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Software Project Management: Tools assessment, Comparison and suggestions for future development.

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Abstract
Software engineering is concerned with the development and advancement of huge and multiple software intensive systems. It shelters theories, methods and tools for the specification, architecture, design, testing, and maintenance of software systems. Today's development of software systems are significantly large, complex and critical, that only through the use of automated approaches can such systems be developed and evolve in an economic and timely manner. While using automated software tools which is vital for successful planning and managing of projects. There are many automated software tools which have been developed for different purposes in different situation. The literature on how to select the appropriate software project management tools is fairly narrow. The identification of quality project management software among the existing tools in literature is critical. In this paper we predict which project management tools have a great quality and how this quality can be standardized in the futuristic development of project management software.

Keywords:
Software Engineering, Project Management, Software Project Management Tools

1. Introduction

Software project management is the process of planning, organizing, staffing, monitoring, controlling and leading a software project. [17] There are numbers of automated software project management tools available in the market and are increasing rapidly, with significant change in development of these tools, many project managers have started using various software project management tools to manage and support their project activities. These tools are mainly used in planning, monitoring and controlling projects. The features provided with these tools vary. The project managers must choose an appropriate set of tools with necessary features among many tools found in the market to optimize performance [53].

Several tools are found in literature and many researcher evaluate different kind of project management tools [16] and also on the survey based study conducted by Matthew J [18] for the selection of best project management tools in literature in which they evaluated the usage of different project management tools and find that Microsoft Project is widely used for project management. In same manner the study of Joo Tan et. al. [1] regarding the web based project management tools in which they define the criteria on the basis of affordability, accessibility and usage of the tools, they define only the feature of the tools and compare them on the basis of defined criteria. But our approach is little different from those studies, we choose those tools for the assessment which are most common in literature. To find the features of every tool and also explain the features of the existing IEEE standard of project management plan. We find the relationship between the features of tools and standard, on the basis of this relationship the quality of the tools is predicted to find the future guidelines for developing the quality project management tools.

The rest of the parts of this paper presented as follows, Section 2 define the collection of tools for assessment. In Section 3 we define the existing standard for project management. Section 4 we presents the detail of the IEEE standard. Section 5 we fully explore the tools detail with feature and their pros and cons. Section 6 in this section we map the feature of tools on existing standard with the detail mention at indication. Section 7 here we explain the analysis of section 6 and in the last section we draw the conclusion and propose the future direction of work.

2. Tools collection

There are a huge number of Software Project Management Tools exists in literature. Here we present some common tools which are most likely used in many areas. We also present their features which is helpful for any software engineer to choose the right tool.

The list of common tools is mention below.

1. Primavera [18], [23], [24], [35], [37], [38]
2. MS Project [1], [14], [15], [16], [17], [18], [19], [23], [24], [51]
3. GanttProject [23], [24, [45], [46], [47], [51]
4. Redmine [25], [26], [29], [30], [31], [32]
5. BaseCamp [1], [2], [4], [5], [39]

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6. dotProject [1], [22], [27], [49], [50]
7. Assembla [6], [10], [11], [12]

3. Defining Standard

"Standards provide the details of what to do"
We found the standard for the Software Project Management Plan in literature which are mention below.
IEEE Std 16326-2009

4. Detail of Std 16326-2009

"This International Standard is intended to aid project managers in managing to successful conclusion those projects concerned with software-intensive systems and software products. This International Standard specifies the required content of the project management plan (PMP). This International Standard also quotes the extracted purpose and outcome statements from the project processes of ISO/IEC 12207:2008 (IEEE Std 12207-2008) and ISO/IEC 15288:2008 (IEEE Std 15288-2008), and adds detailed guidance for managing projects that use these processes for software products and software intensive systems".

Estimation plan

"Specify the cost and schedule for conducting the project as well as methods, tools, and techniques used to estimate project cost, schedule, resource requirements, and associated confidence levels. In addition, to re-estimate the cost, schedule, and resources needed to complete the project".

Staffing plan

"Specify the number of staff required by skill level, the project phases in which the numbers of personnel and types of skills are needed, and the duration of need. This shall also specify the sources of staff personnel; for example by internal transfer, new hire, or contracted".

Resource acquisition plan

"Specify the plan for acquiring and releasing the resources in addition to personnel needed to successfully complete the project. The resource acquisition plan should include a description of the resource acquisition and release process, including assignment of responsibility for all aspects of resource acquisition. The plan should include, but not be limited to, acquisition and release plans for equipment, computer hardware and software, training, service contracts, transportation, facilities, and administrative and janitorial services".

