

SOFTWARE PROJECT MANAGEMENT BEST PRACTICES: A RESEARCH STUDY

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Abstract

Managing software projects is difficult even under the best circumstances. One can reduce the difficulty and increase one's chances of success by applying known industry best practices for software project management. Best practices are based on industry studies of successful and failed projects.

The main thrust of survey is the concept of knowledge management. It is actually conducted to get the experiences of such companies those use models or some what modified form of standards to get knowledge about what the company actually has done to achieve consistency across project teams and project. It is fact, generally defined and well implemented project management processes increase the ability to track and monitor performance with a view to improve, is far more successful.

I have tried to get the best practices out of the successful companies to share the ideas and to come up with standardized approach for Software Project Management especially for small scale organizations. This research study has explored best software project management practices and local software industry norms to formalize a process framework.

This research survey paper has two parts, first part covers the theoretical knowledge of best practices from the different knowledge pools and second part covers the survey resulted best practices. The research survey study has achieved the following objectives:

- 1. Risks, and obstacles in software project management*
- 2. Solutions to cover up shortcomings*
- 3. Best practices*

Key Words: PM, SPM, SQA, SCM, RM, CMM

1. SOFTWARE PROJECT MANAGEMENT

1.1. History

Project management was not used as an isolated concept before the Sputnik crisis of the Cold War. After this crisis, the United States Department of Defense needed to speed up the military project process and new tools (models) for achieving this goal were invented. In 1958 they invented the Program Evaluation and Review Technique or PERT, as part of the Polaris missile submarine program. At the same time, the Dupont Corporation invented a similar model called CPM, critical path method. PERT was later extended with a work breakdown structure or WBS. The process flow and structure of the military undertakings quickly spread into many private enterprises.

There are a number of guiding techniques that have been developed over the years that can be used to formally specify exactly how the project will be managed. These include the Project Management Body of Knowledge (PMBOK), and such ideas as the Personal Software Process (PSP), and the Team Software Process (TSP). These techniques attempt to standardize the practices of the development team making them easier to predict and manage as well as track. Critical chain is the latest extension to the traditional critical path method.

In critical studies of project management, it has been noted that several of these fundamentally PERT-based models are not well suited for the multi-project company environment of today. Most of them are aimed at very large-scale, one-time, non-routine project, and nowadays all kinds of management are expressed in terms of projects. Using complex models for "projects" (or rather "tasks") spanning a few weeks has been proven to cause unnecessary costs and low maneuverability in several cases. Instead project management experts try to identify different "lightweight" models, such as, for example Extreme Programming for software development and Scrum techniques.

1.2. Introduction

Project management is the ensemble of activities concerned with successfully achieving a set of goals. This includes planning, scheduling and maintaining progress of the activities that comprise the project. Reduced to its simplest Project Management is the discipline of maintaining the risk of failure at as low a value as necessary over the lifetime of the project. Risk of failure arises primarily from the presence of uncertainty at all stages of a project.

An alternate point of view is that Software Project Management is the discipline of defining and achieving targets while optimizing the use of resources (time, money, people, space, etc).

Project management is often the province and responsibility of an individual Project Manager. This individual seldom participates directly in the activities that produce the end result, but rather strives to maintain the progress and productive mutual interaction of various parties in such a way that overall risk of failure is reduced.

A project could literally be as simple as making breakfast, but in the context of the practice of project management a project is best defined as an undertaking with a discrete start, a discrete finish, and some complexity. Compare this to, say, and a manufacturing line, which is intended to be a continuous process without a planned end.

Typical software projects might include the computer software program, or development of the real time applications for business, health, engineering, industry etc. The duration of a project is the time from its start to its completion, which can take days, weeks, months or even years.

Generally, there are two approaches that can be taken to project management today. The "traditional" approach identifies a sequence of steps to be completed. This contrasts with the "Agile Methods" approach in which the project is seen as relatively small tasks rather than a complete process. The objective of this approach is to impose as little overhead as possible in the form of rationale, justification, documentation, reporting, meetings, and permission.

