MODERN TREND ANALYSIS IN SOFTWARE PRODUCT DEVELOPMENT: A PATH MODEL FOR PREDICTING TECHNOLOGY

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Abstract

A CMMI Level 3 certified organization has been explored for this project work. One particular project is selected as a focus project to analyze the modern processes with their tools and techniques. However, there are some other projects selected and evaluated to compare the performance of the focus project with those projects of the organization. This project is selected as the success rate in software industry is very less. Detailed statement of problem is mentioned in Idea Generation section.

Research Methodology with different data collection methods are described in section 3.5 [**Methodology**].

Findings & recommendations are described in the section 7.0 [**Conclusion & Recommendation**].

Keywords :

Modern trend analysis, project management, software product development, research organization

List of Symbols, Abbreviations and Nomenclature:

NASA - National Aeronautics and Space Administration• US – United States• PMI - Project Management Institute• PMP - Project management Professional• USA - United States of America• IT - Information Technology• NA - Not Applicable• FR - Functional Requirement•

FS - Functional Specification• SDD - Software Design Document• WBS - Work Breakdown Structure• PDLC - Product Development Life Cycle• PLC - Product Life Cycle• IS - Information Service• HR - Human Resource• OOAD – Object Oriented Analysis•& Design VSS – Visual Source Safe• JDBC – Java Data Base Connectivity• PL/SQL – Procedural Language/ Structure Query Language• UML – Unified Modeling Language• SPM – Software Project Manager• AMC – Annual Maintenance Contract• CR – Change Request• BAP – Business Assurance Program• 7 CSI - Customer Satisfaction Index• CTD - Cumulative Till Date• DRE - Defect Removal Efficiency• RE - Review Effectiveness• TE - Test Effectiveness• MTTRSP - Time Taken To Respond• MTFB - Mean Time taken To Solve• QMS - Quality Management System• GUI – Graphical User Interface• QAG - Quality Assurance Group• QAT – Quality Audit Team• IQA – Internal Quality Audit• PPQA – Process•& Product Quality Assurance CI – Configuration Item• CEO – Chief Executive Officer• SPD – Software Product Development•PMBoK – Project Management Body of Knowledge• CMMI – Capability Maturity Model Integration• TBD – To Be Decided•

Introduction:

The explosion of internet has occurred enabling instant accessibility of any kind of information to anyone willing to invest a modest amount for this facility. This has made possible the virtual project office. Enterprise Resource Planning and e-procurement are widely adopted by several companies. This implies that we are now in a period where velocity is the key word for survival or growth of companies. Although many large private and public limited companies and companies in the public sector are now adopting scientific project management techniques in India, this profession is still evolving in our country. In this context, it is noteworthy that good practices in project management developed and being updated every few years by the Project Management Institute (PMI), U.S.A is also gaining acceptance in India, as seen by companies encouraging their selected employees to obtain the PMP certification (Project management Professional) launched by PMI. PMI is a professional organization for people who manage projects. A major objective of PMI is to advance project management as a profession.

Define, Measure, analyze, improve, standardize (DMAIS)

Define– benchmark, customer requirement, process flow map, quality function deployment, project management plan.

Measure – data collection, defect metrics, sampling.

Analyze – cause and effect, failure modes and effect analysis, decision and risk analysis, root cause analysis, reliability analysis.

Improve – design of experiments, modeling, and robust design.

Standardize – control charts, time series, procedural adherence, performance management, preventive activities.

2.0 Project Scope

Scope of this Assignment is limited to modern trends of project management used in software product development for the research organization.

Following is the major list regarding the scope of this project work.

1. Software project management methods and processes are followed or not.

2. Different project management tools & techniques are used or not.

3. Different processes are monitored or not.

4. Whether findings or outcome of different processes are analyzed or not.

5. Find out improvement scope in any area of project management processes.

6. Finally, preparation of a recommendation list for future project.

3.0 Aims and Objectives

The aim of this particular paper: Verifies and tests existing facts and theory and these help improving our knowledge and ability to handle situations and events.

General laws developed through research may enable us to make reliable predictions of events yet to happen. It aims to analyze inter-relationships between variables and to derive causal explanations: and thus enables us to have a better understanding of the project to control it.

Objectives are set under three headings:

3.1 Performance and Quality

The end result of a project must fit the purpose for which it was intended. At one time, quality was seen as the responsibility of the quality control department. In more recent years the concept of total quality management has come to the fore, with the responsibility for quality shared by all staff from top management downwards. We can control this by measuring defect density and analyzing the root cause of identified defects.

3.2 Effort/Budget

The project must be completed without exceeding the authorized expenditure. Financial sources are not always inexhaustible and a project might be abandoned altogether if funds run out before completion. If that was to happen, the money and effort invested in the project would be forfeited and written off. In extreme cases the project contractor could face ruin. There are 21 many projects where there is no direct profit motive, however it is still important to pay proper attention to the cost budgets, and financial management remains essential. We can control this by monitoring the effort & cost variance (actual vs. budgeted).

3.3 Time to Completion

Actual progress has to match or beat planned progress. All significant stages of the project must take place no later than their specified dates, to result in total completion on or before the planned finish date. The timescale objective is extremely important because late completion of a project is not very likely to please the project purchaser or the sponsor. We can control this by monitoring the schedule variance (actual vs. baseline).

3.4 Hypothesis to be tested

The hypothesis to be tested here is “Whether complete modern trends are followed or not”.

3.5 Methodology

3.5.1 Research Type

Here we used Descriptive Study type of research through empirical observation. It is a fact-finding investigation with adequate interpretation. It is the simplest type of research. It is more specific than an exploratory research. It aims at identifying the various characteristics of a community or institution or problem under study and also aims at a classification of the range of elements comprising the subject matter of study. It can highlight important methodological aspects of data collection and interpretation. The information obtained may be useful for prediction about areas of social life outside the boundaries of the research. They are valuable in providing facts needed for planning social action program.

3.5.2 Sources of data : Primary sources of data are used for analysis which is directly collected & precisely according to research needs.

3.5.3 Data Collection: Method Primary data are first hand information collected through Interview and participative observation method.

3.5.3.1 Interview : Data for this Project has been collected through interviews of the project managers of the on-going and past projects.

3.5.3.2 Observation : In this observation, the observer is a part of the phenomenon or group which is observed and he acts as both an observer and a participant. Here modern trends in project management are studied by a team leader by taking part in software product development and data are collected up to 2 decimal places. The advantages of participant observation are: The observer can understand the actual result of the observed events, and get a deeper insight of their occurrences. The observer will be able to record the context which gives meaning to the observed behavior.

3.5.3.3 Records : I have used existing records of the projects of different types.

4.0 Idea Generation

4.1 Need Identification

Most software projects fail. In fact, the Standish group reports that over 80% of projects are unsuccessful either because they are over budget, late, missing function, or a combination. Moreover, 30% of software projects are so poorly executed that they are canceled before completion. In our experience, software projects using modern technologies such as Java, J2EE, XML, and Web Services are no exception to this rule. A survey of IT experts revealed 43 percent of their organizations had recently killed an IT project. Not only that, now companies want to deliver products and services better, faster, and cheaper. At the same time, in the high-technology environment of the twenty-first century, nearly all organizations have found themselves building increasingly complex products and services. Today, a single company usually does not develop all the components that compose a product or service. More commonly, some components are built in-house and some are acquired; then all the components are integrated into the final product or service. Organizations must be able to manage and control this complex development and maintenance process. The problems these organizations address today involve enterprise wide solutions that require an integrated approach. Effective management of organizational assets is critical to business success. In essence, these organizations are product and service developers that need a way to manage an integrated approach to their development activities as part of achieving their business objectives. So Project management process is very much necessary to develop a software application across all IT industries. This research describes modern trends of project management process that help to improve the success of any project.

4.2 Alternative evaluation

The project life cycles (Project development life cycle, product development life cycle, Project delivery & implementation life cycle etc.) are evaluated for different types of projects. Different processes of standard like CMMI, ISO, PMBoK and some modern key processes are evaluated for different types of projects (like - Pure development Project, AMC project, MSO project, BAP project etc). Selection of a project life cycle or certain project management processes are done depending on project complexity, resource expertise, technology used etc.

4.3 Project defined processes

4.3.1 PMBoK Processes

The objective of this Project Management Process is to ensure that the project management functionaries focus on dispatching project deliverables as per expressed, implied and agreed client expectations, on agreed dates, and in a mode that is acceptable to the client. While doing so, due attention is paid to optimum utilization of project resources and optimization of project costs Project management processes are divided into five groups, defined as the Project Management Process Groups, each group comprising one or more processes. This grouping helps in understanding the relevance and significance of the sequence of, and interaction between the various processes in project management. However, a process group is not a totally discrete phase occurring in isolation from another process group, and the processes have inherent interactions between themselves throughout the implementation life cycle of a project.

Brief **definition** of these process groups are as under:

1. **Initiating process group** – defines and authorizes the project or a project phase.

2. **Planning process group** – defines and redefines objectives and plans the course of action required to attain the objectives and scope that the project was undertaken to address.

3. **Executing process group** – integrates people and other resources to carry out the project management plan for the project.

4. **Controlling process group** – regularly measures and monitors progress to identify variances from the project management plan so that corrective action can be taken when necessary to meet project objectives.

5. **Closing process group** – formalizes acceptance of the product, service or result and brings the project or a project phase to an orderly end. Broadly, the process groups tend to be deployed in the sequence listed as the project progresses. In the event that a project goes off-course, re-planning comes into play, and if a project is found to be in serious trouble, it may have to go all the way back to the initiating process to be restarted. To summarize, the result or output of one process group often becomes an input to another. In the central process groups planning, executing and control), all the links are looped i.e. the links of these central process groups are iterated – planning provides execution with a documented plan early on, and then provides documented updates to the plan, as the project progresses.

