CHAPTER-3
Research Methodology

1. Primary Data Source:
The primary data source is artifact, a document, a recording, or other source of information that was created at the time under study. It serves as an original source of information about the topic. Information has been collected by analyzing various features and functions of project management software and some feedback have been collected from various industries. Project Management Software’s have endless possibilities of the requirements that can be catered by the PM providing company. This data source focuses on the feature related aspect of project management and also the functionality of each feature matters [72]. So the need is to identify the requirement of the client and the features required by the client in his project management software which will enhance the productivity of his organization by selecting the appropriate project management tool. Feature vary from project to project and also the client requirements.

![Software Project functionality analysis](image)

Figure 13. Software Project functionality analysis

This research project will help in selecting the appropriate project management tool which will suffice the requirement of industry as help in productive environment. Many companies today have project failures due to improper selection of project management tools. Any project which is under execution need to be completed within time, allocated budget and
with resources available for project all of these activities require monitoring and management which can be accomplished using project management software tools and features which are required to manage the activities. Project manager has to select appropriate project management tool for completing all the project management activities starting from requirement capturing, requirement gathering, design, development, testing, deployment and maintenance of the project under execution report generation is an important part at each stage of project under execution.

Figure 14. Software project Maintenance Plan

The primary data source in any software project is clients requirement if the requirements are clear and free-zed from client side once discussed with the client, project manager and the stake holder of company then it becomes easy for project execution company to work on project without any mistakes and requirement changes at different phases of the project. But incase requirement from client side is not fixed then project manager needs to constantly work with client to get his feedback and requirement which he want to fulfill in his project which also created overtime and overheads for the project under execution. Time management and resources management can not be done easily as requirement from the client is constantly changing and project manager needs to cater to client requirement so that client is satisfied with the product which he want from software company to be completed. While selecting a project management software for the company the stakeholders should freeze their requirement for phase one
purchase of the product also budget allocated for procurement of the project management software need to be taken into consideration based on the requirement which it can handle. Agile software for project management needs to be procured as agility will help in scalability of the project management software when required at later stage in the company one of the most important aspect while selecting any project management tool for software industry. Modularization of project management software is also a key for selecting the best project management software for the company as modularization will help in expanding the project management tools and functionality as an when required by industry also the budget requirement when increased the company can purchase modules or services which are required for managing various activities of the project. Inter-process communication between modules can be achieved after purchasing new modules for project management software when new module/service is purchased it should function with existing modules with little or no modification from the end users perspective [73].

![Diagram of Modularization of Software Project](image)

Figure 15. Modularization of Software Project

Companies have many customized requirements which cannot be always fulfilled by project management software available in market today. These customizations need to be discussed with project management software company to cater to specific customization if needed in project management software. Collecting and keeping data secure is also an important part of the project as the responsibility of project manager is to manage all the resources effectively and efficiently such that all the activities of the project under execution are executed smoothly and being reported and monitored at each phase of the project life cycle. Data sources of the project under execution need to kept secure and no mishandling of the information needs
to be done. Hence security of project management software is also a key factor to consider while selecting a project management software for the industry. Today most of the companies around the world who have multiple projects under execution rely on project management software which helps companies to execute projects on time and with allocated budgets, resources. Information collaboration between various phases of the project is important and need many modules to sync information between module of the project as and when required by the system. Project management phases and the modules handling information about various phases need to collaborated and exchange information as and when required by the preceding modules. This will help in smooth flowing of information from one phase of the project to the other phase without any new amendment. Each module has resources allocated and budgets which will need exact monitoring by project manager [74]. Management of multiple projects can be taken care by one project manager and a dashboard in the project management software can showcase status of multiple projects under execution and if there is any time delay or resource requirement in any project to complete given project in time. Various research documents have been collected and data from these research papers have been utilized in this research work. Originality of research articles have been maintained after they have been studied carefully and information catering to this research work has been cited as references for the papers which has been used for reference in this research work.