1.3. Project Development Phases

"Net site" is a US company which following its own framework, and its quite

popular and praiseworthy. According to them, major software project lifecycle could contain the following phases: [2]

Deliverable	Form	Phase
Stage one		
Project Overview	Document	Pre-Analysis
Project Business Plan	Document	Pre-Analysis
Initial Estimate	Document	Pre-Analysis
Stage two		
User Requirements	Document	Requirement Analysis
Technical Requirements	Document	Requirement Analysis
Paper Prototype	Document	Requirement Analysis
Electronic Prototype	Software	Requirement Analysis
Time & Cost Estimate	Document	Requirement Analysis
Pre-Design Sign Off	Document	Pre-Design
Stage three		
Infrastructure Design	Document	Design
Systems Design	Document	Design
Application Design	Document	Design
Project Plan	Document	Design
Time & Cost Quotation	Document	Design
Design Sign Off	Document	Design
Stage four		
Infrastructure Installation	Hardware /Software	Development
Systems Installation	Hardware /Software	Development
Application Development	Software	Development
Development Beta Test Report	Document	Development
Development Sign Off	Document	Development
Stage five		
Live System Delivery	Hardware /Software	Development
Infrastructure Specification	Document	Development
System Specification	Document	Development
Application Technical Specification	Document	Development
User Documentation	Document	Development
Deployment Sign Off	Document	Development
Stage six		
Post Deployment Assessment	Document	Post Analysis

Table 1: SPM Stage wise Deliverables

By applying this simple set of definite steps and deliverables at the outset and relating this to a transparent time and cost structure, it provides clients with an effective framework against which to measure expectation, quality, progress and cost for their project.

In addition to providing the technical lifecycle framework, it also provides clients with a simple step by step plan at the outset of their project, which details how each step is initiated, what documents or details are required from the client to enable the activities to be carried out and where feedback or confirmation is likely to be needed, to ensure that the deliverables meet the need.

Alongside this, a transparent payment schedule is submitted in advance, to allow budget cash flow to be managed effectively in line with progress of the project. To give clients even more flexibility and control, it treats each phase as a separate billable service, so if a client only wants a design to be created by it, they just commission for the design phase, or if by the end of the design phase, business priorities have changed or budgets have been constrained, the subsequent project phases can be shelved or postponed with no further commitment.

1.4. Project Management Lifecycle

Every software project management effort goes through a life cycle, a process that includes all activities in the management and development cycles that take place up to initial delivery. The main function of a life cycle model is to establish the order in which a project initiates, implements, and performs its activities. The appropriate life cycle model can streamline project and help ensure that each step moves closer toward project goal. [3]

A project can mainly divided into major parts, briefly a part can have one or more phases and a phase can have one or more stages. The Figure 1 depicts the Software Project Management Lifecycle.

1.5. Notional SPM Practices

The best practices are summarized in the Figure 2 and details can be seen from the reference [8, 9, 10, 11].

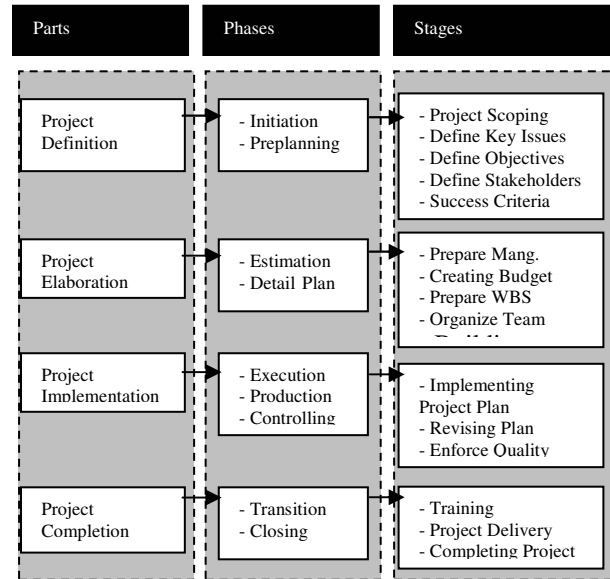
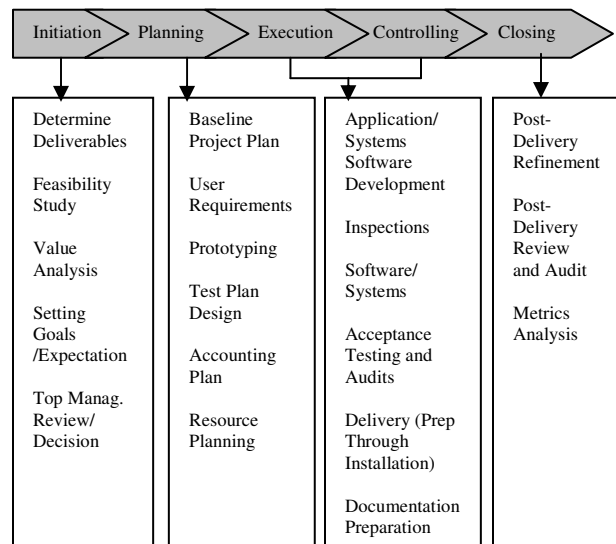