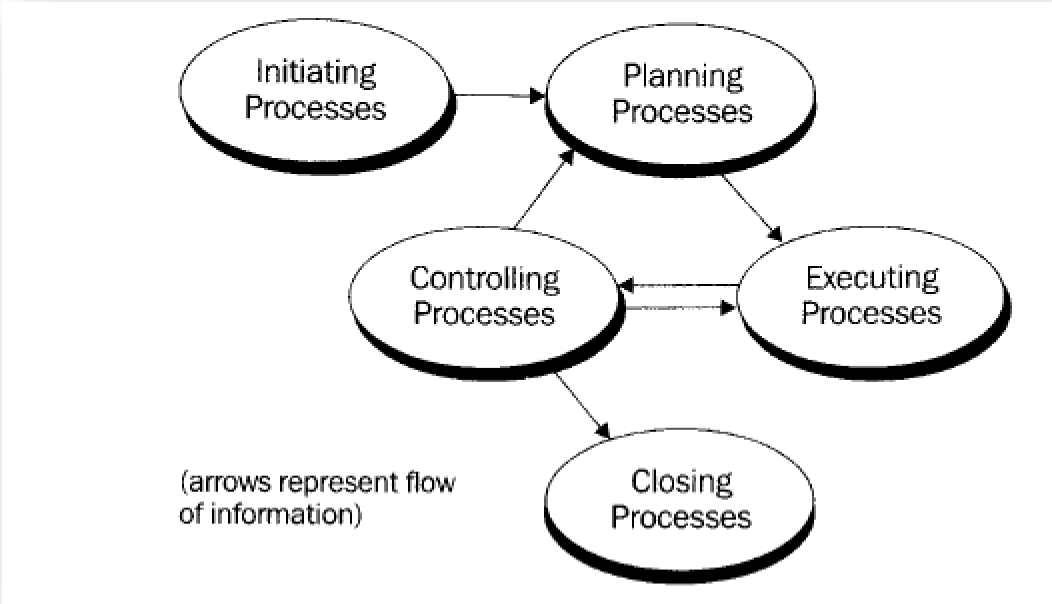

Figure 1: Links among Process Groups in a Phase

Also, though these process groups are presented above as discrete, one-time events; these events overlap and take place at different levels of activity across each phase in the project life cycle. Fig. 1 illustrates this overlapping.

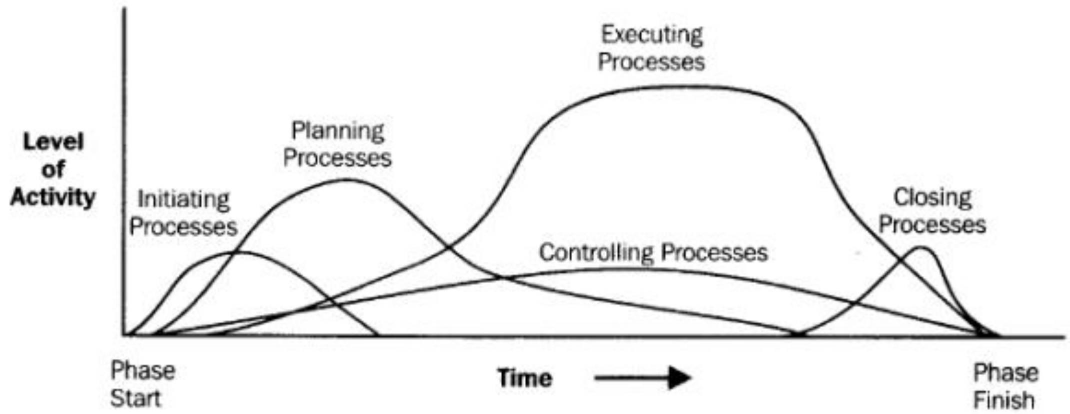

Figure 2: Overlap of process groups in a phase

The Process Groups are not project phases: Where large or complex projects may be separated into phases or even subprojects such as feasibility study, concept development, design, prototype, build, and test etc., all of the Process Group processes would normally be repeated for each phase or subproject. Finally, a phase will usually involve all these five process groups within their iterations inside the phase, before that phase is closed to provide the input to the next phase. For example, closing the design phase requires acceptance from the client on the design document, which defines the product description for the ensuing implementation phase. Project management processes describe and organize project activities. Project management processes that are common to most projects have been classified into nine classifications by PMBoK. Though each of these processes discusses the significance of individual activities in relation to the project, all the processes are interrelated. For instance, project procurement management, which is a process for acquiring goods and services from a firm external to the project organization, will need to be performed to satisfy the project requirements implicit in scope management, cost management, quality management etc.

1. Project Integration management

2. Scope management

3. Time management

4. Cost management

5. Quality management

6. Human resource management

7. Communications management

8. Risk management

9. Procurement management

Table 1:

Requirements Traceability Matrix

Project Code: ABC

Project Name: ABC

Customer Name: Internal

Serial No.	Item No. in FR	Item in FR	Sub-section Reference in FS	Sub-section Reference in SDD	Source Code Reference	Reference of Unit Test Cases	Reference of Integration and System Test Cases
1	G001	Background highlighting of the field that has focus	Sec 3.1.1	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
2	G002	Warning if the user is navigating away from a page that has unsaved data	Sec 3.1.2	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
3	G003	Progress indicator for long operations	Sec 3.1.3	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
4	G004	Disabling of buttons during long operations	Sec 3.1.4	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
5	G005	Sort, filter and rearrange columns for data in a grid	Sec 3.1.5	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
8	G008	Clicking on the "close window" ("X") button to shut down application, logs out user	Sec 3.2.1	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
9	G009	Workflow (next, previous, cancel, finish) for complex operations	Sec 3.2.2	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
10	G010	A confirmation (summary) page at the final step for all Wizards	Sec 3.2.3	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
11	G011	Floating window for error messages	Sec 3.2.4	ABCCorporateCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls

12	G012	'Report this' link on every alert for reporting errors and debugging info	Sec 3.3.1	ABCResidentialCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
13	C001	Creation of a new Customer	Sec 3.3.2	ABCCorporateCustomer_Creation_SD,	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
14	C002	Backdated customer creation	Sec 3.3.3	ABCResidentialCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
15	C003	Future dated customer creation	Sec 3.3.4	ABCResidentialCustomer_Creation_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls
16	C004	View Customer demographics	Sec 3.4.1	ABCCorporateCustomer_Retrieval_SD , ABCResidentialCustomer_Retrieval_SD	ABCCCustomer.CPP	ABCCCustomer_UT.xls	ABCCCustomer_SI.xls

5.3 Research Life cycle

The concept of a Life Cycle is central to software engineering methods. The purpose of a Product Development Life Cycle (PDLC) definition is to provide an understanding of the underlying software engineering processes so that those can be planned and monitored. There are many different representations of the related software product development life cycle models, which comprises of various phases. All product development projects must pass through these phases, with a different emphasis placed on each, depending on the type of the product being developed. Product Life Cycle (PLC) refers to the life cycle phases and activities relevant for the development, implementation and maintenance of a software product.

Typically, a PLC may be sub-divided into 3 broad phases:

- Product Development phase
- Product Delivery and Implementation phase
- Product Support and Maintenance phase.

Due to the nature of customer requirements and the priorities of the management, it was decided to use a new set of technologies to enable the delivery of the user experience over a web browser. The incremental model was chosen as Product Development Lifecycle Process for this project as it is the most appropriate choice. The Incremental Model combines the elements of Waterfall model with the philosophy of an iterative approach. As illustrated below, it applies the linear sequences in the Waterfall Model in a staggered manner as the calendar time progresses. Each linear sequence produces an incremental deliverable of the software. The first increment is often a core software system where the basic requirements are addressed, but many supplementary features remain undelivered. The core software system is reviewed in detail by the customer and may be even used. As a result of the detailed review and/or use of the core software system a plan is developed for the next increment. The plan addresses the modification of the core software system to better meet the needs of the customer and delivery of the additional features and functionality. This process is repeated following the delivery of each increment until the complete software system is developed. This has a number of distinct advantages over the traditional sequential development model. This is the best choice for projects that has high technical risks, and objective is achieved by breaking down the project organization and systems construction into manageable subprojects. The advantage of this model is that the development team understands customer's expectations in gradual steps and gets the opportunity to implement changes in the same incremental steps. It is particularly useful when staffing is unavailable for a complete implementation of the full system by the project deadline. The core software system can be implemented with fewer staff that can be put to use by the user. If the core software system is well received by the user, additional staff is added to work on the subsequent increment(s).

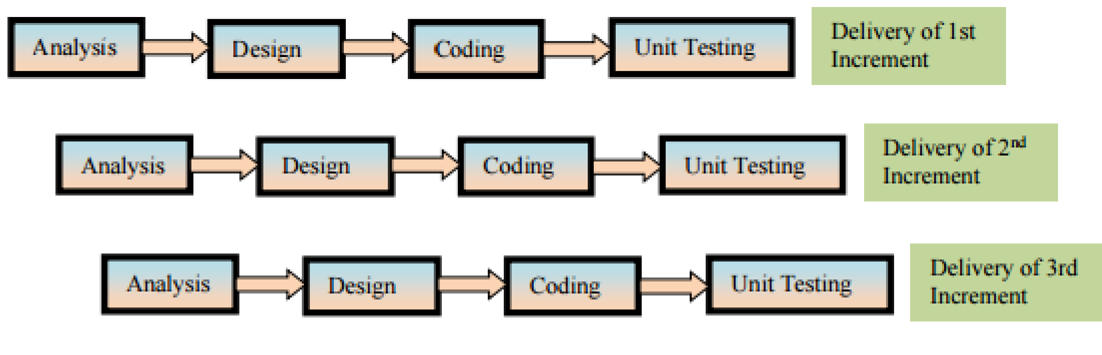

Figure 3: Product Development Life Cycle – Incremental Model

A series of activities was carried out as part of the project's defined process prior to starting work on the increments as per the incremental model. The activities identified are as follows:

1. Study of customer requirements

2. Study of existing functionalities

3. Enumerate generic features of certain modules Analysis Design Coding Unit Testing Delivery of 1st Increment Analysis Design Coding Unit Testing Delivery of 2nd Increment Analysis Design Coding Unit Testing Delivery of 3rd Increment

4. Identification of architectural attributes to be retained in the application.

5. Preparation of Functional specifications and incorporate new requirements identified in step 1

6. Identification of candidate technologies and tools for evaluation

7. Evaluation of identified alternative technologies and tools by prototyping

8. Selection of tool and technology set for delivering the subsequent increments

Risk Analysis:

Risk is the probability of occurrence of an event which can hinder the project goals. While some of the risks are trivial, others could make a significant difference in the way projects are executed. Thus Risk Management is recognized as an essential process in any organization. Risk Management focuses mainly on minimizing threats and maximizing opportunities. It plays a very important role in optimizing the objective achievements. Ideal Risk Management minimizes the spending and maximizes the reduction of the negative effects of risk.

Hence, one of the key areas requiring proactive management within projects is risk. Risk in a project arises from a wide range of sources and has a broad scope of possible effects on the project. Given that the two dimensions associated with any project are the tasks to be performed and the risks inherent in the project environment, it is a key success factor for every project manager to predict and manage the project risks well. Risk management is therefore a process of identifying and assessing risks in a project. Additionally, it also entails ensuring that effective measures are planned and implemented to minimize the occurrence of these risks and to deliver the project in line with defined objectives.