Project staff training plan

"Specify the training needed to ensure that necessary skill levels in sufficient numbers are available to successfully conduct the project. The training schedule shall include the types of training to be provided, numbers of personnel to be trained, entry and exit criteria for training, and the training method".

Project work plans

"Specify the work activities, schedule, resources, budget and procurement details for the project".

Work activities

"Specify the various work activities to be performed in the project. A work breakdown structure should be used to depict the work activities, for each work activity, factors such as the necessary resources, estimated duration, work products to be produced, acceptance criteria for the work products, and predecessor and successor work activities".

Schedule allocation

"The schedule should include frequent milestones that can be assessed for achievement using objective indicators to assess the scope and quality of work products completed at those milestones. Techniques for depicting schedule relationships may include milestone charts, activity lists, activity Gantt charts, activity networks, critical path networks, and PERT".

Resource allocation

"Resource allocation may include, as appropriate, personnel by skill level and factors such as computing resources, software tools, special testing and simulation facilities, and administrative support. A separate line item should be provided for each type of resource for each work activity".

Budget allocation

"The activity budget shall include the estimated cost for activity personnel and may include, as appropriate, costs for factors such as travel, meetings, computing resources, software tools, special testing and simulation facilities, and administrative support".

Requirement management plan

"Specify the control mechanisms for measuring, reporting, and controlling changes to the product requirements, and the impacts of requirements changes on project schedule, budget, resources, risk and performance throughout the project's life cycle. Techniques that may be used for requirements control include traceability, prototyping and modelling, impact analysis, and reviews".

Schedule control plan

"Specify the control mechanisms to be used to measure the progress of work completed at the major and minor project milestones, to compare actual progress to planned progress, and to implement corrective action when actual progress does not conform to planned progress".

Budget control plan

"Specify the control mechanisms to be used to measure the cost of work completed, to compare planned cost to budgeted cost, and to implement corrective action when actual cost does not conform to budgeted cost".

Quality assurance plan

"Specify the mechanisms to be used to measure and control the quality of the work processes and the resulting

work products. The quality assurance plan shall include provisions for vendor valuation and control. Quality control mechanisms may include quality assurance of work processes, verification and validation, joint reviews, audits, and process assessment".

Subcontractor management plans

"This shall contain plans for selecting and managing any subcontractors that may contribute work products to the project. In particular, requirements management, monitoring of technical progress, schedule and budget control, product acceptance criteria, quality assurance, and measurement and risk management processes shall be included in each subcontractor plan". Project closeout plan

"This shall contain the plans necessary to ensure orderly closeout of the project. Items in the closeout plan should include a staff reassignment plan, a plan for archiving project materials, a plan for post-mortem debriefings of project personnel, and preparation of a final report to include lessons learned and analysis of project objectives achieved".

Supporting process plans

"This shall contain plans for the supporting processes that span the duration of the project. These plans shall include, but are not limited to, project supervision and work environment, decision management, risk management, configuration management, information management, quality assurance and measurement".

Risk management

"This shall specify the risk management plan for identifying, analyzing, and prioritizing project risk factors. This subclause shall also describe the procedures for contingency planning, and the methods to be used in tracking the various risk factors, evaluating changes in the levels of risk factors, and the responses to those changes".

Configuration management

"This shall contain the configuration management plan for the project, to include the methods that will be used to provide configuration identification, control, status accounting, evaluation, and release management. In addition, the processes of configuration management to include procedures for initial baselining of work products, logging and analysis of change requests, change control board procedures, tracking of changes in progress, and procedures for notifying concerned parties when baselines are first established or later changed".

Documentation

"This shall contain the documentation plan for the project, to include plans for generating non-deliverable and deliverable work products. Organizational entities responsible for providing input information, generating, and reviewing the various documents shall be specified in the documentation plan. Non-deliverable work products may include items such as requirements specifications, design documentation, traceability matrices, test plans, meeting minutes and review reports. Deliverable work products may include source code, object code, a user's manual, an on-line help system, a regression test suite, a configuration library and configuration management tool, principles of operation, a maintenance guide".

Quality assurance

"The quality assurance plan should indicate the relationships among the quality assurance, verification and validation, review, audit, configuration management, system engineering, and assessment processes".

