human labour. Building projects are getting more demanding and complex, and delays would result from using the traditional construction process. Construction delays are expensive, which has led developers to embrace mechanization. Construction machinery is used to increase productivity, to complete tasks that cannot be completed with manual labour, to limit the amount of heavy manual labour that would lead to tiredness, and to sustain high output.

The following are the reasons for employing modern methodologies:

1. The job may be completed quickly, preventing time and expense overruns.
2. Because a large number of materials can be handled, the project's size can be raised.
3. The intricate tasks utilizing premium materials.
4. The ability to sustain high standards.
5. A timetable can be maintained.
6. Best possible use of resources, including money and labor.
7. A lack of effective and skilled labor.
8. Mechanized equipment may be utilized to control duration and costs more effectively than the conventional way, which can be used when planning a construction project.
9. Lower insurance premiums for contractors.
10. Work that is simpler and safer for construction personnel.
11. Long-term sustainability improvement of a building.
12. Minimal to no construction waste on the building site.

The value of contemporary methods used in the civil industry.

1. It uses less energy
2. Poses fewer health and safety dangers
3. Quality control
4. More affordable than traditional techniques
5. Less faults
6. Time-saving

In comparison to a conventional risk map, the DRASTICA map illustrates a more favourable scenario of vulnerability thanks to its confirmation by actual groundwater quality field data. Urban regions have exceptionally high levels of nitrate contamination as a result of human activity. When compared to net recharge, aquifer media, soil media, and topography, hydraulic conductivity, depth to the water table, and anthropogenic impact are more useful factors. The groundwater vulnerability potential map resulting from this process is better suited for use as an efficient first step in the management, planning, and protection of groundwater resources. Due to shallow water levels and significant anthropogenic effect, the Gosaiganj block, Sarojini Nagar block, and urban areas of the Lucknow district are characterized by high susceptibility. A moderately sensitive zone covers the majority of the district as a result of agricultural activity. Low vulnerability zones include those near water bodies, forest land, shrub land, and waste land. Urban areas demonstrated a high sensitivity to pollution. Urban groundwater samples also had significant nitrate amounts.

An empirical indicator termed the DRASTIC model was used to assess the groundwater sensitive areas of an urban setting in Lucknow, India. Additionally, a novel methodology known as the modified DRASTIC model, or DRASTICA, was created by incorporating both the anthropogenic influence (A) and the land-use/land-cover (LULC) surrounding the Lucknow urbanised area. This was done by using satellite observations of nightlights from human settlements as a proxy. The traditional DRASTIC risk map displayed three degrees of vulnerability (low, medium, and high), whereas the modified DRASTIC or DRASTICA risk map revealed four classes of vulnerability (low, medium, high, and extremely high vulnerability) in the Lucknow region. In urbanised regions, it was shown that the DRASTICA approach provided more conclusive groundwater vulnerability assessments [5].

Drastic Model for Vulnerability Assessment:

The parametric vulnerability mapping method known as DRASTIC is well-known and frequently applied. With the intention of supporting managers, planners, and administrators, it was developed in the United States as a part of an EPA (Environmental Protection Agency) initiative. DRASTIC can be used in a variety of settings because of the low setup cost and simplicity of data collection. The choice of numerous parameters and their interrelationship, "decreases the probability of ignoring some important parameters, restricts the effect of an incidental error in the calculation of a parameter and thus enhances the statistical accuracy of the model." This approach, which measures inherent vulnerability based on the aquifer's physical and hydrogeological characteristics, is a well-known overlay and index method. Numerous scholars throughout the world have evaluated groundwater vulnerability using the straightforward DRASTIC technique.

Many regions of the world, including Africa, India, Indonesia, Iraq, Iran, Jordan, USA, Europe, and the employ the DRASTIC model. In this technique, vulnerability is essentially assessed using seven parameters. The grades and weights of these model factors are taken into account to determine the DRASTIC index value [6].