Table 2: Identification of Risks and Steps for their Mitigation

Customer's Name: Internal Project Code, if any: ABC

Project Name: ABC

	Risk Details			Forecast			Closure		
Serial No.	Risk Item	Date Raised	Status	Probability of occurrence (H / M / L)	Impact (H / M/ L)	Risk Exposure	Provision for Risk (Rs.)	Mitigation Action Plan	Contingency Action Plan
1	Timely availability of inputs regarding look-and-feel and process flow from Task force	8th April 2010	Occurred	M	H	H		Pre-sales and customer to be informed regarding inputs	No Contingency

2	Quality of inputs from external consultant	8th April 2010	Occurred	M	H	H		Qualifications of External consultant to be defined and selection of external consultant to be done on basis of proven track record	No Contingency
3	Support for problems encountered due to usage of software from external sources	8th April 2010	Occurred	M	M	M		Sources of External software to be vetted and support agreements to be put in place.	Seek support from online support forums and user groups
4	Timely availability of training for certain key technologies.	8th April 2010	Occurred	M	M	M		Technology vendors to provide training with training materials.	Procure books and other public domain information.
5	Timely assignment of user documentation and training material preparation resources	8th April 2010	Occurred	L	L	L		No Mitigation	No Contingency

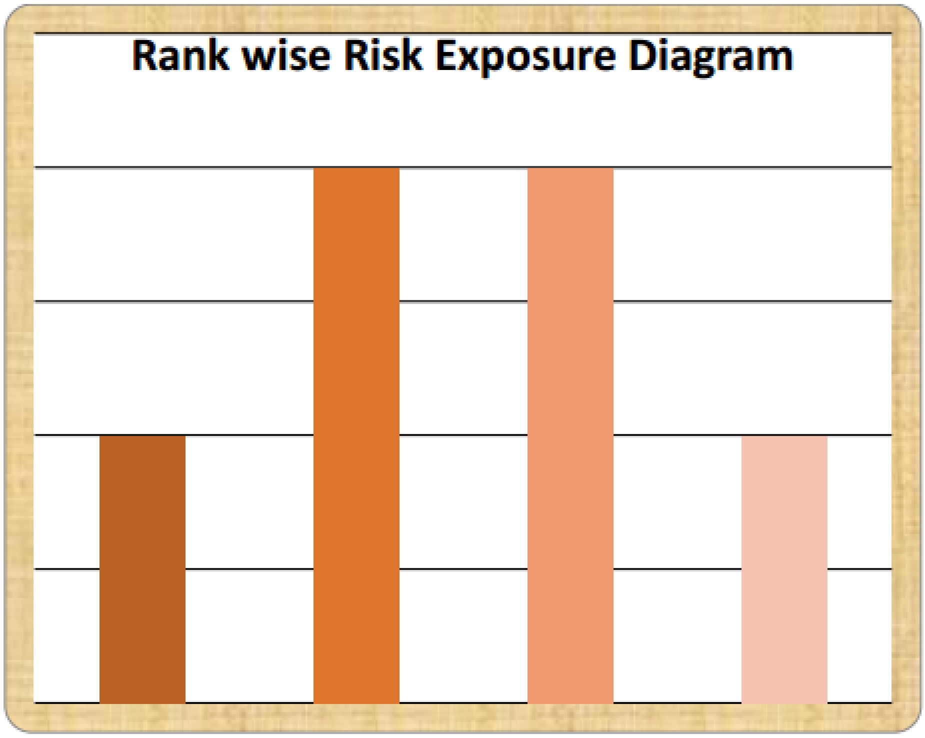

Figure 4: Rank wise Risk diagram

Team Building:

Team Building refers to a wide range of activities, presented to businesses designed for improving team performance. Team building is pursued via a variety of practices, and can range from simple bonding exercises to complex simulations and multi-day team building retreats designed to develop a team. It generally sits within the theory and practice of organizational development, but can also be applied to sports teams, school groups, and other contexts. Teambuilding is an important factor in any environment, its focus is to specialize in bringing out the best in a team to ensure self development, positive communication, leadership skills and the ability to work closely together as a team to problem solve. Work environments tend to focus on individuals and personal goals, with reward & recognition singling out the achievements of individual employees.

Reasons for Team Building

Reasons for Team Building include• Improving communication• Making the workplace more enjoyable• Motivating a team• Getting to know each other• Getting everyone "onto the same page", including goal setting• Teaching the team self-regulation strategies• Helping participants to learn more about themselves (strengths• and weaknesses) 50 Identifying and utilizing the strengths of team members• Improving team productivity• Practicing effective collaboration with team members•

Level/ Job profile	**Number**	**Necessary Competence**	**Desirable Competence**
Software Project Manager	1	Project Management	Project Management
Configuration Controller	1	Configuration Control	Configuration Control
Senior Designers/Designer	3	Analysis and Design	Analysis and Design
Senior Developer	4	Core Java, JDBC, SQL, Oracle PL/SQL, hands on working ability, Java Debugging	Hibernate, Spring, XML, OOAD, Unit testing, Usage of configuration management tools like VSS, Spectrum, SDLC, Code reviews, Metrics, Technical Software Performance engineering
Developer	3	Core Java, JDBC, SQL, Oracle PL/SQL, UML, Unit testing, Usage of	Hibernate, Spring, XML, UML, OOAD, Unit testing, Usage of configuration management tools like VSS, Spectrum, SDLC, Code

Observation / Defect Analysis

Defect analysis generally seeks to classify defects into categories and identify possible causes in order to direct process improvement efforts. Defect data is used and analyzed for continuous quality improvement. **Root Cause Analysis** (RCA) is a management process that seeks to locate the ultimate cause or 80/20 rule causes behind performance or process-related problems in a business or engineering environment, and then proceed to resolve the problem by treating these underlying causes. The advantage of Root Cause Analysis as a failure-management method over troubleshooting, for example, is that the latter is a knee-jerk reaction to the occurrence of some critical problem or failure. Some fire-fighting is carried out in order to handle and recover immediately. Since this expeditious approach deals with the patching up symptoms quickly, the problem seems temporarily solved. Over time, the problem is likely to recur, resulting in a similar knee-jerk troubleshooting process, racking up huge costs along the way. The benefits of Root Cause Analysis, as a result, are the deeper investigation into the reason for the occurrence in the first place. The root cause or causes 63 might be much deeper than outward symptoms reveal, and several layers may have to be pushed aside to reach the "root" cause. So, the focus is on analysis of this fabled "root cause" that propagated forward and manifested in the form of the problem at hand, rather than exclusively treating the symptoms, as troubleshooting does. The resulting Ishikawa Diagram is then analyzed by the senior management to draw up a plan of action to root out the causal factors, so that the root causes can be solved. This is frequently done, by taking the enumerated causes, and measuring their occurrence in various processes.

After recording these data for a specific period, the results are examined in a Pareto Chart, wherein the 80/20 rule makes it apparent where to invest the appropriate organizational effort to reduce the unwanted effects so analyzed in this process (or perhaps to increase intended positive effects). As can be seen above, the Cause and Effect exercise may be seen as the first step toward any quality management effort. Problem-solving techniques continue where this exercise leaves off. An innovation on the Ishikawa fishbone is the "lateral tree", which is supposed to have an edge over the former when it comes to handling more complicated scenarios involving causal branches of several depths. The latter strives to vertically align all items on the same causal level, thus providing more perspective to analysts.

Count of Root Cause											
	FNC: Function wrongly specified	**INC: Incorrect information**	**IRF: Incorrect reference**	**IRR: Irrelevant information**	**LER: Lingual error**	**LGC: Incorrect processing**	**MIN: Missing/inadequate information**	**OTH: Others**	**STD: Standard Related**	**TDS: Template/doc std not followed**	**Grand Total**
R- PRS: Lacking technical know how/ domain expertise		5					2				7
R- PRS: Over sight		11	1				1	1			14
R- PRS: Time pressure							2				2
R-FNC: Analyst did not know the requirement		1					1				2
R-FNC: Analyst/Coder requires training on Analysis / Design Technique				1				2			3
R-FNC: Analyst/Coder requires training to write the document				1	2		2				5
R-FNC: Inadequate Requirement Analysis Document / SRS review not properly done								1			1
R-FNC: Mapping of requirement could not be done		2									2
R-FNC: Missed the functionality or kept incomplete by mistake		7		1			20				28
R-FNC: Not aware of the implicit requirement		2			1			1			4

R-INIP: Incorrect inputs provided	1					1					2
R-INIP: Insufficient specs. Provided							1				1
R-LGC: Not covered or improperly specified in Design doc or Spec or Test Plan		3						1			4
R-OTH: Clarifications not provided in time				1			1				2
R-OTH: Time pressure							2				2
R-STD: Did not understand standard							2				2
R-STD: Standard itself is incorrect									1	1	2
R-STD: Standard not followed										2	2
Grand Total	**1**	**34**	**1**	**6**	**3**	**1**	**40**	**6**	**1**	**3**	**96**

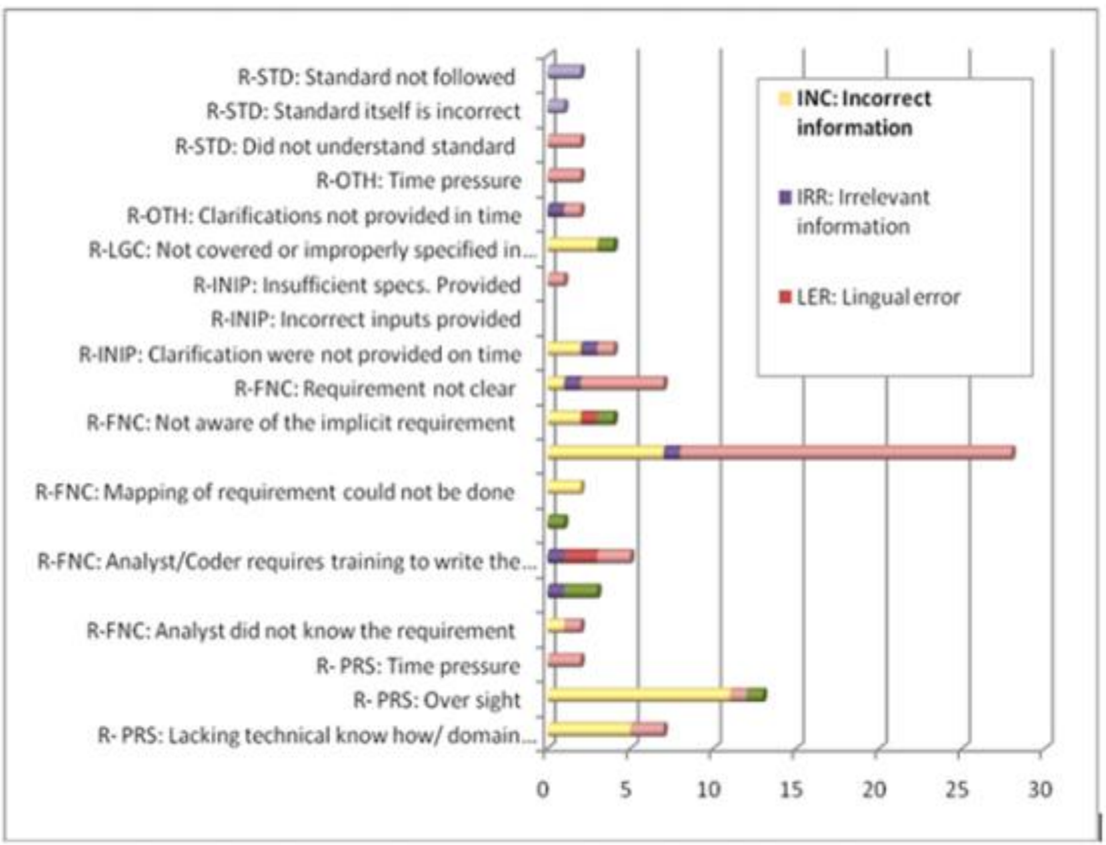

Fig.5 Root cause wise No. of defects

Quality Management Plan & Audit Process:

This Quality Management Process comprises of procedures being followed at the Company for Quality Management activities, viz. establishing the organizational policies for quality management and the management organization, defining and maintaining the Quality Management System, QMS performance reporting, and ensuring Corrective and Preventive actions for detected /reported non-conformities.