Figure 1: SPM Phases and Sub-Phases (Stages)



3. SURVEY BRIEFINGS

3.1. Survey Methodology

Survey is conducted through informal analysis technique, Questionnaire. There are three levels o phases of survey: Phase I is conducted to get General SPM Process Areas and relevant information, Phase II is conducted to get the Practices of SPM Process Areas and relevant information, Phase III is conducted to get the Risks, obstacles, and Issues while

implementing the surveyed practices. Results are tabulated and presented graphically. Each survey has open ended questions and answers are kept undisclosed to avoid biasness.

3.2. Survey Blueprint

As there are three levels or phases of survey, in phase I, each survey question has assigned a maximum marks depending on the participant. The scored marks for each question are the votes given by the participants.

4. PHASE-I SURVEY VERDICT

4.1. Main Components of SPM

There are many main components of Software Project Management; these components can be ranked into to processes and practices. The general components identified by this survey are given in Table No. 2.

No.	Component	Description
1	Client Management	It deals with client, client oriented software quality attribute, and client oriented change management, client commitment management.
2	Team Management	It deals with coordination with team, team meeting sessions, team conflict management, and team job assignment.
3	Requirement Management	It deals with requirement change management, requirement validity, requirement traceability, requirement leveling and incorporation.
4	Planning and Estimation	It deals with tasks identification, resources identification and estimations.
5	Risk Management	It deals with identification of issues and problems, identification of solution to issues, and mitigation policies.
6	Monitoring and Control	It deals with monitoring and controlling tasks, progress, and check and balance on resources, cost, timelines and performance.
7	Change	It deals with over all change

	Management	management in software product or process.
8	Domain Knowledge	It deals with the domain expertise and experiences. It also enforces to do R&D work if there is a lack of sound domain knowledge.

Table 2: SPM Component List

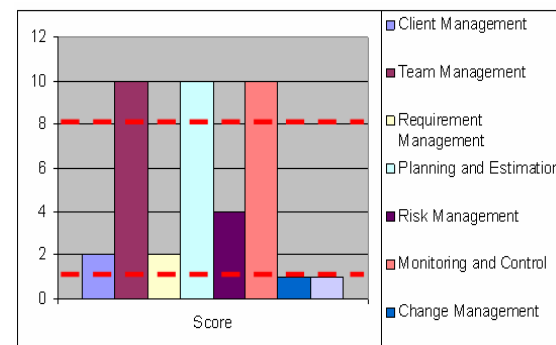
In Table 2, Client Management and Domain Knowledge are quite new components and require a lot of effort in these areas. Majority of components are traditional but components like risk management and requirement management are not so much practiced.

The survey has reported some of the best and prominence components to incorporate in general Software Project Management, In Table 3, components are ranked with scores. The maximum score is 10 due to ten participant companies.

No.	Component	Score	Percentage
1	Client Management	2	20%
2	Team Management	10	100%
3	Requirement Management	2	20%
4	Planning and Estimation	10	100%
5	Risk Management	4	40%
6	Monitoring and Control	10	100%
7	Change Management	1	10%
8	Domain Knowledge	1	10%

Table 3: SPM Component Score

In Table 3, Planning and Estimation, Team Management and Coordination, and Monitoring and Control are most demanding and emphasizing component so they must be incorporated and managed. In Graph 1 two boundary lines are drawn against the scores.



Graph 1: SPM Component Score Chart

In Figure 3, the above dashed line at score 8 shows entry line for mandatory components and below dashed line at score 1 shows negligible component. So it means the components having minimum score 8 must be done, and components having maximum score 1 can be ignored.