Measurement

"Specify the methods, tools, and techniques to be used in collecting and retaining project measures. The measurement plan shall specify the identified information needs, the measures to be collected, the definitions of each measure, and the methods to be used in validating, analyzing, and reporting the measures".

Review and audits

"Specify the schedule, resources, and methods and procedures to be used in conducting project reviews and audits. The plan should specify plans for joint acquirer-supplier reviews, management progress reviews, developer peer reviews, quality assurance audits, and acquirer-conducted reviews and audits".

Verification and validation

"This shall contain the verification and validation plan for the project to include scope, tools, techniques, and responsibilities for the verification and validation work activities. Verification planning should result in specification of techniques such as traceability, milestone reviews, progress reviews, peer reviews, prototyping, simulation, and modelling. Validation planning should result in specification of techniques such as testing, demonstration, analysis, and inspection".

A new clause has implemented in Std 16326-2009

Procurement plan

"This shall list the goods and services that will be purchased for the project and how they will be obtained. It shall specify the types of contracts to be used, who will conduct the procurement, sources of standard procurement documents, the deadline for obtaining each good and service and the lead times needed to conduct the procurement process".

Scope change control plan

"This shall describe how to detect activities out of the project's scope and the actions that are to be taken if such activities are found or requested".

Product delivery

"This shall contain plans for delivery of the project's product(s), and shall specify the product delivery approach, the required information flow both internal to the project and to all external organizations required to support the delivery, the packaging and physical delivery plans, and all associated customer documentation such as operation manuals, maintenance manuals and training materials".

Project supervision and work environment

"This shall state how the project manager provides day-to-day instructions, guidance, and discipline to help project members fulfil their assigned duties. The project manager shall provide a work environment in which project personnel can work together toward common project goals".

Decision management

"This shall specify decision categories based on circumstances and the need for decisions, and shall specify a scheme for their categorization. It shall specify a decision strategy for each decision category. This shall also identify method(s) for tracking and evaluating the outcomes and for supplying the required information for documenting and reporting in accordance with the information management sub-clause".

Information management

"This shall contain the plans for identifying what project information is to be managed, the forms in which the information is to be represented, who is responsible for the various categories of project information, and how project information is to be recorded, stored, made available to designated parties, and disposed of as required".

Communication and publicity

"This shall list the stakeholders that need to receive information about the project, the information to be communicated and the format, content and level of detail. Communication tools can include numerous types of publicity and marketing. The plan shall specify who is responsible for each element of communication, who will receive the communication, the methods and technologies that will be used, the frequency of communication, and how issues will be raised to higher levels of management if they are not resolved within specified timeframes".

5. Overview of Software Project Management Tools

Primavera [15], [18], [23], [24], [35], [37], [38]

Primavera is a best Project Management module is comprehensive, multi-project planning and control software, built on SQL, Oracle, and SQL Server Express server databases for organization wide project management scalability.

Features:

- Scheduling: [21], [35], [44]
  For calculating the project schedules a technique is used known as Critical Path Method (CPM). Activity duration and relationships between activities is used in CPM to calculate the project schedule.
- Tracking: [21], [35], [37]
  This feature assist the Project Manager in performing schedule, cost, and resource analyses by enabling him to access, display, and manipulate project data in a variety of formats.
- Activity [21], [35], [37]
  Many activity operation like add, view, edit, and delete can be done on defined activities for the open projects.
- Reports [21], [35], [44]
  Two reporting tools are available to access and report information stored in the database: the Report Wizard and the Report Editor.
- Resources [21], [38], [44]
  Resources include the personnel and equipment that perform work on activities across all projects. The Project Management module also enables you to distinguish between labor, material, and non-labor resources. Labor and non-labor resources are always time-based, and material resources, such as consumable items, use a unit of measure you can specify.
- Work Breakdown Structure (WBS) [44] , [21]
  A WBS is a hierarchy of work that must be accomplished to complete a project, which defines a product or service to be produced. The WBS is structured in levels of work detail, beginning with the deliverable itself, and is then separated into identifiable work elements.
- Expenses [44], [21]
  Expenses are non-resource costs associated with a project and assigned to a project's activities. They are typically one-time expenditures for non-reusable items.
- Work Products and Documents [44], [21]
  Use Work Product and Document Details to view and edit detailed information about and/or open the selected work product or document.
- Project Threshold [44], [21]
  Use the Project Threshold Details to view or modify information about the selected threshold. The Project Threshold Details appear in the Project Thresholds window.
- Project Risk [43], [21]
  To identify, categorize, and prioritize potential risks associated with specific work breakdown structure (WBS) elements and resources.
- Project Issues [44], [21]
  Issues are known problems within a project plan that require attention or corrective action.