All these procedures facilitate continuous improvement of the company's products, services, operations, and the quality management system. The objectives of defining and implementing the Quality Audit process are to:

- Standardize on the procedures which would be followed throughout the organization

- Determining the degree of conformance of the implemented Quality System with the documented Quality Management System through the audit process

- Facilitate continuous improvement

Quality Control

Standards Applicable

1. Java coding standard.

2. Documentation standard.

3. GUI standard as per customer representative input.

Table 3: Product Review & Testing

SL. No.	Work Product/ Drawing/ Document	Type of Review / Testing planned	Proposed level of Reviewer / Tester
1	Project management plan, Project schedule, Risk analysis note, Project team organization	Independent Review	QAG, PG-Head, Customer representative
2	Functional Specifications, Design Document	Independent Review	Identified design board member

Table 4: Quality Audit Plan

SL. No.	Audit Type	Audit Item / Life Cycle activities Covered	Periodicity of Audit	Target Date of Audit	To be done by
1	IQA	Project initiation	Bi-Monthly	16/04/2010 2/06/2010	QAT
2	PPQA	Phase End	Phase End/Predeli very	Phase End	QAT
3	Configurati on Audit	Configuration Item	Quarterly	11/09/2010	QAT

Table 5: Software quality audit report

SQA audit phase	Date	No. of NCs	No. of Observations	Mean time to close(in days)
IQA1	12/4/2010	2	0	10
IQA2	2/6/2010	1	0	10

5.13 Configuration Management

Objective of configuration management is to ensure appropriate level of access control to the work products produced by projects, departments or groups. This process describes the Configuration Management Process that shall be followed for establishing and maintaining the integrity of the work products of the project throughout the project life cycle.

Moreover, work products produced by different department or groups shall also be under configuration management process of the Company. The prime objective of the Configuration Management Process is to

- Plan configuration management activities
- Identify and control selected work products
- Control identified changes to the work products,
- Publish the status
- Distribute baselines to all the affected groups in the Company and
- Conduct audit in regular intervals over to ensure smooth operation of configuration management activities.

Configuration Control Procedure

This will be as per the Configuration Management Process defined in QMS, *i.e.* Identify the configurable Items

Maintaining a proper directory structure along with the access rights of team members in the folders

Standardize the naming convention of the files

Version maintenance

Change Request management

VSS tool is used for configuration control like access control, base lining and release of CI

Retention Period of each CI

1 year after CI is OBSOLETE

Procedure for base lining a CI

Microsoft VSS is used to manage all CIs

Procedure for moving to a new baseline is:

Doing Change Management on the CI

Send new version for approval to relevant stakeholder

On-approval, update CI Register to incorporate new version as baseline.

5.14 Metrication Plan

A Measure is a quantitative value that indicates some characteristic aspect(s) of a project, product, or process. Typically a ratio of measures (even a distribution data) is referred to as a metric. Through proper analysis of metrics data we can have better control over a project, product quality, or a process. It helps the management to react proactively rather than reactively. To achieve the desirable product quality and process performance, proper implementation of the metrication program of the organization is essential.

Setting Control Limits

When metrics data are being analyzed and plotted in a Control Chart, control limits need to be set to facilitate setting the organizational goals. The guidelines for setting the control limits shall be as given below. Let us assume X is the mean and σ is the standard deviation. Then, $X \pm 3\sigma$ is used in the organization to set the control limit. 73 The following is a list of desirable metrics for use by the projects in the organization.

a) Customer Satisfaction Index (CSI)

This metrics is used to identify the customer satisfaction level over a period of time and taking appropriate measure for improving, if any gap is perceived.
N: Total number of questions answered in the questionnaires.
S: Total number derived, adding all the points against each question answered.

Formula

(Total number derived, adding all the points against each question answered (S))/ (Total number of questions answered in the questionnaires)

Source, frequency and format of data capture

Source: Customer Satisfaction Survey Questionnaire
Frequency: Quarterly

Data Capture: Data is captured through the defined format: Customer Satisfaction Survey Questionnaire

Frequency of metrics data reporting and analysis

After every three months of a Project tenure and also End of each project

Method of metrics data analysis

The figure in an ideal world should be 100. Once this figure is reached it is established that the customer requirements is truly satisfied. The collected figures are to be plotted and the figure is lying outside the control limits of organization need to be performed appropriate exploration.

Benefits

Measures can be taken to improve the CSI in case it's tending towards unfavorable figure

b) Effort Variance – Original

This metric helps in finding out the overall effort slippage in a project as compared to the original estimated effort during the execution stage and at the end of the project.

A: Actual effort spent in the project CTD (Cumulative Till Date)

O: Original total estimated effort

E: Effort to complete the balance work

Formula
[{(A+E) – O} * 100] / O

Source, frequency and format of data capture

Source: Time sheet

Frequency: Monthly

Data Capture: Data is captured through the Project Status Report

Frequency of metrics data reporting and analysis

Month end

Method of metrics data analysis

The figure ideally should be zero, which will prove that project has been completed as per initial estimation. If the figure is falling outside the control limits of organization then estimation process / techniques needs to be revisited or other associated process followed during execution of the project is required to be analyzed.

Benefits
Necessary measure can be taken and appropriate reason can be established for satisfying organization goal. Also it helps out for setting up new control limits.

c) Schedule Variance – Original

This metric is useful for finding out the overall schedule slippage of a project as compared to the originally estimated scheduled duration during the execution stage and at the end of the project. Calculation of Schedule Variance is tricky and can often be misleading. To calculate this metric during the execution stage of a project, one would need to consider only the latest completed activity on only the Critical Path in the project schedule and compare it with the originally planned schedule using the formula below.

For projects which are completed, the formula II may be used.

Ac: Actual date of completion of the latest completed activity on Critical Path.

A: Actual duration of the project

O: Originally estimated project duration

Formula:
(A – O)*100 / O

Source, frequency and format of data capture

Source: Project Schedule

Frequency: Monthly

Data Capture: Data is captured through the Project Status Report 76

Frequency of metrics data reporting and analysis

- Monthly

- Project end

Method of metrics data analysis

The figure preferably should be zero. Once this figure is arrived then it is confirmed that project is running as per the originally estimated schedule. If the figure is outside the control limits of organization then processes followed during execution of the needs to be analyzed in detail.

Benefits
This is very much useful for taking any corrective action during the execution stage to avoid any overrun. Also it helps out for setting up new control limits of the organization.

d) Average Defect density - Pre-Release & Post-Release

This metric aims to measure the quality of the product before and after delivery to the customer.

There may be several metrics under this category. The typical classification is Average pre-Release Defect Density and Average post- Release Defect Density. These may be further classified by the severity of the defects found, e.g.

Average pre-Release Defect Density – Critical Defects

Average pre-Release Defect Density – Major Defects

Average pre-Release Defect Density – All Defects

Average post-Release Defect Density – Critical Defects

Average post-Release Defect Density – Major Defects

Average post-Release Defect Density – All Defects

Nn pre-release: Total number of defects of severity n (n can be critical, major, minor) detected before release of a product.

Nn post-release: Total number of defects of severity n (n can be critical, major, minor) detected after release of a product.

S: Latest estimated or measured size of the software product.

Formula

Average pre-Release Defect Density – Critical Defects = ((Nn prerelease)* 100)/S, where Nn pre-release is measured for n = critical

Average pre-Release Defect Density – Total Defects = ((Nn pre-release)*100)/S, where Nn pre-release is measured for n = all defects i.e. critical + major + minor defects

Average post-Release Defect Density – Critical Defects = ((Nnpostrelease)* 100) /S, where Nn post-release is measured for n = critical

Average post-Release Defect Density – Total Defects = ((Nnpostrelease)* 100) /S, where Nn post-release is measured for n = all defects i.e. critical + major + minor defects

Source, frequency and format of data capture

Source: Test Log, Review Report

Frequency: Phase wise

Data Capture: Data is captured through the Project Status Report

Frequency of metrics data reporting and analysis

Project end

Method of metrics data analysis

The numbers ideally should be zero it can be plotted for analysis.

Benefits
Appropriate reason can be established for satisfying organization goal, if there is any deviation. This is used for setting up new control limits for improvement.

e) Defect Severity Ratio

This metric gives an indication of the proportion of defects of a particular severity type with respect to the total number of defects. A high proportion of defects of severity Fatal or Serious is a great cause of concern. Causal analysis is to be done by the Project Manager/Project leader and preventive actions are to be taken to minimize the defects (in addition to the required corrective actions).

Formula
Defect Severity Ratio of severity n = Number of Defects of Severity n /Number of Defects where n can be Critical, Major or Minor

Source, frequency and format of data capture
Source: Review Report/Defect Log Sheet
Frequency: As and when data review/testing is conducted

Format: Project Status Report

Frequency of metrics data reporting and analysis

The frequency of Metrics data reporting and analysis will be phase end/Project end.

Method of metrics data analysis

Histogram needs to be plotted for Defect Severity Ratio.

Benefits
Organization wide corrective measures can be taken to minimize the critical defects and recurring major defects, which can lead to critical defects later.

Defect Removal Efficiency (DRE %)

This metric gives an indication of how much defect has been removed from the product so that minimum defects are carried forward to post deliver stage.

Formula
Overall Defect Removal Efficiency (DRE) %= (Total Number of defects prior to delivery X 100)/Total No of defects (Pre delivery and post delivery)

It can also be calculated / done at the end of each phase.

Source, frequency and format of data capture

Source: Review report/Defect Log Sheet

Frequency: As and when data review/testing is conducted

Format: Project Status Report

Frequency of metrics data reporting and analysis

The frequency of Metrics data reporting and analysis will be phase end/Project end.

Method of metrics data analysis

- Defects prior to delivery: All defects identified before the product is released to the client.