![Software Project Tracking based on Tasks](image)

Figure 16. Software Project Tracking based on Tasks

Project management software is an essential part of extracting relevant information from various parts of the software projects [15]. Today software industry is having multiple projects and also management of these software project is critical so its important to keep track and
extract the exact information from the projects as and when it is required [16]. Data mining
algorithms are used to extract and display the relevant information, which is crucial to the end
users of the system. In today's society, information systems, data warehouses, knowledge
repository center. Data warehousing, enterprise-wide integrated information from which to
analyze the historical data of information processing by providing a solid platform supports [17].
And make a profit. Data mining is a guide to data analysis of the recent enhancements to help
improve strategic decision-making. Data mining production, customer satisfaction and retention
and better profit potential to improve the quality of that data to reveal patterns of aging by
examining the enterprise data warehouses and other data stores is to exploit that knowledge [18].
Information will be accessible at any point in time so that the project is a central location to store
all information in a data warehouse is a need to. Data mining can be applied to the data
warehouse and the holder of the relevant information cannot be displayed. Project management
for data mining and warehousing, we can move into the future without abandoning the past.
Centralization of project data and thus improve future moves can get access to information at any
time [19]. Data warehousing, one of the highest critical factor in the success of the stakeholders
have input. Data warehousing is very unique to the organization, its business processes, systems
architecture and decision support needs. For data warehousing, project management and project
large amounts of user input at all stages allows [20]. Data warehouse project management is
ready for commercial software products. Most of the software project information is stored in the
data warehouse which is created by the management team of the software project information is
extracted and displayed to the users on the role based login which provides information
extraction and collaboration of data from various phases of the software project. Data
warehouses are created depending on the types and categorization of the project [21]. Centralized
repository for data storage is done in the data warehouse extraction of the data is carried out
using the data mining algorithms and information extraction tools today. Various stages of
software development collect data from various sources information about all the software
projects is stored in the central repository all the tables and the databases in the repository
communicate with each other and information synchronization is maintained today its important
to collect information from various sources and integrate them together and extract the relevant
information using data mining algorithms [22]. The code complexity and function point analysis
of the software project under development are also calculated using the standard formula for
function point and system development the function point of the system is more actual man-hours inserted by the developers and the development team members. Information synchronization among various phases of software engineering is maintained [23]. The cost estimation of the software engineering project is also important the functional and the non-functional requirement cost is also calculated using the COCOMO model 2 of the software engineering. The cost estimation of the modules and the cost estimation of the entire project can now be easily calculated using the software engineering COCOMO model 2 design. The code complexity of the project is also calculated using the formula which displays the complexity of the software engineering project under development [24]

One of the most common activity which is done by most of the project management software’s is scheduling of the tasks which have been assigned to the stakeholder involved in the project this activity is the primary activity of any project management solution available in the market today. Scheduling of tasks plays an important role in organizing the work in sequence such that all tasks are given priority and based on the priority of the tasks the tasks are executed. Research articles related to task management and resource allocation for individual activities in the project management were utilized in this research work. Work force utilization and resources allocation are major activities which a project manager need to complete as this will help him in
completing project on time for which there are tools such as Gantt Chart which helps project manager and the stakeholder involved in the project management to schedule the project tasks in a timeline each task and subtask which needs to be completed in given time frame is assigned a time slot in the Gantt Chart also resources allocation can be done in Gantt Chart tool for each task and subtask the project manager needs to decide which resource will be suitable to complete this task or subtask on time which depends on the resource knowledge and expertise in his field. Once the resource is allocated to the task or subtask then he will be responsible to complete the task or the subtask on time and deliver the module in time so that the other modules are not left behind by the other stakeholder working on other module in the project.

![Gantt Chart](image)

**Figure 18.** Gantt Chart template with tasks and days to complete the tasks

Task allocation activity is not an easy job for the project manager also as he will be responsible to decide which resource in the company is suitable to complete the task within time with expertise and other knowledge factors which are required to complete the task on time and in the time frame provided by the project manager for the given module to be completed without any delay in the activity [75].