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CHAPTER - 8

DRASTIC MODEL

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Residents of Hornby Island are worried about groundwater contamination because it is the only source of water for drinking on the island [1],[2]. A groundwater vulnerability assessment that uses a Geographical Information System (GIS) to locate the sensitive areas is required to safeguard this priceless natural resource [3],[4]. By using the DRASTIC model on Hornby Island, we want to show a visual representation of the areas on the island that are most vulnerable to pollution [5],[6]. The NSW Department of Land and Water Conservation in Australia has used the modified version of the US EPA's DRASTIC aquifer vulnerability model in prior investigations. In order to assess Hornby Island's aquifer susceptibility, this model will include the island's slope changes, the soil type, the geology, recharge rate, impact of the vadose zone, and precipitation. An overview of the model is provided in the section that follows. The DRASTIC model requires a variety of spatial attributes to be mapped as a composite description of all the important geological and hydrologic elements that govern and control groundwater migration into, though, and out of an area in order to map the aquifer vulnerability for Hornby Island. The most significant mappable elements in a hydrogeologic context that regulate groundwater contamination are collectively referred to as DRASTIC.

1. D: Depth to Water Table
2. R: Recharge
3. A: Aquifer media
4. S: Soil Media
5. T: Topography (slope)
6. I: Impact of Vadose Zone media
7. C: (Aquifer Hydraulic) Conductivity

It has been widely used in countries all over the world. The generated maps of groundwater vulnerability are particularly helpful for organizing and preserving groundwater resources. Using the DRASTIC model in ArcGIS 10.3 software, the aquifer vulnerability maps and hydro - geological characteristic maps were created for this study. The previously mentioned model took into account seven parameters, and the associated seven map layers served as its input. The DRASTIC acronym uses a numerical ranking for each letter. The three important components are weights, ranges, and ratings. First, each DRASTIC trait is assigned a weight based on its relevance, which ranges from 1 to 5. The most significant factor influencing aquifer susceptibility will be given a five, while the least significant factor will be given a one. Then, based on their influence on pollution potential, the upper and lower characteristics limits of the media kinds were developed.

Dimensions to Water Table:

The depth to water table (DTWT) gives us a measurement of how far the contamination must travel through unsaturated material before reaching the ground water (or the saturated zone). This is crucial because as the depth of the unsaturated zone increases, the time it takes for pollutants to reach the water table also increases.

Recharge:

Recharge is the volume of water that seeps through the surface of the ground into the water table after passing through the unsaturated zone. Because it moves possible contaminants both laterally inside the aquifer and vertically downward to the water table, the net recharging is significant. The Recharge also regulates the quantity of water that is accessible for pollutant conveyance and dilution in the vadose and saturated zone. The likelihood of groundwater pollution will increase as recharge increases. Three factors are taken into account during recharge: precipitation, slope, and soil permeability.

Soil Media:

The groundwater flow system and, consequently, the contaminants in the aquifer are controlled by the aquifer media. The pollutant flow is significantly influenced by the paths and porosity of the aquifer media. The amount of time available for various processes, such as adsorption, reaction, and dispersion, depends on the length of the groundwater's route. Additionally, the degree of contact between the contamination and the aquifer media depends on the porosity of the various aquifer media.

Topography (slope):

The slope and slope variations of the ground surface are regarded as topography. Because pollutants are less likely to be retained when the grade is steep, there is often less chance for contaminant infiltration. Conversely, shallow slopes have a greater chance of pollutant retention and subsequent contamination infiltration. The range and rating given to the slope when it is viewed as a feature on its own are shown in this table.

Impact of Vadose Zone media:

The soil layer above the water table known as the vadose zone is either continuously or sporadically saturated. The kind of substance in the vadose zone dictates the features, length, path, time available for attenuation, and amount of substance that can come into contact with. The depth to the water table and the permeability are two distinct aspects of the Vadose Zone's impact. The ranges and rankings of these attributes are provided in the following three tables (Depth to Water Table, Soil Permeability, and Impact of Vadose Zone).

Conductivity:

The quantity of pore space in the soil medium regulates hydraulic conductivity, which controls the speed at which water can pass through permeable media under a specific hydraulic gradient. Water

entering the aquifer at different rates depends on groundwater velocities. The conductivity rating is provided in this table.