- Defects post delivery: All defects reported after the release to client.These defects may originate from any source but after analysis are 80 attributed to the base version. A period of 1 year, following the release, will be considered to capture this metric.

For all Customization Projects

- Defects prior to delivery: All customization defects identified before the product is accepted to the client (External Client)

- Defects post delivery: All defects reported after the acceptance of client (External Client). These defects may originate from any source but after analysis are attributed to the customized version. A period of 1 year, following the release, will be considered to capture this data.

Benefits

This indicates that how much defects are being delivered to the customer, which were not detected and fixed before delivery. Organization should strive to achieve DRE of 100%.

f) Review Effectiveness (RE) %

This metric gives an indication of the efficacy of the Review process.
Formula
Review Effectiveness Ratio (RE) %=

(Total Number of defects found during all reviews X 100)/Total number of defects

Source, frequency and format of data capture

Source: Review Notes

Frequency: As and when data review/testing is conducted

Format: Project Status Report 81

Frequency of metrics data reporting and analysis

The frequency of Metrics data reporting and analysis will be phase end/Project end.

Method of metrics data analysis

Histograms for individual projects are plotted against TE. It is compared with the Process Capability Baseline and Organization Goal. It should approach to 100%.

Benefits

It gives us the scope for improvement of the testing process.

g) Test Effectiveness (TE) %

This metric gives an indication of the efficacy of the testing process.

Formula

Test Effectiveness Ratio (TE) %= (Total Number of defects found during testing X 100) / Total number of defects

Source, frequency and format of data capture

Source: Defect Log Sheet

Frequency: As and when data review/testing is conducted

Format: Project Status Report

Frequency of metrics data reporting and analysis

The frequency of Metrics data reporting and analysis will be phase end/Project end.

Method of metrics data analysis

Histograms for individual projects are plotted against TE. It is compared with the Process Capability Baseline and Organization Goal. It should approach to 100%.

Benefits

It gives us the scope for improvement of the testing process.

Table 6: Metrics for the project and the corresponding goals to be achieved

Sl. No.	Metric Name	Organization Goal	Project's Goal	Periodicity of analysis & Review	Reasons for Deviation from Organization's Goal, if any
1	Effort Variance	10%	10%	Monthly	
2	Schedule Variance	15%	15%	Monthly	
3	Defect distribution phase / release wise	TBD	TBD	Phase end	
4	Defect Rate / Pre-release	TBD	TBD	Phase end	
5	Defect Rate / Post-release	TBD	TBD	Phase end	
6	Review Effectiveness	TBD	TBD	Phase end	

Table 7: Effort Variance (MM %)

Budget	Consumed	Required	Variance (%)
72.5	57.92	15	1.28

Table 8: Mean Time Taken To Respond (MTTRSP)

Priority	No of Issues	MTTRSP (In Hours)	MTTRSP (In Days)
P1	0	-	
P2	11	0.01	0.00
P3	17	0.02	0.00
P4	6	0.02	0.00

Table 9: Mean Time taken To Solve (MTFB)

Priority	No of Issues	MTFB (In Hours)	MTFB (In Days)
P1	0	-	
P2	11	32.7	1.36
P3	17	107.93	4.50
P4	6	113.22	4.72

Table 10: Defect Rate

	CR Effort (MM)	Critical	Major	Minor	Critical Rate	Total Rate	RE (%)	TE (%)
Testing	4.63	0	2	3	0	2.59	58.33	41.67

Table 11: Defect Rate (Post-release)

Defect Rate (Post-release)		
No. of Defect Post-delivery	**Total Effort Spent till Date**	**Defect Rate (%)**
(DPS)	(TE)	(DPS/TE)
8	206.28	0.038782238

Table 12: Defect Rate (Pre-release)

Defect Rate (Pre-release)		
No. of Defect Pre-delivery	**Total Effort Spent till Date**	**Defect Rate (%)**
(DPR)	TE	(DPR/TE)
296	206.28	1.434942796

Table 13: Defect Distribution (phase wise)

Phase	Critical Defects	Major defects	Minor Defects	# of Defects	Total # of Defects	% Distribution of defect
(Phase when Defect Detected)				*(Number of defects Detected - N)*	*(Total Defects over all phases - T)*	*(N/T)*100*
SOW/FR	0	0	0	0	304	0%
FS	0	0	0	0		0%
Designing	0	0	0	0		0%
Development (Coding)	0	0	0	0		0%
SI/Functional Testing	1	4	170	175		58%
Release	2	1	5	8		3%

Table 14: Pre-Shipment Defect Severity Ratio

Defect Severity	# of Defects - n	Total # of Defects - N	Defect Severity Ratio - (n*100)/N
Critical	1	16	6.25%
Major	5		31.25%
Minor	10		62.50%

Table 15: Post-Shipment Defect Severity Ratio

Defect Severity	# of Defects - n	Total # of Defects - N	Defect Severity Ratio - (n*100)/N
Critical	1	16	6.25%
Major	5		31.25%
Minor	10		62.50%

Table 16: Total Defect Severity Ratio

Defect Severity	# of Defects - n	Total # of Defects - N	Defect Severity Ratio - (n*100)/N
Critical	7	96	7.29%
Major	34		35.42%
Minor	55		57.29%