4.2. SPM Process Areas and Components

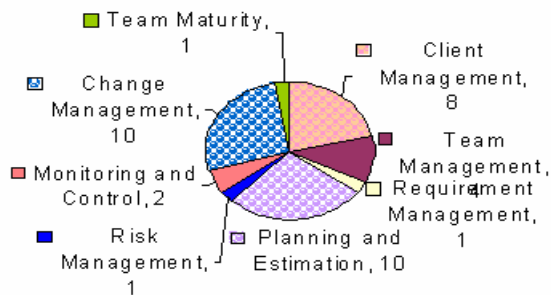
4.2.1. Critical Process Areas and Components

There are many general SPM components or areas but few of them are critical, critical in a sense that they are hard to implement or they risky and challenging. The Table No. 4 depicts the most critical areas or components of SPM. Each component or area has been ranked with a score out of 10 marks.

In Graph 2, the textured filled pies represent most critical SPM components, and indicates special care requirement while implementing or handling them. Client Management, Planning and Estimation and Change Management are most critical process areas and components of the Software Project Management.

No.	Component	Score	Percentage
1	Client Management	8	80%
2	Team Management	4	40%
3	Requirement Management	1	10%
4	Planning and Estimation	10	100%
5	Risk Management	1	10%
6	Monitoring and Control	2	20%
7	Change Management	10	100%
8	Team Maturity	1	10%

Table 4: SPM Critical Component Score



Graph 2: Critical SPM Components Chart

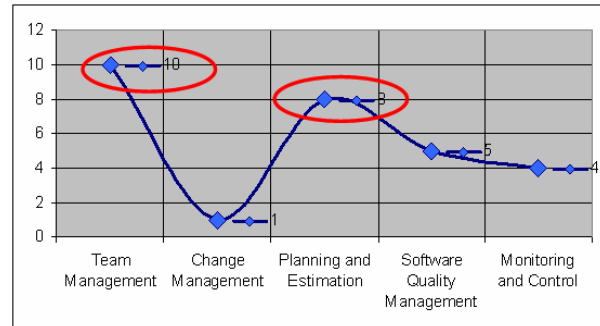
4.2.2. Strong SPM Process Areas and Components

Survey has reported that there many strong SPM areas and components which are exceedingly trouble-free to manage and uncomplicated in local software sector of Lahore. Table No. 5 shows strong SPM process areas and components, each process area and component is ranked with a score.

No.	Component	Score	Percentage
1	Team Management	10	100%
2	Change Management	1	10%
3	Planning and Estimation	8	80%
4	Software Quality Management	5	50%
5	Monitoring and Control	4	40%

Table 5: Strong SPM Component Score

The encircled areas are strong SPM areas and components in local software sector. In Graph 3 we can see that Team Management and Planning are quite strong components.



Graph 3: Strong SPM Component Chart

4.2.3. Weak SPM Process Areas and Components

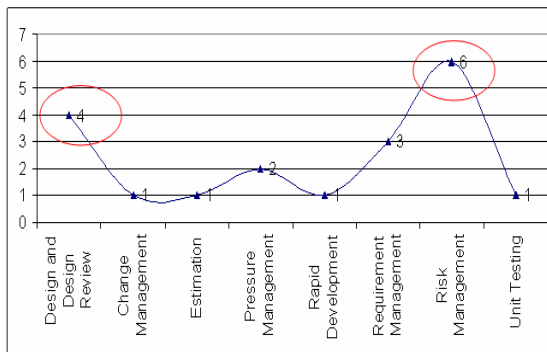
Survey has reported that there are many weak SPM process areas and components in Local Software Sector, where exceptional concern should be paid. The Table 6 shows the list of weak SPM process areas and components and each area and component is ranked with help of a score.

No.	Component	Score	Percentage
1	Design and Design Review	4	40%
2	Change Management	1	10%
3	Estimation	1	10%
4	Pressure Management	2	20%

5	Rapid Development	1	10%
6	Requirement Management	3	30%
7	Risk Management	6	60%
8	Unit Testing	1	10%

Table 6: Weak SPM Component Score

In Graph 4 the encircled are most weak areas and components. The Risk Management and Design Review are weak in local software sector.