After each of the seven DRASTIC characteristics has been given a ranges and a rating, their weight is determined by dividing all of the ratings by the specified weight. This method is used to overlay all elements on a single map in order to show visually which sections of Hornby Island are more susceptible to aquifer contamination.

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CHAPTER - 9

CONVENTIONAL CONSTRUCTION METHODS

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A common or standard building approach is conventional construction. It often uses conventional materials and stays within a certain range of limitations [1],[2]. Layouts with somewhat basic specifications and regular floor plans serve as the foundation for the majority of conventionally constructed structures. Prefabricated building is speedier, but it doesn't necessarily give the same reliability as traditional building [3],[4]. The appeal of conventional building is that each one is uniquely created from the ground up, making it impossible for two to be identical. Conventional structures have a remarkable durability that is unique to this approach. If a commercial or industrial conventional structure building is needed, Progressive Construction, Inc. has expertise in a wide range of construction types.

Conventional construction

Conventional building refers to construction done using standard methods and supplies. The reason why new houses are constructed virtually exactly in the same way as those constructed more than 25 years ago is because this technique of building trade expertise is transmitted from one generation to the next. The majority of builders are generally happy with the Building Code's current state since they know they can construct according to it successfully and will reject modifications that would force them outside of their comfort zone. Nowadays, the majority of typical homes are planned and constructed with the simple intention of meeting the minimal requirements of the Building Code. Unfortunately, the majority of building codes don't take into account energy use, running expenses (utilities) to maintain livable levels of comfort, or assuring excellent indoor air quality. Although this minimalistic building technique will undoubtedly result in the lowest initial construction cost, it is not the most cost-effective construction method for the end user when yearly operational (utility) expenses are taken into account. The majority of contractors are unaware that passive house is a superior option for design and construction nowadays.

The problem with conventional building enclosures:

To make up for their poor thermal resistance, conventional building enclosures rely primarily on active (mechanical) heating systems. Building Code-compliant room temperature and relative humidity values must be maintained at a high operational (utility) cost due to this energy-intensive trade-off. Every space has to be kept consistently cool and clean, particularly during the chilly winter months. Not for the people living there, but for the building itself. While turning off home heating system would save you money, it might lead to condensation damage, which could lead to decay in the structure and poor indoor air quality. The formation of mold and fungus, which may have serious health effects, makes poor indoor air quality a threat to people's health. The mold and fungus are often concealed within the building enclosure and go undetected from the inside and

outside. Traditional building enclosures need active (mechanical) heating systems to operate and to provide a comfortable environment for the occupants. Beyond to first satiate, then surpass, your requirements. Construction carried out at the building site utilizing raw materials is referred to as in situ construction or traditional construction in the field of construction engineering. [5].

Advantages:

1. It includes a variety of building types.
2. One might presume that it is essentially monolithic.
3. The connection blends in with the rest of a frame.
4. It may be used for two-way structural systems with ease.
5. There is no need to pay for the crane to be on site.
6. No of the weather, construction may continue.
7. Improved working conditions for construction workers.

Disadvantages:

1. Need a large workforce and on-site facilities.
2. Formwork construction takes time.
3. It's challenging to maintain quality.
4. Any changes cannot be made after the concrete has been cast because it is too complicated.
5. Weather issues may affect both curing and construction as a whole.
6. Putting them up and linking them to create the finished structure.
7. Before it is loaded, concrete has to cure.
8. Finish surfaces' quality assurance is not guaranteed.

The conventional construction:

Because conventional building is the most well-known, widely used, and tested construction technique in Greece. With Smart Building, the cost of traditional building is reduced by 5% to 15% from of the market owing to the company's crew organization and ability to achieve low costs via large-scale procurement. However, if you examine the drawbacks of traditional building in comparison to alternative construction approaches, you will find that:

A. Longer delivery periods are involved.
B. Social Security payments are quite expensive.

Pricier building technique compared to composite construction. The cost of traditional building is between 30 and 40 percent higher on the market than that of composite construction. The same conventional construction may be had from Smart Building for just 10% to 25% more than the composite construction thanks to its subsidiary DOMIKI SACHINOR (building materials marketing). Difficulty and expensive expense of damage restoration. A support structure that may bend may be rapidly, readily, and affordably repaired using composite construction.