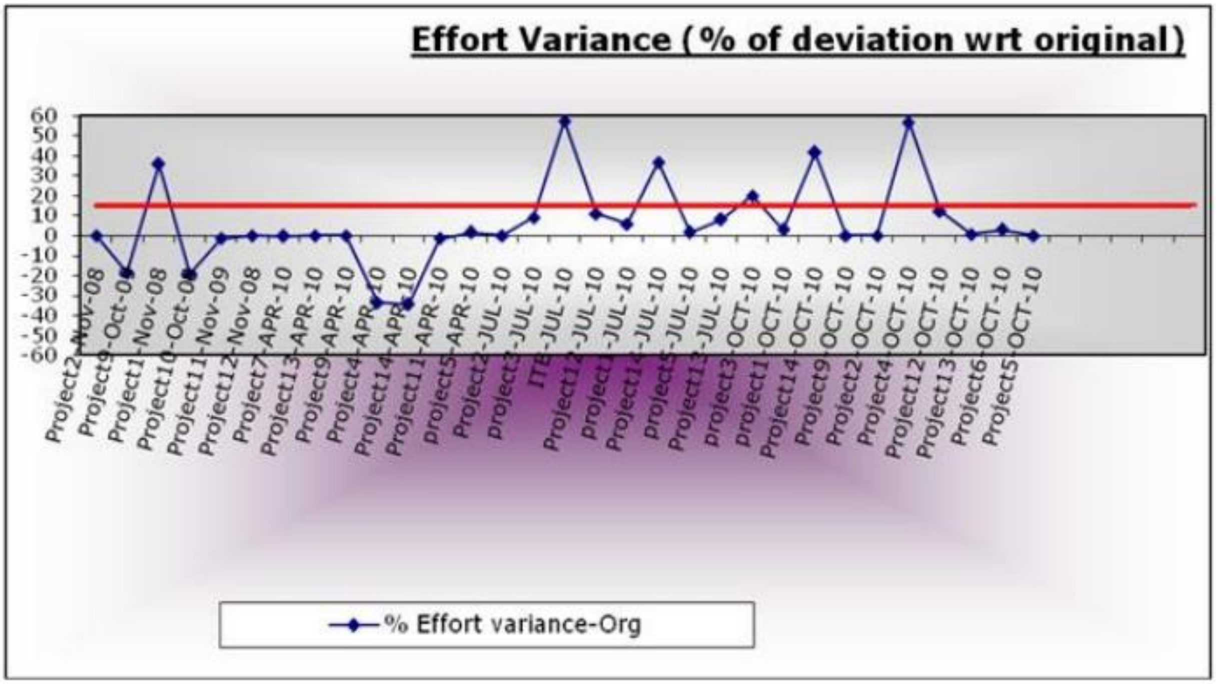

Figure 6: Compare Effort Variance

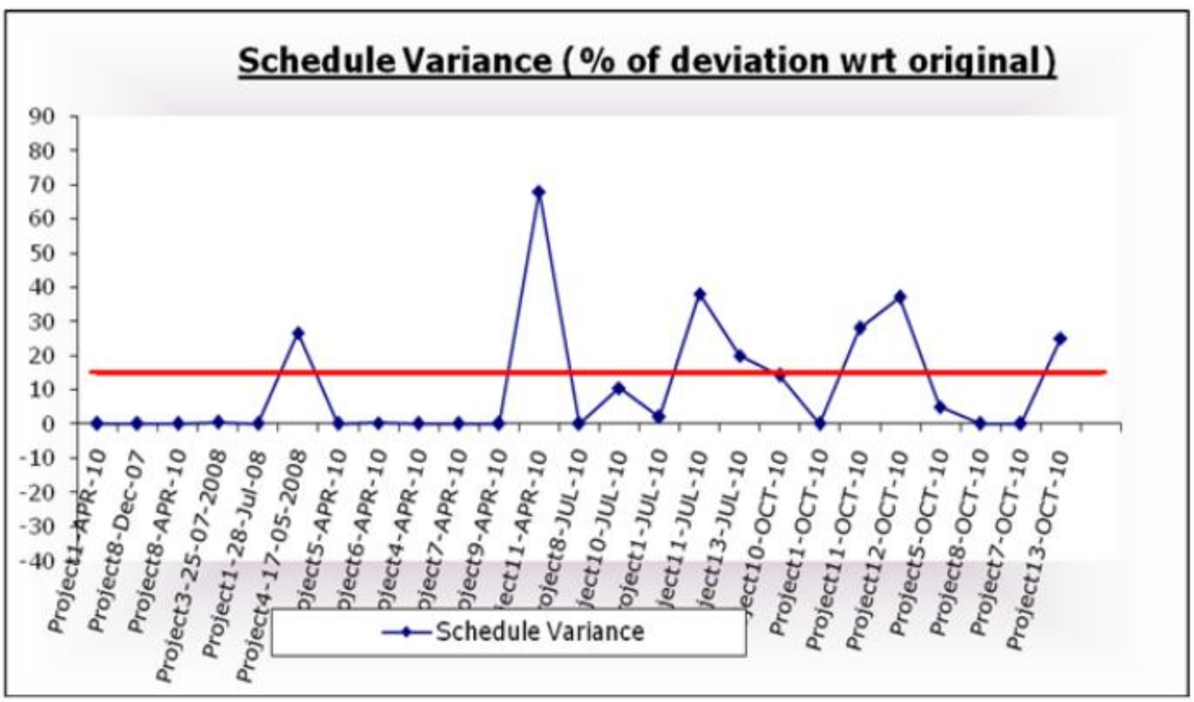

Figure 7: Compare Schedule Variance

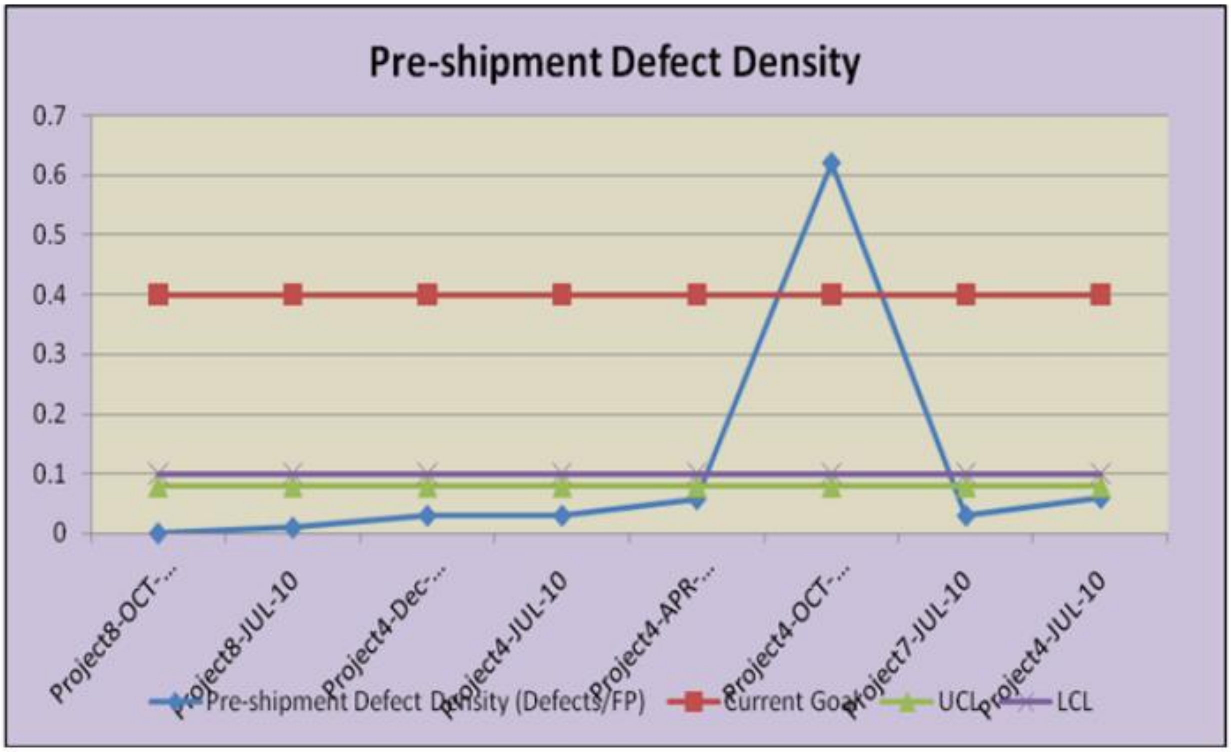

Figure 8: Compare Pre-Shipment Defect Density

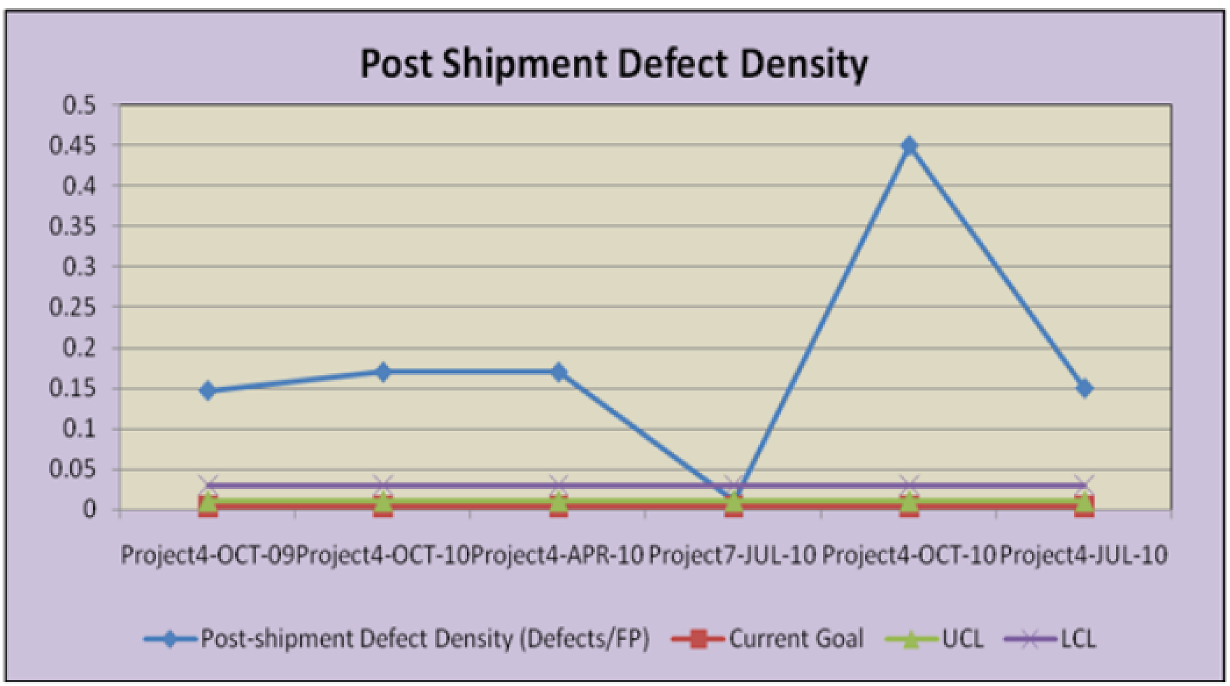

Figure 9: Compare Post-Shipment Defect Density

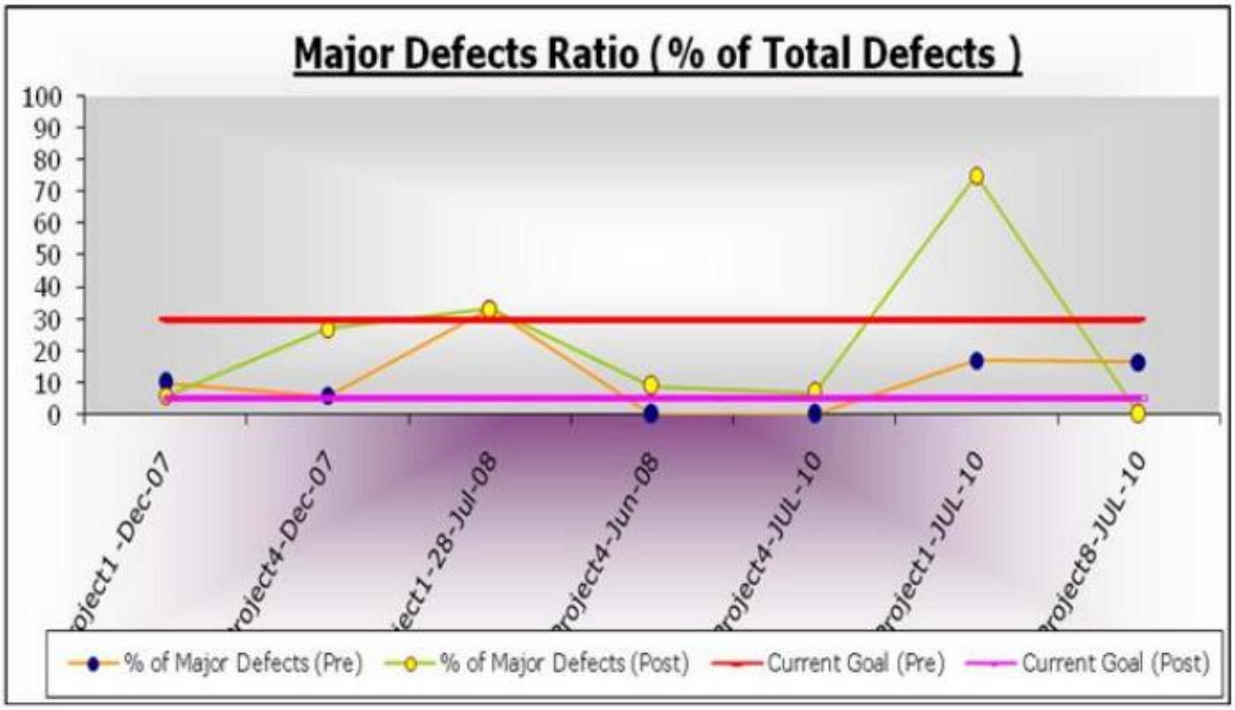

Figure 10: Compare Major Defect Ratio

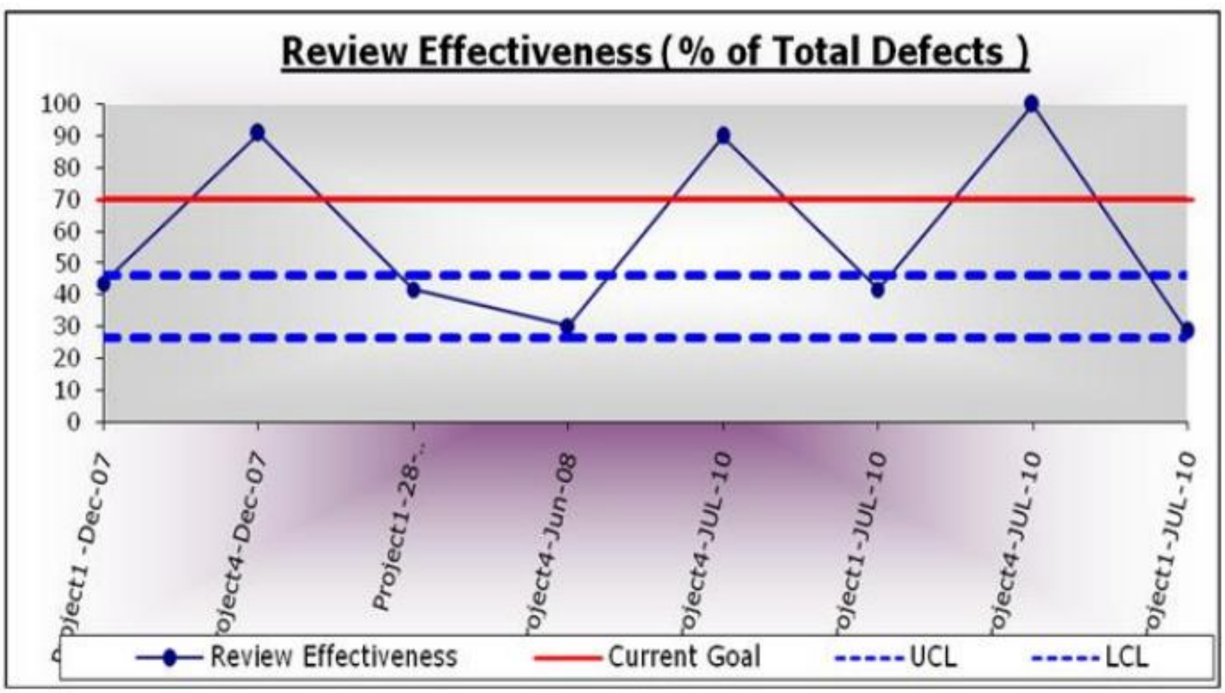

Figure 11: Compare Review Effectiveness

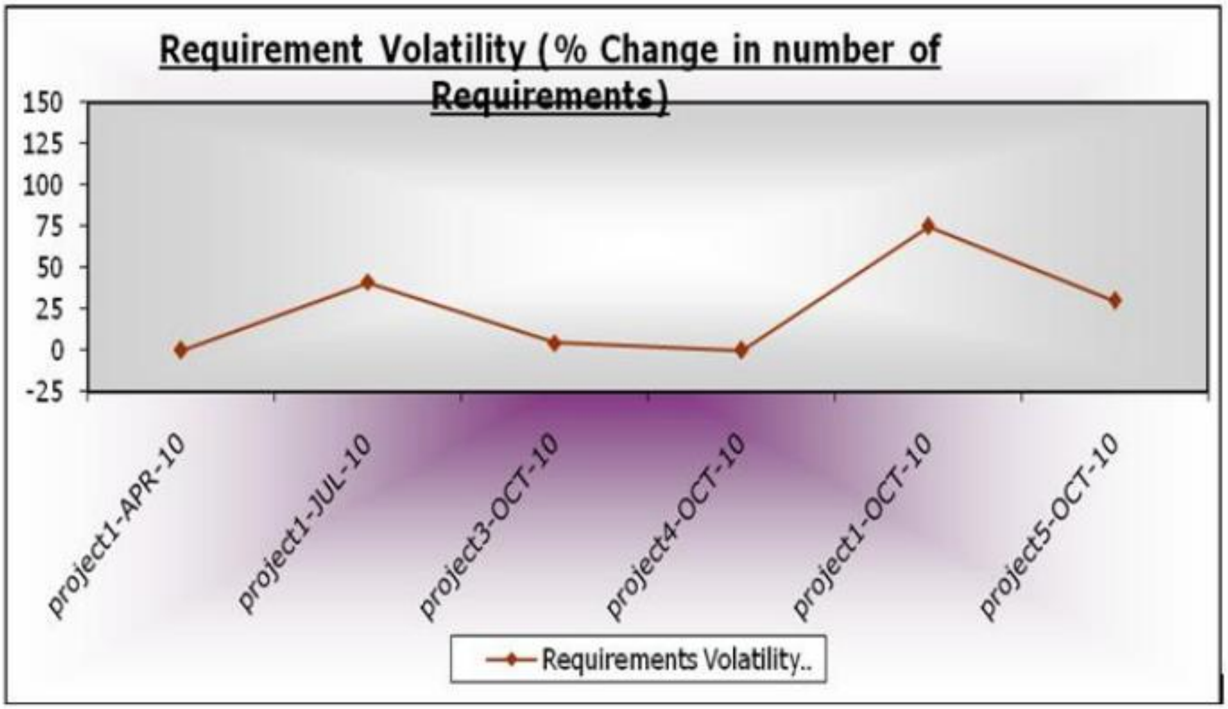

Figure 12: Compare Requirement Volatility

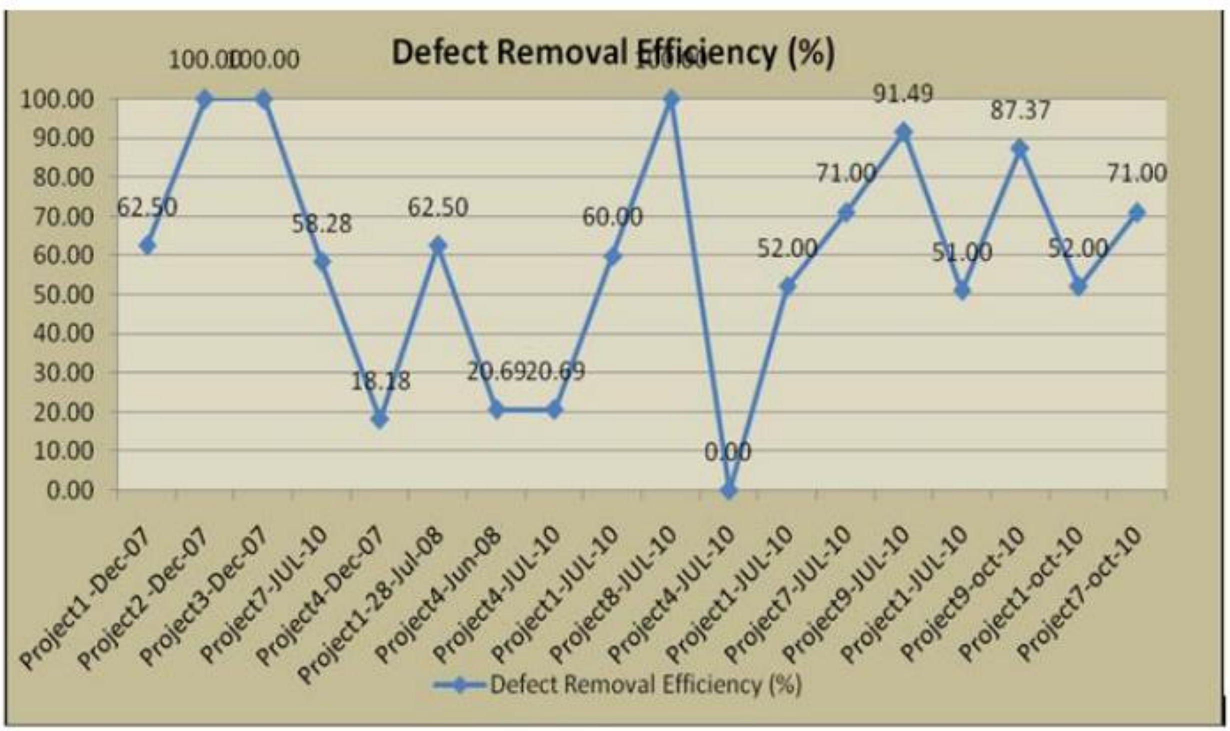

Figure 13: Compare Defect Removal Efficiency

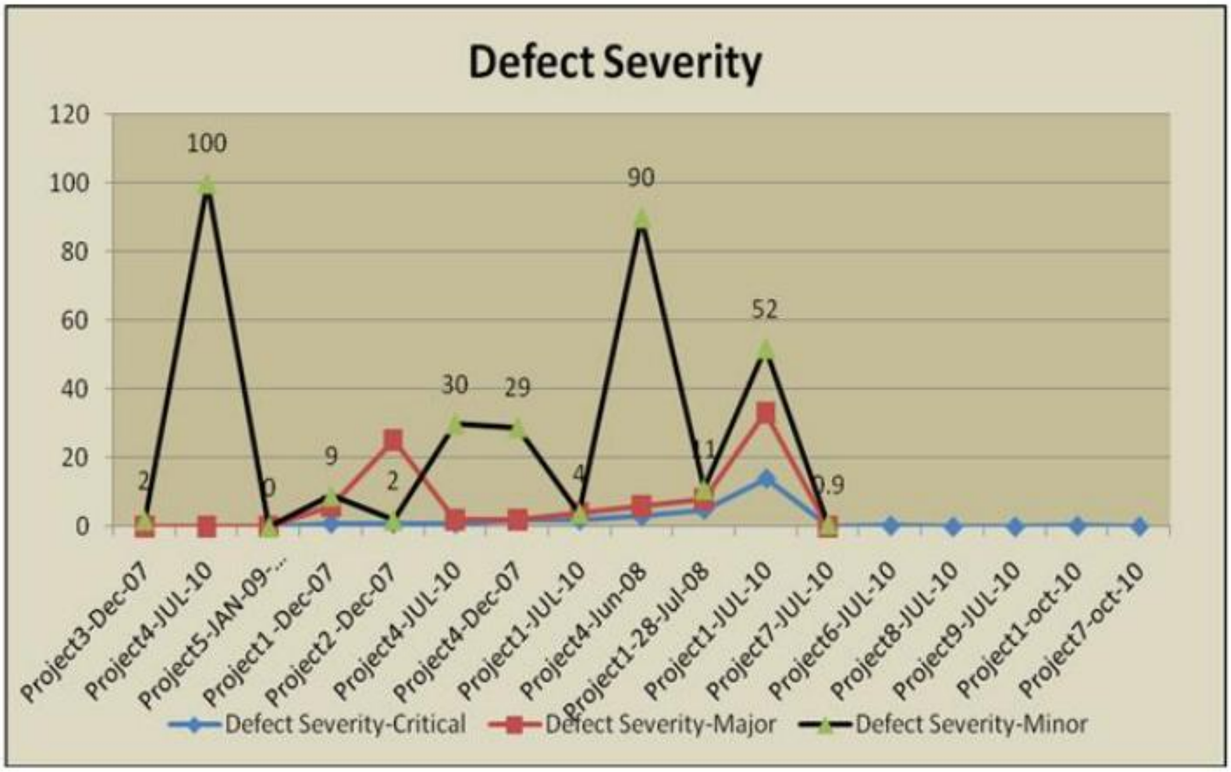

Figure 14: Compare Defect Severity

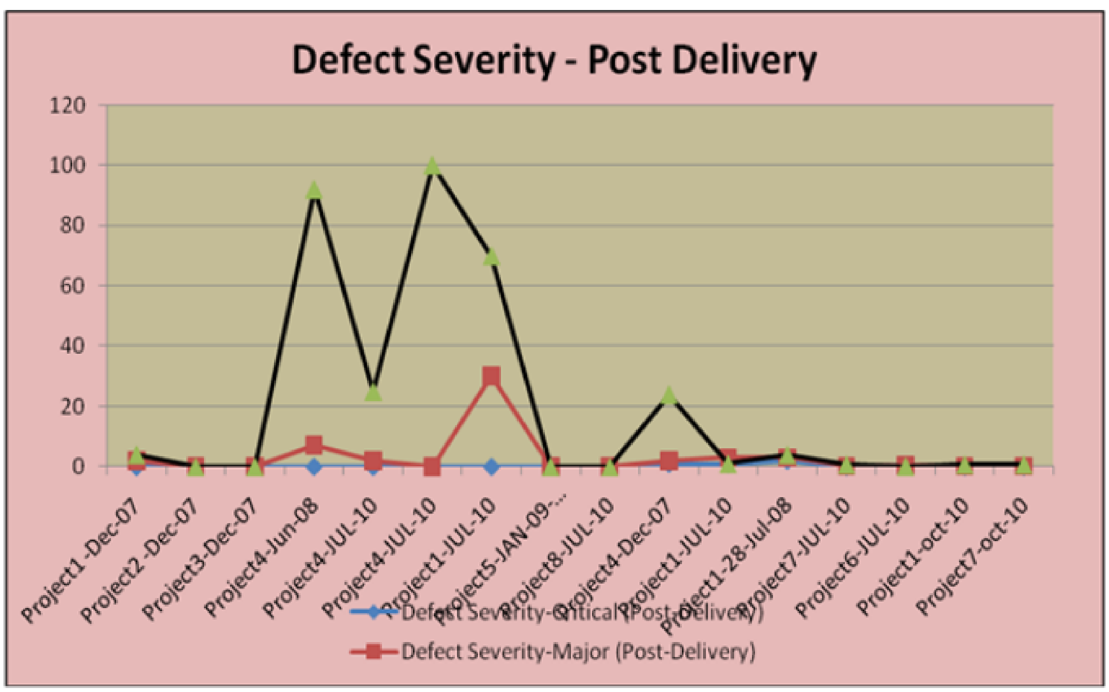

Figure 15: Compare Defect Severity – Post Delivery

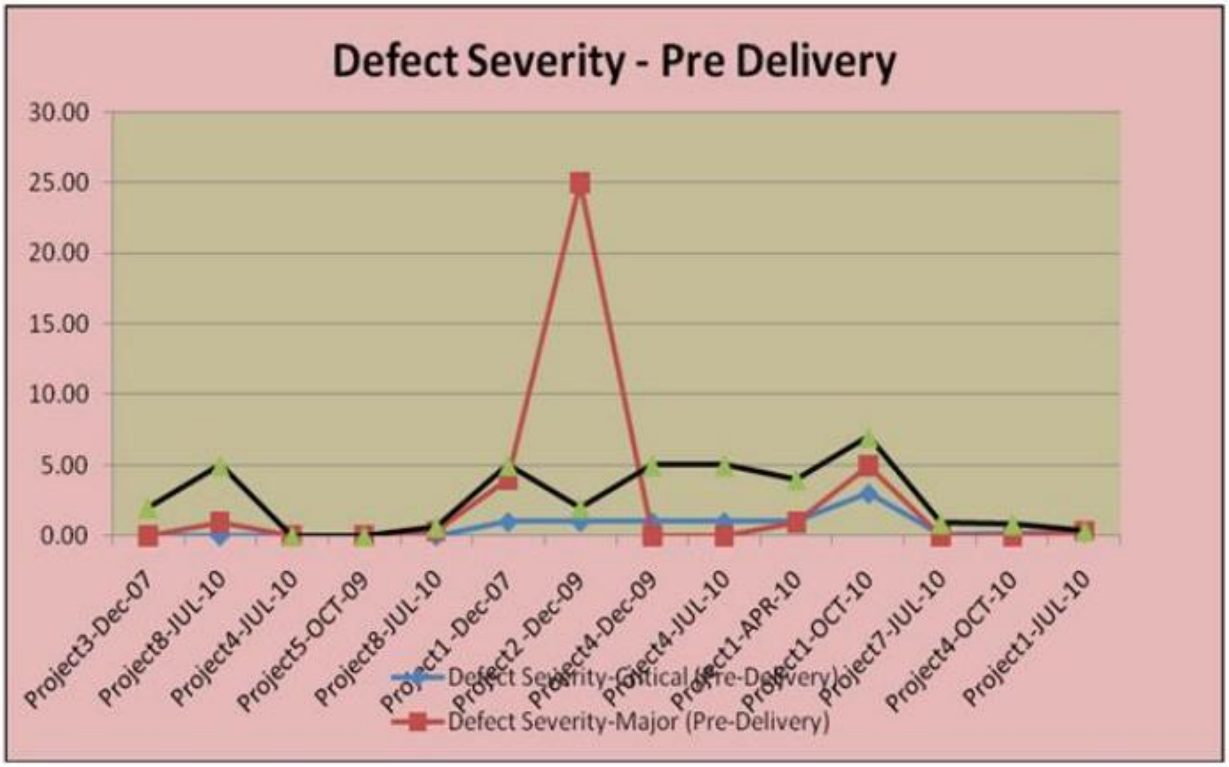

Figure 16: Compare Defect Severity – Pre Delivery

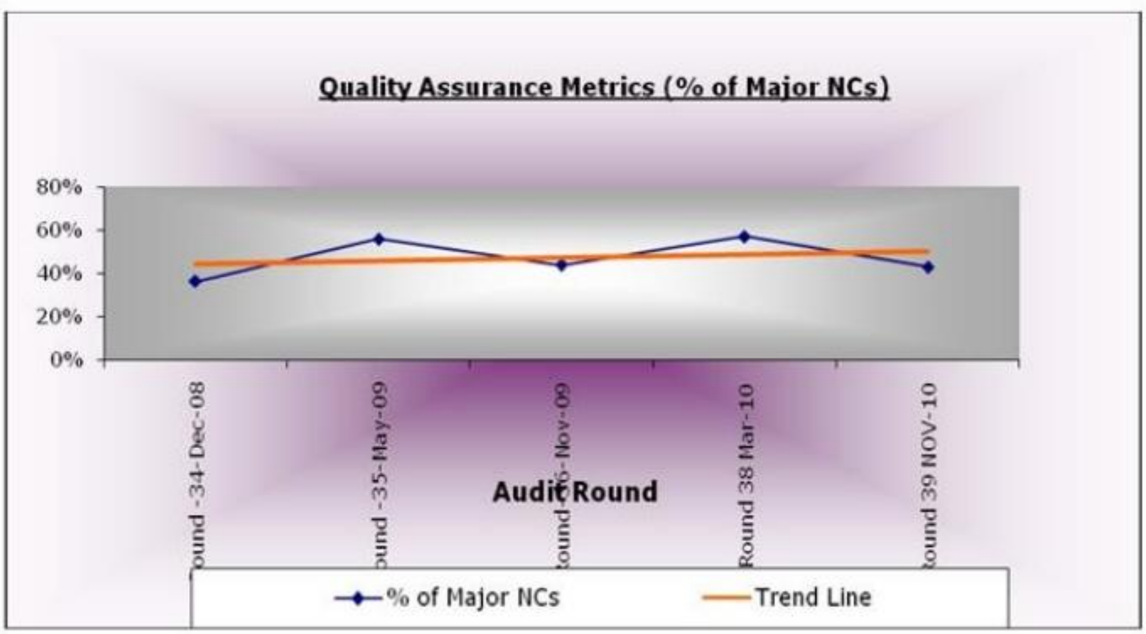

Figure 17: Quality Assurance Metrics for different quarters

Analysis of Data

The goal of this Journal was to analyze current and future trends of the allied management disciplines that influence project management. We asked project managers, team members and different stake-holders about the availability of knowledge and the potential impact of allied disciplines on project management. We were able to assess where the allied disciplines currently stand in terms of availability and impact as well as make predictions about the future. The thoughts and visions collected from this research provide valuable insights for identifying trends in the allied disciplines and their impact on the future of project management, as well as opportunities, challenges, and obstacles.

Mainly different types of risks, metrics data related to effort, schedule, and different types of defects are analyzed to understand the performance of the project and try to find out the areas of improvement.

- A lack of standardization has been clearly understood to be existing in the project oriented organizations, which can be critical in time of perfect competitive scenario.

- Furthermore, the target being drawn by a typical project management team is often arbitrary (as no well defined industry guidelines could be identified in this context). This often creates to misunderstanding among the various project teams resulting in higher chances of time over-run.