Graph 4: Weak SPM Component Score

4.2.4. Most common SPM Issues

Survey has reported the following common issues as follows:

1. Coordination with marketing
2. Lack of R&D and process improvement resources
3. Lack of project management tools
4. Lack of domain and technology focus and reusable code
5. Lack of communication and support from top management
6. Lack of project management training
7. Poor change management
8. Lack of written and verbal communication skills
9. Lack of domain knowledge
10. Disability to manage the pressure
11. Poor Quality Management
12. Poor Designing and Testing
13. Lack of SPM Techniques
14. High turnover rate

5. PHASE-II SURVEY VERDICT

5.1. Most Critical SPM Process Areas' Practices

As I have already reported the most critical SPM process areas, the survey was also conducted for the critical practices for reported areas from each individual, but in this report, I have written the only most critical process areas based on the consensus of survey participant after compiling the results. The most critical process areas are:

1. Team Management
2. Planning and Estimation
3. Monitoring and Control
4. Risk Management

The less critical process areas are:

1. Change Management
2. Requirement Management
3. Client Management

5.1.1. Team Management Best Practices

The most critical steps of practices involved in team management are given as:

1. Team Selection and Role Assignment
2. 2-Task Assignment
3. Personal conflicts Resolutions
4. Formal and Informal Status Progress, & issue meetings
5. Issue resolution, both project related

5.1.2. Planning and Estimation Best Practices

The following are most critical practices for planning and estimation:

1. Task Identification
2. Task Dependencies Identification
3. Resources Identification
4. Duration Estimation
5. Resources Estimation
6. Effort Estimation
7. Cost Estimation
8. Assignment of Resources to Task

5.1.3. Monitoring and Control Best Practices

The following are most critical practices for monitoring and controlling:

1. Formal and Informal Progress Monitoring
2. Issue Resolution and handling of unexpected events
3. Change Management
4. Replanning to handle derivations from original plan

5.1.4. Risk Management Best Practices

The following are the most critical practices for risk management:

1. Identification of risks
2. Documentation and communication of risks to all concerned people and parties
3. 3-Contingency planning and mitigation strategies

5.1.5. Client Management Best Practices

The following are the most critical practices for client management:

1. Agreement on communication channels (Medium)
2. Identification of Interface personal, Structure, Roles and responsibilities
3. Contract Negotiation and Agreement of terms and conditions
4. Change Management, client Query and Request Handling
5. Client relationship Management

5.1.6. Requirement Management Best Practices

The following are the most critical practices for requirement management:

1. Requirement Identification, Clarification, Documentation
2. Client Review, Walkthrough, Feedback and updates
3. Requirement Change Management
4. Requirement prioritization and incremental planning
5. Traceability Matrix

5.1.7. Change Management Best Practices

The following are the most critical practices for change management:

1. Definition of process

2. Communication and agreement of process with all concerned people
3. Implementation and monitoring of process

6. PHASE-III SURVEY VERDICT

6.1. SPM Practices' Critical Issues

Survey has reported many critical issues, risks and obstacles while implementing the SPM practices, the issues are categorized into SPM Process Areas issues.

6.1.1. Project Planning and Estimation Issues

The critical issues in project planning and estimation are given as:

1. Timeline pressure from the client and from marketing group
2. Generally the Project Manager is from the development (programming group), so there is a tendency to keep just development group and not the rest of the groups (QA, DB etc.) updated about project progress and issues
3. Interpersonal issues between development groups (QA, Development, and System Administration etc.)

6.1.2. Change Management Issues

The critical issues in change management are given as:

1. Not following any well defined process, can lead to issues such as ill-defined implementation, failure to meet timelines etc.
2. In order to meet some internal timeline, clients tend to initiate a project without having the consent of all stake holders. This leads to frequents changes in functionality and scope after the development work has been initiated
3. Marketing/higher management tends to support the client in such scenarios
4. When changes are implemented in a rush, proper documentation is not done which can cause maintenance issues later.
5. Frequent changes tend to deform the initial design/architecture and result in a poorly designed/implemented product, which

may be performing the required tasks but is very difficult to maintain and extend.