Conventional construction building method

The structure consists of:

A. Supports, beams and concrete slab
B. Masonry from bricks and plaster

Concrete slab:

A typical slab is the kind of slab supported by columns and beams. The thin slab thickness and the deep depth of the beam cause the weight to be transmitted to the beam and subsequently the column. More formwork was required for this than for flat slabs. The column cap is not necessary for conventional slabs. Typical slabs typically 4 inches or 10 cm thick, however it is best to make the concrete 5 to 6 inches thick if it will often be exposed to large loads like RVs or trash trucks. Standard slabs are strengthened by straps that are fitted either horizontally or vertically. The straps that are put vertically serve as distribution bars, while the buckles which are placed horizontally serve as primary reinforcing bars[6].

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CHAPTER - 10

MODERN CONSTRUCTION METHODOLOGIES

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Modular building has won praise for its speedy design and construction of high-quality pre-built homes, which contributes to addressing the housing shortage in the UK [1],[2]. Due to a number of circumstances, including a labor shortage and unfavorable weather that impedes or slows operations onsite, the construction industry often encounters delays [3],[4]. These issues can be solved with modular homes. Off-site construction in a safe industrial setting reduces risk and speeds up development without maintaining high build performance standards. Because factory-made modular homes can be created with both individuals and the environment in mind, boosting energy efficiency and shortening building timelines, modular housing options are growing in popularity [5],[6]. The term "modern construction methods" (MMC) refers to techniques created in the construction sector with thorough planning and design to complete each project more rapidly, economically, and sustainably. Several techniques are developed and used in the current situation. Here is a summary of the most popular and often used modern construction techniques.

Modern Construction Techniques:

The conventional "brick-and-block" construction method was used to construct the majority of homes in the UK. However, new approaches that diverge from this paradigm are emerging increasingly often, most notably in the development of social housing. The acronym MMC stands for many alternative construction techniques. The components for properties are normally made by MMC in a factory off-site. This comprises of prefabricated walls, floors, roofs, and whole rooms that are easily transported and assembled quickly, generally within a few hours, at their destination.

3D volumetric building:

The practice of building modules in a controlled setting (such as a factory or warehouse) prior to their being delivered to the project site is known as modular and 3D volumetric construction. This might include constructing the base unit or constructing inside walls and finishes in order to get everything ready for assembly. Anything can be created quickly, consistently, and correctly when done inside a controlled environment with the same components.

Flat slabs:

Since flat concrete slabs are used in flat slab construction and thus are supported and stabilized using concrete columns, no beams are required. The flexibility of the concept, especially the lack of limits just on height between levels, and the speedier construction are two of this method's main advantages.

Timber frame:

The goal of a timber frame construction is to integrate a variety of structural frames, including such external and interior walls, flooring, and roofs, that have been built off-site in a factory to produce a composite structure that can be covered with another material, including such brick, on-site. Wood frame building is a kind of construction that uses sustainable materials. In terms of the form and appearance of the structure, it also gives architects and designers a good level of versatility.

Precast paneling:

Precast panels are produced when wall and floor modules are created off-site and transported to be assembled on-site to build a strong framework. They may be perfect for projects like new structures where repetitive tasks are carried out. This provides speed, accuracy, and quality equivalent to other pre-prepared systems by requiring factory-made components to go through a rigorous process before becoming simple to assemble on-site. Additionally, panels permit the addition of windows, doorways, and furnishings, giving the designer additional creative freedom.

Concrete walls and floors:

Concrete's strength, stiffness, fire resistance, but also longevity make it a crucial component in the building of sturdy structures. Concrete floors are typically flat slabs of concrete which have been either produced off-site and delivered to the location or poured on-site. Because it can handle heavy loads and boost overall strength when combined with rebar, commonly known as reinforcing steel, it is perfect for ground floors.