- There is no serious effort to eradicate the “root causes”. Though the teams are found to be hundred percent concerned about the efficacy of the end result (deliverables) but none are serious about the “defects” which are resultant by product.

- No standard risk registers/metric registers are available for different types of projects executed in the organization (as observed).

- Technological limitation (state-of-the-art) has been found to be existing within the organization which happens to be a problem in itself.

7.0 Conclusion & Recommendation

This Project clubbed with the field research provided a list of best practices/standards that can help improve in the success of a **software development project**. By following these best practices, IT-Industries have a better chance of completing their project successfully. All the managers' have to know the recent trends in the project management in order to apply them to his problem solving methodology. The focus should be to understand and follow these trends to tackle similar IT product development problem today and tomorrow.

Recommendation for further improvements

- **Take actions on findings**

Root causes are identified for each and every defect but there is no evidence to rectify them. If Causal Analysis and Resolution [CMMI ML5 process] can be followed to identify causes of defects and other problems and take action to prevent them from occurring in the future, then the project can be managed even in better way to make it ultimate success.

Here, Fish bone diagram can be used to find out the direction of exact root cause with cause & effect analysis by a brain storming session.

- **Availability of standard registers**

At present there is no standard risk register/metric list available for different types of projects executed in the organization. In most of the cases, Project managers are confused during selection of different risks/metrics for their project to measure the performance of different activities. So, brain storming session is must and a pre-requisite activity once a new project is started in the organization.

- **Budget must be directly linked with effort**