Pros:

- Efficient assessment and overview facility. [15]
- Cost reduction. [15]
- Shared resources. [15]
- Primavera users particularly praised its rigorous and disciplined task logic. [41]
- Primavera P6 is the most effective as it allows the user to define theoretically unlimited number of criteria as priority rules. [42]
- Robust and easy-to-use. [43]

- Provide a single solution to manage the project size and define the level of complexity to the project. [43]

Cons:

- The defect management problem in the beginning was that the development features were prioritized over fault fixes by the scrum team members. In order to fix all the faults, they needed to dedicate one full sprint in the end just for fixing the bugs that were left unfixed earlier. [36]
- Have a less tracking. [40]
- Primavera is also comparatively more expensive than the other similar tools. [40]

MS Project [1], [14], [15], [16], [17], [18], [19], [23], [24], [51]

Microsoft Project have been developed to assist in the monitoring of the progress of projects, automatically requesting and logging status reports from team members and alerting the project manager if these are late or incomplete, [17]. It became the dominant PC-based project management software.

Features:

- Milestone view. [18], [52]
  A reference point marking a major event in a project and used to monitor the project's progress. Any task with zero duration is automatically displayed as a milestone; you can also mark any other task of any duration as a milestone.
- Resource management [20], [52]
  Resources are the people, equipment, and material needed to complete the tasks in a project. Work resources are the people and equipment that do the work of the project.
- Calendar view [20], [52]
  The Calendar view is probably the simplest view available in Project; however, even the Calendar view offers several formatting options.
- User control scheduling [18], [52]
  MS Project 2010 has several scheduling enhancements to improve your control over your schedule. You can also create initial task lists in Microsoft Excel or Word and paste them into Project without having to reformat them.
- Fine tuning the Project plan [18], [52]
  When you build a project plan, you work with tasks, resources, and assignments together. Changes you make to tasks, for example, affect the resources assigned to those tasks.
- Gantt chart view [18], [52]
  The Gantt chart view consists of two parts: a table on the left and a time scaled bar chart on the right. The bars on the chart graphically represent the tasks in the table in terms of start and finish dates, duration, and status (for example, whether work on the task has started or not).
- File management [18], [52]
  Provide the feature of automatically save and recover office files, support different file format, to customize the list of recently used files and save it in earlier version.
- Tracking progress [18], [52]
  Properly tracking actual work and comparing it against the plan enables you to identify variance early and adjust the incomplete portion of the plan when necessary.

Pros:

- Fluent user interface. [18]
- Flexible and ease. [18]
- The manager should know the costs associated with each work and material resource. [52]
- The ability to track actual work in a project plan. [52]
- The Project Guide helps you set up your project plan correctly for the level of tracking you want to do. [52]
- Before tracking actual work in a project plan, you should save a baseline. This gives you a “snapshot” of your initial project plan for later comparison against actual progress. This is one way to tell if your project is on track or not. [52]
- A big time saving of making a new project plan. [52]

Cons:

- There is no indication for new Project users make is to place semi-flexible or inflexible constraints on too many tasks in their projects. Such constraints severely limit your scheduling flexibility. [52]
- It might not be practical or even possible to track tasks that are measured in minutes or hours. [52]

GanttProject [23], [24, [45], [46], [47], [51]

GanttProject is a cross-platform desktop tool and used for project scheduling and management. [47] GanttProject is a multi-application platform for planning and Project management [46] GanttProject can run on any operating system, GanttProject follows the task scheduling process same as defined in the Workflow 2, for saving the schedule the GanttProject uses an XML file format and that can be exported into HTML Webpages [23], and GanttProject conducted the scheduling activities by integrated through the e-Hub enacted workflow. [23], [24]

Features:

- Scheduling [23], [45], [47]
  Gantt chart and resource load chart is used for the identification of project scheduling, [45] and manage PERT charts, export and import charts in several file formats (e.g. PDF and HTML) [47]. The scheduling activities conducted in GanttProject are integrated through the e-Hub enacted workflow.
- Task managing [45], [47]
  For the task management the GanttProject break the all tasks and define the dependency between these tasks.
- Work break down structure [47]

Work break down represent the chunks of the major works, to simplify the scheduling of the activities and find the dependency between the activities.
- Milestone view [47]
  Through the milestone view the whole summary of the project can be understand. GanttProject provide the milestone viewing option for its user to identify the project planning.
- Calendar view [51]
  Calendar view is very important for project planning and scheduling through the calendar the boundary of project and task or activities times can be define. GanttProject provide the calendar view for scheduling and managing the project activities.
- Resource management [47], [51]
  Define the human resources and their work on tasks.