Unfinished foundations:

Precast concrete, sometimes referred to as precast foundations, and is created using reusable molds at a facility remote from the building site. It may be used in conjunction with other panels to build constructions. This technique may be used to beams, floors, and stairways, although it is most often employed on walls. Precast foundations are indeed a highly effective, beneficial, and affordable construction technique that are especially helpful in inclement weather.

Twin-wall construction:

Twin wall technique boosts the strength and speed of the construction by using both pre-made and also in concrete. Two prefabricated walls are connected and reinforced using twin wall technology before even being filled with concrete. This method is often used in conjunction with concrete walls and floors since it is quick and affordable.

Masonry with thin joints:

The use of thinner mortar (3mm or less as opposed to 10mm) with thin joint masonry speeds up the laying process and boosts productivity. More buildings might be created in a single day because to the mortar's short drying time it often reaches full strength in much less than two hours.

Modern construction methods confront difficulties.

Due to legislative changes, a shortage of training, and inadequate certification, the industry has been considered as having a restricted adoption of innovative construction methods. Employers have expressed concern about the lack of qualified candidates, which may be made worse by

problems like the COVID-19 epidemic and Brexit. The method has also drawn criticism in the UK because it may harm British industry because many of the prefabricated parts and materials used in modern construction techniques are imported. Pre-fab homes are not very popular in the UK, maybe because the word is associated with subpar structures built immediately after World War II. Wood is used in many prefabricated dwellings. The heightened fire safety hazards of a timber-framed house may deter some individuals from acquiring a home built using current construction techniques, despite the fact that this sustainable material is often more favorable for the environment.

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CHAPTER - 11

CAUSES OF GROUND WATER POLLUTION

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When contaminants are released into the air or ground and find their way into groundwater, this is referred to as groundwater pollution or groundwater contamination [1],[2]. This kind of water pollution can also happen naturally as a result of a tiny and unwelcome element, contaminant, or contaminant in the groundwater; in this case, contamination is more appropriate than pollution. Groundwater contamination can be brought on by onsite sewage systems, landfill leachate, wastewater treatment plant effluent, leaking sewers, gas stations, hydraulic fracturing (fracking), or excessive fertilizer use in agriculture. Natural pollutants like arsenic or fluoride can also cause pollution (or contamination) [3],[4]. Using contaminated groundwater puts the general people at risk for illness or poisoning [5],[6]. The secret to solving any issue is to locate and understand its root cause. Therefore, some of the main reasons for groundwater pollution will be discussed in this article. We'll also investigate several measures to stop groundwater pollution.

Primary Groundwater Pollution Causes:

Landfills, effluents emitted from businesses or wastewater treatment facilities, sewage leaks, gas stations, and fertilizers/pesticides used in agriculture can all be sources (or cause) of groundwater pollution. It's interesting to note that fluoride or arsenic contamination can also be a native (natural) cause of groundwater pollution.

Tank storage. They could be either above or below ground and could contain liquids such as chemicals, oil, gasoline, or another kind. With 10 million storage facilities are thought to be underground in the United States; over time, these tanks may corrode, crack, and leak. Serious contamination may result if the toxins escape and enter the groundwater.

Septic tanks. Systems for disposing of wastewater on-site that are utilised by residences, workplaces, or other structures that are not attached to a public sewer system. Human waste is meant to be slowly and safely drained away underground via septic systems. Inadequate septic systems can leak bacteria, virus, household cleaners, and other toxins into the groundwater, which can be quite problematic.

Unregulated Hazardous Waste: There are already more than 20,000 recognised unmanaged and abandoned hazardous waste sites in the United States, and that figure is increasing yearly. If there are barrels or other containers lying about that are full of dangerous materials, hazardous waste sites might result in the poisoning of groundwater. These pollutants may eventually permeate the soil and enter the groundwater if there is a leak.

Landfills. Our trash is transported to landfills to be buried there. In order to keep toxins from entering the water, landfills are intended to have a protective layer at the bottom. On the other hand, if there isn't one or it is broken, toxins from the waste may seep into the groundwater.