Project planning research articles have also been studied in this research work which have enlightened this research work on how project activities can be planned and how to schedule the tasks at its priority how project management tasks can be executed and aligned to be completed within stipulated time and how the dates can be assigned to each task such that it does not create any problem for the other tasks which needs information from this on going task. Important point while task scheduling is dependency between tasks and how to create and cater to the dependency requirements in the tasks Gantt Chart tool helps in assigning dependency
between tasks and also show which resource is assigned to which task. It also portrays information related to dependency between tasks and how to tackle these dependencies between the tasks and subtasks. Dependent tasks need to be completed soon as the next task which is waiting will take information from the dependent task and will complete its activity soon. Information related to workload and also planning for the holidays need to be done so that the tasks as the project manager will plan all the activities based on the working time of the stakeholder who is responsible to execute the task within time so that the project is completed without any delay and the scheduling on the dependency can be achieved by the project manager who is looking at the project execution activity. Project manager is also responsible to optimally utilize resource to its full efficiency so that all the resources get exact weightage and no resource is underutilized in organization and each resource is allocated with required number of tasks and subtasks such that the project working goes on smoothly if incase an resource is not available to work on any task or subtask within the allocated time frame due to some serious reasons then the task of project manager is to assign some other resource who has knowledge about how to manage and control the activity of ongoing project. Thus optimal resource utilization is also important.

Collaboration with teammates in the same project is important as information regarding the project can be exchanges and tool for doing such communication between various stakeholder in the project needs to be established by the project manager. Also instant communication to customers should be done as some time some tasks in the project require customers intervention and feedback from the customer is important for the project team to progress in the right direction of the project under execution.
Customer need some gateway in the project management tool which will help him in establishing communication with the team members working on his project he can also view the progress of his project and provide feedback were ever necessary for the project manager. Also the customer feedback will help the development team members to progress fast in the project if there are no corrections or errors in design and user interface of the system. As the project is progressing and stakeholders are working on their assigned tasks the customer can get status report about the completion of various task’s and subtasks of his project which portrays that the company is working on the customer’s requirement for which they are being invested by the customer. If such a provision is available, then the project management software will not only be helpful for the software development company but also it will be helpful for the customer to view progress of this project under execution. Evidences can be generated by the software development companies regarding activities which are going on in project these evidences can be generated as reports and displayed to customer regarding the progress of the project which they have given to company for completion project management software can generate reports of evidences related to completed and ongoing project in the company software projects have many phases and at each phase of the project evidences can be generated which will help the company to track various activities of the project at any given time so that these reports can be given as evidences to the top level management of company.
Visual representation of Information regarding the project will help project manager and the customer to view progress and other project related activities in more graphical way. As the amount of data in multiple projects under execution is flooding project management servers its important to visually get information related to each project in readable and visual format so that the stakeholder involved in the project can get graphical view of various status reports of projects [76]. Visual information is more easy to understand and can be easily portrayed top level management of company so as to take necessary action on the ongoing project in the company. Collaboration of various datasets will be needed to generate good visual reports in project management system. Collaborative tools will help various stakeholder to exchange information at different levels in project some project management software’s provide client server model where the collaborators will be using the client system on standalone machine and updated data on the server side by connecting to server using the client login process. Information exchange will should be various activities of project at different levels is important for smooth execution of the project. Project portfolio will help project managers to manage all the activities governing a project in time and within allocated budget project managers task is to organize and break project into tasks which can be completed within time and with allocated budget. Customer satisfaction plays a key role in the project as he will be the end user who will use the product designed by the project management company.