Pros:
- It can be run on any operating system. [23]
- Easy to use. [48]
- Simple gantt-chart functionality. [48]
- Baselining. [48]
- Freeware. [48]

Cons:
- Planing featuers to assistent the project manager are not available. [48]
- Resource leveling and critical path visualization is not available. [48]
- Only the resource strains are visualized. [48]
- GanttProject contains too few instance of Blob. [45]

Redmine [10], [25], [29], [30], [31], [32]

Redmine project management web application tool was introduced during the initial agile implementation in MIMOS, which help the team and capture the requirement. It lists all the product backlogs. [26] Redmine is web based management tool. [29], [30] Redmine is more of a generic project management tool and does not offer a support for agile and scrum. A ticket system was used to submit user stories and tasks. [25]

Features:
- Task identification [25], [29]
  Where's in other tools, representing the task with ID and attribute for description the same is done in Redmine in terms of ticket.
- Issue tracking [26], [28], [30]
  Define you own statuses and issue types Workflow transitions can be set up for each issue type and role through the web-based administration interface (a default configuration can be loaded when installing the application).
- Discussion board [32]
  Discussion of multiple people of the same project can be facilitated through the discussion board.
- Calendar view [28], [34]
  Calendar based on issues start and due dated an automatic gantt chart can be generated.
- News, documents & files management [28], [34]
  Any files can be shared easily with the opportunity of posting messages with the file also.
- Email Notification [25], [28], [34]
  An email can be sent and notify for project activity, change set, news, issues, issue changes for showing the availability of atom feeds.
- Time tracking [28], [34]
  Time can be entered at project or ticket level a simple report can be generated to view the time per user, issue type, category or activity.
- Per project wiki and forums [28], [34]
  Wiki uses textile syntax and free linking within the wiki using brackets Diff and annotate views are available.

Pros:
- Redmine is flexible not rigid. [29]
- In Redmine we can handle the current status and description of each ticket because each ticket contains its own web page. [29]
- Redmine support Software Configuration Management. [30]
- Multi language support. [34]
- Multi database support. [34]
- Redmine provide a graphical representation for changes. [30]

Cons:
- Redmine does not offer specific support for Agile and Scrum. [25], [33]
- No source code management. [33]
- Does not generate the burn down charts automatically. [33]
- Rally and RTC generate the burn down charts automatically whereas Redmine does not. [25]

BaseCamp [1], [2], [4], [5]

It is a web based application tools only require internet access and web browser, it can be access. [2] Basecamp the project collaboration tool offers a free one-active project plan with two writeboards.[1] It allow many project and allowing the storage space for project.

Features:
- Milestone view [1], [3]
  Milestone tab show the calendar on the right side of the page which shows all scheduled milestones with either yellow or blue highlighting and dashboard also provides a 14-day view of milestones due.
- Activity view [1], [3]
  All the activities can be viewed through the dashboard.
- Completed task view [1], [3]
  Completed tasks are clearly marked as strike-off and can be viewed through the dashboard.
- Calendar view [1], [3]

Calendar view displayed on the right side of the page which shows all scheduled milestones with either yellow or blue highlighting.
- Integrated messaging system [1], [3], [4]
  Participants of the same project can chat with each other using the chat tool called Campfire, which is one of group chat room web-based password protected application.
- Effective communication [1], [3]
  The communication channel is on-line so there is no change to delay in the communication setup.
- Time tracking [1], [3]
  The time tracking option is used to keep track on task after every hours [1] and also track the completion time of the project.