Chemicals and deicing agents: Another potential source of groundwater contamination is the extensive use of chemicals and deicing agents. Chemicals include items used in homes and businesses as well as those used on lawns and farm fields to eliminate weeds, insects, and fertilise plants. These substances may leak into the ground during rainstorms and finally reach the water. In the winter, road salts are used to melt ice on the roadways to prevent cars from swerving. The salt is washed off the roadways and finally finds its way into the water as the ice melts.

Contaminates in the atmosphere: As a component of the hydrologic cycle, groundwater is susceptible to contamination from other sections of the cycle, such as the atmosphere or bodies of surface water.

Alternatives to Groundwater Pollution:

Some methods for preventing groundwater pollution include:

Utilizing the precautionary principle: According to the precautionary principle, "lack of full scientific knowledge shall not be used as a justification for delaying cost-effective measures to avert environmental degradation where there are concerns of irreversible damage." The Rio Declaration included this idea as a strategy to tackle groundwater pollution, and it is highlighted in their 15th principle. Additionally, this is one of the EU's water policy's six guiding principles.

Utilizing a telemetry system to monitor the quality of groundwater: It is important to monitor the quality of groundwater, especially for industries that need to detect things like pH, flow rate, TSS, water level, etc. If an issue is seen, immediate action should be done.

Marking or Land Zoning: Another tactic to use is zoning or identifying land areas to enable a stronger focus on particular areas for reducing groundwater pollution. Many countries all over the world have utilized this method of mapping land use. Aquifer vulnerability maps and source security maps are the two main categories of zoning maps.

Aquifer vulnerability maps are made with the knowledge that some aquifers, particularly shallow aquifers, are more vulnerable to groundwater contamination than others. This is because there are fewer layers between the land's surface and the water-holding aquifer layer that serve as filters.

To safeguard specific water sources, such as wells or springs, source security maps are created. If there is enough time for the pollutants to travel from the biodegradable pollutant sources to the groundwater source, they will be removed by the absorption or filtering process. In order to indicate the radial areas near a water source where actions that potentially lead to pollution must be avoided, source protection maps are developed.

Through statue regulations: A major factor in addressing the problem of groundwater pollution is government restrictions. The Central Groundwater Authority (CGWA), a statutory organization established in India under section 3 of the Environment (Protection) Act, is in charge of keeping track of groundwater developments throughout the nation. According to the most recent CGWA standards, it is required that certain industries that meet specified requirements build a groundwater monitoring telemetry system and submit a report to CGWA.

Training Others: Fighting the problem will also need raising awareness of the necessity of taking immediate action to prevent groundwater pollution. Everyone uses groundwater, which is a resource. Therefore, it is everyone's responsibility to preserve it against contamination and ensure that there is enough of it for both the present and future generations. Every person may contribute

by making tiny but impactful changes, such as not wasting water at home or at work, using fewer plastics, and utilising proper disposal techniques.

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CHAPTER - 12

ASSESSMENT OF GROUND WATER VULNERABILITY

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Vulnerability of ground water is a vague idea rather than a quantifiable characteristic. Since contamination is a probability (i.e., "the propensity or likelihood"), it must be inferred from observable surrogate information [1],[2]. In this way, a vulnerability assessment is a prognostication for processes that occur underground and over considerably longer time scales, similar to a weather forecast [3],[4]. There are numerous techniques for estimating ground water susceptibility [5],[6]. The behaviour of chemicals in the subsurface environment is approximated by several of them using mathematical models and equations. Process-based methods are the name for these techniques. Another set of techniques creates a weighted index or numerical score by combining physical characteristics that influence vulnerability. A third strategy makes correlations with locations where contamination is known to have happened using statistical techniques. The more intricate and thorough procedures typically call for a deeper understanding of the system being evaluated. Simpler approaches involve less in-depth knowledge of the system being evaluated, but they also incorporate more approximations and are less exact. Although more complicated methods may more accurately characterize transport mechanisms, the necessary facts are sometimes lacking and must be guessed from the scant available knowledge.