![Figure 20: Project Status Dashboard](image)

Sample data size of 50+ has been collected from various companies and analyzed

**2. Secondary Data Source:**
The secondary data sources are the research articles, books and journal, conference papers which are available for reference also the data which is collected by analyzing the various features and
functions of project management software are taken as secondary data source the values which are generated by analyzing each feature and function of project management software are plotted as a graph. Lots of project management software are now online and can be consumed by the clients as services. These services can be enhanced and can be scaled as and when required based on the demand from the client’s end. Features can be added and dropped by the client when he is consuming these services. As lots of project management companies have now adopted cloud computing all the features and the functions are now available on the cloud to be consumed by the client. The service providers of the project management software offer features as services which can be consumed by the end client as and when required also they can scale the service already consumed based on demand from the organizations requirement. Managing project related data is crucial to all companies and also the key feature which is required any project management software need to manage and maintain this feature. In my research I have analytically collected information about the features and functions which are present in most of the project management software’s which are available in the market today. In this research work I have articulated most common features which are consumed and are provided by most of the vendors of project management software’s. In this data source I have gathered information from various project management related magazines and also research articles from well know sources e.g. IEEE and ACM which I have found useful in writing my research work.

![Figure 21. Project management and Workforce Management](image)

These sources have huge amount of information about project management and their usage also the common mistakes which one does in project management. Some of the sources explain how the clients are consuming the project management resources to boost their productivity. The secondary data sources are greater references which have been written by well-known authors and their contribution in this field of project management, by analyzing these sources I have figured out that information regarding the comparative study of project management software is
missing and needs to be focused upon. Hence this research project focuses on the key features and functions which are required by the industry today [77]. Industries around the world are consuming project management software’s to boost their productivity and most of the project management software companies are providing the features and functions required by these industries. As new projects require new features and functions to be added to the project management lifecycle thus there is a need of scalability of project management software to add these features so that the industries consuming their software’s get the benefit and productivity out of it. So it now becomes the responsibility of project management companies to scale their products or else the client using their software can switch over to some other project management software which provides the features required to manage his projects. Thus it becomes important to select the right project management tool to boost productivity of ongoing project in the industry. Software as a service is being offered by many project management software companies today also PM software modules are now being offered as services so if any company wants to use different modules of project management software then what can be done is modules of project management can be offered as web services and each service can be charged to the client based on usage of service by the requesting client. This will help the client to manage his budget and also to utilize the required services of project management on the go as an when required by the client. Modularization of web services which can be consumed by client require less efforts to deploy and maintain. Secondary data sources have been of great help in analyzing problems related to project management software’s available in the market today some of the sources which are included in this research work talk about how project management industry is progressing today and what will it be twenty years later these research articles have enlighten problems which are present in some project management software and how companies who are using such project management software’s have overcome these issues related to various stages in project management software [78].
Risk management is also an important aspect of project management system as one should inform the customer about various risks governing his on here project. What are the circumstances when risk will be a key factor to consider for the project. As some project management software provide template for the different types of risks involved in the software project. These risks can be overcome by the customer provided he will follow the risk document given by the software company to the customer related to his project. Customer can further take actions based on the risk document and overcome risks associated with his project. Risk can be categorized based on hardware or software project under execution and also one can take precautionary measure to avoid risks associated with different kind of project in software industry. Change control management is also an important part of project management this module will be responsible to manage and maintain changes in the software project under execution. If the software detects any change in any level of software development lifecycle it will record information related to the change which has taken place at any level of the project. Change tracking will help to justify the any action which has gone wrong in project execution if the project is not functional due to any reason change control will monitor all the phases of project management and changes in each phase under execution.
Change control reports can be generated based on phases of the project or at last when the project is completed and ready for delivery to the customer. Change control report can also help in deploying the project correctly at the customer’s end. Changes requested by the customer can be viewed by the software company stakeholders and necessary action can be taken by the stakeholders of the company for example the project manager can notify the development team about which changes to incorporate in the product which the customer has finally requested for. Customer can also see if the change has been incorporated in the project or not and also the progress of project after incorporating the change requested by the customer.