Pros:
- It is a useful tool for project collaboration. [1]
- It allows easy upgrade from the free project option to any of the paid plans. [1]
- It also provides an attractive alternate tool option for collaborative teamwork. [1]
- Very Simple [3]
- Editable [3]
- Simple task management [3]

Cons:
- It is so simple and you have to manually create more advanced reports [3]
- People can forget to add time, add later, or change down the road [3]
- Cannot assign specific deadlines [3]

dotProject [1], [22], [27], [49], [50]

It is a web-based project management application, [49] designed to provide project layout and control functions. To understand dotProject, you need to understand what project management is all about. [22]

Features:
- Email based trouble Ticket System [22], [49]
  The documents of meetings status that which documents should be discussed and which minutes documents to be serves for further meeting.
- Schedule analysis [49]
  The fundamental of the Project Monitoring and Control is to understanding a project progress so that the project managers can take corrective action timely to ensure that the project meets its schedule or not.
- Cost analysis [49]
  The fundamental of the Project Monitoring and Control is to understanding a project progress so that the project managers can take corrective action timely to ensure that the project cost is under control and within estimated targets.
- File Repository [22]
  A proper file management is to be done through the File Repository function in the dotProject.
- Calendar view [22]
  dotProject grants the view of the calendar for proper scheduling of the project.
- Discussion Forum [22]
  Through the Discussion Forum in dotProject multiple people of the same project can discuss their issues in a group and found some better result.
- Issue tracking [49]
  After the identification of an issue the project manager specify the project and task and describe the problem, its cause, and planned corrective actions for resolving the issue.
- Risk management [49]
  The add-on module of the dotProject for risk management provides basic functionality for registering risks.
- Task tracker [49]
  The track's which are defined during the project plan. A Task Tracker can be used for these tasks which take the users track time by recording the time during task execution.
- Report generation [49]
  It generates various basic reports, such as a daily/weekly report, a task summary report, project statistics, and schedule comparison Gantt charts, demonstrating actual progress on various tasks (percent completed). It also provides a high-level overview on the effort spent in all ongoing projects.

Pros:
- Free (open source) web based PM tool with a good user interface.[27], [49] ,[50]
- It comes with a good ticket management system and Multi-language support.[27]
- Gantt charts, permissions based access, forums, history function, collaboration through attaching files to tasks/projects.[27]
- It makes it easy to manage multiple companies and multi-projects.[27]
- dotProject is volunteer-supported and provided free. [49]

Cons:
- No hosting available as it needs to be installed on a web server.[27]
- Doesn't provide a mechanism for recording effort required to complete a task.[27]
- Accurate tracking of schedule and cost is difficult. The documentation is cryptic and difficult to understand.[27]
- The developments on this tool seem slow.[27]

Assembla [6], [10], [11], [12]

It is a web based tool; it allows companies to hire its PM applications online. It depends on the project team's need to perform project activities. Some features of the Assembla tool [8], [9], [12] is given below.

Features:
- Milestones view [8], [9]

Milestones view is available to all team member of the project they can easily calculate the progress of the project through the achievements of the targeted milestones.

- Email Integration [8], [9], [12]
  Assembla web-based project management tool provide easy email facility to all the participant of the project.
- Issue tracking [8], [9]
  The project manager describes the problem, defines its cause, and planned corrective actions for resolving the issue by the issue tracking facility provided by Assembla tool.
- Instant messaging [8], [9]
  Any update can be conveyed quickly through the instant messaging facility provided by Assembla tool.
- Ticketing [7], [8], [9], [12]
  Accelerate your team with a task tracking

Pros:

- It can be accessed from anywhere [13]
- Easy to use [13]
- Can be customize as our need [13]
- Brief content [13]

Cons:

- What happens if their server goes down? We have no control over this [13]
- Internet connection is required while using.
- Costly

Indication:

√: The clause presented in standard has been mostly automated in the related features of tools.

P1: Only the cost control mechanism specified in the standard clause "Budget control plan" has been automated in the tracking feature of the tool.

P2: Only the preparation of final report defined in the standard clause "Project Closeout Plan" has been automated in the report feature of the tool.

P3: Only the preparation of meeting minutes & review report in the standard clause "Documentation" has been automated in the report feature of the tool.

P4: Only the expenses charged on the administrative support in the standard clause "Budget Allocation" has been automated in the expenses feature of the tool.

P5: Only on how the issue will be raised to higher level of management if they are not resolved within specified timeframe in the standard clause "Communication & Publicity" has been partially automated to automatically generated issue for consideration in the project issue feature of tool.

P6: As the issue tracking is the additional clause defined by the author in which tracking of the identified issue covered the tool feature project issue partially automate the additional clause issue tracking by automatically generating the issue.

P7: Only to see the work completed at the major and minor project milestones in the standard clause "Schedule Control Plan" has been automated through the milestone review feature of the tool.