Accreditation Process Uncertainty: It is difficult to predict ground water susceptibility. It is expensive to gather information on the subsurface, especially for broad areas, and assessment techniques can only provide approximations of true environmental processes or other associations. Consequently, the Second Law of Ground Water Vulnerability is reached:

All vulnerability evaluations have some level of uncertainty: As a result of incorrect specification, improper application, and data problems, all of these procedures are based on abstraction of reality and are uncertain. Due to considerable gaps in our understanding of contaminant behaviour in the subsurface and the spatial databases that are utilised to generate assessments, there is inherent uncertainty in vulnerability assessments. The majority of methodologies in use give a false sense of how uncertain vulnerability assessments are. The Second Law has the effect that vulnerability should be described in probabilistic terms (i.e., likelihood) that reveal the assessment's inaccuracy. Ratings of vulnerability may be provided by many methods that disagree with one another or with ground water pollution measurements. Because the outcomes (i.e., vulnerability ratings) cannot be experimentally verified using conventional scientific methods, the model evaluation challenge for huge areas, or even a field, is particularly challenging.

Vulnerability Assessment Components

It is impossible to develop a general method for predicting vulnerability that takes into account all probable modes of contamination. The reference location (such as the water table or a specific

location within the ground water system), the level of contaminant specificity, the contaminant pathways taken into account, and the time and spatial scales of the assessment are important factors to take into account in a vulnerability assessment for a specific application

Assessments of groundwater vulnerability are required

Groundwater is frequently unexpectedly durable in the face of threats from potentially polluting activities, and water quality is generally good throughout a substantial portion of the globe. This is due in part to the fact that many aquifer systems naturally have the ability to attenuate and hence buffer the impacts of pollution. Even though groundwater is not easily contaminated, once this happens, remediation can be challenging. A failing local aquifer's high replacement cost can put a strain on other water sources that were considered as alternatives. Furthermore, such remediation could end up being virtually unfeasible in developing nations. Determining which aquifer networks and environments are most susceptible to degradation is crucial.

The vulnerability studies allow for evaluation of the severity of the potential effects of pollution loading. Water quality degradation is used to gauge how serious the effects are. In accordance with the findings and suggestions of the International Conference on Vulnerability of Soil and Groundwater to Pollutants, Lobo-Ferreira and Cabral (1991) suggested that groundwater vulnerability to pollution be defined as the sensitivity of ground water to an imposed toxic chemical load, which is determined by the intrinsic characteristics of the aquifer. When compared to pollution risk, which depends on both vulnerability and the presence of large pollutant loading entering the subsurface environment, vulnerability as just described is different. If there is no considerable pollutant loading, aquifer vulnerability could be high with little pollution risk, or it could be low with high pollution risk if the pollutant loading is extraordinary.

The difference between vulnerability and risk must be made clear. This is because the danger of contamination depends both on the presence of potentially polluting activities, which are dynamic elements that may, in theory, be changed and regulated, and on the intrinsic properties of the aquifer, which are generally static and scarcely modifiable. The severity of the effect on water use will depend not only on how vulnerable an aquifer is to pollution but also on how bad the pollution event was and how much the pollution episode cost groundwater resource. The maps offer a distinct assessment of the groundwater susceptibility in the rocks that make up the underlying bedrock and those that are overlying superficial rocks. They take the place of the previous groundwater protection purposes map and also represent advancements in data mapping and understanding of the elements impacting vulnerability.

Each aquifer type's groundwater vulnerability is expressed on a scale from high to unproductive.

A. **High:** locations where groundwater pollution is easily transferred. They are distinguished by high levels of soil leaching and a lack of surface deposits with low permeability.
B. **Moderate:** locations that provide some protection for groundwater in the middle of the vulnerability spectrum.
C. **Low:** locations where groundwater is most shielded from pollution. They are probably distinguished by low-leaching soils and/or the presence of surface deposits with limited permeability.

D. **Unproductive:** Rock-filled places with little bearing on water supplies or base flows to marshes, lakes, and rivers. They are made up of bedrock or thin, impermeable layers that naturally shield any groundwater that may be present beneath.

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