Pipeline management of software project is also important to keep track of how the project manager can fit project development activity within available resources and with allocated budget such that customer project is not delayed and delivered in time with available resources and budget. The project manager is responsible to give estimate if the project can be taken by project management company for execution with available funds and resources available in company [79].
Strategic planning activity is needed by the project manager to cater to the needs of the company to justify that the available resources will be sufficient for completing the customers project on time and with available recourses and funds available in company. Various team members involved in the project require different tools for reporting and project execution each tool is equally important for each phase of the project if the tool is not available it may delay the project execution and will delay the deliver of the project at large for the organization thus company may loose its client if the tool is not provided to the developers or the stakeholder of the project on time. It’s the responsibility of the project manager to provide all necessary tools for project execution and reporting to all the stakeholders in the company who are working on the customer project also the customers control panel should be available so that the customer can view the progress of project and track all the activities going on in this project. Tracking tools will help monitor progress of the project and will help in completing the project on time without any delay. Web services for monitoring these activities such be present in project management software which is purchased or invoked as a services by the software development company. All the above mentioned services will help in completing the project on time and will also provide transparency between customer and software development company project management software will help build communication between various stakeholders of the company. The portfolio of project provides a larger view about project and gives management full control over all the activities of ongoing project. Project manager has full control over all the modules of project and various tasks, activities of projects under his execution thus he is responsible person to control all project related issues which arise in projects under his supervision. Most project
managers generate reports at various stages of the project and produce it as reports to the top management and the customer [80].

Figure 25. Project work breakdown structure

Major concern of any customer is about the progress of project which he has given to software development company for execution. Human resource management is also an important activity which needs to be taken care by project manager and top level management of the software development company. Software which is procured by the software development company should have human resource management module where they can keep track of the human resource which is available in the company this module will be used by the HR department of company and will keep track of every resource available in the company and their data about which project the human resource is currently working on and his position in company. The HR team will also provide information to various other departments in the company who need human resource for the project execution as and when requested by various departments tracking progress of human resource available in the company is also an important activity which needs to be taken care by the software development company and there should be one module in the software project which keeps track of this activity.

3. Sample Size:
Some 50+ samples are collected from various industries and analysis is done on those samples. Comparative study is carried out based on which management software is good for the industry to use. These samples are collected from various stakeholders of the company, which
belong to various positions and are at different levels in the company. Most of the companies consume resources which are common and are available in most project management software’s but some industries have catered needs of features and functions which are not available in most of the project management software’s available in the market today. While collecting and analyzing these samples I have figured out that each industry needs more scalability and more agility in the project management software but as the vendors of the project management software’s have defined features and functions some time it becomes difficulty to select the appropriate project management software to boost the productivity and increase efficiency in the project execution team. Thus its important to select the exact project management tool to boost the productivity and efficiency of the project at large. The sample collected also enlighten that the requirement of the client is ever changing and its difficulty for the project management companies to cater to all the requirements of the client for this customized project management software. Demand and supply of features and functions in projects management software are always a battle in the real world. These samples have helped in identifying various lacunas which are present in project management software and how the demand is increasing for the features which should be present in an ideal project management software. Software development companies and customer have high demands but the available software’s in the market today are either too expensive to procure or they do not provide required features to manage project activity in software companies thus there is always a demand and supply issue which is plaguing the software industry today and management tools should provide all features which are required by various project management companies in many disciplines today. Project management software has many general properties some of which include the PM is web based, hosted on premises, SaaS, licenses and programming language which will be used to deploy the project on clients machine. One of the software which has been studied actively is Active Collab this project management software has many features and functions which can be useful for managing various activities in software project. This project management software is web based also it can be hosted on premises this software has Software as Service the product has propriety licenses and programming language which will be used to deploy this project management software on client side machine is PHP. Second project management software which has been actively studied is Assembla this project management software has less functions as compared to Active Collab. It has been found that Assembla project management software is preferred in some
companies whose features and function requirement are less some of the features and functions which are not present in this product are budget management and invoicing these two tools are separately taken by the companies purchasing Assembla. The budget management tool is required to manage project related budget and funding which is given by client to the project development company also the invoicing module is rarely used in many companies as invoicing software packages are available as open source tools which help in completing the process of invoicing by the project development companies [81]. These modules will not affect project execution in the company as they are supportive modules which help in achieving in atomizing the process of billing and invoicing most companies delete these modules while looking for project management solutions to manage various activities in the project. Some project management software’s cater to these functionalities as web services.