P8: Only milestone review in the standard clause "Verification and Validation" has been automated through the milestone review feature of the tool.

P9: Only to estimate the resource requirement in the standard clause "Estimation Plan" has been automated through the resource management feature of the tool.

P10: Only the work activities defined against necessary resources in the standard clause "Work Activities" has been automated through the resource management feature of the tool.

P11: Only the acquisition and release plans for equipment in the standard clause "Resource Acquisition Plan" has been automated through the project plan feature of the tool.

P12: To improve the quality and clarify the variance in plan the quality assurance audits in the standard clause "Review and Audits" has been automated through the track actual work against plan in the tracking progress feature of the tool.

P13: Only to see the work completed at the major and minor project milestones in the standard clause "Schedule Control Plan" has been automated through the milestone review feature of the tool.

P14: Only milestone review in the standard clause "Verification and Validation" has been automated through the milestone review feature of the tool.

P15: Only the preparation of meeting minutes & review report in the standard clause "Documentation" has been automated in the report feature of the tool.

P17: Only milestone review in the standard clause "Verification and Validation" has been automated through the milestone review feature of the tool.

P18: Activity view in the standard clause "Work Activity" has been automated through the GUI activity view feature of the tool.

P19: Only the compare actual progress to planned progress in the standard clause "Schedule Control Plan" has been automated through the Schedule analysis feature of the tool.

P20: Only the preparation of final report in the standard clause "Project closeout plan" has been automated through the report generation feature of the tool.

P21: Only the preparation of meeting minutes & review report in the standard clause "Documentation" has been automated in the report generation feature of the tool.

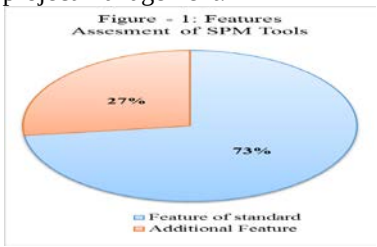
P22: Only to see the work completed at the major and minor project milestones in the standard clause "Schedule Control Plan" has been automated through the milestone review feature of the tool.

P23: Only milestone review in the standard clause "Verification and Validation" has been automated through the milestone review feature of the tool.

6. Gap Analysis

In section 6, while analyzing the existing features of the IEEE standard and the additional features followed for the development of software project, as described in Figure-1, that the additional 27% new features have been used by cloud based software development.

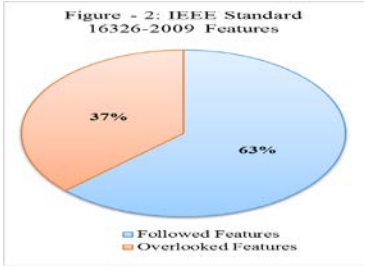
Figure-2 describes that there are 37% features of defined IEEE standard 16326-2009 have been overlooked by automated tools that have been developed for the purposes of software project management.



Refer to the Project Planning clause the Analysis Table at Section-6 shows that, the sub clauses i.e. Staffing plan, Project staff training plan and Procurement plan have been overlooked.

The sub clauses Scope change control plan and Subcontractor management plan of the Project assessment & control have also been overlooked.

The Standard clause i.e. Supporting process plans contains the sub clauses Project supervision, Decision management, Information management, Quality assurance and Measurement have been entirely overlooked by the automated tools. Product delivery clause of the Standard has also overlooked.



The features defined in the standard, like in the Project Planning clause the sub clause Estimation plan has been partially automated in the MS Project tool by the name of feature resource management, the scope of this feature is to estimate and planned the resources. The sub-clause Review and audits of the supporting process plans has been partially automated in the feature of MS Project tool named tracking progress.

7. Analysis

Mapping of tool's Features on Existing Standard.

The sub-clause budget allocation under the project planning clause has been partially automated in Primavera tools.

In the Project assessment and control clause the sub clause Schedule control plan and Project closeout plan, has also been partially automated by various automated tools.

In the Supporting process plans clause the sub clause Verification & Validation, Review & Audits has also been partially automated by various tools.

8. Conclusion and Future Work

We analysis the commonly referred software project management tools in a different way. While mapping the features of SPM tools on the existing IEEE standard. The additional features has been defined separately in the analysis table. We found there are 27% of the new additional features which are not mentioned in the existing standard. We also found that only 63% features of the existing standard are followed by tools and the some of the standard features has been overlooked i.e 37%. The features like, Issue tracking, Calendar view, Email notification and task management are mostly repeated features in most of the tools. The detail of these additional features not clearly mentioned in the existing standard of project management plan. The details of these features and the additional new features can be added in the standard for upcoming software development tools in future.