There is no link of budget with estimated effort (in the above mentioned research data parametric). Hence, it has been observed that effort and budget were having a clear and logical gap. To take this into concern the above mentioned process needs to be given a relook and thought. Both 95 are maintained separately. If any effort variance occurred during execution of the project, there is no proper visibility of profit/loss to the Sr. management.

MS-Project can be used to do this activity.

- **Go for CMMI Level 5 implementation**

The organization is certified for CMMI Level 3. There are some important processes & key practices available in CMMI Level 5 which can be used in all projects of the organization to control & monitor them in better way.

- **Synchronize Organization Goal with Industry Goal**

There is no proper visibility of setting organization goal for each & every metrics with the goal setting by similar kind of industry. It would not be a case of over statement or mollified statement to state that the industry benchmark is clearly elusive so far as this research is concerned. The industry benchmark not being available had to be clearly ignored which might create some variable differences with that of the organization goal as well as industry goal. Therefore, it should be synchronized with other industries in equal aspect. In some cases project goal as well as organizational are not yet set.

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Firstly,

I would like to thank the organization for giving me the opportunity to do this project. I would like to thank all the project managers and other colleagues of the organization for their contribution to complete this project successfully.

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BIBLIOGRAPHY

Basic Coverage

1.The Fast Forward MBA in Project Management.
2. CMMI® for Development, Version 1.2 – SEI(Carnegie Mellon University) 96
3. Quality Manual – QMS of the Organization.
4. Project Management Body of Knowledge – Third Edition Version 1.2, PMI, USA.
5. Research Methodology, Theory & Practice.
6. Making Things Happen: Mastering management.
7. Strategic Project Management Made Simple – Practical Tools for Leaders and Teams

Websites

1.https://balancedscorecard.org/Shop/Product-Details/ProductID/1
2.www.goodreads.com/shelf/show/strategic-management
3.http://www.envisionsoftware.com/articles/Root_Cause_Analysis.html
4. http://www.ibm.com/developerworks/websphere/library/techarticles/030
6_perks/perks2.html