6. Lack of investment in re-engineering when required

6.1.3. Risk Management Issues

The critical issues in risk management are given as:

1. Timeline constraints are some times ignored
2. Human resource constraints are mostly ignored
3. Lack of awareness and training
4. No proactive actions are defined for identified risks
5. Lack of proper tools

6.1.4. Team Management Issues

The critical issues in team management are given as:

1. High turnover rate
2. Poor prioritization at upper management level related to team management issues
3. Active political lobbies
4. Lack of ownership of project

6.1.5. Controlling and Monitoring Issues

The critical issues in monitoring and controlling are given as:

1. Lack of proper tools
2. Lack of periodic inspections and audits
3. Lack of proper reporting mechanism

6.1.6. Client Management Issues

The critical issues in client management are:

1. Lack of PM training
2. Lack of upper management support
3. Lack of education at client side
4. Bad Marketing Conditions
5. Lack of training and education of marketing people

6.1.7. Requirement Management Issues

The critical issues in requirement management are given as:

1. Lack of processes
2. Lack of change control
3. Lack of tools for traceability
4. Lack of awareness
5. Lack of investment of time and effort by client and developers

6.2. SPM Practices' Critical Success Factors

The critical success factors are those parameters which directly impact the performance or productivity of a process. The identified factors are:

6.2.1. Client Management Critical Success Factors

The critical success factors identified in client management are:

1. Building the right relationship and maintaining it
2. Contract definition and management
3. Client side commitments schedules and reporting
4. Terms of Reference and Conditions Documentation
5. Milestone reporting and time and cost updates reporting

6.2.2. Team Management Critical Success Factors

The critical success factors identified in the survey report are:

1. Getting the right people and right team combination (selection)
2. Establishing good communication (Formal and Informal)
3. Team building and training
4. Issue Resolution
5. Proper Reporting and Feedback Mechanism

6.2.3. Requirement Management Critical Success Factors

The critical success factors identified in requirement management are:

1. All level requirements (BR, UR, FR, and NFR)
2. Proper process

3. Change control process
4. Proper prioritization
5. Stakeholder list
6. Traceability Matrix

6.2.4. Risk Management Critical Success Factors

The critical success factors identified in risk management are:

1. Critical Risk Identification Process
2. Risk Prioritization Process
3. Mitigation and Monitoring Process
4. Risk Management Training
5. Reporting of Identified risks to stakeholders
6. Investment of time and cost

6.2.5. Change Management Critical Success Factors

The critical success factors identified in change management are:

1. A simple and effective process
2. Change prioritization process
3. Impact Analysis and Reposting process
4. Change Traceability process

6.2.6. Project Controlling and Monitoring Critical Success Factors

The critical success factors identified in monitoring and controlling the project are:

1. Proper controlling process at balanced level
2. Timely Communication with all involved people
3. Timely Issue Resolution
4. Periodic updates in plans
5. Proper reporting process

6.2.7. Project Planning Critical Success Factors

The critical success factors identified in project planning are:

1. Proper Work Break Structure
2. Critical Path of Project Plan
3. Precise and Accurate Estimates
4. Planning Tools

5. Ability to have a complete grasp of the overall development process for a particular project
6. Ability to effectively communicate views related to development timelines and other development concerns to the client and to upper management
7. Ability to keep various development groups in synchronous and in harmony
8. Technical skills of the development team

7. CONCLUSION

The survey results are satisfactory and acceptable to some extent. One of the major key issues identified during this survey is "Higher Management Attitude". Majority of the issues have been coming from management side and project manager (PM) role is vital in this regard as he or she needs to communicate with higher and lower management in both directions. PM is responsible for awaking the higher management for quality processes and motivating the lower management to do follow quality processes. Again the issues will remain same if standardized processes could not become the actual processes. To make standard processes as actual processes, time, cost and constant effort is required from all level of management. For any kind of evolutionary or revolutionary activity across the organization needs commitment from the higher management.

8. FUTURE WORK

This survey report has some limitations as it gives a bird view to project management issues; suggested processes are quite optimistic and again voluminous. I could not be able to come up with a framework due to shortage of time. This survey is conducted over a limited sample pool so there is a great scope improvement and enhancement in following ways:

1. Conduct the survey over vast sample pool
2. Shortlist the practices and process areas
3. Make framework of best SPM practices

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