As currently most of the development of software is done on cloud basis, the web based software development trend grows up very quickly. The web based management tools used for handling such kind of management of software development. The global software development is related with the current circumstances that violates the coverage of the features of existing project management standard. This analysis study can be further enhanced to other web based management tools. On the basis of that new standard for the management of global software development (GSD) can be launched on the basis of finding such kind of additional features of the tools.

S.No	Name of Tools	Feature of Tools	IEEE Standard 16326-2009																											Additional Features									
			Project Planning									Project assessment and control							Supporting process plans																				
			Estimation Plan	Staffing Plan	Resource acquisition plan	Project staff training plan	Work activities	Schedule allocation	Resource allocation	Budget allocation	Procurement plan	Requirement management plan	Scope change control plan	Schedule control plan	Budget control plan	Subcontractor management plan	Project closeout plan	Product delivery	Project supervision	Decision management	Risk management	Configuration management	Information management	*Documentation*	*Communication & publicity*	Quality assurance	Measurement	Review and audits	Verification and validation	Issue Tracking	Calendar View	Discussion Board	E-mail Notification	File Management	Time tracking	Project Threshold	Pre-project wiki	Instant Messaging	Task management
1.	Primavera [15], [18], [35], [23], [24], [37], [38]	Scheduling [35], [21]	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Tracking [35], [37], [21]	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Activity [35], [37], [21]	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Report [35], [44], [21]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2	X	X	X	X	X	X	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Resources [38], [21]	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		WBS [44], [21]	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Expenses [44], [21]	X	X	X	X	X	X	X	4	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Documents [44], [21]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Project Threshold [44], [21]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X
		Project Risk [43], [21]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Project Issues [44], [21]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5	X	X	X	X	6	X	X	X	X	X	X	X	X	X
2.	MS Project [14], [15], [16], [17], [19], [23], [24], [51]	Milestone view [18]	X	X	X	X	✓	X	X	X	X	X	X	7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	8	X	X	X	X	X	X	X	X	X	X
		Resource management [20]	9	X	✓	X	0	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Calendar view [20]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
		Scheduling [18]	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Project plan [18]	X	X	1	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Gantt chart view [18]	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		File management [18]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X
		Tracking progress [18]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	2	X	X	X	X	X	X	X	X	X	X	X
3.	Ganttproject [23], [24], [45], [46], [47], [51]	Scheduling [23], [45], [47]	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Task management [45], [47]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
		WBS [47]	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Milestone view [47]	X	X	X	X	✓	X	X	X	X	X	X	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4	X	X	X	X	X	X	X	X	X	X
		Calendar view [51]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
		Resource management [47], [51]	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.	Redmine [10], [25], [29], [30], [31], [32]	Task identification [25], [29]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
		Issue tracking [26], [28], [30]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X
		Discussion board [32]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X
		Calendar view [34]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
		Documents & File Management [34]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X
		Email Notification [25], [34]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X
		Time tracking [34]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X
		Pre project wiki [28], [34]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X
5.	BaseCamp [1], [2], [4], [5]	Milestone view [1], [3]	X	X	X	X	✓	X	X	X	X	X	X	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	7	X	X	X	X	X	X	X	X	X	X
		Activity view [1], [3]	X	X	X	X	8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Task view [1], [3]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
		Calendar view [1], [3]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
		Integrated messaging [1], [3], [4]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X
		Communication [1], [3]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Time tracking [1], [3]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X
6.	Dotproject [22], [27], [49], [50]	Email system [22]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X
		Schedule analysis [49]	X	X	X	X	X	X	X	X	X	X	X	9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Cost analysis [49]	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		File repository [22]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X
		Calendar view [22]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
		Discussion forum [22]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X
		Issue tracking [49]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X
		Risk management [49]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		Task tracker [49]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
		Report generation [49]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.	Assembla [6], [10], [11], [12]	Milestone view [8], [9]	X	X	X	X	✓	X	X	X	X	X	X	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3	X	X	X	X	X	X	X	X	X	X
		Email integration [8], [9], [12]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X
		Issue tracking [8], [9]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X
		Instant messaging [8], [9]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X
		Task tracking [7], [8], [9], [12]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓

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